UNITED STATES
HOUSE OF REPRESENTATIVES

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

FINAL STAFF REPORT FOR THE 110[TH] CONGRESS

October 31, 2008

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EXECUTIVE SUMMARY

Global climate change presents one of the gravest threats not only to our planet's health, but also to the United States' economy, national security, and public health. Scientists warn that we may be approaching a tipping point, after which it will become increasingly difficult, or perhaps impossible, to halt global warming and its catastrophic effects. The United States confronts this issue at the same time it faces a deepening energy crisis—characterized by skyrocketing prices, an increasing dependence on foreign oil, and continued reliance on high-carbon fuels that worsen the climate crisis.

We are at a watershed moment in the history of energy production—and the choices we make at this juncture will determine the fate of our planet and the national security and economic future of the United States. Between now and 2030, over $20 trillion will be invested in energy infrastructure worldwide, and an estimated $1.5 trillion will be invested in the U.S. power sector alone. This new infrastructure is long-lived and costly, and the decisions made in the next decade will set the course of the global and U.S. energy system—and of the global climate—for the next century and beyond. This transition also presents an unprecedented opportunity for economic growth and job creation in the clean energy technology sector. But the United States must act now if it is to be a leader in this rapidly developing global market.

Recognizing the urgency of these challenges, Speaker Pelosi announced at the outset of the 110th Congress her intention to create a select committee to tackle them. On March 8, 2007, the House passed Resolution 202, establishing the Select Committee on Energy Independence and Global Warming and directing it to "investigate, study, make findings, and develop recommendations on policies, strategies, technologies and other innovations, intended to reduce the dependence of the United States on foreign sources of energy and achieve substantial and permanent reductions in emissions and other activities that contribute to climate change and global warming."[1] In keeping with this mandate, the Select Committee has worked to identify balanced and workable solutions to the urgent challenge of securing America's energy independence while combating global warming.

Over the past 18 months, the Select Committee has held over 50 hearings on a broad array of subjects ranging from the security, economic, and environmental threats posed by climate change, to advanced vehicle and renewable energy technologies, to policy options for lowering prices at the gasoline pump. These hearings are listed in Appendix A of this report. Many were groundbreaking "firsts"—including the first congressional hearing on the national security implications of climate change, the first "green jobs" hearing, the first hearing at which the head of the Intergovernmental Panel on Climate Change testified, the first hearing on U.S. cities' efforts to combat climate change, the first hearing with the Administrator of the Environmental Protection Agency on the implications of the Supreme Court's decision in *Massachusetts v. EPA*, the first hearing on the Department of the Interior's handling of the decision whether to list the polar bear as an endangered species, and the first hearing on the voluntary carbon offset market—to name a few. In addition, the Select Committee has held field hearings atop Cannon Mountain in New Hampshire, at the U.S. Conference of Mayors' meeting

[1] H.Res. 202, § 4(c), 110th Cong. (2007).

in Seattle, Washington, and in Hartford, Connecticut. Meanwhile, it has hosted numerous briefings to educate House staff on a broad array of key energy and climate issues.

The Select Committee has aggressively pursued oversight of the Bush Administration's energy and climate policies, including through oversight hearings, letters, and information requests focusing on the Environmental Protection Agency, the Department of Energy, the Department of the Interior, the National Highway Traffic Safety Administration, the Department of State, and the Centers for Disease Control and Prevention.

The Select Committee organized or participated in several major Congressional delegations focused on energy security and climate change issues. These include delegations led by Speaker Pelosi to Greenland and the European Union in May 2007 and to India in March 2008, as well as a Select Committee delegation to Brazil in February 2008. In addition, Select Committee staff delegations have traveled to the UN Climate Change Conference in Bali, Indonesia in December 2007 and to the National Center for Atmospheric Research, the National Ocean and Atmospheric Administration's Earth Systems Research Laboratory, and the National Renewable Energy Laboratories in Colorado.

Finally, the Select Committee has worked to communicate directly with the American public about energy security and climate change issues—principally through its website, which has won the prestigious "Golden Dot" Award for the best website in all federal, state, and local government (presented by the School of Political Management at George Washington University), an Honorable Mention from the Webby Awards, a Pollie Award from the American Association of Political Consultants, and a Silver Mouse Award, presented by the Congressional Management Foundation. Chairman Markey—by "avatar"—delivered the first international address on climate using virtual world ("Second Life") technology to the UN climate change conference in Bali, Indonesia, in December 2007.

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This Final Staff Report details the findings and recommendations of the Select Committee staff. Part I of the report addresses the challenges posed by the climate crisis and America's growing energy needs. Part II provides recommendations on a series of "win-win" solutions that will bolster America's energy security while achieving the reductions in global warming pollution needed to save the planet. Part III presents the findings and recommendations resulting from the Select Committee's oversight activities. Part IV discusses international issues, and reviews the findings of the Select Committee Congressional delegations to Greenland and the EU, Brazil, and India.

The Report's key findings and recommendations are as follows:

KEY FINDINGS

The scientific debate on the cause of climate change is over. A clear scientific consensus now holds that global warming is happening, that manmade greenhouse gas emissions are largely responsible, and that failure to dramatically reduce those emissions in

the coming decades will result in catastrophic impacts. Human activities have changed the atmosphere as much in 200 years as natural variations changed it over 20,000 years. Atmospheric concentrations of carbon dioxide—a key heat-trapping gas—have increased from 280 parts per million to 380 parts per million since 1750, and are higher than any level seen in the last 650,000 years. These concentrations could exceed 700 parts per million by 2100—leading to an increase in global average surface temperature of over 11 ºF—if current trends in emission growth continue.

Among the more alarming predictions regarding the likely near- to medium-term impacts of unchecked global warming are the following:

- **Increasingly severe water scarcity in the United States and globally, resulting in massive economic damages in the United States and subjecting up to 1.2 billion additional people in Asia, up to 220 million people in Africa, and up to 80 million people in Latin America to water stress by 2030.**

- **Increasing warming and acidification of the oceans, contributing to the collapse of coral reefs around the world and severely impacting global fisheries.**

- **Sea level rise of at least 1-2 feet—and possibly much more—by 2100, subjecting the roughly 1 billion people living in coastal areas around the world to increased risk of inundation, storm surges, coastal erosion, and saltwater intrusion into drinking water supplies.**

- **Increased heavy precipitation events and flooding in the United States and globally, as well as the potential for more frequent and more intense hurricanes and extreme weather events.**

- **A broad range of adverse effects on public health including more frequent and more intense heat waves, thousands of additional deaths and millions of additional cases of respiratory illness due to ground-level ozone air pollution, as well as increased risk of infectious disease in the United States and many other regions of the world.**

- **More frequent and more intense wildfires, and a longer fire season, throughout the Western United States, together with a decline in forest health due to increased infestation from pests.**

- **Forty percent of the world's species could face extinction by the latter half of this century as a result of global climate change.**

Tragically, these impacts will fall disproportionately on vulnerable communities, particularly in the developing world, that are least responsible for climate change and least able to adapt to it. However, the United States and other wealthy countries will also suffer devastating economic, environmental, and human costs if global warming continues unabated.

The potential costs of global warming—both globally and here in the United States—are staggering. Economic studies suggest that global warming could cost the global economy from 5 to 20 percent of gross domestic product (GDP). Here in the United States, preliminary studies suggest that even a narrow range of global warming impacts could slash GDP by 1.8 to 3.6 percent by 2100. These costs far outweigh the potential costs of economy-wide legislation to reduce global warming pollution.

There is a growing consensus that climate change presents a serious and growing risk to the United States' national security interests around the world, acting as a "threat multiplier." Climate change impacts will increase the risk of water and food scarcity, mass migration, and resource conflict in the developing world, with the potential for destabilization in many regions. Climate change impacts will also affect military and strategic infrastructure and energy supplies, both here in the United States and abroad.

To avert catastrophic global warming, it will be necessary to reduce global greenhouse gas emissions by at least 50-85 percent by 2050—including a reduction by the United States and other developed countries of at least 80 percent by 2050. Strong interim targets, including a reduction of U.S. emissions by at least 20 percent by 2020, will be needed to achieve these goals. This will require an unprecedented transformation of the U.S. and global economy and energy systems—an energy technology revolution, which the United States must lead.

In the face of this crisis, the Bush Administration's approach to climate change has been marked by pervasive delay, obfuscation, and political interference in scientific research and agency decision making. In addition to its well-documented attempts to censor government climate scientists, the Bush Administration has worked aggressively to prevent the EPA from fulfilling its legal obligation under the Clean Air Act to regulate greenhouse gas emissions and has blocked California and over a dozen other states from implementing greenhouse gas emission standards for motor vehicles. Further, the Administration has delayed progress in international climate talks, undermining the United Nations negotiations and refusing to agree to binding emission reduction targets.

At the same time, the United States is confronting a deepening energy security crisis—characterized by skyrocketing energy prices, growing dependence on foreign oil, and a widening gap between rising energy demand and stagnant supply.

The United States' continuing "addiction" to oil presents a serious and growing threat to our national security and economy. The United States is the largest consumer of oil in the world, accounting for 25 percent of global demand—principally to power our transportation system, which is 95 percent dependent on oil. In the past 40 years, the United States has gone from importing 21 percent of the oil it consumes to importing nearly 70 percent. The vast majority of the world's oil—and virtually all of its spare production capacity—is located in countries that are members of OPEC. As a result, the United States' national security and economy is increasingly threatened by the potential for a supply disruption or market manipulation by sometimes unfriendly foreign governments.

Oil and gasoline prices have skyrocketed in the past year, and are predicted to remain at historically high levels for the foreseeable future, primarily as a result of rising global demand. Crude oil prices have increased by over 300 percent since 2001, and gasoline prices increased by 150 percent in this period. Even with the recent drop in prices, oil remains very expensive and volatile. While oil market speculation and the weak U.S. dollar have undoubtedly played an important role in the recent price run-up, experts agree that growing global demand—mostly in rapidly growing developing countries—is likely to result in sustained high prices for the foreseeable future. Soaring prices have had a crippling effect on American consumers—with mid-2008 gasoline expenses eating up nearly 10 percent of an average American worker's pre-tax income. The oil and gas industry, meanwhile, is raking in record-breaking profits—$123 billion in 2007 and on track for $150 billion in 2008—while reducing investment in new exploration and putting little or no investment into alternative energy sources or research and development.

We cannot drill our way out of this problem. While the United States consumes 25 percent of the world's oil, it accounts for only 10 percent of global production and has less than 3 percent of global reserves. While the past year was marked by strident calls to open new areas of the Outer Continental Shelf (OCS) and the Arctic National Wildlife Refuge to drilling—and by the expiration of the 27-year moratorium on OCS drilling off the East and West Coasts of the United States—the facts make clear that increased drilling will have a negligible impact on crude oil supply or prices.

U.S. electricity demand is rising faster than new supply is coming online, our electricity transmission and distribution infrastructure is outdated and overtaxed, and uncertainty about climate regulation is stalling new investment. U.S. electricity demand is predicted to increase by 29 percent by 2030, requiring the construction of over 290,000 megawatts of new generating capacity—or equivalent increases in efficiency. This rising demand is outstripping predicted increases in supply and in transmission capacity. Many regions of the country are predicted to see declining levels of reserve capacity—putting the reliability of the grid at greater risk. While coal remains the single largest source of electricity in the country (over 49 percent), the massive contribution of coal-fired power plants to global warming pollution and uncertainty regarding climate policy are making it increasingly inadvisable and difficult to build new conventional coal-fired plants. Natural gas and wind power, meanwhile, are experiencing strong growth. While many advocate nuclear power, massive expansion would be necessary even for it to maintain its current share of U.S. generation, and there are very substantial financial, market, and other obstacles to such an expansion.

Natural gas demand and prices have risen dramatically in recent years, but the United States is not highly dependent on natural gas imports and new "unconventional" onshore resources are expanding domestic supply. Natural gas has become the fuel of choice for new power plants in the United States because of its low emissions and the comparatively low capital cost and short lead times for plant construction. Increased use of natural gas for residential and commercial heating is also contributing to rising demand. Natural gas prices have shot up over the past several years, with adverse impacts on residential and industrial consumers. Although the United States has less than 4 percent of global reserves, over 80 percent of the natural gas we consume is domestically produced, with most of the remainder coming from Canada. Rising prices are contributing to a boom in "unconventional" domestic production from shales and coalbed methane, boosting domestic supply and putting downward pressure on prices. Completion of the Alaska Natural Gas Pipeline would further expand access to domestic resources. In contrast, opening previously closed areas of the OCS to gas production area will not significantly increase supply or reduce prices.

The energy security and climate challenges now facing us present a critical opportunity for economic growth and job creation. The policies recommended by this report will unleash an energy technology revolution that will far outstrip the information technology revolution of the past two decades in generating economic growth and American jobs. By contrast, if the United States does not seize this opportunity, it will become a laggard, instead of a leader, in what promises to be the largest global market of this century.

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ACHIEVEMENTS OF THE 110TH CONGRESS

The 110th Congress has taken a number of major steps towards addressing the climate and energy security challenges.

Most importantly, the enactment of the Energy Independence and Security Act of 2007 (EISA):

- Fuel Economy Standards: Raised corporate average fuel economy (CAFE) standards for the first time since 1975, to at least 35 miles per gallon by 2020—a minimum 40 percent increase over current standards—in keeping with the proposal advocated by Chairman Markey for the prior seven years.

- Renewable Fuel Standard: Established a renewable fuel standard that requires inclusion in the U.S. fuel supply of at least 36 billion gallons of renewable fuels by 2022, over half of which must come from next-generation biofuels including cellulosic ethanol and biodiesel.

- Lighting, Appliance, and Federal Building Efficiency Standards: Established lighting and appliance efficiency standards, as well as new efficiency standards for federal buildings.

- Green Jobs Training: Established a comprehensive "green jobs" training program for workers in the renewable energy and energy efficiency industries and authorized $125 million per year for this program.

Taken together, these policies are predicted to reduce U.S. oil consumption by 4 million barrels per day by 2030, equivalent to more than twice the oil we import from the Persian Gulf. They are predicted to reduce greenhouse gas emissions by 1.3 billion metric tons carbon dioxide equivalent annually by 2030—equivalent to 24 percent of the reductions needed by 2030 to keep us on track to reduce total U.S. emissions by 80 percent by 2050. They are expected to produce

$475 billion in net consumer savings by 2030—including $230 billion from fuel economy standards alone—and will create hundreds of thousands of new jobs.

In addition, as part of the economic rescue plan enacted on October 3, 2008 (H.R. 1424), Congress enacted the "Energy Improvement and Extension Act of 2008"—which provides an $18 billion package of tax credits for clean energy and energy efficiency. Included in this package were the following:

- Production Tax Credits for Renewable Electricity: A two-year extension of the production tax credit (PTC) for electricity generated from biomass, geothermal, hydropower, landfill gas and solid waste, and a one-year extension of the PTC for electricity generated from wind. For the first time, projects generating electricity from river and ocean currents, waves, tides, and thermal energy conversion are also eligible for the PTC.

- Investment Tax Credits for Renewable Electricity: An eight year-extension of investment tax credits (ITC) for up to 30 percent of the cost of residential and commercial-scale solar energy projects, together with removal of the $2,000 cap on residential photovoltaic solar investments, previously a significant barrier to growth in the residential market.

- Plug-In Hybrid Tax Credits: Tax credits on the purchase of fuel-efficient, plug-in hybrid electric vehicles. The tax credit starts at $2,500 and increases based on battery capacity and vehicle size to up a maximum of $7,500 for cars and $15,000 for heavy-duty trucks.

- Carbon Capture and Storage Credits: Tax credits for carbon capture and sequestration demonstration projects. Facilities would be eligible to receive a $20 tax credit for each metric ton of carbon dioxide captured and disposed of in secure geological storage and a $10 tax credit for each metric ton captured and used for qualified enhanced oil or natural gas recovery projects.

- Biofuel Credits: Incentives for the production of homegrown renewable fuels like biodiesel, and for the installation of E-85 pumps for consumers to fill up flexible-fuel vehicles.

- Efficiency and Smart Grid Incentives: Incentives for energy conservation in commercial buildings, residential structures, energy efficient clothes washers, dishwashers and refrigerators, and accelerated depreciation for smart electric meters and grid equipment.

- Clean Renewable Energy Bonds: $800 million worth of new clean renewable energy bonds for electric cooperatives and public power providers to finance facilities that generate electricity from renewable resources.

- Energy Conservation Bonds: $800 million worth of new Energy Conservation Bonds for State and local governments to make energy conservation investments in public infrastructure and invest in research.

The 110th Congress also enacted a number of measures aimed at protecting American consumers from high energy prices, including the following:

- LIHEAP Funding: Funding the Low-Income Home Energy Assistance Program (LIHEAP) at its full authorization level of $5.1 billion.

- Weatherization Assistance Program Funding: Increasing funding to the Weatherization Assistance Program, which supports weatherization of low-income homes to reduce energy costs, to $478 million—nearly double historic levels.

- Strategic Petroleum Reserve Fill Suspension: Enacting H.R. 6022, the "Strategic Petroleum Reserve Fill Suspension and Consumer Protection Act of 2008," which avoids wasteful spending and reduces pressures on oil prices by blocking the Department of Energy from buying oil for the Strategic Petroleum Reserve during a period of historically high oil prices.

Finally, the House passed several important energy security and climate measures that were not enacted into law, including the following:

- A national renewable electricity standard that would have required 15 percent of the national electricity supply to be generated using renewable resources by 2020 (up to 4 percent of which could be satisfied through efficiency measures).

- Federal model building standards that would have required a 30 percent improvement in the energy efficiency of new residential and commercial buildings by 2010 and a 50 percent improvement by 2020.

- "Use-it-or-lose-it" provisions that would require oil and gas companies to diligently pursue production on the 68 million acres of federal lands already leased to them.

- Recovery of $5.8 billion in Outer Continental Shelf oil and gas lease royalties lost due to erroneous omission of price caps for royalty relief in certain leases issued in 1998 and 1999.

- H.R. 6604, the Commodity Markets Transparency and Accountability Act of 2008, which would have addressed excessive speculation in energy markets by closing the so-called "London Loophole," which allowed traders to avoid regulation by offshoring their trades, requiring greater information be made public on trading activities in energy markets, and requiring the Commodity Futures Trading Commission to set position limits for energy futures markets.

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RECOMMENDATIONS

The 111th Congress and the next Administration should prioritize the implementation of the following recommendations, organized based on eight core objectives:

1. **Enact Economy-Wide "Cap-and-Invest" Legislation Based on the Following 10 Principles:**
   - Science-Based Emission Targets: Climate legislation must achieve a reduction in greenhouse gas emissions of at least 20 percent by 2020 and at least 80 percent by 2050.
   - Market-Based, Economy-Wide Cap-and-Trade System: To maximize cost savings, climate legislation should implement a market-based cap-and-trade system that covers as great a proportion of U.S. emissions as is practicable.
   - Ensure Fairness and Effectiveness by Auctioning Pollution Allowances: Climate legislation should auction 100 percent of pollution allowances, to ensure fairness and effectiveness of the cap-and-invest system and to minimize social costs.
   - Consumer Focused: Climate legislation should return at least half of allowance auction proceeds directly to low- and middle-income households to offset any increase in energy costs.
   - Invest in Efficiency, Clean Energy Technology, and American Workers: Climate legislation should spur the transition to a low-carbon economy by investing auction proceeds in energy efficiency programs, in the development, demonstration, and deployment of clean energy technologies, and in helping American workers to transition to good jobs in the new low-carbon economy.
   - Ensure Global Participation: Climate legislation should include an integrated system of "carrots" and "sticks" to ensure that other countries join with us in reducing greenhouse gas emissions.
   - Smart Offsets and Incentives for Supplemental Emission Reductions: Climate legislation should establish rigorous standards governing the award of offset credits, and should provide robust financial incentives for supplemental reductions in "uncapped" emissions not eligible to generate offset credits.
   - Rigorous Carbon Market Oversight: Climate legislation should establish a rigorous framework for oversight and regulation of the market for emission allowances, offset credits, and derivatives—ensuring transparency, fairness, and stability.
   - Build Resilience to Climate Change Impacts: Climate legislation should build resilience to unavoidable impacts of climate change, both in the United States and in the most vulnerable developing countries. This must include investment in the necessary capacity to provide a robust Earth observation and prediction system.
   - Integrate Complementary Policies and State and Local Roles: Climate legislation should integrate complementary policies (especially in the area of power sector, building, and transportation sector efficiency) to reduce the overall cost of reducing emissions, and should preserve appropriate roles for State and local action.

2. **Boost the Efficiency of the Power Sector and Residential and Commercial Buildings:**
    - National Building Efficiency Standards: Enact federal building efficiency standards requiring at least a 30 percent improvement in new building efficiency by 2010 and a 50 percent improvement by 2020.
    - Incentives for Building Efficiency Retrofits: Provide funding for the zero net-energy commercial buildings initiative created under EISA, and promote building efficiency labeling standards for existing buildings.
    - National Appliance Standards: Authorize new national appliance standards for high energy-consuming appliances such as flat-screen televisions, servers, and computers, and encourage the Department of Energy to promptly issue and/or update appliance efficiency standards under existing authority.
    - National Energy Efficiency Resource Standard: Adopt a national energy efficiency resource standard that requires utilities to achieve gradually increasing level of annual efficiency gains.
    - Performance-Based Incentives for State and Local Governments: Provide performance-based federal incentives—potentially funded through cap-and-invest auction proceeds or a national wires charge—to encourage utilities, States, and local governments to adopt energy efficiency measures.
    - Fund Combined Heat and Power, Fuel Cell, and Smart Grid RD&D Programs: Fully fund initiatives authorized under EISA to promote research, development, demonstration, and deployment of combined heat and power, fuel cells, and smart grid technologies.

3. **Expand Renewable Electricity Generation:**
    - National Renewable Electricity Standard: Establish national Renewable Electricity Standard requiring that 20 percent of U.S. electricity be supplied by renewable sources by 2020.
    - 5-8 Year Extension of Renewable Energy Tax Credits: Enact a five- to eight-year extension of the production tax credit for renewable electricity generation.
    - Double Federal RD&D: Double current levels of federal investment in RD&D on renewable electricity generation.
    - Develop a National Green Transmission and Distribution Policy: Encourage or require the Department of Energy and the Federal Energy Regulatory Commission to formulate a national policy to encourage construction of transmission lines connecting renewable resources with population centers.

4. **Drive the Development of Carbon Capture and Sequestration (CCS) Technology:**
    - Fund CCS Demonstration Projects and R&D: Fully fund the CCS demonstration program authorized under Sections 702 and 703 of EISA and increase funding for CCS-related R&D efforts.
    - Performance Standards for New Plants: Enact legislation, either in tandem with cap-and-invest legislation or as a precursor to it, to require all new coal-fired power plants to implement CCS by 2020.
    - Administration Task Force: Encourage or require the new administration to establish an interagency task force to address and make recommendations to Congress on

regulatory and legal barriers to the commercial deployment of CCS, including a proposed framework for long-term liability issues.

5. **Transform the U.S. Transportation System Through Fuel Efficiency, Electric-Drive Vehicles, Low-Carbon Fuels, and Transportation Choices:**
    - Ensure Rigorous Implementation of CAFE Authority: Require NHTSA to use realistic estimates of fuel prices and technologies in determining the "maximum feasible" fuel economy standards for the U.S. fleet.
    - Low-Carbon Fuel Standard: Enact a federal low-carbon fuel standard that requires gradual and continuous reductions in the carbon intensity of the U.S. fuel supply, is harmonized with the existing renewable fuel standard from the present through 2022, and replaces the renewable fuel standard after 2022.
    - Expand Tax Credits for Plug-In Hybrids and Other Advanced Vehicles: Provide tax credits for conversion of hybrid vehicles to plug-in hybrids.
    - Fund Loan Guarantees for Advanced Battery Development: Fully fund loan guarantees for advanced battery development under Section 135 of EISA.
    - Fund Electrification of State Vehicle Fleets: Establish a grant program to assist States with conversion of their vehicle fleets to plug-in hybrids and electric vehicles.
    - Double Federal RD&D: Double current levels of federal investment in RD&D on biofuels and advanced vehicle technologies.
    - Promote Mass Transit and Smart Growth: Make promotion of mass transit and smart growth policies to reduce vehicle miles traveled a priority for transportation reauthorization and other relevant federal policies.

6. **Support Green Jobs and Clean Tech Growth**
    - Fund Green Jobs Training: Fully fund the green jobs training program established under Section 1002 of EISA.
    - Clean Tech Investment Support: Consider the establishment of institutions and mechanisms, such as a clean energy investment bank, to encourage private investment in clean energy technology.

7. **Provide Short-Term Energy Relief to American Consumers:**
    - Fully Fund LIHEAP and the Weatherization Assistance Program: Fund the Low-Income Home Energy Assistance Program and the Weatherization Assistance Program at full authorization levels.
    - Manage Strategic Petroleum Reserve to Protect Taxpayers and Consumers: Require the Department of Energy to swap 10 percent of the light crude in the SPR for heavy crude to better balance the Reserve. Provide guidance to the Department of Energy on management of the SPR during periods of high oil prices to avoid wasteful spending and to utilize the Reserve to provide short-term relief to consumers.
    - Provide New Authority to Crack Down on Speculation: Amend the Commodities Exchange Act to close loopholes in the existing regulatory regime. Provide funding for 100 additional staff for the Commodities Futures Trading Commission to oversee energy commodities futures markets.

8. **Responsibly Manage Expanded Domestic Oil and Gas Production:**
   - Encourage Diligent Development of Existing Leases: Enact legislation to require oil and gas leaseholders that fail to develop such leases diligently to surrender them to the Department of the Interior so that they can be offered to other producers.
   - Responsibly Address Outer Continental Shelf Drilling: Revisit the issue of Outer Continental Shelf oil and gas exploration and drilling to ensure that environmentally and economically sensitive areas are protected and that States' rights are respected in future OCS drilling activities.
   - Encourage Development of the Alaska Natural Gas Pipeline: Encourage presidential leadership in completion of the Alaska Natural Gas Pipeline, which could expand domestic supply of natural gas to the lower 48 States by 7 percent of current levels.

I. THE CLIMATE AND ENERGY CHALLENGE

A. THE CLIMATE CRISIS

The scientific debate on the cause of global warming is over. A clear scientific consensus now holds that global warming is happening, that manmade greenhouse gas emissions are largely responsible, and that the consequences of failing to reduce such emissions will be catastrophic.

1. The Scientific Consensus on Climate Change

Global warming refers to the global temperature rise and subsequent impacts from the increase of heat-trapping gases in the atmosphere from human activities, primarily the combustion of fossil fuels. This additional pollution enhances the so-called "greenhouse effect" and warms the Earth. The Intergovernmental Panel on Climate Change (IPCC) declared in its Fourth Assessment Report released in 2007 that the evidence for warming is "unequivocal"[2] and that most of the observed warming is very likely—greater than 90 percent certainty—due to the increase of global warming pollution from human activities.[3] Over the last century, the global average temperature has increased 1.4°F, with almost 90 percent of the warming occurring over the last 50 years.[4]

Just like the glass of a greenhouse traps warm air inside, certain gases in the atmosphere trap heat that would otherwise escape into space. There are a number of such "greenhouse gases": water vapor,[5] carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), high-altitude ozone, and certain man-made industrial gases, including chlorofluorocarbons, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

The impact of each gas on global warming is a combination of its ability to trap heat, its concentration in the atmosphere, and how long it stays in the atmosphere. For example, while one molecule of methane traps more heat than one molecule of CO_2, the higher concentration and longer atmospheric lifetime of CO_2 means it has contributed more to global warming than methane has. Most efforts to control global warming pollution have focused on the CO_2 emissions from the burning of fossil fuels because they have the greatest effect and we have the greatest control over them.

Since the Industrial Revolution, the concentration of CO_2 in the atmosphere has increased from 280 parts per million (ppm) to over 380 ppm.[6] This 100 ppm change is the same increase

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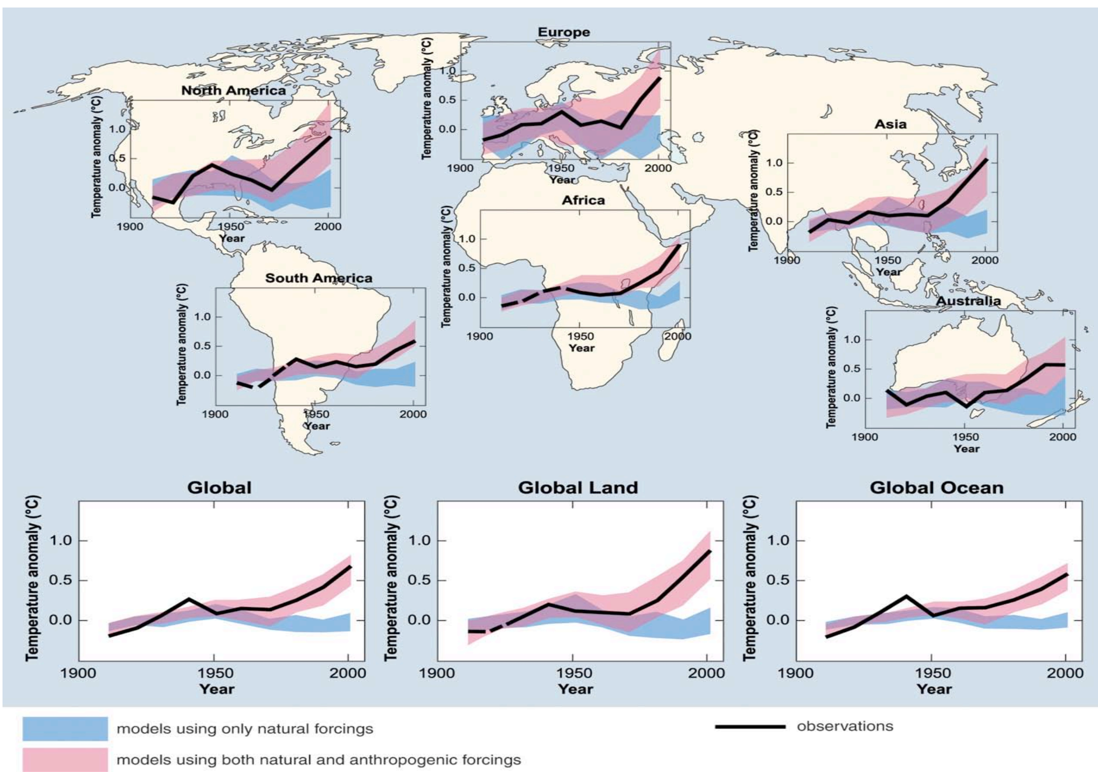
[2] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 5 (2007).
[3] Id. at 3.
[4] Id. at 5.
[5] Water vapor is different from the other greenhouse gases primarily because of the much shorter time it stays in the atmosphere—days rather than years, decades or centuries. As noted below, the quantity of water vapor in the atmosphere depends primarily on temperature, rather than human activities.
[6] The total CO_2-equivalent concentration of all greenhouse gases is 455 ppm. Intergovernmental Panel on Climate Change, 2007: Mitigation of Climate Change, Summary for Policymakers, at 27 (2007).

as the world experienced from the last ice age about 20,000 years ago until just before the 1800's.[7] Human activities have changed the atmosphere as much in 200 years as natural variations changed it over 20,000 years. The current level is higher than any level seen in the last 650 thousand years.[8]

Scientists can model the temperature effects of natural and human-induced, or anthropogenic, changes in the global temperature. The results show that natural variations alone cannot explain the observed temperature rise of the last decades. The changes from human activities are necessary to fully explain the observed warming. Indeed, the IPCC has estimated that of the processes that can change global temperature, what they call "radiative forcings," the components from human activities are cumulatively 10 times larger than the best estimates of the changes from solar activity.[9] A 2007 study found that all the trends in the Sun's activity that could influence the temperature of the Earth have been in the opposite direction needed to explain the rise in temperature over the last 20 years.[10]

Correlation Between Human Forcings and Observed Temperature Increases



[7] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 112 (2007).
[8] Urs Siegenthaler, et al., Stable Carbon Cycle–Climate Relationship During the Late Pleistocene, 310 Science 1313 (2005).
[9] Intergovernmental Panel on Climate Change, 2007, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 4 (2007).
[10] Lockwood and Froehlich, Recent Oppositely Directed Trends in Solar Climate Forcings and the Global Mean Surface Air Temperature, 463, Proceedings of the Royal Society, 24427 (2007).

Source: Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers (2007) (Figure 2-5).

Scientists predict that if greenhouse gas emissions continue to grow unchecked, global warming—and resulting climate change—will accelerate. The IPCC's estimate of the likely increase in global average surface temperature by 2100 ranges from 2 ˚F to 11.5 ˚F above 2000 levels, depending on the scenario for greenhouse gas emissions growth.[11] It should be emphasized, however, that current trends in emissions growth are consistent with or higher than the scenarios on the high end of this range. Business-as-usual emissions growth could result in atmospheric CO_2 concentrations of well above 700 ppm by 2100,[12] yielding a likely temperature increase of 8.8 to 11 ˚F.[13] These levels of warming will result in disastrous impacts for the planet, as the following sections explain.

Further, many scientists are increasingly concerned that, because of "positive feedback" mechanisms associated with climate change, we are approaching a "tipping point" beyond which climate change will accelerate and will become increasingly difficult to reverse. As Dr. James Hansen explained at a briefing before the Select Committee held 20 years after his historic first testimony before Congress that human activities were altering the climate:

> "Elements of a 'perfect storm,' a global cataclysm, are assembled. Climate can reach points such that amplifying feedbacks spur large rapid changes. Arctic sea ice is a current example. Global warming initiated sea ice melt, exposing darker ocean that absorbs more sunlight, melting more ice. As a result, without any additional greenhouse gases, the Arctic soon will be ice-free in the summer."[14]

Another worrisome climate feedback involves the methane stored in frozen arctic soils. Although it is hard to quantify, there is likely five times, if not more, carbon trapped in these soils than humans have released into the atmosphere from the burning of fossil fuels since the Industrial Revolution.[15] As these soils warm and release methane, temperatures will increase, causing more soil to melt and more methane to be released. How quickly this warming and release happens is a critical question. As Dr. Jack Fellows said about this question in testimony before the Select Committee, "If it is released quickly, it could be the end of civilization."[16]

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[11] Intergovernmental Panel on Climate Change, 2007, Climate Change 2007: The Physical Science Basis, Summary for Policymakers, at 13, 69-70 (2007).

[12] See, e.g., Environmental Protection Agency, EPA Analysis of Bingaman-Specter Request on Global CO2 Concentrations at 7 (Oct. 1, 2007), available at http://www.epa.gov/climatechange/downloads/s1766analysispart1.pdf.

[13] See Intergovernmental Panel on Climate Change, Climate Change 2007: Mitigation of Climate Change, Summary for Policymakers at 39 (Table TS.2) (2007).

[14] James Hansen, "Global Warming Twenty Years Later: Tipping Points Near," Briefing of the Select Committee on Energy Independence and Global Warming, June 23, 2008, available at http://www.columbia.edu/~jeh1/2008/TwentyYearsLater_20080623.pdf.

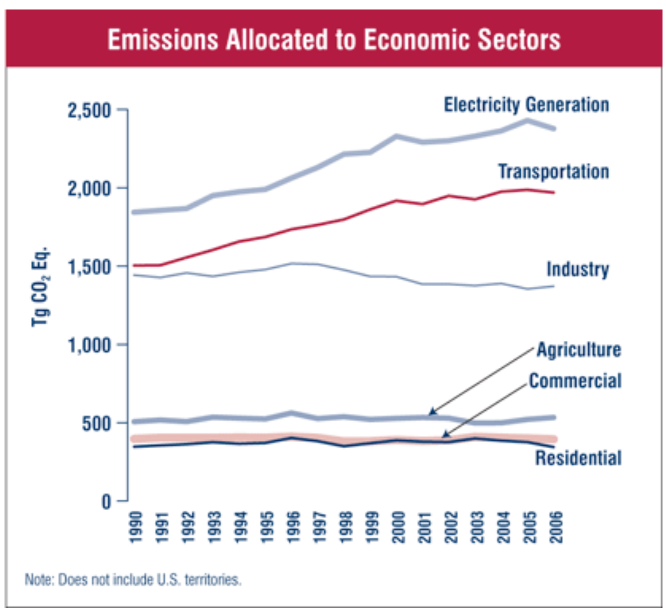
[15] Sergey A. Zimov, et al., Permafrost and the Global Carbon Budget, 312 Science 1612 (2006).

[16] Transcript of Select Committee on Energy Independence and Global Warming hearing on "Investing in the Future: R&D Needs to Meet America's Energy and Climate Challenges, Sept. 10, 2008, at 57

2. Greenhouse Gas Emissions Sources and Trends

The United States accounts for roughly 20 percent of global CO_2 emissions, and U.S. emissions have grown steadily over the past two decades at a rate of roughly 1 percent per year. In 2006 (the most recent year for which data is available), the United States emitted 7,054 million metric tons CO_2 equivalent in greenhouse gases—a 14.7 percent increase since 1990 (the earliest year for which EPA data are available). Net emissions, including sources and sinks, similarly increased from 1990 to 2006, from 5,411 to 6,171 million metric tons CO_2 equivalent.[17] Absent policy interventions, U.S. emissions are expected to increase between 20 and 52 percent by 2025 from 2000 levels.[18]

In 2006 U.S. emissions were dominated by emissions from the electric power sector (comprising 34 percent of total U.S. emissions), transportation sector (28 percent), and industrial sector (19 percent). The remaining emissions were due to the agricultural (8 percent), commercial (6 percent), and residential (5 percent) sectors. Emissions from the electric power, transportation, and agricultural sectors have increased since 1990, while emissions from the industrial, commercial, and residential sectors have held steady or declined over the same period. If emissions from the generation of electric power are instead attributed to the end-use sectors, these proportions shift somewhat: The industrial (29 percent), commercial (17 percent), and residential (17 percent) sectors play an increasing role, while contributions from the transportation (28 percent) and agriculture (8 percent) sectors remain relatively constant.[19]



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[17] Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, at ES-4 to ES-6 (April 15, 2008) [hereinafter "EPA Inventory"], available at http://www.epa.gov/climatechange/emissions/downloads/08_CR.pdf.

[18] Kevin A. Baumert et al., World Resources Institute, Navigating the Numbers: Greenhouse Gas Data and International Policy at 18 (2005) [hereinafter "WRI Navigating the Numbers"], available at http://pdf.wri.org/navigating_numbers.pdf.

[19] EPA Inventory, supra note 17, at ES-15 to ES-16.

Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, USEPA #430-R-08-005 (2008).

In 2006, 80 percent of U.S. emissions were CO_2 from the combustion of fossil fuels. Additional CO_2 emissions (representing 5 percent total U.S. emissions) were generated from other activities, such as the manufacture of iron and steel and cement. Remaining emissions were comprised of CH_4 (8 percent) and N_2O (5 percent), largely from agricultural activities, landfills, natural gas systems, and coal mines, and HFCs (2 percent) used as a substitute for ozone-depleting substances. PFCs and SF_6 each comprised less than 1 percent U.S. emissions. Net carbon sequestration (primarily in U.S. forests and agricultural soils) was 884 million metric tons CO_2 equivalent—offsetting 13 percent of total U.S. emissions.[20]

Global greenhouse gas emissions grew by 24 percent between 1990 and 2004,[21] have accelerated since then, and are now running above the IPCC's worst case scenario. While a slowing global economy in 2007 was expected to slow energy consumption and subsequent greenhouse gas emissions, global CO_2 output instead rose 3 percent from 2006 to 2007. Anthropogenic CO_2 emissions are growing four times faster since 2000 than during the previous decade, and are now running above the worst case emission scenario of the IPCC.[22] In 2006, China surpassed the United States in total annual CO_2 emissions,[23] with each country accounting for more than 20 percent of the global total.[24] The EU-25 countries accounted for an additional 15 percent. India is on track to become the world's third largest emitter in 2008, surpassing Russia.[25] When the United Nations Framework Convention on Climate Change was drafted in 1992, the 38 countries initially agreeing to limit their greenhouse gas emissions were responsible for 62 percent of all carbon dioxide emissions. Today this number has fallen to around 47 percent, demonstrating the transformation of the global economy and the rapid growth occurring in many parts of the developing world.[26]

Electricity and heat account for 25 percent of global emissions, followed by industry (21 percent), land use change and forestry (18 percent), buildings (15 percent), agriculture (15 percent), transport (14 percent), and waste (4 percent).[27] The International Energy Agency's (IEA's) Reference Scenario projects global greenhouse gas emissions to increase 44 percent between 2006 and 2030. Emissions from China and India are expected to grow by 86 and 104 percent, respectively, while emissions from the United States are expected to grow by 25 percent

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[20] EPA Inventory, supra note 17, at ES-4 to ES-6.
[21] Intergovernmental Panel on Climate Change, Climate Change 2007: Mitigation of Climate Change, Summary for Policymakers at 27 (2007).
[22] Global Carbon Project, Carbon budget and trends 2007 (2008), at http://www.globalcarbonproject.org/carbontrends/index.htm (last visited Oct. 20, 2008).
[23] Id.
[24] International Energy Agency, Key World Energy Statistics 2008 at 45, 50, 56 (2008), available at: http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf.
[25] Oak Ridge National Laboratory Press Release, "CO_2 emissions booming, shifting east, researchers report" (Sept. 24, 2008), available at http://www.globalcarbonproject.org/global/pdf/Press%20Release_OakRidge%20NationalLab_USA_final.pdf.
[26] Id.
[27] WRI Navigating the Numbers, supra note 18, at 57.

over the same time period.[28] Emissions from the EU have stayed relatively flat since 1990, and the EU has unilaterally committed to reduce emissions by 20 percent by 2020—and up to 30 percent with cooperation from the international community.

While China has now overtaken the United States as the largest greenhouse gas emitter on an annual basis, the United States continues to have one of the highest per capita emission rates—far greater than India, China, or the EU. In 2005, the United States emitted 20 tons of CO_2 per capita annually, compared to 12 tons per capita in Russia, 10 tons in Japan and the United Kingdom, and 8 tons per capita for the EU. The worldwide average per capita CO_2 emissions level is 4.3 tons, and the average person in China and India is responsible for 4 tons and 1 ton of CO_2 emissions per year, respectively.[29]

Moreover, the United States is responsible for nearly a third of the cumulative greenhouse gas emissions in the atmosphere—nearly four times as much as China and over 14 times as much as India. Developing countries with 80 percent of the world's population still account for 20 percent of the cumulative emissions since 1751. The poorest countries in the world—where 800 million people live—have contributed less than 1 percent of these cumulative emissions.[30] For most industrialized countries, their historic (i.e., cumulative) share of global emissions is much higher than their current (i.e., annual) share. For the period between 1850 and 2002, the United States contributed 29 percent world's CO_2 emissions, leading all other countries. EU-25 follows closely behind, with a contribution of 27 percent world's CO_2 emissions, but no other country contributes more than 10 percent. For example, China's cumulative contribution is 8 percent, and India's is only 2 percent.[31]

The IPCC has concluded that, to have even a 50-50 chance of avoiding the dangerous climate change associated with a 3.6 ºF increase in global average surface temperature, global emissions must be reduced by 50-85 percent by 2050. This requires the United States and other developed countries to reduce emissions by at least 80 percent by 2050.[32] Given the current trajectory of rapidly rising greenhouse gas emissions, both here in the United States and globally, a substantial change of course is required in the very near term to avoid the catastrophic impacts outlined below.

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[28] International Energy Agency, World Energy Outlook (2006); and International Energy Agency, Key World Energy Statistics (2008).
[29] Energy Information Administration, International Energy Annual 2005, at Table H.1cco2 World Per Capita Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 1980-2005 (2007) available at: http://www.eia.doe.gov/pub/international/iealf/tableh1cco2.xls.
[30] Global Carbon Project, supra note 22.
[31] WRI Navigating the Numbers, supra note 18, at 32.
[32] Intergovernmental Panel on Climate Change, Climate Change 2007: Mitigation of Climate Change, Summary for Policymakers at 38-39 (Table TS.2); Amy L. Luers et al., Union of Concerned Scientists, How to Avoid Dangerous Climate Change: A Target for U.S. Emission Reductions (Sept. 2007), available at http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/a-target-for-us-emissions.html.

3. The Catastrophic Impacts of Climate Change

a. Going Dry—Increasing Water Scarcity and Declining Water Quality

One of the most dramatic impacts of global warming in the 21st century will be the exacerbation of already severe water scarcity—both here in the United States and abroad. Freshwater scarcity and threats to water quality are increasing dramatically both in the United States and across the world. Over a billion people currently lack access to safe drinking water.[33] By 2025, 1.8 billion people are expected to be living in regions experiencing water scarcity and "two-thirds of the world's population could be living under water stressed conditions."[34] Climate change will greatly exacerbate current and future water stress. For example, the IPCC projects that by 2020, between 75 and 250 million people in Africa alone will experience an increase of water stress due to climate change.[35] For Asia, the number is between 120 million and 1.2 billion people, and for Latin American it is 12 to 81 million.[36]

Global warming is leading to rapid melting of land ice, glaciers, ice caps, and snow fields which over time will exacerbate water scarcity in many regions of the globe. One-sixth of the world population currently relies on meltwater from glaciers and snow cover for drinking water and irrigation for agriculture.[37] The IPCC's 2008 Climate Change and Water report projects widespread reductions in snow cover throughout the 21st Century, and a 60 percent volume loss in glaciers in various regions.[38] The melting of these ice reservoirs, which store 75 percent of the world's freshwater, will exacerbate water scarcity conditions.[39] While melting will temporarily increase freshwater supply, more winter precipitation falling as rain rather than snow, and an earlier snowmelt season will deplete frozen freshwater reserves.

Increased water stress due to climate change will disproportionately affect the dry tropics and dry regions at lower mid-latitudes—notably Southeast Asia, southern Africa, Brazil, and the American Southwest.[40] According to the 2008 IPCC Climate Change and Water Report, semi-arid and arid areas in Southeast Asia, Southern Africa, Brazil, and the western United States are "projected to suffer a decrease of water resources due to climate change."[41] In Asia, decreasing precipitation and rising temperatures result in increasing frequency and intensity of droughts.[42] In northwestern China and Mongolia, snow and glacier melt will cause

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[33] German Advisory Council on Global Change, Climate Change as a Security Risk Summary for Policy-makers at 2 (2007).
[34] United Nations Commission on Sustainable Development, The Food Crisis and Sustainable Development (May 2008), available at http://www.un.org/esa/sustdev/csd/csd16/documents/bgrounder_foodcrisis.pdf.
[35] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability, Summary for Policy Makers at 13 (2007).
[36] Testimony of Rajendra Pachauri before the Select Committee on Energy Independence and Global Warming, "Learning from a Laureate: Science, Security and Sustainability," Jan. 30, 2008; see also Intergovernmental Panel on Climate Change, Climate Change and Water at 36 (2008) [hereinafter "IPCC Climate Change and Water"].
[37] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation, and Vulnerability, Summary for Policymakers at 11 (2007).
[38] IPCC Climate Change and Water, supra note 36, at 28.
[39] Id. at 19-26.
[40] Id. at 3.
[41] Id. at 88.
[42] Id. at 86.

floods in the spring in the near term but result in freshwater shortages by the end of the century.[43] Global warming of 5.4 to 7.2 °F would result in more persistent El Niño conditions that would shift the Amazon rainforest from "tropical forest to dry savannah"[44]—imperiling an ecosystem that sustains thousands of people and is one of the greatest concentrations of biodiversity on Earth.[45]

The United States is already experiencing water stress, which will worsen severely in the coming decades due to climate change. In the American West, the Sierra Nevada snowpack is at its lowest level in 20 years and threatens most of the water supply to Northern California.[46] Experts warn that "even the most optimistic climate models for the second half of this century suggest that 30 to 70 percent of this snowpack will disappear."[47] The Southwest is already experiencing a severely reduced flow in the Colorado River—upon which 30 million people depend for water—as a consequence to decreasing snowmelt from the Rocky Mountains.[48] The Midwest is expected to experience "drought-like conditions resulting from elevated temperatures, which increases levels of evaporation, contributing to decreases in soil moisture and reductions in lake and river beds" as a result of climate change.[49] In addition to a range of other costs, agriculture in the Great Plains and the Southwest is likely to suffer massive economic losses due to increasing water scarcity.[50]

Climate change will also negatively impact the quality of freshwater resources. For example, reduced flows will reduce rivers' ability to dilute effluent, leading to increased pathogen or chemical loading.[51] In addition, increased heavy precipitation events due to climate change—discussed below—"may increase the total microbial load in watercourses and drinking-water reservoirs."[52] And warmer water temperature combined with higher phosphorus concentrations will increase the occurrence of freshwater algal blooms, with adverse impacts on freshwater ecosystems and fisheries. Fish habitat may also be compromised because altered water chemistry will promote the intrusion of invasive species.[53] These impacts will exacerbate the precarious state of freshwater fish species in North America, nearly 40 percent of which are already at risk.[54]

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[43] Id. at 87.
[44] Timothy M. Lenton et al., Tipping Elements in the Earth's climate system, 105 Proceedings of the National Academy of Sciences 1790 (2008).
[45] WWF Climate Change Programme, Climate Change Impacts in the Amazon: Review of Scientific Literature at http://assets.panda.org/downloads/amazon_cc_impacts_lit_review_final_2.pdf (last visited Oct. 20, 2008).
[46] Jon Gertner, "The Future is Drying Up", New York Times, Oct. 21, 2008, available at http://www.nytimes.com/2007/10/21/magazine/21water-t.html?_r=1&ref=todayspaper&oref=slogin.
[47] Id.
[48] Id.
[49] Id.
[50] Matthias Ruth et al., University of Maryland Center for Integrative Environmental Research, The US Economic Impacts of Climate Change and the Costs of Inaction at 24, 27 (2007), available at http://dl.klima2008.net/ccsl/us_economic.pdf.
[51] IPCC Climate Change and Water, supra note 36, at 67.
[52] Id. at 68.
[53] Environmental Protection Agency, National Water Program Strategy: Response to Climate Change at ii (Mar. 2008), available at http://www.epa.gov/water/climatechange/docs/TO5_DRAFT_CCR_Revised_10-16.pdf.
[54] Allison Winter, Fisheries: Freshwater species in steep decline – USGS, Greenwire, Sept. 10, 2008.

b. The Great Melt—Impacts on the Arctic and Antarctic

The Arctic is literally one of the hotspots of global warming. Over the past 50 years average temperatures in the Arctic have increased as much as 7° F, five times the global average.[55] In the next 100 years, some areas in the Arctic may see an increase in average temperatures as high as 13° F.[56]

As temperatures rise in the Arctic, sea ice and glaciers are melting at an unprecedented and alarming rate. In 2007, a record 386,000 square miles of Arctic sea ice melted away, an area larger than Texas and Arizona combined and as big a decline in one year as has occurred over the last decade.[57] In 2008, the sea ice extent was only slightly greater than in 2007, but the sea ice volume is likely the lowest on record due to the decline in multiyear old ice and the thinness of the remaining ice.[58] Recent observations suggest that Arctic sea ice could completely disappear during the summer as early as 2020.[59]

The Greenland ice sheet is melting at an alarming rate. Between 1979 and 2002, the extent of melting in Greenland has increased on average by 16 percent—an area roughly the size of Sweden.[60] In the record-breaking year of 2005, parts of Greenland melted that have never melted during the 27-year long satellite record.[61] In May 2007, members of the Select Committee observed firsthand the disintegration of the Jakobshavn Glacier at Ilulissat in western Greenland. According to the scientists that met with the delegation and who have been monitoring the glacier for almost two decades, the receding of this glacier has doubled in the past eight years, from 5 to nearly 9 miles per year, draining a large portion of the ice sheet.

A complete melting of Greenland would result in a rise in global sea level of over 20 feet,[62] with catastrophic consequences for coastal regions around the world. Furthermore, melting Arctic glaciers would contribute large amounts of fresh water into the ocean, potentially changing oceanic currents, damaging eco-systems and altering current weather conditions.

Parts of Antarctica, too, are melting fast. At the opposite end of world, massive amounts of water are trapped in the two ice sheets of Antarctica. The larger East Antarctic ice sheet covers the majority of the continent, while the West Antarctic ice sheet has significant ice shelves partially floating in the ocean. Taken together, they contain 90 percent of Earth's ice and

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[55] Arctic Climate Impact Assessment, Impacts of a Warming Arctic Highlights at 4 (2004), available at http://www.amap.no/acia/Highlights.pdf.
[56] Id.
[57] European Space Agency, "Satellites witness lowest Arctic ice coverage in history," Sept. 14, 2007, at http://www.esa.int/esaCP/SEMYTC13J6F_index_0.html (last visited Oct. 20, 2008).
[58] National Snow and Ice Data Center, Arctic Sea Ice Down to Second-Lowest Extent; Likely Record-Low Volume, Oct. 2, 2008, at http://nsidc.org/news/press/20081002_seaice_pressrelease.html (last visited Oct. 20, 2008).
[59] Julienne Stroeve et al. Arctic sea ice decline: Faster than forecast, 34 Geophysical Research Letters L09501 (2007).
[60] Arctic Climate Impact Assessment, supra note 55, at 6.
[61] Sebastian H. Mernild et al., Surface Melt Area and Water Balance Modeling on the Greenland Ice Sheet 1995–2005, Journal of Hydrometeorology: In Press (2008).
[62] USGS Fact Sheet 002-00, Sea Level and Climate (2000), available at http://pubs.usgs.gov/fs/fs2-00/.

70 percent of its freshwater and would raise sea level over 200 feet if they completely melted.[63] In the spring of 2002, scientists were shocked to discover that an ice shelf the size of Rhode Island had disintegrated from the West Antarctica ice sheet in just over a month.[64] The collapse of the Larsen B ice shelf was a wake-up call to scientists who had thought that these large areas of ice would take a millennium to disappear, not a month.

Dr. James Hansen testified before the Select Committee that, because the floating ice of the West Antarctic is subject to both warming air and ocean temperatures, it is especially vulnerable to global warming.[65] Until recently, it was believed that only coastal areas of the West Antarctic were vulnerable to melting. Satellite analysis has now revealed that large inland regions are also showing signs of the impacts of warming. NASA and university researchers have found clear evidence that an area the size of California melted in January 2005 in response to warm temperatures.[66] One reason that Antarctica has not experienced the same increase in temperatures as the Arctic is the cooling effect of the ozone hole. Scientists predict that as the atmosphere recovers from ozone depletion, the interior of Antarctica will warm with the rest of the world.[67]

c. Warming and Acidification of the World's Oceans

The world's oceans will suffer devastating impacts as a result of global climate change—as the Select Committee learned at its April 2, 2008 hearing entitled "Rising Tides, Rising Temperatures: Global Warming's Impacts on the Oceans."

Oceans are already warming due to climate change. The oceans cover 70 percent of the Earth's surface and are critical components of the climate system for redistributing heat around the world and absorbing CO_2 from the atmosphere. According to the IPCC, global ocean temperature has risen by 0.18°F from 1961 to 2003.[68] Since the ocean has a heat capacity 1,000 times greater than that of the atmosphere, it has taken up 20 times more heat than the atmosphere during this same period.[69] As a result of the ocean's relatively large heat capacity, it has a great effect on the Earth's heat balance and how energy from solar radiation is distributed throughout the global environment.

Increasing atmospheric CO_2 concentrations are causing acidification of the oceans. Elevated atmospheric CO_2 concentrations lead to higher absorption of CO_2 into the upper ocean, which makes the surface waters more acidic and reduces the concentration of carbonate ions.

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[63] USGS Fact Sheet 2005-3055, Coastal Change and Glaciological Maps of Antarctica (2007), available at http://pubs.usgs.gov/fs/2005/3055/index.html.
[64] N. F. Glasser & T.A. Scambos, A structural glaciological analysis of the 2002 Larsen B ice shelf collapse, 54 Journal of Glaciology 3–16 (2008).
[65] Testimony of James Hansen before the Select Committee on Energy Independence and Global Warming, "Danger Human-Made Interference with Climate", April 26, 2007, at 13.
[66] S. V. Nghiem et al., Snow Accumulation and Snowmelt Monitoring in Greenland and Antarctica, in Dynamic Planet (2007).
[67] Judith Perlwitz et al., Impact of stratospheric ozone hole recovery on Antarctic climate, 35 Geophysical Research Letters L08714 (2008).
[68] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis at 387 (2007).
[69] Id. at 389.

According to the National Oceanic and Atmospheric Administration (NOAA), ocean chemistry currently is changing at least 100 times more rapidly than it has changed during the 650,000 years preceding our industrial era.[70] If current emission trends continue, the ocean will experience acidification to an extent and at rates that have not occurred for tens of millions of years. Ocean acidification has serious implications for the calcification rates of organisms living at all levels within the global ocean, from corals to zooplankton that serve as the foundation of many ocean food chains. According to NOAA, when dissolved carbon dioxide was increased to two times pre-industrial levels, a decrease in the calcification rate by 5 to 50 percent was observed.[71]

Warming and acidification of ocean waters due to climate change are contributing to the collapse of coral reefs around the globe. Coral reefs are habitat for about a quarter of marine species, are the most diverse among marine ecosystems, and are already in a state of decline. Recent studies indicate that over a third of all coral species are already endangered.[72] When key temperature thresholds are exceeded, mass bleaching and complete coral mortality often result. By mid-century, these temperature thresholds are expected to be exceeded on an annual or bi-annual basis for the majority of reefs worldwide. After bleaching, algae quickly colonize dead corals and may make future coral growth and restoration more difficult. Other factors that influence the health of reefs are impacted by climate change, including sea level rise, storm severity and dust and mineral aerosols.[73] These, together with non-climate factors such as over-fishing, invasion of non-native species, pollution, and increased nutrient and sediment loads, add multiple stresses, increasing coral reefs' vulnerability to climate change. Corals could become rare on tropical and subtropical reefs by 2050 due to the combined effects of acidification and increasing frequency of extreme temperature events that cause bleaching.

NOAA estimates the commercial value of United States fisheries from coral reefs is over $100 million,[74] and the total economic value of coral is estimated to be $30 billion.[75] Coastal states, like Florida, would be especially harmed where reef-based tourism in the Florida Keys generates $1.2 billion in annual revenue.[76] Healthy coral reefs provide other benefits, as well, including shoreline protection, beach sand supply, potential pharmaceuticals, biodiversity, and fish habitat.

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[70] Richard Feeley et al., Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Carbon Dioxide and Our Ocean Legacy (April 2006), available at http://www.pmel.noaa.gov/pubs/PDF/feel2899/feel2899.pdf

[71] Kathy Tedesco et al., National Oceanic and Atmospheric Administration, Impacts of Anthropogenic CO2 on Ocean Chemistry and Biology, at http://www.oar.noaa.gov/spotlite/spot_gcc.html (last visited Oct. 20, 2008).

[72] Krent E. Carpenter et al., One-Third of Reef-Building Corals Face Elevated Extinction Risk from Climate Change and Local Impacts, Science Express, July 10, 2008.

[73] R.A. Cropp and A.J. Gabric, Evidence for global coupling of phytoplankton and atmospheric aerosols, 4 Oceans 2003. Proceedings 2341 (2003).

[74] National Oceanic and Atmospheric Administration, NOAA Ocean Service Education, Importance of Coral Reefs, at http://oceanservice.noaa.gov/education/kits/corals/coral07_importance.html (last visited Oct. 20, 2008).

[75] Elizabeth Weise, Scientists: Global Warming could kill coral reefs by 2050, USA Today, Dec. 13, 2007, available at http://www.usatoday.com/weather/climate/globalwarming/2007-12-13-coral-reefs_N.htm.

[76] Thomas Damassa, World Resources Institute, The Value of Ecosystems (Dec. 5, 2006), available at http://www.wri.org/stories/2006/12/value-coastal-ecosystems.

Climate change threatens global fisheries. Warmer water and acidification not only harm coral reefs that function as fish hatcheries, but could also change the circulation of the world's ocean currents. Most fish species have a fairly narrow range of optimum temperatures due to temperature effects on their basic metabolism and the availability of food sources that have their own optimum temperature ranges.[77] A given species' geographic range may expand, shrink, or be relocated with changes in ocean conditions caused by climate change.[78] The United Nations Environment Programme found that "climate change may slow down ocean thermohaline circulation crucial to coastal water quality and nutrient cycling in more than 75 percent of the world's fishing grounds."[79] Less hospitable waters would have a significant effect on the global fishing industry. In the United States alone, commercial and recreational fisheries contribute $60 billion to the economy each year and employ more than 500,000 people.[80]

Finally, there is growing concern that the oceans' capability to absorb atmospheric CO_2 may be declining—reducing a critical buffer against further climate change. The oceans are the largest natural reservoir for carbon, absorbing approximately one-third of the CO_2 added to the atmosphere by human activities each year.[81] Recent research suggests that the vast Southern Ocean's capability to absorb atmospheric CO_2 may be declining, due in part to saturation of surface waters.[82] In addition, as water warming increases so does ocean stratification which "reduces vertical mixing . . . leading to slower removal of excess carbon from the surface ocean."[83] This is yet another positive feedback mechanism that could speed climate change.

d. Sea Level Rise and Coastal Impacts

Sea levels are already rising, and are predicted to rise by at least 1-2 feet by 2100—with the potential for a nearly 40-foot rise in sea level if the Greenland and West Antarctica ice sheets were to melt completely. The IPCC predicts that sea levels will rise by 8 to 24 inches above current levels by 2100, primarily due to thermal expansion from rising ocean temperatures[84]—with current emissions trends more consistent with the higher end of this range. However, how much and how quickly the polar ice sheets will melt in response to global

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[77] National Oceanic and Atmospheric Administration, Pacific Fisheries and Environmental Laboratory, Climate Variability and Marine Fisheries: How Does Climate Affect Fish Populations?, at http://www.pfeg.noaa.gov/research/climatemarine/cmffish/cmffishery.html (last visited Oct. 20, 2008).
[78] James R. McGoodwin, "Effects of climate variability on three fisheries economies in high-altitude regions: Implications for fisheries policies," 31 Marine Policy 40-55 (2007)
[79] United Nations Environmental Programme, Press Release, Warmer World May Mean Less Fish, Feb. 22, 2008, at http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=528&ArticleID=5751 (last visited Oct. 20, 2008).
[80] Testimony of James L. Connaughton on the Reauthorization of Magnuson-Stevens, Senate Commerce Committee, Nov. 16, 2005.
[81] Tedesco et al., supra note 71.
[82] Testimony of Vikki Spruill, before the Select Committee on Energy Independence and Global Warming, "Global Warming's Impacts on the Oceans," April 29, 2008, at 9; Corinne Le Quéré et al., Saturation of the Southern Ocean CO_2 Sink Due to Recent Climate Change, 316 Science 1735-38 (2007).
[83] Inez Y. Fung et al., "Evolution of carbon sinks in a changing climate," 102 Proceedings of the National Academy of Sciences 11203 (2005).
[84] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 70 (2007).

warming is a critical question. Many scientists are increasingly concerned that the Greenland and West Antarctic ice sheets are melting at a greater rate than previously predicted. Because scientists do not fully understand the dynamics of ice sheet melting, the IPCC found that larger values of sea level rise could not be excluded.[85] A complete melting of the Greenland ice sheet alone would cause a 20-foot rise in sea level, and complete melting of the West Antarctic ice sheet would cause a 16-foot sea level rise. We know from geological history that as the massive ice sheets of the last Ice Age melted, sea level rose as fast as 15 feet per century.[86]

Sea level rise will have severe impacts on the world's coastal populations, including here in the United States. Rising sea levels are already causing inundation of low-lying lands, erosion of wetlands and beaches, exacerbation of storm surges and flooding, and increases in the salinity of coastal estuaries and aquifers. The most dramatic near-term effects of sea level rise are being felt by inhabitants of small island states, the very existence of which is now endangered. Further, about one billion people live within 75 feet elevation of today's sea level, including many U.S. cities on the East Coast and Gulf of Mexico, almost all of Bangladesh, and areas occupied by more than 250 million people in China.[87] In total, more than 70 percent of the world's population lives on coastal plains, and 11 of the world's 15 largest cities are on the coast.

In addition, rising sea level due to climate change will threaten drinking water supplies in coastal areas—causing intrusion of saltwater into both surface water and ground water.[88] New York City, Philadelphia, and much of California's Central Valley obtain some of their water from portions of rivers that are just upstream from the point where water currently turns salty during droughts.[89] If sea level rise pushes salty water further upstream, existing water intakes might draw on salty water during dry periods. The freshwater Everglades currently recharge Florida's Biscayne aquifer, the primary water supply to the most populous counties in South Florida, including the cities of Miami and Fort Lauderdale. As rising water levels submerge low-lying portions of the Everglades, portions of the aquifer would become saline.[90] Aquifers in New Jersey east of Philadelphia are recharged by the Delaware River which also may become saline in parts in the future, leading to a degradation of drinking water quality.[91]

e. Extreme Weather Events

Global warming has already changed the intensity, duration, frequency, and geographic range of a variety of weather patterns and will continue to do so—with potentially severe impacts on the United States and the world.[92] There is a broad scientific consensus that

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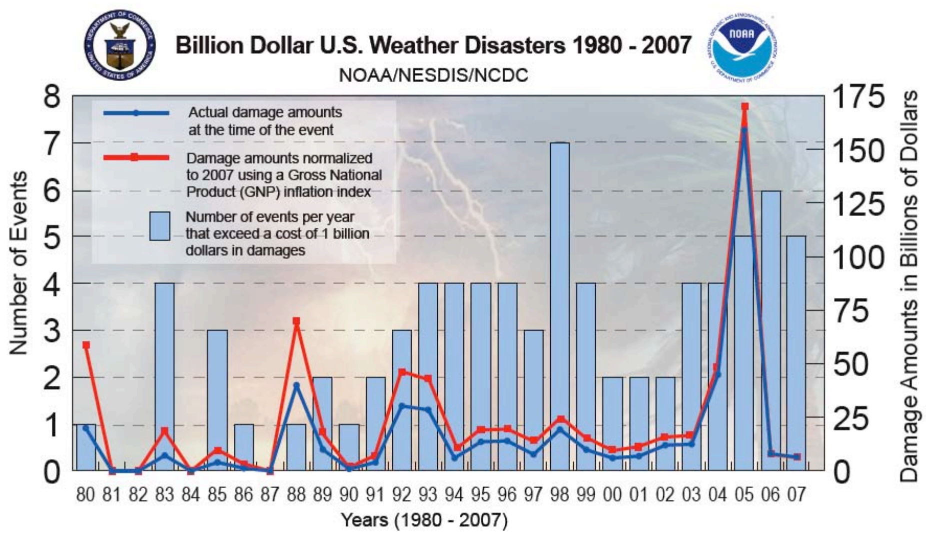
[85] Id. at 14.
[86] Testimony of James Hansen, before the Select Committee on Energy Independence and Global Warming on "Dangerous Human-Made Interference with Climate," April 26, 2007, at 11.
[87] Id. at 12.
[88] Environmental Protection Agency, Coastal Zones and Sea Level Rise, at http://www.epa.gov/climatechange/effects/coastal/index.html (last visited Oct. 20, 2008).
[89] Id.
[90] Id.
[91] Id.
[92] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis at 8 (2007); see generally U.S. Climate Change Science Program, Synthesis Assessment Product 3.3, Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands at 8 (June 2008).

the United States is vulnerable to weather hazards that will be exacerbated by climate change. The cost of damages from weather disasters has increased markedly from the 1980's, rising to over 100 billion dollars in 2007. In addition to a rise in total cost, the frequency of weather disasters costing over one billion dollars has increased.[93] In the United States, several hundred people already die from flooding and extreme heat events every year.



Source: National Climatic Data Center, Billion Dollar U.S. Weather Disasters, at http://www.ncdc.noaa.gov/oa/reports/billionz.html.

Global warming will lead to more extreme precipitation events and flooding. As the atmosphere warms, it is able to hold more water vapor. When a storm occurs, this higher concentration of water vapor leads to rainfall occurring in larger quantities, which can result in flooding. The IPCC has found that "[t]he frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapor."[94] The U.S. Climate Change Science Program has concluded that heavy precipitation events averaged over North America have increased over the past 50 years.[95] In the future, it is very likely that North America will experience more frequent and intense heavy downpours and higher levels of total rainfall in extreme precipitation events.

Flooding and extreme precipitation events cost lives and can cause massive damages to infrastructure, property, and agricultural lands, as was highlighted by the flooding in the Midwestern United States in the summer of 2008. Those floods washed away nearly 2 percent of the nation's corn crop. The American Farm Bureau Federation estimated that crop losses

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[93] See National Climatic Data Center, Billion Dollar U.S. Weather Disasters, at http://www.ncdc.noaa.gov/oa/reports/billionz.html (last visited Oct. 20, 2008).
[94] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 8 (2007).
[95] U.S. Climate Change Science Program, supra note 92, at 4.

would exceed $8 billion across the Midwest, with half of the total occurring in Iowa.[96] An additional $1.5 billion in property damage occurred in Iowa[97] and $1 billion in Indiana.[98]

Increased sea surface temperatures are a critical determining factor in the strength of hurricanes, and some scientists predict that global warming will result in an increase in hurricane and tropical cyclone frequency and intensity. The IPCC has found observational evidence for the increase in intense hurricanes in the North Atlantic since the 1970s, correlated with increasing sea surface temperatures.[99] Some researchers have argued that there is evidence for increased hurricane intensity around the world and emerging evidence for an increase in frequency of hurricanes in the Atlantic.[100] Stronger hurricanes lead to more destructive winds and higher storm surges, increasing the risk to coastal communities in their paths. As sea level rises and storm surges increase, the vulnerability of cities to flooding, and the related impacts, increases significantly.

Severe thunderstorms, hail, tornados, and winter storms may also increase. The current observational record for these smaller scale storms is insufficient to determine whether there are trends correlated to warming temperatures.[101] However, these phenomena are often associated with heavy precipitation events and hurricanes; as the latter storms become more frequent and possibly increase in intensity, then the probability of thunderstorms, hail, and tornadoes should also increase. Warming temperatures may also expand the range over which tornados occur. Over the last few years, tornados have occurred earlier in the year and further north than what is typically thought of as “tornado alley.”[102] Finally, strong cold season storms are also likely to become more frequent, with stronger winds and more extreme wave heights.[103]

Climate change will lead to more frequent and more intense heat waves in the United States and globally.[104] The impacts of heat waves are discussed further in the public health section that follows.

f. Public Health

There is a broad consensus among experts within the worldwide public health community that climate change poses a serious risk to public health. The IPCC’s Fourth Assessment report concluded that climate change’s likely impacts on public health include:

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[96] National Climatic Data Center, Climate of 2008: Midwestern U.S. Flood Overview (updated July 9, 2008), at http://www.ncdc.noaa.gov/oa/climate/research/2008/flood08.html#impacts

[97] Id.

[98] Phillip Fiorini, Purdue researchers to assess damage from Midwestern floods, Lafayette Online, Sept. 29, 2008, at http://www.lafayette-online.com/purdue-news/2008/09/purdue-researchers-assess-flood-impact/.

[99] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 9 (2007).

[100] Testimony of Dr. Judith Curry before the Select Committee on Energy Independence and Global Warming hearing on “Dangerous Climate Change,” April 26, 2007.

[101] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Summary for Policymakers at 9 (2007); U.S. Climate Change Science Program, supra note 92, at 7.

[102] Nicholas Riccardi, “Twisters ‘on a record pace’”, L.A. Times, May 13, 2008, at A12, available at http://articles.latimes.com/2008/may/13/nation/na-tornado13.

[103] U.S. Climate Change Science Program, supra note 92, at 7.

[104] Id. at 4.

- More frequent and more intense heat waves, leading to marked short-term increases in mortality.
- Increased numbers of people suffering from death, disease, and injury from floods, storms, fires and droughts.
- Increased cardio-respiratory morbidity and mortality associated with ground-level ozone pollution.
- Changes in the range of some infectious disease vectors.
- Increased malnutrition and consequent disorders, including those relating to child growth and development.[105]

This assessment included a specific analysis of regional impacts to health, including in the United States.[106] In addition, EPA,[107] the Centers for Disease Control and Prevention (CDC),[108] and NOAA have all concluded climate change poses a serious public health risk. The World Health Organization (WHO) released a quantitative assessment concluding that the effects of climate change may have caused over 150,000 deaths in 2000 and that these impacts are likely to increase in the future.[109] According to the IPCC, climate change contributes to the global burden of disease, premature death and other adverse health impacts.[110]

Heat waves will increase in intensity and frequency in the United States and globally. According to the National Weather Service, heat waves kill on average 170 people per year in the United States, and 253 people died in 2006 alone.[111] According to the CDC, from 1979 to 2003 more people died from heat waves in the United States than from all other natural disasters.[112] The European heat wave of August 2003 is estimated to have killed up to 45,000 people.[113] In France alone, nearly 15,000 people died due to soaring temperatures, which reached as high as 104 °F and remained extreme for two weeks.

There is consensus that heat waves "have become more frequent over most land areas" and there is confidence that climate change will result in the "very likely increase in frequency of

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[105] Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, Summary for Policymakers at 48 (2007).
[106] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability at 617-652 (2007).
[107] Environmental Protection Agency, Climate Change—Health and Environmental Effects, at http://www.epa.gov/climatechange/effects/health.html (last visited Oct. 20, 2008).
[108] Centers for Disease Control and Prevention, CDC Policy on Climate Change and Public Health, at http://www.cdc.gov/climatechange/pubs/Climate_Change_Policy.pdf (last visited Oct. 20, 2008).
[109] World Health Organization, Fact Sheet No. 266, Climate and health (Aug. 2007), at http://www.who.int/globalchange/en/.
[110] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability at 391-431 (2007).
[111] National Weather Service, Natural Hazard Statistics: Weather Fatalities, at http://www.weather.gov/os/hazstats.shtml (last visited Oct. 20, 2008).
[112] Centers for Disease Control and Prevention, Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety, at http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp (last visited Oct. 20, 2008).
[113] European Commission, Directorate General for Health and Consumer Protection, The 2003 European heat wave, at http://ec.europa.eu/health/ph_information/dissemination/unexpected/unexpected_1_en.htm (last visited Oct. 20, 2008).

hot extremes."[114] There is evidence that present day heat waves over Europe and North America "coincide with a specific atmospheric circulation pattern that is intensified by ongoing increases in greenhouse gasses."[115] The intensity, duration and frequency of heat waves will increase in western and southern regions of the United States and in the Mediterranean region.[116] Other areas not currently as susceptible, such as northwest North America, France, Germany, and the Balkans will also experience "increased heat wave severity in the 21st century."[117] With continued warming by 2100, Washington, D.C. will experience the temperatures that Houston does today, Denver will be as warm as Memphis is today, and Anchorage will be as warm as New York City is today.[118] The populations most at risk of dying in a heat wave are the elderly and people in underserved communities, and as growth in the U.S. population over the age of 65 coincides with warmer temperatures, more deaths can be anticipated.

Global warming will exacerbate ground-level ozone pollution, leading to substantial increases in deaths and respiratory illness. Ground-level ozone (O_3), unlike other primary pollutants, is not emitted directly into the atmosphere, but is a secondary pollutant produced by reaction between nitrogen dioxide (NO_2), hydrocarbons, and sunlight. The ozone forming reaction occurs at a higher rate with more intense sunlight and higher temperatures. Thus, as temperatures rise from global warming, ground level ozone is expected to increase. Ozone is a known public health threat that can damage lung tissue causing respiratory illness, and exacerbate pre-existing respiratory conditions. The IPCC predicts increased levels of ozone across the eastern United States, "with the cities most polluted today experiencing the greatest increase in ozone pollution."[119] The increase in temperature in urban areas specifically and increases in ozone can increase rates of cardiovascular and pulmonary illnesses as well as temperature-related morbidity and mortality for children and the elderly.[120] Similar impacts will be felt in urban areas around the globe. By mid-century, ozone related deaths from climate change are predicted to increase by approximately 4.5 percent from the 1990s levels.[121] Even modest exposure to ozone may encourage the development of asthma in children.[122] Recently, an analysis linking CO_2 emissions to mortality revealed that for each increase of 1.8°F caused by

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[114] Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, Summary for Policymakers at 2, 8 (2007).
[115] Gerald A. Meehl & Claudia Tebaldi, More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century, 305 Science 994 (2004).
[116] Id.
[117] Id.
[118] Frank Ackerman & Elizabeth Stanton, Natural Resources Defense Council, The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked at vi (May 2008), available at http://www.nrdc.org/globalwarming/cost/cost.pdf.
[119] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability at 632 (2007).
[120] U.S. Climate Change Science Program, Synthesis and Assessment Product 4.6, Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems at ES-6 (2008).
[121] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability at 632 (2007).
[122] R. K. McConnell et al., Asthma in exercising children exposed to ozone: A cohort study, 359 The Lancet 386 (2002); J.F. Gent et al., Association of low-level ozone and fine particles with respiratory symptoms in children with asthma, 29 J. Am. Med. Assoc. 1859 (2003).

CO_2, the resulting air pollution would lead annually to about a thousand additional deaths and many more cases of respiratory illness and asthma in the United States.[123]

Climate change will lead to changes in geographic distribution of infectious diseases, with potentially serious impacts on public health in the United States and globally. The WHO estimates that climate change was responsible in 2000 for approximately 2.4 percent of worldwide diarrhea, and 6 percent of malaria in some middle-income countries.[124] While in the United States, diarrheal illnesses rarely result in death, the WHO estimates that worldwide there are approximately four billion cases of diarrhea each year, and 2.2 million deaths resulting from diarrheal illnesses. It is one of the leading causes of death among children in the developing world. Given the relationship between elevated temperatures and the incidence of diarrheal diseases if average global temperature increases by a further 1.8° F (1° C), this could result in an additional 320 million cases and 176,000 deaths from diarrheal illnesses annually.[125]

According to EPA, "Climate change may increase the risk of some infectious diseases, particularly those diseases that appear in warm areas and are spread by mosquitoes and other insects."[126] For example, the IPCC has concluded that the global population at risk from vector-borne malaria will increase by between 220 million and 400 million in the next century.[127] Similarly, the IPCC predicts that climate change is likely to increase risk and geographic spread of the West Nile virus—another mosquito-borne disease.[128] West Nile virus was first identified in the United States during the summer of 1999, and has since killed 1112 people.[129] Shifting patterns of temperature may also redistribute ticks that transmit pathogens causing Lyme disease.[130]

g. Forests and Wildfires

The clearing and degradation of tropical forests is a major driver of global climate change. Forests cover about 30 percent of the Earth's land surface and hold almost half of the world's terrestrial carbon.[131] They can act both as a source of carbon emissions to the atmosphere when cut, burned, or otherwise degraded and as a sink when they grow, removing carbon dioxide from the air through photosynthesis. Between 1990 and 2005, carbon in forest biomass decreased in Africa, Asia, and South America primarily from deforestation, but

[123] Mark Jacobson, On the Causal Link Between Carbon Dioxide and Air Pollution Mortality, 35 Geophysical Research Letters L03809 (2008).
[124] World Health Organization, World Health Report 2002: Reducing risks, promoting healthy life (2002).
[125] W. Checkley et al., Effect of El Niño and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children, 355 The Lancet 442 (2000).
[126] Environmental Protection Agency, Climate Change – Health and Environment Effects: Health, at http://www.epa.gov/climatechange/effects/health.html#climate (last visited Oct. 20, 2008).
[127] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability at 409 (Table 8.2) (2007).
[128] Id. at 619.
[129] Center for Disease Control, West Nile Virus Human Case Counts for 1999-2008, available at http://www.cdc.gov/ncidod/dvbid/westnile/surv&control.htm (last visited Oct. 26, 2008).
[130] U.S. Climate Change Science Program, supra note 120, at 2-18.
[131] Richard A. Houghton, "Tropical Deforestation as a source of greenhouse gas emissions," in Tropical Deforestation and Climate Change at 13 (P. Moutinho & S. Schwartzman eds., 2005), available at http://www.edf.org/documents/4930_TropicalDeforestation_and_ClimateChange.pdf.

increased in all other regions as previously cleared land in Europe and North America reverted from agriculture uses to forests.[132]

Since the 1950s, greenhouse gas emissions from land use change, including deforestation and degradation, have been significant, on the order of 20 to 50 percent of fossil fuel emissions.[133] Deforestation and degradation currently account for 20 to 25 percent of global anthropogenic greenhouse gas emissions, roughly equivalent to the total fossil fuel emissions from the United States.[134] These emissions come predominantly from deforestation of tropical rainforests.

Tropical forests play an especially crucial role. Tropical forests encompass a variety of forest types around the equatorial region of the world. Nearly all the nutrient and carbon content of a tropical forest is in the living plants and the decomposing vegetation on the forest floor. Trees in tropical forests hold, on average, about 50 percent more carbon per acre than trees outside of the tropics.[135] When forests are destroyed by fire, much of the carbon they store returns to the atmosphere, enhancing global warming. When a forest is cleared for crop or grazing land, the soils can become a large source of global warming emissions, depending on how farmers and ranchers manage the land. In places such as Indonesia, the soils of swampy lowland forests are rich in partially decayed organic matter, known as peat. During extended droughts, such as during El Niño events, the forests and the peat become flammable, especially if they have been degraded by logging or accidental fire. When they burn, they release huge volumes of CO_2 and other greenhouse gases.

Rainforests also play another important part in the climate system—generating rainfall. Up to 30 percent of the rain that falls in tropical forests is generated by the forest itself.[136] Water evaporates from the soil and vegetation, condenses into clouds, and falls again as rain in a perpetual self-watering cycle. Recent studies have also indicated that rainforests play an important role in rainfall well beyond the borders of the forest. The evaporation and rainfall in tropical forests helps cool the Earth's surface. In many computer models of future climate, replacing tropical forests with pasture and croplands creates a drier, hotter climate in the tropics.[137] Some models also predict that tropical deforestation will disrupt rainfall patterns far outside the tropics, including in China, northern Mexico, and the south-central United States.[138]

In contrast to the emissions from deforestation in the tropical regions, forests in North America have been growing and acting as sinks for carbon in the last few decades. Growing vegetation in North America removed the equivalent of approximately 30 percent of the fossil

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[132] United Nations Food and Agriculture Organization, Forest Resource Assessment 2005: Key Findings, at http://www.fao.org/forestry/32250/en/.
[133] Richard A. Houghton, "Carbon Flux to the Atmosphere from Land-Use Changes: 1850-2005," in TRENDS: A Compendium of Data on Global Change (2008), available at http://cdiac.ornl.gov/trends/trends.htm.
[134] Houghton, supra note 131.
[135] Id.
[136] NASA, Earth Observatory, Tropical Deforestation: Climate Impacts, at http://earthobservatory.nasa.gov/Library/Deforestation/deforestation_update2.html (last visited Oct. 20, 2008).
[137] Id.
[138] David Werth & Ron Avissar, The local and global effects of Southeast Asian deforestation, 32 Geophysical Research Letters L20702 (2005).

fuel emissions produced from North America, and 50 percent of this sink was due to forest growth in the United States and Canada.[139]

Forests are vulnerable to climate change. The climate strongly influences forest productivity, compositions, and disturbances such as forest fire, insect outbreaks and droughts. The impacts of climate change on many aspects of forest ecology are not well understood. In areas with adequate water availability, warmer temperatures have likely increased forest growth and will continue to do so. Increasing CO_2 concentrations will likely increase photosynthesis but will only increase wood production in young forests where adequate nutrients and water are available. The impact on carbon storage in forest soils from rising temperatures and CO_2 remains unclear.[140] Increasing global temperatures are already affecting tropical forests, with droughts provoking forest fires in Amazonia and Indonesia. The combination of degraded forests from logging and agriculture with more extreme climate events suggests that forest fires are likely to play an even more important role in the future of tropical forests and their contribution of global warming pollution.[141]

There is growing scientific consensus that climate change is already increasing the frequency and intensity of wildfires in the United States, and this trend is likely to worsen in the coming decades. Scientists have concluded that from 1986 to 2006 longer, warmer summers have resulted in a four-fold increase in major wildfires and a six-fold increase in the area of forest burned, compared to the period from 1970-1986.[142] Similar results were published on wildfire activity in Canada from 1920-1999.[143] In addition to more intense and more frequent fires, the length of the fire season and the burn duration of large fires have also increased. Models of future climate have consistently concluded that the areas burned will increase in the coming years and decades. For example, wildfire burn areas in Canada are expected to increase by 74 to 118 percent in the next century,[144] and similar increases are predicted for the western United States. With more wildfires come more greenhouse gas emissions. Although estimates vary widely, wildfires may represent up to 10 percent of total U.S. greenhouse gas emissions.[145]

Scientists have identified several mechanisms through which climate change is lengthening the fire season and increasing the frequency and intensity of wildfires. One extremely important factor is the impact of global warming on snowmelt. Warmer temperatures cause an earlier snowmelt which can lead to an earlier and longer dry season.[146] This provides

[139] U.S. Climate Change Science Program, Synthesis and Assessment Product 2.2, The First State of the Carbon Cycle Report: North American Carbon Budget and Implications for the Global Carbon Cycle at vii (2007).
[140] U.S. Climate Change Science Program, Synthesis and Assessment Product 4.3, The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States at 7 (2008).
[141] Ane Alencar et al., "Carbon emissions associated with forest fires in Brazil," in Tropical Deforestation and Climate Change at 23 (P. Moutinho & S. Schwartzman eds. 2005), available at http://www.edf.org/documents/4930_TropicalDeforestation_and_ClimateChange.pdf.
[142] Anthony L. Westerling et al., Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity 313 Science 940 (2006).
[143] N. P. Gillett et al., Detecting the effect of climate change on Canadian forest fires, 31 Geophysical Research Letters L18211 (2004).
[144] M. D. Flannigan et al., Future Area Burned in Canada, 72 Climatic Change 1 (2005).
[145] Guido R. Van der Werf et al, Continental-Scale Partitioning of Fire Emissions During the 1997 to 2001 El Niño/La Niña Period, 303 Science 73 (2004).
[146] Westerling et al., supra note 142.

more opportunities for large fires by creating a longer period in which ignitions can occur and by increasing the drying of soils and vegetation making them more prone to fire. This has also expanded the range in which serious wildfires occur to higher elevations in mountainous regions.

Global warming is also exacerbating insect infestations (most notably bark beetles), which in turn make forests more susceptible to wildfire. Drought stress makes trees and vegetation more susceptible to attack by insects, and warmer winter temperatures allow a higher number of insects to survive and increase their populations. Warmer temperatures can also increase reproductive rates of insects, resulting in two generations in a single year. Finally, warmer temperatures allow insects to invade areas previously outside their natural range, as has happened with the mountain pine beetle in the western United States. Research has clearly demonstrated the link between warmer temperatures and drought on extensive insect outbreaks in southwestern forests and Alaska.[147]

h. Wildlife and Endangered Species

If climate change goes unchecked, it could lead to the extinction of up to 40 percent of the world's species by the latter half of this century. The International Union for the Conservation of Nature's 2008 annual report lists 38 percent of catalogued species as *already* threatened with extinction—including nearly 25 percent of all mammals.[148] According to the IPCC's Fourth Assessment Report, "the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances, (e.g. flooding, drought, wildfire, insects, ocean acidification), and other global change drivers."[149]

According to the IPCC: "Approximately 20-30% of plant and animal species assessed so far are likely to be at an increased risk of extinction if increases in global average temperature exceed 1.5 – 2.5º C [2.7 – 4.5 º F]."[150] Additional warming could lead to "significant extinctions around the globe," including the loss of more than 40 percent of all plant and animal species.[151] A 2004 study suggests that 15 to 37 percent of terrestrial species may be "committed to extinction" by 2050 due to climate change.[152]

The species most vulnerable to climate change have a specialized habitat, a narrow environmental tolerance that is likely to be exceeded due to climate change, and dependence on specific environmental triggers or interactions that are likely to be disrupted by climate change. The IPCC identifies "coral reefs, the sea-ice biome, and other high-latitude ecosystems (e.g. boreal forests), mountain ecosystems and mediterranean-climate ecosystems" as the systems

[147] U.S. Climate Change Science Program, supra note 140, at 81-82.
[148] International Union for the Conservation of Nature, Press Release, IUCN Red list Reveals world's mammals in crisis, Oct. 6, 2008, at http://www.iucn.org/news_events/events/congress/index.cfm?uNewsID=1695.
[149] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability, Summary for Policy Makers at 11 (2007).
[150] Id.
[151] Id.; see also Testimony of Dr. Camille Parmesan before the Select Committee on Energy Independence and Global Warming, hearing on "Dangerous Climate Change," April 26, 2007.
[152] C.D. Thomas et al., Extinction risk from climate change, 427 Nature 145 (2004).

most vulnerable to the impacts of climate change.[153] One tragic and iconic example is the polar bear. Polar bear populations are expected to decline by 30 percent in the next 35 to 50 years—and to disappear from Alaska altogether—due to disappearing habitat resulting from global warming.[154]

4. National Security Impacts

The current and projected impacts of global warming have serious national security consequences for the United States and our allies, in many cases acting as "threat multipliers." The security issues raised by global warming have received increasing scrutiny in the last few years both in Congress and in international venues, including a debate at the UN Security Council in April 2007. The first-ever U.S. government analysis of the security threats posed by global climate change was issued in June 2008 as the National Intelligence Assessment (NIA), *National Security Implications of Global Climate Change to 2030.* The 2008 NIA was the result of a process initiated, in part, by Chairman Markey's April 2007 introduction of H.R. 1961, the "Climate Change Security Oversight Act," which required the U.S. Intelligence Community to analyze the national security implications of global climate change. In addition, U.S. and European military and security policy analysts have issued a number of public reports exploring the security consequences of global warming and potential responses. All of these reports emphasize concerns over a few key security impacts, including migration, water scarcity, infrastructure at risk from extreme weather, and new economic routes and access to new energy resources. In most cases, global warming is not creating "new" security threats, but rather is acting as a "threat multiplier."[155]

Numerous impacts of global warming could ultimately increase both the temporary and permanent migration of people inside and across existing national borders—increasing risks of geopolitical instability. Nations dealing with an influx may have neither the resources nor the desire to support climate migrants.[156] As in the past, movement of people into new territory can increase the likelihood of conflict and the potential need for intervention from U.S. and allied military forces.

Rising sea levels threaten low-lying island nations and populous coastal areas. Even if not totally inundated, rising sea levels can render these areas uninhabitable due to sea water incursion into fresh water resources and increased exposure to storms. For example, the risk of coastal flooding in Bangladesh is growing and could force 30 million people to search for higher ground in a country already known for political violence. India is already building a wall along

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[153] Intergovernmental Panel on Climate Change, Fourth Assessment Report, Working Group II Report "Impacts, Adaptation and Vulnerability", Chapter 4, "Ecosystems, their Properties, Goods and Services," P. 214.

[154] See, e.g., Blaine Harden, "Experts Predict Polar Bear Decline," Washington Post, Thursday, July 7, 2005; Page A03, available at http://www.washingtonpost.com/wp-dyn/content/article/2005/07/06/AR2005070601899.html.

[155] Testimony of Gen. Gordon Sullivan (retired), before the Select Committee, hearing on "Geopolitical Implications of Rising Oil Dependence and Global Warming," April 18, 2008, at 2.

[156] Testimony of Thomas Fingar before the Select Committee on Energy Independence and Global Warming and the House Intelligence Community Management Committee, Joint Hearing on "The National Security Implications of Climate Change," June 25, 2008, at 14.

its border with Bangladesh.[157] The densely-populated and oil-rich Niger Delta is already the scene of conflict over the sharing of oil revenues. Land loss and increased risk of storms will exacerbate these tensions as well as the challenge of maintaining the existing oil infrastructure. Other important economic and agricultural coastal areas, like Egypt's Nile Delta and China's southeast coast, are also threatened from rising sea-levels and severe storms. Similar impacts in Central America and the Caribbean could add pressure to pre-existing migration patterns from those areas to the United States.

Increased water scarcity due to climate change exacerbates the risk of conflict over water resources. As discussed above, changing precipitation patterns and increasing temperatures are likely to increase the risk of water scarcity and degraded water quality in many areas. Security experts have long been concerned about the prospects for conflict over water resources in many regions of the developing world, which will be exacerbated by climate change. Water scarcity will also increase the pressure on groups to migrate to areas perceived to have more resources.

Rapidly melting glaciers in the Andes and the Tibetan Plateau threaten the water supply for some of the most populous countries in the world. The major rivers of India and China originate in the Tibetan Plateau glaciers and are an important component of their summer flows. Dwindling water resources or changes in the flow regime could heighten existing tensions within the countries and between the two and their neighbors. For transnational watersheds, even projects designed to adapt to climate change, like new reservoirs, will have to be managed in a way to allow equitable water distribution and governance systems that minimize the possibility of their use for strategic leverage.

Climate change is already contributing to current conflicts. For example, scientists have traced declines in rainfall in the Darfur region to disruption in the African monsoon due to warming sea surface temperatures.[158] As their lands failed, tension between African farmers and Arab herders increased and became a contributing factor to the genocide that has occurred there. In the Select Committee's first hearing, General Gordon Sullivan, the Army Chief of Staff during U.S. operations in Somalia in 1993, testified that drought and food scarcity allowed the Somali warlords to use incoming food aid as leverage over the population, necessitating the intervention of U.S. military forces.[159] He cautioned that the U.S. military will have to prepare to deal with more situations of this kind due to the impacts of global warming.

Global warming will directly impact U.S. military infrastructure at risk of damage from extreme weather and melting permafrost. Infrastructure upgrades, repair and replacement to increase resilience to global warming impacts, and rebuilding after extreme weather events will be costly. For example, the East and Gulf Coasts will be at increased risk from storm surge, and U.S. naval shipbuilding facilities have already been damaged by Hurricanes Katrina and Rita. Many active U.S. coastal military installations around the world are at a significant and

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[157] George Black, "The Gathering Storm", OnEarth, Summer 2008, available at http://www.onearth.org/article/the-gathering-storm?page=all.
[158] Alessandra Giannini et al., A Global Perspective on African Climate, 90 Climatic Change 359 (2008).
[159] Transcript of Select Committee hearing on "Geopolitical Implications of Rising Oil Dependence and Global Warming," April 18, 2007, at 61.

increasing risk of damage from storm surges and associated flooding and damages.[160] For example, the U.S. airbase at Diego Garcia in the Indian Ocean, which is critical to operations in Iraq and the surrounding region, is an average of four feet above sea level and is threatened by sea level rise and storm surges.[161]

Global warming impacts also threaten energy supplies, as demonstrated in the devastating hurricane season in 2005. The paths of Hurricane Katrina and Hurricane Rita passed through three-quarters of the oil platforms and two-thirds of the natural gas platforms in the Gulf of Mexico and a major concentration of refining capacity on land. Together they destroyed over a hundred offshore platforms and damaged 183 pipelines. Over 1.5 million barrels of oil and 10 billion cubic feet of natural gas production per day was taken off-line for both hurricanes. Katrina also significantly affected electricity supply with 2.7 million customers and other critical infrastructure losing power.[162] In Alaska, melting permafrost and fewer days with an adequate amount of snow for exploration purposes could hinder oil production and transport of oil from fields on the North Slope.

Finally, accelerating melting of Arctic sea ice is impacting the United States' strategic interests in the region. Russia has moved to stake claim to over 460,000 square miles of territory, including areas with potential oil and natural gas resources.[163] With the opening of the Northwest Passage for the first time in recorded history, the Prime Minister of Canada announced his intention to increase his country's military presence in the Arctic.[164] Other circumpolar nations, including the United States, have begun to examine their potential claims on Arctic territory and identify necessary preparations for increased maritime traffic in the area. Given that the 2008 melt was almost as great as 2007, this issue will remain one of immediate concern. As new economic routes and energy resources become available, the United States will have to adapt and perhaps redeploy resources to deal with the changing physical and economic landscape.

5. The Economic Costs of Climate Change

Climate change impacts of the types described above will have staggering economic impacts in the United States and the rest of the world in the coming decades. Measuring these impacts in dollars is a unique challenge, requiring analysis of local and global impacts, long time horizons, quantification of risk and uncertainty, and capturing the possibility of tipping points that induce major, catastrophic change. While the variables are many and complex, estimates of potential economic impacts are massive. The Stern Review—one of the most in-depth and

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[160] Testimony of Thomas Fingar before the Select Committee on Energy Independence and Global Warming and the House Intelligence Community Management Committee, Joint Hearing on "The National Security Implications of Global Warming," June 25, 2008, at 15.

[161] The CNA Corporation, National Security and the Threat of Climate Change at 37 (2007), available at http://securityandclimate.cna.org/report/National%20Security%20and%20the%20Threat%20of%20Climate%20Change.pdf.

[162] Testimony of Secretary of Energy Samuel Bodman, before Senate Energy and Natural Resources Committee, Oct. 27, 2005.

[163] Scott Borgerson, "Arctic Meltdown: The Economic and Security Implications of Global Warming," Foreign Affairs, March/April 2008.

[164] Id.

respected economic impact analyses on climate change conducted thus far—used formal economic models to estimate that unabated climate change will cost at least 5 percent of global gross domestic product (GDP) each year, now and forever.[165] This amounts to around $3.3 trillion per year at the current value of the global economy.[166] If a wider range of risks and impacts is taken into account, the damages could rise to 20 percent of GDP or more annually over the next two centuries.

In the United States, the economic impacts of climate change will be felt throughout the country and within all sectors of the economy. The greatest economic impacts will stem from stress to fresh water supply networks, changes to the agricultural sector, threats to coastal infrastructure from storms and sea level rise, effects on energy supply and demand, increased risk to human health, and more frequent and extensive forest fires.[167] Tourism and other weather-dependent industries will continue to be hit especially hard as well. Modeling results from a recent Tufts University and Natural Resources Defense Council study show that if present trends continue, the total cost of four global warming impacts alone—hurricane damage, real estate losses, energy costs, and water costs—will cost the United States nearly $1.9 trillion annually by 2100 (in constant 2008 dollars), or 1.8 percent of U.S. GDP. Factoring in a wider range of harms such as health impacts and wildlife damages, these costs could reach 3.6 percent of GDP annually in the United States by 2100.[168]

6. Impacts on Vulnerable Communities

While the ramifications of climate change will be felt in every community, the greatest impacts will be borne by those already most economically vulnerable and who have contributed least to climate change. This makes climate change not only an issue of the environment, but also one of justice and human rights. Left unabated, climate change will exacerbate deep inequalities within countries and between them. The human face of the climate story is one in which communities least responsible for the climate crisis are the first pushed to the edge of survival, and then ultimately over the edge if they are unable to adapt to climate changes. This was underscored at the Select Committee's October 18, 2007 hearing entitled "Energy and Global Warming Solutions for Vulnerable Communities," at which it heard from representatives of communities, both here in the United States and overseas, particularly vulnerable to the impacts of climate change.

Climate change will have devastating impacts on the developing world, reversing gains in poverty reduction, food security and nutrition, health, and basic services and putting millions of lives at risk. Poor communities are especially vulnerable because they have less capacity to adapt to changes in climate and are more dependent on climate-sensitive resources such as local water and food supplies.[169] Increased exposure to drought and water scarcity, more intense storms, floods, and other environmental pressures will hold back the efforts of the

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[165] Stern Review: The Economics of Climate Change (2006).
[166] CIA World Fact Book. available at https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html#Econ.
[167] Ruth et al., supra note 50, at 10-15.
[168] Ackerman & Stanton, supra note 118.
[169] Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation and Vulnerability, Summary for Policymakers at 7, 22 (2007).

world's poor to build a better life for themselves and their children. Climate change is likely to reverse many of the recent gains in poverty alleviation around the world, adding to the total of 2.6 billion people now living on $2 a day or less. By the end of the century, an additional 145-220 million people in South Asia and Sub Saharan Africa could fall below the $2 per day poverty level as a result of climate change impacts.[170] According to the Stern Review, unchecked climate change could turn 200 million people into refugees this century, precipitating the largest migration in history as entire countries and regions succumb to drought or flood. In addition, increased frequency and severity of droughts and floods will affect crop productivity and food production, disproportionately affecting the 850 million people already experiencing food scarcity.[171]

This prospective devastation is more easily grasped through actual experiences. In testimony before the Select Committee, Amjad Abdulla, representing the Republic of the Maldives, explained how his island country is dealing with both the long and short term challenges of global warming. Rising ocean temperatures, coupled with increasing acidification from CO_2 dissolved in sea water, threaten what are considered to be some of the most beautiful and productive coral reefs in the world. These reefs are the foundation of the Maldives' economy, driving a productive fishing industry and attracting large numbers of tourists. In the long term, rising sea-levels represent a truly existential threat. With the highest point on the islands little more than six feet above sea level, all 1,190 islands making up the Maldives could eventually be rendered uninhabitable.

Poor communities and communities of color within the United States are vulnerable to climate change impacts as well, and suffer disproportionately from illnesses due to the social determinants of health. According to the U.S. Census Bureau, around 39 million citizens in the United States are impoverished, over 50 percent living in urban settings. As the devastation of Hurricane Katrina in 2005 demonstrated, poorer communities are especially vulnerable to extreme weather events. Poorer communities and communities of color are also more vulnerable to public health impacts of climate change. As explained above, the frequency of respiratory diseases like asthma is directly related to high concentrations of ground level ozone, which are known to increase as a result of global warming and often accumulate in unsafe levels in urban environments. Today, over 70 percent of African Americans live in counties in violation of federal air pollution standards,[172] and 78 percent of African Americans and Latinos live within 30 miles of a coal-fired power plant, compared to 56 percent of non-Hispanic whites.[173] In all of the largest 44 major metropolitan areas in the United States, African Americans are more likely than whites to be exposed to higher air toxic concentrations. As a result, African Americans are nearly three times as likely to be hospitalized or killed by asthma.[174] In Harlem, New York, 25 percent of children now have asthma.[175] Latinos—66 percent of whom live in areas that violate

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[170] Stern Review, supra note 165, at 55.
[171] Id. at 59.
[172] Congressional Black Caucus Foundation, Climate Change and Extreme Weather Events: An Unequal Burden on African Americans (Sept. 2005), available at http://www.cbcfinc.org/pdf/climatechange_issuebrf.pdf.
[173] Environmental Justice and Climate Change Initiative, Climate of Change: African Americans, Global Warming, and a Just Climate Policy for the U.S. at 12 (2008), available at http://www.ejcc.org/climateofchange.pdf.
[174] Id. at 2.
[175] Richard Perez-Pena, Study Finds Asthma in 25% of Children in Central Harlem, New York Times, April 19, 2003.

federal air quality standards—face disproportionate health impacts as well.[176] These impacts are exacerbated by their disproportionate lack of health insurance and lower utilization of health services compared with both non-Hispanic whites and African Americans.

The WHO has found that negative public health impacts of climate change, discussed above, will likely disproportionately impact communities that are already vulnerable. In 2007, more than 46 million Americans lacked health insurance. Minorities are more likely to be uninsured regardless of income level and often experience greater challenges in accessing health care services. Consequently, they are more likely to suffer as a result of public health impacts related to climate change.

Vulnerable Alaskans are already dealing with the harsh reality of global warming. According to the U.S. Army Corps of Engineers, at least three Alaskan villages—Shishmaref, Kivalina, and Newtok—will be lost to coastal erosion due to rising sea levels in the next 8 to 13 years.[177] With flooding and erosion currently affecting 184 out of 213, or 86 percent, of Alaska Native villages to some extent, [178] the number of villages needing major assistance is sure to swell over the next century. The cost of saving these villages through either man-made erosion protection or total community relocation could be up to $200 million or more per village.[179] As devastating as it may be to watch a town fall in to the sea, the more destructive and irreplaceable transformation occurring within these native communities is to cultures and traditional ways of life. As Mike Williams, Vice-Chairman of the Alaska Inter-Tribal Council, eloquently testified before the Select Committee:

> "Global warming is undermining the social identity and cultural survival of Alaska Natives and American Indians. As we watch our ice melt, our forests burn, our villages sink, our sea level rise, our temperatures increase, our oceans acidify, and our animals become diseased and dislocated, we recognize that our health and our traditional ways of life are at risk. Our elders, in particular, are deeply concerned about what they are witnessing. In Alaska, unpredictable weather and ice conditions make travel and time-honored subsistence practices hazardous, endangering our lives."[180]

[176] Adrianna Quintero-Somaini et al., Natural Resources Defense Council, Hidden Danger: Environmental Health Threats in the Latino Community at vii, 14 (2004), available at http://www.nrdc.org/health/effects/latino/english/latino_en.pdf.
[177] U.S. Army Corps of Engineers, Alaska Village Erosion Technical Assistance Program (April 2006), available at: http://housemajority.org/coms/cli/AVETA_Report.pdf
[178] Government Accountability Office. Alaska Native Villages, Report No. GAO-04-895T (June 29, 2004), available at: http://www.gao.gov/new.items/d04895t.pdf.
[179] U.S. Army Corps of Engineers, supra note 177.
[180] Testimony of Mike Williams before the Select Committee on Energy Independence and Global Warming, hearing on "Energy and Global Warming Solutions for Vulnerable Communities," October 18, 2007.

B. THE ENERGY CRISIS

Even as the impending climate crisis looms before us, the United States is already facing a deepening energy crisis. The most critical aspect of that crisis is our growing dependence on foreign oil, coupled with the skyrocketing prices of oil and gasoline. But in a range of other key areas, including natural gas and electricity generation and transmission, the United States is facing challenges arising from growing demand, limits on supply, and rising global prices. At the same time, we find ourselves on the cusp of an unprecedented wave of investment in infrastructure and technology, which will benefit those workers and companies positioned to answer the challenge. Between now and 2030, over $20 trillion will be invested in energy infrastructure worldwide, and an estimated $1.5 trillion will be invested in the U.S. power sector alone. This places us at a critical decision point in the development of the U.S. and global energy economies.

1. The Oil Challenge

The single greatest energy security challenge facing the United States in the 21st century is our growing dependence on foreign oil. The United States imported 4.9 billion barrels oil in 2007, or 58.2 percent of its total oil consumption. This import figure is up from 52.9 percent of total consumption in 2000 and 42.2 percent in 1990. The dramatic rise in oil prices over the past several years—driven primarily by rising global demand—has highlighted the growing urgency of this challenge. At the same time, combustion of oil in the United States accounts for nearly a third of our greenhouse gas emissions—more than the total emissions of the Russian Federation (which ranks third in the world in emissions).[181]

Oil and gasoline prices have skyrocketed over the past several years. The price of oil has risen from $18 per barrel in January 2002, to $147 per barrel in July of 2008, an increase of over 700 percent.[182] Prices doubled in just 12 months between July 2007 and July 2008, before declining to under $80 per barrel by October 2008 in the face of an expanding global financial crisis.[183] Similarly, gasoline prices soared from under $1.50 per gallon in January 2001 to over $4.11 in July 2008, before declining to under $3.00 in October 2008.[184]

These price hikes have had a crippling impact on American consumers. Each $1 per gallon increase in the average cost of gasoline adds nearly $600 to an average American's annual transportation fuel bill.[185] For the average American worker, who makes $30,000 a year, $3.75

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[181] For U.S. petroleum-related emissions, see Energy Information Administration, International Energy Annual 2005, Table H.2co2, "Carbon Dioxide Emissions from the Consumption of Petroleum, 1980-2005," available at http://www.eia.doe.gov/pub/international/iealf/tableh2co2.xls. For total greenhouse gas emissions by country, see UNFCCC, Subsidiary Body for Implementation, National greenhouse gas inventory data for the period 1990–2005, at 17 (Table 4) (Oct. 27, 2007), available at http://unfccc.int/resource/docs/2007/sbi/eng/30.pdf.

[182] Energy Information Administration, Daily Cushing, OK WTI Spot Price FOB (spot prices for Cushing, OK West Texas Intermediate crude oil, the benchmark price for the United States), available at http://tonto.eia.doe.gov/dnav/pet/hist/rwtcd.htm.

[183] Id.

[184] Energy Information Administration, Weekly U.S. Regular All Formulations Retail Gasoline Prices, available at http://tonto.eia.doe.gov/dnav/pet/hist/mg_rt_usw.htm.

[185] This is based on EPA estimates of fuel economy and miles driven of an average U.S. passenger vehicle. See

per gallon gasoline consumes about 8 percent of that person's total pre-tax income.[186] Witnesses at the Select Committee's May 9, 2007 hearing on the "Economics of Dependence on Foreign Oil – Rising Gasoline Prices" testified that, even as of May of 2007 (with gasoline prices at just above $3.00 per gallon), American consumers, businesses, and local governments were experiencing severe impacts—including school districts eliminating school bus service or charging parents for such service, and farmers and small businesses facing substantial losses due to rising fuel prices. At the Select Committee's September 25, 2008 hearing on "The Future of LIHEAP Funding: Will Families Get the Cold Shoulder this Winter?," discussed at greater length below, the Select Committee learned that the 8 million American households that rely on heating oil to warm their homes should expect to pay an average $2,524 in heating costs during the 2009-2010 winter, an increase of 30 percent over the previous winter.

As consumers suffer, oil company profits soar. This was underscored by the Select Committee's April 2008 hearing entitled "Drilling for Answers: Oil Company Profits, Runaway Prices, and the Pursuit of Alternatives," at which top executives from the five largest independent oil companies testified. In 2002, these five companies—ExxonMobil, ConocoPhillips, Shell, BP, and Chevron—had a combined net income of over $28 billion. By 2007, these same companies recorded yearly profits of over $123 billion. In 2008, they are projected to make over $150 billion in profits. Average CEO compensation at the five oil majors is over $23 million per year.

Meanwhile, the major oil companies fail to invest in either new supplies or oil alternatives on the scale needed. Instead of favoring greater exploration or alternative energy investments, the oil majors have increased stock buybacks from $10 billion in 2003 to $60 billion in 2006.[187] As the Select Committee learned on June 11, 2008 in a hearing entitled "The Future of Oil," the exploration spending of the five largest oil companies was flat or decreased between 1998 and 2006. Despite professing a strong commitment to development of renewable energy sources, the largest U.S. oil company—ExxonMobil, with 2007 profits of over $40 billion—revealed at a Select Committee hearing that it invests only $10 million annually in renewable energy research and projects, or less than three hundredths of one percent of ExxonMobil's annual profits. The other four companies estimated their investments in renewable energy at $100-200 million per year over the past five years. As the Select Committee heard at a September 10, 2008 hearing entitled, "Investing in the Future: R&D Needs to Meet America's Energy and Climate Challenge," research and development (R&D) investments by the major oil companies is miniscule compared to other sectors. While companies in sectors like biotech, information technology, and semiconductors routinely invest 13 to 18 percent of revenues in R&D, the major oil companies invest only 0.002 percent.

Environmental Protection Agency, Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle, Fact Sheet EPA420-F-05-004 (Feb. 2005), available at http://www.epa.gov/oms/climate/420f05004.htm.

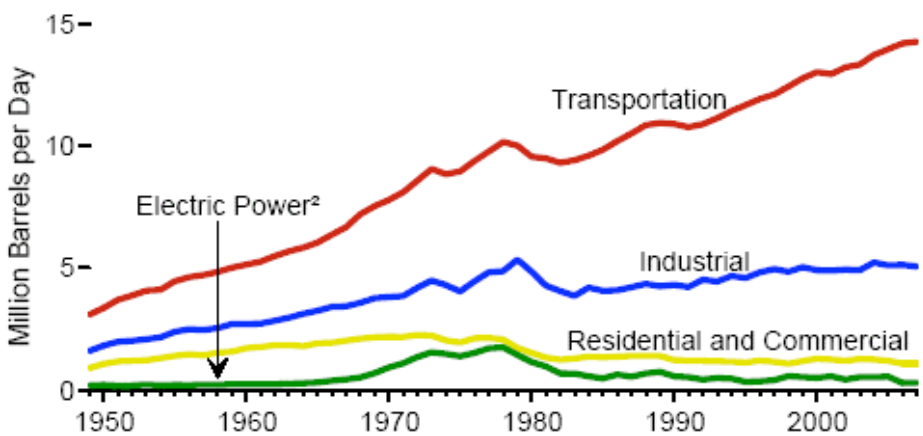
[186] According to the Department of Transportation, U.S. cars, vans, pickups, and SUVs in 2005 traveled an average of 11,856 miles and used 594 gallons of gasoline over the course of the year. U.S. Department of Transportation, Federal Highway Administration, Annual Vehicle Distance Traveled in Kilometers and Related Data – 2005, By Highway Category and Vehicle Type (Table VM-1M) (Nov. 2006), available at http://www.fhwa.dot.gov/policy/ohim/hs05/pdf/vm1m.pdf. Based on those figures, with gasoline prices at $3.75 per gallon, the average consumer would spend $2,227.50.

[187] See Select Committee Staff Report, "Big Oil: Where Have All the Profits Gone?" (May 21, 2008), available at http://globalwarming.house.gov/tools/2q08materials/files/0045.pdf.

Although excessive speculation and a weak U.S. dollar undoubtedly played a role in the recent run-up in oil prices, experts forecast sustained high prices for the foreseeable future—largely due to limited supply and dramatically increasing global demand, especially in China, India, and the Middle East. Many experts believe that market fundamentals indicate that the oil market has entered a period of sustained high prices.[188] The world's oil spigots are close to fully open, and spare production capacity has nearly disappeared around the world. By 2030, global demand for oil is expected to expand by 30-38 percent above current levels of 84 million barrels per day (mbd).[189] Most of the increase in demand is anticipated to come from China, India, and the Middle East. Demand from China alone grew 5.1 percent per year between 1980 and 2004 and is expected to continue to grow rapidly.[190] In the United States, absent significant changes in driving habits or in vehicle fuel efficiency beyond what is already required by EISA, demand for oil is expected to grow from 20.7 mbd today to 22.8 mbd in 2030—an 11 percent increase.[191]

The oil crisis is basically a transportation challenge. The transportation sector accounts for approximately 69 percent of U.S. oil consumption, and motor vehicles alone account for roughly 59 percent of consumption.[192] The U.S. transportation system is over 95 percent dependent on oil as a fuel source.

U.S. Petroleum Consumption by Sector[1]



[1]Petroleum products supplied is used as an approximation for consumption.
[2]Through 1988, electric utilities only; after 1988, includes independent power producers.

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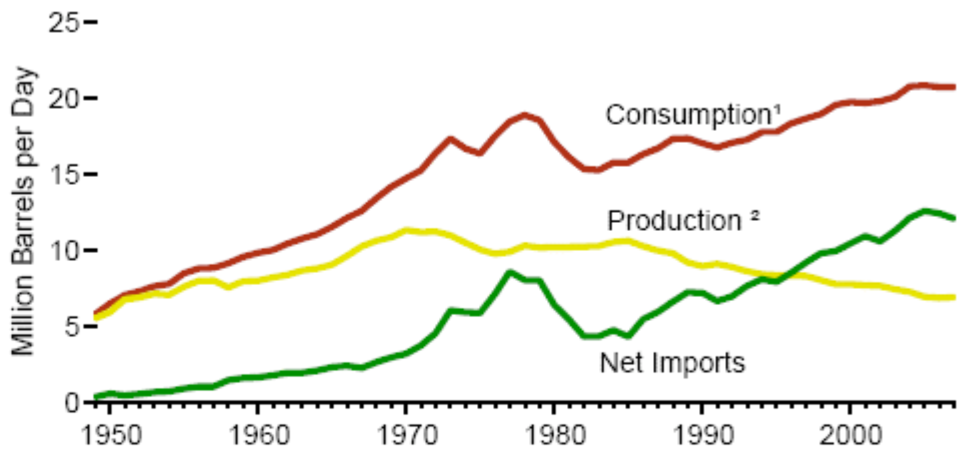
[188] See, e.g., Testimony of Adam Sieminski and Testimony of Amy Myers Jaffee, before the Select Committee on Energy Independence and Global Warming, hearing on "The Future of Oil" (June 11, 2008).
[189] International Energy Agency, World Energy Outlook 2006 at 86 (2006).
[190] Id. at 87
[191] Energy Information Administration, Annual Energy Outlook 2008 at 81 (2008) [hereinafter "EIA AEO 2008"].
[192] Energy Information Administration, Annual Energy Review 2007, Tables 5.11 and 5.13c (June 2008). The industrial sector accounts for approximately 24.4 percent, the residential and commercial sectors approximately 1.6 percent, and the electric power sector approximately 1.4 percent. *Id.* at Tables 5.11, 5.13a, 5.13b, 5.13c, and 5.13d.

Source: Energy Information Administration, Energy Perspectives (2008) (Figure 18), available at http://www.eia.doe.gov/emeu/aer/ep/ep_frame.html.

The United States is increasingly dependent on foreign sources of oil—imposing a massive drain on the U.S. economy. The United States accounts for 25 percent of global oil consumption but accounts for less than 10 percent of global production and has around 2 percent of proven oil reserves. Meanwhile, over the past three decades, we have seen a dramatic increase in the United States' reliance on imported oil to satisfy its growing demand. Net imports have grown from 21 percent in 1970, to 52.9 percent in 2000, and to over 58 percent today.[193] Oil imports cost the United States a staggering $319 billion in 2007, over 45 percent of our total trade deficit—up from less than 24 percent of the trade deficit in 2002.[194] Dr. David L. Greene of the Oak Ridge National Laboratory estimates that the full cost of dependence on foreign oil to the U.S. economy is much higher—$750 billion in 2008, including a loss of potential GDP of $352 billion (about 2 percent of total GDP).[195]

U.S. Crude Oil Consumption, Production, and Net Imports



[1]Petroleum products supplied used as an approximation for consumption.
[2]Crude oil and natural gas plant liquids production.

Source: Energy Information Administration, Energy Perspectives (2008) (Figure 14), available at http://www.eia.doe.gov/emeu/aer/ep/ep_frame.html.

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[193] Energy Information Administration, Annual Energy Review 2007, Petroleum Net Imports by Country of Origin, Table 5.7 (June 2008).

[194] For U.S. trade deficit numbers, see Bureau of Economic Analysis, "U.S. International Trade in Goods and Services – Exports, Imports, and Balances," available at http://www.bea.gov/newsreleases/international/trade/trad_time_series.xls. For U.S. oil import expenditures, see U.S. Census Bureau, FT 900: U.S. International Trade in Goods and Services, Exhibit 17 (Imports of Energy-Related Petroleum Products, Including Crude Oil) (July 2008), available at http://www.census.gov/foreign-trade/Press-Release/current_press_release/exh17.pdf, and FT 900: U.S. International Trade in Goods and Services, Exhibit 17 (Imports of Energy-Related Petroleum Products, Including Crude Oil) (July 2003), available at http://www.census.gov/foreign-trade/Press-Release/2003pr/07/exh17.pdf.

[195] David L. Greene, Oak Ridge National Laboratory, "Costs of Oil Dependence Update 2008: Summary" (Aug. 8, 2008).

This growing dependence on foreign oil has dire implications for U.S. national security and economic stability. Dependence on imported oil makes the United States increasingly vulnerable to foreign governments' manipulation of supply and prices, as well as to potential disruptions in global supply. OPEC countries control 76 percent of estimated global oil reserves and account for 38 percent of global production.[196] Moreover, investor-owned companies control only about 6 percent of the world's known oil reserves. By contrast, government-owned and operated companies in oil-producing countries, such as Saudi Aramco in Saudi Arabia or the National Iranian Oil Company in Iran, control most of the rest.[197] Of the top 20 oil producing companies in the world, 14 are national oil companies (NOCs) or newly privatized NOCs.[198] Although Canada and Mexico supply a substantial proportion of U.S. imports, OPEC countries control virtually all of the world's marginal production capacity and therefore have the ability to set the global price for this commodity.

This makes the United States uniquely vulnerable to a supply crisis, which could be created by a range of scenarios. These include a cutoff of oil supplies by a major exporter such as Venezuela, a confrontation with Iran, an Iranian or terrorist threat to the Strait of Hormuz, through which 16-17 million barrels of oil passes each day, terrorist attacks on major oil production facilities or export infrastructure in Nigeria or elsewhere, a broadening of conflict in Iraq, or destruction of oil production or fuel refining infrastructure as a result of a severe storm or natural disaster.[199] This vulnerability was underscored at the Select Committee's November 7, 2007 hearing entitled "Oil Shock: Potential for Crisis," at which former Commander of the U.S. Pacific Command, Admiral Dennis Blair, and former EPA Administrator Carol Browner testified on "Oil Shockwave"—a "war game" exercise focusing on a crippling oil crisis.

Despite increasingly strident calls to open the Outer Continental Shelf (OCS) and the Arctic National Wildlife Refuge to drilling, the facts make clear that we cannot drill our way out of this problem. More drilling may be good for U.S. oil company profits but will have little or no impact on prices consumers pay for oil or gasoline and will not substantially reduce U.S. dependence on foreign oil. As a preliminary matter, it bears emphasis that there is no shortage of opportunities for drilling on federal lands in the United States. Oil and gas companies currently hold leases to nearly 68 million acres of federal lands and offshore areas on which they are not currently producing.[200]

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[196] Energy Information Administration, International Energy Annual 2005, Table G.1 (World Production of Crude Oil, Natural Gas Plant Liquids, and Other Liquids, 1980-2005) (2007), available at http://www.eia.doe.gov/pub/international/iealf/tableg1.xls; BP Statistical Review of World Energy June 2008, Table A1 (Oil – Proved Reserves), available at http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/downloads/spreadsheets/statistical_review_full_report_workbook_2008.xls#'Oil – Proved reserves'!A1.

[197] David Baker, "Big Oil has trouble finding new fields," San Francisco Chronicle, Feb. 1, 2008, available at http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/02/01/BUMDUOD7S.DTL.

[198] Amy Myers Jaffe & Ronald Soligo, The International Oil Companies at 3 (Nov. 2007) (The James A. Baker III Institute for Public Policy), available at http://www.bakerinstitute.org/publications/NOC_IOCs_Jaffe-Soligo.pdf.

[199] See, e.g., Testimony of Amy Myers Jaffe, before the Select Committee on Energy Independence and Global Warming, hearing on "The Future of Oil" (June 11, 2008), at 1-2.

[200] See, e.g., Testimony of Athan Manuel, before the Select Committee on Energy Independence and Global Warming, hearing on the "Future of Oil" (June 11, 2008), at 11.

With regard to the OCS, nearly 83 percent of technically recoverable offshore oil reserves offshore in the United States are located in areas *already* available for leasing and drilling.[201] Of a total of 101 billion barrels of reserves, only 18 billion barrels are in areas that, up until October 1, 2008, were off limits—including 10 billion barrels off the coast of California, where there is a consistent record of bipartisan opposition to drilling.[202] The Department of Energy's Energy Information Administration (EIA) estimates that, even if the entire lower 48 OCS were opened to drilling, this would increase cumulative U.S. oil production by only 1.6 percent by 2030 and would have an "insignificant" impact on prices.[203]

As to the Arctic National Wildlife Refuge, EIA estimates that if the Refuge were opened for drilling, production would likely peak in 2027 at just 0.78 million barrels per day—reducing world oil prices by 78 cents per barrel in EIA's average price and resource case—corresponding to an estimated 4 cent per gallon decrease in the price of gasoline.[204]

Finally, regardless of U.S. oil production trends, there are serious questions about how increasing global demand will be met—and whether it can be met at all. This concern was underscored at the Select Committee's June 2008 hearing on the "The Future of Oil." Estimates of the total petroleum resource currently in the ground – both conventional and unconventional[205]—vary from 14 to 24 trillion barrels.[206] However, actual "proven reserves" that have already been discovered and are expected to be economically producible are much lower—estimated at between 1.1 and 1.4 trillion barrels worldwide. Chevron Corporation has estimated that humanity has consumed 1 trillion barrels of oil during the past 125 years, but that it will take just 30 years to burn through another trillion barrels. The IEA estimates current proven reserves, including non-conventional sources, could last 42 years if they were produced at current rates.[207]

At the same time, generating new oil supply is proving increasingly difficult. The fields that oil companies find are generally in hard-to-reach places like deep water areas in the Gulf of Mexico, where drilling and pumping costs far more than it does on land. Much of these companies' current oil supplies come from old giant fields which are now in decline and

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[201] U.S. Mineral Management Service, Report to Congress: Comprehensive Inventory of U.S. OCS Oil and Natural Gas Resources (Feb. 2006). available at http://www.mms.gov/revaldiv/PDFs/FinalInvRptToCongress050106.pdf. Figures are adjusted to account for the estimated 1.26 billion barrels of oil and 79.96 trillion cubic feet of gas in the Gulf of Mexico that were made accessible following this inventory by the Gulf of Mexico Energy Security Act of 2006.

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

[203] Id.

[204] Energy Information Administration, Analysis of Crude Oil Production in the Arctic National Wildlife Refuge (May 2008), available at http://www.eia.doe.gov/oiaf/servicerpt/anwr/index.html. See also Testimony of Athan Manuel before the Select Committee on Energy Independence and Global Warming, "The Future of Oil" at 3-4 (June 11, 2008).

[205] Conventional oil is crude oil and natural gas liquids produced from underground reservoirs by means of conventional wells. Non-conventional oil includes oil shales, oil sands, and extra-heavy crude.

[206] Energy Information Administration, Long-term Global Oil Scenarios: Looking Beyond 2030 (Slide presentation by Glen Sweetnam from EIA 2008 Energy Conference, April 7, 2008) (EIA uses 20.6 trillion barrels as its base case.).

[207] International Energy Agency, supra note 189, at 88.

deepwater fields which may have shorter lifespans than traditional fields.[208] Further, a growing share of reserve additions are coming from revised appraisals of existing fields, not the discovery of new fields. Even with advances in technology, the average size of discoveries per exploratory well is around 10 million barrels, which is half the output of wells dug between 1965 and 1979.[209]

OPEC's oil production capacity has not kept up with demand growth and has actually fallen over the past 25 years, from 38 mbd in 1979 to roughly 31 mbd today. Yet, for the world to reach the 2030 oil supply targets offered by IEA and EIA, roughly 60 percent of new supplies would need to come from OPEC. More than half of that volume is projected to come from just three countries whose relations with the United States are, at a minimum, strained and whose own domestic stability is questioned by many: Iraq, Iran, and Saudi Arabia.

In short, the shrinking margin between stagnant supply and soaring demand provides yet another reason that the United States and the world need to begin to look beyond oil to meet our growing energy needs.

2. The Electricity Challenge

The U.S. power sector is facing rapid and sustained growth in demand over the coming decades. EIA projects that electricity demand will grow by 29 percent from 2006 to 2030,[210] as compared with a projected 23 percent growth in the U.S. population.[211] Most of the predicted demand growth is in the commercial and residential sectors, with 49 and 27 percent projected growth, respectively. This increase in demand is fueled by a combination of population growth, population shifts towards warmer regions with higher cooling needs, and increasing reliance on electrically powered appliances and equipment. EIA estimates that this increase in demand, together with the expected retirement of 45 gigawatts of generating capacity, will require the construction of 263 gigawatts of new capacity (or equivalent increases in efficiency above and beyond predicted increases).[212] The largest portion of new capacity will be needed in the southeast (characterized by rapid population growth and high cooling needs).[213]

Rapidly growing demand together with underinvestment in transmission infrastructure is creating concerns about the reliability of the electrical grid. A number of steps have been taken to increase grid reliability in the wake of the 2003 blackouts in the northeast. However, transmission congestion remains a problem and the margin between capacity and demand is growing thinner in many regions of the country—notably the Midwest, Southwest, and

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[208] Matthew R. Simmons, Simmons & Company International, The 21st Century Energy Crisis Has Arrived (Presentation to the CFA Society of Atlanta: April 16, 2008).
[209] International Energy Agency, World Energy Outlook 2006 at 90 (2006).
[210] EIA AEO 2008, supra note 191, at 67.
[211] See U.S. Census Bureau, Interim Projections of the Total Population of the United States and States: April 1, 2000 to July 1, 2030, available at http://www.census.gov/population/projections/SummaryTabA1.pdf.
[212] EIA AEO 2008, supra note 191, at 68.
[213] EIA AEO 2008, supra note 191, at 69.

California—creating concerns about the potential for brownouts or blackouts in the next several years.[214]

Retail electricity prices have seen a steady upward march over the last decade—due to rising fuel and infrastructure costs. Prices have increased from an average of 6.81 cents per kilowatt hour in 1999 to 9.14 cents in 2007—a 34 percent rise.[215] Larger and faster upticks in prices are expected in many areas of the country due to rising costs of coal and natural gas, among other factors.

Electricity generation is heavily dependent on water, and growing water scarcity due to climate change will constrain power generation in many areas here in the United States and abroad. Power plants that convert thermal energy into electricity—primarily coal, natural gas, oil, and nuclear power plants—currently produce 90 percent of U.S. electricity and consume massive amounts of the country's fresh water supply for steam generation and cooling. Hydroelectric power, which accounts for another 7 percent of U.S. power generation, is of course highly dependent on water flow. As the Select Committee heard from Dan Keppen of the Family Farm Alliance in a July 10, 2008 hearing entitled "Global Warming Effects on Extreme Weather," water used by electric utilities accounts for 20 percent of all the non-farm water consumed in the United States. This figure could rise to 60 percent by 2030, with fast-growing regions like the Southwest and Southeast hit the hardest. Over the last two years, decreased river flow and increased water temperatures already have led to shut-downs of nuclear power plants in the southeastern United States. These problems will be exacerbated as global warming increases temperatures and water scarcity.

The overall fuel mix for power generation in the United States has remained relatively stable over the past decade. Coal remains the leading fuel source, accounting for 49 percent of generation, followed by natural gas with 21 percent, and nuclear with 19 percent. Hydroelectric power accounts for 6 percent, and non-hydro renewables (wind, solar, and geothermal) provide 2.4 percent.[216]

The construction of new generating capacity, however, suggests a shift towards heavier reliance on natural gas and an explosion in wind power. In 2007, natural gas accounted for 56 percent of all new generating capacity, wind accounted for over 30 percent, and coal accounted for just 9.5 percent—with oil and hydro making up the balance.[217] Shattering all its previous records, the wind energy industry installed 5,244 megawatts in 2007, expanding the nation's total wind power generating capacity by 45 percent in a single calendar year and injecting an investment of over $9 billion into the economy.[218]

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[214] See generally North American Electric Reliability Corporation, 2007 Long-term Reliability Assessment (Oct. 2007).

[215] Energy Information Administration, Average Retail Price of Electricity to Ultimate Customers: Total by End-Use Sector (Aug. 25, 2008), available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html.

[216] Energy Information Administration, Annual Energy Review 2007, at 224-26 (2008).

[217] Energy Information Administration, Electric Power Annual with data for 2006, at Table 2.4 (Planned Nameplate Capacity Additions from New Generators, by Energy Source, 2007 through 2011) (2007), available at http://www.eia.doe.gov/cneaf/electricity/epa/epat2p4.html.

[218] American Wind Energy Association, AWEA 2007 Market Report (2008), available at http://www.awea.org/projects/pdf/Market_Report_Jan08.pdf.

Meanwhile, there are substantial obstacles to expansion of coal and nuclear generation—two of the mainstays of the current U.S. generation portfolio.

Coal

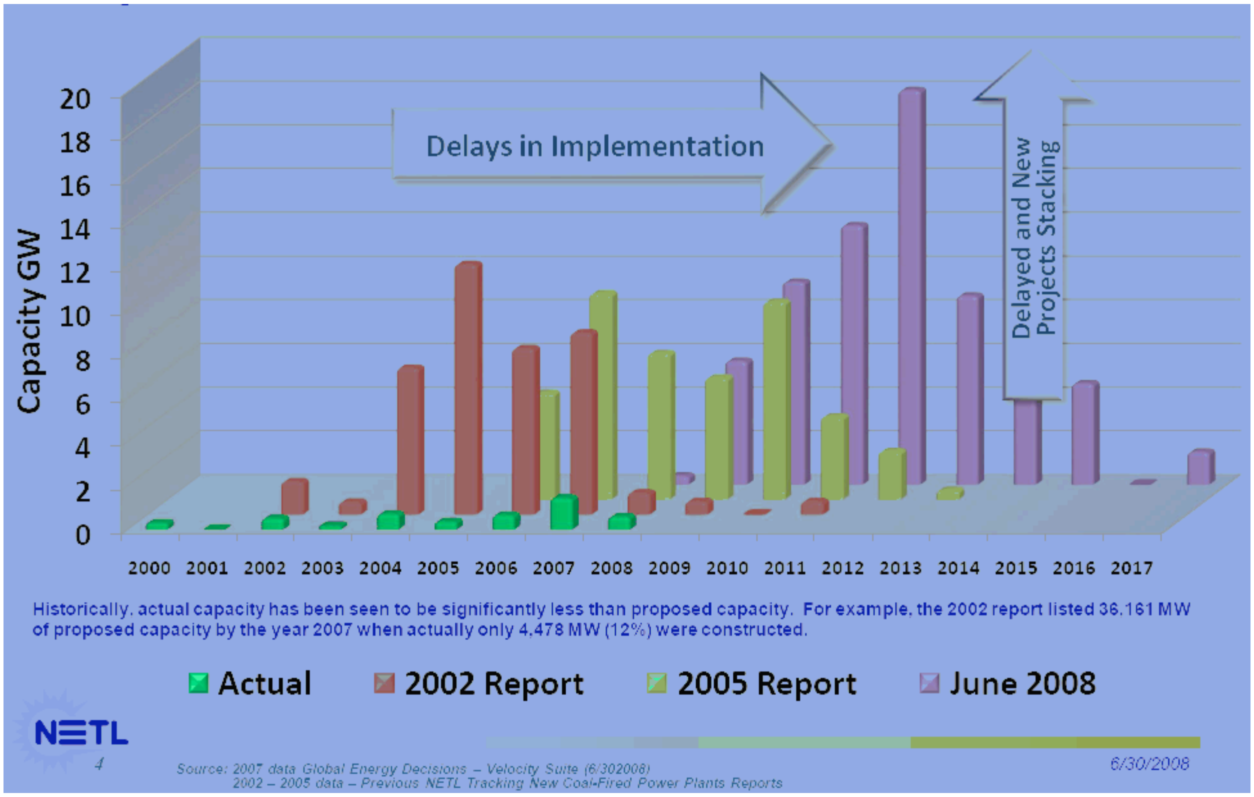
Coal remains a key fuel for the electric power sector, both for the United States and the rest of the world. Often referred to as the Saudi Arabia of coal, the United States has the largest coal reserves in the world (27 percent of global reserves) and produces over a billion short tons of coal annually. Over 90 percent of U.S. coal consumption is used for electricity generation. It is frequently asserted that U.S. reserves are sufficient to last 250 years at current rates of consumption, though a recent National Research Council report emphasized that this estimate could not be confirmed and some question whether full recovery is feasible.[219] China and India, two of the largest, fastest growing economies in the world, have large reserves and rely on coal for most of their electricity generation (79 percent for China and 68 percent for India).

Coal presents a serious challenge from the perspective of global warming. Because of coal's high carbon content, coal-fired power plants emit roughly twice as much carbon dioxide per unit of electricity as natural gas-fired plants. Existing coal-fired plants account for about a third of U.S. CO_2 emissions. Projected business-as-usual expansion in conventional coal-fired power plants would make achievement of our climate goals impossible. Absent limits on CO_2 emissions, EIA estimates that over half of new capacity added by 2030 will be provided by coal-fired generation. If constructed without carbon controls, these new coal-fired plants alone would increase U.S. greenhouse gas emissions by over 10 percent. Globally, an estimated 1.4 million megawatts of new coal-fired generating capacity is expected to be built by 2030—the lion's share in China and India. If built without carbon controls, these plants alone would increase global greenhouse gas emissions by roughly 30 percent above present levels.

Here in the United States, there has been a major slowdown in construction of new coal-fired power plants. According to one tally, 59 coal-fired power plant projects were cancelled in 2007 alone,[220] and the pace of cancellations has continued in 2008. Of the 36,000 megawatts of new coal-fired generating capacity predicted to be constructed between 2002 and 2007, only around 4,500 megawatts were actually built.[221] This slowdown was due in large part to public and regulatory opposition related coal plants' emissions of CO_2 as well as conventional pollutants, such as mercury. This opposition, together with uncertainty about future climate regulation, is making it increasingly difficult for new coal-fired power plants to secure financing. For example, in February 2008, three of what were then Wall Street's biggest investment banks issued standards requiring utilities seeking financing for coal-fired power plants to demonstrate that the plants will be economically viable even with stringent federal controls on CO_2 emissions.[222]

[219] See National Research Council, Coal: Research and Development to Support National Energy Policy at 3 (2007).
[220] See Coal Moratorium Now, Progress Towards a Coal Moratorium 59 Coal Plants Cancelled or Shelved in 2007, available at http://cmnow.org/59plants.pdf.
[221] National Energy Technology Laboratories, Tracking New Coal-Fired Power Plants, June 30, 2008, at 5, available at http://www.netl.doe.gov/coal/refshelf/ncp.pdf.
[222] See, e.g., Jeffrey Ball, "Wall Street Shows Skepticism Over Coal: Banks Push Utilities To Plan for Impact Of Emissions Caps," Wall Street Journal, Feb. 4, 2008, at A6.

Past Announcements vs. Actual Construction of Coal-Fired Power Plants



Source: National Energy Technology Laboratories, Tracking New Coal-Fired Power Plants (June 30, 2008).

Nuclear Power

While some are forecasting a nuclear "renaissance", a massive wave of construction in the next two decades would be necessary just to maintain nuclear power's current share of U.S. electricity generation. For nuclear power to maintain its current 19 percent share of U.S. electricity supply, around 50 new nuclear plants will need to be constructed by 2030. For nuclear power to grow to supply 30 percent of U.S. electricity, more than 100 reactors would need to be built by 2030.

A large and sustained expansion in nuclear generation is unlikely in light of the major hurdles facing the industry. The Nuclear Regulatory Commission expects to receive applications for 34 new nuclear power plants by the end of 2009.[223] Until this year, it had been three decades since a new application had been submitted. The last reactor completed in the United States came online in 1996 after a construction period of 23 years. A pattern of cost overruns and construction delays drove private investors away from nuclear energy in the 1970s.

[223] EERE Network News, NRC Expects Applications for 34 Nuclear Power Plants by 2010 (July 16, 2008), available at http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11876.

Cost projections for new nuclear power plants have increased dramatically—in many cases surpassing the total value of the electric utility—making it extremely unlikely new plants can be financed without taxpayer-backed loan guarantees. Just a few years ago, the nuclear industry was projecting a new 1,000 megawatt reactor would cost around $2 billion. A 2007 Keystone Center study found costs for the same plant could reach $4 billion. New plants are now expected to cost $6-8 billion each, a figure which approaches or exceeds the total market capitalization of many electric power companies.[224] For the 67 nuclear plants that have come online in the United States since 1976, on average more than 13 years passed between when a new plant application was officially accepted by the Nuclear Regulatory Committee and when the plant began commercial operation.[225]

In light of these costs and risks, it remains in doubt whether private financing will be available for any new nuclear facilities without the assurance of federal government guarantees on the loans. The Congressional Budget Office estimates the risk of default on these loans to be "very high—well above 50 percent."[226] The Department of Energy has received applications for federal loan guarantees from 21 proposed nuclear power plants. But the $122 billion in requested assistance far surpasses the $18.5 billion Congress made available in loan support. The director of the Department of Energy's loan program office has stated that $18.5 billion could probably accommodate only two power plants.[227]

The Nuclear Energy Institute (NEI) has stated that additional financing from French and Japanese government export credit agencies, in exchange for agreements on the sourcing of reactor components, could—in conjunction with the federal loan guarantees—increase the number of nuclear plants receiving loan guarantees to three or four.[228] At no time "in the immediate future" does NEI anticipate private companies will be able to finance new nuclear plants without the aid of federal loan guarantees.[229]

Meanwhile, the United States has not found a solution to the problem of long-term disposal of spent nuclear fuel. Approximately 56,000 metric tons of high-level nuclear waste is stored at 65 operating and 9 decommissioned reactor sites around the country. Without any expansion in the current fleet, spent fuel waste will grow to more than 80,000 metric tons by the end of existing reactor licenses, and would expand to over 120,000 metric tons if all current licenses are renewed.[230] The Yucca Mountain facility has been plagued by delays, cost overruns, serious questions about safety, and political opposition. The Department of Energy projects that

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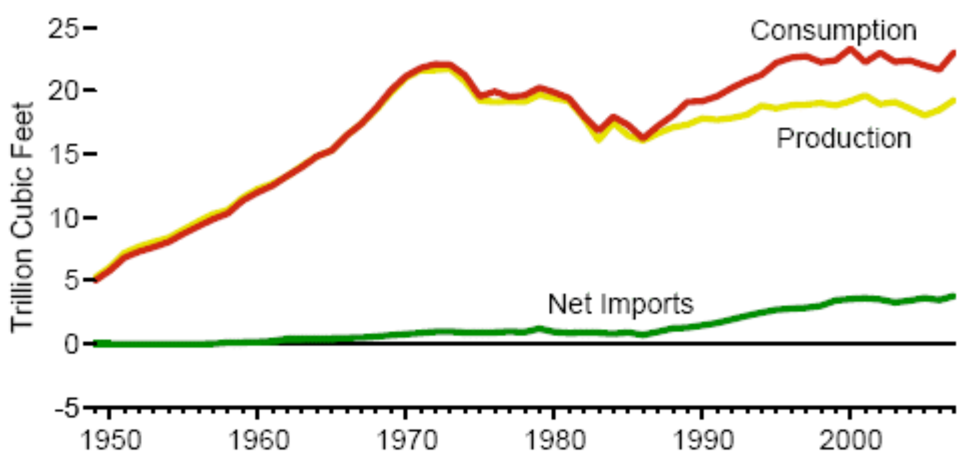
[224] Nuclear Energy Institute response to follow-up questions submitted by Rep. Markey after the June 19, 2008, hearing on climate change in the Energy and Air Quality Subcommittee of the House Committee on Energy and Commerce. Frank Bowman, President and CEO of the Nuclear Energy Institute, testified during that hearing. Received Oct. 21, 2008.
[225] Id.
[226] Congressional Budget Office, Cost Estimate, S.14, Energy Policy Act of 2003, at 11 (May 7, 2003), available at http://www.cbo.gov/ftpdocs/42xx/doc4206/s14.pdf.
[227] Katherine Ling, "Nuclear Power: 17 apply for DOE loan guarantees, far exceeding available cash," Greenwire, Oct. 2, 2008.
[228] Nuclear Energy Institute, supra note 224.
[229] Id.
[230] The Keystone Center, Nuclear Power Joint Fact-Finding at 75 (June 2007), available at http://www.keystone.org/spp/documents/FinalReport_NJFF6_12_2007(1).pdf.

it will open no earlier than 2017, and there are substantial doubts as to whether it will ever do so. Even if it is opened, Yucca Mountain will have a 70,000 metric ton capacity, making it is insufficient to accommodate all the waste from existing facilities. An expansion of 45 to 100 additional reactors would require the construction of another Yucca Mountain-sized facility every 17-24 years for as long as the fleet was in operation. Without resolution of the waste disposal issue, it is difficult to see how a significant expansion of nuclear power can proceed.

3. The Natural Gas Challenge

The United States accounts for over 22 percent of global consumption of natural gas, but has only 3.4 percent of global reserves. However, domestic production satisfies 80 percent of U.S. demand—and over 80 percent of U.S. imports come from Canada. Although there is slightly greater geographic distribution of natural gas reserves around the world than oil, the majority of natural gas reserves are still concentrated in relatively few countries—notably Russia (27.2 percent of global reserves), Iran (15.3 percent), and Qatar (14.6 percent).[231] According to EIA, U.S. annual consumption of natural gas in 2007 was 23 trillion cubic feet or 63 billion cubic feet per day. Of that, the United States imports about 4.6 trillion cubic feet—approximately 20 percent. In 2007, 83 percent of U.S. natural gas imports came from Canada by pipeline. Liquefied natural gas (LNG) imports in 2007 totaled about 770 billion cubic feet—just over 3 percent of U.S. consumption.[232]

U.S. Natural Gas Consumption, Production, and Net Imports



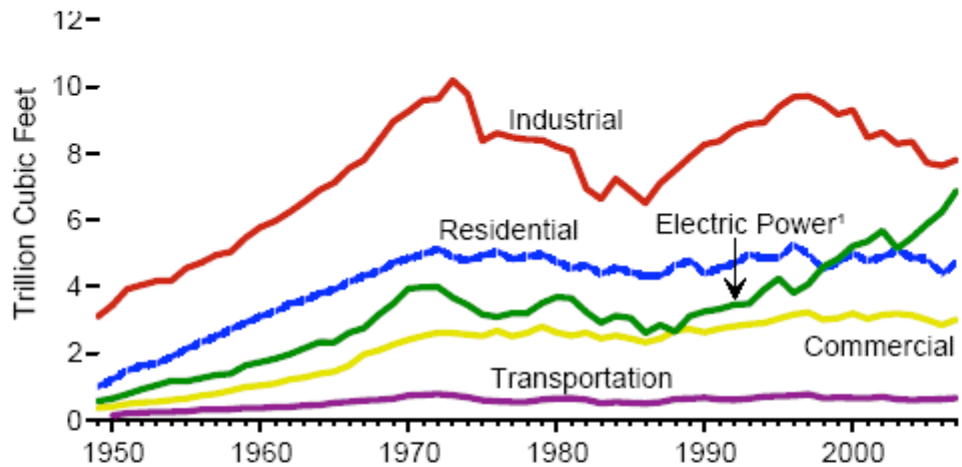
Source: Energy Information Administration, Energy Perspectives (2008) (Figure 34), available at http://www.eia.doe.gov/emeu/aer/ep/ep_frame.html.

Natural gas has become the fuel of choice for new power plants in the United States, because of its low emissions of CO_2 and conventional air pollutants in comparison with coal. In addition, natural gas plays a critical role as a feedstock and fuel for U.S. manufacturing.

[231] Energy Information Administration, International Energy Outlook 2008, at 44 (Table 6) (2008), available at http://www.eia.doe.gov/oiaf/ieo/pdf/nat_gas.pdf.
[232] Energy Information Administration, U.S. Natural Gas Imports by Country, available at http://tonto.eia.doe.gov/dnav/ng/ng_move_impc_s1_a.htm.

The four main consumers of natural gas in the United States are electricity generation (30 percent), and the residential (20 percent), commercial (13 percent), and industrial (29 percent) sectors.[233] Natural gas accounted for 55 percent of new generating capacity built in the United States in 2007. In addition, over half of U.S. homes are heated or cooled with natural gas, and over 70 percent of new homes are designed to use natural gas for space heating.[234] In the commercial sector, the primary uses of natural gas are also space heating and cooling and water heating. Industrial consumption of natural gas is focused primarily in the pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic, and food processing industries—including as a feedstock for the manufacturing of a wide range of products, such as fertilizer.

U.S. Natural Gas Consumption by Sector



Source: Energy Information Administration, Energy Perspectives (2008) (Figure 37), available at http://www.eia.doe.gov/emeu/aer/ep/ep_frame.html.

There has been a substantial increase in natural gas prices over the past several years, which has had an adverse effect on U.S. manufacturers that depend on this resource. The average annual Henry Hub spot price in 2007 was $6.97 per million Btu—more than double the average annual price of $3.36 in 2002.[235] Rising natural gas prices have had a serious adverse impact on the U.S. manufacturing sector, particularly in specific sectors like fertilizer production. At the Select Committee's July 30, 2008 hearing entitled "What's Cooking With Gas?: The Role of Natural Gas in Energy Independence and Global Warming Solutions," Rich Wells of The Dow Chemical Company testified that natural gas price increases over the past eight years have "contributed significantly to the US manufacturing sector losing over 3.7 million jobs, the chemical industry losing nearly 120,000 jobs, and the permanent loss of nearly half our fertilizer production capacity."

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[233] Energy Information Administration. Natural Gas Consumption by End Use, at http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm.
[234] Natural Gas Supply Association, Natural Gas Overview Residential Uses, available at http://www.naturalgas.org/overview/uses_residential.asp (last accessed on October 26, 2008).
[235] Energy Information Administration, Natural Gas Year-In-Review 2007 (Mar. 2008).

Fortunately, U.S. natural gas production from "unconventional" onshore sources—principally shale resources—is increasing rapidly and has the potential to provide substantial new resources and to relieve pressure on prices. In the past few years, U.S. natural gas production has increased after a decade of essentially flat production. EIA predicts that production will continue to increase for the next few years if demand and prices stay high.[236] This increase has come in large part from the development of unconventional resources, which now are the source of 47 percent of U.S. natural gas production. New drilling technologies, especially horizontal drilling and hydraulic fracturing, have allowed the extraction of natural gas from geologic formations that could not be tapped with traditional techniques. In the western United States, there has been a dramatic increase in production of natural gas associated with coal deposits, so-called coalbed methane.

Shale formations are growing in importance for natural gas production. They are widely distributed, large, and contain huge resources of natural gas, but are just starting their full development. According to the EIA, the production from one Barnett Shale field in Texas alone contributes more than 6 percent of production from the lower 48 States, which is more than from Louisiana, one of the largest producing states.[237] Since 2005, more shale resources have been discovered including the recent announcement by Chesapeake Energy of the Haynesville field located in East Texas and Louisiana. The company says wells drilled on its leases could produce as much as 44 trillion cubic feet of natural gas—nearly twice what the United States consumed last year.[238] Based on their National Oil and Gas Assessment, the U.S. Geological Survey estimates that in "continuous resources," which are typically unconventional formations like shales, there is 328 trillion cubic feet of natural gas[239] or approximately 14 years of resources at current consumption levels.

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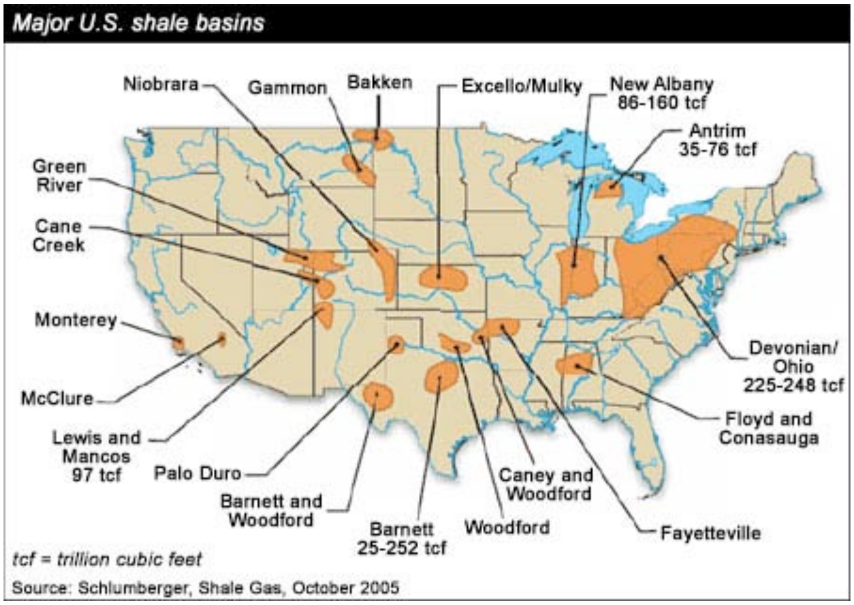
[236] Energy Information Administration, "Is U.S. natural gas production increasing?" (June 2008), available at http://tonto.eia.doe.gov/energy_in_brief/natural_gas_production.cfm

[237] Id.

[238] Ben Casselman, "Chesapeake, Plains Set to Tap Gas Field," Wall Street Journal, July 3, 2008.

[239] Calculation based on mean vales for the regional assessments from the USGS National Oil and Gas Assessment, available at http://energy.cr.usgs.gov/oilgas/noga/.



Development of these unconventional resources has raised concerns over water quality and availability that may reduce production in some parts of the country. Hydraulic fracturing requires the injection of large amounts of water, which can include dangerous contaminates and threaten underground drinking water supplies.[240] Coalbed methane production releases saline water from the coal seams that can also contain arsenic, lead and other heavy metals[241] and must be dealt with properly to avoid contamination of water supplies or destruction of pasture as has occurred in some areas of Wyoming.[242] In some areas of the country, water supply systems are struggling to meet the demands of increased natural gas production on top of existing drinking and agriculture usage.[243]

Construction of the Alaska Natural Gas Pipeline could bring online a substantial new source of domestic supply. Alaska's North Slope has massive natural gas resources, with potential recoverable reserves estimated at 100 trillion cubic feet.[244] Proposals for a natural gas pipeline to transport this "stranded" resource to markets in the lower 48 States—over 3000 miles via Alberta, Canada to Chicago—have been discussed for over two decades. In 2004, Congress enacted the Alaska Natural Gas Pipeline Act, which, among other things, authorized $18 billion in loan guarantees to support construction of the pipeline. As natural gas prices have risen over the past decade, interest in development of a pipeline has likewise increased. The State of Alaska has established its own framework for promoting the pipeline—awarding a license to build the pipeline to TransCanada Corporation in August 2008 with $500 million in state support. Nevertheless, the ultimate fate of the pipeline—estimated to cost up to $40 billion—

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[240] Steve Hargreaves, Natural gas vs. contaminated water, CNNMoney.com, July 29, 2008, at http://money.cnn.com/2008/07/28/news/economy/_shale_drilling/index.htm.
[241] U.S. Geological Survey, Fact Sheet FS-156-00, Water Produced With Coal Bed Methane (Nov. 2000), available at http://pubs.usgs.gov/fs/fs-0156-00/fs-0156-00.pdf.
[242] Hal Clifford, Wyoming's powder key, High Country News, Nov. 5, 2001, available at http://www.hcn.org/issues/214/10823.
[243] Vickie Welborn, "Competition for Water Raises Concerns" Shreveport Times, August 8, 2008
[244] William F. Hederman, Congressional Research Service, "The Alaska Natural Gas Pipeline: Status and Current Policy Issues," No. RL34671, at 9 (Sept. 12, 2008).

remains unclear.[245] If built, the pipeline at full initial capacity could deliver 4.5 billion cubic feet per day of natural gas to the lower 48—equivalent to 7 percent of current domestic consumption.[246]

By contrast, recent proposals to open new areas of the Outer Continental Shelf for gas production are unlikely to lead to substantial new production or to significant downward pressure on prices. According to EIA, total U.S. proven natural gas reserves—resources that have been identified and tested and either have been or will be developed—were 211 trillion cubic feet at the end of 2006. Of the total U.S. proven natural gas reserves, 15 trillion cubic feet or about 7 percent were Outer Continental Shelf (OCS) offshore reserves. EIA estimates that 73 percent of these technically recoverable natural gas resources in the OCS (or all but 2 percent of total proven natural gas reserves) are available for leasing and development.[247] Furthermore, EIA's analysis found that "lower 48 natural gas production is not projected to increase substantially by 2030 as a result of increased access to the OCS."[248]

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[245] See, e.g., Serge Kovaleski and Mike McIntire, "Palin's Pipeline Is Years From Being A Reality," New York Times, Sept. 10, 2008.
[246] William F. Hederman, Congressional Research Service, "The Alaska Natural Gas Pipeline: Status and Current Policy Issues," No. RL34671, at 5 (Sept. 12, 2008).
[247] Energy Information Administration, Impacts of Increased Access to Oil and Natural Gas Resources in the Lower 48 Federal Outer Continental Shelf (2007), available at http://www.eia.doe.gov/oiaf/aeo/otheranalysis/ongr.html
[248] Id.