Assessing U.S. energy policy

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Comment by Marilyn A. Brown,
Benjamin K. Sovacool & Richard F. Hirsh

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For decades, our political leaders have told us that we need to use energy more efficiently and derive more of it from domestic sources.[1] Since the energy crisis of 1973, U.S. presidents have declared the need to gain independence from unstable foreign energy suppliers and to do so with the same moral fortitude as if fighting a war. Some politicians have proposed massive government programs to achieve the goals of their energy policies; others have sought to unleash free-market forces that would encourage companies to develop novel sources of energy and motivate consumers to use energy more wisely.

Despite more than three decades of such efforts, the United States has not achieved the goal of energy independence. While progress in adopting more energy-efficient technologies has saved billions of dollars throughout the economy, most other indicators of energy autonomy – such as the percentage of imported fuel – demonstrate that the country has become less independent than ever. President Bush acknowledged this fact in his recent State of the Union address, telling Americans that the country has become "addicted to oil" and urging citizens to find alternative ways to satisfy their energy needs. For those with a sense of history, Bush's clarion call sounded eerily familiar.

Even though energy efficiency has taken root in some sectors of the economy,

Marilyn A. Brown is interim director of Oak Ridge National Laboratory's Engineering Science and Technology Division. An expert on the commercialization of new energy and environmental technologies and the evaluation of government programs and policies, she has authored more than 140 publications.

Benjamin K. Sovacool is a Eugene P. Wigner Postdoctoral Fellow at the Oak Ridge National Laboratory. Through the National Science Foundation's Electric Power Networks Efficiency and Security Program, he has investigated the social impediments to distributed and renewable energy systems.

Richard F. Hirsh is professor of History and Science & Technology Studies at Virginia Polytechnic Institute and State University. The author of "Technology and Transformation in the American Electric Utility Industry" (1989) and "Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System" (1999), he currently manages Virginia Tech's Consortium on Energy Restructuring.

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it has not compensated for the growth in energy consumption that has occurred since 1973, nor will it (if current trends continue) accommodate the growth that forecasters anticipate in coming decades. Moreover, America's dependence on oil from insecure or politically unstable countries has required extensive diplomatic and military efforts that incur huge costs borne by energy users and taxpayers. Today's information economy also remains inextricably tied to reliable power and to just-in-time manufacturing and distribution processes that depend on fleets of petroleum-guzzling trucks and airplanes.

Disruptions in increasingly fragile energy systems can cause havoc to the nation's economy and to everyday life. We have already had a taste of such disruptions in the form of the California electricity crisis of 2000 to 2001, the 2003 Northeast blackout, and the fuel-supply interruptions resulting from the Gulf Coast hurricanes in 2005. These disruptions may be trivial preludes to what could be more substantial future catastrophes. Indeed, the country faces at least five immense and interconnected energy challenges due to (1) the risk of oil-supply disruptions; (2) increasing electricity usage; (3) a fragile electric-power (and overall energy) infrastructure; (4) the lack of sustained efforts to push energy-efficiency practices; and (5) the growing environmental impacts of increasing energy consumption.

First, the United States remains vulnerable to the risk of oil-supply disruptions, despite plenty of warnings over the past three decades. In 1973 the Arab members of the Organization of Petroleum Exporting Countries (OPEC) orchestrated an oil embargo, the first supply disruption to cause major price increases and a worldwide energy crisis. In unadjusted terms, the price of oil on world markets rose from $2.90 per barrel in September 1973 to $11.65 per barrel in December 1973. Further price hikes and economic repercussions accompanied the Iranian revolution in 1979. Eleven years later – in 1990 – when Iraqi forces invaded Kuwait, OPEC controlled roughly 5.5 million barrels per day (MBD) of spare capacity, enough to replace the oil from the combatant countries and to supply about 8 percent of global demand. Even so, the elimination of Iraqi and Kuwaiti shipments contributed to oil prices jumping from around $21.50 per barrel in January 1991 to $28.30 in February 1991.

In 2005, OPEC's spare production capacity stood at only 2 percent of world demand, with roughly 90 percent of this spare capacity located in Saudi Arabia. The rapidly growing demand for oil by China and India to fuel their expanding economies has placed unprecedented pressure on the world supply of oil, leading to recent prices of crude oil at $70 per barrel and higher. Because spare production capacity is both extremely limited and concentrated in one volatile region, world oil markets remain vulnerable to short-term disruptions. This situation will not likely improve since almost half of the world's proven reserves of conventional oil are in Saudi Arabia, Iraq, and Iran.

The United States remains more susceptible today to oil-supply disruptions and price spikes than at any time in the recent past. It has grown to become the world's largest oil consumer by a considerable margin while its domestic oil production has rapidly diminished. Oil imports have filled the expanding gap and accounted for 58 percent of total U.S. oil consumption in 2005 – up from 22 percent in 1970.

To obtain a sense of the consequences of a disruption in a constrained world oil market, the National Commission on Energy Policy, a bipartisan group of sixteen leading energy experts, simulated an 'oil-supply shockwave' in 2005. Unrest in oil-producing Nigeria, an attack on an Alaskan oil facility, and the emergency evacuation of foreign nationals from Saudi Arabia precipitated the imagined shockwave, which removed three MBD from the world's market of oil. As result of these events, the price of gasoline in the United States rose to $5.75 per gallon, two million Americans lost their jobs, and the consumer price index jumped 13 percent. Worse, panelists who participated in the study concluded that we could do nothing to avoid these impacts after the hypothetical disruptions began.

The stagnating fuel economy of cars has contributed to America's vulnerability to oil disruptions. Corporate Average Fuel Economy (CAFE) standards for cars peaked in 1985 at 27.5 miles per gallon. For the past two decades, consumer (and manufacturer) preferences for larger and more powerful autos have negated technological advances in front-wheel drive transmissions, electronic fuel injection, enhanced power-train configurations, and computer-controlled engines, which would improve gas mileage even if nothing else were changed in cars. New-vehicle fuel economy therefore remains no higher today than in 1981, but automobile weight has increased by 24 percent and horsepower has almost doubled. In addition, more cars populate the roads, and are driven more miles each year. The net result of these trends has been growing demand for oil in the transportation sector and greater imports to meet that demand.

Second, the United States continues to see increasing demand for electricity in a way that threatens its ability to produce it. The country consumed about 167 percent more electricity in 2004 than it did in 1970, with power usage growing from 25 percent of the nation's total energy use in 1970 to 40 percent in 2004. And this demand for electricity will continue to grow: the Energy Information Administration forecasted in 2005 that electricity use will increase at a rate of 1.9 percent annually through 2025. Though much lower than the 7 percent annual growth rate experienced before the 1973 energy crisis, the current rate would still require a doubling of electricity production in about thirty-seven years.

Increased demand for power in the past decade has been met almost exclusively through the use of quickly built and increasingly efficient natural-gas combustion turbines or combined-cycle equipment. Indeed, more than 150 gigawatts (GW) of gas-fired power generation have been added to the power grid between 1999 and 2004, which totaled about 1,000 GW for the nation in 2004. Despite the high price of this clean-burning gas in the last few years, its use in new power plants seems likely to increase.

But energy analysts see problems with this trend. The National Petroleum Council predicts that current North American sources will be able to satisfy only 75 percent of domestic demand for natural gas. Questions of security will likely emerge as the trend of natural-gas imports begins to emulate the increasing trend of petroleum imports. Aggravating this concern is the possibility that today's nuclear-power plants could be retired over the next fifty years as current licenses expire, depriving the nation of one of its key noncarbon energy sources and pushing up demand for natural gas if that fuel replaces nuclear energy for electricity production.

What about other sources of power? Coal's high carbon content and added cost of pollution abatement will continue to pose challenges for power providers. Clean coal technologies such as integrated gasification combined cycle and fluidized bed combustion offer policymakers a way to capture concentrated streams of carbon dioxide, but they still remain years away from commercial viability. Because of security problems related to fuel sources and waste disposal, as well as potential public opposition, new nuclear technology also cannot be counted on for widespread near-term use. And despite some impressive federal and state efforts to promote them, non-hydro renewables (such as biomass, geothermal, wind, and solar) have gained only a 2 percent share of electricity generation over the past thirty years. Reductions in the cost of power produced from renewables in this time have been impressive, making them look increasingly attractive for future use. Yet the intermittence of renewables – especially the most cost-effective wind turbines – coupled with high capital costs, a host of lingering utility-monopoly rules, and public opposition to local siting will likely prevent such technologies from taking over the bulk of the generation burden, at least in the next thirty years. Overall, it appears that meeting future demand for electricity will become an increasingly arduous undertaking.

Third, the electric-power-transmission infrastructure remains precarious and brittle, despite its increasing use. Data from the Edison Electric Institute and the Electric Power Research Institute note that utility investment in transmission peaked at almost $10 billion in 1970, but declined to an inadequate level of $2.2 billion in 1998 (in 2003 dollars). Spending grew to $3.8 billion in 2002 and $4.1 billion in 2003, though many analysts still feel more investment is necessary to transmit power to the growing wholesale and retail markets that have been created since utility-industry restructuring began in the 1990s.

But much higher spending may not be forthcoming, given that (as noted in a 2003 RAND Corporation study) incentives in the partially deregulated utility industry favor minimal investments in transmission facilities. Because federal regulators generally limit rates of return on transmission investments, companies often prefer to construct and operate new generation facilities, whose uncapped rates of return depend only on market conditions. To complicate matters more, local opposition to new power lines has grown over the years as the country has become more populated, resulting in delayed construction (or cancellation) of some transmission facilities. Taken together, these trends have resulted in a decreasingly reliable transmission network in many regions of the United States, with grid components being operated close to (or at) their technical limits.

The Energy Policy Act of 2005 includes provisions to respond to some infrastructural problems, such as incentives to increase investment in transmission lines and to simplify the planning and permitting process for building them. These measures may help, as thousands of miles of new transmission lines may be required if the electric-utility system expands along the same lines as it has for the past several decades. Increasing demand for other forms of energy in the future may also stress the country's infrastructure. Numerous new port terminals will be required to handle increased imports of liquefied natural gas and oil, for example. At the same time, new carbon-sequestration sites, bioenergy facilities, and hydrogen repositories and pipelines may be needed, especially as efforts increase to reduce environmental pollution. But these needs will not be easily met. Carbon sequestration, for example, may require use of depleted oil and gas fields, unmineable deep coal seams, or cavernous saline formations. The successful use of these geological formations will depend on techniques that resist operator and equipment failure, extreme weather, and malicious interference or attacks. Similar concerns over technical errors and assaults arise when considering the need for expansion of natural-gas and petroleum facilities. Opposition to construction of these new infrastructural elements has already become evident. Put simply, the future health of the country's energy infrastructure may be in peril.

Fourth, the country faces immense challenges in promoting more energy-efficient technologies. Before the 1973 OPEC oil embargo, U.S. energy consumption grew in lockstep with the nation's gross domestic product (GDP). Measured in terms of energy consumption per dollar of GDP, the energy intensity of the nation remained constant. Economic growth appeared to require consuming more energy.

This trend changed in the period after the 1973 energy crisis, when the economy (as measured by the inflation-adjusted GDP) grew by 148 percent (from 1973 to 2004). Total U.S. energy consumption, meanwhile, grew from about seventy-six quadrillion British Thermal Units of energy (quads) to almost one hundred quads in the same period, an increase of 32 percent. The energy intensity of the economy, in other words, dropped considerably.

What accounted for the change? Individuals purchased more fuel-efficient cars and appliances; they insulated and weatherproofed their homes; and they adjusted thermostats to reduce energy consumption. These measures led to a decrease in per capita residential energy use of 27 percent (and 37 percent per household) despite a 50 percent increase in new home size since 1970 and the growing use of air conditioning, electronic equipment, and a multitude of 'plug loads.' Businesses retrofitted their buildings with more efficient heating and cooling equipment and installed energy management and control systems, accounting for a 25 percent decline in energy use per square foot of commercial building space. Factories adopted more 'energy-stingy' manufacturing processes and employed more efficient motors for conveyors, pumps, fans, and compressors. These gains in energy productivity, prompted by high fuel costs and government policies, represent one of the great economic success stories of this century. If the nation's energy intensity remained the same today as it stood in 1970, the United States would be consuming twice as much energy, and its energy bill would be approximately $1 billion higher per day.

While such data suggest that energy-efficiency investments provide an economic and relatively rapid strategy for meeting the growing demand for energy services, many experts assert that efficiency can only play a limited policy role. For example, Hans Blix, the former director of the International Atomic Energy Agency, has argued, "The more efficient use of energy will only partially slow down the expanding use of energy. Although our light bulbs will save electricity, we shall have more lights." Similarly, Vice President Dick Cheney stated in 2001 that "conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive, energy policy." And Spencer Abraham, President Bush's Secretary of Energy from 2001 to 2005, reiterated this view when he told senators that "improved energy efficiency cannot do the whole job .... [T]he United States will need more energy supply." In short, efficiency may help the nation overcome some of its energy woes, but policymakers do not feel it will be the ultimate solution. As a result, the potential for improved energy efficiency is not being vigorously tapped.

Fifth and finally, the trend toward more energy consumption will exacerbate already prominent concerns about the environment. Since the 1960s, technically trained people, politicians, and the public have become aware of the health consequences of the exploration, extraction, transportation, and combustion of fuels used for making energy. They have also become alert to possible dangers of living near high-voltage power lines and radioactive-waste sites. More recently, people have pointed to the ecological damage created by hydroelectric dams and wind turbines, while also noting that the use of biomass from energy crops may promote agricultural monocultures that can pose severe risks to ecological diversity.

Efforts resulting from three decades of clean-air legislation have decreased sulfur-dioxide emissions from electric generators in the United States. Nevertheless, air pollution remains a serious threat to human and ecosystem health. Americans have experienced a rise in respiratory illnesses, and visibility continues to degrade in formerly pristine areas as a result of pollution from vehicles and coal-burning power plants. Rarely, for example, does visibility in the Great Smoky Mountains National Park achieve its 'natural' limit of ninety-three miles. Instead, average annual visibility has decreased to twenty-five miles in the winter and to twelve miles in the summer. Beyond air-pollution issues, current energy trends will lead to expanded emissions of greenhouse gases, which appear to be contributing to increased global temperatures, recession of glaciers, and more frequent and powerful weather events such as hurricanes.

The pollution associated with electric-power production was vividly documented by the August 14, 2003, Northeast blackout. Not only did the event shut off electricity for 50 million people in the United States and Canada, it also halted emissions from many fossil-fired power plants across the Ohio Valley and the Northeast. In effect, the power outage served as an inadvertent demonstration of the environmental consequences of electricity generation: twenty-four hours after the blackout, New York City's sulfur-dioxide concentrations dropped 90 percent; particulate matter fell by 70 percent; and ozone concentrations slipped to half.

Beyond federal clean-air initiatives, state-government policies have, in certain cases, made positive inroads to pollution abatement. Due to legislative and regulatory initiatives, California – which generates roughly one-fourth of its electricity from efficiently distributed and renewable energy technologies – emitted only 493 metric tons of carbon dioxide in 2002, a mere 12 percent increase from its emission levels in 1990, despite an increase in electricity demand of almost 25 percent.

Though making impressive inroads in pollution abatement efforts, California (and a few other states) remains the exception, not the rule. Few people dispute the fact that total U.S. emissions of carbon dioxide from energy consumption have increased significantly: from 4.3 billion metric tons in 1970 to 5.9 billion metric tons in 2004. Moreover, the Energy Information Administration forecasted in 2005 that carbon-dioxide emissions from energy use will grow an average 1.5 percent annually for the next twenty years, resulting in 8.1 billion metric tons of carbon-dioxide emissions in 2025. Clearly, the last thirty years have not seen the adoption of the low-carbon power and fuels needed to help stabilize atmospheric concentrations of greenhouse gases. Continued growth in energy usage will likely exacerbate environmental problems.

To conclude, despite three decades of 'progress' since the 1973 energy crisis, the United States faces a host of energy challenges that threaten the nation's economy, security, and lifestyle. Because of its huge dependence on imported oil to fuel a transportation sector that has seen little improvement in energy efficiency, the nation could be ravaged by disruptions to oil supplies due to weather, war, or terrorist attacks. At the same time, growing electricity consumption and reliance on power plants employing natural gas, along with a constrained transmission grid, make the electric-utility infrastructure increasingly vulnerable to service disruptions. And while efficiency efforts have successfully stemmed the growth rate of fuel consumption in the last few decades, population increases and economic expansion have forced up the nation's overall use of energy, exacerbating the country's environmental problems.

As a consequence of these trends, the goal of energy independence seems more distant in 2006 than it did in 1974, when President Nixon first proposed it as a way to deal with the oil embargo. While one can fruitfully debate whether complete reliance on domestic energy sources should be the objective of government policy, the fact remains that the United States cannot continue upon its present course. The country has become progressively vulnerable to economic, political, and military threats because of its growing fuel consumption and an increasingly challenged energy infrastructure. The nation's policymakers in business and government, as well as the citizenry, need to realize that the recent trends in energy consumption, production, and distribution reflected in this energy assessment cannot be sustained indefinitely. Americans must confront energy concerns as a top priority and learn to overcome the social, political, and technical obstacles that have hindered true progress for more than three decades.