The U.S. Energy Picture

by Mary Nightlinger

As this study is being written, the United States is engaged in formulating an energy policy. Our energy consumption per person far exceeds that of any other country in the world. The amount of energy we use and the ways we use it affect most of the important aspects of our national life. In spite of the recent electric power fiasco in California and consumer complaints when gasoline prices rise, the traditional fossil fuels we use are cheap. However, they all impose a broad array of hidden or external costs that are paid through our health, foreign policies, military actions and environment, including the incalculable cost of global warming. The United States has one-twentieth of the world's population and is responsible for more than a quarter of the greenhouse gas carbon dioxide that is sent into the atmosphere.

Underlying our energy policy debate is the question, "Do we continue to discount these external costs of traditional fuels, and if not, how do we account for them?" Perhaps the most worrisome effect of the failure to calculate the true costs of fossil fuels is that it is self-perpetuating. Because these fuels seem good buys, it is very difficult for new clean technologies to gain a foothold and acquire economies of scale. Industry's incentive to develop them is weak, and the government's support with research and pump priming is meager.

At this time, a number of energy policy bills are being considered by Congress. Differences are sharp and fundamental. We will try to present the basic elements and choices that are at play in the energy dilemma. bag

The fuels

Coal The United States has an almost unlimited supply of coal. Unfortunately coal is the most polluting of the fossil fuels. Acid rain, global climate change, nitrous oxides and particulate matter (which cause lung diseases) are all by-products of the burning of coal. Coal-burning power plants that have anti-pollution devices installed can remove most of these pollutants. However, the process is expensive. The Clean Air Act required pollution controls on coal-fired boilers. It exempted certain plants that were old and small and deemed unable to be operated economically with the cost of the required equipment. Owners were not permitted to modernize or enlarge them without the addition of proper anti-pollution equipment. None-the-less, many were upgraded without the environmental requirements. Recently the EPA changed its regulations making it legal to expand and update these plants without reducing their air pollution. This EPA decision is now being challenged in court.

The Clean Air Act introduced a system of pollution abatement trading. The system allows a plant which cleans its discharges beyond what is legally required to sell the credit earned to another company which finds the deal cheaper than treating its own discharges. The trading was a great success. It resulted in pollution reduction greatly in excess of the amount industry said it would be able to do.

Oil At present the U.S. imports 57% of the oil we use. If we continue on the present course, we can expect to be importing 2/3 of our consumption in

2020. It is no longer used much in homes and industries, but it is our sole transportation fuel and the only one with a distribution infrastructure.

Oil is another fossil fuel. It produces air pollution when it is burned and during refining processes. Though not as dirty as coal, it is the primary source of serious pollution problems in many places including the Washington Metro Area.

The unrivaled center of oil reserves is the Middle East where the oil virtually seeps from the sands but where political tensions are severe. The U.S. first began meddling in the politics of the area shortly after World War I, when the U.S. Geological Survey declared that the world's petroleum reserves would be exhausted in the 1940s. Western nations competed for access and influence in Iran and Iraq and the Arabian peninsula. Fear of shortage caused oil companies to use a previously ignored technology for finding oil. What was found was the huge Texas/Oklahoma field, and the world was awash with oil. This story has repeated itself several times since then. Alarms about shortages and high prices have brought new technologies into play, which provide new sources. Today the techniques for locating probable sites of oil deposits are very sophisticated. Drilling now uses one drill hole with numerous horizontal branches to extract from a number of sites.

We are told by the Bush administration that once again we have a crisis of oil supply and must increase domestic oil drilling by opening the Alaska National Wildlife Refuge and other federal lands. Environmentalists say that precious wild places must be saved and conservation and clean technologies are the answer. Both drilling new areas and getting new technologies in place will require many years.

Natural Gas Natural gas is the cleanest of the fossil fuels. That makes it the fuel of choice for home heating. It has become the preferred fuel for electricity generation as well.

Known reserves of natural gas will last about 50 years at today's consumption rates. If we add the estimate of gas yet to be discovered, the supply lasts for 200 years. But if we consider methane hydrates, we confront an amount that seems limitless. Hydrates are ice crystals that trap methane molecules and are believed to form 300 meters beneath the ocean. Bacteria form the methane trapped in the hydrates. With the research yet to be done, we know very little about how to extract it.

The problem with natural gas is that it is hard to transport long distances especially overseas. You cannot load a gas in a ship and send it around the world. It is shipped as a liquid, but to keep it in a liquid state it must be held at or below 130 degrees c or under high pressure. Both are expensive. Overland it is sent compressed in natural gas pipelines. This is expensive also when it covers long distances. It is estimated that the pipeline that is contemplated to take gas from Alaska through Canada to the lower 48 states would cost about $15 to $20 billion to build. The consequence of this transportation problem is that much of the world's reserves of natural gas are commercially worthless because they are in remote places.

Several of the large oil companies are building gas-to-liquid refineries that can convert the methane gas into ultraclean diesel and gasoline fuels near the point of extraction. These plants will use a technology that requires heat and pressure. Meanwhile researchers are

trying to find a catalyst that will convert natural gas directly into liquids at low pressure and temperature.

Uranium Since the partial meltdown accident at Three Mile Island in 1979, the U.S. nuclear power industry has been in deep freeze. High costs, long and uncertain regulatory requirements, the daunting prospect of decommissioning and public opposition have taken new nuclear plants off the table for electric utilities. Now they may be coming back. The Nuclear Regulatory Commission has revamped its regulations and has begun approving new types of reactor designs. The Department of Energy has an $8million project to examine more than 100 conceptual designs for nuclear reactors. After which, they will give out R&D funding for those they find the most promising. The Bush energy plan favors increased use of nuclear generation.

Two big problems stand in the way. One is the old problem of safe disposal and transit of highly radioactive waste and decommissioning of worn-out plants. The other is the new frightening possibility of a terrorist attack turning a nuclear reactor into a home grown weapon of mass destruction.

Wind Wind farms now dot the Great Plains and other favorable places around the world. Wind turbines are the world's fastest growing power source providing global generating capacity sufficient to power 10 million homes. A Canadian environmental agency has mapped Canada and the United States to show where the best wind locations are. Their map shows that the very best wind sites are in the oceans. Whether a way can be found to harvest this resource from close-in sites is an interesting question.

Solar Solar energy is the holy grail of power fuels. What could match clean, limitless sun power? Direct solar heat for space heating persists as an almost unnoticed force. Anyone who lives in a house with south-facing windows knows the strength of the sun even in winter. However projects that concentrated solar heat for generating electricity have remained essentially dead in the water. It is photovoltaics that have begun to turn the corner to a practical and affordable source of electricity. Photovoltaic devices convert photons (light) to electrons.

For decades photovoltaic panels have been composed of silicon crystal semiconductors, basically the same as those used in computers. Covering rooftops with such devices was never going to compete with the price of fossil fuel energy. Recently the industry has found ways to make solar cells using ultrathin films of silicon producing a much less expensive product. The material can be sprayed on tiles, skylights, awnings etc. In the last five years, sales have quadrupled. Even so, solar still has only .04% of power generation worldwide.

The race is on to find even cheaper materials. Electrically conductive plastics are already in use in some hand-held digital devises which conduct electricity to emit light. The process can be reversed so that the plastics absorb light and produce electricity. These plastics or organic polymers can be dissolved in inks and spread on almost anything in extremely thin coatings. The weakness of this material is that it is very fragile and breaks down when exposed to oxygen. However, if they are encapsulated in an impervious polymer like Teflon, they have the working life needed of a solar cell.

Hydroelectric Hydroelectric, which produces electricity by waterpower has historically been thought of as an especially benign way to generate electricity. It is, with regard to pollution. The generators are clean and efficient. But the dams and impoundments that provide the power have turned out to cause problems. Egypt's Aswan dam was built at great cost to control flooding of the Nile and produce power. In doing these things, it catches and holds the silt that used to be carried down the river with the floods. As a result the Nile delta gets no replenishment and is eroding away. In addition, for centuries the floods coated the arable valley with fresh loads of fertile silt each year. That no longer happens. The Grand Canyon had a somewhat similar problem in that its pools and backwaters were losing their special species because the pools were no longer being flushed with fresh nutrient-rich water in the spring. Disruption of a river's ecosystem is a common problem of hydroelectric dams. Creation of an impoundment usually causes flooding of houses and farms or beautiful canyons with exotic inhabitants so building a new dam is a hard sell. Droughts like those the West has suffered for the last few years can cause serious problems of reliability.

Geothermal There are two types of geothermal systems. The first can be used only in the rare places where magma comes close to the surface, places near hot springs or a volcanic region. In such areas a well can be drilled and water run into it where the hot rock produces steam to run a generator. The second type, works more or less anywhere. It is called "GeoExchange" and is based on the fact that temperatures four-to-six-feet underground stay much the same year round. A closed loop pipe is buried underground and water is circulated through the house and underground. In winter a compressor heats the water and circulates it through the house. In summer the water absorbs the heat form the house and then goes into the underground loop where the heat is dissipated into the ground. It is basically a heat pump, and is said to be very efficient.

Biomass Biomass is a niche player in energy production and probably will continue to hold that role. The term refers to renewable fuels such as wood, grasses and corn. As heat generation is low compared to fossil fuels, they need a price advantage to be attractive. Often the waste products of a process are used for fuel. For instance, bark and wood waste are often used to power sawmills. Corn is used to produce ethanol to augment gasoline, but this use is really an agricultural subsidy rather than a needed product. A plant with the production expenses of a food crop does not have good potential as biomass.

Lately there has been some interest in switchgrass as fuel. Switchgrass is a native tall-grass species that grows well in drought areas and on steep slopes. It is an excellent cover crop for preventing erosion. The latest farm bill encourages farmers to remove environmentally sensitive land from crop production. Switchgrass used as biomass would provide both erosion protection and a cash crop.

Hydrogen Hydrogen is the earth's most abundant substance and probably will eventually replace fossil fuels as our dominant power source. However we are not there yet. We are farthest from the use that gets the most attention and R&D money--replacing the internal combustion

engine and gasoline. Giant companies have been making improvements to the gasoline engine for a century and a half. It is deeply entrenched in our economy and so is hard to beat on power and price. Air pollution is another matter of course.

Electric power generation is a more competitive use of hydrogen. Units capable of serving office buildings, and about the size of a tall dumpster, are already on the market serving as backup power generators. These units are composed of stacks of fuel cells. Smaller units for residential and portable applications are coming to market. Motorola is working on hydrogen refills the size of a fountain pen cartridge to power mobile phones.

The tool that gets electricity from hydrogen is the fuel cell. The fuel cell is a sandwich of two conducting plates. Hydrogen enters one cell and oxygen from the air enters the other. The hydrogen, drawn to combine with the oxygen, presses through an electrolyte to the second cell. As it does so, a catalyst causes the hydrogen atom to give up its one electron. The orphaned electrons are then in the first plate and the hydrogen ions in the second. When a wire connects the two plates the electrons speed through it forming an electric current. They recombine with the H ions and the oxygen to form pure water. Nothing is burned and no pollution is created. Manufacturers are constantly working to produce cheaper devises. International Fuel Cells is moving to an electrolyte that is a thin plastic membrane and exploring ways to apply the platinum based catalyst in thin coats.

Even though hydrogen makes up 75% of all known matter, it has very strong molecular bonds that make it difficult to separate out into pure hydrogen. Ironically, we must use a fossil fuel, natural gas, to produce hydrogen fuel. Even so, pollutants are low. Fuel cells have some other advantages over the utility grid. One is that the power delivery is reliable and steady, without spikes and outages. It is superior to fossil fuel backup generators in that the heat generated can be used for space heating and cooling as it is not contaminated with pollutants.

If electric power generation by fuel cell can achieve wide distribution, it would go a long way toward addressing hydrogen's infrastructure disadvantage for transportation uses.

Generation and Distribution of Electricity Proceeding on a widely held belief that unregulated markets lead to lower prices and more efficiency than regulated markets and that electricity is a commodity one unit being the same as another regardless of where it is generated, states have been deregulating their electricity production. In practice, things have turned out not to be so simple. Public opposition to generating plants and high-power lines in their area has made it difficult for supply to keep up with demand. Virtually all the hardware of the current system was built to serve local, centralized enterprises. This includes the generating plants, the transmission grid, the metering system, etc.

In the early 20th century, utilities began connecting their lines to neighboring systems so that they could buy from a neighbor if their supply was low. These exchanges constituted only a small part of traffic on the grid. Now that large amounts of electricity are purchased from resellers who find the cheapest source regardless of location, the current may travel a thousand miles rather than a few hundred. Furthermore, as electrons

follow the path of least resistance, the current will travel over a variety of routes rather than the single path that was paid for. So who really owns the grid? Who is to maintain and upgrade it? Who's the traffic cop? At present the grid is a mishmash of utility owned lines, transmission companies and federal and state agencies that are the grid operators..

One avenue for ameliorating grid problems is adjusting the time of use. Peak uses of the grid, like peak generation demand, are tied to the time of day. Pricing varied with time of use would encourage an evening-out of the peak strain on the grid. Some utilities already use time pricing schemes or give special rates for interruptible service to customers for agreeing to have power turned off for brief periods during power crunches. There are also appliances which respond to the uneven flow of voltage that occurs when the grid is becoming overloaded and turn themselves off.

One change that will take the pressure off the grid is already beginning to create itself. A number of small power generators now feed into the grid when they produce more power than is needed for their primary purposes. Many more are coming. These include backup generators for industries and office buildings that need steady reliable power, solar cell installations, waste incinerators, wind turbines, etc..

Policies

Because the world's transportation system runs on oil, disruptions to the supply of that fuel are feared as a threat to the world economy. The question is—how big a threat? The suppliers, even Saudi Arabia, can ill afford to turn off the tap deliberately, they need the money. The U.S. imports Middle East oil, but much of U.S. imports comes from the Western Hemisphere--Canada, Mexico and Venezuela. Nonetheless the Middle East supplies the most oil to the world, and theirs is the cheapest to produce. Saudi Arabia has vast excess capacity and is in a position to influence the price. We can expect to be vulnerable to the fortunes of the politically volatile Middle East so long as we are dependent on cheap oil.

The debate over what we should do about our oil dilemma is the crucial part of the energy policy debate. One side of the debate believes we need to reduce imports by producing more domestically. Opening the Arctic National Wildlife Refuge to drilling has been the red flag issue of this proposal. The pros imply that the oil in the area will go a long way toward getting us off the import hook. The cons say it would last six months. Neither knows. Though there is no evidence that it is a site of major significance neither is there evidence that it contains little or nothing. The fight is on principle. Are there places that belong to nature or is resource value the trump card? The administration favors opening much more public land and ocean to drilling permits. Geologists consider the lower 48 states to be pretty much tapped out. So we should not count on having significant finds there. The Rocky Mountains are expected to have worthwhile gas deposits. The deep waters of the Gulf of Mexico have lately become accessible and are showing impressive returns. Production from the deep ocean is expensive.

The Caspian Sea and Russia are significant new sources. But because their wells must be kept in constant production during cold weather and because they lack the money and the stable economic structure needed to do

exploration, the area is not a swing producer.

The other side on the energy argument believes the problem must be addressed by conservation and encouraging greater use of nonfossil fuels. Calculations indicate that an enthusiastic conservation program could break our yoke to Middle East oil. The ways we could save energy are widespread. Some quick and cost saving ones include efficient lighting, using waste heat from power generation for space heating and cooling, better insulation and building siting, more efficient heating and cooling equipment and other appliances, as well as more efficient manufacturing machinery. We could also reap significant returns from life- and work-style changes such as telecommuting, electronic conferencing and use of more efficient modes of transportation.

Hybrid cars that run on a combination of gasoline and electricity are on the market now. The batteries recharge automatically. They are produced in small quantities and carry a premium price, but they are very efficient and popular with those who own them.

What policies could the federal government use to rein in our growing fossil fuel use? The best-targeted solution (one used by several European countries) would be a carbon tax. A carbon tax would motivate all fossil fuel users to modify their use of these fuels and encourage further development of nonfossil fuels. Unfortunately, Congress seems to consider it a poison pill. A carbon or gasoline tax could have been tied to the latest income tax reductions reaping energy security benefits without increasing the tax burden, but this was never an issue.

Another common sense policy is strengthening the Corporate Average Fuel Economy (CAFE) standards. Car makers have not been required to improve their average mileage per gallon since 1987. Worse, light trucks and SUVs (which have replaced half the passenger car market) are permitted a less stringent mileage requirement than cars. At this writing, CAFE standard changes are still alive in the Senate Democratic plan, but the proposal is under heavy lobbying pressure.

Most of the remedies to the perils of our energy dependence would take time to become effective. Meanwhile oil has a monopoly on transportation and a serious disruption in supply would need an immediate remedy. The industry's reserves have fallen sharply from their levels in the 1970s. Mergers, cost cutting and just-in-time inventory systems have reduced reserves to a very small buffer on the industry side. Governments' stockpiles are not in good shape either. The U.S. has begun to rebuild its Strategic Petroleum Reserve. We can hope it will proceed quickly.

According to the International Energy Agency if things continue on the present course, the Middle East will need to almost quintuple its production to meet demand in 2010 and double that by 2020. It is in no way certain that they would be able to do this. It would require enormous increases in their production facilities. If world use of oil were to grow that much, it would cause alarming growth in greenhouse gasses and pollutant damage.

It is time for Americans to examine the path we are on with regard to energy. Do we want to continue on the present path? If we do not, we will need to draw a new map and follow it.

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