Center for American Progress

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A Framework for Achieving Energy Security and Arresting Global Warming

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Introduction

Global warming has the potential to cause serious, worldwide national security, economic, and environmental problems, including mass migrations, resource shortages, major environmental disruption and species extinction, changes in agricultural patterns, staggering economic and human losses from extreme weather events, and the spread of deadly diseases.[1] These dangers are closely linked with our dependence on foreign oil; at a price of $75 a barrel, the United States sends about $330 billion a year to other countries to pay for oil imports, some of which goes to hostile states, our enemies, and terrorist organizations.

Political leaders in the United States have so far failed to effectively address either global warming or our dependence on foreign oil. Federal and state governments have for decades proposed improving energy security by reducing dependence on foreign oil and boosting energy efficiency with almost no success. Ninety-six percent of the fuel we use today for transportation still comes from oil, about 60 percent of which is imported. [2]

The latest effort to reduce our dependence on imported oil, the Energy Independence and Security Act of 2007, or EISA, increases fuel economy standards and requires refiners to produce more biofuels. Yet in the absence of even greater rises in fuel prices than the rise that occurred in the first half of 2008, the bill's measures will reduce dependence on foreign oil only marginally between now and 2030 because most of its reductions in oil use will be offset by the growing demand for oil.

U.S. and world leaders have been equally unsuccessful in addressing global warming. The atmospheric concentration of the greenhouse gases that cause global warming, most significantly carbon dioxide, continues to accelerate from an average rate of increase of about 1.5 ppm per year in the 1980s, to 2.0 ppm per year from 2000 until 2006, and 2.4 ppm per year in 2007.[3] The United States' failure to address global warming has contributed significantly to the problem. The United States generates 25 percent of the world's CO2 emissions, and its CO2 emissions have increased by about 19 percent since 1990, yet it has so far only set voluntary reduction targets.[4]

Voluntary reduction efforts in the United States, the emission reduction and trading scheme in Europe, and the Kyoto Treaty's entry into force—which only the United States among industrial nations has failed to ratify—have not been enough to reverse the trend of growing worldwide emissions and rising greenhouse gas levels in the atmosphere. This failure is ominous. There is a significant risk that if we do not act quickly enough and if greenhouse gas levels become too high, global warming will become irreversible for centuries or longer.

Addressing energy security and arresting climate change will require a transition to a non-carbon based economy and more fuel-efficient vehicles. This will take decades, even with strong measures, so new initiatives will have to be durable enough to withstand political vicissitudes and arguments that regulations should be weakened during economic slowdowns. Because efforts to solve both issues are inextricably intertwined, they must be addressed together, and actions to solve one issue cannot compromise the ability to address the other successfully. Most importantly, political compromises that result in half measures, such as the EISA and many of the proposed limitations of global warming now being considered by Congress, are not equal to the magnitude of the problems and are thus likely doomed to costly failure.

The federal government will need to address five key sets of issues in order to confront global warming and reduce our dependence on foreign oil:

1. Identify and set goals that must be achieved to address these issues successfully and create a timetable for action.

2. Implement measures that will accelerate implementation of needed new technologies.

3. Set up a regulatory system that will withstand many decades of political pressures to weaken it.

4. Address the key sectors where CO_2 emissions are projected to increase most significantly and the programs necessary to prevent that increase.

5. Enact policies that will enable developing countries to set and agree to mandatory CO_2 reduction measures and significantly reduce their use of oil for transportation.

Setting goals

Successfully addressing global warming and energy independence will require agreement on a set of goals that are widely accepted both domestically and internationally. Such goals would provide a metric against which proposed legislation to address these issues would be objectively measured. Once goals are set, they will need to be implemented in as cost-effective a manner as is possible.

Global warming goals

Almost all scientists agree that global warming is already having an effect on the world's climate. They believe that there is a significant risk that if greenhouse gas concentrations in the atmosphere become too great, they could trigger the mass melting of polar icecaps, disruption of the Gulf Stream ocean currents, and similar events that will "feed" on themselves and become uncontrollable, rapidly accelerating global warming and making it very difficult to stop or stabilize for many centuries at a minimum.

There is no way to determine with absolute certainty when "feedback loops" will occur, since scientific models such as the ones used to model global warming forecast the future but do not guarantee it. Yet the scientific consensus, based on increasingly refined models, is that when the level of CO2 in the atmosphere exceeds 450 ppm[5] the risks from uncontrollable "feedback loops" become too great.

Several leading scientists, including James Hansen, have concluded recently that atmospheric concentrations should not be allowed to increase above this level—and, once stabilized at 450 ppm or less, should be reduced after a relatively short period of time.[6] The United States should therefore adopt the proposal being considered by the European Union to set an initial goal of reaching equilibrium in CO2 emissions at or before CO2 levels in the atmosphere exceed 450 ppm.[7] Leaders of G8 nations have recognized this and set a target of reducing CO2 levels by 50 percent by 2050, which is roughly equivalent to setting a 450 ppm level.

Scientists estimate that the earth's atmosphere contained 280 ppm of CO2 at the start of the industrial revolution. The CO2 level is currently 385 ppm and is increasing at a rate of about 2.0 ppm to 2.4 ppm per year.[8] If atmospheric concentrations continue to increase at this rate, we will reach a level of 450 ppm in 27 to 32.5 years. We have no time to wait if we hope to achieve equilibrium at the 450 ppm level, but we will have more time within which to achieve atmospheric equilibrium if we can decrease the rate of increase below 2 ppm. For example, if the rate of increase could be reduced to 1 ppm per year, we would have 65 years before reaching a 450 ppm level of CO2 in the atmosphere.

Translating the worldwide 450 ppm cap to a United States reduction target depends on many factors. The United States currently emits about 25 percent of all CO2 emissions, and its emissions are far higher per capita than China's, even though China is now the world's number one emitter. Most of the currently proposed global warming legislation in the United States sets a cap on CO2 emissions in 2050 at a level of between 50 percent to 80 percent below 1990 levels. The United States needs to be a leader in CO2 reductions given its historic contribution to CO2 emissions and its economic and scientific capabilities. The goal should be the 80 percent reduction target, which now has the support of many scientists, commentators, and political leaders.[9] This 80 percent reduction will have to be achieved despite all the economic and population growth that will occur in the years ahead.

The United States' target of reducing emissions by 80 percent by 2050 will need to be coupled with equally aggressive targets for other developed nations and credible, if initially less dramatic, targets for developing countries, particularly China, in order to limit atmospheric levels of CO2 to 450 ppm or less. Cumulative global reductions will need to be of sufficient magnitude and speed to allow us more than 27 years to 32.5 years before reaching the 450 ppm level and then enable us to stabilize CO2 concentrations in the atmosphere at or below that level.

Energy security goals

The greatest energy security risks are not 27 years or more in the future. The United States is suffering from dependence on imported oil now. The United States consumed about 20.65 million barrels of oil per day in 2006, of which 60 percent—about 12.4 million net barrels—was imported.[10] Most of our European and Asian allies face similar or even greater dependence issues. Prior to the passage of the EISA, both the United States Energy Information Administration and the International Energy Agency predicted that world demand for oil would increase by a staggering amount—from about 83 million barrels per day in 2005 to about 118 million barrels per day in 2030.[11]

We can only achieve energy security by ending oil's global monopoly on transportation fuels. This monopoly not only leads to higher prices, it also places the United States, Europe, China, Japan, and other nations in an impossible strategic position because there are no current, viable alternatives to meeting transportation fuel needs. At the same time, in order to cut down or eliminate the flow of $330 billion[12] to other—often hostile—oil-producing nations, the United States must vastly reduce its oil imports. And the United

States has to pursue policies that make it easier for our allies to achieve the same result.

The United States will have to reverse trends that date back over 20 years in order to reduce dependence on foreign oil. U.S. dependence on imported liquid fuels such as crude oil and other sources of petroleum has been increasing rapidly since 1985—from about 4.3 million barrels per day in 1985 to about 12.4 million barrels per day in 2007.[13]

The Energy Independence and Security Act includes two key provisions designed to reduce demand for oil, but these measures will not be sufficient in themselves to significantly lower oil consumption. The first, increasing fuel efficiency for passenger and non-passenger automobiles from 25 mpg to 35 mpg by 2020,[14] will decrease oil use by 2.5 million barrels per day by 2030.[15] The second, increasing biofuel production from 6 billion gallons per year at the time of the Act's passage to 36 billion gallons per year in 2022,[16] would reduce oil use by about 1.3 million barrels per day.[17] These two measures will together decrease oil consumption in the United States by about 3.8 million barrels per day in 2030.[18]

Yet the increased consumption of oil projected for this period will offset the 3.8 million barrel per day decrease in oil use attributable to the EISA. Prior to the passage of EISA, the Energy Information Agency projected in its high oil price scenario in 2007 that consumption would grow by the same amount as the reduction in demand from the Act—about 3.8 million barrels per day during this same period.[19] As a result, even after passage of the EISA, and assuming current levels of crude oil production, the United States will continue to import about 12.4 million barrels of oil per day in 2030.

The United States must break its patterns of consumption and advance energy goals. It can begin by setting far more ambitious goals for fuel efficiency—the International Energy Agency recently called the EISA "too timid"—and for increased use and development of CO2-friendly cellulosic biofuels.[20] EISA's goals do not extend beyond 2020 for automobiles and 2022 for biofuels. Efforts to include more ambitious goals were rejected, although EISA requires is "at least" a 35 mile per gallon level so the secretary of transportation could on his or her initiative, further increase that goal.[21]

Based on studies of the potential to reduce demand for oil by the aggressive, but achievable, measures described below, Congress and the administration should set a goal of reducing demand for oil by another 5 million to 6 million barrels per day by 2030 beyond the projected 3.8 million barrel per day reductions that will result from the passage of the EISA. This more aggressive goal is reasonable given the potential of new technologies such as hybrid vehicles, plug-in hybrids, and certain CO2-friendly cellulosic biofuels. And Congress and the administration should continuously review that goal to see if technological and other developments permit increases beyond the reduction of 9 million to 10 million barrels per day achievable through EISA requirements and the measures recommended below.

The Department of Energy is predicting some increase in domestic oil production between now and 2030, but that increase has only relatively limited potential to reduce oil imports and it will not lower greenhouse gas emissions since it will not reduce oil consumption. The United States possesses only 3 percent of the estimated world oil reserves, but it consumes 25 percent of the world's oil,[22] and U.S. oil production has dropped relentlessly for the past 20 years. Increased offshore oil production from areas that were open to leasing prior to September 2008 is likely to reverse this trend, but the Energy Information Agency predicts only a modest increase in U.S. crude oil production from 5.1 million barrels per day in 2006 to 6.7 million barrels per day in 2030, an increase of 1.6 million barrels per day based on a case assuming a high price for gas and rapid technological advancement.[23]

In September 2008, Congress let a long-standing moratorium on leasing and drilling for oil in certain offshore areas expire, yet this will have little effect on oil production between now and 2030. According to the Energy Information Agency, opening the areas of the lower 48 states' outer continental shelf that were formerly closed to leasing would increase oil production by only about 200,000 barrels per day between now and 2030, even though opening those areas would increase potential oil resources in offshore areas from 41 billion to 59 billion barrels of crude oil.[24]

EIA has not explained why the increase in production would be so small, but the low estimate of production in 2030 from moratorium areas is likely based on: (a) the high cost of drilling in many of the areas subject to the moratorium; (b) the fact that only 8 million of the 42 million acres leased before Congress lifted the moratorium are currently in production;[25] (c) the expectation that oil companies will first develop areas previously eligible for leasing, rather than those that had been subject to the moratorium; and (d) the assumption that production in moratorium areas would displace, rather than add to, production from areas previously subject to leasing.[26]

Synthetic fuels such as coal-to-liquids, tar sands, and oil shale should also not be relied upon to increase oil supplies. There is currently no synthetic fuel industry in the United States, and even if the industry is able to get off the ground, the Energy Information Agency estimates that synthetic fuels will likely be able to close by 2030 only a small (1.5 million barrels per day) part of the gap that is filled by imported oil.[27] Moreover, synthetic fuels are strongly opposed by the Center for American Progress[28] and many other organizations because their production produces more greenhouse gas and uses more resources than conventional petroleum refining and would take us in the wrong direction from a climate perspective.

Increased oil production from conventional fuels, even including the moratorium areas, has the potential to increase oil supplies by about 1.8 million barrels per day in 2030. By contrast, reducing demand for oil has the potential to reduce consumption by 9 to 10 million barrels per day while greatly reducing greenhouse gas emissions. The clear signal is that we should redouble our efforts to reduce oil imports by reducing demand for oil and by developing alternative fuels, utilizing conventional oil supplies to fill the gap between our transportation fuel needs and the availability of oil alternatives.

The technology conundrum: stimulating the deployment of new technologies

The United States will have to confront the question of whether it can achieve the necessary deep reductions in fuel consumption and CO2 emissions if it is unable to make major advances in developing and deploying new technologies such as plug-in electric hybrid vehicles, which have the potential to achieve fuel economy standards of 100 miles per gallon or more. Technology development and rapid deployment are key to reducing worldwide demand for oil, cutting worldwide CO2 emissions, and boosting the American economy by creating jobs at home and exporting new technologies overseas. What's more, some of the profits generated by exporting or licensing new technologies could be used to help offset the costs of developing programs that address climate change.

Yet we haven't been able to develop these technologies in a timely fashion. Many experts have concluded that needed technological advances such as hybrid cars, energy efficiency measures, and wind and solar power are ready for use, while others such as capture and sequestration of CO2 emissions from new coal plants, plug-in hybrid cars, and all electric cars are close to ready for use. The conundrum is that new technologies often take decades before they become commercially dominant in a market. One leading commentator on new technologies describes this gap as a "chasm" that separates the commercial development of a product and its deployment.[29]

Shell Oil Company noted in its 2001 scenario on how energy use is likely to evolve over the next five decades that it has taken an average of 25 years after the commercial introduction of a primary energy form for it to obtain a 1 percent share of the global market.[30] In the automobile industry, a study concluded that it took 10 years to 30 years after the introduction of a new technology before it was deployed on half of new vehicles.[31] Similarly, "[h]ybrids were introduced into the [United States market] … by Toyota and Honda in 1997. Sales began to soar after 2000. . . . [but] in 2005, eight years after they were introduced, [sales of] hybrids were only slightly more than 1 percent of new car sales in the United States."[32] Joe Romm, a leading energy expert and Center for American Progress senior fellow, has written that "[the] distinction between technology development and technology deployment may seem mundane, but it is one that will prove critical to whether or not this nation can avoid catastrophic global warming without devastating its economy."[33]

The most basic explanation for why it takes so long for new technologies to be adopted by a market is that adopting a new technology is risky. It might take years of operating experience before the new technology is understood well enough for it to work as well as promised, and the first-generation plants using a new technology are unlikely to work as well as second- and third-generation plants. Second- and third-generation plants are also likely to cost less to operate and build than first-generation plants.

A good example is carbon capture and sequestration technology. It is almost universally agreed that deploying CCS technology is critical to ensuring that coal remains a viable source of domestic energy in a carbon-constrained world.[34] Yet there is little incentive for most companies to do so now because CCS technology will improve over time and the cost of building and operating a CCS plant will rapidly decrease as the technology evolves. According to a study by the Electric Power Research Institute, if there is aggressive research, development, and deployment, the capital cost of building a CCS plant in 2030 will be 30 percent less than the cost of building one in 2005. Moreover, a plant producing at 30 percent operating effiency today could be operating at 45 percent efficiency in 2030—an improvement of 50 percent.[35]

Most companies in a traditional market situation wait until other companies have tested and perfected a new technology, and until cheaper second- and third-generation plants or equipment are available. That is the most cost-effective and economically rational way to act, but the resulting delay in deployment can often stretch over decades. The policy dilemma when we confront global warming and energy security is that we cannot wait for new, available, and critical technologies to reach the point where they can become dominant in an industry under a business-as-usual scenario.

There are several possible ways to speed up the implementation of a new technology. The first is to rely on market mechanisms such as a system that sets a market price for CO2 emissions. For example, if the cost of building a coal-fired power plant with CCS is greater than the cost of building a plant without CCS, a system that requires a non-CCS plant to internalize the cost of emitting CO2 might make plants that capture CCS cost-competitive. But assuming that incentivizing the construction of coal-fired plants with CCS is only one aspect of a system that sets a market price for CO2 emissions, the market might not set a CO2 price that is high enough to overcome the cost differential between plants with and without CCS. Seeking to push up the price to overcome the difference runs the risk of distorting the market price for other participants in the market. In fact, in the case of CCS, the market price for CO2 is likely to be far lower than necessary for many years to make plants with CCS cost-competitive with plants without CCS that have to pay for their CO2 emissions.[36]

There are similar problems with relying on market price signals alone to speed the deployment of advanced, fuel-efficient vehicles. The price of crude oil on January 1, 2003 was about $1.50 per gallon for all grades, or approximately $1.50 lower than it was on July 1, 2007.[37] Yet gasoline usage increased between 2003 and 2007 and sales of fuel-efficient cars such as the Prius gained only a very small market share during this period. Sales of fuel-efficient cars started showing the first signs of growth only after gasoline prices began to approach and then exceed $4.00 per gallon.[38] Gasoline prices have, however, again fallen substantially, and it is unclear if this decrease will again slow the momentum to switch to fuel-efficient cars.

There is another perhaps even more important problem with relying on market mechanisms alone to ensure rapid deployment of a new technology, particularly with regard to technologies that are purchased by businesses. Even when a new technology becomes cost-competitive with the old technology, most companies will not buy early versions of the technology because of the risks described above. They will instead wait for second- and third-generation technologies. These risks—non-price barriers to entry—can be very difficult to price and very expensive to overcome, and they require incentives beyond those necessary to make a new technology cost-competitive.[39]

Another way to speed up the deployment of a new technology is to mandate the level of performance that the new technology can achieve once one or more new technologies are available to achieve the performance level. Such a mandate overcomes the non-price barrier to entry since all participants in the market have to achieve a comparable level of performance and cannot wait for second- and third-generation plants before adopting the technology.

Using mandates has been a standard practice in addressing difficult clean air issues, and the United States has in the past been successful at using mandates to reduce emissions despite the construction of many new sources of pollutants. The United States historically met this challenge by requiring new plants to use the best available existing technology, proving that we can have both economic growth and the minimal impact that is technically feasible from new sources of emissions.

For example, the United States has developed a very successful market system to address acid rain pollution that requires all new power plants to use the best available technology to reduce emissions that cause acid rain. Such measures engender little debate in the business community, although requirements to retrofit existing plants have caused great controversy.

Mandates have also been used successfully to increase automobile mileage standards. Automobile mileage standards helped reduce U.S. oil consumption by 17 percent from 1977 to 1985, even as the gross domestic product grew over those years by 27 percent.[40]

Implementing selective and carefully chosen mandates to complement a general market-based system of achieving CO2 reductions will be the key to making the deep changes necessary to address climate change and speed up the achievement of energy security.

Such mandates would set a performance level in reducing CO_2 emissions or increasing energy efficiency, and it is appropriate to implement such mandates after at least one proven technology exists that can achieve the performance standard.

Because performance mandates require a performance level and not the use of a particular technology, they do not force a choice between different technologies and, thus, the selection of winners and losers—the key objection that free market economists have to technology deployment programs. Performance mandates therefore allow full-market competition over a range of options that could ultimately achieve the prescribed performance standard.

Because these performance standards are mandated before they can be produced at the lowest cost, they are likely to be far more expensive in the early years of their deployment than they would be for second- or third-generation plants, vehicles, or products. The government should therefore subsidize early deployment in order to make mandates acceptable to industry and reduce the effect of rapidly rising costs on consumers.[41] These subsidies—particularly if funded from the sale of allowances in a cap-and-trade auction, as described in the next section—should be viewed as a reallocation of funds from more- to less-intensive sources of CO_2 emissions and from less- to more-fuel-efficient vehicles. The subsidies would speed the transition to more sustainable, carbon-free sources of energy and far more fuel-efficient vehicles.

Establishing a robust regulatory system

A cap-and-trade system, a tax on carbon, and various mandates have all been proposed to arrest greenhouse gas emissions and reduce use of oil in vehicles. A system that combines the best elements of each is needed to address these issues.

Virtually all proposed global warming legislation establishes a cap-and-trade system to reduce greenhouse gas emissions. A cap-and-trade system sets up a continuously declining cap on emissions. It assigns or sells through an auction process permits (often called allowances) to emit greenhouse gases, and authorizes those regulated entities to retire those allowances or sell them if they can generate reductions more efficiently than other regulated entities. If the system does not auction 100 percent of its allowances, the free market aspect of the system—where entities can buy and sell allowances to each other—markedly increases its efficiency. Similar economic efficiencies would occur in a 100 percent auction-based system.[42] Outside "offset" allowances from non-regulated sources, such as from reforestation and avoided deforestation, or from entities in developing countries that are not subject to regulation, are permitted up to a prescribed limit in most proposed bills.

Most proposed legislation has chosen a cap-and-trade program over a tax for sound policy reasons. A primary attribute of a greenhouse gas regulatory system must be its "robustness"—its ability to withstand political attack and last for many decades. Whatever their economic efficiency advantages, tax systems are simply not robust in the American political system. Congress has found it exceedingly difficult to pass significant energy tax increases in the United States, and opponents would lambaste as a major burden even a relatively small tax that was too low to have any real effect on greenhouse gas emissions. And to match the results of a cap-and-trade system that reduces emission levels over time, a carbon tax would have to escalate constantly. Such an escalating tax is extremely unlikely to find and maintain political support in the United States.

Gasoline taxes provide a good example of the difficulties in setting a tax. Taxes on gasoline of even a few pennies have been vigorously opposed in recent years, even when they would raise funds for needed road improvements. Determining the correct tax to convince consumers to buy more fuel-efficient cars also would be very difficult. As described above, even though gasoline prices increased by about $1.50 per gallon for all grades between January 1, 2003 and July 1, 2007, gasoline usage increased during this period. Yet if a tax of $1.50 per gallon had been passed in 2003, it would have been hailed by those seeking to reduce the use of gasoline and thus gasoline imports as a major step toward achieving reductions in gasoline use and in greenhouse gas emissions. As we learned in the first half of 2008, rising gasoline prices through market forces or a tax will eventually decrease gasoline use and encourage consumers to buy more fuel-efficient cars, but the decline in gasoline use in the first half of 2008 was modest.[43] It did not provide sufficient information to calibrate the level at which a gasoline tax would result in a significant reduction in the use of gasoline.

Cap-and-trade systems are also preferable because they set a declining cap on emissions, which provides certainty about the amount of emission reductions. Taxes, by contrast, set a firm price but do not ensure a set level of reductions. If the price signal is wrong, it will prove very difficult to raise the tax. Given the critical need to reduce greenhouse gas emissions, the uncertainty in reductions resulting from a tax and the likely inability to constantly adjust the tax to the right level are fatal weaknesses.

A cap-and-trade system alone also has weaknesses. Market systems, like a cap-and-trade program, do little to ensure that new technologies are rapidly adopted, which allows companies to continue constructing massive inefficient emission sources that could have been replaced from the outset by more efficient facilities or vehicles. Carefully chosen performance standards are needed in combination with a cap-and-trade system in order to achieve rapid deployment of new technologies. Such standards have proven very politically robust, as they do not require constant tinkering and provide certainty to businesses about what they must do. Carefully chosen mandates to capture and sequester CO2 emissions from new coal plants, mileage standards for automobiles, renewable energy portfolio standards, and energy efficiency requirements are vital to developing an effective global warming and energy security regulatory system.

A cap-and-trade system can also build in economic incentives similar to those provided by a tax by providing for the auction of some or all of the CO2 allowances. Building in a price for emitting greenhouse gas would encourage regulated entities to reduce greenhouse gas emissions as quickly as economically practical while at the same time retaining the certainty in emission reductions provided by a cap-and-trade program. Auction revenues would also provide a dedicated source of funding for new energy technology subsidies and incentives, and for payments to lower-income persons to offset increased energy costs from global warming and energy security programs. Most of the proposed global warming bills include an auction system in which the number of allowances auctioned increases each year, and many politicians have called for a 100 percent auction requirement.

Addressing oil demand and CO2 emission growth

The first step toward reducing greenhouse gas emissions and limiting oil imports will be to minimize the effect of new sources of emissions and oil use by new vehicles. The transportation sector and the electricity generation sector, of particularly new coal plants, are likely to generate the greatest increase in CO2 emissions in the coming years, and the transportation sector will use the most imported oil. Together, these two sectors account for 72 percent of U.S. greenhouse gas emissions.[44] Coal-fired plants account for 80 percent of all CO2 emissions from power plants, and about 90 percent of transportation emissions come from household vehicle use.[45] Electric power plants will also provide electricity for plug-in hybrid vehicles and for ethanol plants, and are thus critical to the level of life-cycle CO2 emissions from these sectors.

The transportation and power sectors are also the sectors where greenhouse gas emission growth has been the greatest since 1990. Emissions have risen an average of 1.5 percent per year in the transportation sector and 1.8 percent per year in the electric power sector.[46] The growth in emissions in these two sectors is greater than the overall rate of emissions growth for the whole economy, which was only 1 percent per year, and also greater than the growth of emissions from the industrial sector of the economy, which has not increased since 1990.[47]

Continued reliance on high-emitting technologies in these two sectors will lock in emissions increases that will persist for decades, requiring difficult reductions in emissions in future years when emissions reduction requirements tighten and driving up future mitigation costs. The median turnover for the automobile fleet is 15 years,[48] and new coal plants—the largest source of greenhouse gas emissions—will likely be in use for 50 years to 60 years. Using new technologies to drive down emissions in these sectors now is critical to achieving future emission reductions at a reasonable cost and should be a near-term priority for policymakers addressing global warming.

Increasing efficiency in the transportation sector

Growth in the number of vehicles on the road and the miles traveled per vehicle has historically offset improvements in vehicle fuel economy. As new cars are added to the fleet, older, less-efficient cars are removed from service, but oil use still grows each year if enough new vehicles are purchased.

Even the new 40 percent increase in mileage standards and major new biofuel mandates by 2020 are insufficient to reduce the need for imported oil more than marginally between now and 2030.

Reducing the United States' dependence on oil imports by reducing oil consumption will require bold action and confidence in the country's ability to achieve technological breakthroughs. Current proposals include reducing demand for gasoline through greater fuel efficiency, replacing oil with advanced cellulosic biofuels, and reducing mileage traveled by offering shorter commutes and alternatives to driving.

Reducing demand for gasoline through greater fuel efficiency. Reducing demand for gasoline will lessen both oil use and CO2 emissions and is necessary to break oil's monopoly on transportation. The needed technologies are ready or likely to be ready for mass production in the next few years. And fuel-efficient cars that use new technologies can be sold and produced both inside and outside the United States, thus addressing the strategic question of reducing worldwide demand for oil.

As described above, the EISA will reduce the use of oil by an estimated 3.8 million barrels per day by 2030, but much greater reductions are technically feasible and should be required. The EISA sets a vehicle fleet goal of 35 mpg by 2020, but recent studies indicate that vehicle fleets could meet a fuel efficiency standard of 39 mpg or 40 mpg by 2020.[49] This would reduce oil use by an estimated 0.4 million barrels per day. In addition, aggressive implementation of the fuel economy provisions for medium- and heavy-duty vehicles included in the EISA would reduce oil use by an estimated 0.75 million to 1.3 million barrels per day in 2030.

The greatest long-term reductions will come from increasing the mileage standards well above the EISA floor of 35 mpg. Earlier versions of the EISA proposed increasing mileage standards from 35 mpg in 2020 to 55 mpg in 2030. If Congress and the White House adopted this target, it would decrease oil imports by at least an additional 1.6 million barrels per day by 2030.[50] And as more old, fuel-inefficient cars are replaced after 2030, the gains from increasing the mileage standard to 55 mpg will become much greater—eventually leading to a doubling of average mileage for all cars and a 50 percent reduction in fuel use by cars and light vehicles from current levels.

There is every reason to think that these fuel-efficiency standards can be achieved and that new technologies, particularly plug-in hybrid cars, can achieve even more dramatic reductions in oil use.

General Motors and Toyota have announced that they will begin commercial production of plug-in hybrid vehicles in 2010. GM expects to have an initial production run of 60,000 vehicles for its plug-in, the Volt. The Volt should be able to drive 40 miles on its electric charge, at which point a gasoline engine would be used to recharge the battery; the car will be able to go up to 500 miles on one charge plus one gas tank. It is estimated that about 78 percent of all motorists drive less than 40 miles per day,[51] and no gasoline would be used during those trips. On an overall basis, a plug-in hybrid like the Volt, which is capable of running for 40 miles on a single charge, is expected to get the equivalent of 134 mpg—and potentially consume even less gasoline if bio-fuels are part of its fuel blend.

It will take considerable time for plug-in hybrids to significantly decrease fuel use. The technology must be perfected, and this could take longer than expected. Costs of plug-in hybrids will be higher than gasoline-powered cars, at least in the early stages of plug-in production, and a significant tax credit will be necessary to encourage significant early sales.[52] Financial assistance to the car industry to retool their plants to produce cleaner cars would also speed up their introduction.[53] Nevertheless, if the goal is to improve mileage efficiency for the overall fleet from 35 mpg to 55 mpg from 2020 to 2030, hybrids, plug-in hybrids, and all electric cars make reaching that target technically feasible. They even raise the strong possibility that the goal can be achieved more quickly, and that more aggressive goals can then be set. The Massachusetts Institute of Technology report "On the Road in 2035" concluded that doubling fuel economy of new cars by 2035, the reference date used in the MIT study, "is technically feasible, but achieving this in practice will require aligning the preferences of consumers and manufacturers through strong fiscal and regulatory incentives."[54]

Although plug-in hybrid vehicles must be charged with electricity generated by power plants, including coal-fired plants, "recent studies have found that with today's grid [where about 51 percent of the grid's power is produced by coal-fired plants[55]] and driving patterns, plug-in hybrids would reduce total emissions of heat-trapping gases from vehicles in the United States by 27 percent to 37 percent."[56] The reason is that a traditional internal combustion engine is astonishingly inefficient.[57] A recent joint study by the Electric Power Research Institute and the Natural Resources Defense Council concluded that as older power plants are replaced by cleaner power plants, plants that capture and sequester their CO2 emissions, and renewable energy sources, greenhouse gas emissions from plug-in hybrids will decrease by 40 percent to 65 percent compared to conventional vehicles.[58]

Replacing oil with advanced cellulosic biofuels. Biofuels, including cellulosic ethanol, will be able to further reduce the use of oil. Earlier versions of the EISA proposed increasing the mandate of 36 billion gallons of ethanol in 2020 by another 24 billion to 60 billion gallons per year. If this were achieved, it would reduce oil use by an additional 1.6 million barrels per day.[59]

Biofuels have been called into question recently over concern about increased use of corn-based ethanol. There is considerable debate concerning whether corn-based ethanol fuels reduce CO2 emissions compared to oil over their life cycle, whether the cost in both direct and indirect land destruction resulting from land clearing to produce crops for ethanol is too costly from an environmental standpoint, and whether the cost of using food crops to produce ethanol is too great.[60] There is, however, general consensus that the next generation of biofuels—primarily cellulosic biofuels—can be sourced from feedstocks that do not raise these concerns. To qualify for inclusion in the mandates, the EISA requires that new corn-based ethanol plants achieve at least a 20 percent reduction in CO2 emissions over the entire life cycle of producing the fuel and a 50 percent to 60 percent lifecycle reduction for cellulosic biofuels compared to conventional gasoline.[61]

The current biofuel mandate of 36 billion gallons per year limits the amount that comes from grain-based ethanol to 15 billion gallons per year. Ethanol plants in operation or under construction already have a capacity of 13.6 billion gallons, so most of the grain-based mandate has already been filled.[62] Barring new evidence that grain-based ethanol can meet all of the above concerns, the 15 billion gallon grain-based mandate should not be expanded, and an increase from 36 billion to 60 billion gallons of ethanol per year should require sustainable biofuels that meet the life-cycle CO2 and environmental benchmarks set forth above.

The Union of Concerned Scientists recently concluded that sustainable biofuel production is likely to be limited to 40 billion to 50 billion gallons using currently known feedstocks.[63] New biomass resources, such as ethanol produced using algae, will have to be developed to reach the level of 60 billion gallons.[64] Nevertheless, there are 22 years until 2030, and given the rapid technological developments in this field[65] reaching 60 billion gallons a year by 2030 should be a reasonable target.

Reducing mileage traveled by offering shorter commutes and alternatives to driving. Oil use can also be reduced by a series of other measures designed to get the most mileage out of each car and reduce driving time. These measures could include increased mass transit opportunities and smarter growth measures that bring housing closer to places of work.[66] They could also encourage people not to drive as much by offering pay-as-you-drive insurance that would allow car owners to pay less insurance if they drive less and through congestion pricing.

The federal government could also encourage increased efficiency of existing cars through maintenance measures such as providing vouchers for free maintenance, providing free air and accurate air gauges at all gas stations, and requiring efficiency standards on replacement tires that would increase efficiency by 8 percent or more and reduce demand for oil by about 0.6 million barrels per day.[67] Together these measures should reduce demand for oil by 1.4 million to 1.8 million barrels per day.

Implementing all the demand reduction measures and biofuel proposals described above would enable the nation to reduce its use of oil by 9.45 million to 10.4 million barrels of oil per day by 2030.

The road to energy security

Oil imports	Millions of barrels per day
2006 total petroleum imports (starting point)	12.4
2006–2030 projected business as usual increase in domestic consumption	+ 3.8
2030 actual projected petroleum imports	= 16.2

Reducing oil imports	Millions of barrels per day
Projected reductions resulting from 2007 Energy Act by year 2030	
Increasing vehicle fuel efficiency to 35 mpg by 2020	– 2.5
Increasing domestic biofuel production to 36 billion gallons per year by 2022	– 1.3
Increasing fuel efficiency to 39 mpg by 2020	– 0.4
Increasing fuel efficiency from 39 mpg by 2020 to 55 mpg by 2030	– 1.6
Increasing biofuel mandate from 35 in 2022 to 60 billion gallons per year by 2030	– 1.6
Implementing aggressive fuel efficiency standards for medium & heavy duty trucks	– .75–1.3
Reducing fuel use by other measures such as promoting mass transit, congestion pricing, telecommuting, etc.	– 1.4–1.8
Increases in 2030 in domestic oil production including production in former off-shore moratorium areas	– 1.8
Measures that reduce oil imports (2007 Energy Act mandates combined with other achievable reductions)	= 11.35–12.3
Oil imports in 2030	4.85 to 3.9

Building cleaner coal plants

Reducing the carbon footprint of power generation is essential. The electricity sector is now the largest source of greenhouse gas emissions, and electricity demand could increase with the deployment of plug-in hybrids or all-electric vehicle batteries. The first and most important challenge is to build new coal plants with carbon capture and sequestration technology. Utilities and their partners are now making fuel selections for future power plants that, once built, will have a projected lifespan of 50 years to 60 years. It is estimated that as many as 1,400 gigawatts of new coal-fired plants will be built around the world between now and 2030.[68] The EIA projected in 2007 that 150 gigawatts of these new coal plants would be built in the United States.[69]

Current state-of-the-art technology for conventional coal-fired power plants utilizes advanced, pulverized coal technology. A new 1,000 megawatt pulverized coal power plant without CCS produces about 5.4 million metric tons of CO2 annually. This means that if the projected 1,400 gigawatts of new plants are built using pulverized coal technology, as much as 7.56 billion additional tons of CO2 would be generated worldwide each year. This is roughly equivalent to the annual emissions in the United States, which currently emits about 7 billion tons of greenhouse gases per year. Emissions from these new plants between now and 2030 would equal about 50 percent of all emissions from all power plants during the past 250 years and could neutralize all efforts to reduce emissions in other sectors.[70]

Opposition is building against the construction of new traditional coal plants because of concerns about the viability of coal-fired plants in a carbon-constrained world. One recent study found that 59 proposed coal plants were either cancelled or suspended in 2007.[71] Traditional coal plants are finding it increasingly difficult to obtain financing. For example, several leading investment banks in early 2008 announced guidelines that make it more difficult to fund new traditional coal plants, at least until global warming legislation is enacted, because of concerns about global warming and uncertainty about future greenhouse gas regulation in the United States.[72]

If a cap-and-trade system results in a price for carbon that is low enough, uncontrolled coal plants might still be financially viable, although the future of the industry will only be truly secure if new coal plants that do not cause significant increases in CO2 emissions can be built. This can be accomplished if coal plants capture and sequester their CO2 emission in deep underground formations. The technology for new coal-fired power plants that is furthest along in development is known as integrated gasification combined-cycle.

IGCC plants allow CO2 to be removed pre-combustion; a number of IGCC plants are in operation, and more are planned.[73] The plants in operation do not yet capture CO2 emissions, but most experts agree that there are no significant barriers to incorporating carbon capture into IGCC technology. At the same time, past combustion capture technologies are being developed for use with traditional pulverized coal plants that could supplement or supplant IGCC and be used to retrofit existing plants.[74]

Similarly, almost all experts believe that abundant and safe opportunities exist to sequester emissions.[75] But rules for safe sequestration and storage reservoir tests must still be developed and demonstration projects must be completed.

Despite the fact that there seem to be no technical barriers to developing CCS plants, their deployment could still take decades under a business-as-usual scenario. As with any new technology, there are companies that are willing to adopt the technology in an early phase and others who are skeptical or don't believe it will work. And as described above, traditional coal plants that have to buy CO2 allowances are likely for many years to be cheaper to build and operate than the first generation of CCS plants.

Congress should issue a performance standard that requires CCS by a date certain between 2016 and 2020—the period when most commentators think that CCS will be ready for deployment[76]—for all coal-fired plants that begin construction after the passage of global warming legislation. This will ensure the early deployment of plants with CCS, provide the maximum encouragement for technology development and sequestration testing, and avoid the massive increase in emissions that would occur from building more traditional non-CCS, coal-based plants. The government should also provide subsides that eliminate the difference in construction and operating costs between a plant with CCS and a plant without CCS that has to purchase CO2 allowances in order to ensure support for deployment within the utility industry and avoid disparities in electricity costs between coal- and non-coal-dependent regions.[77] The subsidies would diminish over time as the cost of acquiring allowances increases.[78]

Supporting any coal plants, even ones that capture and sequester their emissions, will not come easily to the environmental community and to much of the public. But even if construction of every new coal plant in the United States were stopped, coal plants would still be built in other countries, and these plants will make it almost impossible to arrest global warming if they do not limit their CO2 emissions. The only real solution is to develop and deploy capture and sequestration technology around the world as quickly as possible.

Working with Developing and Developed Countries to Stop Global Warming and Reduce Demand for Oil

The United States and other developed nations cannot stop global warming from occurring on their own. But the developed world has caused over 80 percent of the current CO2 loading in the atmosphere, and it is therefore equitable for developed nations to implement mandatory reduction requirements first. The United States is the only developed country that has failed to do so. Western European countries have substantially reduced their CO2 emissions without the noticeable negative effects on competitiveness that are so feared by climate change doubters in the United States.

In order to influence other nations, the United States must first act in a manner that gives credibility to its negotiating positions. This will require implementing strong short- and long-term measures to reduce greenhouse gas emissions in the United States, as well as developing a vision that enables the United States to articulate why worldwide action is necessary. Setting a goal of keeping greenhouse gas levels in the atmosphere below 450 ppm would provide such a framework. Given sufficiently strong measures in the United States, we could argue convincingly that if the developing world does not act, it will be impossible to deal with global warming effectively.

Key developing nations such as China, India, Brazil, and Mexico also will have to agree to the mandatory reduction requirements that are necessary to keep CO2 levels in the atmosphere below the 450 ppm goal. But action in those countries does not have to be on the same schedule as in the United States and the developed world, and might initially have to cover only selected, energy-intensive industries as long as the 450 ppm goal is met. The reduction goals in the developing world also do not have to be the same as those for developed nations. But they do have to be sufficient to keep CO2 levels in the atmosphere below 450 ppm. This will probably require that developing countries initially agree to reduce emissions growth substantially below business-as-usual projections, and achieve absolute reductions in emissions perhaps starting in 2020.

The United States and other developed nations can help developing nations by paying for CO2 emission reduction allowances generated by offset projects in developing nations[79] and through technology transfer programs. Offset programs both transfer funds to developing nations and reduce the cost of allowances in the United States; the offset allowances can be used in the United States and will thus increase the supply of allowances.

Nevertheless, offsets cannot replace significant measures within developed countries to reduce emissions, and total reductions from developed and developing countries must be sufficient to avoid increases in atmospheric levels above 450 ppm.

Some have argued for unlimited use of offsets, but this would not be consistent with the need for strong reductions in emissions in developed countries. Most proposed legislation in the United States limits international offsets to a percentage of all offsets in the system—15 percent in the proposed Lieberman-Warner legislation. Moreover, as the emission reduction goals assumed by developing nations become tighter, these countries will want to take credit for reductions previously used as offsets, and this will put developed countries under more pressure to meet their emission reduction goals through domestic measures.

There is one area of offsets in which the European Union has not permitted offset credits, but where the United States can take the lead: developing an offset program that allows credit for CO2 sequestered through avoided deforestation in developing countries. Deforestation in the tropics accounts for about 20 percent of all global emissions of C02,[80] and reducing deforestation would have great benefits for protecting biodiversity and the health of rural economies in the tropics. Many have voiced concerns about such credits "flooding" the market, but providing a cap on the number of eligible allowances would eliminate that risk, and in any case recent studies have concluded that such market flooding is unlikely to occur.[81] Recent studies have also shown that sufficient safeguards can be built into an avoided deforestation program to ensure the integrity of offset credits generated by these projects.[82]

The competitive consequences that would come from the United States acting before countries like China and India are not as unfavorable as critics contend. For instance, as author and New York Times columnist Thomas Friedman points out, clean energy and technologies that address climate change are likely to be among the most important commercial opportunities of the future.[83] In 2007, $148 billion was spent on alternative energy projects worldwide,[84] and the potential market for clean coal technology runs into the trillions of dollars. Countries that do not regulate CO2 emissions will be at a competitive disadvantage in the race for a clean energy future.

There are also many ways that the United States can seek to keep its energy intensive industries competitive. One approach is to seek agreement from developing countries to meet an emission performance or efficiency standard for energy-intensive manufacturing operations that supply products to global markets. This would be an important first step for countries that are working to develop their own mandatory programs to counteract global warming.

If that does not work, the United States could—as provided for in various proposed global warming bills—impose border tariffs on imported products from nations that have not implemented greenhouse gas abatement policies comparable to those taken by the United States. There is an argument that placing identical CO2 requirements on domestic and foreign goods would not violate World Trade Organization requirements, although experts disagree on this point and unilateral border tariff adjustments could spark retaliatory measures. Congress could also ameliorate the competitive disadvantages of different greenhouse gas reduction requirements in developed and developing countries by providing extra allowances to domestic energy-intensive industries—or free allowances, in the case of an auction system—which those industries could sell to reduce the effect of CO2 restrictions.

Reducing worldwide oil usage is also necessary to promote global stability and prevent transfers of wealth to producing nations that are not responsible actors. As is the case in the United States, there is little evidence that the world can produce enough conventional petroleum or synfuels to meet long-term demand at an economically sustainable price. The United States' key contribution is to lead the way in producing sustainable biofuels and a new generation of highly efficient vehicles that drastically reduce oil use.

Conclusion

Stopping global warming and lessening our dependence on imported oil are two of the greatest challenges the United States has ever faced. Solving them will require measures that are strong enough to achieve the desired results in a timely manner. Otherwise, the measures will be doomed to costly failure. The measures we choose must foster technologies and set standards that can be adopted globally in developing as well as developed countries. As daunting as these tasks are, the strategic consequences of failure are so great that we cannot ignore them any longer.

With a set of wise and aggressive policies, the United States can first put its own house in order and then influence the rest of the world to build on our example and take the measures necessary for a successful global effort to arrest global warming and achieve energy security.

Endnotes

1 See generally Kurt M. Campbell et al., "The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change" (Washington: Center for Strategic and International Studies, 2007); John Podesta and Peter Ogden, "The Security Implications of Climate Change," The Washington Quarterly, Winter 2007-2008; Intergovernmental Panel on Climate Change Working Group II, "Climate Change 2007: Impacts, Adaptation and Vulnerability" (2007); Scott G. Borgerson, "Arctic Meltdown: The Economic and Security Implications of Global Warming," Foreign Affairs (Mar/Apr. 2008); Richard Holbrooke, "The Next President," Foreign Affairs, (Sept./Oct. 2008): 6-7.

2 David Sandalow, Freedom From Oil: How the Next President Can End the United States' Oil Addiction (New York: McGraw Hill, 2008), at pp. 14, 42.

3 National Oceanic and Atmospheric Administration, "Carbon Dioxide, Methane Rise Sharply in 2007" (2008), available at www.noaanews.noaa.gov/stories2008/20080423_methane.html. See also Lauren Morello, "Emissions: World's Greenhouse Gas Output Increased in 2007, U.S. Says." Climate Wire, April 24, 2008, available at www.eenews.net/climatewire/print/2008/04/24/2.

4 Energy Information Administration, "U.S. Carbon Dioxide Emissions from Energy Sources 2007 Flash Estimate" (2008), available at www.eia.doe.gov/oiaf/1605/flash/flash.html. See also, Raymond J. Kopp and William A. Pizer, "Assessing U.S. Climate Policy Options: A Report Summarizing Work at RFF as Part of the Inter-industry United States Climate Policy Forum" (Washington: Resources For the Future, 2007), at p. 24.

5 See, e.g., David Hawkins et al., "What to Do About Coal." Scientific American, Sept. 2006, pp. 70; James Hansen et al., "Dangerous Human-made Interference with Climate: A GISS modelE Study," Atmospheric Chemistry and Physics (May 2007); but see James Hansen, et al., "Target Atmospheric CO2: Where Should Humanity Aim?" Open Atmospheric Science Journal (April 2008), available at http://arxiv.org/abs/0804.1126 2008/TargetCO2_20080407.pdf, concluding that CO2 levels in the atmosphere will have to be reduced to at most 350 ppm at pp. 1, 2, and 13. The European Union is proposing that global temperature increases should not exceed two degrees centigrade, which corresponds to CO2 levels in the atmosphere of no more than 450 ppm. Council on Foreign Relations, "Report of an Independent Task Force, Confronting Climate Change: A Strategy for U.S. Foreign Policy" (2008) at pp. 66 (EU policy position) and pp. 12 (corresponding CO2 levels in the atmosphere) [uncorrected proofs, 2008].

6 See generally, Hansen et al., "Dangerous Human-made Interference with Climate" and Hansen et al., "Target Atmospheric CO2," supra note 5.

7 The European Union is proposing that global temperature increases should not exceed two degrees centigrade, which corresponds to CO2 levels in the atmosphere of no more than 450 ppm. Council on Foreign Relations, "Report of an Independent Task Force," supra note 5, at pp. 66 (EU policy position) and pp. 12 (corresponding CO2 levels in the atmosphere).

8 National Oceanic and Atmospheric Administration, "Carbon Dioxide, Methane Rise Sharply in 2007," supra note 3. See also Morello, "Emissions: World's Greenhouse Gas Output Increased in 2007, U.S. Says," supra note 3 and Kopp and Pizer, "Assessing U.S. Climate Policy Options," supra note 4, at pp. 43.

9 See e.g., Elliot Diringer, "International Climate Change Negotiations: Bali and the Path Toward a Post-2012 Climate Treaty," Testimony before the Senate Foreign Relations Committee, Jan. 24, 2008; David D. Doniger, "Testimony to the Committee on Energy and Air Quality," "Hearing on Climate Change: Competitiveness Concerns and Prospects for Engaging Developing Countries, " Feb. 28, 2008. See also, John Podesta, Todd Stern, and Kit Batten, "Capturing the Energy Opportunity" (Washington: Center for American Progress, 2007), at pp. 3, 4, 21, and 36.

10 Energy Information Administration, "Annual Energy Outlook 2008 with Projections to 2030" (2008), at pp. 81, 148; see also Sandalow, Freedom From Oil, supra note 2, at pp. 18, 42.

11 Energy Information Administration, "International Energy Outlook 2007" (2007), at pp. 29; International Energy Agency, "World Energy Outlook 2007: China and India Insights" (2007), at pp. 79, 80.

12 Assumes an average price of $75 per barrel of oil. Calculated by multiplying $75 by 12 million (the number of barrels imported per day) by 365.

13 "Energy Information Administration Petroleum Navigator: United States Crude Oil and Petroleum Products Net Imports (Thousand Barrels per Day)," available at http://tonto.eia.doe.gov/dnav/pet/hist/mttntus2a.htm.

14 Energy Independence and Security Act 2007, 49 USC § 49 USC 32902(b)(2)(a). The term non-passenger automobile includes light trucks up to a 10,000 pound gross vehicle weight.

15 Jim Kliesch, "Setting the Standard: How Cost Effective Technology Can Increase Vehicle Fuel Economy" (Cambridge: Union of Concerned Scientists, 2008), at pp. 29, Figure 15 available at www.ucsusa.org/assets/documents/clean_vehicles/UCS-setting-the-standard.pdf. As interpolated by David Friedman of the Union of Concerned Scientists to the author to apply to a 35 mpg standard.

16 Energy Independence and Security Act of 2007, 42 USC § 7545(a)(2).

17 Calculated by dividing 30 billion by 42 (the number of gallons in a barrel), then multiplying that by 0.67 (ethanol has only 0.67 of the energy content of gasoline) and dividing that by 365.

18 Helicopter Association International, "House Clears Energy Bill" (2007), available at www.rotor.com/Default.aspx?tabid=510 &newsid905=57165.

19 Energy Information Administration, "Annual Energy Outlook 2007 with Projections to 2030" (2007), at pp. 96. EIA also includes a low price and a reference case scenario, and under these scenarios, oil consumption could increase by as much as 7.8 million barrels per day. If, however, oil prices increase to an even higher level than anticipated by the EIA, this would further reduce demand.

20 Katherine Ling, "Energy Policy: U.S. 'Timid' on Fuel Economy, Renewable Energy — IEA," E&E News PM, Feb. 15, 2008, available at www.eenews.net/eenewspm/print/2008/02/15/1 (internal citation omitted); see also, "IEA Urges U.S. to Use Pricing to Combat Energy Challenges," Feb. 15, 2008, available at http://rawstory.com/news/afp/IEA_urges_US_to_use_pricing_to_comb_02152008.html.

21 Energy Independence and Security Act of 2007, section 102 (b)(2)(A).

22 Natural Resources Defense Council, "Issues: Oil and Energy," available at http://www.nrdc.org/air/energy/fensec.asp.

23 The EIA stated in its 2007 Annual Energy Outlook that "[a] large portion of the total U.S. resource base of on-shore conventional oil has been produced. New oil []discoveries are likely to be smaller, more remote (e.g., Alaska), and increasingly costly to exploit." In its 2008 report, EIA estimates in its high-price case that crude oil production will increase by about 1.3 million barrels per day, and in its high technology advancement case that production will increase by a further 300 thousand barrels per day in 2030, resulting in a 1.6 million barrel per day increase in that year. EIA, "Annual Energy Outlook 2008," at pp. 79, 80, and 164 (the high-price case scenario is set forth on pp. 164).

24 Energy Information Administration, "Impacts of Increased Access to Oil and Natural Gas Resources in the Lower 48 Federal Outer Continental Shelf" (2007), available at www.eia.doe.gov/oiaf/aeo/otheranalysis/ongr.html.

25 Mineral Management Service, "Total Producing and Non-Producing Leases by Category Fiscal Year 2007," available at www.mrm.mms.gov/MRMWebStats/Disbursements_Royalties.aspx?report=TotalLeases byCategory&yeartype=FY&year=2007&datetype.

26 The other area with potential oil reserves that is subject to a moratorium on leasing is the Arctic National Wildlife Refuge. That area is closed to leasing for environmental reasons and President-elect Barack Obama opposes its reopening. Moreover, its potential oil reserves are relatively limited. According to the EIA, the potential reserves are 800 thousand barrels per day, with only a 5 percent probability that a greater rate of recovery could be achieved, and with the first production occurring 7 years to 12 years after approval for exploration. See Energy Information Administration, "Potential Oil Production from the Coastal Plain of the Arctic National Wildlife Refuge: Updated Assessment" (1999), available at www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/arctic_national_wildlife_refuge/ html/analysisdiscussion.html.

27 Energy Information Administration, "Annual Energy Outlook 2008," supra note 9, at pp. 80 (140,000 from shale oil and the rest from coal-to-liquids and gas-to-liquids).

28 Podesta, Stern, and Batten, "Capturing the Energy Opportunity," supra note 9, at pp. 38.

29 Geoffrey A. Moore, Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers (New York: Harper Business, 1991), at p.5.

30 Global Business Environment, Energy Needs, Choices and Possibilites: Scenarios to 2050 (London: Shell International, 2001) at 22, cited in Joseph Romm, Hell and High Water (New York: William Morrow, 2007), at p. 146.

31 A. Bandivadekar et al., "On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions" (Cambridge: Massachusetts Institute of Technology, 2008) at pp. 109, citing N. Nakicenovic, "The Automobile Road to Technological Change: Diffusion of the Automobile as a Process of Technological Substitution," Technological Forecasting and Social Change 29 (4) (1986): 309-340.

32 Romm, Hell and High Water, supra note 31, at pp. 147-148.

33 Ibid. at pp. 138-139 (emphasis removed).

34 See, e.g., Christa Marshall, "COAL: The CEO of a Big Utility Makes a Bold Bet." Climatewire, Sept. 3, 2008, available at www.eenews.net/climatewire/print/2008/09/03/1 (statement of Michael Morris, Chief Executive Officer of American Electric Power, that "this technology [CCS] is going to save the existing [coal] fleet and save the American electrical consumer trillions of dollars").

35 Electric Power Research Institute, "The Power to Reduce CO2 Emissions: The Full Portfolio," Discussion Paper (2007), at pp. 3-11.

36 See generally, Kenneth Berlin and Robert M. Sussman, "Global Warming and the Future of Coal: The Path to Carbon Capture and Storage" (Washington: Center for American Progress, 2007); Kenneth Berlin and Robert M. Sussman, "Early Deployment: Maximizing Carbon Capture and Storage Under the Lieberman Warner Global Warming Bill" (Washington: Center for American Progress, 2008).

37 "Energy Information Administration Petroleum Navigator: Weekly All Countries Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel)(2008)," available at http://tonto.eia.doe.gov/dnav/pet/hist/wtotworldw.htm; see also "Gas Prices – U.S. Retail Historical Data, Weekly (1993-2007)(2008)," available at www.swivel.com/data_columns/spreadsheet/4447418?page=6.

38 According to the EIA, U.S. oil consumption decreased by 900,000 barrels per day during the first five months of the year, but by only 400,000 barrels per day in June and July. The EIA predicts that for all of 2008, consumption will drop by an average of 500,000 barrels per day or by 2.4 percent. Despite the drop in oil consumption in the United States, worldwide consumption increased by 500,000 barrels during the first seven months of 2008. See Energy Information Administration, "Short-Term Energy Outlook" (2008), available at www.eia.doe.gov/emeu/steo/pub/contents.html.

39 Ibid.

40 Podesta, Stern, and Batten, "Capturing the Energy Opportunity," supra note 9, at pp. 26, citing E. Lovins, "Winning the Oil Endgame" (Boulder: Rocky Mountain Institute, 2007) at pp. xiii.

41 Ibid.

42 "In a 100 percent auction, a facility that reduced its emissions would not have any excess to sell, since by definition, it did not receive an allocation to begin with. However, if its marginal cost of reductions were below that of the market, it would still have all the same incentive to reduce emissions internally, thereby mitigating the need for it to buy more expensive reductions (allowances) from the market. The same would hold true for a facility with higher costs of emissions reductions—it would prefer to buy allowances from the market (as opposed to from the under-emitter). This would effectively reduce bilateral allowance trading between companies, as the under-emitters wouldn't have any excess allowances to sell—but the economics of the system should work the same way." Personal communication from Steve Fine, ICF Corporation, November 25, 2008.

43 Total motor gasoline used in January 2007 was 8.89 mbd. Usage peaked in July 2007 at 9.64 mbd, then declined to 8.81 mbd in January 2008 after which it again increased, to 9.07 mbd in July 2008. It rose again to 9.39 mbd in August 2008 before declining, despite rapidly falling gasoline prices, to 8.90 mbd in September 2008. Energy Information Administration, "STEO Table Browser," (2008), available at http://tonto.eia.doe.gov/cfapps/STEO_Query/steotables.cfm?tableNumber=9&periodType=Monthly&startYear=2007&startMonth=1&startMonthChanged=fasle&startQuarterlyChanged=false&endYear=2008&endMonth=12&endMonthChanged=false&endQuarterChanged=false&noScroll=false&loadAction=Apply&Changes.

44 Podesta, Stern, and Batten, "Capturing the Energy Opportunity," supra note 9, at pp. 19; see also Kopp and Pizer, "Assessing U.S. Climate Policy Options," supra note 4, at pp. 24.

45 Podesta, Stern, and Batten, "Capturing the Energy Opportunity," supra note 9, at pp. 9; see also Kopp and Pizer, "Assessing U.S. Climate Policy Options," supra note 4, at pp. 28.

46 Kopp and Pizer, "Assessing U.S. Climate Policy Options," supra note 4, at pp. 163.

47 Ibid., supra note 4, at pp. 24.

48 David Sandalow, Freedom From Oil, supra note 2, at pp.18.

49 Union of Concerned Scientists, Testimony before the Senate Committee on Commerce, Science and Transportation, June 24, 2008, at pp. 4.

50 Kliesch, "Setting the Standard," supra note 15, as interpolated to the author by David Friedman to apply to a 55 mpg standard.

51 "New Electric Car: Concept Chevy Volt," (2008) available at www.chevrolet.com/electriccar/; see also, "About GM-Volt," (2008) available at http://gm-volt.com/about/.

52 Massachusetts Institute of Technology, "On the Road in 2035," supra note 32, at pp. 34, estimates, for example, that in 2035 plug-in hybrid car sales will still cost $5,900 and light trucks $8,300 more than standard vehicles. Many others believe that as production of plug-in hybrid cars increases, economies of scale will substantially reduce this estimated cost differential.

53 Ibid., at pp. 110, estimates that it would cost about $2.2 billion for each 10 percent of domestic production (about 1.3 million vehicles) converted to producing hybrids and that on average it takes about 12 months to 18 months to convert a facility.

54 Ibid. at pp. 142.

55 Kopp and Pizer, "Assessing U.S. Climate Policy Options," supra note 4, at pp. 149.

56 Sandalow, Freedom From Oil, supra note 2, at pp. 65.

57 Ibid. at pp. 64.

58 Electric Power Research Institute and Natural Resources Defense Council, "Environmental Assessment of Plug-in Hybrid Electric Vehicles, Volume 1: Nationwide Greenhouse Gas Emissions," at pp. 8.

59 Calculated by dividing 24 billion by 42 (the number of gallons in a barrel) and multiplying that by 0.67 (assuming cellulosic biofuels are only 0.67 percent as efficient as gasoline) and dividing by 365.

60 Timothy Searchinger et al., "Use of United States Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change," Sciencexpress (2008), at pp. 1-3, available at www.scienceexpress.org/7Feb2008/page1/10.1126/Science1151861.

61 Energy Independence and Security Act of 2007, 42 USC § 7545B(i).

62 Renewable Fuels Association, "Ethanol Biorefinery Locations: U.S. Fuel Ethanol Industry Biorefineries and Production Capacity," available at http://www.ethanolrfa.org/industry/locations.

63 David Friedman on behalf of the Union of Concerned Scientists in testimony before the Senate committee on Commerce, Science and Transportation on June 24, 2008, stated that sustainable biofuels production that minimizes tradeoffs between food and fuel and does not encourage deforestation would be closer to 40 billion to 50 billion gallons in the absence of breakthroughs in novel biomass resources.

64 Ibid.

65 At least 11 companies are planning to build cellulosic ethanol plants in the United States. Katie Fehrenbacher, "11 Companies Racing to Build U.S. Cellulosic Ethanol Plants," earth2tech, June 3, 2008, available at http://earth2tech.com/2008/06/03/12-companies-racing-to-build-cellulosic-ethanol-plants-in-the-us/.

66 For a full discussion see Podesta, Stern, and Batten, "Capturing the Energy Opportunity," supra note 9, at pp. 40-43.

67 Department of Energy data indicates that regular tuneups can boost fuel economy by about 4 percent, while maintaining proper tire inflation could increase fuel economy up to 3 percent. "Keeping Your Car in Shape," available at http://fueleconomy.gov/feg/maintain.shtml (last accessed September 2008). The National Academies/Transportation Research Board national tire efficiency study indicated that a 10 percent reduction in rolling resistance of replacement tires would reduce fuel consumption by 1 percent to 2 percent. Transportation Research Board, "Tires and Passenger Vehicle Fuel Economy" (2006), available at http://onlinepubs.trb.org/Onlinepubs/sr/sr286.pdf.

68 Berlin and Sussman, "Global Warming and the Future of Coal," supra note 37, at pp. 1.

69 Energy Information Administartion, "Annual Energy Outlook 2007," supra note 11, at pp. 9; See also Berlin and Sussman, "Global Warming and the Future of Coal," supra note 37, at pp. 1.

70 Robert Socolow, "Can We Bury Global Warming?" Scientific American, July 2005, at pp. 52 (estimating that coal plants accounted for 542 billion tons of CO2 emissions from 1751-2002 and will account for 501 billion tons of CO2 from 2002-2030).

71 "Coal Plants Cancelled in 2007," available at www.sourcewatch.org/index.php?title=Coal_plants_cancelled_in_2007; see also Berlin and Sussman, "Global Warming and the Future of Coal," supra note 37.

72 Carbon Principles, "Leading Wall Street Banks Establish Carbon Principles: Guidelines to Strengthen Environmental and Economic Risk Management in the Financing and Construction of Electricity Generation" (2008); see also, the narrative account of intent/purpose in: http://carbonprinciples.org/documents/Carbon%20Principles%20Statement%20of%20Intent.pdf, and the response to Q.1 in this fact sheet, http://carbonprinciples.org/documents/Carbon%20Principles%20QA.pdf.

73 See, e.g., list of proposed CCS projects in Climate Change Business Journal (May 2008), at pp. 5.

74 Ibid.

75 On October 31, 2006, the Department of Energy announced its support of seven tests in North America to advance carbon sequestration technologies. DOE will provide more than $450 million over the next 10 years to validate that the capture, transportation, injection, and long-term storage of CO2 can be done safely, permanently, and economically. See Department of Energy, "Department of Energy Advances Commercialization of Climate Change Technology," October 21, 2006, available at www.netl.doe.gov/publications/press/2006/06062-Carbon_Sequestration_Testing_Suppo.html; see generally, National Energy Technology Laboratory, "Carbon Sequestration Atlas of the United States and Canada" (2007), available at www.netl.doe.gov/technologies/carbon_sec/refshelf/atlas/ATLAS.pdf.

76 Berlin and Sussman, "Global Warming and the Future of Coal," supra note 37; see, e.g., the statement of Michael Morris, supra note 35 (CCS will be operational by 2015). The recently released Dingell-Boucher draft climate bill in Section 812 requires CCS, but on a less ambitious schedule than recommended herein. It requires that all new plants built after January 1, 2009 reduce capture and sequester 60 percent of their CO2 emissions by January 1, 2025.

77 These subsidies could take several different forms. See Berlin and Sussman, "Maximizing Carbon Capture and Storage Under the Lieberman-Warner Global Warming Bill," supra note 37.

78 Ibid.

79 For an excellent and creative analysis of offset issues, see David Hayes, "Getting Credit for Going Green: Making Sense of Carbon 'Offsets' in a Carbon-Constrained World," (Washington: Center for American Progress, 2008).

80 Johannes Ebeling and Maï Yasue, "Generating Carbon Finance Through Avoided Deforestation and its Potential to Create Climatic, Conservation and Human Development Benefits," Philosophical Transactions of the Royal Society 363 (B) (2008): 1917, available at www.ecosecurities.com/GetAsset.ashx?AssetId=12093. See also Nigel Purvis and Erin Myers, "Conserving the Climate: Scaling–up Global Markets for Forest Carbon" (Washington: Resources for the Future, 2008) at pp. 1, available at http://launch.rff.org/RFF/Documents/RFF-IB-08-02.pdf.

81 Pedro Piris Cabezas and Nathaniel Keonane, "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD): Implications for the Carbon Market" (Washington: Environmental Defense Fund, 2008).

82 Purvis and Myers, "Conserving the Climate," supra note 80.

83 See generally, Thomas L. Friedman, "The Power of Green." The New York Times, April 15, 2007, available at www.nytimes.com/2007/04/15/magazine/15green.t.html?_r=1&scp=15&sq=The%Power%20of%20Green&St=cse&oret=slogin.

84 Joel Makower, Ron Pernick, and Clint Wilder, "Clean Energy Trends 2008." Clean Edge, March 2008, at pp. 2 and 6.

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