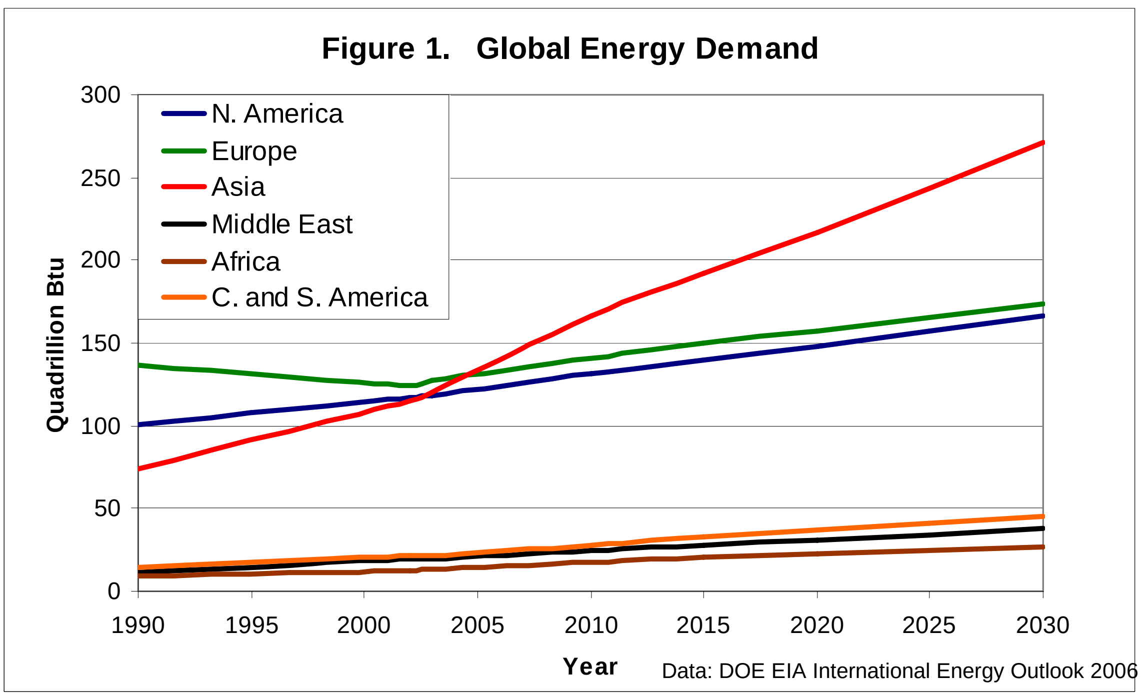
Energy Projections 2006 – 2030
Price and Policy Considerations

Dr. Randy Hudson
Oak Ridge National Laboratory

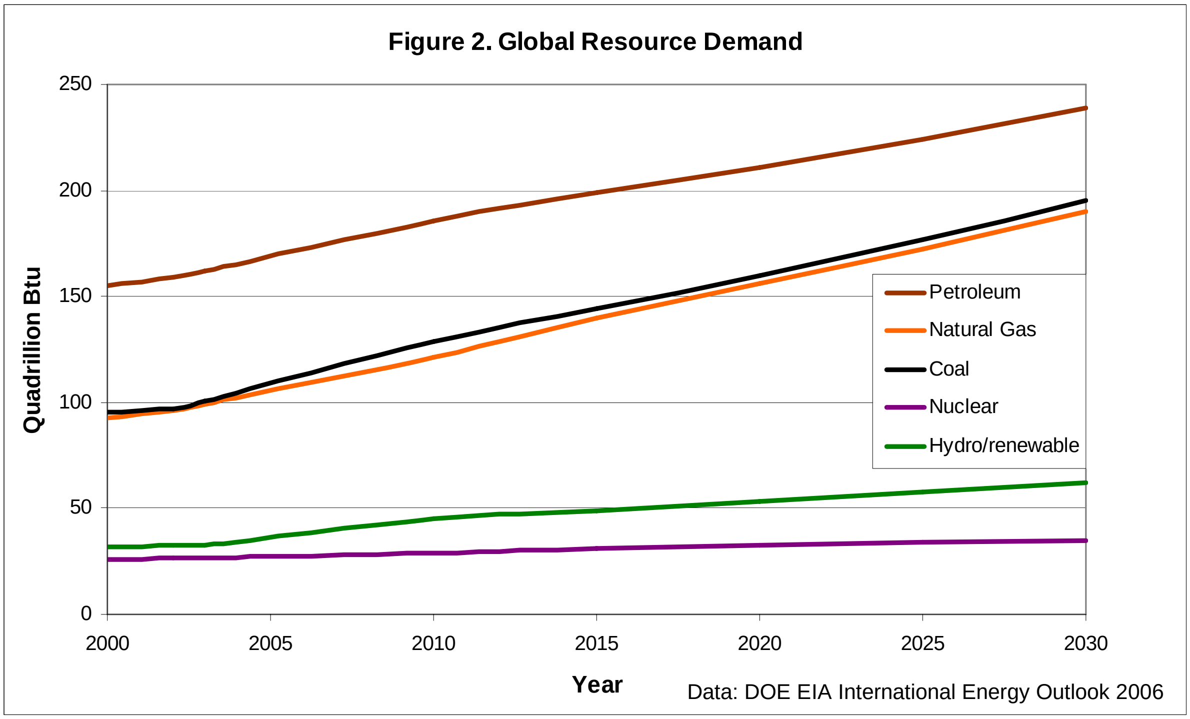
There is perhaps no single current topic so potentially impacting to all life on this planet as energy usage. Continuing economic growth in developed countries and rapid expansion of the economies in large developing countries are creating resource and environmental stresses that will be very challenging to resolve. As part of the support to The University of Tennessee in their preparation of their Campus Energy Plan, this paper will review global and domestic energy resource consumption projections through the year 2030. The impact of energy use on prices, emissions, and potential government policies will also be discussed.

Energy Demand

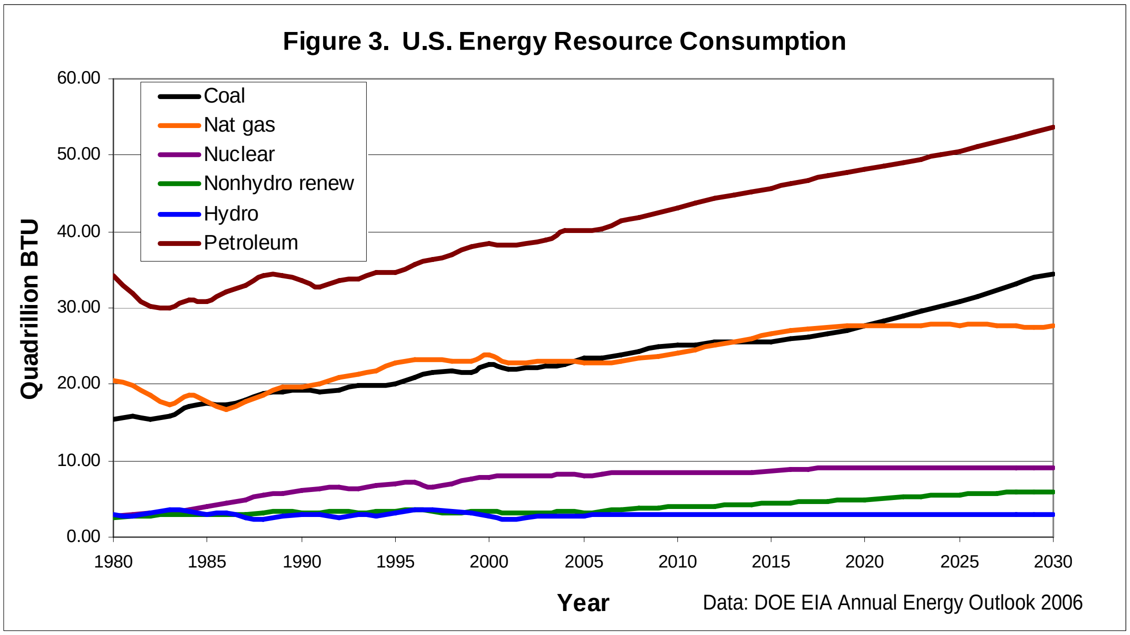
Over the next 25 years, the overall global demand for energy is expected to grow at an average rate of 2%/year. As shown in Figure 1, major growth in the economies of Asia, particularly in China and India, will drive their energy use to the highest of any region, with over a 3% annual growth rate.



Recent projections by the U.S. Department of Energy, Energy Information Administration (EIA),[1,2] indicate that 86 percent of this global demand will be met by fossil fuels (i.e., petroleum, natural gas, and coal). As indicated in Figure 2, the greatest increase in resource utilization will be for coal and natural gas at 2.4 %/year. Petroleum, while in greatest demand, will have an average demand growth rate of 1.4%/year. Hydro and renewable resources also are projected to have a 2.4%/year growth rate, but with much smaller absolute contributions. Nuclear power is expected to grow during the period at 1%/year.

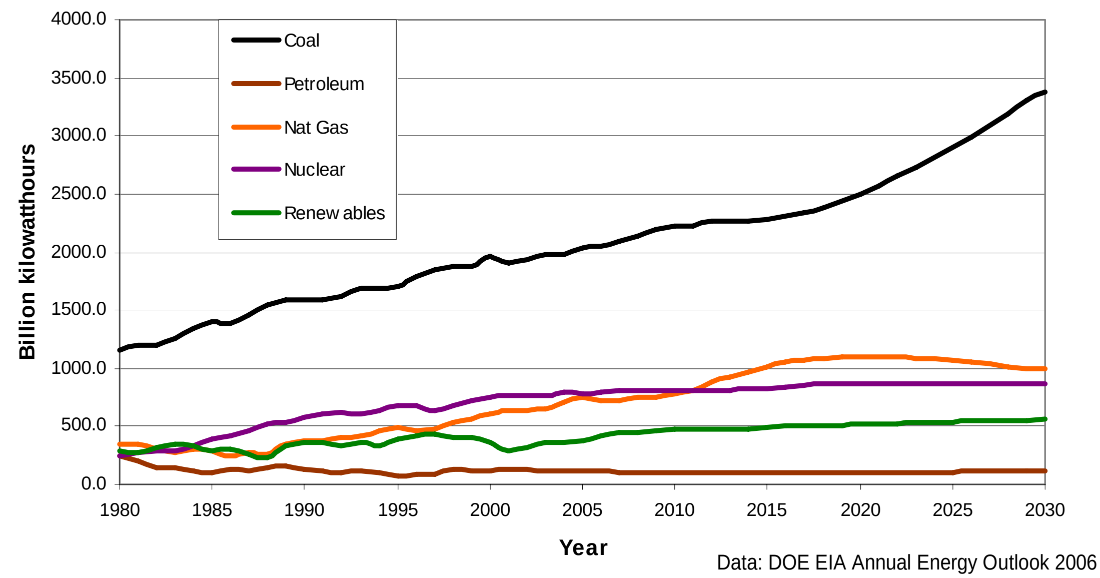


Domestically, energy resource consumption follows a similar pattern (Figure 3). It should be noted that these projections by EIA reflect no major policy shifts or new regulations beyond that currently in-place. As such, these values represent a "business as usual" scenario with no assumptions regarding future legislation or regulations.



In the production of electricity, which consumes 40 percent of U.S. primary energy, coal is projected to be the dominant primary energy resource (Figure 4), producing more electricity than all other resources combined.

Figure 4. U.S. Electricity Generation by Fuel Source



Unit Energy Prices

Regarding future unit prices for various energy resources, classic supply and demand pressures will heavily influence prices. As shown in Figure 2, the high global demand for petroleum, coupled with constrained sources of supply, will cause price escalation of crude oil and related petroleum products. EIA's base case forecast for crude oil assumes that additional supplies of oil will enter the market to reduce price pressure. Given the current price of crude oil and the uncertainties in the Middle East, this paper has included the EIA high oil price scenario to illustrate the range of unit prices that might occur for various crude oil prices. The high price scenario assumes less easily recoverable resources and production restrictions that force prices higher. As shown in Figure 5, the current price of crude oil is well above EIA's projections. The impact of crude oil prices will be most directly reflected in products that are made from crude oil, such as in the average delivered price of gasoline, shown in Figure 6.

Similar supply and demand behavior is shown in the projections of natural gas prices in Figure 7. As a result of the development of new natural gas supplies and slower growth in consumption, natural gas prices decline through 2016. After 2016, as the cost of developing the remaining U.S. natural gas resource base increases, natural gas prices increase. The high price case assumes that the unproven domestic natural gas resource base is 15 percent lower than the estimates used in the base case.

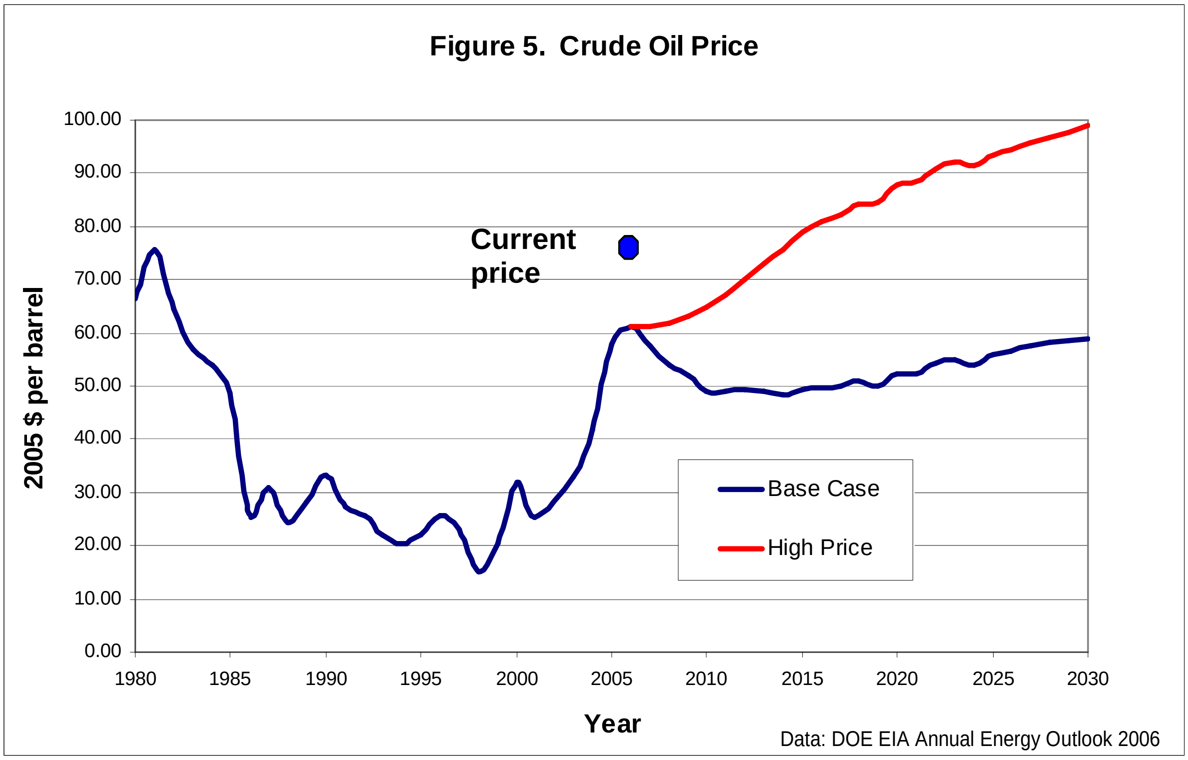


Figure 5. Crude Oil Price
2005 $ per barrel
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Current price
Base Case
High Price
Data: DOE EIA Annual Energy Outlook 2006

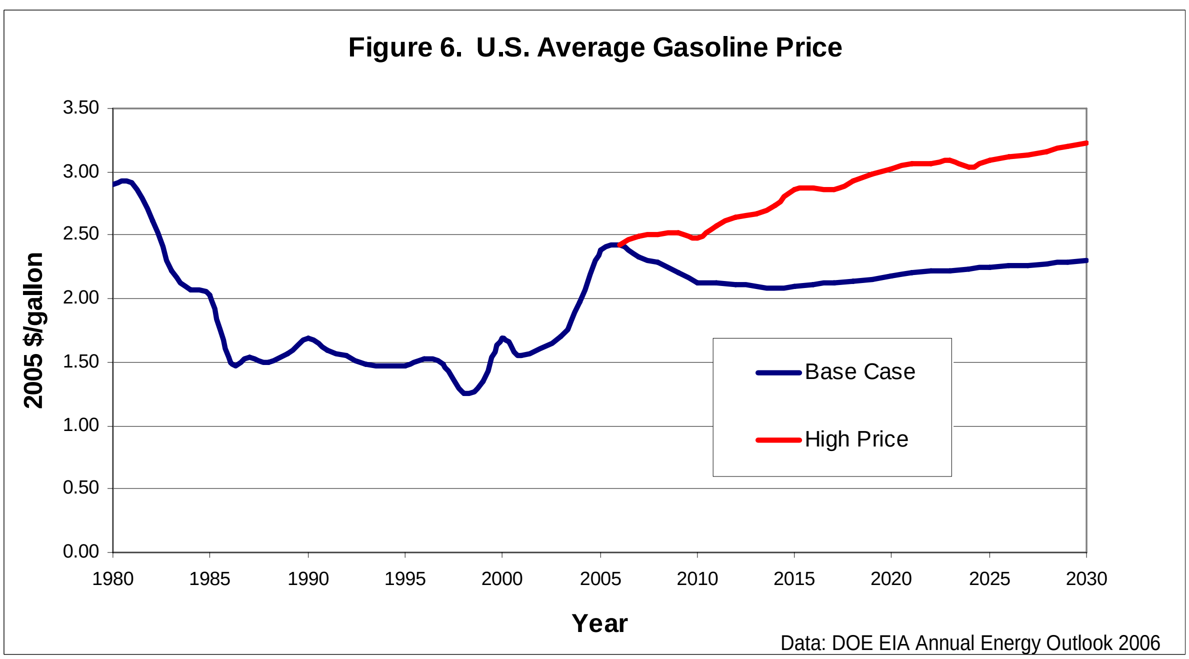
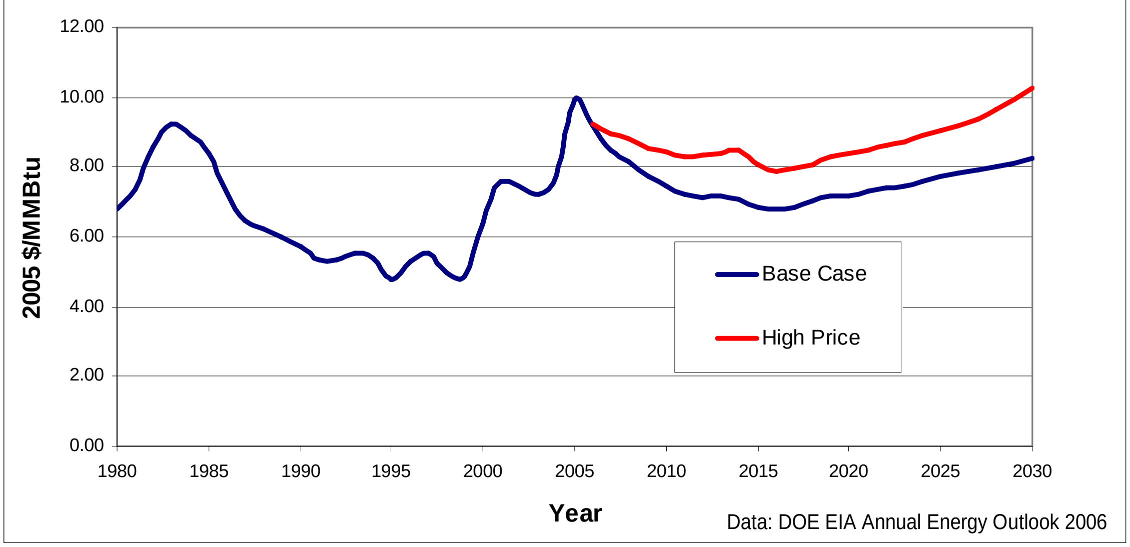


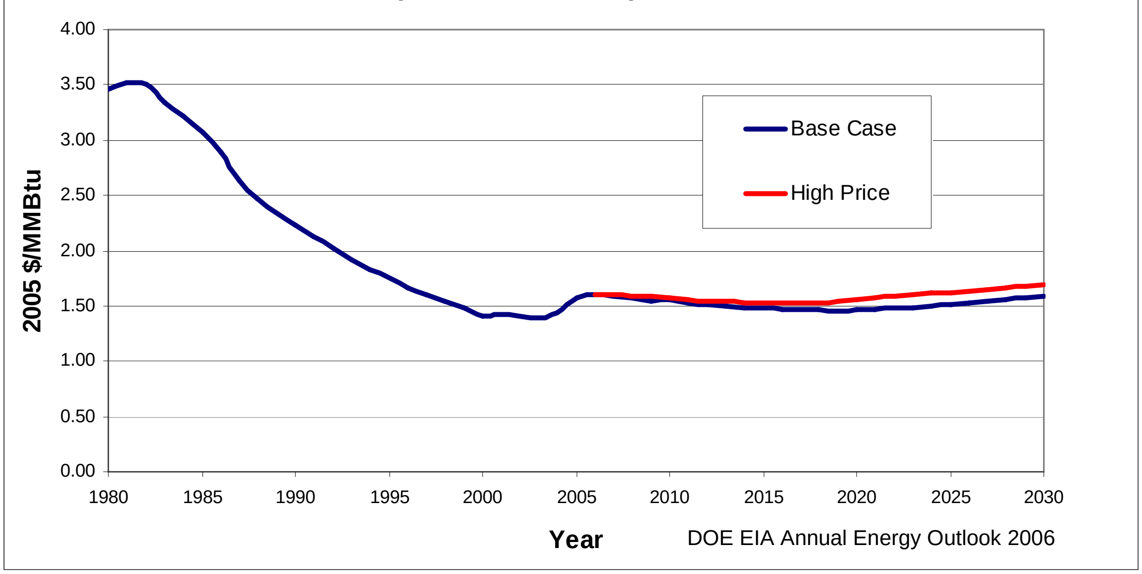
Figure 6. U.S. Average Gasoline Price
2005 $/gallon
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Base Case
High Price
Data: DOE EIA Annual Energy Outlook 2006

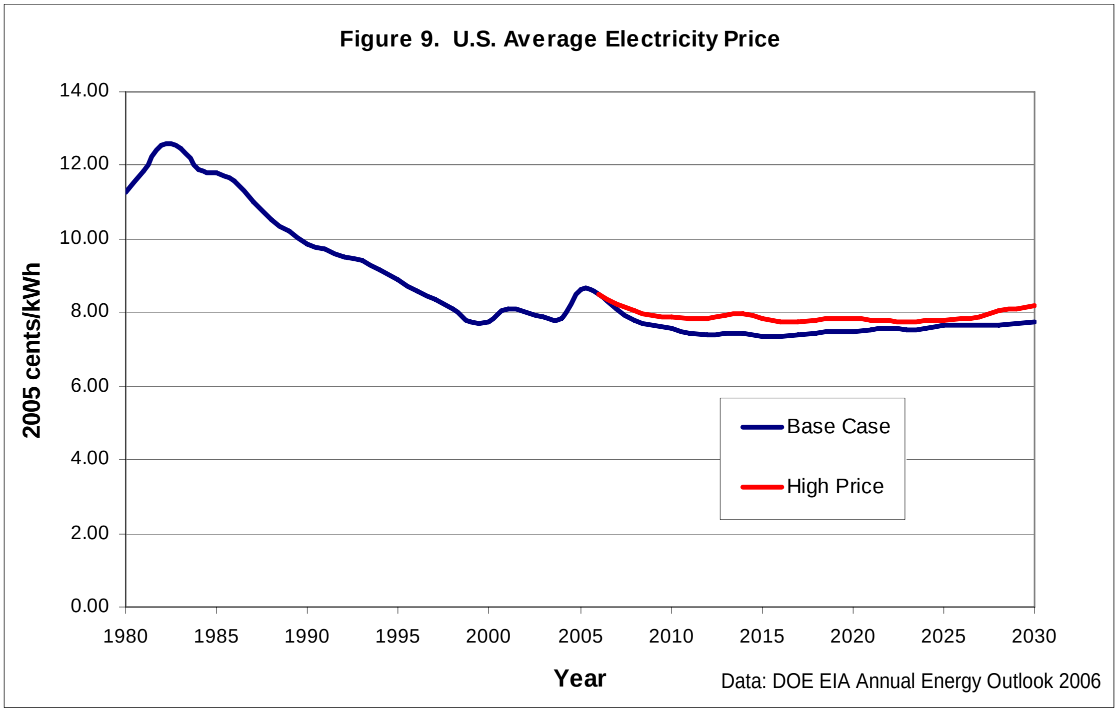
Figure 7. U.S. Average Natural Gas Price



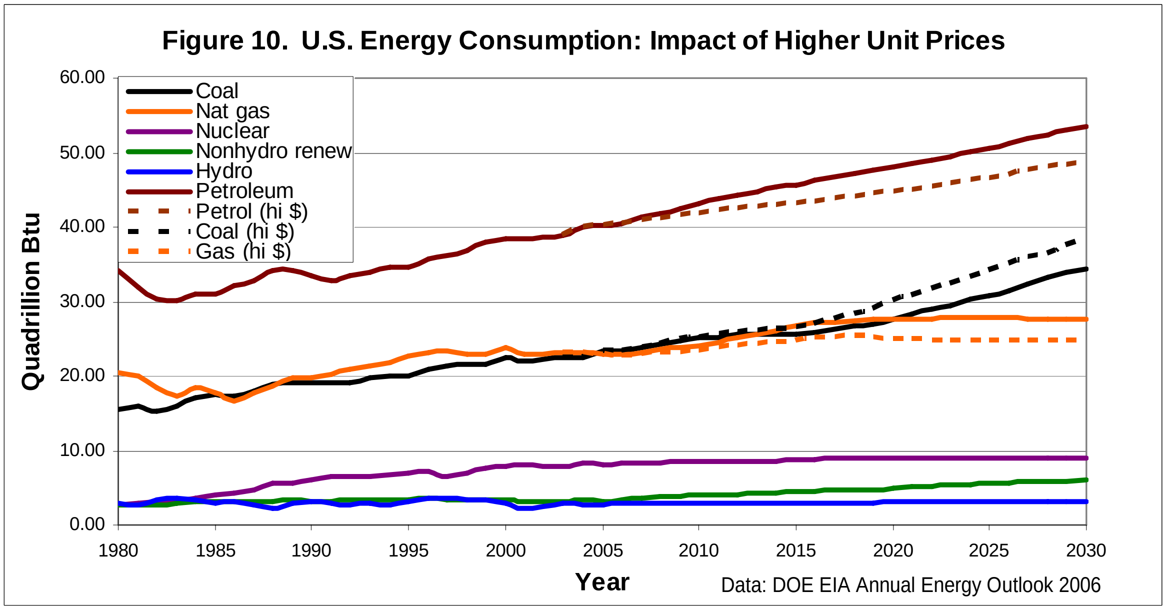
As shown in Figure 8, the average delivered price of coal is projected to be stable over the next 25 years. This is due primarily to the fact that the U.S. has the world's largest supply of recoverable coal reserves (270 billion tons). Given the high fraction of coal used in the generation of electricity, corresponding prices of electricity are expected to be stable as well (Figure 9). As mentioned previously, it is important to bear in mind that these projections do not reflect the impact of future regulations or requirements related to emissions, for example, beyond those currently in-place. For instance, the capital costs for coal-fired plants with carbon capture and sequestration equipment, while uncertain at this time, are expected to be much higher than those for conventional coal-fired plants, and their fuel conversion efficiencies are expected to be lower. New emission reduction requirements may have a notable impact on the price of electricity, as well as on the resource mix used to generate electricity.

Figure 8. U.S. Average Coal Price





Given the range in unit prices between the base case and the high price scenario, particularly for petroleum, it is worthwhile to observe the changes in U.S. energy demand due to the price differences. As shown in Figure 10, higher petroleum and natural gas prices produce expected declines in use of those resource streams, but the natural gas price increase tends to shift an equal resource demand onto coal, particularly for electricity generation. Overall, the net change in total U.S. energy use resulting from higher unit prices is rather small, indicating low price-demand elasticity for energy in this country.



Energy Policy Considerations

The most important U.S. legislation on energy in many years, the Energy Policy Act of 2005 (EPAct), was signed into law on August 8, 2005 after four years of wrangling and debate. The primary concern driving the Act is the desire that the United States have assured domestic fuel and energy supplies in the future. Contained within the 1,724 pages are eighteen sections and hundreds of provisions addressing a wide range of energy topics. The Act authorizes numerous studies, programs, and tax credits related to both energy supply (e.g.., oil, gas, coal, nuclear, renewables, electricity, hydrogen) and demand (e.g., energy efficiency). Some of the energy efficiency provisions include energy reduction goals and performance requirements for federal facilities and public housing, energy efficiency standards for residential and commercial products, and tax credits for energy efficient homes and commercial building properties.

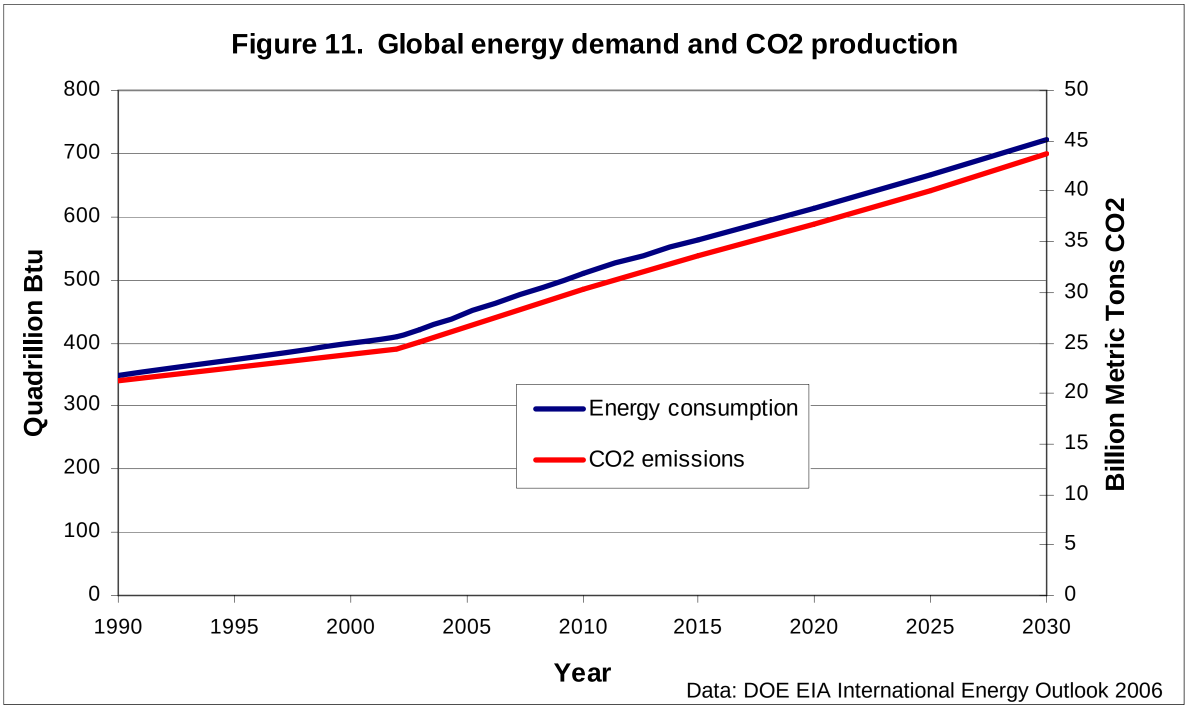
The majority of provisions in the Act relate to enhancing energy supplies through creation of federal programs and tax benefits. Some of the key supply-side provisions include:

- Increased support for renewable energy resources (e.g., solar, wind, hydro, biomass, geothermal)
- Incentives for exploration, development, production, and transportation of domestic oil and natural gas
- New programs for greater use of coal (e.g., Clean Coal Power Initiative)
- Authorization for the Next Generation Nuclear Plant Project
- Tax credits and financial guarantees for new commercial nuclear power facilities
- Creation of an Electric Reliability Organization for the electric transmission system
- Development of additional electric transmission capabilities (including use of eminent-domain powers)
- Development of technologies for the production, distribution, storage, and use of hydrogen energy and fuel cells.

EPAct also included a section on climate change which requires the administration to establish a committee on climate change technology; to establish a Climate Change Technology Program to coordinate federal R&D on greenhouse gas (GHG) intensity reducing technologies; and to provide financial and technical assistance to developing countries to reduce greenhouse gas intensity in their countries.

There were several energy-related matters that were not included in the final version of the Act. EPAct did not increase auto fuel efficiency (CAFE) standards, establish a renewable portfolio standard, or set any type of greenhouse gas emission limits. It is also important to note that while the Act *authorized* a number of new programs and activities, it did not *appropriate* the funds to actually implement the activities. Appropriation of funds for EPAct activities must come from future budget appropriations by the Congress.

So what is likely to follow EPAct? Perhaps a better question is what is likely to be the biggest issue affecting long-term energy policy? This author and a growing number of others feel it is global warming. As shown in Figure 2, under the current course, 86 percent of global energy will be supplied by fossil fuels. It should come as no surprise that projected carbon dioxide emissions follow in lock-step with world energy consumption (Figure 11), increasing at a compound rate of 2%/year. With current regulations, global CO_2 emissions in 2030 will be 75% higher than 2003 levels.



One subtle, but very important, distinction in current U.S. policy toward GHG emissions is the characterization of controlling greenhouse gas emission *intensities*. GHG intensity is defined as "the ratio of greenhouse gas emissions to economic output", [3] such as metric tons of CO_2 per $million of gross domestic product (GDP). Thus, as shown in Figure 12, if economic output is increasing at a rate faster than the increase in absolute emissions, as is the case in current projections, then the claim can be made that emission *intensities* are decreasing. Unfortunately, this masks the true nature of the impact of GHG emissions on the environment. When the same projection is expressed on an absolute scale (e.g., metric tons of CO_2 emitted per year) as in Figure 13, a very different picture emerges. Here we see that the amount of CO_2 released into the environment is projected to increase by 40% from 2003 levels. Figure 13 also provides a valuable insight into how far and fast we are departing from the Kyoto Protocol's target for the United States of 7% below 1990 emission levels.

While GHG regulation based on emission intensity limits can produce meaningful, absolute reductions in GHG[4], the rate of reduction of the intensity limit through time must be greater than the rate of increase in economic output in order for there to be an absolute decrease in emissions. In lieu of the Kyoto target, the current administration has a goal of reducing emission *intensities* by 18% of 2002 levels by 2012.[2] This goal represents a rate of intensity decrease of 1.7%/year. With current GDP growth projections of 3%/year, absolute GHG emissions will actually increase by 14% during this period. Clearly, if actual GHG emissions are to be reduced, more stringent limits will be needed.

Reducing GHG emissions will require political fortitude in the face of opposition from affected interests. Last year, the U.S. Senate rejected a measure calling for mandatory limits on GHG emissions. Opponents said the legislation would be too costly for businesses and would force manufacturers to move operations and jobs overseas.[5] In June of this year, the German cabinet decided to not require the German coal industry to participate in the European Union's carbon trading program, under which companies must buy permits before they can release higher-than-mandated levels of carbon dioxide into the atmosphere.[6]

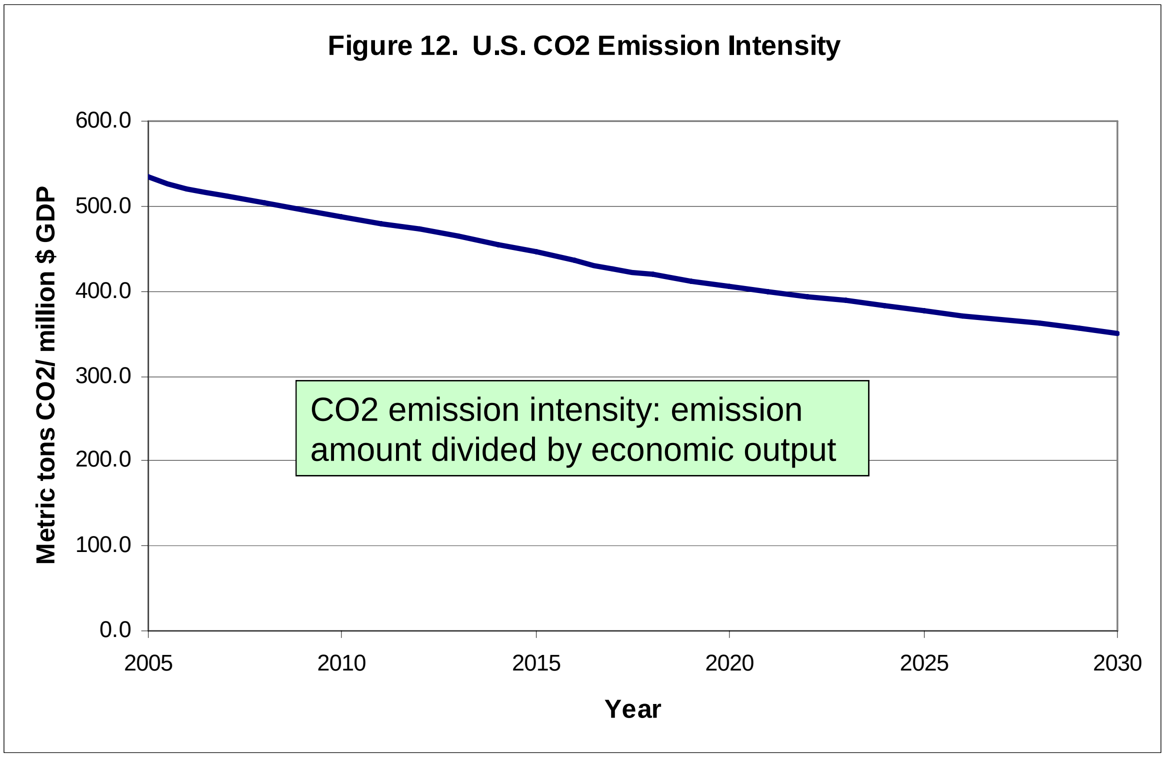


Figure 12. U.S. CO2 Emission Intensity
Metric tons CO2/ million $ GDP
600.0
500.0
400.0
300.0
200.0
100.0
0.0
2005
2010
2015
2020
2025
2030
Year
CO2 emission intensity: emission amount divided by economic output

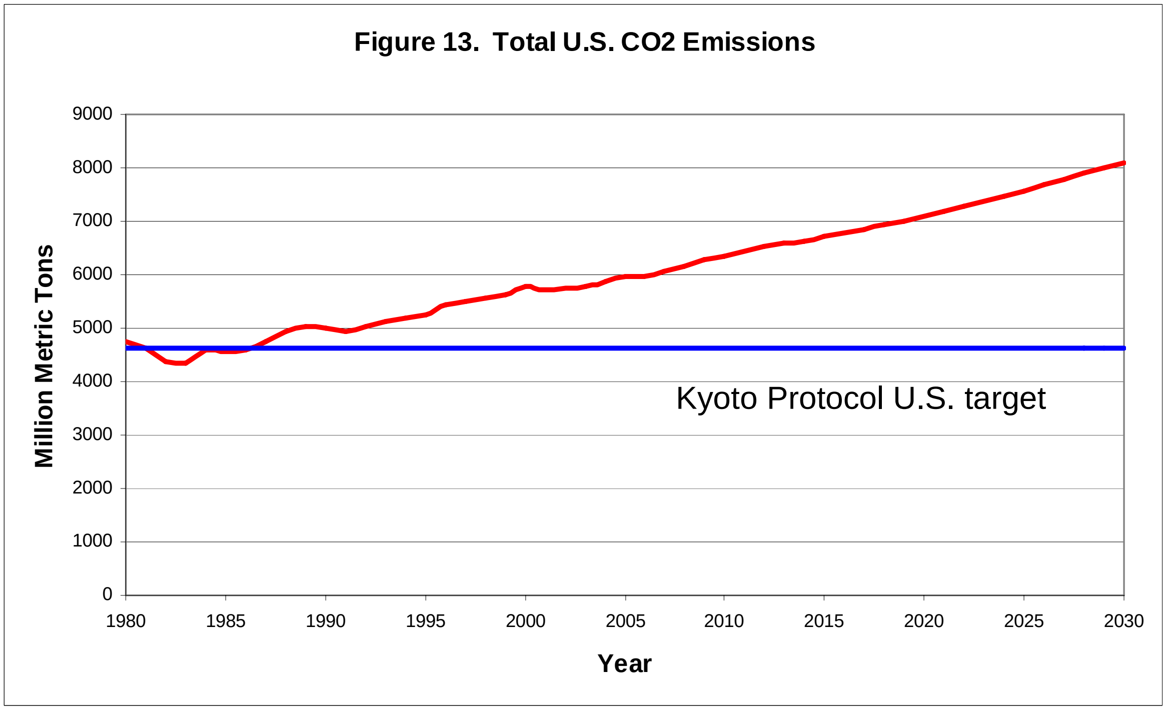


Figure 13. Total U.S. CO2 Emissions
Million Metric Tons
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Kyoto Protocol U.S. target

A recent study on scenarios to reduce GHG emissions by the International Energy Agency[7] stated the following:

> It will take a huge and coordinated international effort to achieve the [emission reduction] results…Public and private support will be essential. Unprecedented cooperation will be needed between the developed and developing nations, and between industry and government. The task is urgent… The effort will take decades to complete, and it will require significant investments.

Successful reduction of greenhouse gas emissions will not be accomplished with one technology or in one sector. It will require a portfolio of solutions including:

- Increased energy efficiency in buildings, industry, and transportation
- Increased reliance on nuclear power and renewables for electricity
- Increased use of natural gas and biofuels
- CO2 emission reduction incentives (e.g., regulation, taxes, trading schemes)
- CO2 capture and storage
- Development of the hydrogen economy.

There are substantial challenges to GHG reduction, however. Some technical solutions may be difficult and/or expensive to implement (e.g., power plant carbon capture and sequestration). A mechanism to equitably share the costs of emission reductions has yet to be decided. For developing countries, questions of sovereign rights and international inequities on limits may complicate progress. Some potential solutions will require greater public acceptance (e.g., nuclear power), and overall, success will require strong political will.

With respect to The University of Tennessee and its development of a Campus Energy Plan, the following guidance is offered:

- Continue to be good environmental stewards
    - Improve building energy efficiencies
    - Reduce campus energy consumption
    - Reduce GHG contributions
- Engage in relevant research
    - Public policy and urban design
    - Carbon capture and sequestration
    - R&D in non-carbon energy resources
    - GHG measuring and monitoring.

No one individual or entity can solve the crisis of global warming, but equally can no one individual or entity not be a part of the solution.

[1] Energy Information Administration, *International Energy Outlook 2006*, DOE/EIA-0484, June 2006.
[2] Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383, February 2006.
[3] Energy Policy Act of 2005, 109th Congress, July 2005.
[4] Ellerman, A. Denny, Ian Sue Wing, *Absolute vs. Intensity-Based Emission Caps*, MIT Joint Program on the Science and Policy of Global Change, Report No. 100, July 2003.
[5] Blum, J., *Senate Rejects Greenhouse Gas Limits*, Washington Post, June 23, 2005.
[6] Dempsey, J., *New German Rule Could Increase Greenhouse Gas Emissions,* New York Times, June 29, 2006.
[7] International Energy Agency, *Energy Technology Perspectives 2006 – Scenarios & Strategies to 2050*, 2006.