Congress of the United States
Washington, DC 20515

October 23, 2008

Dear Colleague,

The amount of misinformation surrounding the energy and climate change debate has led us to prepare the attached report in an attempt to burn through the fog and lay out the realities of the situation we face.

Energy policy is one of the most pressing and important issues of our day. Securing reliable and domestically available energy supplies is essential to the continued economic prosperity of the United States. It is also a national security issue. However, energy policy is also inseparable from the parallel, and sometimes adversarial, discussions over CO_2 and its impact on climate change. This energy report brings the realities of the energy crisis into focus, in the hopes that it will motivate policy makers to set aside their partisan differences and come together on a real solution which protects our national economic and security interests as well as the environment.

This report shows the current state of world energy consumption patterns, as well as likely future scenarios, to bring into focus the challenges we face as we seek to reduce our carbon footprint and wean our nation off fossil fuels. This report also briefly presents the current state of technology for alternative fuel sources – including biofuels, coal-to-liquid, wind, solar, and geothermal energy – in order to assess its present and future ability to displace fossil fuel consumption. While the thrust of this report is on securing adequate sources of energy, there is also a discussion of important policies that should be pursued to decrease our national demand for energy.

The summary findings are an attempt to clearly state the issues in a national discussion that has become nothing more than political posturing, disingenuousness and one-upsmanship of one special interest lobby versus another.

Sincerely,

Darrell Issa
Member of Congress

Tom Davis
Member of Congress

U.S. House of Representatives

ENERGY: A MATTER OF NATIONAL, ECONOMIC, AND ENVIRONMENTAL SECURITY

Ranking Member Tom Davis (R-VA) and Representative Darrell Issa (R-CA)
Committee on Government Reform

MINORITY STAFF REPORT

House Committee on Oversight and Government Reform
Subcommittee on Domestic Policy
By Ranking Member Tom Davis (R-VA) and Rep.Darrell Issa (R-Calif.)

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FINDINGS:

An energy policy that does not address all facets of energy production is a failure and threatens our economy, our national security, and the environment.

- Whether one accepts or rejects the science of climate change, with the adoption of the Bali Roadmap the reality is that all Americans will be adjusting to a carbon-constrained world.

- Energy policy is both an economic issue and a national security issue.
    a) Energy is essential to the economic activity that sustains and improves the quality of life.
    b) Countries hostile to the United States are increasingly using energy as a strategic tool against U.S. interests.

- All options should be "on the table" when crafting a sensible energy policy. This includes drilling for oil and gas on the outer continental shelf and on federal lands. It should encourage conservation and demand-side management while accelerating the investment in known and new energy resources such as alternative fuels and renewables.

- The development of renewables such as wind, solar and geothermal must be pursued, but the reality is that it may take years before any substantial impact is felt. Biofuels, such as ethanol, hold limited promise and cellulosic ethanol, which is yet to be produced commercially, may have negative environmental consequences.

- Alternative energies alone will not meet our current and future energy needs. Drilling and new nuclear plants will provide the amounts of energy needed sooner than renewables or alternative fuels.

- Nuclear energy and coal hold the keys to our nation's future energy. Nuclear energy is an emission-free source of electricity and is also the roadmap to the hydrogen economy, which will dramatically decrease automobile emissions, if used to power the transportation network. Clean coal technology is critical for electricity generation and for the production of coal-to-liquid fuel. Coal presently accounts for over half of electricity generation and cannot be replaced in the short- or medium-term.

- The Democrat Majority is flat out wrong in viewing the energy debate as an either/or approach. They want the American public to choose between promoting increased domestic oil production vs. encouraging conservation and increasing renewables and alternative fuels. It is ridiculous to even speculate that the two don't go hand in hand. The Democrats' 2008 energy bill, the "Comprehensive American Energy Security and Consumer Protection Act," focuses exclusively on conservation. The reality is that the United States must pursue all options- including new sources of energy- to preserve, protect, and defend our economy, our environment, and our national security interest.

- An energy and environment policy that fails to account for competitiveness concerns will cause the U.S. manufacturing base to shift more American jobs overseas, while actually increasing carbon emissions. If high energy prices, due to policy makers' failure to take actions to produce more oil and gas and encourage needed investment in new efficient technologies and new energy resources that increase the energy supply, force U.S. companies to relocate, then U.S. consumers, workers, and industry will pay the price for the federal government's shortsightedness.

- The Democrat majority is captive of the radical elements of the environmental lobby which sees high gasoline prices as a positive development causing Americans to drive less and buy smaller more fuel-efficient cars, thus reducing emissions. This is the reason the Democrat majority has vehemently resisted lifting the ban on drilling for oil and gas on federal lands and offshore.

- In this light, former Vice President Al Gore's call for civil disobedience to prevent construction of new coal plants or the statement of Senator Joe Biden to let others build coal plants, but just not here, is evidence of an ignorance of the CO_2 issue. CO_2 emissions will reach us regardless of where plants are built, either here or in China (which builds at least one new coal plant per week). Refusal to build additional clean coal plants domestically will only accelerate the export of American jobs, while simultaneously increasing world-wide CO2 emissions. It is well known that China (the likely beneficiary of misguided energy policies) has an energy intensity that is three times higher, and rising faster than in the U.S. or Europe. This means that any manufacturing process in China will emit at least 300 percent more CO_2 than a similar manufacturing process in the U.S. In other words, policies that encourage U.S. companies to leave our shores can do more than cost American workers good jobs, they can have a terrible impact on the environment and energy sources.

- Although the Democrats have moved closer to allowing offshore drilling, the Democratic leadership, led by Senate Majority Leader Harry Reid, is trying every trick in their political playbook to reimpose the moratorium on offshore drilling. We cannot afford an energy policy that leaves key energy assets off the table. As this report was being finalized, Senate Majority Leader Reid was attempting to reinstate a ban on finalizing regulations to govern oil shale development. At stake is the future development of an estimated 1.2 to 1.8 trillion barrels of oil in Colorado, Utah, and Wyoming.

CHAPTER 1: ENERGY SECURITY

Faced with dramatically increasing world demand for energy, increasingly hostile ownership of energy resources, and carbon constraints, energy security must be redefined. Following the energy crisis of the 1970s, policy makers in Washington defined energy security as securing a diverse supply of foreign oil, while taking precautions to deal with interruptions in crude oil production. The strategic petroleum reserve is a typical example of the federal policies employed to ensure our nation's energy security by protecting against interruptions in supply. While energy remains critically important to both our economy and our national security, this report argues that energy security means developing a diverse portfolio of domestically available energy resources, and implementing both supply-side and demand-side measures to protect against serious adverse consequences to our nation and the

1.1 The Importance of Energy Security to our Economy

Energy is essential to the economic activity that sustains and improves the quality of life. Having energy security means having a diversity of energy supplies at reasonable prices to keep the economy growing, while ensuring that the nation is not overly dependent on specific elements of supply and distribution—whether nations, geographical regions, type of fuel, or infrastructure. Current energy policy does not do enough to ensure diversity of supply either by the type of energy or the source of supply, and as a result our economy is vulnerable to high energy prices.[1] The U.S. continues to rely heavily on foreign sources of oil, and thus knowingly exposes our economy to the price instability associated with supply shocks and international volatility. This may lead to economic crisis here at home.

1.1a The U.S. Economy is Vulnerable to Changes in International Demand for Oil

Increased international demand for oil drives up energy prices.[2] In geo-economic terms, the biggest impact will come from increasing demand for oil and natural gas from developing countries, which may outpace the development of new sources of supply, thereby putting pressure on prices.[3] The U.S. and the rest of North America will soon be displaced by Asia as the largest consumer of energy. China is now the second largest oil consumer and importer in the world and its energy demand projections are staggering. India, a nation of more than 1.1 billion people, is not far behind.

1.1b Chinese Demand for Oil

China alone was the source of 40 percent of world oil demand growth from 2001 to 2005 and China's electricity consumption has recently been climbing at a 15 percent annual rate.[4]

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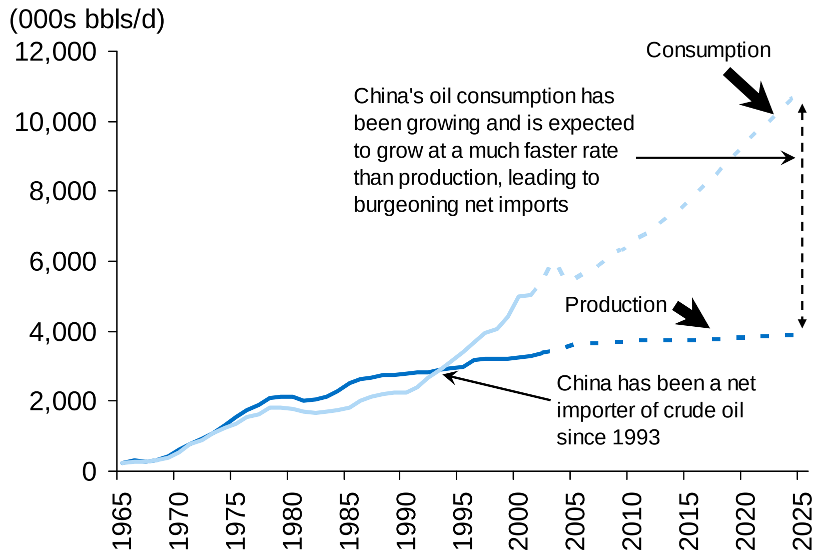
[1] Moira Herbst, *The Spillover Effect of $100 a Barrel Oil*, BUSINESS WEEK, January 14, 2008 (stating that the high price of fuel affects the price of virtually everything that consumers purchase.)
[2] FACING THE HARD TRUTHS ABOUT ENERGY, A COMPREHENSIVE VIEW TO 2030 OF GLOBAL OIL AND NATURAL GAS, National Petroleum Council (2007) (online at http://www.npchardtruthsreport.org/download.php) [hereinafter *Hard Truths*]
[3] *Id.*
[4] COUNTRY ANALYSIS BRIEF: CHINA, Energy Information Administration, 2005.

In addition, using more conservative estimates than Western analysts, the Chinese government predicts the number of cars and trucks in China will reach 130 million by 2020, rising from less than 20 million in 2000.[5] The amount of gasoline or diesel fuel required to meet these estimates will be enormous.

China Oil Consumption Increasingly Outpaces Production



Source: Goldman Sachs International[6]

1.1c Indian Demand for Oil

India's energy use is expected to follow closely in the footsteps of China. With a population of 1.14 billion, India will experience strong annual increases in demand for oil and natural gas, especially when the Tata Nano(a low cost compact car designed to replace the motorcycles that currently dominate the streets), begins to permeate the new market.[7] Even before the introduction of the Tata Nano, India's oil consumption was forecast to increase 24 percent by 2010, and Indian demand for natural gas will continue to increase 4.6 percent annually.[8]

According to the U.S. Energy Information Administration (EIA), developing Asian countries will lead the world in energy consumption growth as their economies become more advanced and populations continue to rise. EIA forecasts that the region will account for 45 percent of the total increase in world oil consumption through 2025.[9]

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[5] *Vehicle Market Growth Imposes Challenges*, CHINA DAILY, May 11, 2004.

[6] Written Testimony from Ambassador Robert Hormats, Vice Chairman Goldman Sachs International. Testimony before the House Government Reform Subcommittee on Energy and Resources Hearing, *America's Energy Needs as Our National Security Policy*. April 6, 2005, p. 3.

[7] *The People's Car with a Market of 1.8m*, THE INDEPENDENT, January 13, 2008.

[8] INTERNATIONAL ENERGY OUTLOOK, 2008 Energy Information Administration (2008) (hereinafter Energy Outlook 2008) [online at http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2008).pdf]

[9] *Id*.

Not withstanding any domestically enacted policies that attempt to curtail the demand for energy in the U.S., the red hot economies of China and India will continue to propel the world's demand for energy. Most forecasts predict that during the next 25 years, global energy demand will double from 2001 to 2030.[10] There are only two possible responses in the energy market: increased supply to match the growth in demand or increased prices as countries bid for scarce resources. Either way, if new energy resources are not developed, energy prices will inevitably rise. World oil prices are currently over $100 per barrel, at $108.02, after hitting a record high of $147.02 a barrel; demand is the only constraint on the skyrocketing prices of oil.

1.1d Why International Demand Matters to the U.S. Oil Market

The U.S. is currently the largest participant in the global energy system and the largest consumer of oil, coal, and natural gas.[11] The developing world is catching up at a rapid pace, putting upward pressure on prices. In the last 25 years, world energy demand has increased approximately 60 percent and now *growth* in world oil demand is outpacing increases in discoveries of new oil reserves and petroleum production.[12] Forecasts for the next 25 years project a similar percentage increase in energy demand, but from a much larger base. Moreover, global *competition* for oil and natural gas will likely intensify as demand grows, as new parties enter the market, and as countries explore new ways to guarantee their source of supply. If the United States remains dependant on foreign sources of oil to feed our energy needs, then increased demand from the developing world will inevitably lead to higher energy prices at home.

While the pain of higher energy prices will be shared by all sectors of the economy, there are two groups who will be hardest hit: the working poor and the manufacturing base. Americans earning low to moderate incomes are especially vulnerable to higher energy prices as higher energy bills increasingly cut into other priorities, such as housing, medical, and nutritional needs along with school supplies and other day to day essentials. Additionally, the impact of higher energy prices on the U.S. manufacturing sector could be devastating because the cost of energy to this group is substantial and unavoidable. Manufacturing is energy intensive and the industrial sector currently consumes one third of all U.S. energy.[13] Industrial demand for natural gas, which was 28 percent of the total U.S. market in 2002, is expected to double by 2030. Demand for oil will increase by 15 percent through 2030.[14] Manufacturers are already feeling the pinch of high energy prices as their spending for natural gas grew an estimated 59 percent from 2002 to 2004, increasing money spent on natural gas, even as consumption of the commodity declined.[15] This is because the price for natural gas more than doubled from 2003 to 2005, rising from $4 per thousand cubic feet to $8. The manufacturing industry is very price responsive. Faced with

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[10] *Hard Truths, supra* note 2.
[11] *Id.*
[12] DEVELOPMENT OF AMERICA'S STRATEGIC UNCONVENTIONAL FUEL RESOURCES (Task Force on Strategic Unconventional Fuels) (2006) [hereinafter, Unconventional Fuels] (online at http://www.fossil.energy.gov/programs/reserves/npr/publications/sec369h_report_epact.pdf.)
[13] *Hard Truths, supra* note 2.
[14] *2007 Energy Outlook, supra* note 5.
[15] NAM, The Escalating Cost Crisis

rising prices, energy intensive manufacturers will be forced to either increase their efficiency, or if not economically viable, they will shift more of their operations to lower energy cost regions outside the U.S. Policy makers' failure to take actions to produce more oil and gas and encourage needed investment in new efficient technologies and new energy sources that increase the energy supply will result in high energy prices that could force U.S. companies to relocate. If that's the case, then U.S. consumers, workers, and industry will pay the price for the government's shortsightedness. Increased domestic drilling must be a part of any energy policy.

1.1e Increasing U.S. Energy Efficiency Increases our Competitive Advantage

The good news is that even as the developing world is ramping up their energy consumption levels, the U.S. is one of the most energy efficient nations, consuming 25 percent of the world's energy in order to produce 32.6 percent of the world's GDP.[16] The U.S. economy is much more efficient in using energy than in years past, due in large part to energy conservation and fuel-switching actions. Since 1970, the amount of energy needed to produce each dollar of U.S. GDP has been reduced by 49 percent.[17] Moreover, the Energy Information Agency (EIA) predicts that the rate of growth of energy consumption in the U.S. will be lower than the GDP growth rate for the next 20 years.[18] So while it is true that the U.S. is the largest consumer of the world's energy, there is not a one for one relationship between increased economic output and additional energy consumption. This is not the case with the developing world. Accordingly, policies that enhance our nation's energy efficiency will not only help reduce our dependence on foreign sources of energy, but it will also help maintain an important competitive advantage as energy prices continue to rise.

The U.S. is currently the largest consumer of energy produced by fossil fuel in the world, but China and India are rapidly closing the gap. The insatiable demand of these developing economies will continue to drive up the price of energy, which can lead to severe economic hardship for our manufacturing base, our workers, and our families, who have little choice but to pay the higher prices. In order to prevent this predictable outcome, we must begin to adopt policies today that will increase domestically available sources of energy that can satisfy future needs.

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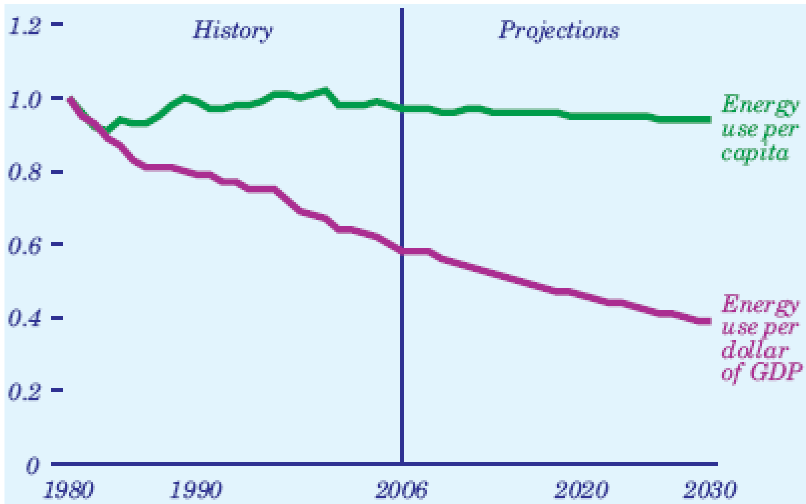
[16] GDP is calculated from *World Development Indicators*, World Bank, Country GDP 2003 (online at http://devdata.worldbank.org/wdi2006/contents/cover.htm).

[17] ANNUAL ENERGY REVIEW, Energy Information Administration (*2004)* (online at http://tonto.eia.doe.gov/FTPROOT/multifuel/038404.pdf).

[18] ANNUAL ENERGY OUTLOOK, Energy Information Agency, (2007) (hereinafter Energy Outlook 2007) (online at http://www.eia.doe.gov/oiaf/aeo/index.html) [hereinafter *2007 Energy Outlook*].

U.S. Energy Use Per Capita and Per Dollar of GDP



Source: EIA Annual Energy Outlook 2008

1.2 The Importance of Energy Security to our National Security

Energy is not merely an economic issue. Energy is also a national security issue. Today, the U.S. is more vulnerable to supply shocks and strategic manipulation of energy supplies than at any time in recent memory. As demand grows, oil and natural gas become strategic commodities susceptible to being used for geopolitical leverage.[19]

Predictably, oil producing countries are increasingly using control of petroleum supplies as a tool—or more appropriately as a weapon—to persuade other nations to back their controversial international positions or to advance their own strategic interests.[20] Iran, Venezuela, Russia, and China have each realized that energy is an increasingly scarce and valuable resource and the countries with large oil resources will be able to leverage it to their advantage.

1.2a Venezuela

One of the most flagrant example of a country leveraging oil resources for strategic purposes hostile to the U.S. is Venezuela. In 2006, Venezuela was the world's 6th largest

[19] *Hard Truths, supra* note 2, at 213.

[20] See also *Hard Truths, supra* note 2 at 218, (stating that non-OECD nations will include both the largest holders of conventional energy resources, as well as their fastest growing consumers. As these new entrants, like China and Russia, play an increasingly important role in the international economic system, the fundamental Western inspired values that have underpinned the system - representative government, the rule of law, transparency, and open markets – can no longer be taken for granted.)

exporter of oil selling 2.2 million barrels of oil a day.[21] Venezuela's President, Hugo Chavez, has pursued an aggressive policy of nationalizing Venezuela's oil industry, which gives him the power to influence production and distribution decisions. In a ceremony marking the take over of the last privately run oil fields, Chavez announced, "The nationalization of Venezuela's oil is now for real!" and in the same speech, with Russian-made fighter jets flying overhead, he shouted, "Down with the U.S. empire!"[22] In November 2007, Chavez made his fourth trip to Iran in just two years to strengthen ties with Iranian President Mahmoud Ahmadinejad. Iran's foreign ministry spokesman said the two leaders would sign memoranda of understanding in economic fields.[23] Chavez has also threatened to withhold crude oil from the American market and then sold home heating oil at cut-rates to some U.S. cities in an attempt to undermine Administration foreign policy. The exploitation of oil supplies to antagonize U.S. interests is clearly a bedrock principal of the Chavez regime, and he will continue to work against U.S. interests using any leverage his government has as a result of their energy resources.

1.2b China

The manipulation of energy resources to achieve strategic international objectives is not unique to Venezuela. China is using increasingly aggressive tactics to secure long-term access to oil and natural gas. Chinese state-owned companies have sought to strengthen China's hand in a new and extended "great game" of geopolitics through regional agreements and acquisitions.[24] The China National Petroleum Company has acquired petroleum concessions in Kazakhstan, Venezuela, Sudan, Iraq, Iran, Peru, Ecuador, and Azerbaijan. State-run oil companies from China, the Philippines, and Vietnam have already signed an agreement to jointly conduct a seismic survey in the South China Sea to systematically determine energy potential in the area. China and Canada are promoting cooperation in oil sands production. In October 2005, China National Petroleum Corporation successfully sealed a deal for PetroKazakhstan. The first fuel has already been delivered through the 1,800-mile Atasu-Alashankou pipeline between Kazakhstan and China. The pipeline will also carry Russian oil to China from western Siberia. Finally, China recently completed a number of energy agreements with Russia, including a joint venture between state-owned companies.[25]

In addition to securing future supply chains, China has also not hesitated to seek out alliances with energy sources controlled by governments hostile to U.S. interests. This is an issue of great importance because these states may view China as a "buffer" against what they perceive is U.S. aggression.[26] For example, China receives almost 15 percent of

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[21] TOP WORLD OIL PRODUCERS AND CONSUMERS, ENERGY INFORMATION ADMINISTRATION, available at http://www.eia.doe.gov/emeu/cabs/topworldtables1_2.htm.
[22] Robert Collier, *Battle over Venezuela's Oil Industry Heats Up*, SAN FRANCISCO CHRONICLE, May 2, 2007.
[23] Nasser Karimi, *Venezuela's Chavez Visits Iran*, AP, Nov. 19, 2007.
24 The first "great game" refers to the conflicts and maneuvering to control the resources of Central Asia during the 19th Century.
25 *Stratfor Situation Reports*, 3/22/06, 8/26/05, 8/22/05, 3/14/05.
26 *Stratfor*, "China's Overseas Expansion Strategy," 4/17/03.

its oil from Iran and is the largest buyer of oil from Sudan.[27] In December 2004, Venezuelan President Hugo Chavez signed eight agreements in Beijing that prepared the foundation for granting Chinese oil companies preferential access to oil and gas projects in Venezuela, including exploration and production, and the construction of new pipelines, refineries, and petrochemical plants. Both China and India have entered long-term agreements with Iran for natural gas supply, and both countries have taken equity stakes in Iranian natural gas production. Chinese and Indian companies recently submitted a joint bid to obtain a 38 percent share of a Syrian petroleum company.[28]

1.2c Iran

Iranian President Mahmoud Ahmadinejad has not hesitated to use its strategic relationship as a major energy supplier to China to its own advantage. In 2006, Iran was the world's 4th largest oil exporter, selling 2.5 million barrels of oil a day to the world market.[29] As Washington pushes for tougher sanctions in the wake of a deal between Iran and UN Inspectors, Iran is claiming to have the support of China in opposing any added pressure.[30] After talks with senior Chinese diplomats, Iran's Interior Minister Mostafa Pourmohammadi said, "In our discussions with the Chinese side, we agree that resolving this issue through the IAEA is more effective."[31][32] With a permanent seat on the U.N. Security Council, China holds the power to pass or veto possible new sanctions on Iran.

1.2d Russia

Finally, nowhere has the wielding of political power in energy markets by governments and state-owned companies been more evident than in Russia. Besides the well-known Yukos affair in which the fairness, impartiality and objectivity of the Russian authorities were called into question as they acted with excessive disregard for fundamental rights of the defense guaranteed by the Russian Criminal Procedure Code and by the ECHR, Gazprom, whose former chairman is Russian President Dmitry Medvedev, has used its supply of natural gas in an attempt to subvert Ukrainian autonomy from Russian influence. Unlike crude oil, there is a very limited international spot market for natural gas, and supplies are not easy to come by. Russian government officials and Gazprom executives acted in concert to pressure the Ukraine into paying exorbitant prices for natural gas. A compromise agreement to phase-in a less damaging but still high price was reached, but only after Russia reduced the flow of natural gas to the Ukraine, affecting greater Europe. More than one-quarter of natural gas consumed by European Union countries is imported from Russia—almost 40 percent in all European countries—and 80 percent of that transits Ukraine.[33] Since then, a number of Russia's neighbors have scrambled to negotiate new agreements with Russia or to seek alternative arrangements. In essence, they have been

27 Sudan's western Darfur region is the site of one of the world's worst humanitarian crisis, where more than 200,000 people have been killed and more than two million forced from their homes since 2003.
[28] *Stratfor Situation Reports*, 11/29/05, 12/27/04.
[29] *Hard Truths, supra* note 2, at 213.
[30] *Iran Says China on Side Against Fresh Sanctions*, REUTERS, Sept. 14, 2007.
[31] *Id*.
[32] International Atomic Energy Agency (IAEA)
[33] *Stratfor*, "EU: Exploring Its Energy Options," 1/03/06.

forced to make a choice between being firmly in Russia's sphere of influence or moving closer to greater Europe with doubtful prospects for a near-term solution to their energy problems.

Clearly, Iran and Venezuela are leveraging their vast oil supplies to enhance their position against the interest of the United States. China has so far been willing to go along with them in order to secure its continued access to their oil. The manipulative behavior of Russia with respect to supplying natural gas to the EU and its former satellite nations provides energy rich nations with a playbook on how to best leverage their energy resources. Accordingly, our dependence on foreign sources of oil, and the concentration of energy resources in unstable countries, leaves the U.S. vulnerable both economically and strategically. Moreover, U.S. demand for oil, which averaged 12 million barrels of oil a day in 2006,[34] not only props up the price of oil, but also props up the very dictators who have publicly and frequently held positions hostile to U.S. interests.

[34] *Hard Truths, supra* note 2, at 213.

Ch. 2. Beyond Scarce Resources - Operating in a Carbon Constrained Environment

It is clear that the United States government must take a stronger leadership role in ensuring energy independence for the sake of our economic and national security interests. This means fostering domestically available energy sources, including increasing domestic drilling, and lessening our demand for imported oil. But any action taken to increase our energy supplies will have an impact on our national carbon footprint, and any attempt to decrease our carbon footprint will impact the price Americans pay for energy. Until now, both of these critical issues have been discussed as if they are in isolation, which is irresponsible.

2.1 Climate Change Policy

As noted, there is growing concern that anthropogenic (or human) activities are affecting the heat and energy-exchange balance between Earth, the atmosphere, and space. Science suggests that anthropogenic activities, such as the burning of coal and oil contribute to increased levels of CO_2 and other "greenhouse" gases in the atmosphere. This accumulation of gases causes the "greenhouse effect," a rise in temperature due to trapped energy from the sun. The "greenhouse effect" is thought to be the root cause of the change in the Earth's climate, inducing "global warming."

Chief among the gases thought to accelerate the greenhouse effect is CO_2. Atmospheric concentrations of $CO_2$are thought to have increased by 35% from pre-industrial values of 280 parts per million (ppm) to 378 ppm over the past 150 years. Moreover, CO_2 is thought to remain in the atmosphere for up to 100 years. Since the early 1990's the U.S. government has acknowledged the risks associated with climate change, and has adopted policy positions that emphasize support for additional research and voluntary mitigation efforts.[35]

The Intergovernmental Panel on Climate Change (IPCC)[36] periodically assesses the scientific, technical, and socio-economic information relevant to understanding the scientific basis of risk connected with human-induced climate change. The most recent IPCC publication, the Fourth Assessment, released in March 2007 found that more than half the observed increase in globally averaged temperatures since the mid-20th century is very likely (confidence level >90%) connected to human greenhouse gas concentrations.[37] There is significant international pressure to achieve meaningful reductions in

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[35] The US ratified the United Nations Framework Convention on Climate Change (UNFCCC), the first international effort to combat climate change, which committed developed countries to try to return their greenhouse gas emissions to their 1990 levels by the year 2000.

[36] The IPCC is affiliated with the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP).

[37] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

CO_2emissions based on the finding that humanity is contributing to climate change, primarily though its use of fossil fuels.[38]

The U.S. has been a part of this international dialogue on climate change since the 1990's, through its participation in the United Nations Framework Convention on Climate Change (UNFCCC). This treaty committed developed countries to try to return their greenhouse gas emissions to their 1990 levels by the year 2000. Under the treaty, developed countries were to adopt national plans and policies to reduce greenhouse gas emissions. The U.S. submitted such plans in 1992, 1994, 1997, and 2002.[39]

The George H.W. Bush and Clinton Administrations both encouraged voluntary reductions by industry through administrative initiatives, such as the U.S. Environmental Protection Agency's (EPA) various "green" programs. This largely voluntary approach to complying with UNFCCC allowed the two Administrations to implement a climate change policy without having to ask Congress for new authorities.

Both administrations focused on fostering market choices that would conserve energy, increase energy efficiency, and encourage natural gas use. Additionally, both Bush and Clinton sought to strengthen selected regulatory standards that also reduced greenhouse gas emissions -- such as landfill regulations that curtailed methane releases.

In February 2002, President George W. Bush announced policy initiatives intended as a "new approach for meeting the long-term challenge of climate change." Included in this announcement was the plan to reduce U.S. greenhouse gas intensity (energy used per dollar of GDP) by 18 percent by 2012. According to the 2007 EIA report, U.S. energy intensity is on schedule to decline at an average annual rate of 1.8 percent from 2005 to 2030, which is sufficient to meet the goal established by President Bush.

In addition to its focus on reducing greenhouse gas intensity, the Bush Administration has engaged the U.S. in the Asia Pacific Partnership on Clean Development and Climate. The Asia Pacific Partnership was created in July 2005. It is a non-binding international agreement between Australia, India, Japan, China, South Korea, and the United States. The goal of the Asia Pacific Partnership is to develop and transfer greenhouse gas-reducing technology amongst the nations. The partnership engages both developed and developing nations as equals.

Most recently, the United States joined with nations around the world to adopt the Bali Roadmap. This initiative creates a process and set of principles for negotiating a successor

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[38] While there is significant international resolve to act aggressively to combat climate change, it is inappropriate to suggest that there is scientific unanimity on the subject of climate change. According to a recently issued staff report by the Senate Environment and Public Works Minority, over 400 scientists disagreed with the findings of the IPCC's 4th Assessment. The report can be accessed at http://epw.senate.gov/public/index.cfm?FuseAction=Minority.Blogs&ContentRecord_id=f80a6386-802a-23ad-40c8-3c63dc2d02cb.

[39] LARRY PARKER AND JOHN E. BLODGETT, US GLOBAL CLIMATE CHANGE POLICY: EVOLVING VIEWS ON COST, COMPETITIVENESS, AND COMPREHENSIVENESS, Congressional Research Service (January 2007).

to the Kyoto Protocol, which expires in 2012. The roadmap calls for, “deep cuts in global emissions,” and for a final agreement by the end of 2009.[40]

The debate over climate change is no longer whether or not it exists, but rather what can and should the United States do to reduce its own carbon footprint. Most mitigation efforts will be tightly correlated to energy policy, either through the consumption choices that Americans make or energy conservation efforts. Therefore any responsible strategy to provide for our nation’s future energy needs will consider and account for our expected commitments to reduce our CO_2emissions.

2.2 Energy Policy Should Acknowledge and Plan for a Carbon Constrained World

Until very recently, policymakers in Washington were generally split into two camps: one side argues that our nation is facing an energy crunch and we must do more to generate new sources of energy. The 2005 Energy Policy Act, which focuses on facilitating the discovery and recovery of new energy sources, is the embodiment of this approach.

The other camp argued that the U.S. should focus exclusively on reducing demand, so as to mitigate expected CO_2 emissions, and developing clean alternatives, such as wind and solar, to reduce our dependence on fossil fuel. This is the fundamental approach taken by the current Congress in the Clean Energy Act of 2007. The reality is that both approaches are necessary, but standing alone, insufficient to address the looming energy and climate change crisis because each fail to provide for a significant aspect of the challenges ahead.

Today, policymakers should abandon their entrenched positions and focus on both securing additional sources of domestically available energy and reducing carbon emissions. Like any structural shift, this energy transformation from carbon intense to carbon free will not happen overnight and it will not happen without the government’s active involvement. We must create an environment today that encourages and facilitates research and development into energy efficiency and alternative energy sources. There is a significant period of time between developing a new technology and its commercial deployment. For example, it can take over 20 years for a newly commercialized technology to be broadly applied to the vehicle fleet on the road.[41] Moreover, commercializing new technologies in the oil and gas markets take an average of 16 years to progress from concept to widespread commercial adoption.[42] The time to invest in these emerging sources of energy is now.

2.3 Need for a Global Solution

Climate change is inherently global in nature. Therefore additional international factors must be considered when crafting energy/climate change policy, which makes our challenge unlike any other environmental policy thus far enacted. The rapid mixing of CO_2 in the atmosphere ensures that CO_2 emitted anywhere in the world is quickly distributed throughout the atmosphere. This means that CO_2 emissions from a power plant in China

[40] Bali Action Plan, Decision CP.13
[41] *Hard Truths, supra* note 2.
[42] *Id.*

impact the CO_2 concentrations in the atmosphere above California or any other state. Accordingly, the challenges posed by climate change demand a global solution. In spite of the voluntary actions taken by the United States and the mandatory emission reduction provided for in the Kyoto Protocol, worldwide CO_2 emissions are expected to rise almost 2 percent per year from 2005 to 2030.[43] One half of the projected increase in emissions comes from new power stations in India and China, mainly using coal for base load generation.[44] The Netherlands Environmental Assessment Agency recently reported that China is now the world's top emitter of CO_2, as their emissions have risen 9 percent annually, compared with a 1.4 percent increase in CO_2emissions in the U.S.[45] Moreover, a recent report sponsored by the Center for Strategic and International Studies found that Chinese CO_2emissions could be as much as twice the U.S. emissions by 2025, while the EIA predicts that China's energy related emissions will exceed those of the US by 41 percent in 2030.[46] The chart below, prepared by the Energy Information Agency, demonstrates how CO_2 emissions from non-OECD countries will rapidly surpass the developed nations starting in 2010.[47]

The drastic emission reductions called for by the IPCC cannot be achieved by actions of the developed nations alone.[48] In September 2007, the executive director of the United Nations Framework Convention on Climate Change, Dutch diplomat Yvo de Boer, said that from the perspective of the environment, Kyoto, which focused solely on mitigation efforts by developed nations, could be considered a failure. He said, "You could, I suppose, say it's a failure from the point of view of the atmosphere, from the point of view of climate because it's only managing to reduce greenhouse gases by a little less than 5 percent. So in that sense you could call it a failure."[49]

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[43] INTERNATIONAL ENERGY OUTLOOK, Energy Information Agency, (2008)

[44] MALCOLM SHEALY AND JAMES P. DORIAN, GROWING CHINESE ENERGY DEMAND, IS THE WORLD IN DENIAL: A REPORT OF THE ENERGY AND NATIONAL SECURITY PROGRAM CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES, 8 (CSIS) (2007) (Stating that 70 percent of Chinese energy needs are meet by coal. Moreover, Chinese goals for rapid urbanization of app. 400 million people by 2030 will likely push electricity demand up even faster.) (hereinafter *Growing Energy Demand*)

[45] CHINA NOW NO. 1 IN CO2 EMISSIONS; USA IN SECOND POSITION, Netherlands Environmental Assessment Agency, available at http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html.

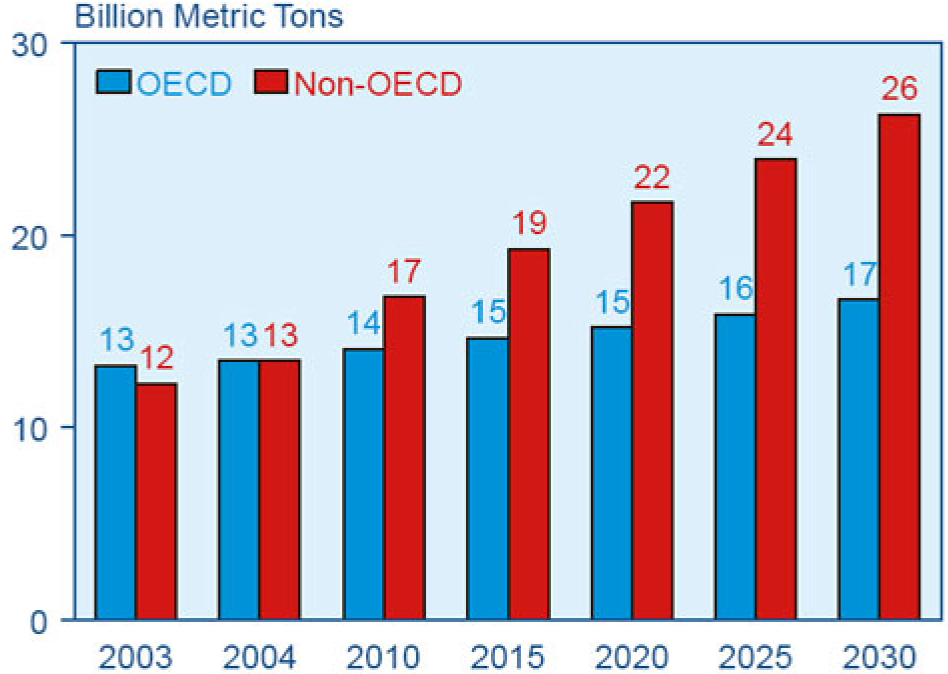
[46] *Chinese Energy Demand, supra,* note 30 at 8; *2007 Energy Outlook, supra* note 5 at 75.

[47] Twenty countries originally signed the Convention on the Organization for Economic Co-operation and Development (OECD) on 14 December 1960. Since then a further ten countries have become members of the Organization.

[48] Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-spm.pdf.

[49] Interview by Monica Trauzzi, On-Air Reporter, Energy and Environment Daily, with Executive Secretary of the UNFCCC, Yvo de Boer (Sept. 24, 2007).

Figure 7. World Carbon Dioxide Emissions by Region, 2003-2030



Sources: **2003 and 2004:** Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site www.eia.doe.gov/iea. **Projections:** EIA, System for the Analysis of Global Energy Markets (2007).

In fact, the United States rejected the Kyoto Protocol in part because by exempting China and India it did not provide a truly global plan to reduce CO_2 emissions.[50] During ongoing negotiations in Bali, Indonesia, Senator John Kerry (D-Mass.) warned the world negotiators that the U.S. could not agree to a document if it “does not embrace the notion that less developed countries also have to be part of the solution at an appropriate moment in an appropriate way” because otherwise it would be very difficult to pass something [in the U.S.].[51] Given the dramatic increase in emissions from Asia, the exemption of China and India was clearly detrimental to efforts to even slow the growth of CO_2emissions.

[50] In 1997, a unanimous Senate adopted S.R. 98, which asked President Clinton not to agree to limits on greenhouse gas emissions if the agreement would injure the economic interests of the U.S. or if it would not “mandate new specified scheduling commitments to limit or reduce greenhouse gas emissions for Developing Country parties within the same compliance period” as the U.S.; In 1999, Congress added language to the EPA Appropriations Act prohibiting the agency from using any funds to “propose or issue rules, regulations, decrees, or orders for the purpose of implementation or in preparation for implementation of the Kyoto Protocol.

[51] Press Conference, Senator John Kerry (D-Mass.), Bali, Indonesia, December, 2007.

Moreover, signers of the Kyoto Protocol have struggled to meet their emission reduction obligations, as the chart below demonstrates.

But in addition to the increase of CO_2generated by their growing economies, policy makers should be aware that international agreements that fail to include complimentary obligations on developing countries run the risk of actually causing more carbon emissions.

Change in Emissions for Countries in the European Union

Country	Target	% Change in emissions between 1990 and 2003	Compliant?
Austria	-13%	+16.50%	no
Belgium	-7.50%	+1.30%	no
Denmark	-21%	+6.80%	no
Finland	0	+21.50%	no
France	0	-1.90%	yes
Germany	-21%	-18.20%	almost
Greece	25%	+25.80%	almost
Ireland	13%	+25.60%	no
Italy	-6.50%	+11.50%	no
Luxembourg	-28%	-16.10%	no
Netherlands	-6%	+1.50%	no
Portugal	27%	+36.70%	no
Spain	15%	+41.70%	no
Sweden	4%	-2.30%	yes
United Kingdom	-12.50%	-13%	yes

Source: [1] Cass Sunstein, *The Montreal and Kyoto: A tale of Two Protocols*, 31, 39 HARV. LAW REV. 1 (2007).

2.3a Misguided Domestic Policies Could Cost us Jobs and Increase Emissions

Policy makers are frequently concerned about the relocation of our manufacturing facilities to China, India, or other developing nations costing American workers good paying jobs. However, in the climate change context, the off shoring of manufacturing is an even larger problem because China's energy intensity is three times higher and rising faster than it is in the U.S or Europe.[52] This means that any manufacturing process in China will emit at least 300 percent more CO_2than a similar manufacturing process in the U.S. In other words, policies that encourage U.S. companies to leave our shores can do more than cost American workers good jobs, they can have a terrible impact on the environment and energy sources. These policies could actually result in a net increase in greenhouse gas emissions, because the developing world simply does not have the same environmental standards in place as

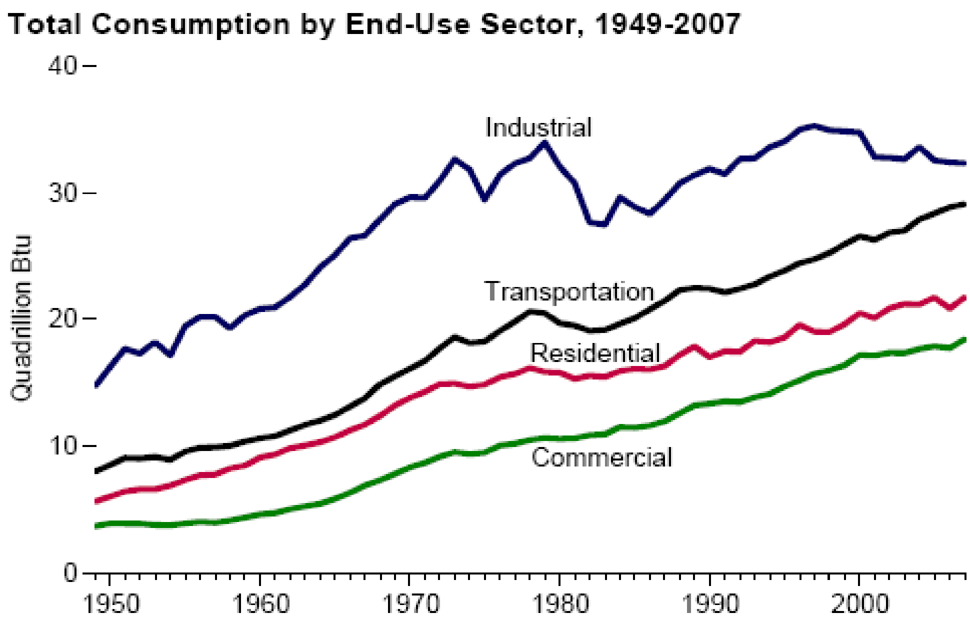
[52] Greg Peel, *Reality Check: China's Increasing Energy Intensity*, STOCK INTERVIEW.COM, Dec. 1, 2006 available at http://www.stockinterview.com/News/12032006/Peel-China-Energy-Intensity.html; *See also Chinese Energy Demand, supra*, note 30 (stating that Chinese energy intensity is significantly higher than that of US manufacturers. Chinese demand rose at a rate of 11.4% per year from 2000 to 2004, while Chinese GDP growth averaged 9.4% per year).

we do here at home. Accordingly, poorly drafted climate change legislation could not only cost us jobs, it could actually encourage the growth of CO_2 emissions. Clearly, any meaningful international agreement to reduce carbon emissions must include the developing world since they are an essential part of the problem and the solution. Moreover, any sensible energy/climate change policy will strive to minimize the negative impact that higher energy prices could have on our manufacturing base in order to keep the jobs here at home.

CHAPTER 3: CURRENT TRENDS IN DOMESTIC ENERGY CONSUMPTION

To craft a solution that can harmonize the competing demands of energy security and reduced CO_2emissions, we must first understand the current structure of domestic energy consumption. U.S. energy consumption has almost tripled since 1950, with the transportation and residential energy consumers leading the way, while energy consumption by the industrial sector (the heaviest user) has actually grown at the slowest rate. Moreover, most of the growth in total consumption took place before 1970. Therefore, the greatest gains in energy efficiency can likely be gained from focusing on transportation and residential energy consumers.

The vast majority of energy consumed in the United States is derived from either petroleum or coal, and both are major sources of CO_2 emissions. The electricity sector is fueled primarily by coal plants, while the transportation sector is the primary consumer of petroleum products. Electricity usage in the U.S. is projected to grow more than twice as fast as resources currently projected for electricity generation over the next 10 years."[53] Based on the elementary principals of supply and demand, if there is not an increase in the amount of resources invested in electricity generation, it is easily foreseeable that the average American will be paying a significant amount more to heat and cool their homes and to keep their lights on.



Source: Annual Energy Review 2007, Table 2.1a

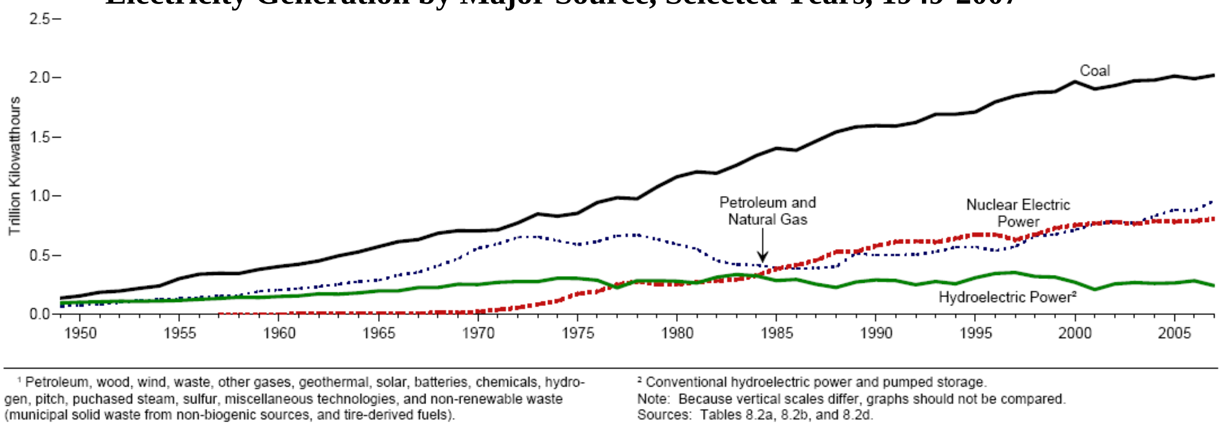
[53] Press Release, North American Demand Continues to Outpace Resource Growth; Reliability Concerns Remain, (Oct. 16, 2007) available at ftp://www.nerc.com/pub/sys/all_updl/docs/pressrel/10162007_1.pdf.

3.1 Primer on Electricity

Electricity is created from the conversion of a fuel or other source of energy into electrons. This process occurs in an electricity generating plant. The primary electricity generating fuels used in the U.S. are coal, nuclear, hydro power, and natural gas. All of these energy sources use power turbines that generate electricity.[54] While our domestic consumption of *energy* increased three fold since 1950, the consumption of *electricity* has increased at an even more rapid pace. Annual power generation is currently ten times what it was in 1950.

In addition to the increase in the amount of electricity consumed, there was also a shift in the source of electricity generation. In 1950, the electric power sector consumed less than 20 percent of the coal burned, while in 2004, the same sector used more than 90 percent of all coal burned that year. Between 1950 and 2005, coal was used to generate about half the rapidly increasing amount of electricity consumed. Consequently, consumption of coal doubled between 1950 and 2000.

Electricity Generation by Major Source, Selected Years, 1949-2007



Source: EIA, Annual Energy Review 2007, Table 8.2a.

3.2 Coal

The American industrial sector is very dependent on the use of coal as 78 percent of energy produced by coal is consumed by industry. Global demand for coal has mirrored our domestic consumption patterns, mostly driven by increased consumption in China.[55] A major reason the U.S. is so dependent on coal as an energy source is because the largest coal reserves in the world are found in the U. S.. China's coal reserves are also sizable.

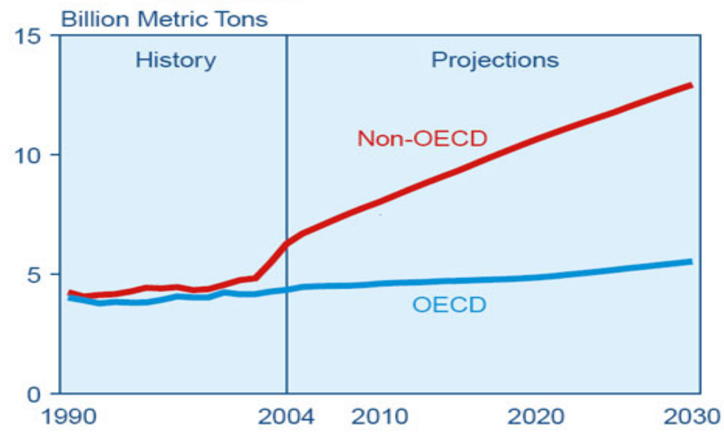
On the global scale, coal supplies the second largest share of world energy, and its consumption is projected to increase over the next 20 years, driven mainly by growing electricity demand in developing countries. In the U.S., coal supplies 20 percent of all

[54] A NEOPHYTE'S GUIDE TO THE CHANGING ELECTRIC UTILITY INDUSTRY (American Public Power Association) (2007).
[55] CAROL GLOVER AND CARL BEHRENS, ENERGY: SELECTED FACTS AND NUMBERS 4 (CRS)(2007).

energy demand, but 50 percent of all electricity generation. Natural gas and nuclear energy respectively supply 18 percent and 19 percent of electricity generation, Hydro accounts for 6% and other renewables such as wind and solar account for 3 percent. Unlike petroleum, the U.S. is a net exporter of coal, supplying approximately 19.7 million short tons (mmst) of coal to Canada and Brazil.[56] According to a recent BP World Statistical Survey of Energy Resources, U.S. Coal reserves exceed 493 Billion short tons and could meet current U.S. Coal demand, for at least 200 years.[57] Economically recoverable coal in the U.S. is projected to last for at least another 100 years.[58] EIA projects that the consumption of coal will increase from 22.9 quadrillion BTU in 2005 to 34.1 in 2030. China and India account for 72 percent of the projected increase in coal related CO_2 emissions.[59]

As a source of energy, coal is abundant in the U. S. and is increasingly relied upon by the developing world. However, coal combustion produces more CO_2per unit of energy than natural gas or oil. Stated differently, coal combustion contributed 39 percent of worldwide energy related CO_2 emissions into the atmosphere in 1990, and EIA predicts that by 2030 coal's share of CO_2 emissions will rise to 43 percent.[60] With respect to coal as an energy source, the twin goals of energy security and climate change are in direct conflict with each other. Coal is a domestically available and affordable energy source, but the combustion of coal is a key contributor to our carbon footprint. Absent the development of a technology that can mitigate coal's carbon emissions, the use of coal as a source of energy will continue to present a public policy dilemma.

Figure 83. World Carbon Dioxide Emissions from Coal Combustion by Region, 1990-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site www.eia.doe.gov/iea. **Projections:** EIA, System for the Analysis of Global Energy Markets (2007).

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[56] EIA Quarterly Coal Report (available at: http://www.eia.doe.gov/cneaf/coal/quarterly/qcr_sum.html)
[57] (cite DOE fact sheet)
[58] *Hard Truths*, *supra* note 2.
[59] *2007 Energy Outlook*, *supra* note 5 at 76.
[60] *2007 Energy Outlook*, *supra* note 5 at 73. (stating that total world wide CO_2 emissions from coal combustion are projected to increase from 10.6 billion metric tons in 2004 to 18.5 billion metric tins in 2030.)

3.3 Oil

Since 1950, almost 40 percent of the energy consumed in the U. S. is supplied by petroleum and 60 percent of petroleum based energy is consumed by the transportation sector. While petroleum consumption has continued to increase throughout the last half century, U.S. domestic production peaked in 1970. Since then, the U.S. has been consuming more oil than we are producing and have accordingly grown increasingly dependent on imported petroleum products. Absent a significant shift in our consumption pattern, the U. S. will grow increasingly dependent on foreign, and sometimes hostile, sources of oil. In 1960 we imported 20 percent of petroleum consumed, whereas in 2005 we imported 60 percent of our supply.[61] Worldwide, the major exporters of crude oil are Saudi Arabia, Russia, and Iran. The major importers of crude oil are the United States, Japan, and China. Steep increases in oil prices have led to significant transfers of wealth from energy consumers to a small and increasingly concentrated group of energy producing nations.[62] On January 2, 2008, the price of crude oil broke the historic threshold of $100 per barrel on the New York Mercantile Exchange and after a spike to a record high of $147.02, currently fluctuates between $70-80 per barrel. This means that oil is now within reach of its historic inflation adjusted peak, untouched since 1980. Unlike the oil spikes in the 1970s and 80s, caused by sudden interruptions in oil supplies from the Middle East, today oil prices have risen steadily over several years because of the increased demand for oil throughout the world.

High prices of conventional oil and advances in technology have made extraction of oil from oil shale more cost competitive. Oil shale is sedimentary rock that contains solid materials, called kerogen, that are released as petroleum-like liquids when the rock is heated in the chemical process of pyrolysis.[63] According to moderate estimates, there are 800 billion barrels of recoverable oil from oil shale in the Green River Formation in Colorado, an amount three times greater than the proven oil reserves of Saudi Arabia.[64]

Together, oil and coal supply 60 percent of our domestic energy needs. Additional sources of energy, primarily used for electricity generation, include nuclear energy, natural gas, hydroelectric energy, and renewable fuels. The next section of this report will focus on energy sources other than coal and oil to assess their potential to displace carbon intense fossil fuels as well as the time horizon for deployment of the different technologies.

3.4 Nuclear

Nuclear energy is a cost effective source of base load electricity generation that emits no CO_2. Nuclear energy is produced by a controlled nuclear chain reaction, which creates heat that is used to boil water, produce steam, and drive a steam turbine. The turbine can be

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[61] CAROL GLOVER AND CARL BEHRENS, ENERGY: SELECTED FACTS AND NUMBERS 4 (CRS)(2007).

[62] *Hard Truths, supra* note 2 at 223 (stating that energy producing nations are typically undiversified extractive economies, with a youthful population seeking gainful employment, and political systems that are beginning to show signs of strain because of insufficiently representative governments. However, current high oil prices have taken much of the political urgency out of addressing these problems.)

[63] ARGONNE NATIONAL LABORATORY, U.S. DEPARTMENT OF ENERGY http://ostseis.anl.gov/guide/oilshale/index.cfm

[64] *Id.*

used for mechanical work and also to generate electricity. Today there are 103 operating U.S. nuclear reactors, which generate almost 20 percent of the nation's electricity, or 8 percent of the total energy domestically consumed.[65] However, with no new nuclear plant construction, the nuclear power industry is expected to produce just 15.1 percent of U.S. electric power in 2025.[66] Recently, plans have been announced for license applications for up to 32 new reactors, but no new plants are currently under construction or on order.

While nuclear power's share of electricity is forecast to decline in the U.S. due to plant retirements, nuclear power is experiencing a resurgence around the world. Nuclear power already supplies a larger percentage of electricity in 17 countries than it does in the U.S., and the number of countries meeting their energy needs through nuclear power generation is expected to grow. As of April 2005, 35 nuclear reactors were being constructed in 12 countries, including China, South Korea, Japan, and Russia.[67] The United Kingdom, Sweden, and Germany are reviewing their energy policies that assumed intermittent renewable sources, like wind energy, would be capable of meeting everyday electricity needs without nuclear power.[68] Other European countries are also considering increasing their own nuclear programs in response to the recent crisis brought on by Russia's willingness to withhold natural gas from dependent consumers. As a result of this increased investment in nuclear energy, the International Energy Outlook (IEO) projection for nuclear power generation in 2025 is up by almost 31 percent from the IEO 2003 projections.[69] Leading all other nations is France, where 78 percent of all electricity generation comes from nuclear power plants. As a result of the dominance of nuclear generation in France, they emit 25 percent less CO_2 than the European average.

If American policy makers can get past the roadblocks associated with nuclear waste and other regulatory hurdles, nuclear energy has the potential to play a significant role in meeting future energy needs in a carbon constrained environment. It is a mistake to believe that a nuclear resurgence can occur at a moment's notice. The necessary manufacturing, fabrication, labor, and construction equipment infrastructure is available today or can be developed to support the construction and commissioning of up to eight nuclear units during the period from 2010 to 2017.[70] However, it is important to note that there is the potential for a serious bottleneck in the development process because of the limited availability of nuclear grade large ring forgings needed to fabricate reactor pressure vessels

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[65] Nuclear Energy Institute

[66] DOE NP 2010 Nuclear Power Plant Construction Infrastructure Assessment http://www.ne.doe.gov/np2010/reports/mpr2776Rev0102105.pdf

[67] *Plans for New Reactors Worldwide*, World Nuclear Association, August 2008, available at http://www.world-nuclear.org/info/inf17.html.

[68] Maturing renewable power sources such as solar and wind are important to US energy security and must be developed. However, most renewables are intermittent in nature and cannot meet baseload demand because there is no way to store this energy. For example, the US National Academies of Science predicts future improvements will only increase the utilization capacity of wind turbines from 30 to 40 percent—meaning they cannot be relied upon to always deliver power when and where it is needed. In the U.S., EIA forecasts that renewables will not exceed 10 percent of the energy portfolio in the next 25 years.

[69] *2008 Energy Outlook.*

[70] DOE NP 2010 Nuclear Power Plant Construction Infrastructure Assessment http://www.ne.doe.gov/np2010/reports/mpr2776Rev0102105.pdf

(VRV). These forgings are currently only available from one Japanese supplier, which is also supplying the orders from all other nations constructing new nuclear facilities.[71]

Increased nuclear electricity has several critical advantages over the status quo. It will free natural gas supplies for critical uses in automobiles and manufacturing, reducing electricity costs to the consumer, be emissions free, and pave the way for drastically reduced petroleum dependency. Nuclear electricity in sufficient quantities could be used to produce hydrogen to power a critical mass of emissions free automobiles. In a hydrogen economy, hydrogen fuel would be manufactured from some primary energy source and used as a replacement for gasoline in combustion engines. Hydrogen is consumed by a chemical reaction in a fuel cell, and doesn't emit CO_2. The fuel cell simply combines hydrogen and oxygen chemically to produce electricity, water, and waste heat.

To its credit, the Bush Administration has identified nuclear energy as an important source for future electricity generation and is in the process of implementing the Department of Energy's Nuclear Power 2010 (NP-2010) program, which is focused on reducing the technical, regulatory and institutional barriers to deployment of new nuclear power plants.[72] Specifically, NP-2010 is attempting to facilitate the deployment of Generation III+ advanced light water reactors, which offer advancements in safety and economics over the Generation III designs certified by the Nuclear Regulatory Commission (NRC) in the 1990s.[73] To enable the deployment of new Generation III+ nuclear power plants in the United States in the relatively near-future, it is essential to complete Generation III+ reactor technology development and to demonstrate the as yet untested Federal regulatory and licensing processes for the siting, construction, and operation of new nuclear plants.

3.5 Natural Gas

Another significant source of energy for electricity generation is natural gas, which comprises 19 percent of the U.S. electric industry's generation capacity.[74] In the power sector, natural gas is an attractive choice for new generating plants because of its relative fuel efficiency and low carbon emissions. Currently, high prices for natural gas make the operating cost of electricity generated from natural gas fired generating units the most expensive. Therefore, natural gas fired generating units are generally only used as intermediate or peak load units, and not as base load units.

Historically, the U.S. has been both the largest producer and the largest consumer of natural gas in North America. Improved technology, such as hydraulic fracturing, has given the U.S. access to an estimated 1,525 trillion cubic feet of gas, which is enough to last 82 years at current production rates.[75] Canada has been the primary source of U.S. natural gas

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[71] Id.
[72] http://www.ne.doe.gov/np2010/neNP2010a.html
[73] *Id.*
[74] 2007 LONG-TERM RELIABILITY ASSESSMENT 15 (North American Electric Reliability Corporation) (Oct. 2007) available at ftp://www.nerc.com/pub/sys/all_updl/docs/pubs/LTRA2007.pdf (hereinafter, *Long-Term Reliability*)
[75] Katherine Ling, *Natural Gas: US Reserves to Last 82 Years*, E&E NEWS PM, Sept. 13, 2007.

imports.[76] In 2004, Canada provided 85 percent of gross U.S. imports of natural gas. Natural gas consumption in North America is projected to increase at an average annual rate of 1.0 percent from 2004 to 2030.[77] The average annual growth rate for natural gas demand in the U. S. is projected to be 0.6 percent, significantly less than in Canada and Mexico, largely because of the impact of higher natural gas prices and supply concerns in U.S. natural gas markets. It is important that policy makers understand that unlike petroleum, natural gas does not have a global price, so domestic policies that limit domestic supply lead directly to higher prices.[78] Conversely, policies that encourage natural gas recovery will tend to decrease the market price of the commodity.

Energy companies are increasingly relying on a process known as hydraulic fracturing (HF) to tap into vast supplies of domestic natural gas, and the National Petroleum Council estimates that 60 to 80 percent of all the wells drilled in the next decade to meet natural gas demand will require fracturing. Fracturing is a technique used to allow natural gas and oil to move more freely from the rock pores where they are trapped to a producing well that can bring them to the surface. Estimates indicate hydraulic fracturing has increased the recovery of domestic oil and gas reserves by 30 percent and it has been responsible for the addition of more than seven billion barrels of oil and 600 trillion cubic feet of natural gas to meet the nation's energy needs. It is critical to dramatically increasing domestic production oil, particularly from oil shale.

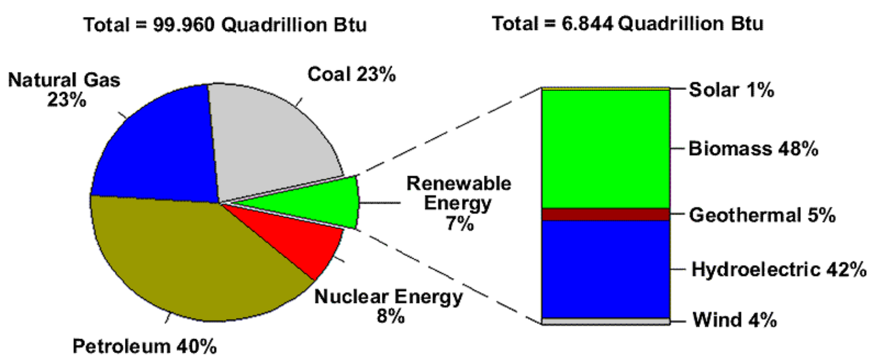
[76] *2007 Energy Outlook, supra* note 5.
[77] *Id*.
[78] THE ESCALATING COST CRISIS, AN UPDATE ON STRUCTURAL COST PRESSURES FACING U.S. MANUFACTURERS vi (National Association of Manufacturers 2006.)

Chapter 4: The Way Forward

As mentioned earlier in this report, the United States will not be able to obtain sufficient energy resources to meet predicted energy needs in a carbon constrained world, without a significant shift in present day consumption patterns. This shift could include additional nuclear capacity coming on line, the development and deployment of carbon capture and sequestration, or the development and commercialization of alternative energy sources, such as cellulosic ethanol, improved wind and solar technology, or the ability to tap into geothermal energy.

The twin goals of energy independence and combating climate change have led to new research and investment in renewable energy sources, biofuels, carbon sequestration methods, and next generation nuclear. With the exception of nuclear, each of these low carbon energy sources are in their adolescent stages of development and are currently decades away from rivaling oil and coal as the major sources of energy.[79] Renewable energy's market share stood at only 7 percent in 2006.[80]

The Role of Renewable Energy Consumption in the Nation's Energy Supply, 2006



Source: EIA 2007 Energy Outlook

Over half of renewables are produced for electricity production, while the industrial sector consumed 28 percent, with the transportation and commercial sectors using the remainder. However, renewable energy resources are not perfect substitutes to traditional fossil fuels. There are unique challenges associated with the transmission and distribution of wind and solar generation because resources are often remotely located and require new transmission infrastructure over challenging terrain to deliver their power to population centers.[81] Moreover, wind and solar resource variability requires supplementary services such as

[79] *Hard Truths, supra* note 2 at 215 (observing that "the long lead times necessary to develop and introduce new conventional fuel supplies and alternative energy forms, demand for fossil fuels is expected to continue to dominate the global energy mix for at least the next two decades.")
[80] *Renewable Energy Consumption and Electricity Preliminary 2006 Statistics*, Energy Information Agency, available at http://www.eia.doe.gov/cneaf/solar.renewables/page/prelim_trends/rea_prereport.html.
[81] *Long-Term Reliability, supra*, note 45

voltage support, frequency control, increased base-load unit dispatch flexibility, and spinning reserves.[82]

Despite the relatively minimal contribution that alternative fuels currently play in our energy portfolio, these energy sources likely hold the key to helping the U. S. become more energy independent and reduce our carbon footprint in the near future. The following section will discuss the promising new sources of energy, as well as the obstacles that must be overcome for the new sources to effectively substitute for fossil fuels.

4.1 Biofuels

Biofuels are liquid fuels and blending components produced from biomass (plant) feedstocks, used primarily for transportation, and they are envisioned as a possible replacement for gasoline or diesel fuel. The most prevalent sources of biofuels currently available are corn ethanol (predominantly used in the U.S.), sugar ethanol (mostly from Brazil) and rapeseed oil for biodiesel in Europe. Regardless of the original source, ethanol is the same and burns similarly, but it produces one third less energy per gallon than gasoline, at an average wholesale cost of 33 percent more.[83] It is predominately used in the U.S. as a gasoline octane enhancer and in 2006 it comprised four percent of finished motor gasoline production. Ethanol can also be used in high concentrations (E-85) in vehicles designed for its use.[84] In 2005, 38 million gallons of ethanol were consumed by E-85 vehicles.

Because of the advanced state of technology, and the ability to commercially deploy corn based ethanol as an oil substitute, this alternative fuel has received the lion's share of public interest in the U.S. However, the pollution and emissions associated with the specific plant's production cycle vary widely. After accounting for all inputs (planting, fertilizing and harvesting, along with the processing and transportation of the fuel) corn ethanol produces 0 percent to 3 percent less greenhouse gas emissions than gasoline, while sugar ethanol from Brazil, over its lifecycle, produces 50 percent to 70 percent less greenhouse gas emissions than gasoline. Given the relatively minor decrease in carbon emissions associated with corn based ethanol, it does not appear that it is helping to reduce our carbon footprint, though it does marginally decrease our oil imports.

Moreover, there has been significant concern that food products that rely on corn are in increased competition with corn used for energy, and that this competition is driving up the price of food.[85] The U.S. Department of Agriculture (USDA) estimates that 20 percent of the 2006 corn crop was used to produce ethanol. According to an Iowa State University study, food prices have climbed an average of $47 per person due to the ethanol surge since July 2006.[86] Moreover, the Organization for Economic Cooperation and Development (OECD) recently released a report calling for a dramatic drawdown in the subsidies and

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[82] *Id.*
[83] John Wasik, *Forget the Ethanol Myth, Avoid Biofuel Bubble*, BLOOMBERG, July 23, 2007.
[84] *2007 Energy Outlook*, *supra* note 5.
[85] Jeff Cox, "Corn and milk: A 1-2 inflation combo" June 19, 2007.
[86] John Wasik, *Forget the Ethanol Myth -- Avoid Biofuel Bubble*, BLOOMBERG, July 23, 2007.

preferential trade laws granted to biofuel producers in OECD countries.[87] According to the OECD, "The current push to expand the use of biofuels is creating unsustainable tensions that will disrupt markets without generating significant environmental benefits." The study estimates the U.S. alone spends $7 billion a year helping make ethanol.

Finally, corn based ethanol can never fully replace oil in our economy. The amount of ethanol needed to run the U. S., for example, is greater than what our farmland can produce, even if fields now used for food were converted for production of non-food-grade corn. It has also been estimated that "if every bushel of U.S. corn, wheat, rice and soybean were used to produce ethanol, it would only cover about 4% of U.S. energy needs on a net basis."[88] It is for these reasons that the public focus must move beyond ethanol as a remedy to our dependence on oil.

4.1a Cellulosic Ethanol

The next generation of ethanol is cellulosic ethanol, which is chemically identical to ethanol from other sources, such as corn starch or sugar, but has the advantage that the raw material is available in a great diversity of biomass including waste from urban, agricultural, and forestry sources. However, cellulosic ethanol differs from corn ethanol because it requires a greater amount of processing to make the sugar monomers available to the microorganisms that are typically used to produce ethanol by fermentation. Because of this complication, cellulosic ethanol production only exists at the "pilot" and "commercial demonstration" scale. Switchgrass is often considered a good candidate for ethanol fuel production due to its hardiness against poor soil and climate conditions, rapid growth and low fertilization and herbicide requirements. Unlike corn and sugarcane, switchgrass is perennial and has a huge biomass output of 6 to10 tons per acre.[89] Unlike corn, switchgrass does not deplete the soil it is grown in, rather it adds organic matter to its soil, and is often used for erosion control due to its vast stem and root systems. Moreover, swtichgrass has the potential to produce the biomass required for production of up to 100 gallons of ethanol per metric ton. This gives switchgrass the potential to produce 1000 gallons of ethanol per acre, compared to 665 gallons for sugarcane and 400 gallons for corn. The key to the viability of switchgrass as an energy crop is for scientists to engineer metabolic pathways in bacteria to more efficiently convert cellulose to ethanol.

The US Department of Energy is actively encouraging the development of cellulosic ethanol, recently announcing $385 million in grant funding to 6 cellulosic ethanol plants.[90]

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[87] RICHARD DOORNBOSCH AND RONALD STEENBLIK, BIOFUELS: IS THE CURE WORSE THAN THE DISEASE? (Organization for Economic Development Cooperation and Development) (Sept. 2007) (available at http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf).

[88] *Is Corn The New Inflation Crop?* RTT NEWS, Oct. 27, 2007, available at http://www.rttnews.com/sp/todaystop.asp?date=10/25/2007&item=77&vid=0. [LINK IS NOW ANOTHER STORY]

[89] DOE Joint Genome Institute, "Why Sequence Switchgrass?" available at http://www.jgi.doe.gov/sequencing/why/CSP2007/switchgrass.html.

[90] Press Release, Department of Energy, DOE Selects Six Cellulosic Ethanol Plants for Up To $385 Million in Federal Funding (Feb. 28, 2007), Available at http://www.energy.gov/print/4827.htm.

This grant funding accounts for 40 percent of the plants' investment costs.[91] The remaining 60 percent cost has been fronted by the promoters of those facilities. Hence, a total of $1 billion will be invested for approximately 140 million gallon capacity of cellulosic ethanol per year. This translates into $7/annual gallon in capital investment costs, which is obviously not cost competitive with gasoline or corn based ethanol. However, if there is a breakthrough in the production process, which can cut the capital costs, cellulosic ethanol is a very promising alternative fuel that has the ability to reduce our dependence of foreign sources of oil, while reducing our carbon footprint, without putting upward pressure on the price of food.

Dr. Peter Huber, an engineer at the Massachusetts Institute of Technology, says that "To improve on (the damage caused by) wood burning fires or grass eating cows, perfect the cellulose-splitting enzyme. Then watch what 7 billion people will do to your forests and your grasslands." He fears if the process for producing cellulosic ethanol becomes cheap and easy in less developed countries, it would hasten the conversion of forestlands and other wilderness into a fuel source, or a vast expansion of what we are already seeing happening to food as it becomes an energy commodity. Huber has also stated that "History has already taught us what a carbohydrate energy economy does to a rich, green landscape- it levels it." It is important to note the probable consequences of our energy policies regardless of their intentions. While we may be able to produce some cellulosic ethanol as part of the whole energy solution, the propensity for nations with dense forestation and little development to use their forests for energy is great and should be expected. If anything, Cellulosic ethanol could potentially make the environment much worse if it ever became a truly viable alternative fuel and would likely cancel out its benefits.

4.2 Renewable Fuels

Renewable fuels include energy derived from wind, water, and the sun, which generate electricity. All forms of renewable energy have zero net emissions, however each of these sources of energy faces constraints imposed by resource availability, variability in energy production, or regulatory and legal barriers.

The United States is second in the world in renewable energy production, following closely behind China which is bolstered by massive new hydroelectric production. The U.S. leads the globe in consumption of non-hydro renewable energy for electricity production.[92]

In 2007, renewable energy accounted for seven percent of the nation's energy supply, down 1 percent from 2006. This decline reflects the dwindling and volatile roll of hydroelectric production, but these losses will soon be eclipsed by increasing production by non-hydro renewables. Between 2003 and 2007, renewable energy consumption increased at an average annual rate of 3 percent (compared to a 1 percent increase in overall energy

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[91] The 2005 Energy Policy Act authorized DOE to solicit and fund proposals for the commercial demonstration of advanced bio-refineries that use cellulosic feedstock to produce ethanol.

[92] Energy Information Administration, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics*, (May 2008). http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html

consumption), driven largely by escalating production through biofuels and wind, with 5-year average annual growth rates of 25 and 26 percent, respectively.[93]

Electricity production still accounts for 51 percent of all renewable energy, but this reflects an eight percent drop between 2006 and 2007 due to decreased precipitation and the subsequent effect on hydroelectric production. Hydroelectricity still serves as the largest source of renewable-generated electricity at 71 percent, followed by biomass (16 percent), wind (9 percent), geothermal (4 percent), and solar (0.2 percent). While hydroelectric generation declined 14 percent in 2007, wind increased 21 percent with solar close behind at 19 percent.[94]

U.S. Energy Consumption by Energy Source, 2007
(Quadrillion Btu)

Energy Source	**2007**
Total	101.605
Coal	22.786
Natural Gas[a]	23.625
Petroleum[b]	39.818
Nuclear	8.415
Renewable	6.830
Biomass[c]	3.615
Geothermal	0.353
Hydroelectric Conventional	2.463
Solar/PV	0.080
Wind	0.319

Source: EIA Renewable Energy Consumption and Electricity Preliminary Statistics 2007

4.2a Wind Energy

Wind energy is kinetic energy present in wind motion that can be converted to mechanical energy for driving pumps, mills, and electric power generators.
In the U.S. “wind farms” or “wind power plants” are clusters of wind machines scattered over a large area and are the primary mechanism for harnessing wind energy. In 2006, President Bush emphasized the nation’s need for greater energy efficiency and a more diversified portfolio. This led to a collaborative effort to explore a modeled energy scenario in which wind provides 20% of U.S. Electricity by 2030.[95]
Oklahoma oilman T. Boone Pickens has proposed a wind-centered energy plan which includes building wind facilities in the corridor that stretches from the Texas panhandle to North Dakota to produce 20% of the electricity for the United States at a cost of $1 trillion.

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[93] Ibid
[94] Ibid

[95] U.S. Department of Energy, National Renewable Energy Laboratory, available at http://www.eere.energy.gov/

It would take another $200 billion to build the capacity to transmit that energy to cities and towns.[96] Therefore, while the 20% scenario is reachable, wind energy must overcome significant hurdles.

In 2005 and 2006, the United States led the world in new wind installations.[97] The world's largest wind farm, the Horse Hollow Wind Energy Center in Texas, has 421 wind turbines that generate enough electricity to power 230,000 homes per year. In 2005, wind machines in the U.S. generated a total of 17.8 billion kWh per year of electricity, enough to serve more than 1.6 million households. This is enough electricity to power a city the size of Chicago, but it is only a small fraction of the nation's total electricity production - about 0.4 percent. By the end of 2006, wind net summer capacity stood at 11,119 megawatts, or about 2 ½ times its level in 2002.[98]

Since wind speed increases with altitude and over open areas with no windbreaks, good sites for wind plants are the tops of smooth, rounded hills, open plains or shorelines, and mountain gaps that produce wind funneling.[99] Proposals to develop offshore wind have emerged in the U.S. However, a major debate erupted over safety, economic, and environmental aspects of a proposal by Cape Wind Associates to develop a 420-megawatt offshore wind farm in Nantucket Sound, south of Cape Cod, Massachusetts.[100] In addition to the concerns raised regarding the Cape Cod venture, there are also concerns that tall wind turbines will create false radar signals that may disrupt civilian and military radar equipment and some wildlife groups have urged consideration of the impact that wind turbines have on wildlife.

4.2b Solar Energy

Solar energy is the solar radiation that reaches the earth and can be converted directly or indirectly into other forms of energy, such as heat and electricity. The major drawbacks of solar energy are: (1) the intermittent and variable manner in which it arrives at the earth's surface and, (2) the large area required to collect it at a useful rate.

Solar thermal power generation is essentially the same as conventional technologies except that in conventional technologies the energy source is from the stored energy in fossil fuels released by combustion. Solar thermal power plants use the sun's rays to heat a fluid, from which heat transfer systems may be used to produce steam.

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[96] T. Boone Pickens Plan available at
http://www.pickensplan.com/index.php

[97] Wiser, R. and M. Bolinger. 2007. *Annual Reports on U.S. Wind Power Installation, Cost and Performance Trends: 2006.*
http://www.osti.gov/bridge/product.biblio.jsp?query_id=0%page=0&osti_id=908214

[98] Energy Information Administration, Renewable Energy Consumption and Electricity Preliminary 2006 Statistics, (hereinafter, *EIA Preliminary 2006 Statistics*) available at
http://www.eia.doe.gov/cneaf/solar.renewables/page/prelim_trends/rea_prereport.html (hereinafter

[99] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy available at
http://www1.eere.energy.gov/windandhydro/wind_how.html#sizes, May 2007.

[100] FRED SISSINE, RENEWABLE ENERGY: BACKGROUND AND ISSUES FOR THE 110TH CONGRESS (Congressional Research Service) (Oct. 2007).

The energy crisis of the 1970s saw the beginning of major interest in using solar cells for power on Earth, but prohibitive prices (approximately 30 times current prices) made large scale applications unfeasible. Solar energy only accounts 1 percent of electricity generation in the U.S.[101] Its main roadblock to increased use is that it is not cost competitive as compared to fossil fuels and it is only a viable source where there is a large amount of sunlight, such states like Arizona and California.

4.2c Hydropower

Hydraulic power, the force or energy of moving water, supplies around three percent of the nation's energy supply, and 36 percent of all renewable energy is derived from hydropower.[102] Worldwide, hydroelectric power now supplies about 19 percent of world electricity and is normally applied to peak load demand because it is readily stopped and started. In the U.S., construction of major hydroelectric projects have essentially ceased because most major sites have already been exploited or are unavailable for environmental considerations. The share of electricity generation from hydropower has gradually declined, from 30 percent in 1950 to 15 percent in 1975 and less than 10 percent in 2000, as overall energy demand and consumption has risen and new hydropower stations have not been built. However, hydroelectric power is still the largest source of renewable-generated electricity in the US, accounting for 71 percent of production in 2007.[103] Hydropower will remain an important source of renewable energy, albeit in a more diminished role, due to environmental, regulatory and economic constraints on expansion, and as alternative sources such as wind, solar, and geothermal continue to expand their capacity in this sector. Though it may see a reduced share in the national energy supply, hydropower remains highly important on a regional basis.

Some opportunities exist for increased production through efficiencies in conventional hydropower technologies and new innovations such as ocean and wave energy, in-stream hydrokinetic and tidal power, many industry experts remain skeptical of adding significant capacity in the next 10 years.[104]

While we should continue to encourage the development and deployment of renewable fuels for electricity generation, it does not appear that there is sufficient growth potential for these energy sources to realistically compete with and eventually replace our reliance on coal for base load generation.

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[101] *EIA Preliminary 2006 Statistics, supra*, note 63.

[102] Energy Information Administration, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics*, (May 2008).
http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html

[103] Ibid

[104] Department of Energy, Energy Efficiency and Renewable Energy, *Hydro Resource Potential. http://www1.eere.energy.gov/windandhydro/hydro_potential.html*

4.2d Geothermal Energy

The U.S. is the world's biggest mass producer of geothermal power, with long running plants in western hot springs and geysers. In 2007, geothermal accounted for five percent of all renewable energy production.[105] In the electric power sector, geothermal was eclipsed by wind energy.

Geothermal energy is generated in the earth's core, about 4,000 miles below the surface. Recent studies suggest that deep drilling and seismic exploration techniques developed in the oil industry could be used to draw out geothermal energy found three or more miles underground. Wells similar to those used to produce oil and natural gas are already being drilled, releasing a mixture of hot water and steam, which is separated and sent to a power plant where it spins a turbine to generate electricity. These power plants release only one to three percent of the CO_2 emissions of a fossil fuel plant. Studies have shown that currently, sites identified as potentially producing geothermal energy could produce electricity for amounts ranging from 10.3 cents per kilowatt-hour to $1.05 per kilowatt-hour.[106] When compared to the cost of operating a coal fired power plant at approximately 3.5 cents per kilowatt-hour, it is clear that geothermal energy is not yet cost competitive. However, if a few well defined technical problems are overcome to boost the fluid production rate, costs would plummet to less than 10 cents per kilowatt-hour.

Only a small group of sites around the globe — primarily in the Pacific Rim region — provide the special conditions needed to generate geothermal energy. Most of the geothermal reservoirs in the U.S. are located in the western states, including Alaska and Hawaii. Currently, California generates the most geothermal electricity.

Just under half of U.S. installed geothermal capacity is on federal land. According to the Bureau of Land Management (BLM), around 530 million acres in the 12 western states have geothermal potential, with BLM and National Forest System (NFS) administering about 47 percent of this acreage. There are currently 480 geothermal leases on BLM and NFS lands, 58 of which are producing. Efforts are underway to expedite leasing procedures on federal lands. Decreasing costs, coupled with improved technology and increasing demand for non-fossil energy sources, have the potential to greatly increase geothermal output within the next ten years.

While future prospects for geothermal production are positive, especially through controversial deep drilling techniques, major environmental, geological, and regulatory hurdles reduce the possibility that these benefits could be realized in the near future.

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[105] Energy Information Administration, *Renewable Energy Consumption and Electricity Preliminary 2007 Statistics*, (May 2008).
http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html
[106] http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf, section 1-27

Chapter 5: Technological Solutions to Address the Twin Challenges of Energy Independence and Climate Change

"Put simply, the world needs a technological revolution … Existing energy technologies alone will not meet the global demand for energy while also reducing emissions to necessary levels. Secretary Rice addressing UN/US major Economies Meeting. (9.25)

As discussed, renewable energy and bio-fuels provide some relief from our dependence on fossil fuel energy sources. However, the only sources that have realistic growth potential (solar, wind, geothermal and biomass) currently make up approximately 5 percent of the nation's energy supply. Even with healthy growth, these energy sources will not be sufficient to cure our dependence on coal and oil or support our energy needs. Accordingly, policy makers must look to technologies that decrease the externalities associated with coal and nuclear – two energy sources that could be abundantly available in the U.S. – to meet our nation's energy needs, while limiting the CO_2 that is emitted into the atmosphere.

5.1 Carbon Capture and Sequestration

Carbon Capture and Sequestration (CCS) is a potential means of reducing the amount of CO_2 released into the atmosphere as a result of coal combustion, freeing up our nation's vast supply of coal for energy production that is associated with low carbon emissions. Carbon capture technologies can potentially remove 80 percent-95 percent of CO_2 emitted from electric power plant or other industrial sources. The CCS process consists of the separation of CO_2 from industrial and energy sources, its transportation to a storage location, and its long term isolation from the atmosphere. Power plants are the most likely initial candidates for CCS because they are predominantly large, single-point sources, and they contribute approximately one-third of U.S. CO_2 emissions from fossil fuels. Additionally, CCS can be directly applied to the extraction of unconventional oil as well as the Coal–to-Liquids process, so CCS has the potential to mitigate the extra CO_2 burden beyond the immediate application to power plants.[107]

However, the CCS process consumes a significant amount of energy itself and can add between 10 percent to 40 percent more energy to electricity generation.[108] Moreover, retrofitting existing plants with CO_2 capture is expected to lead to higher costs and less overall efficiencies than what can be expected from newly built power plants with CSS. According to an industry report, capital costs associated with CCS are estimated to increase by 47 percent while operation and management costs will increase by 79 percent, when compared to units of energy without CCS.

In addition to the separation process involved, CCS will require significant pipeline infrastructure to transport dry CO_2 from the generating site to the storage area. While these methods have been used as part of the enhanced oil recovery (EOR) process, there is

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[107] *Hard Truths, supra* note 2 at 237
[108] IPCC Special Report on CCS

relatively little experience in combining CO_2 capture, transportation and storage into a fully integrated CCS system.[109] In most CCS approaches, CO_2 would be transported by pipeline to a porous rock formation that holds (or previously held) fluids where the CO_2 would be injected underground. When CO_2 is injected over 800 meters deep in a typical storage formation, atmospheric pressure induces the CO_2 to become relatively dense and less likely to migrate out of the formation. However, there remains the possibility of continuous leakage of CO_2 from sequestered sites, offsetting the benefits of CCS for mitigating climate change. Few countries have specifically developed legal or regulatory frameworks for long term CO_2 storage.[110]

EPA is currently working with the Department of Energy on its carbon sequestration research and development program and is also coordinating efforts to evaluate potential impacts on health, safety and the environment. EPA has also announced that they expect to develop regulations to establish a clear path for geologic sequestration. Once completed, the regulations should ensure there is a consistent and effective permit system under the Safe Drinking Water Act for commercial-scale geologic sequestration programs to help reduce the effects of climate change.[111]

5.2 Coal to Liquids

Beyond coal's current role as a major supplier of electricity, there is also the potential to turn coal into a synthetic gas through the Fischer-Tropsch (FT) coal-to-liquids process, which could be a substitute for oil in gasoline. Moreover, the Integrated Gasification Combined Cycle (IGCC) can incorporate the FT process of converting coal to liquids with an electricity plant and generate significant quantities of electricity. The resulting fuel burns very clean diesel, with virtually no sulfur. However, the gasification process generates significant quantities of CO_2. It is conceivable that combined with carbon sequestration technology, coal to liquids can be a viable way to reduce our dependence on foreign sources of oil.

5.3 Next Generation Nuclear

The Energy Information Administration's *2008 Annual Energy Outlook* provided that the percentage of electricity produced by nuclear generation will fall slightly from today's level of 19 percent to 18 percent by 2030.[112]

Realigning policies to ensure nuclear power is the primary supplier of baseload electricity is an essential part of solving our energy crisis in a carbon constrained world. The U.S. should consider recycling nuclear materials with the goal of achieving an innovative

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[109] *Hard Truths, supra* note 2 at 238
[110] *Id.*
[111] Press Release, EPA, EPA To Develop Regulations for Geologic Sequestration of Carbon Dioxide, (10/11/2007) available at: http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/84bd1ef19c00eb7a85257371006b6a21!
[112] Energy Outlook 2008 [online at http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2008).pdf]

“closed loop” fuel cycle, as opposed to the “once through” fuel cycle that is currently in use. This will make for more efficient use of nuclear fuel, and reduce the quantity and toxicity of nuclear waste that must ultimately be disposed of in a long-term waste facility.

Nuclear technology has steadily advanced and companies have designed standard reactor models that can be constructed anywhere in the world, in stark contrast to the existing fleet of aging U.S. nuclear plants that were customized according to each location and permitting process. The switch to nuclear power as the primary source of baseload electricity will not come without a cost; it will need tremendous political support and financial investment from private institutions and the federal government. This process will also require time and patience. The federal government has begun to realize this, albeit to a limited extent. The 2005 Energy Policy Act (EPACT 2005) provides for tax credits for new nuclear capacity, and as part of the Department of Energy’s Generation IV initiative, the public-private partnerships allow government and industry, as well as international players, collaborate on the research and development of new nuclear technologies. In an important breakthrough, NRG Energy filed the first full application in nearly 30 years for a new plant license to build two new reactors at an existing Texas power station.[113] The company expects to bring both units on line by 2015. Currently the Nuclear Regulatory Commission has 16 new reactor applications under review.

[113] E&E News PM, “Lawmakers applaud application for new reactors” Sept. 25, 2007.

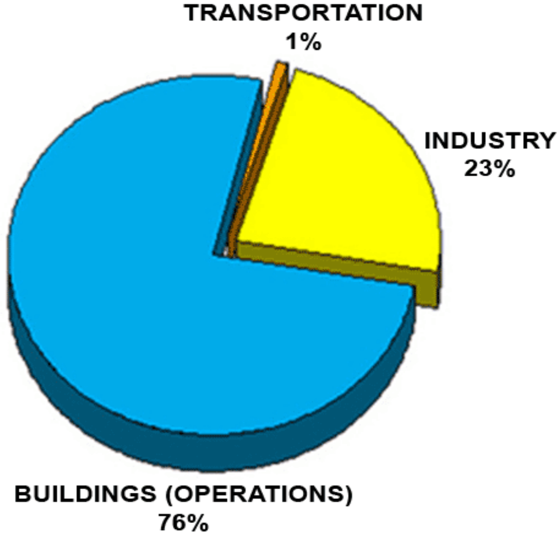
CHAPTER 6: REDUCING THE DEMAND FOR ENERGY

Thus far this report has considered existing and potential sources of energy that the U.S. can utilize to meet its energy needs in a carbon constrained world. However, equally important is a discussion on ways that Americans can use energy resources more efficiently. Huge efficiency gains can be achieved by increasing the fuel economy of the 15 million new vehicles that are purchased annually in the U.S.[1] Moreover, there are huge gains to be had from a more thoughtful design and construction of the buildings in which we live and work.

6.1 Buildings, Energy Use, and Sustainable Design Principles

Among the energy end-use sectors, the most rapid growth in total world demand for electricity is the building sector, primarily from new office space, hospitals, and hotels.[114] In the U.S., the building sector is the largest energy consumer, accounting for 39 percent of total energy consumption and 71 percent of electricity consumption.[115] In fact, U.S. buildings emissions approximately equal the combined carbon emissions of Japan, France, and the United Kingdom.[116]

Graphic of US Electricity Consumption



Source: Architecture 2030

Currently, U.S. building stock sits at 300 billion square feet. Experts predict that between now and 2035, 52 billion square feet of building stock will be demolished, 150 billion square feet will be remodeled, and another 150 billion square feet will be newly constructed.[117] It is possible that by the year 2035, approximately three-quarters (75 percent) of the built environment will be either new or renovated. This represents a huge

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[114] EIA, IEO 2007, p. 61.

[115] 2007 Buildings Energy Data Book, U.S. DOE, available at http://buildingsdatabook.eere.energy.gov/docs/1.1.3.pdf

[116] 2007 Buildings Energy Data Book, U.S. DOE, available at ttp://buildingsdatabook.eere.energy.gov/docs/3.1.1.pdf (stating that U.S. buildings are responsible for the emission of 630 metric tons of carbon in 2005.)

[117] http://www.architecture2030.com

opportunity to design the new structures with an eye towards energy efficiency. By utilizing sustainable design principles, it is possible to construct buildings that use far less energy than conventional buildings often at a relatively small cost. If our nation is serious about reducing energy use and promoting energy efficiency, addressing energy consumption in the built environment is an essential part of the solution. The Energy Independence and Security Act of 2007, signed in to public law on December 19, 2007 heads in the right direction, as it includes incentives for the development of more energy efficient "green" commercial buildings and requires that total energy use in federal buildings be reduced by 30 percent by 2015. However, the Federal government plays mostly an advisory role in setting building codes to encourage energy efficiency, because establishing building codes to regulate the construction of new homes and commercial buildings has historically been the responsibility of the states.

6.2 Stronger Corporate Average Fuel Economy (CAFE) Standards

Sixty nine percent of oil consumed in the U.S. is consumed by the transportation sector, which accounts for one third of all U.S. CO_2 emissions. Passenger vehicles alone represent sixty percent of transportation emissions, which translates to twenty percent of total U.S. CO_2 emissions.[118] In order to reduce our dependence on imported fuel, and mitigate CO_2 emissions, the U.S. has three primary options: widespread development and commercialization of alternative fuels, increasing gasoline taxes, and aggressively revise (corporate average fuel economy) standards. P.L. 110-140, the Energy Independence and Security Act of 2007, which established a single CAFE standard of 35 miles per gallon (mpg) for passenger vehicles by model year 2020, is a significant and positive step toward reducing both our carbon footprint as well as our dependence on foreign sources of oil. Moreover, increasing fuel economy is both technologically feasible and is not expected to have a wide-ranging negative impact on the economy. This is not the case for alternative fuels or a gas tax. As discussed in the previous sections, alternative fuels and ethanol are undergoing welcome and rapid development but their gasoline-reduction impact will not be realized on a national scale until well into the future. Moreover, sufficiently raising gasoline taxes to greatly reduce demand would harm the economy, disproportionately impact rural areas, and is not politically feasible.[119]

It was a competitive mistake to let domestic CAFE standards remain virtually stagnant for the last two decades, while advances over the last 20 years in the domestic automotive market have gone to increased horsepower and vehicle size. While short-term profits were realized by concentrating on sport utility vehicles and minivans during times of cheap gasoline, U.S. automakers are now poorly positioned because global oil markets dictate that consumers will not value these vehicles as highly for the foreseeable future. Higher mileage requirements are achievable and cost-effective. Indeed, General Motors announced

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[118] BRENT YACOBUCCI, Automotive and Light Truck Fuel Economy: The CAFE Standards 9 (Congressional Research Service January 2008)
[119] If increases in gasoline taxes at these levels ($1.25 to $2.25 per gallon) were not to harm the economy, at the minimum accompanying tax cuts at equivalent levels would need to be made to counteract the negative effects on consumers and business.

in September 2007 that it is testing an experimental combustion engine that can deliver annual fuel savings of up to 15 percent without requiring any emission controls.[120] This particular engine improves its efficiency by using a compression of fuel and air instead or a spark to power the engine. The U.S. government should encourage developments such as these, along with hybrids and plug-ins, because increases in CAFE standards will ultimately make U.S. automakers more—not less—competitive.

The authors of this report are also pleased that the Energy Policy and Security Act of 2007 established for the first time a market system of tradable credits across the automobile manufacturing industry.[121] By allowing a system of tradable credits, car manufacturers have the freedom to design and build the types of vehicles that will bring the most profit taking into account the market for CAFE credits. Greater efficiencies in the overall domestic market will be reached without requiring each manufacturer to build, market, and sell all types of vehicles. Rather, each manufacturer can focus on its core competencies and design expertise.

[120] US Vehicle Emissions Fell For First Time in Decades Report Finds, GREENWIRE, Sept. 4, 2007.
[121] This option has been popularized by the non-governmental, bipartisan National Commission on Energy Policy.

CHAPTER 7: LOOKING FOR SOLUTIONS

The solution to the energy crisis is not an "either or" choice between promoting production and promoting conservation and alternatives. Rather, we must pursue all available options. We must conserve and reduce our demand growth for energy. We can reduce the projected demand for coal if we construct buildings with sustainable design principles and transition to energy efficient lighting. We can lessen our dependence on foreign sources of oil and fossil fuels if the government works with the automotive industry to preserve consumer choice while increasing average fuel economy rates. However, we are not going to be able to conserve our way out of the energy crisis nor will conservation efforts here at home impact the rising rate of emissions from developing nations. Therefore a solution that looks only towards conservation efforts is fatally flawed and will not achieve the carbon reduction goals of its supporters.

Renewable energy sources such as solar, wind, and geothermal energy are promising technologies and worthy of government support in order to facilitate research, development, and commercialization. However, renewable energy sources are only part of a viable energy portfolio that can meet the current needs of an expanding economy while insulating the U.S. from international events. In order to cope with the looming energy crisis under carbon constrained conditions, policy makers must turn to either coal with CCS technologies and/or nuclear technologies. But the fundamental reality is that all options must be on the table.

However, the federal government does not have the resources to bring about an energy revolution alone. In order for private business to invest the massive amounts of money necessary to bring these concepts to market – the government must foster a predictable and hospitable investment environment. The U.S. government can foster investment by sharing some of the risk, constructing a sensible regulatory scheme, and minimizing litigation risk. The investment decisions that are taken today will affect both our emissions profile and energy independence in the future.

While making specific policy proposals is beyond the scope of this report, the authors believe that the first step in molding an effective energy policy is to fully understand the breadth and scale of the looming energy and climate change crisis. It is equally critical that the public dialogue acknowledge and begin to come to terms with the reality that these are not two separate problems that can be addressed in a vacuum. Our economy, our security, and our world will only be protected and preserved if policy makers step up to the challenge before them, with all options on the table, and craft an energy policy that is worthy of the citizens who elected them to office. Moreover, it is the authors' sincere hope that this report will contribute to the public discourse on energy and climate change policy in a way that promotes clarity and sound decisions, and avoids political gamesmanship. An issue of this magnitude, where the decisions that we make today will impact the quality of life for future generations of American's deserves nothing less.