The State of Energy: Then, Now, and in the Future

Author of 'monumental' energy-price analysis shares his 30-year perspective of energy crisis

*Editor's note: In April 1976, Alfred E. Guntermann, PE, then-president of Energy Economics in Fort Wayne, Ind., presented a paper titled "The Mystery of Future Energy Prices" (*www.guntermannengineering.com/Publications.htm*) at the Conference on Improving Efficiency and Performance of HVAC Equipment and Systems for Commercial and Industrial Buildings at Purdue University. Herb Laube, founder and chief executive officer of Singer Air Conditioning Co., described the paper as "nothing less than monumental." Thirty years later, Guntermann takes a look back—and ahead—at the energy issues facing the United States and the rest of the world.*

By **ALFRED E. GUNTERMANN, PE**
Guntermann Engineering
New Haven, Conn.

In 1976, I published a paper discussing factors expected to influence future energy prices and the effects those prices would have on life-cycle costing. Thirty years later, it is unsettling to see how little has been accomplished and realize how much time has been wasted. This article will examine the energy issues that continue to nag us and that are expected to do so for the foreseeable future. Further, global warming and alternative energy sources will be discussed.

WORLD CRUDE OIL AND NATURAL GAS

In 1976, I wrote that world oil and natural-gas production would peak between the years 2000 and 2020.

In 2000, the U.S. Energy Information Administration (EIA) released the results of a five-year study of the world's crude-oil and natural-gas resources. Using a hypothetical estimate of 6 trillion barrels of oil in place, the study made three projections as to the amount of oil that will ever be found and practically recovered. With a 40-percent recovery rate and 10-percent reserve growth assumed, the study's mean projection (50-percent probability) was a total of 3 trillion barrels. A second, high-reserve projection (5-percent probability) was 3.9 trillion barrels, while a third, low-reserve projection (95-percent probability) was 2.25 trillion barrels. With 2-percent energy growth attributed to increased population and a higher standard of living in developing countries, the study predicted a peak in oil production of 2026 for the low-reserve scenario, 2037 for the mean scenario, and 2047 for the high-reserve scenario.

There has been considerable debate among

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*The principal of Guntermann Engineering (*www.guntermannengineering.com*), a provider of mechanical and electrical consulting-engineering services for commercial, industrial, and residential buildings, with special expertise in energy-conservation analysis and construction support, Alfred E. Guntermann, PE, has nearly 40 years of construction-industry experience, during which he has received a number of local, regional, and national engineering awards; written nearly two dozen articles published in national engineering magazines; and served on numerous boards and committees, including the American Society of Heating, Refrigerating and Air-Conditioning Engineers' energy-calculation and life-cycle-cost committees.*

experts regarding the peaks predicted in the EIA study. Donald Evans, oil executive and retired secretary of commerce, recently said he believes the world's oil supply is peaking now, at 89 million barrels a day.

According to a recent *New York Times* article, many experts agree that most of the world's largest oil fields, including major fields in Norway, Alaska, Mexico, Kuwait, and Russia, have peaked. Regardless, an "elephant" field to replace these or any other major field that may have peaked has not been found for decades.

While most of the world's oil fields are operating at full or reduced capacity, Saudi Arabia hopes to increase production by 2 million barrels a day next year. Some experts, however, are skeptical.

The United States, which currently has 3 percent of the world's 1.1 trillion barrels of proven oil reserves, saw its oil supply peak in 1959, followed by its oil production in 1970. Since 1970, U.S. production has declined an average of 15 percent per year. Around the world, the rate of decline ranges from 10 to 30 percent.

Natural gas is believed to be peaking at the same time as oil.

THE THIRD WORLD

In 1976, I wrote that Third World countries are demanding more of the world's resources.

The EIA study assumed a 2-percent-per-year, or 2.2-million-barrels-a-day, increase in world oil demand. In developing countries, demand attributed to increased population and an improved standard of living could grow faster. In 2004, China's demand rose 16 percent.

If the world's 7 billion people each consumed 125 million Btu per year (36 percent of U.S. per-capita consumption), we would use up all of the world's proven recoverable oil, gas, and coal in 36 years.

ALTERNATIVE AUTOMOBILES

In 1976, I wrote that future alternatives to gasoline-powered automobiles included electric and hydrogen-powered cars. At the time, research into hydrogen, fuel-cell, and hybrid electric cars already was under way. But because of low energy prices and cuts in federal funding, the development of these vehicles was abandoned by the United States.

A HYDROGEN ECONOMY

In 1976, I wrote that, "pound for pound," hydrogen has more energy than any other fuel and that, when it is burned, water is formed, with zero pollution. I noted the possibility of offshore nuclear-power plants being used to generate hydrogen, which could be piped and, though tricky, stored.

With hydrogen, which is the smallest molecule, 5-percent leakage though pipes and similar technical problems are common. Additionally, various methods of hydrogen production require hydrocarbons, such as natural gas. In short, hydrogen is difficult to use and expensive to produce and will not be a short-term solution.

Little federal funding has been provided to establish a hydrogen economy, and, despite recent political rhetoric, little progress has been made.

COAL AND OIL SHALE

In 1976, I wrote that 49 percent of the world's known energy resources were in North America, mostly in the form of coal and oil shale, and that, essentially, the optimum energy solution involved an "energy mix" of a liquid fuel, such as oil; a natural gas, a synthetic gas, or hydrogen; and electricity. Synthetic fuels were seen as a more cost-effective option for the replacement of petroleum and natural gas than a total electric economy, with the existing network of natural-gas-distribution pipelines providing a great economic advantage for synthetic natural gas.

The energy produced from oil shale/sands and coal gasification and liquefaction costs substantially more than existing oil and natural gas, but is likely to be the least-expensive short-term and mid-term replacement for oil and natural gas. Further, it can be used in the petrochemical industry as feedstock.

The oil-shale/tar-sand deposits in Alberta, Canada, contain as much oil as the Saudi oil fields, with production recently increased to 1 million barrels a day. However, there are limits to how much and how fast output of this oil can be increased, as production requires substantial amounts of water, natural gas, and labor that production of regular oil does not. Moreover, production of this oil causes substantial pollution.

With coal considered a "dirty" fuel, new "clean-coal" technologies are needed. In 1979, the Carter administration funded the construction of a prototype plant for developing synthetic oil and gas from coal. In 1988, the project was canceled.

The Bush administration is funding the development of clean-coal-fired electricity-generating stations; however, the transportation of sufficient quantities of coal to generating stations already is causing problems with the railway system. Converting coal to oil and gas near coal fields and transporting it using

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existing pipelines seems to make more sense.

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ELECTRICITY

In 1976, there was a general feeling that ours would become a total electric economy. What else was there, proponents asked. We are running out of oil and natural gas, electricity can be generated with coal or nuclear fuel, and the heat pump can increase end-use efficiency, they reasoned. Based on 6.4 quads of electricity use in 1975 and a 6-percent annual growth rate, the electric-industry predicted 11.0 quads of electricity use in 1985 and 22.2 quads of electricity use in 2000, building plants to meet those projections.

What the advocates of a total electric economy failed to consider was that much of the oil and natural gas consumed was for space heating and that replacing it with electricity would require generating capacity that would be used only during winter. My paper argued that the low utilization rate would be expensive and that electric heat pumps would not reduce peak use.

In 2003, electricity consumption totaled 12 quads. Energy conservation and the lack of a total electric economy had reduced electricity growth to approximately half of the 1975 projection for 2000.

NUCLEAR POWER

In 1976, I wrote that the nuclear-power-plant designs of the day were obsolete and inefficient.

Because of reduced electricity demand and a rise in the cost of their construction from $1,000 to $5,000 per kilowatt, nuclear-power plants have not been built in the United States for 25 years.

At last, the Bush administration is providing federal funding for new nuclear-power-plant designs. Although there are no accurate cost estimates, the cost will be high. A lot of time has been lost, and most of the problems concerning the disposal of nuclear waste still exist.

It will take decades to build and test prototype nuclear-power plants and construct the hundreds of plants that will be necessary to increase electricity output significantly. This is a mid-term solution at best.

SOLAR ENERGY AND BIOFUELS

The problem with solar energy is that it is very dilute and irregular and, thus, material-intensive. In 1976, I wrote about the environmental and social

costs of manufacturing solar collectors. With each square foot of solar collector (flat-plate hydronic) saving about 100,000 Btu per year, I put the cost of producing 1 quad of solar energy at $100 billion ($10 per square foot of solar collector times 10 billion sq ft). That cost reflected not only labor, but approximately 10 billion lb of copper, 30 billion lb of glass, and 1 quad of energy.

After hydronic solar energy proved to be a poor solution, attention turned to photovoltaic solar energy. Today, photovoltaic solar energy is cost-effective at 28 cents per kilowatt-hour, or two to four times the cost of traditional generated electricity. However, photovoltaic solar cells are only 8- to 15-percent efficient (solar energy converted to usable energy, compared with the amount of sunlight falling on the surface), while hydronic solar collectors are 65-percent efficient.

With hydronic solar collectors at 65-percent efficiency, the surface area required to produce 1 quad (1 percent of current U.S. consumption) is 359 sq mi; with photovoltaic solar cells at 15-percent efficiency, it is approximately four times as much, or the size of Rhode Island. What's more, the area must be unshaded by trees and other buildings.

Similar problems are inherent in alternative energy sources. For example, the production of ethanol requires substantial energy for fertilizing, planting, harvesting, milling, and distilling. Milling energy is supplied by oil, coal, or natural gas. According to a recent article,[1] "With current production methods, corn ethanol displaces petroleum use substantially, (but) only 5 to 26 percent of the energy content is renewable." To produce enough ethanol to replace the 20 million barrels of oil we consume every day, we would have to double our current usage of natural gas and/or coal, increasing total national energy consumption from 100 to 119 quads with no benefit—except to farmers. Further, according to recent studies, an acre produces an average of 140 bushels of corn,[2] while a bushel of corn produces an average of 2.5 gal. of ethanol,[3] resulting in 350 gal., or 7.95 barrels of ethanol, per acre (assuming 44 gal. per barrel), or 5.3 gal. of equivalent oil. (Ethanol has 66 percent of oil's energy by volume.) With the United States consuming 7.3 billion barrels of oil per year, 2,178,400 sq mi, or 50 percent of the United States' total area, of arable land would be needed to produce an equivalent amount of ethanol. As ethanol becomes a bigger part of the energy solution, its cost will increase greatly. Additionally, bad weather could reduce crops and create enormous energy-supply problems. Other biofuels will face similar problems. Tax credits for the production of alternative energy will hide these problems temporarily.

While there is nothing wrong with increasing the use of solar energy and ethanol, we should not allow ourselves to believe that these are solutions to the impending energy crisis and the need to replace fossil fuels.

While there is nothing wrong with increasing the use of solar energy and ethanol, we should not allow ourselves to believe that these are solutions to the impending energy crisis and the need to replace fossil fuels. Oil and natural gas are wonders of nature and will be much more difficult to replace than commonly understood. Having taken around 200 million years to make, they could be used up in 200 years.

ECONOMICS

In 1976, I wrote that economics was vastly underrated and poorly understood and that energy conservation increases productivity.

In 2004, the United States imported 12.1 million barrels of oil a day. (U.S. consumption was 20.8 million barrels a day, while production was 8.7 million barrels a day.) A year later, U.S. oil imports totaled $252 billion, or 29 percent of the country's $800 million trade deficit. Both the amount and cost of imported petroleum are expected to continue to rise.

Increasing U.S. oil supplies is not an option, as we have used up most of our oil. Increasing production would only result in oil being used up faster, leaving us without oil and gas in the future. Reducing energy demand may be the only practical short-term policy to avoid future trade-deficit problems.

ENERGY CONSERVATION

In 1976, the thinking among government leaders was, to quote the Ford Foundation: "(Energy) conservation is much too benign a label for this policy option in the near term. Rather, it should be presented to the public as what it likely will be for the foreseeable future: a policy of lower real income, reduced standard of living, reduced mobility, and, possibly, higher unemployment."

Despite 30 years of success, energy conservation is referred to in the same faulty terms by the Bush administration, which has based its energy policy almost entirely on increasing supply, while consumption grows at a rate of 1 percent.

In 1976, when U.S. energy use totaled 76 quads, the U.S. government issued a study projecting consumption of 150 quads in 2000. Actual consumption rose to 81 quads in 1979. In 1981, it fell to 73 quads, where it remained until 1983. By 1988, it was back to 81 quads. In 2005, it was 100 quads. Thanks to the energy-conservation policies of the

Carter administration, improved energy-conservation retrofit techniques, and higher energy prices, the country enjoyed zero energy growth for nine years and negative energy growth for three, clearly showing that energy conservation could be a national policy that reduces energy demand. Notably, energy prices decreased from 1988 to 2003, with resulting increased energy consumption.

Despite having only 4 percent of the world's population, the United States consumes 25 percent of the world's oil. With the right national polices, however, the United States should be able to cut its energy consumption in half.

A national energy-conservation policy should have the goal of negative energy growth in transportation, as well as residential, commercial, and industrial buildings and processes. Additionally, it should have clear short-, mid-, and long-term goals that give everyone time to plan.

Energy conservation can utilize existing technology and be implemented quickly. Further, it creates jobs and is an investment with a future payback. All it requires to be implemented fully is additional economic incentive.

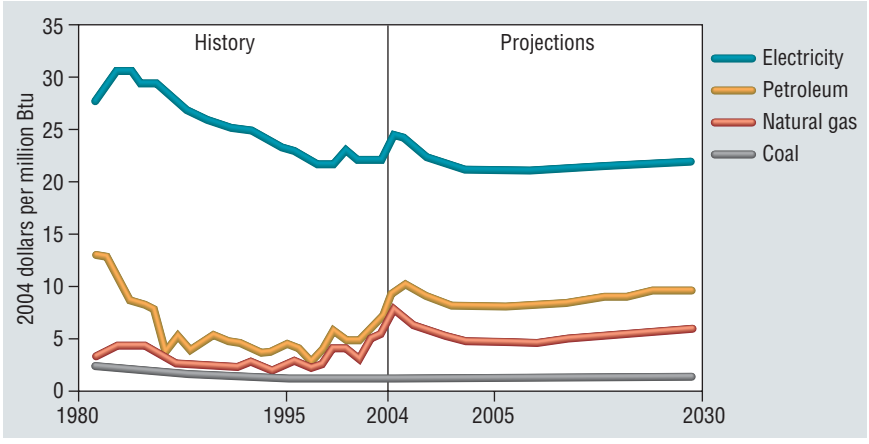

FIGURE 1. Energy prices in 2004 dollars per million British thermal units.

ENERGY PRICES

In 1976, I wrote that energy-price increases would be 25- to 50-percent less through the year 2000 if an "energy-retrofit attitude" were adopted. The cumulative effect of negative energy growth, I wrote, would be not only lower energy prices per unit, but less energy used, as peak dates would be delayed. Additional benefits would be fewer environmental problems and more time to develop better energy technology.

The price of oil increased from $7 a barrel in 1976 to $38 a barrel in 1981, before slowly decreasing to $11 a barrel in 2001. By 2006, it had climbed to $75 a barrel.

In 2006 dollars, the price of oil was $97 a barrel in 1981. Figure 1 shows that, in constant 2004 dollars, energy prices actually have decreased over the last 25 years.

It is likely that energy conservation, which has reduced energy demand to a third below projected levels over the last 30 years, is what has caused the real price of energy to be contained over the last 25 years.

GOVERNMENT INTERVENTION

"The federal government can affect the energy markets in so many ways ...," I wrote in 1976. "The effect of taxes and tax incentives on ... market price is to hide the true cost of energy in taxes," lower energy costs, and, perhaps, encourage energy waste.

In 1978, when oil and gas prices were regulated by the government, reduced industry investment in oil and gas production led to shortages in U.S. energy supplies. In response, President Carter deregulated the price of oil over several years. After Ronald Reagan was elected president, he quickly removed the graduated increases, and oil jumped from $17 a barrel to $38 a barrel, overshooting the real cost. The cost of energy was approximately 6 percent of the gross national product (today, it is only 4 percent) and had a major impact on inflation.

In an attempt to reign in inflation caused primarily by energy, Federal Reserve Chairman Paul Volker raised the interest rate to 18 percent in 1981, causing a severe recession. To stimulate the economy, President Reagan instituted massive tax cuts, which had the effect of the economy being on "uppers" and "downers" at the same time. In 1983, Volker began reducing the interest rate to 7 percent, and the economy took off. Unfortunately, many of the tax cuts, such as accelerated depreciation of buildings, had been overly stimulative. By 1987, there was a surplus of speculative buildings, many of which were empty. When the tax breaks were repealed in 1988, many buildings were underfinanced, lending institutions were in trouble, and another recession began. The savings-and-loan industry was forced out of business, and a number of real-estate developers were bankrupted. There is good reason to ask if any of that was necessary or if energy costs should have been allowed to work their way through the economy.

President Carter had instituted strong energy-conservation and alternative-energy programs. The Reagan administration canceled those programs and ordered all of President Carter's federally funded energy-conservation research destroyed.

The current Bush administration's energy policies have involved tax incentives and opening up more land to oil and gas companies to increase short-term production. Providing tax incentives to the oil and natural-gas industry will cause the world's finite energy resources to be used up faster, leading to an energy crisis,

not preventing one. Opening up Alaska's Anwar oil reserves would make little difference, as it only would reduce our imports by 5 percent for several years.

The Bush administration believes strongly in free-market solutions, meaning it does little planning in anticipation of a problem and, when one develops, primarily hopes the free market will be the answer. That the administration has not analyzed alternative-energy policies for future energy solutions, as the Carter administration did, is troubling. An energy crisis or global warming may prove to be the true "weapon of mass destruction."

Because both President Bush and Vice President Cheney have strong backgrounds in the energy industry and their national energy policies have been aimed at increasing energy supplies, enacting an effective energy-conservation policy while they are in office may be difficult.

DECONTROLLING ENERGY PRICES

In 1976, I wrote that decontrolling energy prices increases production significantly more than it encourages conservation.

This free-market approach to energy leads to cycles of shortages and surpluses and, thus, excessively high prices and excessively low prices. This makes the future harder to plan for because energy costs can change quickly and vary greatly, affecting consumer preferences. It is one reason General Motors is having trouble competing with energy-efficient imports.

ENERGY TAX VS. TAX CREDITS

In 1976, I wrote that the best way to enact an energy-conservation program is to implement an energy tax. Like tax credits, an energy tax increases the economic attractiveness of a decision. But unlike tax credits, which require discretion in terms of where they are applied and how much incentive is needed, an energy tax is uniform and applied in the exact proportion of the energy consumed.

An energy tax increases both energy costs and the rate of return on energy-efficient systems. This gives individuals incentive to reduce their energy consumption. If, however, someone still chooses to drive a "gas guzzler," he or she will reimburse society by paying more taxes. In short, an energy tax is a free-market approach to implementing a national energy-conservation program that requires leadership, but not "big government."

Energy taxes can be revenue-neutral. Because our government requires a fixed amount of revenue obtained through a basket of taxes, revenue easily could be shifted from income, payroll, capital-gains, or corporate taxes to an energy tax. Thus, each energy-tax dollar could be paid for with a dollar cut in income or corporate taxes, meaning an energy-conservation program could be implemented without any real cost to taxpayers. With tax credits, on the other hand, other taxes would have to be increased to make up for the increased deficit.

An energy tax was proposed by both President Carter and President Clinton, neither of whom could get it past the political process. However, it currently is a favored policy of a number of economists and both conservative and liberal thinkers. For more than 30 years, Europe has had an energy tax that essentially has doubled its energy cost and resulted in per-capita usage that is half that of the United States.

In a recent *New York Times*/CBS News poll,[4] when framed simply as a new tax, a gasoline tax was opposed by 85 percent of respondents. When framed as part of a national strategy to reduce dependence on foreign oil, however, a gasoline tax was *favored* by 55 percent of respondents.

When energy shortages occur and energy prices rise, energy companies or foreign countries profit. By reducing energy demand, energy taxes can reduce the "real" cost of energy, as occurred from 1981 to 2000, reducing the profits of oil companies and foreign countries. Any increase in taxes to make up for the lower

energy costs would reduce our deficit.

Complex details need to be addressed before a national energy-tax policy can be enacted. For example, an energy tax would be a regressive tax that would greatly affect the poor. One solution would be increased credits for the poor. Because the point of an energy tax is energy efficiency, however, a better choice might be assisting the poor with energy-conservation retrofits. Another issue in need of addressing concerns flexibility, as an energy-tax system would have to enable the development of new energy supplies to be effective.

Although most of the current discussion is about a gasoline tax for transportation, what we need is a universal energy tax so that all forms of energy conservation are encouraged, and we achieve the maximum amount of energy reduction possible.

To avoid economic shocks, an energy tax should be brought on slowly, with incremental increases each year.

GLOBAL WARMING

Relatively new to the energy discussion is global warming, much of which has occurred over the last 30 years. With few exceptions, experts around the world agree not only that global warming is a problem, but that it is a very serious problem, probably more serious than the energy crisis. The best way to reduce global warming may be through energy conservation.

WORLD PEACE

The world's population of 7 billion people cannot be sustained without sufficient energy. Already, countries are scrambling to obtain energy supplies, and this may lead to conflicts. The United States' dependence on Middle East oil is affecting its policies. Reducing that dependence could save lives and trillions of dollars in fighting wars.

CONCLUSION

In 1976, I wrote: "The energy problem is a most complex question. To unravel the solution, it appears ... we have to unravel the economic questions ... plaguing America. ... If we don't find the answers, the consequences may be harsh."

That is truer now than ever before.

Because of the enormity and complexity of our energy needs, which require new technologies that take time to develop, solving the energy crisis by increasing energy supplies is more difficult than putting a man on the moon. It is more on par with putting a million men on the moon.

Reducing energy demand is a better solution to the energy crisis. A national energy-conservation policy should have as a goal a 50-percent reduction in our energy consumption. The cost of implementing energy conservation would be far less than the cost of replacing an equivalent amount of energy with alternative energy sources.

We generally are aware of the customer savings that come from energy-conservation measures. Less obvious are the economic benefits to the United States and the rest of the world that would be realized with policies that: (1) prevent the running out of energy, (2) reduce the foreign trade deficit, (3) halt global warming, and (4) avoid world problems over securing energy supplies. A national energy-conservation policy would produce far greater benefits than any other policy because it would help solve all of these problems at the same time.

Our government must enact an energy-conservation policy similar in scope to President Eisenhower's interstate-highway program. What's more, that energy-conservation policy should be implemented with energy taxes, just as the interstate-highway system is financed with gasoline taxes. The longer we wait to enact an energy-conservation policy, the graver this energy crisis we find ourselves in will become.

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