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U.S. ENERGY POLICY FAQ: THE U.S. ENERGY MIX, NATIONAL SECURITY AND THE MYTHS OF ENERGY INDEPENDENCE

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The 110th U.S. Congress passed the Energy Independence and Security Act of 2007 on Dec. 18, 2007, and President George W. Bush signed it into law the following day. The new legislation is a step in the right direction toward a more comprehensive energy policy in the United States but still leaves more work to be done in the future. Baker Institute energy fellows Amy Myers Jaffe and Kenneth Medlock III and energy program associate Lauren A. Smulcer look at current U.S. energy use and recent policy and offer the following answers to frequently asked questions about the U.S. energy situation. The James A. Baker III Institute for Public Policy wishes to thank Shell Oil Company for providing public polling data on U.S. energy policy to aid our effort to inform the public about energy use and national strategy.

Q. Are we currently experiencing a shortage of oil in the United States?

Oil prices have been rising steadily for several years. This indicates that market participants perceive that at the previously lower oil prices that we were used to, current and future oil supply would be unlikely to keep pace with demand for oil — now and in the future. Oil prices are determined in the global market; therefore the global patterns of supply and demand are important in determining oil prices.

Oil demand has been rising steadily since 2003, accompanying rapid growth in the global economy and straining existing global oil supply infrastructure. However, due to high prices and changing national policies, it is estimated that oil demand in the industrialized West fell by 0.4 percent in 2007. As a result, the estimated increase in total global oil demand is only 1 percent in 2007, which is slower than the historical average of 2 percent a year.

This slowdown in recent average demand growth has yet to produce lower oil prices for a number of reasons. First, the Organization of Petroleum Exporting Countries (OPEC) continues to restrain its oil output to sustain higher prices. Second, the largest privately held oil companies also have been slow to increase spending on new, greenfield oil exploration and development, thus limiting production growth outside of OPEC. Third, market participants anticipate that near-term oil supply is at risk due to potential disruptions from war, terrorism or severe weather, placing strong upward pressure on prices in an already tight market. Moreover, many market participants anticipate that future oil supply may not materialize in the required timeframe or be adequate to meet the expected rise in demand over the next 25 years.

A fourth and often overlooked factor that has contributed significantly to the rising price of oil is the weakening value of the U.S. dollar in foreign exchange markets. International crude oil sales are denominated in dollars. Accordingly, when the dollar weakens, oil exporters need to charge a relatively higher dollar price for their oil just to be able to purchase the same amount of foreign goods denominated in currencies other than the dollar (euros, for example).

The U.S. dollar has fallen by more than 50 percent relative to the euro since 2000, and major oil exporting countries, such as the Persian Gulf countries, buy a substantial portion of their imports from European Union countries. Thus, in order for the Persian Gulf countries to simply stay even, the price of oil denominated in dollars must rise by more than 50 percent as well.

A very rudimentary calculation can highlight the effect of the weakening dollar further: If the U.S. dollar/euro exchange rate today was at the same level as in December 2000, the price of oil would be roughly the equivalent of around $60 per barrel. While this is substantially higher than the prices seen in the 1990s, it is still much lower than the $90-$100 oil prices we see today.

All of these factors have contributed to the increase in prices during the past five years.

Q. What percentage of global oil demand comes from the United States? What other countries are large consumers of oil?

Although the oil market is global, consumption in the United States is a very important driver of world oil prices. Americans are the largest consumers of oil in the world. The United States consumes about 20.6 million barrels per day (b/d) of oil, or roughly 25 percent of global demand. By comparison, China is the second largest consumer of oil at 7.2 million b/d and Japan the third at 5.2 million b/d. Russia and Germany are fourth and fifth, respectively, at 3.1 million b/d and 2.6 million b/d. India’s oil demand also is rising quickly, increasing by almost 40 percent since 1995 to the current average of about 2.5 million b/d. The most glaring differences in demand exist in the transportation sector. U.S. road petroleum use represents 33 percent of all road petroleum use globally, which is twice as high in percentage terms as all of Europe. China, by contrast, currently represents 5 percent of all global road petroleum use.

The breakdown of global oil demand is likely to change over the next decade as the economies of China and India continue to develop. Currently, per capita U.S. oil consumption equates to 68.4 barrels of oil per thousand people each day. That compares to Chinese demand, which only stands at 5.5 barrels per thousand people each day, and Indian demand, which averages just 2.2 barrels per thousand people each day. As individual wealth continues to grow in China and India, especially in the rising middle classes in those countries, the number of motor vehicles and other personal appliances will also grow, and oil demand will grow with it — likely closing the gap in demand to the levels of per capita consumption seen in the United States.

Q. Is the United States the largest consumer of imported oil? What other countries are also highly dependent on imports?

In 2006, the United States was the top importer of oil in the world, with net imports at 12.2 million b/d, or representing about 60 percent of its overall total oil demand. Countries that followed were Japan, with net imports at 5.1 million b/d (about 98 percent of demand); China, with net imports at 3.44 million b/d (about 48 percent of demand); Germany, with net imports at 2.48 million b/d (about 95 percent of demand); and South Korea, with net imports at 2.17 million b/d (just under 100 percent of demand).

Q. Many experts are warning that we are running out of oil and that global oil production is peaking, in much the same way U.S. oil production peaked in the 1970s and then began to decline. Has global oil production peaked or will it peak in the near future?

Despite the decline in oil and natural gas production in the United States and Europe, the possibility that the world will geologically “run out” of fossil fuels seems remote. There has been much speculation that future energy challenges will derive from the imminent peaking of the world’s existing hydrocarbon resource base. This view seems premature given the enormous resource base that remains across the globe. The ratio of world-proven reserves to production currently equals about 42 years, substantially higher than it was in 1972.

Global oil supply averaged 85.8 million b/d in 2007, up only slightly from 2006. Non-OPEC production increased by 1 million b/d over the past year, but OPEC lowered its oil production at various times over the course of the past year to sustain higher prices. OPEC’s policy of artificially constraining production is, at least for now, capping global oil production.

On a long-term geologic basis, billions of barrels of conventional oil reserves remain under the ground, and trillions of barrels of more expensive, unconventional resources, such as Canadian tar sands, are available. But oil is ultimately a finite resource, which means we will eventually have to replace it by using more unconventional resources to meet total primary energy requirements. This transition could be hastened by a growing concentration of oil resources in a few regions of the world, which could result in geography and geopolitics rendering future oil supplies less reliable than in the past. More than 60 percent of the world’s remaining conventional oil resources are found in the Middle East.

While vast amounts of oil resources remain available for exploitation, more than 75 percent of the undiscovered resources outside OPEC are located offshore, according to the U.S. Geological Survey (USGS). This lends credence to contentions that much of the “easy” oil has already been found. Oil production has indeed already peaked in the United States. In addition, production in the North Sea, the leading local supply source for Europe, has declined from 6.39 million b/d in 2000 to under 2.11 million b/d at the end of 2005. U.S. domestic “crude oil” production totaled 5.12 million b/d in 2005, down from 6.48 million b/d 10 years earlier.

There is general agreement that world dependence on Middle East oil is likely to grow over time as a natural peak emerges for oil and natural gas production in the West. National oil companies (NOCs), mainly within OPEC, currently control 80 percent of the remaining conventional global reserves of oil. As a result, these NOCs will have to be responsible for close to 90 percent of the increase in oil output to meet projected demand over the next three decades. This is a stark contrast to past decades when privately owned international oil companies operating outside of OPEC controlled more than 40 percent of new oil output.

Projections that OPEC will increase capacity by an additional 10 million to 20 million b/d in the next 20 years to meet the projected demands discussed above run counter to historical experience. OPEC's capacity has fallen, not increased, over the past 25 years, from 38.76 million b/d in 1979 to roughly 31 million b/d currently (excluding new OPEC member Angola), as corruption, civil unrest, inefficiency and geopolitical constraints have thwarted timely and effective resource investment and development in those countries. Similar constraints remain at play inside OPEC today, and many analysts are questioning whether world conventional oil production will ever rise above 100 million b/d by 2030 — a question not based on geological considerations, but based on current political, economic and policy constraints. As a result, advances in alternative energy and unconventional oil are expected to play a great role in satisfying primary energy requirements in the coming decades.

Q. How dependent is the United States on imported oil?

The United States is more dependent now on foreign oil than ever before. In 2006, the United States imported 12.2 million b/d in 2006, or about 60 percent of its 20.6 million b/d total consumption. That represents a substantial increase in share — up from 35 percent of total demand in 1973. The share of imported oil is projected to continue to rise to close to 70 percent by 2020, with the United States becoming increasingly dependent on oil from the Persian Gulf. U.S. oil imports from the Persian Gulf are expected to rise from 2.2 million b/d (17.4 percent of total U.S. oil imports) in 2006 to 4.2 million b/d by 2020, or 62 percent of total U.S. oil imports, according to forecasts by the U.S. Department of Energy (DOE).

Q. What economic sector is most reliant on this foreign oil?

U.S. dependence on imported crude oil derives primarily from the transportation sector. Americans own more than 242 million motor vehicles, close to a vehicle for every person in the country. We travel more than 12,000 miles per vehicle each year, and virtually all our vehicles are powered by petroleum-based fuel. As a result, despite the fact that we are only 5 percent of the world's population, we use in excess of 33 percent of all the petroleum consumed for road transportation in the world. Future U.S. oil consumption is tied to developments in the transportation sector and the degree to which new technologies and alternative fuels can be utilized. Currently, the transportation sector represents more than two-thirds of current total petroleum use and will constitute greater than 70 percent of the projected increase in demand.

Q. Is oil important to generate electricity in the United States or for use as an industrial fuel?

No, oil is no longer a major fuel source for electricity production in the United States. Oil and oil products account for less than 2 percent of all U.S. electricity generation. Coal is the largest feedstock for electricity with a 51 percent share. About 19 percent of all electricity generated in the United States derives from the combustion of natural gas, which is up from only about 10 percent in 1986, when natural gas prices were fully decontrolled. In fact, due largely to efficiency and environmental considerations, around 52 percent of all new power stations built since 1995 have been natural gas-fired. Moreover, the majority of those plants have been larger than the average new plant (many of which were small wind generators), so that natural gas accounts for 90 percent of all newly installed megawatts of capacity in the United States since 1995. Nuclear power represents 20 percent of electricity supply, while renewable energy — mainly from hydroelectric sources — constitutes 8 percent of supply.

Oil remains an important industrial feedstock in the United States. After the oil crises of the 1970s, the use of oil in the U.S. industrial sector fell from 5.3 million b/d in 1979 to 3.9 million b/d in 1983. But as the U.S. economy grew and oil prices moderated in the 1980s and 1990s, industrial use of oil rebounded. In 2006, oil use in the industrial sector averaged 5.1 million b/d, or about 45 percent of primary energy use in that sector.

Q. How important a role can alternative energy play in replacing imported oil over the next five years?

Given that oil is used mainly in the transportation sector, it will be very difficult for alternative energy to replace imported oil in the next few years. In 2006, the United States produced 319,000 b/d of ethanol (4.9 billion gallons a year), mainly from corn. However, current U.S. ethanol production is but a small fraction of the 9.7 million b/d of gasoline fuel used in the United States currently during the peak summer driving season. About 6 billion gallons of ethanol are needed in the United States to replace methyl tertiary-butyl ether (MTBE) as a fuel additive, which would allow refiners to comply with clean air regulations for reformulated fuels. Thus, current ethanol production is not yet significantly replacing gasoline per se, but replacing additives that are being removed from the fuel system.

Ethanol production is targeted to reach 15.2 billion gallons a year or close to 1 million b/d by 2012 under the new 2007 Energy Independence and Security Act. In order for ethanol to simply prevent gasoline demand from rising over the next 10 years, it would take an additional 1.9 million b/d of ethanol production, which is more than six times higher than U.S. production in 2006 and represents about a 16 percent per year increase. Ethanol production rose 19 percent between 2005 and 2006 and is projected to rise at an even faster rate from 2006 to 2007. However, continuing to grow domestic ethanol production at this pace over the next five to 10 years will prove highly challenging, as food and other agricultural prices have skyrocketed this past year in response to this new demand for corn. Moreover, even with such future growth in ethanol production, we will still only be eliminating future increases in oil imports, not actually lowering them from current levels.

Beyond the five-year time frame, plug-in electric cars or hydrogen fuel could play an increasingly important role in diversifying fuel choices in the transportation sector. Today, however, they only represent a small experimental place in the market. If they were to grow, then renewable fuels and nuclear energy could displace oil as transportation fuels, as they would provide the necessary electricity to power a transformed transportation sector.

More than 50 percent of Americans heat their homes with natural gas, compared to 40 percent who use heating oil and/or electricity. It is possible for more Americans to heat their homes with nonoil fuels or to use less heating oil for heating by improving home insulation and installing a more efficient heating system. In 1970, 32 percent of homes in the United States used oil for heating. That figure had fallen to about 14 percent by 2005. Peak heating oil demand was about 1.7 million b/d in the winter of 2005, compared to 2.1 million b/d in 1999.

If customers were to switch to electric heating, then renewable sources could play a larger role in displacing oil. There is certainly room for growth. For example, in 2006 nonhydro renewable sources provided about 96,423 thousand megawatt hours of total electricity, or about 2.3 percent of total U.S. electricity generation. Clearly, even modest growth in generation from sources such as solar power and wind could displace oil demand for home heating.

Q. What percentage of total U.S. primary energy supply comes from oil? What percentage comes from other fuels?

In 2006, the United States consumed 99.873 quadrillion Btu (British thermal units) of energy, according to the U.S. Energy Information Administration (EIA). Fossil fuels were the major source of this energy use, providing about 85 percent of the total. Petroleum provided 39.6 percent of total U.S. primary energy, followed by coal and natural gas at 22.5 percent each, then nuclear at 8.2 percent, and renewables at 6.8 percent.

Of the roughly 7 percent of energy derived from renewable sources, biomass provided the largest portion at 48 percent, followed by hydroelectricity at 42 percent, geothermal sources at 5 percent, wind at 4 percent, and solar power at 1 percent. The electricity sector continued to consume the majority of renewable energy, standing at 56.4 percent, with the industrial sector using 28.5 percent, and the remainder being used in the residential (6.9 percent), transportation (6.5 percent), and commercial (1.7 percent) sectors.

Q. Twenty-five years from now, is oil still predicted to be a large percentage of total U.S. primary energy?

The authoritative International Energy Agency (IEA), based in Paris, projects that U.S. oil demand will reach 25 million b/d in its business-as-usual case scenario. This forecast is very similar to that of the U.S. Department of Energy. However, the IEA indicates that this projected oil use can be reduced by up to 10 percent — or as low as 22.5 million b/d in 2030 — through the adoption of alternative policies that include a moderate, progressive increase in fuel economy standards and expansion of renewable portfolio standards, biofuels use targets, and tax credits for integrated gasification combined cycle clean coal plants. Under this alternative policy scenario, the IEA projects U.S. total primary energy demand to be about 7.5 percent lower, but oil will still remain at 38 percent of primary energy, with renewables rising only to 9.5 percent (up from the business-as-usual forecast of 8 percent of primary energy). Natural gas, nuclear and renewables all gain market share in this alternative policy scenario, suggesting that a multipronged approach is needed to reach a target of lower oil use. Still, the IEA alternative scenario analysis highlights the difficulties of moving the shares of various fuels without undertaking major policy interventions, such as energy or carbon taxes, or dramatic changes in efficiency regulations for automotive technology and substantially higher economic incentives for renewable energy.

U.S. Policy Options

Q. Is achieving U.S. energy independence plausible?

Eliminating 12 million b/d of oil imports from our daily lives is not plausible. In fact, talk of energy independence is ridiculous and may not even be a worthwhile goal. For example, if achieving energy independence means relying on very high-cost forms of energy when suitable low-cost sources of supply are available internationally, then economic well-being and consumer welfare could be compromised by favoring self-sufficiency over free trade.

Q: What about achieving U.S. energy independence through an aggressive ethanol program like Brazil?

This is highly unlikely. The amount of motor fuel that would have to be produced to eliminate imports in the United States is considerably higher than what is currently produced. U.S. ethanol production was 319,000 b/d in 2006, up from 255,000 b/d in 2005. To achieve “overnight” oil independence by replacing gasoline with ethanol, we would need to produce approximately 10 times the amount of biofuels being produced *worldwide* today.

It is important to point out that Brazil did not achieve energy independence through its ethanol program alone. Brazil engaged in an aggressive offshore oil exploration campaign that raised Brazil’s domestic oil production from 650,000 b/d in 1990 to 2 million b/d currently. Brazil’s ethanol production has only increased from 232,500 b/d in 1990 to 313,000 b/d currently.

Q. What is the possible maximum contribution that wind can make to the U.S. energy mix?

Wind’s contribution lies in the generation of electricity, which is a sector with very little direct oil use. Wind power accounts for just over 1 percent of U.S. electricity. The American Wind Energy Association (AWEA) estimates that the industry installed about 5,244 megawatts (MW) of new wind power generation capacity in 2007, representing about a 45 percent increase in total U.S. wind generation. AWEA expects similar growth in 2008. About 31 billion kilowatt-hours (kWh) were generated by wind power in the United States in 2007, enough electricity to power the equivalent of nearly 3 million average homes.

President George W. Bush, in his February 2006 Advanced Energy Initiative, stated that wind energy could potentially provide for 20 percent of U.S. electricity consumption, representing roughly 300 gigawatts (GW) of installed wind capacity. Research by the National Renewable Energy Laboratory (NREL), AWEA and other notable wind power organizations confirm that such a target could be technically feasible. Even so, reliability is an issue, since wind is in general highly variable. Thus, the benefits of wind could be significantly higher if an efficient method of electricity storage were to be developed.

Wind potential varies across the United States. There are four North American Electricity Reliability Corporation (NERC) regions that have significant class 4 or greater wind resources in the range of 0–4,390 Terawatt hours (Twh) including Western Electricity Coordination Council (WECC), Midwest Reliability Organization (MRO), Southwest Power Pool (SPP) and the Electricity Reliability Council of Texas (ERCOT). About 29 percent of the lands with the highest wind potential are located on federal property, mostly in western states.

Q. The United States has the largest reserves of coal of any country in the world. Coal can be converted to liquid fuel. Shouldn't we be using more coal? What about clean coal?

Coal is the most abundant fossil fuel. The United States has the world's largest proven coal reserves at 245 billion tons, or roughly 27 percent of global coal reserves.

Coal-to-liquids (CTL) technology is not new, but it has evolved. CTL was used heavily by the Germans in World War II and by South Africa during apartheid. The United States is well suited to utilize CTL as a means of reducing dependence on oil; however, both environmental and economic factors inhibit wide-scale adoption.

Economically, oil prices must remain, by most accounts, above $45 per barrel in the long run for CTL to be a competitive alternative to oil.

On the environmental side, coal mining and processing presents many concerns, in particular, the high greenhouse gas emissions that come from using coal. Burning coal produced 35 percent of all global CO_2 emissions between 2000 and 2005. If environmental factors are to be considered, then either coal will be off-limits because of its carbon intensity, or sequestration technologies must be employed to limit CO_2 emissions from its use. Sequestration, however, poses an additional cost that can render such options uneconomic.

In the power generation sector, the U.S. Department of Energy has been investigating how to develop a public-private partnership to design, build and operate the world's first coal-fueled, near-zero emissions power plant (so-called "FutureGen"). But it recently suspended its backing for one project that would have been built in Mattoon, Ill., at a net estimated cost of $1.8 billion. At present, there is no commercial coal plant in the United States that is using this clean coal carbon sequestration technology. Integrated gasification combined cycle (IGCC) technology gasifies coal before combustion, so it emits far fewer traditional pollutants such as sulfur dioxide (SO_x) and nitrogen oxide (NO_x) than traditional coal plants, but it still has higher greenhouse gas emissions.

The U.S. Department of Energy estimates that the marginal cost of electricity generated by a FutureGen-type plant will be about twice that of an IGCC plant that is operating without sequestration and about four times that of a traditional coal plant. This cost is high when compared to other fuel sources, but potential cost reductions may be revealed through the development and operation of future clean coal carbon sequestration-equipped facilities.

Q. Why can't the United States just increase oil production at home?

The United States has a premier energy resource base, but it is a mature province that has reached peak production in many traditional producing regions. The United States is the third largest producer of oil in the world behind Saudi Arabia and Russia, having produced 8.3 million b/d in 2006, of which 5.3 million b/d are crude oil and the remainder natural gas liquids (NGL), other liquids, ethanol and oxygenates. Expanding U.S. production is difficult due to a combination of geology, economics and policy.

Existing conventional oil that is produced in the United States comes from mature regions that have been fairly well explored and are now experiencing geologically driven production declines. Recently, technology and higher prices have made it profitable to explore in deeper waters in the Gulf of Mexico, and new oil reserves are being proven, but the process of exploration and development can take years before oil is actually produced. There are an estimated 800 billion barrels of crude oil locked away in shale deposits in the United States, but extraction is very expensive. Companies have only recently started to invest in shale development as prices have risen.

In recent years, environmental and land-use considerations have prompted the United States to remove significant acreage from energy development that was once available for exploration. Twenty years ago, nearly 75 percent of federal lands were available for private lease to oil and gas exploration companies. Since then, the share has fallen to 17 percent.

For key offshore areas in the Eastern Gulf of Mexico, Pacific and Atlantic Outer Continental Shelf (OCS), and in Alaska, access restrictions instated by the United States are in place due to explicit federal prohibition of drilling in environmentally sensitive areas. The total area of the federal OCS is about 1.76 billion acres. Of this acreage, about 46 percent is under active lease for oil and gas exploration, and about 20 percent of these active leases are in production.

The first OCS moratorium, covering 736,000 acres of coastal California, was passed by Congress in 1982 as part of the U.S. Department of the Interior appropriations bill. Between 1982 and 1992, several more annual moratoria were passed, which covered only the year in which they were enacted. These moratoria covered disparate parts of the OCS including the North and Middle Atlantic, Eastern Gulf of Mexico, and California coast. President George H.W. Bush issued a presidential directive in 1990 that created a 10-year blanket moratorium, which included most of the Eastern Gulf of Mexico. In 1998, President Bill Clinton extended the moratorium to 2012.

In other regions of the United States, burdensome requirements and restrictions exist as conditions for obtaining drilling permits, such as in the Rocky Mountain region. Certain regions in the Rocky Mountains are closed to exploration and development under federal access or no surface occupancy rules. In addition, the National Environmental Policy Act (NEPA) passed in 1969, the Endangered Species Act (ESA) passed in 1973, and the National Historic Preservation Act (NHPA) passed in 1966 present sometimes impossible hurdles through arduous conditions in order to gain approval for oil and gas development in the key Rocky Mountain areas such as the Wyoming Thrust Belt, the Green River and Powder River basins, and the San Juan and Uinta-Piceance basins.

In December 2006, Congress passed and President George W. Bush signed the U.S. Gulf of Mexico Energy Security Act into law. The measure opened access to 8.3 million acres in the Eastern and Central Gulf, while providing a 125-mile buffer for the Florida coast. Gulf Coast states will receive 37.5 percent of the royalties generated from the leases. The Mineral Management Service (MMS) has proposed holding lease sales 206 and 224 for the Central and Eastern Gulf of Mexico on March 19, 2008, which would be the first sale in the Eastern Gulf of Mexico planning area to offer these blocks since 1988. In July 2007, the U.S. House of Representatives affirmed its annual moratorium on drilling in most of the OCS as part of its discussions for 2008 appropriations for the U.S. Department of the Interior.

Environmentally related restrictions prevent a considerable quantity of oil from being produced (some estimates place it in excess of 85 billion barrels of recoverable oil) in areas of the Eastern Gulf of Mexico, the Atlantic and Pacific Offshore Continental Shelves, and areas in Alaska. Opening these areas for drilling would likely boost U.S. domestic oil production over the next decade but would still not be enough to significantly reduce the requirements for foreign oil imports.

An example of the influence of the access restrictions is found in a recent study of U.S. natural gas supply undertaken by the Baker Institute. The study shows that opening restricted areas in the OCS and Rocky Mountains to drilling and natural gas resource development will not render the United States energy independent nor will it even lower U.S. dependence on liquefied natural gas (LNG) imports in 2015 by a significant volume. However, the resulting diversity of supply is important, as higher OCS production weakens the potential for large foreign natural gas exporters to exert market power (see Baker Institute study at http://www.rice.edu/energy/publications/naturalgas_na.html).

Q. How much could we reduce oil imports by opening the Alaska National Wildlife Reserve (ANWR) for drilling?

The exact amount of oil in the ANWR is uncertain, but geologists at the USGS have estimated that the area has up to 10.4 billion barrels of economically recoverable oil. Ignoring costs, at a constant rate of potential production of 1 million b/d, this equates to roughly 28 years of supply once drilling began. If we consider costs, however, the number is likely lower. Thus, by itself, opening ANWR will not result in a substantial reduction in import dependence.

Q. The new 2007 energy bill increases corporate average fuel economy standards (CAFE) to 35 miles per gallon (mpg) for new automobiles by 2020, with first improvements required in passenger fleets by 2011. Is this new policy enough to lower U.S. oil imports?

No, the new 35 mpg standard for passenger cars is a step in the right direction, but it will only be able to ameliorate the projected *increase* in U.S. oil imports over the next 10 years. In addition, it will not reduce our imports from current levels. Given the schedule for the phase in of the new fuel standards, on-road efficiency of all motor vehicles should reach about 20.5 mpg by 2017, assuming new vehicle purchases represent about 6.5 percent of the entire fleet each year (this is the average for the past couple of years). This would reduce oil demand in the transportation sector in the United States by about 9.5 percent, putting U.S. motor fuel demand in 2017 at 12.0 million b/d instead of the 13.3 million b/d previously projected for 2017 but still 0.7 million b/d higher than U.S. gasoline use in 2006.

By 2020, the new standards would put U.S. gasoline demand at 11.6 million b/d, 2.3 million b/d below previously projected levels but 0.3 million b/d above 2006 demand levels. In total, between now and 2030, the new CAFE regulations could push oil use about 2.5 million b/d of oil lower than what was previously projected, assuming the average rate of vehicle purchases experienced in recent years.

To hold U.S. gasoline use completely flat at 2005 levels by 2017 through car mileage standards, *on-road* vehicle efficiency must reach 21.8 mpg. For this to occur over the next nine years, again assuming new vehicle purchases represent about 6.5 percent of the entire fleet each year, all *new* cars sold between 2008 and 2017 would have to average an efficiency of just over 30 mpg, substantially higher than what is currently mandated.

However, if the new standards are phased in differently than currently planned, or new vehicle purchases accelerate or decline so that the rate of new vehicle diffusion slows, the impact could be substantially different. If the rate of new vehicle diffusion into the existing U.S. passenger fleet were to slow from the rate of 6.5 percent that has been true in recent years (so that there was a smaller turnover in total existing U.S. on-road vehicle stocks — say only a 20 percent change) by 2017, vehicle fuel efficiency for new cars would have to average 42 mpg to hold gasoline demand flat between 2005 and 2017.

Further improvements in vehicle efficiency beyond those imposed by the new CAFE standards could also be potentially very important down the road. If, for example, a major breakthrough in car technology and innovation were to occur such that new vehicle fuel efficiency accelerated after 2015 to an average of 50 mpg by 2020, the implications would be substantial, even if no other regulatory policies are enacted. If new cars could achieve 50 mpg by 2020, fuel consumption would be about 7 percent lower in 2020 than it is today and would continue to fall beyond 2020 as the higher-efficiency new vehicles would diffuse more broadly into the vehicle fleet.

Q: What about reaching a 20 percent reduction in U.S. gasoline use through conservation or public transportation?

Let's consider the case of simply holding U.S. gasoline use at 2005 levels by 2020. To do this through conservation, by 2020 the average American adult would have to be driving about 23 miles less per vehicle per week, assuming on-road efficiency improves as assumed above under the new CAFE standards. For many, that could be one day a week commuting to work by car pool or by public transportation.

Q: Nuclear power is a carbon emission-free source of energy. Could nuclear power be the solution to our oil import dependence?

Reducing oil import dependence is not likely to happen through the electric power sector because very little of our nation's electricity comes from oil-fired generation. Nuclear power could, however, be part of a broader solution to our oil import dependence if the transportation sector moved to using more battery power than liquid fuel. One such avenue that has been proposed is through the adoption of the "plug-in" hybrid motor vehicle that could use electricity instead of gasoline as a main fuel.

The 2005 energy bill extended the U.S. federal insurance program that limits liability for nuclear power-plant accidents and included a number of measures aimed at enhancing the security of commercial nuclear reactors. Moreover, risk insurance to cover unexpected cost overruns caused by regulatory delays was authorized, as was a production tax credit of 1.8 cents per kWh for the first 6000 MW built before 2021. The new regulations have led to a flurry of permit applications for the construction of new or expanded nuclear facilities in the United States, but no more than three to six new plants are forecast to be built in the next 10 years given rising construction costs and the long lead times from first permitting to construction.

Q: Are plug-in hybrid electric vehicles a viable option, and could they help reduce our oil dependence?

The plug-in hybrid, were it to come to market, seems to be a very attractive option when the cost of utilization is considered. These vehicles would allow most short-distance driving to be achieved through the use of only a battery. The cost to charge up to 35 kWh at an average retail price of 9.45 cents per kWh (the average price to residential consumers in 2005) in the United States is $3.31. Such a charge would give a range of up to 150 miles, rendering a cost of 2.2 cents per mile. This is far better than the cost per mile for the average gasoline-fueled internal combustion engine of 17 cents per mile (a $3 per gallon equivalent at 17.3 miles per gallon). In fact, in order to get the cost per mile up to a $3 per gallon gasoline equivalent, the retail price of electricity must be greater than 50 cents per kWh, which is considerably higher than current price of 9.5 cents per kWh.

Of course, moving to a transportation sector that is more dependent on electricity would drive up electricity demand, which could increase our dependence on imported natural gas while reducing our oil import dependence. But, if clean coal, nuclear, solar and wind energy were a part of this approach, the oil savings could be achieved without the offsetting increase in dependence on natural gas.

Q. The State of California is pushing solar energy as a way to both reduce greenhouse gases and enhance energy security. What are the barriers to widespread use of solar energy in the United States?

At a cost of between 20 cents to 30 cents per kWh, solar energy is considerably more expensive than other existing fuels for electricity generation, thereby rendering solar power an unattractive primary fuel source based solely on economics. Making solar energy easier and cheaper to store remains a key challenge. Sadly, despite solar energy's great potential as an unlimited renewable resource, U.S. federal spending on solar energy is quite small because it lacks a large political constituency to push for its funding. U.S. federal spending on solar energy is only $70 million per year, compared to $2 billion per year for clean coal research. Such a small budget for research and development for solar energy reduces the chances of a major breakthrough to lower the costs for producing this ideal source of energy. Nanotechnology has contributed, and should continue to contribute, tremendous benefits for the advancement of solar technology by opening the possibility for new, more efficient technologies to capture sunlight.

Even with aggressive incentive programs, scaling up the use of solar energy is likely to take a long time and incur great expense, especially to reach levels that make a critical contribution. Germany and Japan introduced incentives in 1999 and 1994 respectively but neither market has exceeded 1,500 MW of installed capacity. California's new solar initiative aims to provide 3,000 MW of additional solar capacity in 10 years through more than $3 billion in subsidies and incentives. While a step forward, 3,000 MW of electricity only amounts to about six natural gas combined cycle facilities, and represents less than 3 percent of the nation's total generation capacity. An additional 3,000 MW of giant solar collection and generation projects have been announced for vast stretches of the U.S. Southwest, to be completed between 2009 and 2014.

Q. Why do we need a comprehensive energy policy?

Unfortunately, the reality is that no single solution will lead to a *decrease* in U.S. oil consumption or achieve U.S. energy independence. The problem of U.S. oil import dependence is a complicated one to solve. It is going to take a broad portfolio of policies to actually lower oil use rather than just control the rate of increase.

A comprehensive U.S. energy policy would include improving efficiency, encouraging alternative fuels, promoting public transportation and other measures to curb oil use in the United States, as well as consideration of measures to increase access to lands for energy resource development. It may also require changes in lifestyle and perhaps, depending on circumstances in the future, personal sacrifices or new taxes on energy use or carbon intensity. That is the reality of our situation and the barometer through which proposed energy policies should be judged.