THE SELECT COMMITTEE ON

ENERGY INDEPENDENCE & GLOBAL WARMING

CHAIRMAN EDWARD J. MARKEY

111th Congress Staff Report

SELECT COMMITTEE STAFF REPORT 2010

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INTRODUCTION

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, roughly $26 trillion will be invested in energy infrastructure worldwide. Clean energy will likely make up an increasing share of this investment with every passing year. The International Energy Agency (IEA) estimates that $5.7 trillion will be invested in renewable electricity generation alone between 2010 and 2035.[1] 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. Other countries are taking the lead in clean energy and the United States must act now if it is to remain competitive in this rapidly developing global market.

Global climate change presents one of the gravest threats to our planet's health, and to America's economy, its national security, and its 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, high dependence on foreign oil, and continued reliance on high-carbon fuels that worsen the climate crisis.

The Select Committee on Energy Independence and Global Warming was created by Speaker of the House Nancy Pelosi in 2007 to examine and make recommendations on the interrelated issues of energy independence, national security, America's economic future and global warming.

During its four years, the Select Committee held 80 hearings and briefings, conducted investigations, led fact finding trips with Congressional members, and contributed to the most active four years in energy and climate policy development and debate in the United States Congress.

As a result of the Select Committee's work in raising the profile of energy and climate issues, and spurring increased debate, the House of Representatives passed several pieces of legislation that will reduce our nation's consumption of foreign oil, increase energy efficiency, and create new jobs in the clean energy sector.

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[1] International Energy Agency, World Energy Outlook 2010. Available at http://www.worldenergyoutlook.org/

In 2007, the first year of the Select Committee, the House passed the Energy Independence and Security Act, which included fuel economy provisions co-authored by Rep. Edward J. Markey, Chairman of the Select Committee. The bill also increased America's use of advanced biofuels, and updated energy efficiency standards for appliances and lighting systems.

The Select Committee also was instrumental in pushing for increased investment in clean energy technologies. The American Recovery and Reinvestment Act of 2009 invested $90 billion in clean energy, which jump-started new domestic industries like advanced electric batteries, boosted household energy efficiency, and helped key renewable energy sectors like wind and solar avoid collapse during the recession.

In June of 2009, the House passed the Waxman-Markey American Clean Energy and Security Act, the first passage of a comprehensive energy and climate bill in the history of the U.S. Congress. The bill set ambitious carbon reduction targets, which were used by U.S. negotiators to craft the Copenhagen Accord. It also created a roadmap to create clean energy jobs and the next generation of clean energy technologies.

These legislative achievements happened as historic events indicated that swift action was needed to address a strained energy system and a dangerously destabilized climate. The years 2007-2010 are all in the top ten warmest years on record, according to NASA. Oil and gasoline prices peaked to record levels in 2007 and are on the rise again as the country emerges from the recession.

As the Select Committee ends its tenure of progress, it is clear that there is much left to be done to stabilize our global climate, and spur the development of clean energy technology and jobs here in America.

This report summarizes the results and findings of the Select Committee's hearings and investigations, highlights legislative accomplishments that flow from the information it has developed and makes recommendations for steps moving forward. We begin with a discussion of the key issue of energy independence.

Energy Independence

Introduction

The United States is confronting a deepening energy security crisis—characterized by escalating and volatile energy prices, unacceptably high dependence on foreign oil, and increasing global demand for limited energy resources. At the same time, an unprecedented economic and job creation opportunity has developed in the clean energy sector. According to the IEA, roughly $26 trillion in investment will be needed through 2030 to meet the world's energy demand, a significant share of which will be made in the rapidly growing clean energy sector.[2] Nations that move aggressively now will position their domestic companies and workers to disproportionately benefit in this key growth sector.

The Oil Challenge

The United States' continuing addiction to oil presents a serious threat to our national security and economy. The United States is the largest consumer of oil in the world, accounting for 22 percent of global demand—principally to power our transportation system, which is 95 percent dependent on oil.[3] About half of all U.S. oil consumption in 2010—3.5 billion barrels—came from foreign sources. Imports have declined from their peak of 60 percent of total consumption in 2005 but are still up from 42 percent in 1990 and 27 percent in 1985.[4]

Oil and gasoline prices have been on a roller coaster ride over the past four years, 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 250 percent over the last decade while gasoline prices have more than doubled.[5] In just the last 3 years, the price of a barrel of oil has soared to $147, dropped to $36, and climbed back above $90 by the close of 2010.[6]

Experts agree that rapidly growing oil demand from developing countries is likely to result in sustained high prices for the foreseeable future. China, for example, alone is expected to grow its vehicle fleet from 40 million vehicles today to 350 million by 2035, according to the International Energy Agency (IEA).

Soaring petroleum prices have been a drain on the economy and have a crippling effect on American consumers. Nearly $1.3 trillion has been sent overseas to import oil over the past four years, while oil imports have grown to account for nearly half the U.S.

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[2] International Energy Agency, World Energy Outlook 2008. Available at http://www.iea.org/textbase/nppdf/free/2008/weo2008.pdf

[3] Energy Information Administration; *World Oil Balance: Second Quarter 2010* and *U.S. Consumption by Sector*. Available at http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/demand_text.htm#Global Oil Consumption

[4] Energy Information Administration, Monthly Energy Review November 2010, Table 3.3a Petroleum Trade: Overview. Available at: http://www.eia.doe.gov/mer/pdf/pages/sec3_7.pdf

[5] Energy Information Administration *Weekly United States Spot Price FOB Weighted by Estimated Import Volume (Dollars per Barrel)* (November 2010) Available at http://www.eia.gov/dnav/pet/pet_pri_wco_k_w.htm

[6] Id.

trade deficit.[7] Each $1 per gallon increase in the average cost of gasoline adds nearly $600 to an average American's annual transportation fuel bill.[8] At mid-2008 gasoline prices, fuel expenses were eating up nearly 10 percent of an average American worker's pre-tax income.[9]

In addition, nearly 8 million American households rely on heating oil to warm their homes during the winter. These households face an expected average heating bill of $2,146 during the 2010-11 winter, 61 percent more than households spent on average 6 winters ago.[10]

OPEC countries control 70 percent of estimated global oil reserves and account for 40 percent of global production.[11] OPEC's share of global production is projected to continue to increase, reaching more than 50 percent by 2035.[12] 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.[13] Of the top 20 oil producing companies in the world, 14 are national oil companies (NOCs) or newly privatized NOCs.[14] Although Canada and Mexico supply a substantial proportion of U.S. imports, OPEC countries control virtually all of the world's

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[7] As calculated by Select Committee staff, from census data. See U.S. Census Bureau Foreign Trade, Exhibit 9- Petroleum and Non-petroleum End-Use Category Totals (Sept 2010) Available at *http://www.census.gov/foreign-trade/Press-Release/2010pr/10/exh9.pdf*

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

[9] 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.

[10] Energy Information Administration, Short-Term Energy Outlook, December 2010 – Table WF01. Available at http://www.eia.gov/emeu/steo/pub/wf-table.pdf

[11] Energy Information Administration, International Petroleum Monthly (November 2010) Available at *http://www.eia.doe.gov/ipm/supply.html;* and Oil and Gas Journal - World Proved Reserves of Oil and Natural Gas, Most Recent Estimates, (March 2,2009) Available at http://www.eia.doe.gov/emeu/international/reserves.html

[12] International Energy Agency, World Energy Outlook 2010 at 48 (2010).

[13] 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

[14] 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.

marginal production capacity and therefore have the ability to set the global price for this commodity. 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.

Despite increasing calls to open the Outer Continental Shelf (OCS) and the Arctic National Wildlife Refuge (ANWR) to drilling, the facts make clear that we cannot drill our way out of this problem**.** While the United States consumes 22 percent of the world's oil, it has less than 3 percent of global reserves. More drilling will have little or no impact on prices consumers pay for gasoline and will not substantially reduce U.S. dependence on foreign oil.

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.[15] 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.[16] EIA notes that "the Organization of Petroleum Exporting Countries (OPEC) could neutralize any potential price impact of ANWR oil production by reducing its oil exports by an equal amount."[17]

In addition, there is currently 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.[18] From 2000 through 2009, the federal government has offered more than 517 million acres for lease offshore and leased more than 8,700 tracts.[19] Onshore, more than 40,000 permits have been approved for drilling. Nearly 83 percent of technically

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

[16] 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

[17] Id, p. 11.

[18] Department of Interior, Minerals Management Service, All Reported Royalty Revenues, Fiscal Year 2004. Available at http://www.mrm.mms.gov/MRMWebStats/Disbursements_Royalties.aspx?report=TotalLeasesbyCategory&yeartype=FY&year=2007&asOfDate=10-26-2007.

[19] Department of Interior. Mineral Management Service, Table 1. All Lease Offerings. Available at http://www.gomr.boemre.gov/homepg/lsesale/swiler/Table_1.PDF

recoverable offshore oil reserves offshore in the United States are located in areas *already* available for leasing and drilling.[20]

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. Estimates of the total petroleum resources currently in the ground – both conventional and unconventional[21]—vary from 14 to 24 trillion barrels.[22] However, actual "proven reserves" that have already been discovered and are expected to be economically producible are much lower—estimated at between 1.2 and 1.3 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. Proven U.S. reserves are estimated at 21 billion to 30 billion barrels, enough to meet U.S. demand for 3 or 4 years.[23]

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 deepwater fields which may have shorter lifespans than traditional fields.[24] The 87 day BP Deepwater Horizon oil and gas spill illustrates the inherent risk and increased environmental and safety challenges of pursuing ever more remote, highly pressurized, and difficult to extract hydrocarbon deposits.

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.[25] As a result, the IEA believes that

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[20] Department of Interior, 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.

[21] 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.

[22] 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.).

[23] Energy Information Administration, World Proved Reserves of Oil and Natural Gas, Most Recent Estimates, Oil and Gas Journal, (March 3, 2009) Available at http://www.eia.doe.gov/emeu/international/reserves.html

[24]Matthew R. Simmons, Simmons & Company International, The 21st Century Energy Crisis Has Arrived (Presentation to the CFA Society of Atlanta: April 16, 2008).

[25] International Energy Agency, World Energy Outlook 2006 at 90.

crude oil output will not exceed the all-time peak production level of 70 million barrels per day (mb/d) reached in 2006. Instead, crude output plateaus around 68-69 mb/d over the next decade, while production of natural gas liquids and unconventional oil grows.[26]

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.

Part II: The Electricity Challenge

Even with the recession reducing economic growth and electricity demand in 2008 and 2009, the U.S. power sector is facing rapid and sustained growth in demand over the coming decades. Additionally, 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 30 percent by 2035, requiring the construction of 250,000 megawatts of new generating capacity—or equivalent increases in efficiency.[27] Many regions of the country are predicted to see declining levels of reserve capacity—putting the reliability of the grid at greater risk.

More than 10,000 megawatts of new wind generating capacity was installed in the United States in 2009,[28] making it the second consecutive year in which more wind capacity was installed than natural gas, coal, or any other resource.[29] While coal remains the single largest source of electricity in the country (45 percent), fuel-switching to natural gas contributed to a 12 percent decline in coal-fired generation in 2009, its lowest share of the electricity market since 1978. Longer-term, 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.

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[26] International Energy Agency, World Energy Outlook 2010 at 48.

[27] Energy Information Administration, Annual Energy Outlook 2010. Available at http://www.eia.doe.gov/oiaf/archive/aeo10/electricity.html

[28] American Wind Energy Association, U.S. Wind Industry Annual Market Report, Year Ending 2009 Available at http://e360.yale.edu/images/digest/Annual_Market_Report_Wind.pdf

[29] Energy Information Administration, Electric Power Annual 2008 Available at ftp://ftp.eia.doe.gov/electricity/034808.pdf; and Energy Information Administration, Electric Power Annual 2009, See table 1.5 *Capacity Additions, Retirements and Changes by Energy Source, 2009* at 19. Available at http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile1_5.pdf

Beginning January 1, 2011, EPA will phase in permitting requirements for new plants with greenhouse gas emissions. Power plants will also face new air toxics regulations in the next several years. Meanwhile, discoveries of domestic shale gas deposits and advances in horizontal drilling and hydraulic fracturing techniques, has led to expanded domestic gas reserves and production and the lowest well-head prices[30] in seven years. U.S. solar electric capacity grew 37 percent in 2009[31] as the price of photovoltaic modules has declined 50 percent in price over the last two years. 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.

Rapidly growing demand, security challenges, and underinvestment in transmission infrastructure have created 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 California—creating concerns about the potential for brownouts or blackouts in the next several years.[32] The grid's increasing reliance on automation and two-way communications, especially with the rise of advanced metering and other "smart grid" capabilities, has increased the grid's vulnerability to remote cyber attacks.

Retail electricity prices have seen a steady upward march over the last decade due to rising fuel and infrastructure costs. Prices have increased from a nationwide average of 6.64 cents per kilowatt hour in 1999 to 9.89 cents in 2009, a 49 percent rise.[33] However, electricity represents a much less price volatile form of energy, as average annual electricity rates are projected by the EIA to stay relatively steady, increasing to 10.2 cents per kilowatt hour in real dollars through 2035.

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.

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[30] The well-head price is the price charged by the producer for petroleum or natural gas without transportation costs.

[31] Solar Energy Industry Association, US Solar Industry Year in Review 2009 (April 15, 2010), Available at http://seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf

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

[33] Energy Information Administration, Average Retail Price of Electricity to Ultimate Customers: Total by End-Use Sector. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html.

Hydroelectric power, which typically accounts for another 6-9 percent of U.S. power generation, is of course highly dependent on water flow. Water used by electric utilities accounts for 20 percent of all non-farm water use in the United States.[34] This figure could rise to 60 percent by 2030, with fast-growing regions like the Southwest and Southeast hit the hardest. In recent years, decreased river flow and increased water temperatures already have led to shut-downs of nuclear power plants in the southeastern United States and across Europe. These problems will be exacerbated as global warming increases temperatures and water scarcity.

Coal

Coal has not been immune to the increase in fossil fuel costs, as domestic prices have soared nearly 60 percent between 2000 and 2009.[35] These higher prices drove a decline in coal-fired generation to its lowest share of the domestic electricity market since 1978.

Yet 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 (28 percent of global reserves[36]) and produces more than 10 billion short tons of coal annually. More than 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 2007 National Research Council report emphasized that this estimate could not be confirmed and some question whether full recovery is feasible.[37] 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 (80 percent for China and 71 percent for India).[38]

Coal presents a serious challenge from the perspective of global warming, and the successful development of carbon capture and sequestration (CCS) technologies will be crucial to reconciling our continued reliance on coal with the urgent need to reduce

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[34] Peter Spotts, "Trade-off looms for arid US regions: water or power?" *The Christian Science Monitor*, April 17, 2007.

[35] Energy Information Administration, Annual Energy Review 2009, Table 7.8 Coal Prices, Selected Years, 1949-2009. Available at *http://www.eia.gov/emeu/aer/pdf/pages/sec7_19.pdf*

[36] Energy Information Administration, International Energy Statistics, Total Recoverable Coal. Available at *http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=6*

[37] National Research Council, Coal: Research and Development to Support National Energy Policy (2007).

[38] Energy Information Administration, International Energy Outlook 2010, at 87. Available at http://www.eia.doe.gov/oiaf/ieo/pdf/electricity.pdf

greenhouse gas emissions. 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, and projected business-as-usual expansion in conventional coal-fired power plants would make achieving science-based reductions of carbon emissions impossible. Globally, coal-fired generation is expected to nearly double between 2007 and 2035, with the lion's share of new capacity being built in China and India.[39] If built without carbon controls, these new coal plants alone would increase global greenhouse gas emissions by nearly 19 percent above current levels.[40]

Here in the United States, construction of new coal-fired power plants has slowed. According to one tally, more than 100 coal-fired power plants were cancelled, abandoned, or put on hold between 2007 and 2009.[41] While 2009 saw more new coal capacity come online in the United States in a single year since 1991, it was far less than new wind (9,410 MW) and natural gas (9,403 MW) capacity added that year.[42] In fact, more than four times as much planned coal capacity was cancelled or abandoned (14,900 MW) as was completed (3,200 MW) in 2009.[43] 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.[44]

Natural Gas

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[39] Energy Information Administration, International Energy Outlook 2010, Available at http://www.eia.doe.gov/oiaf/ieo/pdf/electricity.pdf

[40] As calculated by Select Committee Staff. See Energy Information Administration, International Energy Outlook 2010, Available at http://www.eia.doe.gov/oiaf/ieo/pdf/electricity.pdf

[41] Source Watch "Coal plants cancelled in 2009," available at *http://www.sourcewatch.org/index.php?title=Coal_plants_cancelled_in_2009*

[42] Energy Information Administration, Electric Power Annual 2009, Table 1.5. Capacity Additions, Retirements and Changes by Energy Source (2009) Available at *http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile1_5.pdf*

[43] National Energy Technology Laboratories, Tracking New Coal-Fired Power Plants, January 8, 2010 Available at *http://www.netl.doe.gov/coal/refshelf/ncp.pdf*

[44] 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.

Two qualities make natural gas an important bridge fuel in the U.S. energy system: it emits roughly half the carbon as coal in producing the same amount of energy, and it is found and produced in the United States. Although the United States consumes 23 percent of the world's natural gas and has less than 4 percent of global reserves[45]—ultimately an unsustainable equation—natural gas does not present the same immediate geopolitical and economic security risks as oil. Net natural gas imports currently make up just 12 percent of total supply, the vast majority of which comes from Canada. Further, EIA projects imports to fall to 6 percent of U.S. supply in 2035.[46] After four consecutive years of production increases, the United States is now producing more natural gas than it ever has before. It has become a fuel of choice for new power plants in the United States because of its low emissions, comparatively low capital cost, short lead times for plant construction, and relatively low current fuel prices. The electric power sector now accounts for 30 percent of total U.S. natural gas consumption, nearly the same as the manufacturing sector.[47]

New drilling technologies, especially horizontal drilling and hydraulic fracturing, have driven the recent surge in domestic production by allowing the extraction of shale gas from geologic formations that could not be tapped with traditional techniques. The resource potential of shale gas has significantly increased the natural gas reserve estimates in the United States.[48] The Potential Gas Committee estimated in 2009 that the United States held 35 percent more gas reserves than it believed two years earlier, an 80-year domestic supply at current rates of production.[49] Shale gas now accounts for nearly a third of total U.S. gas reserves, and the EIA estimates that shale resources will provide 24 percent of total U.S. natural gas supply by 2035, up from 6 percent currently.[50]

By contrast, recent proposals to open new areas of the Outer Continental Shelf (OCS) for gas production are unlikely to lead to substantial new production or to significant downward pressure on prices**.** According to EIA, less than 7 percent of total

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[45] Energy Information Administration, World Proved Reserves of Oil and Natural Gas, Most Recent Estimates (March 3, 2009), Oil and Gas Journal data. Available at *http://www.eia.doe.gov/emeu/international/reserves.html*

[46] Energy Information Administration, Annual Energy Outlook 2010 with Projections to 2035, May 11, 2010 Available at *http://www.eia.doe.gov/oiaf/aeo/gas.html*

[47] Energy Information Administration, Natural Gas Consumption by End Use (November 2010) Available at http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_m.htm

[48] Energy Information Administration, Annual Energy Outlook 2010 with Projections to 2035, May 11, 2010, at 1, Available at *http://www.eia.doe.gov/oiaf/aeo/gas.html*

[49] Potential Gas Committee, Press Release: "Potential Gas Committee Reports Unprecedented Increase in Magnitude of Natural Gas Resource Base," June 18, 2009. Available at *http://www.energyindepth.org/wp-content/uploads/2009/03/potential-gas-committee-reports-unprecedented-increase-in.pdf*.

[50] Energy Information Administration, Annual Energy Outlook 2010, available at *http://www.eia.doe.gov/oiaf/aeo/*

U.S. proven natural gas reserves are 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 already available for leasing and development.[51] 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.*"*[52]

Development of onshore unconventional resources has stressed water availability and quality in some areas. The Energy Policy Act of 2005 exempted hydraulic fracturing from regulation under the Safe Drinking Water Act, which has intensified concerns about the potential environmental impacts of hydraulic fracturing, focusing primarily on the potential for fracturing fluid, which may include chemical lubricants, gels, and biocides, to contaminate water supplies.[53] Coalbed methane production—another form of unconventional gas development—releases saline water from the coal seams that can also contain arsenic, lead and other heavy metals[54] and must be dealt with properly to avoid contamination of water supplies or destruction of pasture as has occurred in some areas of Wyoming.[55] 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.[56]

Natural gas also comes with the same price volatility concerns as oil. Between 2002 and 2008, average monthly U.S. well head prices soared more than 400 percent. Just a year later, in 2009, prices had fallen by two-thirds from their high in 2008. This has had a deleterious effect on some industries that rely on natural gas a key input—such as pulp and paper, metals, glass, and plastic—as well as end users like farmers, who must spend much more for natural gas-based fertilizer.

Nuclear

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[51] 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*

[52] Id.

[53] Steve Hargreaves, Natural gas vs. contaminated water, CNNMoney.com, July 29, 2008, available at *http://money.cnn.com/2008/07/28/news/economy/_shale_drilling/index.htm*.

[54] 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*.

[55] Hal Clifford, Wyoming's powder key, High Country News, Nov. 5, 2001, available at *http://www.hcn.org/issues/214/10823*.

[56] Vickie Welborn, "Competition for Water Raises Concerns" Shreveport Times, August 8, 2008.

With a fleet of 104 commercial nuclear reactors, the United States is by far the largest producer of nuclear power in the world. In 2009, nuclear accounted for 20 percent of total U.S. electric generation, a share that has remained relatively stable over the last two decades. While the number of commercial reactors has remained the same since 1998, the fleet capacity factor—or the percentage of the time the generators are running at full capacity—has increased from 78 percent to more than 90 percent.[57] While U.S. reactors were designed and commissioned to operate for 40-year lives, 59 commercial reactors have now received 20-year license extensions from the Nuclear Regulatory Commission (NRC), giving them up to a total of 60 years of operation. Extensions for 21 additional reactors are currently under review, and more are anticipated, according to NRC.[58]

Electric utilities have filed 17 applications with the Nuclear Regulatory Commission for 26 new reactor operating licenses since 2007, the first new reactor applications submitted to U.S. regulators in three decades. While some are reading this activity as an indication of a nuclear "renaissance", the nuclear industry continues to face significant challenges. The cost of new nuclear plants has ballooned in recent years and now approaches or exceeds the total market capitalization of many electric utility companies.[59]

While nuclear power is a mature technology that has been around for more than half a century, the industry's long-running inability to build safe reactors on time and on budget continues to make financing very difficult for new projects. According to the Congressional Budget Office for the more than 40 nuclear power projects underway since the partial-core meltdown at Three Mile Island in 1979, construction cost overruns exceeded 250 percent. 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.[60] The last reactor completed in the United States came online in 1996 after a construction period of 23 years. Since the nuclear building boom of the 1970s and 1980s, the nuclear industry and the number of skilled nuclear workers in the United States has contracted substantially, making a nuclear resurgence all the more difficult and less likely to be driven by domestic workers.

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[57] Energy Information Administration, Annual Energy Review, 2009. p277.

[58] Nuclear Regulatory Commission, *Status of License Renewal Applications and Industry Activities*, February 3, 2010,Available at http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html

[59] Lovins, Amory B., Invited testimony to the Select Committee on Energy Independence and Global Warming, Hearing on "Nuclear Power in a Warming World: Solution or Illusion?" (March 12, 2008) available at *http://globalwarming.house.gov/tools/assets/files/0401.pdf*

[60] Id.

Cost projections for new nuclear power plants have also increased dramatically and made it unlikely new projects can be financed without taxpayer-backed loan guarantees. The nuclear industry projects a new large reactor would cost around $2 billion to construct, which would place new projects at the low end of the $2 to $6 billion range seen for reactors completed since the mid-1980s (in 2007 dollars).[61] However, the 2007 Keystone Center study has found costs for the same plant could reach $4 billion. New plants are now expected to cost $6-8 billion each,[62] a figure which approaches or exceeds the total market capitalization of many electric power companies.

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 has estimated the risk of default on such loans to be "very high—well above 50 percent."[63]

The existing Department of Energy Loan Guarantee Program has been authorized to award $38.5 billion in loan guarantees,[64] more than half of which is specifically targeted at jumpstarting nuclear power. The Department has received 19 applications for federal loan guarantees to build 22 proposed nuclear power plants, totaling $122 billion in requested assistance. The Director of the Department's loan program office has stated that $18.5 billion could probably accommodate only two power plants unless coupled with additional financing assistance.[65] Additional financing from foreign 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 four. The Nuclear Energy Institute has stated that at no time "in the immediate future" are private companies anticipated to be able to finance new nuclear plants without the aid of federal loan guarantees. In recognition of this, the Nuclear Energy Institute endorsed the major energy infrastructure financing mechanism—the Clean Energy Deployment Administration—that was included

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[61] Congressional Research Service, Report RL33558, *Nuclear Energy Policy*, by Mark Holt (October 21, 2010) available at http://www.crs.gov/Products/RL/PDF/RL33558.pdf

[62] Nuclear Energy Institute, Policies That Support New Nuclear Power Plant Development (October 2009) available at http://www.nei.org/resourcesandstats/documentlibrary/newplants/factsheet/policiessupportnewplantdevelopment/?page=2

[63] 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.

[64] This does not include $2.5 billion appropriated through the Recovery Act which is estimated to support approximately $21 billion in loan guarantees. Department of Energy, Loan Guarantee Programs, (August 2010) available at http://www.energy.gov/recovery/lgprogram.htm

[65] Katherine Ling, "Nuclear Power: 17 apply for DOE loan guarantees, far exceeding available cash," *Greenwire, Oct. 2, 2008.*

in the American Clean Energy and Security Act that passed the House of Representatives in 2009.[66]

Loan guarantee commitments are offered conditionally, contingent upon an applicant subsequently receiving both a reactor design certification and a construction and operating license from the NRC.[67] On February 16, 2010, the Department of Energy announced the first of these nuclear loan guarantees, an $8.3 billion award to a consortium led by the Southern Company to support the construction of two nuclear reactors in Georgia.[68] The other recent loan guarantee deal that was in the final stages fell through when the applicant, Constellation Energy, pulled out after a disagreement over the financing terms offered by the loan guarantee program.[69] The Georgia project is unique in that, under Georgia state law, the consortium can begin recovering project costs from rate payers while the plants are under construction, several years before the project generates any power for its customers. This is another financing mechanism that utilities in some states are looking to replicate to help cover the huge cost of new nuclear projects.

Beyond the financing problem, nuclear power faces a major challenge in remaining competitive in electricity markets where low cost generation has priority dispatch to the grid. While the cost of nuclear power is very low on an operating basis, when the huge up-front capital costs are calculated into electricity rates charged to consumers, nuclear power becomes very expensive. Over the long term, the way nuclear power will overcome this and become more competitive is through the realization of its low-carbon benefits. That is why the CEOs of Constellation Energy (60 percent of its electric generation is from nuclear power), Exelon (the largest nuclear plant operator in the United States), Florida Power and Light (20 percent of generation from nuclear), and Entergy (50 percent of generation from nuclear) all support a national cap on greenhouse gas emissions.

Long-term nuclear waste disposal continues to be a problem as well. The Obama Administration requested no funding for the Yucca Mountain repository for FY 2011, instead determining that developing the Yucca Mountain repository is not a workable

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[66] Nuclear Energy Institute, June 26, 2009 available at http://www.nei.org/newsandevents/senatevotenuclearplantdeployment/nei-welcomes-inclusion-of-clean-energy-provisions-in-climate-bill-okd-by-house/

[67] Secretary Stephen Chu response to questions from Rep. Markey, December 22, 2009. See http://globalwarming.house.gov/mediacenter/pressreleases_2008?id=0186#main_content

[68] New York Times (ClimateWire), *DOE Delivers Its First, Long-Awaited Nuclear Loan Guarantee,* February 17, 2010, available at http://www.nytimes.com/cwire/2010/02/17/17climatewire-doe-delivers-its-first-long-awaited-nuclear-71731.html

[69] The Washington Post, *Constellation Energy shelves plan for Calvert Cliffs reactor,* October 13, 2010, available at http://www.washingtonpost.com/wp-dyn/content/article/2010/10/08/AR2010100807370.html

option and the nation needs a different solution for nuclear waste disposal.[70] Alternatives to Yucca Mountain are being evaluated by the Blue Ribbon Commission on America's Nuclear Future, which was formally established by the Department of Energy on March 1, 2010.

Renewables

Renewable sources of energy can and should become a major contributor to the U.S. electricity supply within the foreseeable future. Renewables such as wind, solar, biomass, geothermal, and hydro currently generate 10.5 percent of the country's electricity, with non-hydro renewables responsible for 3.6 percent.[71] Even with no changes to current policy, EIA projects renewable generation to account for 45 percent of the increase in total generation from through 2035. Assuming a long-term extension of the production tax credit (PTC), renewable energy's share of increased electricity generation grows to 61-65 percent through 2035.[72] Reaching 20 percent of total generation by 2020 is an ambitious, but achievable target for renewables based on the current state of the technologies and the available renewable resources.

Adoption of a national renewable electricity standard (RES) requiring that 20 percent of electricity generated in the United States come from renewable sources by 2020 should be a centerpiece of our national energy strategy. A key driver of renewable energy growth in the United States has been state-level RESs. Thirty States and the District of Columbia now have enforceable RESs or similar laws. In 2009, these states were responsible for 77 percent of total U.S. renewable energy.[73]

The types and quantities of renewable electricity required under these programs vary widely among the states, but it has become clear that states with RESs are deploying more renewable electricity generation than states without them. At the same time, RES policies are having little or no impact on consumer electricity rates and in many markets the renewable electricity is priced competitively with fossil fuel-based generation.[74] The

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[70] Department of Energy, FY2011 Budget Justification.

[71] Energy Information Administration, Annual Energy Review 2007, Table 8.2b Electricity Net Generation: Electric Power Sector, Selected Years, 1949-2007 (2007).

[72] Energy Information Administration, Annual Energy Outlook, 2010

[73] Energy Information Administration, Renewable Energy Consumption and Electricity Preliminary Statistics 2009, available at http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html

[74] Ryan Wiser & Galen Barbose, Renewable Portfolio Standards in the United States: A Status Report with Data Through 2007, Lawrence Berkeley National Laboratory (April 2008), available at http://eetd.lbl.gov/ea/EMS/reports/lbnl-154e-revised.pdf.

House of Representatives passed a national RES of 15 percent by 2020 in the 110th Congress and a national RES of 20 percent by 2020 in the 111th Congress, but neither measure passed in the Senate. Like many state programs, these House-passed RESs allowed a percentage of the renewable energy requirement to be fulfilled through utility programs that increase energy efficiency. This energy efficiency mechanism provides utilities with increased flexibility and gives regions with less renewable resources another way to achieve compliance, even providing lower utility bills to consumers in the process.

Tax incentives—including the existing Production Tax Credit (PTC) and the Investment Tax Credit (ITC)—also play a key role in deploying renewable electricity generation, providing a policy "bridge" that is helping the renewable energy industry survive in an environment where the benefits of low- and zero-carbon emissions are not properly valued by the market. These two policies have been a major driver of renewable energy development over the past several years by giving individuals, businesses, and utilities incentives to invest in renewable energy generation.

In response to a collapsed tax equity market in late 2008 that made it difficult for renewable energy developers to use these tax credits, the 1603 Treasury Grant Program was included in the American Recovery and Reinvestment Act to temporarily allow renewable energy developers to convert tax credits into cash grants of equal value. The highly successful program allowed the renewable energy industry to continue to grow during the recession, creating 55,000 jobs and directly leading to the deployment of 4,250 megawatts of renewable energy in 2009.[75]

The federal government has an important role to play in eliminating regulatory barriers to the expansion of renewable electricity generation. Despite the success of state-level initiatives to promote renewables, the balkanized structure for electricity regulation and the inconsistency of federal and state incentive programs have created a relatively unstable investment climate for the domestic renewable electricity market, limiting financing opportunities for individual projects and domestic manufacturing capacity. The federal government has a key role to play in helping to rationalize these programs and regulatory regimes to encourage expanded renewable electricity generation.

Wind

[75] American Wind Energy Association, Press Release: Tens of Thousands of Layoffs in American Wind Energy Seen at State in Tax Extender Package , December 7, 2010, available online at http://www.awea.org/rn_release_12-07-10.cfm

The global market for wind power grew 32 percent in 2009, as more than 38,000 megawatts of new wind capacity was installed worldwide. More than 10,000 megawatts of this was installed in the United States[76] where, for the second consecutive year, more wind capacity was installed than any other source.[77] Over the last five years, wind installations in the United States have expanded 39 percent annually.[78] Four U.S. states—all of which have state RESs—account for 51 percent of total U.S. wind capacity: Texas, Iowa, California, and Washington.[79] However, while the U.S. is the global leader in installed wind capacity, China is catching up quickly and may overtake the United States in 2010 or 2011.[80]

Department of Energy research suggests generating 20 percent of electricity from wind in the United States by 2030 is an ambitious yet feasible scenario, which would require a build-out of 300,000 megawatts of wind capacity.[81] The EIA projects 27,000 megawatts to be installed through 2013, which would bring total installed capacity to 62,000 megawatts.[82] To meet the 20 percent goal, wind turbine production capacity would have to ramp up to 16,000 new megawatts per year by around 2018,[83] up from a current baseline production capacity of nearly 8,000 megawatts per year.[84]

As wind technology continues to improve, prices are falling and capacity factors are increasing. The cost of wind energy over the past 20 years has dropped from 40 cents per kWh to 4 to 6 cents per kWh at good sites. Increases in the capacity factor of the

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[76] American Wind Energy Association, U.S. Wind Industry Annual Markey Report, Year Ending 2009, Available at http://e360.yale.edu/images/digest/Annual_Market_Report_Wind.pdf

[77] Energy Information Administration/Electric Power Annual 2008, available at ftp://ftp.eia.doe.gov/electricity/034808.pdf; and Energy Information Administration/Electric Power Annual 2009, U.S. Energy Information Administration/Electric Power Annual 2009, page 19, see
table 1.5. *Capacity Additions, Retirements and Changes by Energy Source, 2009* available at http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile1_5.pdf

[78] American Wind Energy Association, Windpower Outlook 2010, Available at http://www.awea.org/documents/reports/Outlook_2010.pdf

[79] Energy Information Administration, Electric Power Industry 2009: Year in Review (November 2010) available at http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html

[80] Pew Environment Group, *Who's Winning the Clean Energy Race?* (2010), Page 13. Available at http://www.pewglobalwarming.org/cleanenergyeconomy/pdf/PewG-20Report.pdf

[81] U.S. Department of Energy, 20% Wind Energy By 2030: Increasing Wind Energy's Contribution to the U.S. Electricity Supply (July 2008). Available at http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf.

[82] Energy Information Administration, Annual Energy Outlook 2011.

[83] U.S. Department of Energy, 20% Wind Energy By 2030: Increasing Wind Energy's Contribution to the U.S. Electricity Supply (July 2008). Available at http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf.

[84] Bloomberg New Energy Finance, Ethan Zindler, *Fostering Green Technology Innovation*, slide presentation, July 8, 2010.

turbines—or the percentage of time in which they are producing at their full capacity—have grown 11 percent over the past two years and will continue to increase as the technology improves. While most new wind turbines in the United States produce 1.5 to 2.5 megawatts of power, superconducting materials may enable the construction of 10 megawatt turbines in the near future. These larger machines will be well suited for offshore wind developments, plans for which have accelerated recently. In addition to the 130-turbine wind farm off the coast of Massachusetts that is poised to start construction in 2011, Cape Wind, there are at least 11 other offshore wind projects in development across seven states.[85] The available wind resources off U.S. coasts is massive, estimated by the National Renewable Energy Laboratory to be 4,150,000 megawatts, or more than four times the capacity of all existing U.S. electrical generation.[86]

Solar

More energy in the form of solar radiation strikes the Earth's surface in an hour than humanity uses in an entire year. Capturing this energy and converting it into electricity is primarily done through photovoltaic cells that convert sunlight into direct electrical current and concentrating solar power, which concentrates the sun's energy using huge mirrors or lenses and then uses this heat to run a conventional turbine.

Solar photovoltaics (PV) have experienced explosive growth over the last several years, with world capacity growing 44 percent in 2009 alone[87] and installed capacity has grown from 1,200 megawatts in 2000 to more than 20,000 megawatts in 2009.[88] Total U.S. solar electric capacity climbed past 2,000 megawatts in 2009, enough to serve more than 350,000 homes. Solar has expanded out of the residential and commercial rooftop niche, with more than 6,000 megawatts of utility-scale solar projects announced in the United States. The National Renewable Energy Laboratory has identified the potential for nearly 7,000,000 megawatts of solar thermal power generation in the southwestern United States, roughly seven times current U.S. electric generating capacity. Globally, research from the European Photovoltaic Industry Association and Greenpeace suggests

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[85] The Washington Post, *Offshore wind farm near Cape Cod, first in U.S., gets federal approval*, April 29, 2010, available at http://www.washingtonpost.com/wp-dyn/content/article/2010/04/28/AR2010042804398.html

[86] National Renewable Energy Laboratory, Large-Scale Offshore Wind Power in the United States; Assessment of Opportunities and Barriers (September 2010), available at http://www.nrel.gov/wind/pdfs/40745.pdf

[87] Solar Energy Industry Association, US Solar Industry Year in Review 2009 (April 15, 2010) available at http://seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf.

[88] European Photovoltaic Industry Association and Greenpeace, Solar Generation V – 2008 Solar electricity for over one billion people and two million jobs by 2020 (2008), available at http://www.greenpeace.org/raw/content/international/press/reports/solar-generation-v-2008.pdf.

that by 2030, global PV capacity could reach 1,864,000 megawatts and satisfy the electricity needs of 14 percent of the world's population.[89]

Technology advances and increases in the scale of production in the solar industry have exceeded those of any other renewable energy sector as prices for PV modules have fallen to less than $3.50 per watt from almost $100 per watt in 1975.[90] Solar PV prices have declined an average of 4 percent per year over the past 15 years.[91] The accumulation of innovations and movement down the technological learning curve experienced in solar PV is somewhat analogous to Moore's Law[92] in microelectronics. Over the long term, every time deployment of solar PV capacity doubles, the cost of solar falls by 18 percent. Projected forward, this learning curve would have solar PV reaching grid parity by 2020.[93] The Department of Energy's Solar America Initiative seeks to make solar PV cost-competitive with conventional forms of electricity by 2015. Huge investments in new production of polysilicon (the critical input for most PV cells) have come online recently, ending a temporary materials shortage and leading to a solar module price drop upwards of 50 percent over the past 2 years.[94]

Geothermal

The Earth produces more internal energy, in the form of heat, than humans can possibly use. Like solar, the use of geothermal energy is only limited by technology and the associated costs. Unlike solar, geothermal is a baseload power resource and not vulnerable to intermittency problems. While the United States has the most installed capacity of geothermal energy in the world -- about 2,500 megawatts across six states -- the amount of electricity produced from geothermal energy has essentially been flat for the past two decades. However, the American Recovery and Reinvestment Act created a

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[89] European Photovoltaic Industry Association and Greenpeace, Solar Generation V – 2008 Solar electricity for over one billion people and two million jobs by 2020 (2008), available at http://www.greenpeace.org/raw/content/international/press/reports/solar-generation-v-2008.pdf.

[90] This reflects crystalline silicon cell technology, which forms about 90% of the solar cell market. See Solar Buzz, Solar Module Retail Price Highlights: December 2010, Available at http://www.solarbuzz.com/Moduleprices.htm

[91] Solarbuzz. Fast Solar Energy Facts: Global Performance, available at http://www.solarbuzz.com/FastFactsIndustry.htm

[92] Moore's law describes the long-term trend in computing hardware in which the number of transistors that can be placed on an integrated circuit has doubled approximately every two years.

[93] Emanuel Sachs, in testimony to the Select Committee on Energy Independence and Global Warming, Hearing on "New Technologies: What's Around the Corner" (July 28, 2009) available at *http://globalwarming.house.gov/pubs?id=0007#main_content*

[94] Solar Energy Industry Association, US Solar Industry Year in Review 2009 (April 15, 2010) available at http://seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf.

building boom in the United States recently with 188 projects currently in different stages of development across fifteen states which could produce as much as 7,875 MW of new electric power.[95] The sector is expected to grow rapidly in several other countries as well over the next 5 years, ramping up global capacity by 78 percent to more than 19,000 megawatts in 2015.[96]

The United States has massive, untapped geothermal energy resources. Scientists with the U.S. Geological Survey (USGS) recently found that the electric generation potential from currently identified geothermal systems distributed over 13 U.S. states is more than 9,000 megawatts. Their estimated power production potential from yet to be discovered geothermal resources is more than 30,000 megawatts. An additional 500,000 megawatts may be available by harnessing geothermal reservoirs characterized by high temperature, but low permeability, rock formations.[97]

Biomass

Biomass currently supplies more electricity in the United States than wind, solar, and geothermal power combined, and the potential for additional generation from this energy source is vast. Biomass available for electricity generation includes residues from forests, primary mills, and agriculture, as well as dedicated energy crops and urban wood wastes. Biomass can be used as the sole fuel source for power plants, or it can be used in conventional power plants to substitute for a portion of the traditional fuel, typically coal, in a process called co-firing. While most co-firing plants use biomass for between 1 and 8 percent of heat input,[98] biomass can effectively substitute for up to 20 percent of the coal used in the boiler.[99] In addition to reducing lifecycle greenhouse gas emissions, co-firing biomass also lowers fuel costs, avoids landfilling, and reduces emissions of sulfur oxide and nitrogen oxide.

An EIA analysis of the impacts of a 15 percent national renewable electricity requirement found that electricity production from biomass could grow by a factor of

[95] Geothermal Energy Association, Geothermal grows 26% in 2009 GEA identifies new projects underway in 15 states, April 2010 Update Release, Available at http://geo-energy.org/pressReleases/April2010_Final.aspx

[96] ABS Energy Research, The Geothermal Energy Report - Direct Use and Power Generation, Edition 6 2010, available at http://www.absenergyresearch.com/cmsfiles/reports/Geothermal-Report-2010.pdf

[97] U.S. Geological Survey, Fact Sheet: Assessment of Moderate- and High-Temperature Geothermal Resources of the United States (2008), available at http://pubs.usgs.gov/fs/2008/3082/pdf/fs2008-3082.pdf.

[98] Zia Haq, Energy Information Administration, Biomass for Electricity Generation, available at http://www.eia.doe.gov/oiaf/analysispaper/biomass/.

[99] Federal Energy Management Program (FEMP), Biomass Cofiring in Coal-fired Boilers, DOE/EE-0288. (2004), available at http://www1.eere.energy.gov/femp/pdfs/fta_biomass_cofiring.pdf.

eight between 2005 and 2030.[100] Most of this generation would come in the southeastern United States, where nearly a third of the country's biomass feedstock potential exists.[101] The EIA found that the Southeast region could meet nearly its entire 15 percent renewable requirement through 2020 with indigenous biomass resources.[102] Using biomass for electricity would help the region create thousands of jobs, increase global export opportunities, and keep billions of dollars in the Southeast that would have otherwise left to import coal and other fuels from other states and countries.

Hydropower

Hydropower is the largest source of installed renewable electricity in the United States, providing 7 percent of U.S. electricity in 2009, and accounts for two-thirds of U.S. electricity generated from renewable resources.[103] Only China, Canada, and Brazil generate more electricity from hydropower than the United States.[104] The 78,000 megawatts of installed capacity in the United States has remained relatively unchanged over the past 3 decades.[105] However, with only 3 percent of the 80,000 existing dams in the United States currently generating electricity, there exists great potential for increased hydropower capacity additions. The vast majority of dams in the United States were built and are operated for purposes such as flood control navigation and water supply. The hydropower industry projects nearly 19,000 megawatts of new hydropower capacity could be added by 2025 at existing dam facilities through efficiency upgrades and capacity additions with the passage of an RES. A strong federal RES could also incentivize nearly 16,000 more megawatts of hydro capacity installations by 2025 using wave, ocean current, tidal, and inland hydrokinetic resources. None of these nearly 35,000 megawatts of new facilities would require a new dam, and they would only

[100] Energy Information Administration, Impacts of a 15-Percent Renewable Portfolio Standard at 9 (Table 2: Summary Results) (June 2007), available at http://www.eia.doe.gov/oiaf/servicerpt/prps/pdf/sroiaf(2007)03.pdf.

[101] Marie Walsh et al., Oak Ridge National Laboratory, Biomass Feedstock Availability in the United States: 1999 State Level Analysis (Jan. 2000), available at http://bioenergy.ornl.gov/resourcedata/index.html.

[102] Energy Information Administration, Regional Generation Impacts of a 15-Percent Renewable Portfolio Standard (RPS) (Supplement to Report #: SR-OIAF/2007-03) (June 2007), available at http://www.eia.doe.gov/oiaf/servicerpt/prps/pdf/regional_generation.pdf .

[103] National Hydropower Association, Hydropower: For a Clean Energy Future Fact Sheet, available online at *http://www.hydro.org/hydrofacts/two-pager4.pdf*

[104] Energy Information Administration, International Electricity Generation, available at http://www.eia.doe.gov/emeu/international/electricitygeneration.html

[105] Energy Information Administration, Annual Energy Review 2009, at 264.

scratch the surface of the 371,000 megawatts of new hydro resource potential in the United States.[106]

An Overview of the Climate Change Crisis

A clear scientific consensus now holds that climate change is occurring and that greenhouse gases (GHGs) emitted from human activities are largely responsible. During the past two centuries of industrialization, atmospheric concentrations of GHGs have increased dramatically, a shift comparable to that seen over the last 20,000 years as the Earth naturally transitioned out of its last ice age.[107] Concentrations of carbon dioxide (CO_2), the dominant GHG emitted by human activities, have increased from about 280 parts per million (ppm) in 1750[108] to nearly 390 ppm in 2010[109] and are now approximately 30 percent above the highest levels of the preceding 800,000 years.[110] This has produced a dramatic shift in ocean chemistry, disrupting the delicate acid-base balance to which marine organisms are accustomed. Global average surface temperature has increased about 1.4 °F over the past century. These changes are already causing a broad range of adverse impacts to human and natural systems. Failure to rapidly reduce GHG emissions will result in even more catastrophic impacts at a global scale.

If emissions of GHGs continue to grow unabated, the likely near- to medium-term impacts of unchecked climate change may include:

- Increasingly severe water scarcity, subjecting up to 1.2 billion additional people in Asia, up to 250 million people in Africa,[111] and up to 80 million people in Latin America to increasing water stress by 2020.[112]

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[106] Navigant Consulting, *Job Creation Opportunities in Hydropower* (September 20, 2009)

[107] As reported by the Intergovernmental Panel on Climate Change's Fourth Assessment Report, the total CO2-equivalent concentration of all GHGs is 455 ppm. See http://www.ipcc.ch/

[108] Intergovernmental Panel on Climate Change, Working Group I: The Physical Science Basis (2007). Available at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-2-1.html

[109] National Oceanic and Atmospheric Administration, 2010. Recent Mauna Loa CO2. available at http://www.esrl.noaa.gov/gmd/ccgg/trends/

[110] Karl, T., J. Melillo, and T. Peterson, (eds.), Global Climate Change Impacts in the United States, Cambridge University Press. (2009) Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[111] Intergovernmental Panel on Climate Change, Climate Change, 2007. Impacts, Adaptation and Vulnerability, Summary for Policy Makers.

[112] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water.

- Further warming and acidification of the oceans, severely impacting global fisheries and contributing to the collapse of coral reefs around the world.[113] Ocean acidification has already risen by about 30 percent due to increased carbon pollution since 1750.

- Expected sea level rise of approximately 3 to 4 feet and possibly as much as 6.5 feet by 2100,[114] subjecting roughly a billion people living in coastal areas around the world to increased risk of inundation, storm surges, coastal erosion, and saltwater intrusion into freshwater supplies.

- Increased heavy precipitation events and flooding, as well as more powerful hurricanes.[115, 116]

- Mass extinction of species, perhaps 40 percent of the world's species by the latter half of this century.[117]

- Multiple adverse effects on public health associated with more frequent and intense heat waves, ground-level ozone air pollution, and the spread of infectious diseases.[118]

Tragically, these impacts will fall disproportionately on vulnerable communities, particularly in developing countries that are least responsible for climate change and least able to adapt to its impacts. Still, the United States and other developed countries will suffer devastating economic, environmental, and human health impacts if climate change continues unabated.

The potential costs of climate change are staggering. Economic studies suggest that climate change could cost the global economy 5 to 20 percent of gross domestic

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113 National Oceanic and Atmospheric Administration, 2008. Ocean Acidification State of the Science Fact Sheet, Available at http://www.pmel.noaa.gov/co2/OA/Ocean_Acidification%20FINAL.pdf

114 Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

115 Knutson, T., 2008. Global Warming and Hurricanes. Available at http://www.gfdl.noaa.gov/global-warming-and-hurricanes

116 Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

117 Intergovernmental Panel on Climate Change, Climate Change, 2007. Impacts, Adaptation and Vulnerability, Summary for Policy Makers.

118 Intergovernmental Panel on Climate Change, Climate Change, 2007. Impacts, Adaption and Vulnerability. Available at http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch8s8-4-2.html

product (GDP).[119] In the United States, even a narrow range of climate change impacts could slash GDP 3.6 percent by 2100.[120] These costs far outweigh the potential costs of economy-wide legislation to reduce carbon pollution.[121]

Climate change presents a serious and growing risk to the U.S. security interests around the world. Climate change is expected to act as a "threat multiplier"[122] by increasing the risk of water and food scarcity, mass migration, resource conflict, and political destabilization. Climate change will also adversely affect military and strategic infrastructure, both in the United States and abroad.

In order to avert the most catastrophic consequences of climate change, human-caused GHG emissions must be cut substantially. The Intergovernmental Panel on Climate Change (IPCC), the leading international climate science body, has concluded that to secure even a 50-50 chance of avoiding the dangerous climate change associated with a 3.6 ºF increase in global average surface temperature, global GHG emissions must be reduced by 50 to 85 percent by 2050.[123] This requires the United States and other developed countries to reduce emissions by at least 80 percent by 2050.[124] Strong interim mitigation targets are also needed, including a reduction of U.S. emissions by at least 17 percent by 2020. To accomplish these goals, it is necessary to dramatically increase the amount of clean energy and energy efficiency deployed around the world, an energy technology revolution that the United States must lead.

Scientific Consensus on Climate Change

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[119] Stern, N., 2006. Stern Review: The Economics of Climate Change.

[120] Ackerman, F., and E. Stanton, 2008. The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked. Natural Resources Defense Council. Available at http://www.nrdc.org/globalwarming/cost/cost.pdf

[121] Ackerman, F., and E. Stanton, 2008. The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked. Natural Resources Defense Council. Available at http://www.nrdc.org/globalwarming/cost/cost.pdf

[122] McGuinn, Admiral Dennis, Testimony before the Select Committee on Energy Independence and Global Warming, Not Going Away: America's Energy Security, Jobs and Climate Challenges (2010) Available at http://globalwarming.house.gov/pubs?id=0024

[123] Intergovernmental Panel on Climate Change, 2007. Mitigation of Climate Change Summary for Policymakers; and Luers, A., et al., *How to Avoid Dangerous Climate Change: A Target for U.S. Emission Reductions*. Union of Concerned Scientists. (2007) Available at http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/a-target-for-us-emissions.html.

[124] Intergovernmental Panel on Climate Change, 2007. Mitigation of Climate Change Summary for Policymakers; and Luers, A., et al., How to Avoid Dangerous Climate Change: A Target for U.S. Emission Reductions. Union of Concerned Scientists. (2007) Available at http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/a-target-for-us-emissions.html.

A clear scientific consensus now holds that climate change is happening and that human-caused greenhouse gas (GHG) emissions are the primary cause. "Climate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems."[125] This is the conclusion of the National Research Council, the leading scientific body in the United States, in their comprehensive assessment *America's Climate Choices*. In fact, every major professional science organization working in fields relevant to climate change (e.g., the American Meteorological Society, the American Chemical Society, etc.) and national academies around the world agree that human emissions of GHGs are now the dominant driver of climate change. No scientific body of national or international standing rejects the conclusion that climate changes are being driven by human activities.[126,127] There is now a vast body of scientific evidence that provides the basis for strong mitigation and adaptation actions. The consequences of failing to reduce GHG emissions will be catastrophic.

Background on Global Warming and Ocean Acidification

Global warming refers to the global temperature rise and associated impacts from the increase of GHGs in the atmosphere associated with human activities, primarily the burning of fossil fuels. The build-up of these gases enhances the so-called "greenhouse effect" and warms the Earth's climate system. As the glass of a greenhouse traps warm air inside, these gases trap heat that would otherwise escape into space. Key human-emitted GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, and certain fluorine-containing gases (F-gases) such as chlorofluorocarbons, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The impact of each gas on the climate is determined by its heat-trapping potency, concentration, and atmospheric lifetime. The IPCC declared in its 2007 Fourth Assessment Report that the evidence for global warming is "unequivocal."[128] 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.[129]

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[125] National Research Council, America's Climate Choices (2010), Available at http://americasclimatechoices.org/

[126] Gleick, Peter, Testimony before the Select Committee on Energy Independence & Global Warming Hearing *Not Going Away: America's Energy Security, Jobs and Climate Challenges.* (December 1, 2010) Available at http://globalwarming.house.gov/pubs?id=0024#main_content

[127] Scientific societies' letter to U.S. Senators, (October 21, 2009) Available at http://www.aaas.org/news/releases/2009/media/1021climate_letter.pdf

[128] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

[129] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

There is overwhelming scientific evidence that humans are the primary cause of global warming. The GHGs building up in atmosphere are the same type that humans are emitting by burning fossil fuels and clearing forests. Satellite measurements show that these GHGs are permitting less heat to escape out to space and ground observations show that they are heating up Earth's surface. Further, natural causes of climate change are not capable of explaining either the magnitude or patterns of observed warming. If the sun was responsible, for example, warming would be observed throughout the atmosphere. Instead, scientists see the fingerprint of GHGs: warming isolated to the lower atmosphere and cooling in the upper atmosphere. Indeed, the IPCC has estimated that the global warming contribution, or radiative forcing, from human activities is 10 times larger than the best estimates of the changes from solar activity.[130] A 2007 study found that all the trends in solar activity that could influence the temperature of the Earth have been in the opposite direction needed to explain the rise in temperature over the preceding 20 years.[131] In addition to direct observational evidence, modeling results also confirm the human fingerprint on global warming. These fundamental conclusions related to human attribution of climate change were made clear in expert testimony before the Select Committee during the 111th Congress, including in-depth discussion by Dr. Ben Santer of Lawrence Berkeley National Laboratory and Dr. James Hurrell of the National Center for Atmospheric Research.[132] Given abundant evidence, the IPCC concluded in its 2007 assessment that most of the observed global warming of the past half-century is very likely—with greater than 90 percent certainty—due to the increase of heat-trapping gases associated with human activities.[133]

In addition to global temperature rise, human-emitted CO_2 is causing rapid ocean acidification. Excess CO_2 in the atmosphere from human activities enters the ocean, forming carbonic acid and lowering the pH of the seawater. For example, over the mid-1980s to mid-2000s, the upper ocean absorbed approximately 30 percent of the excess CO_2 emitted through human activities.[134] In response, the upper ocean has become

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[130] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

[131] Lockwood and Froehlich, 2007. Recent Oppositely Directed Trends in Solar Climate Forcings and the Global Mean Surface Air Temperature, Proceedings of the Royal Society, Vol. 463.

[132] Santer, B. Testimony before the Select Committee on Energy Independence & Global Warming. Hearing entitled *Climate Science in the Political Arena*. (May 20, 2010) Available at http://globalwarming.house.gov/pubs?id=0019#main_content; Hurrell, J., 2010. Testimony before the Select Committee on Energy Independence & Global Warming Hearing entitled *The Foundation of Climate Science (May 6, 2010)* available at http://globalwarming.house.gov/pubs?id=0018#main_content

[133] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

[134] National Oceanic and Atmospheric Administration, 2005. Impacts of Anthropogenic CO2 on Ocean Chemistry and Biology Available at http://www.oar.noaa.gov/spotlite/spot_gcc.html

30 percent more acidic over the Industrial Era,[135] a rate of change that is at least 100 times more rapid than at any period in at least the preceding 650,000 years.[136]

Global Emissions of Greenhouse Gases

Of all human-emitted GHGs, CO_2 is most responsible for committing the world to long-term climate change. CO_2 accounts for approximately 77 percent of recent long-lived human-caused GHG emissions (in terms of carbon dioxide equivalents, CO_2-eq, evaluated over a 100-year time horizon).[137] Over the past several decades, about 80 percent of human-caused CO_2 emissions resulted from the burning of fossil fuels, while about 20 percent resulted from deforestation and agricultural practices occurring primarily in developing countries.[138]

After CO_2, the other primary long-lived GHGs are methane, nitrous oxide, and F-gases. Methane emissions derive primarily from agriculture, livestock, mining, transportation, use of certain fossil fuels, sewage, and landfill waste. Currently, methane accounts for approximately 14 percent of global GHG emissions (i.e., CO_2-eq).[139] Nitrous oxide is emitted during agricultural and industrial activities as well as during combustion of fossils fuels and solid waste.[140] Nitrous oxide accounts for approximately 8 percent of recent global GHG emissions (CO_2-eq).[141] F-gases are very potent GHGs that are emitted during refrigeration, air conditioning, and industrial processes. F-gases account for approximately 1 percent of recent global GHG emissions (CO_2-eq).[142]

In addition to long-lived GHGs, tropospheric ozone and water vapor are important GHGs that are short-lived in the atmosphere. Changes in tropospheric ozone concentrations result from emissions of chemicals such as nitrogen oxides, carbon monoxide, and hydrocarbons. While the atmospheric lifetime of tropospheric ozone is relatively short compared to many other GHGs, its instantaneous warming effect is

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[135] National Oceanic and Atmospheric Administration, (2008) available at http://www.pmel.noaa.gov/co2/OA/Ocean_Acidification%20FINAL.pdf

[136] Feeley, R., et al., 2006. Carbon Dioxide and Our Ocean Legacy. Available at http://www.pmel.noaa.gov/pubs/PDF/feel2899/feel2899.pdf

[137] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[138] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[139] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[140] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[141] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[142] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

substantial, about one-fifth of the instantaneous warming associated with human-caused CO_2.[143] Water vapor is a naturally-occurring, short-lived GHG. The amount of water vapor in the atmosphere is dependent on temperature and is not a *direct* result of human activities, but does respond indirectly; as the ocean and atmosphere warm from other GHGs, more evaporation occurs and the atmosphere's capacity to retain moisture also increases, thereby increasing the water vapor concentration.

Over the past two decades, growth in the world economy and its carbon intensity has driven a marked increase in GHG emissions. Between 1990 and 2004, global GHG emissions grew by 24 percent.[144] In 2000, the IPCC developed emissions scenarios that projected an increase of global GHG emissions of 25 to 90 percent (CO_2-eq) from 2000 to 2030.[145] However, recent (2000 – 2007) trends in emissions are higher than the worst case scenario. The growth rate in emissions increased markedly from 1.3 percent per year in the 1990s to 3.3 percent per year for the period 2000 - 2006.[146] In 2007, the IPCC developed an updated set of scenarios that show similar emissions growth by 2030, but they also make clear that more rapid growth is possible.[147] Fossil fuel CO_2 emissions reached a record high in 2008 and subsequently declined slightly in 2009 by 1.3% due in part to the global economic downturn.[148] Under current mitigation policies, however, global GHG emissions will continue to grow over the next few decades.[149] By some estimates, GHG emissions from developing and emerging countries are expected to grow by 84 percent from 2000 to 2025, while GHG emissions from developed countries are expected to rise 35 percent over the same period.[150]

National statistics show a complex and changing environment for the sources of GHG emissions. In 2008, two-thirds of global GHG emissions originated from just ten countries, with China and the United States together responsible for 41 percent.[151] While China is now the largest GHG emitter on an annual basis, the United States continues to

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[143] Intergovernmental Panel on Climate Change. 2007.

[144] Intergovernmental Panel on Climate Change, 2007. Mitigation of Climate Change, Summary for Policymakers.

[145] United Nations Environment Programme, 2009. Climate Change Science Compendium.

[146] United Nations Environment Programme, 2009. Climate Change Science Compendium.

[147] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[148] Global Carbon Project, 2010. Available at http://www.globalcarbonproject.org/carbonbudget/09/hl-full.htm#ffcement

[149] United Nations Environment Programme, 2009. Climate Change Science Compendium.

[150] World Resources Institute. Projected Emissions of GHGs in 2025 Available at http://cait.wri.org/figures.php?page=ntn/3-1

[151] International Energy Agency, 2010. CO2 Emissions from Fuel Combustion 2010. Available at http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2143

have one of the highest per capita emissions rates. As of 2008, the United States emitted 19 percent of global CO_2 from 5 percent of the world's population.[152] In contrast, China contributed 22 percent of global CO_2 from 20 percent of the population.[153] India contributed less than 5 percent of CO_2 from 17 percent of the population.[154]

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 2005, the United States led all countries by contributing 26 percent of global cumulative CO_2 emissions and the EU-27 nation grouping contributed 22 percent.. China's cumulative contribution was 10 percent and India's was 8 percent.[155] In contrast, from 2000 to 2025, China and India's emissions are expected to grow by 118 and 70 percent respectively, while emissions from the United States are expected to grow by 39 percent.[156] Strong new mitigation policies will be required to prevent emissions growth consistent with these projections.

Emissions of GHGs in the United States derive from a variety of sources and have on the whole been on a growth trajectory. As of 2008, 83 percent of U.S. GHG (i.e., CO_2-eq) emissions came from CO_2, emitted almost entirely from energy-related fossil fuel burning. The remaining GHG emissions were comprised of CH_4 (11 percent of all U.S. CO_2-eq emissions), N_2O (4 percent), and F-gases (3 percent). U.S. energy-related CO_2 emissions come from the following end-use sectors: the electric power sector (41 percent), transportation sector (33 percent), and residential, commercial, and industrial sectors (26 percent).[157] 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.

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152 International Energy Agency, 2010. CO2 Emissions from Fuel Combustion 2010. Available at http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2143

153 International Energy Agency, 2010. CO2 Emissions from Fuel Combustion 2010. Available at http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2143

154 International Energy Agency, 2010. CO2 Emissions from Fuel Combustion 2010. Available at http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2143

155Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2010)

156 World Resources Institute. Projected Emissions of GHGs in 2025. Available at http://cait.wri.org/figures.php?page=ntn/3-1

157 Energy Information Agency, Emissions of Greenhouse Gases Report (2009) Available at www.eia.doe.gov/oiaf/1605/ggrpt/index.html

Emissions of CO_2 from all sources grew from 5.02 billion metric tons in 1990 to a record high of 6.03 billion metric tons in 2005.[158] While the long-term emissions trend has been up, year-to-year fluctuations result from a multitude of factors, including economic conditions, weather, and fuel switching in response to price changes. The recent economic downturn combined with a change in energy use–including a substantial switch from coal to natural gas and increased use of renewables for electricity generation–reduced CO_2 emissions in the United States during the last few years. For example, CO_2 emissions from fossil fuels declined 6.6 percent in 2009.[159] However, the current economic recovery is expected to contribute to a rise of CO_2 emissions of 2.1 percent and 1.1 percent for 2010 and 2011, respectively.[160]

Greenhouse Gas Concentrations and Reduction Requirements

The current concentrations of GHGs in the atmosphere are unprecedented in Earth's recent history. Records over the past 800,000 years show variations in atmospheric CO_2 concentrations within a range of approximately 170 to 300 ppm.[161] Human-caused CO_2 emissions since the Industrial Revolution have pushed the concentration from approximately 280 parts per million (ppm) to nearly 390 ppm.[162] The current concentration of CO_2 is roughly 30 percent higher than the highest level of the past 800,000 years.[163] Over the same period, methane has increased from about 715 parts

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[158] Energy Information Agency, Emissions of Greenhouse Gases Report. (2009) Available at http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html

[159] Energy Information Agency, Short-term Energy and Summer Fuels Outlook (2010) Available at http://www.eia.doe.gov/emeu/steo/pub/contents.html#Overview

[160] Energy Information Agency, Short-term Energy and Summer Fuels Outlook (2010) Available at http://www.eia.doe.gov/emeu/steo/pub/contents.html#Overview

[161] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press, available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[162] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[163] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

per billion (ppb) to 1774 ppb and nitrous oxide has increased from about 270 ppb to 319 ppb.[164]

In the absence of mitigation policies, GHG concentrations will continue on a dangerous trend. For example, CO_2 concentrations could increase to 2 to 3 times the highest levels from the past 800,000 years by the end of the 21st century.[165] The IPCC has concluded that to create even a 50-50 chance of avoiding the dangerous climate change associated with a 3.6 ºF increase in global average surface temperature, global GHG emissions must be reduced by 50 to 85 percent by 2050. This requires the United States and other developed countries to reduce emissions by at least 80 percent by 2050.[166] Given the current emissions growth both in the United States and globally, a substantial change of course is required in the very near term to avoid the catastrophic impacts outlined in later sections.

Black Carbon

Black carbon is a potent, short-lived driver of climate change. Unlike GHGs, black carbon is a particle pollutant, which is emitted as a component of soot during incomplete combustion of fossil fuels and biomass. Black carbon alters Earth's energy balance by absorbing sunlight (1) independently in the atmosphere, (2) in water droplets and ice crystals in clouds, and (3) when deposited on snow and ice surfaces.[167] Currently, black carbon is likely the second or third largest driver of global warming and plays a particularly large role in modifying the Arctic climate.[168]

Global emissions of black carbon derive from energy-related combustion and outdoor biomass burning. Of the approximately 8 million tons of black carbon released each year,[169] about 58 percent is emitted through energy-related combustion and 42

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[164] Intergovernmental Panel on Climate Change, 2007. Synthesis Report.

[165] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[166] Intergovernmental Panel on Climate Change, 2007. Mitigation of Climate Change, Summary for Policymakers at 38-39 (Table TS.2); and Luers, A., et al., 2007. How to Avoid Dangerous Climate Change: A Target for U.S. Emission Reductions. Union of Concerned Scientists. Available at http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/a-target-for-us-emissions.html.

[167] Ramanathan, V. and G. Carmichael, 2008. Global and regional climate changes due to black carbon. Nature Geosciences, Vol. 1.

[168] Jacobson, M., 2010. Short-term effects of controlling fossil-fuel soot, biofuel soot and gases, and methane on climate, Arctic ice, and air pollution health. Journal of Geophysical Research, Vol. 115.

[169] Ramanathan, V. and G. Carmichael, 2008. Global and regional climate changes due to black carbon. Nature Geosciences, Vol. 1.

percent is emitted through outdoor biomass burning.[170,171] Residential emissions of black carbon are due largely to home heating and cooking (e.g., using wood, coal, crop residue, dung, and diesel fuel). Diesel fuel vehicles are the dominant source in the transportation sector. In the industrial sector, iron and steel production are major sources. Outdoor biomass burning is largely associated with deforestation activities and the burning of crop residue.[172]

Currently, global emissions of black carbon are dominated by Asia (59 percent), followed by Europe (12 percent), South America (10 percent), Africa (10 percent), and North America (9 percent).[173] In developed countries such as the United States, energy-related combustion, primarily related to diesel fuel, is now the leading source of black carbon. Energy-related combustion also dominates emissions in Asia, though with a much larger contribution from residential sources. In contrast, outdoor burning of biomass is the leading cause of emissions in South America and Africa.

In March of 2010, the Select Committee held a hearing to explore opportunities for reducing black carbon emissions in the United States and abroad.[174] According to the expert testimony, there are substantial climate benefits associated with reducing black carbon emissions and the technologies to do so are already available. Residential emissions of black carbon may be reduced with cleaner cook stoves (e.g., improved-combustion, solar-powered, electric, and gas). Transportation sector emissions may be reduced through the phase out of two-stroke engines, upgrades to higher quality, low-sulfur fuels (e.g., ultra-low sulfur diesel or natural gas), improved engine technology, and engine retrofits for existing diesel vehicles. In the industrial sector, emissions may be reduced substantially by capturing particle pollution from coke ovens and blast furnaces used in steel and iron production. Changes in agricultural and forestry practices could yield large reductions from biomass burning.

Since black carbon has a short atmospheric lifetime, the benefits of emissions reductions could be achieved rapidly. However, it is very important to note that black carbon is co-emitted with other climate-modifying aerosols, including those that act as

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[170] Bond, T., et al., 2004. A technology-based global inventory of black and organic carbon emissions from combustion. Geophysical Research; Letters, Vol. 109.

[171] Bond, T. 2007. Testimony for the Hearing on Black Carbon and Climate Change, House Committee on Oversight and Government Reform. Available at http://oversight.house.gov/images/stories/documents/20071018110647.pdf

[172] Ramanathan, V. and G. Carmichael, 2008. Global and regional climate changes due to black carbon. Nature Geosciences, Vol. 1.

[173] Climate Institute. 2009. How does black carbon change the climate debate? Climate Alert, Vol. 19.

[174] Select Committee, 2010. Clearing the Smoke: Understanding the Impacts of Black Carbon Pollution. Available at http://globalwarming.house.gov/pubs?id=0016#main_content

cooling agents. Still, the fast-acting nature of black carbon emission reductions could be important in preventing the climate system from passing certain tipping points of rapid and irreversible change and greatly improve human health, particularly in developing countries.[175]

Observed and Projected Climate Change

As atmospheric GHG concentrations have increased, the global temperature has increased about 1.4 ºF over the past century. The 2010 meteorological year was the hottest on record dating back to 1880.[176] This follows on the heels of the hottest decade (2000-2009) on record, breaking the previous record held by the 1990s, which broke the previous record of the 1980s. Additionally, every year in the 2000s was warmer than the 1990s average, and every year in the 1990s was warmer than the 1980s average.[177] Historical trends in the temperature record also show that the rate of warming is increasing: the rate of warming was 0.08 ºF per decade for the period 1850 – 2005; 0.11 – 0.13 ºF per decade for 1901 – 2005; and 0.29 - 0.31 ºF per decade for 1979 – 2005.[178]

Global temperatures are expected to continue to rise. Over the next two decades, global temperatures are projected to increase approximately 0.36 ºF per decade for a range of emissions scenarios.[179] Beyond that time frame, the expected temperature rise depends largely on future emissions that will in turn depend on a variety of factors, including energy and climate policies of countries around the world. By the end of this century, if there is no change in policies, global temperatures are expected to increase in a likely range varying from 2 – 11.5 ºF globally[180] and 4 to 11 ºF in the United States[181] for a broad range of future emission scenarios. It should be emphasized, however, that current trends in emissions are consistent with, or higher than, the scenarios on the high end of this range.

The oceans have experienced both significant warming and acidification due to increases in the atmospheric concentration of GHGs. Thus far, oceans have absorbed

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[175] Jacobson, M., 2010. Short-term effects of controlling fossil-fuel soot, biofuel soot and gases, and methane on climate, Arctic ice, and air pollution health. Journal of Geophysical Research, Vol. 115.

[176] Kintisch, E., 2010. NASA: 2010 Meteorological Year Warmest Ever. Science.

[177] National Oceanic and Atmospheric Administration. Available at http://www.ncdc.noaa.gov/img/climate/research/2009/decadal-global-temps-1880s-2000s.gif

[178] Intergovernmental Panel on Climate Change, 2007.

[179] Intergovernmental Panel on Climate Change, 2007 Synthesis Report.

[180] Intergovernmental Panel on Climate Change, 2007 Synthesis Report.

[181] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

approximately 90 percent of the excess heat trapped in the climate system because of human activities. This is due in part because ocean water has a heat capacity 1,000 times greater than that of the air in the atmosphere. Most of the warming is occurring within a few hundred feet of the sea surface; the sea surface itself has warmed about 1.4 ºF over the past century.[182] Increasing concentrations of CO_2 have also acidified the world's oceans by approximately 30 percent over pre-industrial levels.[183] If the current CO_2 emissions trend continues, the ocean will experience acidification to an extent and at rates that have not occurred for tens of millions of years.

In May 2010, the Select Committee examined the fundamental climate changes occurring to Earth's atmospheric, marine, and terrestrial environments.[184] Dr. James Hurrell of the National Center for Atmospheric Research told the Committee that the global warming is accelerating; the rate of warming in the last 50 years is nearly twice that of the warming over the 100-year trend.[185] Dr. James McCarthy of Harvard University reported that scientists now know that the oceans have absorbed about one-third of the CO_2 released from fossil fuel burning in the Industrial Era, threatening a range of calcifying organisms and the marine ecosystems dependent on them.[186] The expert testimony made clear that a broad range of adverse climate change impacts are expected to intensity if human-caused GHG emissions are not curbed substantially.

Climate Change Impacts

The warming of the climate system produces many complex responses, which then lead to a range of impacts on human and natural systems. It bears emphasis that the observed warming and ocean acidification to date has already produced many documented climatic changes. As warming and acidification continue, more dramatic changes are expected. Here, we discuss some examples of climate change impacts.

Ice in the Arctic

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[182] Intergovernmental Pannel on Climate Change, 2007. Fourth Assessment Report.

[183] National Oceanic and Atmospheric Administration, 2008. Ocean Acidification State of the Science, Available at http://www.pmel.noaa.gov/co2/OA/Ocean_Acidification%20FINAL.pdf

[184] Select Committee, Hearing on *The Foundation of Climate Science* (May 6, 2010) , available at http://globalwarming.house.gov/pubs?id=0018#main_content

[185] Hurrell, J., 2010. Testimony before the Select Committee on Energy Independence and Global Warming, *The Foundation of Climate Science* (May 6, 2010) available at http://globalwarming.house.gov/files/HRG/050510climateScience/hurrell.pdf

[186] McCarthy, J., 2010. Testimony before the Select Committee on Energy Independence and Global Warming Hearing " The Foundation of Climate Science" (May 6, 2010) available at http://globalwarming.house.gov/files/HRG/050510climateScience/mcCarthy.pdf

The Arctic region is warming at a staggering rate. By the decade of the 2000s, much of the Arctic warmed by 1.8 – 3.6 ºF relative to the period 1951 to 1980, a level of warming that exceeded most other regions on Earth. Since 1950, northern Greenland has experienced warming of 2.7 – 3.6 ºF.[187] The amplified climate response in the Arctic is thought to be due in large part to the melting of Arctic ice.[188] Ice acts like a mirror to the sun's energy, reflecting much of the energy back out into space. As Arctic ice disappears, dark ocean water and land is revealed, which soaks up more sunlight and heat and thereby accelerates warming and melting.

As temperatures rise in the Arctic, sea ice is disappearing. The Arctic sea ice extents in the last four years (2007 to 2010) have been the four lowest on record.[189] In 2010, the extent of ice in the Arctic was the third-lowest recorded since observations began in 1979[190] and the area of missing ice compared to the baseline period of 1979 - 2000 was nearly five times the size of California.[191] The amount of multi-year ice has been in decline, as has the thickness of ice. From submarine measurements, researchers have observed an average loss of nearly two meters of Arctic sea ice between 1980 and 2008, almost half of the average ice thickness.[192]

Leading models predict that Arctic summer sea ice may completely disappear within the next 30 years and possibly as early as the 2020s, though the precise timing is uncertain.[193] A recent international assessment projects that the polar bear population will decline by more than 30 percent in 45 years due to reduced habitat range and quality.[194] The loss of stable, year-round sea ice is also disrupting traditional seal-hunting and fishing practices on which Inuit livelihoods depend, endangering an entire way of life.

The ice covering Arctic land areas is also melting and contributing to global sea level rise. In Greenland, for example, around 385 cubic miles of ice was lost between April 2002 and February 2009, equivalent to a half millimeter per year of global sea level

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[187] National Aeronautic and Space Administration. Available at http://data.giss.nasa.gov/gistemp/graphs/Greenland.pdf

[188] Arctic Council and the International Arctic Science Committee, 2004. Arctic Climate Impact Assessment. Available at http://www.acia.uaf.edu/

[189] National Snow and Ice Data Center. Available at http://nsidc.org/arcticseaicenews/

[190] National Snow and Ice Data Center. Available at http://nsidc.org/arcticseaicenews/

[191] National Snow and Ice Data Center. Available at http://nsidc.org/arcticseaicenews/

[192] Copenhagen Diagnosis (2009) Available at http://www.ccrc.unsw.edu.au/Copenhagen/Copenhagen_Diagnosis_LOW.pdf

[193] National Oceanic and Atmospheric Administration. Available at http://www.arctic.noaa.gov/future/sea_ice.html

[194] International Union for Conservation of Nature and Natural Resources, 2010. Ursus Maritimus. Available at http://www.iucnredlist.org/apps/redlist/details/22823/0

rise.[195] Further, the rate of ice loss from Greenland has been accelerating,[196] meaning the contribution to global sea level will continue to grow with time.

Melt-water from Arctic land areas may alter ocean currents, potentially disturbing marine ecosystems and weather patterns. As the Arctic permafrost (frozen soil) melts, massive amounts of methane may be released as the carbon-rich soils are exposed to microbial degradation. Since methane is a potent GHG, these emissions will produce a positive feedback that will drive additional warming and subsequent methane emissions.[197] At predicted rates of thaw, it is expected that methane emissions from melting permafrost will contribute an additional 20 to 40 percent to all global methane emissions (natural and manmade) by 2100 and thereby contribute a projected +0.58 ºF to global temperatures.[198] The loss of permafrost is also causing extensive damage to homes and other infrastructure in Inuit villages.

The Select Committee held a briefing in August of 2010 to examine the calving of a massive iceberg from Greenland and the broader pattern of ice loss in the Arctic.[199] In early August 2010, an iceberg covering nearly 100 square miles—four times the size of Manhattan—broke off (calved) from the Petermann Glacier on the northwestern coast of Greenland.[200] The iceberg was the largest to break off in the Arctic in nearly a half century. Dr. Robert Bindschadler and Dr. Richard Alley, two of the scientists participating in the briefing, warned Select Committee members that we could have already passed, or may within only decades pass, a tipping point in the Arctic beyond which climate change may be even more abrupt and effectively irreversible.[201]

Ice in Antarctica

Antarctica is also losing ice with consequences ranging from increased global sea level to loss of wildlife habitat. Antarctica is covered by two ice sheets; the larger East

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[195] University of Colorado at Boulder, (2010) Available at http://www.colorado.edu/news/r/f595fae00e6b451d4016ab9a43a049f8.html

[196] Kahn, S., et al., 2010. Spread of ice mass loss into northwest Greenland observed by GRACE and GPS. Geophysical Research Letters, Vol. 37.; and Velicogna, I. (2009). Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed by GRACE. Geophysical Research Letters, Vol. 36.

[197] Anthony, K., 2009. Methane: A menace surfaces. Scientific American.

[198] Anthony, K., 2009. Methane: A menace surfaces. Scientific American.

[199] Select Committee hearing on *The Greenland Ice Sheet: Global Warming's Impacts on the Arctic Region* (August 10, 2010) available at http://globalwarming.house.gov/pubs?id=0020#main_content

[200] National Aeronautics and Space Administration, 2010. Ice Island Calves off Petermann Glacier. Available at http://www.nasa.gov/topics/earth/features/petermann-calve.html

[201] Select Committee Briefing, 2010. The Greenland Ice Sheet: Global Warming's Impacts on the Arctic Region. Available at http://globalwarming.house.gov/pubs?id=0020#main_content

Antarctic ice sheet covers the majority of the continent, while the West Antarctic ice sheet has significant ice shelves floating in the ocean. Taken together, they contain enough water to raise sea level by around 200 feet if melted completely.[202]

In the spring of 2002, scientists were shocked to discover that an ice shelf the size of Rhode Island had disintegrated in just over a month from the West Antarctica ice sheet. 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.[203]

Since then, satellite measurements made by NASA show that Antarctica as a whole is indeed losing mass at an accelerating rate. There is also evidence that in addition to the loss known to be occurring in the western ice sheet, East Antarctica has also been losing ice since 2006.[204]

Human activities have been identified as an important driver of Antarctic climate change, though a complex set of natural factors are also important.[205] Rigorous analysis of temperature trends show that Antarctica has been warming at an average rate of 0.22 °F per decade (from 1957 to 2006) or more than 1°F for the last half century,[206] roughly comparable to the warming observed for the globe as a whole.[207] Antarctic warming is expected to continue as GHG concentrations rise and the ozone hole, which cools the continent, heals.

As ice extent shrinks, breeding and foraging habitat for Antarctic wildlife is compromised. The population of Emperor penguins, for example, has already declined by 50 percent.[208] Researchers studying Emperor penguins in Terre Adélie, Antarctica, estimate that by the end of the century their population will decline from 6,000 breeding

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[202] National Aeronautics and Space Administration, 2010. Is Antarctica Melting? Available at http://www.nasa.gov/topics/earth/features/20100108_Is_Antarctica_Melting.html

[203] National Aeronautics and Space Administration, 2002. Breakup of the Larsen Ice Shelf, Antarctica. Available at http://earthobservatory.nasa.gov/IOTD/view.php?id=2288

[204] Chen, J., et al., 2009. Accelerated Antarctic ice loss from satellite gravity measurements. Nature, Vol. 2.

[205] Gillett, N., et al., 2008. Attribution of polar warming to human influence. Nature, Vol. 1.

[206] Steig, E., *Warming of the Antarctic ice-sheet surface since the 1957* International Geophysical Year, Nature 457; and National Aeronautics and Space Administration, 2009. *Satellites Confirm Half-Century of West Antarctic Warming.* Available at http://www.nasa.gov/topics/earth/features/warming_antarctica.html; Real Climate, 2009. *State of Antarctica: red or blue?* Available at http://www.realclimate.org/index.php/archives/2009/01/state-of-antarctica-red-or-blue/

[207] National Aeronautics and Space Administration. GISS Surface Temperature Analysis, available at http://data.giss.nasa.gov/gistemp/graphs/

[208] Barbraud, C., and H. Weimerskirch, 2001. Emperor penguins and climate change. Nature 411.

pairs to an expected 400 breeding pairs under IPCC climate projections of business-as-usual emissions of GHGs.[209]

Sea Level Rise

Accelerating sea level rise is threatening coastal communities around the world. Over the past century, thermal expansion of the oceans and widespread melting of ice sheets and glaciers have produced a global sea level rise of approximately 8 inches.[210] Observations from the past two decades indicate that the recent rate of rise has been twice that of the past century.[211] Over the next century, the IPCC has projected global sea level rise of 7 to 23 inches (18 – 59 centimeters), with current emissions trends consistent with the higher end of the range. However, these estimates do not account for changes in ice sheet dynamics.[212] Accounting for this contribution, the rise is expected to be in the range of 3.5 feet by the end of this century, perhaps even as great as 6.5 feet.[213]

Sea level rise will have severe impacts on the world's coastal regions. Rising sea levels are already causing inundation of low-lying lands and infrastructure, 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 threats of sea level rise are being felt by small island states with elevations close to current sea level. Worldwide, about one billion people live within 75 feet elevation of today's sea level, including nearly all of Bangladesh, and areas occupied by more than 250 million people in China.[214] 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.

The coastal regions of the United States are very susceptible to sea level rise. Along the Gulf Coast, an estimated 2,400 miles of major roadway and 246 miles of

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[209] Jenouvrier, S., et al., 2009. Demographic models and IPCC climate projections predict the decline of an emperor penguin population. Proceedings of the National Academy of Sciences. Vol. 106.

[210] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[211] Intergovernmental Panel on Climate Change, 2007. Adaptation North America. Available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter14.pdf

[212] Intergovernmental Panel on Climate Change, 2007.

[213] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[214] Intergovernmental Panel on Climate Change, 2007: The Physical Science Basis, Summary for Policymakers.

freight lines are at risk of permanent flooding for a 4 foot rise.[215] The Transportation Research Board concluded that under business-as-usual, coastal airport runways in Boston, Miami, New York and other areas could be under water by 2050. In addition, rising sea level will cause intrusion of saltwater into both surface water and ground water in many U.S. coastal areas, threatening freshwater supplies.[216]

Warming and Acidification of the World's Oceans

The world's oceans will suffer devastating climate change impacts. The U.N. 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."[217] Less hospitable waters would have a significant effect on the fishing industries. In the United States alone, commercial and recreational fisheries contribute $60 billion to the economy each year and employ more than 500,000 people.[218]

Warming and acidification of ocean waters are also contributing to the collapse of coral reefs around the globe. Recent studies indicate that over one-third of all coral species are already endangered.[219] When key temperature thresholds are exceeded, mass bleaching and complete coral mortality often result. In fact, corals are threatened to extinction within the next century from rising ocean temperatures and ocean acidification if atmospheric CO_2 concentrations continue to rise unchecked. This threatens U.S. reefs with commercial value exceeding $100 million. The total global economic value of coral is estimated to be between $30 and $172 billion annually. In the United States, certain coastal areas would be especially harmed; in Florida, for example, reef-based tourism in the Florida Keys generates $1.2 billion in annual revenue.[220] Healthy coral reefs provide other benefits as well, including shoreline protection, beach sand supply, potential pharmaceuticals, and habitat for fish and other marine organisms.

Extreme Events

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[215] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[216] Environmental Protection Agency. Coastal Zones and Sea Level Rise, Available at http://www.epa.gov/climatechange/effects/coastal/index.html.

[217] United Nations Environmental Programme, 2008. Warmer World May Mean Less Fish. Available at http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=528&ArticleID=575.

[218] Connaughton, J., 2005. Testimony to Senate Commerce Committee.

[219] Carpenter K., et al., 2008. One-Third of Reef-Building Corals Face Elevated Extinction Risk from Climate Change and Local Impacts, Science Express.

[220] Damassa, T., 2006. World Resources Institute, The Value of Ecosystems. Available at http://www.wri.org/stories/2006/12/value-coastal-ecosystems.

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.[221]

A 2009 study by researchers at the National Center for Atmospheric Research (NCAR) shows that the United States experienced approximately twice as many daily record high temperatures than daily record lows over the past decade, as the number of daily record lows has diminished due to global warming.[222] Since the 1980s, the frequency of damaging extreme weather events and the cumulative cost of those storms has increased in the United States.; in recent years, the number of weather events exceeding $1 billion in damages exceeded 100.[223]

Heat waves have already increased in frequency over most land areas, and it is very likely that future climate change will result in an increase in the frequency and intensity of hot extremes.[224,225] The intensity, duration and frequency of heat waves will increase particularly in western and southern regions of the United States.[226] For a high GHG emissions future, parts of the U.S. South that currently have about 60 days per year with temperatures exceeding 90 ºF will experience more than 150 such days by the end of the century.[227] 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

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221 Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis at 8; and U.S. Climate Change Science Program, Synthesis, 2008. Assessment Product 3.3, Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands.

222 University Corporation for Atmospheric Research. Available at http://www.ucar.edu/news/releases/2009/maxmin.jsp

223 National Oceanic and Atmospheric Administration. Billion Dollar U.S. Weather Disasters. Available at http://www.ncdc.noaa.gov/oa/reports/billionz.html

224 Intergovernmental Panel on Climate Change, 2007. Synthesis Report, Summary for Policymakers.

225 Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

226 Meehl, G. and C. Tebaldi, 2004. More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century, 305 Science 994.

227 Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

Anchorage will be as warm as New York City is today.[228] A warmer planet is also expected to experience more extreme summer dryness.[229]

With global warming, heavy winter precipitation and flooding is also increasing.[230] In the United States, for example, the amount of precipitation falling in heavy downpours (heaviest 1 percent of events) has increased nearly 20 percent over the past century.[231] As the atmosphere warms, it is able to hold more water vapor. When a storm occurs, the amount of precipitation can increase, 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."[232] Precipitation is expected to continue to shift towards heavier events, with longer dry periods in between.[233] Contrary to the claims of global warming skeptics, the record snowstorms during the winter of 2009-2010 may have demonstrated this phenomenon; they certainly did not disprove it. 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. Extreme precipitation events and associated flooding costs lives and result in damage to infrastructure, property, and agricultural lands.

Global warming is expected to increase the globally averaged intensity of tropical storms and decrease their frequency.[234] 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

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[228] Ackerman, F., and E. Stanton. The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked. Natural Resources Defense Council. (2008) Available at http://www.nrdc.org/globalwarming/cost/cost.pdf

[229] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[230] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[231] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[232] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

[233] Intergovernmental Panel on Climate Change, 2007. The Physical Science Basis, Summary for Policymakers.

[234] Knutson, T, et al., 2010. Tropical cyclones and climate change. Nature Geoscience 3, 157 – 163.

the related impacts, increases significantly. Finally, strong cold-season storms are also likely to become more frequent, with stronger winds and more extreme wave heights.[235]

In September of 2010, the Select Committee held a briefing to examine the links between climate change and extreme weather events. Pakistan's Ambassador to the United States Husain Haqqani spoke about the devastating economic, health, and security impacts of the flooding that struck Pakistan in the summer of 2010.[236] Twenty percent of Pakistan was inundated, more than 1,700 people lost their lives, and more than 21 million people were directly affected by the floods.

Extreme events consistent with climate change predictions occurred in a number of other locations in 2010 as well. Russia experienced both the worst heat wave and one of the worst droughts on record. In China, massive flooding claimed over 2,000 lives. In India, heat waves killed dozens of people and flooding left 2 million people homeless. Here in the United States, record-breaking temperatures baked the East Coast and disastrous flooding inundated Arkansas, Iowa, Oklahoma, Tennessee, and elsewhere. As the participants of the briefing discussed, as concentrations of GHGs increase in the atmosphere, there will be more extreme weather events, including more intense and frequent heat waves and increased drought and flooding.[237]

Freshwater

One of the most dramatic impacts of global warming in the 21st century will be the exacerbation of already severe water scarcity. Over a billion people currently lack access to safe drinking water.[238] By 2025, 1.8 billion people are expected to be living in regions experiencing water scarcity and two-thirds of the world's population may be living in water stressed conditions.[239] The IPCC projects that by 2020, between 75 and 250 million people in Africa will experience an increase of water stress due to climate

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[235] U.S. Climate Change Science Program, 2008. Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands.

[236] Select Committee, Hearing on *Extreme Weather in a Warming World* (September 23, 2010) Available at http://globalwarming.house.gov/pubs?id=0023

[237] Select Committee, Hearing on *Extreme Weather in a Warming World* (September 23, 2010) Available at http://globalwarming.house.gov/pubs?id=0023

[238] German Advisory Council on Global Change, 2007. Climate Change as a Security Risk Summary for Policy-makers.

[239] United Nations Commission on Sustainable Development, 2008. The Food Crisis and Sustainable Development. Available at http://www.un.org/esa/sustdev/csd/csd16/documents/bgrounder_foodcrisis.pdf.

change.[240] For Asia, the number is between 120 million and 1.2 billion people, and for Latin American it is 12 to 81 million.[241]

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 melt-water from glaciers and snow cover for drinking water and irrigation.[242] The IPCC's 2008 *Climate Change and Water* report projects widespread reductions in snow cover in the 21st Century, and a 60 percent volume loss in glaciers in various regions.[243] While melting may temporarily increase freshwater supply, more winter precipitation falling as rain rather than snow and an earlier snowmelt season will deplete frozen freshwater reserves and exacerbate water scarcity conditions.[244]

Increased water stress due to climate change will disproportionately affect the dry tropics and dry regions at lower mid-latitudes.[245] Semi-arid and arid areas in Southeast Asia, Southern Africa, Brazil, and the western United States are expected to suffer decreasing water resources with climate change.[246] In Asia, decreasing precipitation and rising temperatures will result in the increasing frequency and intensity of droughts.[247] In northwestern China and Mongolia, snow and glacier melt will cause floods in the spring in the near term but will also result in freshwater shortages by the end of the century.[248] Global warming is expected to result in more persistent El Niño conditions that shift the Amazon rainforest from a tropical forest environment towards dry savannah,[249] imperiling an ecosystem that sustains local communities and one of the highest concentrations of biodiversity on Earth.[250] In the American West, the Sierra Nevada

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[240] Intergovernmental Panel on Climate Change, 2007: Impacts, Adaptation and Vulnerability, Summary for Policy Makers at 13.

[241] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 36.

[242] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation, and Vulnerability, Summary for Policymakers at 11.

[243] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 28.

[244] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp.19-26.

[245] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 3.

[246] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 88.

[247] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 86.

[248] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 87.

[249] Lenton, T., et al., 2008. Tipping Elements in the Earth's climate system. 105 Proceedings of the National Academy of Sciences 1790.

[250] WWF Climate Change Programme. Climate Change Impacts in the Amazon: Review of Scientific Literature. Available at http://assets.panda.org/downloads/amazon_cc_impacts_lit_review_final_2.pdf

snowpack is at its lowest level in 20 years, threatening California water supplies.[251] Experts warn that even in optimistic scenarios for the second half of the 21st century, 30 to 70 percent of this snowpack may disappear.[252] As a consequence of decreasing snowmelt in the Rocky Mountains, the U.S. Southwest is already experiencing a severely reduced flow in the Colorado River upon which 30 million people depend for water.[253] The U.S. Midwest is expected to experience drought due to a loss of soil moisture and surface waters.[254] In addition to a range of other costs, agriculture in the U.S. Southwest and Great Plains is likely to suffer massive economic losses due to increasing water scarcity.[255] In September 2010, Dr. Michael Wehner of Lawrence Berkeley National Laboratory briefed the Select Committee on the hydrologic impacts of climate change, explaining that much of the United States will experience severe drought by the end of the 21st century for business-as-usual GHG emissions.[256]

Climate change will also negatively impact the quality of freshwater resources. For example, reduced river flows will limit the dilution of effluent, leading to increased pathogen and chemical concentrations.[257] In addition, increased heavy precipitation events due to climate change may contaminate watercourses and drinking-water reservoirs.[258] 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.[259] These

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[251] Gertner, J., 2008. The Future is Drying Up, New York Times. Available at http://www.nytimes.com/2007/10/21/magazine/21water-t.html?_r=1&ref=todayspaper&oref=slogin.

[252] Gertner, J., 2008. The Future is Drying Up, New York Times. Available at http://www.nytimes.com/2007/10/21/magazine/21water-t.html?_r=1&ref=todayspaper&oref=slogin.

[253] Gertner, J., 2008. The Future is Drying Up, New York Times. Available at http://www.nytimes.com/2007/10/21/magazine/21water-t.html?_r=1&ref=todayspaper&oref=slogin.

[254] Gertner, J., 2008. The Future is Drying Up, New York Times. Available at http://www.nytimes.com/2007/10/21/magazine/21water-t.html?_r=1&ref=todayspaper&oref=slogin.

[255] Ruth, M., et al., 2007. The US Economic Impacts of Climate Change and the Costs of Inaction. University of Maryland Center for Integrative Environmental Research. Available at http://dl.klima2008.net/ccsl/us_economic.pdf

[256] Wehner, M., Testimony before the Select Committee on Energy Independence and Global Warming. Hearing on *Extreme Weather and Climate in a Changing World.* (September 23, 2010) Available at http://globalwarming.house.gov/files/HRG/092310ExtremeWeather/wehner.pdf

[257] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 67.

[258] Intergovernmental Panel on Climate Change, 2008. Climate Change and Water, pp. 68.

[259] Environmental Protection Agency, 2008. National Water Program Strategy: Response to Climate Change. Available at http://www.epa.gov/water/climatechange/docs/TO5_DRAFT_CCR_Revised_10-16.pdf

impacts will exacerbate the precarious state of freshwater fish species in North America, nearly 40 percent of which are already at risk.[260]

Land Resources

Global warming is impacting forests through increased temperatures, altered patterns of precipitation, and changes in the presence and severity of pests. The role of climate change in forest ecology is an area of active scientific research. 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.

But the negative effects of climate change on forests outweigh the benefits. Increasing global temperatures are already affecting tropical forests, with droughts provoking forest fires in the Amazon 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.[261] The dieback of forests represents a form of abrupt climate change, as forests that would otherwise serve as carbon sinks may succumb to water stress and pest exposure; the risk of passing such critical thresholds increases greatly with continued climate change.[262]

In the United States, some forest types are expected to expand (e.g., oak-hickory), while others are expected to contract (e.g., maple-beech-birch).[263] There is also growing evidence that climate change is increasing the frequency and intensity of wildfires in the United States. 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 to 1986.[264] 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. Warmer temperatures cause an earlier snowmelt which

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[260] Winter, A., 2008. Fisheries: Freshwater species in steep decline – USGS, Greenwire.

[261] Alencar, A., et al., Carbon emissions associated with forest fires in Brazil, in Tropical Deforestation and Climate Change (P. Moutinho and S. Schwartzman eds. 2005). Available at http://www.edf.org/documents/4930_TropicalDeforestation_and_ClimateChange.pdf.

[262] Copenhagen Diagnosis, 2009. http://www.copenhagendiagnosis.org/

[263] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[264] Westerling, A., et al., Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity 313 Science 940 (2006).

can lead to an earlier and longer dry season.[265] Models of future climate have consistently concluded that the area burned will increase in the coming years and decades. With more wildfires come more GHG emissions. Although estimates vary widely, wildfires may represent up to 10 percent of total U.S. GHG emissions.[266]

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 U.S. West. Research has clearly demonstrated the link between warmer temperatures and drought on extensive insect outbreaks in southwestern forests and Alaska.[267]

Agricultural lands are also expected to experience substantial impacts from climate change. For most crops there are temperature limits that, when reached, can impair crop yield. For example, an anticipated 2.2 °F rise in temperatures over the next 30 years is projected to decrease yields of maize by 4.0 percent, wheat by 6.7 percent, sorghum by 9.4 percent and dry bean yields by 8.6 percent.[268] Agricultural lands are also sensitive to changes in the timing and intensity of water availability. Runoff in snowmelt-dominated areas is occurring up to 20 days earlier in the U.S. West and up to 14 days earlier in the Northeast.[269] In some regions, global warming is expected to exacerbate drought conditions, whereas others will experience more frequent and intense heavy downpours. Heavy rainfalls reduced the value of the U.S. corn crop by an average of $3 billion per year between 1951 and 1998.[270] Insects and disease pests will also respond to changes in climate and may adversely affect agriculture.[271]

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[265] Westerling, A., et al., Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity 313 Science 940 (2006).

[266] Van der Werf, G., et al, Continental-Scale Partitioning of Fire Emissions During the 1997 to 2001 El Niño/La Niña Period, 303, Science 73. (2004)

[267] Backlund, P. et al. U.S. Climate Change Science Program, 2008. The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States at 7.

[268] Backlund, P., et al, U.S. Climate Change Science Program, 2008 The Effects of Climate Change on Agriculture, Land Resources, Water Resources and Biodiversity in the United States. (

[269] Karl, T., J. Melillo, and T. Peterson, (eds.), 2009. Global Climate Change Impacts in the United States, Cambridge University Press. Available at http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[270] Rosenzweig, C., F.N. Tubiello, R. Goldberg, E. Mills and J. Bloomfield, 2002. Increased crop damage in the US from excess precipitation under climate change. Global Environ. Change, 12, 197-202.

271 Backlund, P., et al, U.S. Climate Change Science Program, 2008 The Effects of Climate Change on Agriculture, Land Resources, Water Resources and Biodiversity in the United States.

Wildlife

If climate change goes unchecked, it could lead to mass extinction of the world's species. 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.[272] A 2004 study suggests that 15 to 37 percent of terrestrial species may be "committed to extinction" by 2050 due to climate change.[273] The IPCC predicts that for a temperature rise of 2.7 – 4.5 ºF, approximately 20 to 30 percent of plant and animal species will be at an increased risk of extinction.[274] Additional warming could lead to even higher rates of extinction, perhaps a loss of more than 40 percent of all plant and animal species by the latter half of this century.[275]

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. 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 loss of habitat resulting from global warming.[276]

Public Health

There is a broad consensus among experts within the worldwide public health community that climate change poses a serious threat to public health. The IPCC's Fourth Assessment Report concluded that climate change's likely impacts on public health include: increases in mortality associated with more frequent and more intense heat waves; increased occurrence of deaths, 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; and increased malnutrition and consequent disorders, including those relating to child growth and development.[277]

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[272] International Union for the Conservation of Nature, 2008, IUCN Red list Reveals world's mammals in crisis, Available at http://www.iucn.org/news_events/events/congress/index.cfm?uNewsID=1695

[273] Thomas C., et al., 2004. Extinction risk from climate change, 427 Nature 145.

[274] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability, Summary for Policy Makers.

[275] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability, Summary for Policy Makers.

[276] Harden, B., 2005. Experts Predict Polar Bear Decline, Washington Post. Available at http://www.washingtonpost.com/wp-dyn/content/article/2005/07/06/AR2005070601899.html.

[277] Intergovernmental Panel on Climate Change, 2007. Synthesis Report, Summary for Policymakers at 48.

In addition, EPA,[278] the Centers for Disease Control and Prevention (CDC), [279] 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.[280] According to the IPCC, climate change contributes to the global burden of disease, premature death and other adverse health impacts.[281]

Heat waves will increase in intensity and frequency in the United States and globally, with significant consequences for human health. The populations most at risk of dying in a heat wave are the elderly and people in underserved communities. The European heat wave of August 2003 is estimated to have killed up to 45,000 people.[282] 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. It is estimated that heat-related deaths in the United States will climb from the current 700 per year to 3,000 – 5,000 by 2050.[283]

Global warming will exacerbate ground-level ozone pollution, leading to substantial increases in respiratory illness and premature death. Ozone is a known public health threat that can damage lung tissue 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."[284] 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.[285] Similar

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[278] Environmental Protection Agency, Climate Change—Health and Environmental Effects. Available at http://www.epa.gov/climatechange/effects/health.html

[279] Centers for Disease Control and Prevention, CDC Policy on Climate Change and Public Health, Available at http://www.cdc.gov/climatechange/pubs/Climate_Change_Policy.pdf

[280] World Health Organization, 2007. Fact Sheet No. 266, Climate and health. Available at http://www.who.int/globalchange/en/.

[281] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability at 391-431.

[282] European Commission. Directorate General for Health and Consumer Protection. The 2003 European heat wave. Available at http://ec.europa.eu/health/ph_information/dissemination/unexpected/unexpected_1_en.htm.

[283] Centers for Disease Control and Prevention. Climate Change and Public Health: Heat Waves. Available at http://www.cdc.gov/climatechange/effects/heat.htm

[284] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability at 632.

[285] U.S. Climate Change Science Program, 2008. Synthesis and Assessment Product 4.6, Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems at ES-6.

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.[286] Even modest exposure to ozone may encourage the development of asthma in children.[287] Recently, an analysis linking CO_2 emissions to mortality revealed that for each increase of 1.8 °F caused by CO_2, the resulting air pollution would lead to about a thousand additional deaths annually and many more cases of respiratory illness and asthma in the United States.[288]

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.[289] If average global temperature increases by a further 1.8° F, an additional 320 million cases and 176,000 deaths from diarrheal illnesses are expected annually.[290] According to EPA, "[c]limate 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."[291] 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.[292] Similarly, the IPCC predicts that climate change is likely to increase the risk and geographic spread of the West Nile virus, a mosquito-borne disease.[293]

National Security

The current and projected impacts of climate change have serious national security consequences for the United States and its allies. The security issues raised by

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[286] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability at 632.

[287] McConnell, R., et al., 2002. Asthma in exercising children exposed to ozone: A cohort study, 359 The Lancet 386; and Gent, J., et al., 2003. Association of low-level ozone and fine particles with respiratory symptoms in children with asthma, 29 J. Am. Med. Assoc. 1859.

[288] Jacobson, M., 2008. On the Causal Link Between Carbon Dioxide and Air Pollution Mortality. 35 Geophysical Research Letters L03809.

[289] World Health Organization, 2002. World Health Report: Reducing risks, promoting healthy life.

[290] Checkley, W., et al., Effect of El Niño and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children, 355 The Lancet 442.

[291] Environmental Protection Agency. Climate Change – Health and Environment Effects: Health. Available at http://www.epa.gov/climatechange/effects/health.html#climate

[292] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability.

[293] Intergovernmental Panel on Climate Change, 2007. Impacts, Adaptation and Vulnerability.

climate change have received increasing attention in recent years both in the U.S. Congress and in international venues.

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 the 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."[294]

Numerous impacts of climate change could ultimately increase both the temporary and permanent migration of people inside and across existing national borders and increase risks of geopolitical instability. Nations dealing with an influx may have neither the resources nor the desire to support climate migrants. 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. 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 its border with Bangladesh.[295] Other economically and agriculturally important coastal areas, like Egypt's Nile Delta and China's southeast coast, are also threatened from rising sea level and severe storms. Similar impacts in Central America and the Caribbean could add pressure to existing migration patterns from those areas to the United States.

Increased water scarcity due to climate change will likely increase the risk of conflict. Already, scientists have traced declines in rainfall in the Darfur region to

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294 McGuinn, Admiral Dennis, 2010. Testimony before the Select Committee on Energy Independence and Global Warming, Hearing on *Not Going Away: America's Energy Security, Jobs and Climate Challenges.* (December 1, 2010) Available at http://globalwarming.house.gov/pubs?id=0024#main_content

295 Black, G., 2008. The Gathering Storm, OnEarth. http://www.onearth.org/article/the-gathering-storm?page=all

disruption in the African monsoon associated with warming sea surface temperatures[296] which has exacerbated conflict between farmers and nomadic herders. 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 freshwater resources; dwindling water resources or changes in the flow regime could heighten existing tensions within the region.

Extreme weather events also pose a significant and growing security threat. Many active U.S. coastal military installations around the world are at risk of damage from storm surges and associated flooding. 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 highly susceptible to coastal storm surges.[297] In September of 2010, the Select Committee held a briefing entitled Extreme Weather in a Warming World, in which Pakistan's Ambassador to the United States Husain Haqqani spoke about the security implications of the devastating floods that struck Pakistan in 2010.[298] Military resources, including U.S. helicopters needed to fight terrorists, had to be diverted for humanitarian assistance. Flood-stricken regions of Pakistan with dislocated populations also became more susceptible to the intrusion of terrorism.

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 new arctic territory, including areas with potential oil and natural gas resources.[299] 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.[300] 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 melting in recent years 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.

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[296] Giannini, A., et al., 2008. A Global Perspective on African Climate, Climatic Change.

[297] The CNA Corporation, 2007. National Security and the Threat of Climate Change. Available at http://securityandclimate.cna.org/report/National%20Security%20and%20the%20Threat%20of%20Climate%20Change.pdf.

[298] Select Committee, Briefing on *Extreme Weather in a Warming World*, (October 23, 2010) Available at http://globalwarming.house.gov/pubs?id=0023#main_content

[299] Borgerson, S., 2008. Arctic Meltdown: The Economic and Security Implications of Global Warming. Foreign Affairs.

[300] Borgerson, S., 2008. Arctic Meltdown: The Economic and Security Implications of Global Warming. Foreign Affairs.

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. Left unabated, climate change will exacerbate deep inequalities within and between countries. 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.

Climate change will have devastating impacts on the developing world, reversing gains in poverty alleviation, food security, nutrition, health, and basic services. Poor communities are especially vulnerable because they have less capacity to adapt to climate changes and are more dependent on climate-sensitive resources such as local water and food supplies.[301] Increased exposure to drought and water scarcity, more intense storms and floods, and other environmental pressures will hold back the world's poor from building a better life for themselves and their children.

Climate change is likely to add 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 to 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.[302] According to the Stern Review, unchecked climate change could turn 200 million people into refugees this century, precipitating the largest migration in history. 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.[303]

Island nations are particularly vulnerable to the impacts of climate change, from the degradation of marine resources to sea level rise. The Republic of the Maldives, for example, is confronting the loss of coral reefs that serve as the basis for its economy, currently driving a productive fishing industry and attracting large numbers of tourists. In the long term, rising sea level represents 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.

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[301] Intergovernmental Panel on Climate Change, Climate Change, 2007. Impacts, Adaptation and Vulnerability Summary for Policymakers.

[302] Stern, N., 2006. Stern Review: The Economics of Climate Change.

[303] Stern, N., 2006. Stern Review: The Economics of Climate Change.

In the United States, climate change impacts are deepening existing inequities. In Alaska, a state already hit hard by climate change, at least three Alaskan villages—Shishmaref, Kivalina, and Newtok—will be lost to coastal erosion due to rising sea levels as soon as in the next decade.[304] 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 global warming transforms the world around them and makes practices and traditions irrelevant or even dangerous.

Climate change may also increase existing health inequities for people of color. In major metropolitan areas, African Americans are more likely than whites to be exposed to higher air toxic concentrations and are nearly three times as likely to be hospitalized or killed by asthma.[305] Latinos, 66 percent of whom live in areas that violate federal air quality standards, face disproportionate health impacts as well.[306] These health inequities may grow, for example, as levels of ground-level ozone increase with warming.

Economic Costs of Climate Change

Climate change impacts of the types described above will have staggering economic impacts in the coming decades. Measuring these impacts in dollars is a challenge, requiring analysis of local and global impacts, long time horizons, quantification of risk and uncertainty, and capturing the possibility of climate tipping points that induce major, catastrophic change. While the variables are numerous and complex, estimates of potential economic impacts are massive.

The Stern Review, one of the most in-depth and respected economic analysis of climate change, 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.[307] If a wider range of risks and impacts is considered, the damages could rise to 20 percent or more of GDP 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 likely result from stress to freshwater supplies, changes to the agricultural

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[304] U.S. Army Corps of Engineers, 2006. Alaska Village Erosion Technical Assistance Program. *Available at* http://housemajority.org/coms/cli/AVETA_Report.pdf

[305] Environmental Justice and Climate Change Initiative, 2008. Climate of Change: African Americans, Global Warming, and a Just Climate Policy for the U.S. Available at http://www.ejcc.org/climateofchange.pdf.

[306] Quintero-Somaini, A., et al. (2004), Hidden Danger: Environmental Health Threats in the Latino Community. Natural Resources Defense Council. Available at http://www.nrdc.org/health/effects/latino/english/latino_en.pdf

[307] Stern, N., 2006. Stern Review: The Economics of Climate Change.

sector, damage to coastal infrastructure from storms and sea level rise, effects on energy supply and demand, adverse impacts to human health, and more frequent and extensive forest fires.[308] Tourism and other weather-dependent industries will continue to be hit especially hard as well.

Modeling results from a Tufts University and Natural Resources Defense Council study show that if present trends continue, the total cost of only four global warming impacts in the United States—hurricane damage, real estate losses, energy costs, and water costs—will cost 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.[309]

Climate Science in the Political Arena

As the political debate over climate change solutions has gained prominence, climate science and the climate scientists themselves have become targets of politically motivated attacks. A number of such incidents occurred during the 111th Congress. The Select Committee played an important role in informing the public on these issues and bringing the best-available climate science into discussions and debates of U.S. energy and climate policy.

Hacked Email Incident Explained

In November of 2010, emails and electronic documents were stolen from the Climatic Research Unit (CRU) at the University of East Anglia. The emails were subsequently taken out of context and distorted to smear the reputations of certain climate scientists and challenge the well-established conclusions of climate science.

However, all of the official reviews of the hacked email incident cleared climate scientists of any wrongdoing and showed there was no real substance to the allegations;

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[308] Ruth, M., et al., 2007. The US Economic Impacts of Climate Change and the Costs of Inaction. University of Maryland Center for Integrative Environmental Research. Available at http://dl.klima2008.net/ccsl/us_economic.pdf

[309] Ackerman, F., and E. Stanton, 2008. The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked. Natural Resources Defense Council. Available at http://www.nrdc.org/globalwarming/cost/cost.pdf

the official reviews included the UK House of Commons Report[310], the Oxburgh panel report[311], the Sir Muir Russell Report[312], and the Penn State Report.[313] The Sir Muir Russell panel's review of the scientists whose emails were stolen concluded that, "their rigor and honesty as scientists are not in doubt." Their review also states that, "we did not find any evidence of behavior that might undermine the conclusions of the IPCC assessments."

The Select Committee held a series of hearings that examined the hacked email incident. In December of 2010, the Select Committee heard testimony from President Obama's science advisor, Dr. John Holdren, and the NOAA Administrator, Dr. Jane Lubchenco, emphasizing that it is the results of thousands of researchers from hundreds of research facilities around the world that makes global warming unequivocal, not the work of a single research group.[314] In fact, NASA and NOAA have conducted independent research that fully confirms the findings of the Climatic Research Unit that came under attack.

In a separate hearing held in May of 2010, the Select Committee heard directly from one of the members of the Oxburgh inquiry panel, which reviewed the hacked email incident; Dr. Lisa Graumlich, then of the University of Arizona, reported that she and her colleagues on the Oxburgh panel "saw no evidence of any deliberate scientific malpractice in any of the work of the Climatic Research Unit." The Select Committee also issued a report explaining how some of the emails--namely those related to Dr. Michael Mann and his analysis of temperature records--were inappropriately taken out of context and that the fundamental conclusions of his work were robust and independently verified by numerous research groups, including the National Research Council.[315]

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[310] House of Commons Science and Technology Committee, 2010. The disclosure of climate data from the Climatic Research Unit at the University of East Anglia. Available at http://climateprogress.org/wp-content/uploads/2010/03/HC387-IUEAFinalEmbargoedv21.pdf; and Secretary of State for Energy and Climate Change, 2010. Government Response to the House of Commons Science and Technology Committee 8th Report of Session 2009-10: The disclosure of climate data from the Climatic Research Unit at the University of East Anglia. Available at http://www.official-documents.gov.uk/document/cm79/7934/7934.pdf

[311] Oxburgh, R., H. Davies, K. Emanuel, L. Graumlich, D. Hand, H. Huppert M. Kelly, 2010. Report of the International Panel set up by the University of East Anglia to examine the research of the Climatic Research Unit. Available at http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAP

[312] Russel, M., G. Boulton, P. Clarke, D. Eyton, and J. Norton, 2010. The Independent Climate Change Email Review, Available at http://www.cce-review.org/

[313] The Pennsylvania State University, 2010. RA-1O Final Investigation Report Involving Dr. Michael E, Mann. Available at http://live.psu.edu/fullimg/userpics/10026/Final_Investigation_Report.pdf

[314] Revkin, A., 2009. On Climate Data, Trends and Peer Review. New York Times, Available at http://dotearth.blogs.nytimes.com/2009/11/30/more-on-the-climate-files-and-climate-trends/

[315] Select Committee staff analysis of the stolen electronic documents from the CRU. Available at http://globalwarming.house.gov/files/DOCS/SelectCommitteeAnalysisStolenElectronicDocuments.pdf

Harassment of Climate Scientists

Following the hacked email incident described above, harassment and intimidation of some climate scientists sharply increased.

In May of 2010, the Select Committee held a hearing to examine the harassment and intimidation of climate scientists.[316] Dr. Ben Santer of Lawrence Livermore National Laboratory told the Committee, "I firmly believe that I would now be leading a different life if my research suggested that there was no human effect on climate. I would not be the subject of Congressional inquiries, Freedom of Information Act requests, or email threats. I would not need to be concerned about the safety of my family. I would not need to be concerned about my own physical safety when I give public lectures."

The late Dr. Stephen Schneider of Stanford University, an early and influential voice on climate change, described a shift in the climate debate since the 1970s, saying, "It was always civil. It was always bipartisan. And it has now gotten to the point where things have become accusatory and highly ideological, and that is very unfortunate." All of the witnesses participating decried political attacks on climate scientists and advocated for a civil dialogue on the issue of climate change.

IPCC Criticism Explained

During the 111th Congress, the IPCC and its Chairman Rajendra Pachauri were also the target of many politically motivated attacks. A number of alleged errors in the IPCC's 2007 Fourth Assessment Report--namely the section on Impacts, Adaptation and Vulnerability--received a great deal of attention. The alleged errors were used to question the conclusions of the IPCC's Fourth Assessment Report, even those derived from other sections of the report. In fact, only one of the alleged errors--an error in the year that Himalayan glaciers are expected to disappear--was legitimate; the IPCC admitted the error and corrected it.[317] Close scrutiny by climate science experts revealed that the other allegations of errors were false.

Numerous newspapers have since retracted stories perpetuating the false allegations against the IPCC. The UK's *Sunday Times* issued an apology and retracted an erroneous story about the IPCC's discussion of climate change impacts in the Amazon,

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316 Select Committee, Hearing on *Climate Science in the Political Arena*, (May 20, 2010) Available at http://globalwarming.house.gov/pubs?id=0019#main_content

317 Intergovernmental Panel on Climate Change, Statement on the melting of Himalayan glaciers. (2010) Available at http://www.ipcc.ch/pdf/presentations/himalaya-statement-20january2010.pdf

acknowledging that, "In fact, the IPCC's Amazon statement is supported by peer-reviewed scientific evidence."[318] The UK's *Telegraph* issued an apology to IPCC Chairman Rajendra Pachauri for putting forth allegations of financial irregularity that were proven false by an independent review. Following the exoneration, the *Telegraph* stated, "We apologise to Dr. Pachauri for any embarrassment caused."[319] The Netherlands government has also accepted responsibility for erroneous information that they provided to the IPCC and which was wrongly attributed to the IPCC in news reports. While the error had no bearing on the IPCC's conclusions, the Netherlands government appropriately stated, "We acknowledge that this error was not the fault of the IPCC."[320] Further, an official review of IPCC procedures and process coordinated by the InterAcademy Council determined that in fact "the IPCC assessment process has been successful overall."[321]

The Select Committee held a series of hearings in which the allegations against the IPCC were examined and debunked. In a Select Committee hearing in May of 2010,[322] for example, Dr. Ben Santer of the Lawrence Livermore National Laboratory told the Committee that, "Responses to these unfounded allegations have been given in a variety of different fora by myself, by the IPCC, and by other scientists, yet the allegations remain much more newsworthy than the rebuttals." Dr. Mario Molina, a Nobel Laureate in Chemistry, told the Committee that, "There appears to be a gross misunderstanding of the nature of climate change science among those that have attempted to discredit it. They convey the idea that the science in question behaves like a house of cards. If you remove just one card, the whole structure falls part. However, this is certainly not the way the science of complex systems works. A much better analogy is a jigsaw puzzle. Many pieces are missing, some might even be in the wrong place, but there is little doubt that the overall image is clear, namely, that climate change is a serious threat that needs to be urgently addressed."

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[318] Kintisch, E., 2010. As Climate Scientists Battle the Press, One Receives Rare Apology From Paper. Science. Available at http://news.sciencemag.org/scienceinsider/2010/06/climate-scientists-battle-press.html

[319] The Telegraph, Dr Pachauri - Apology (August 20, 2010). Available at http://www.telegraph.co.uk/news/7957631/Dr-Pachauri-Apology.html

[320] Netherland Environmental Assessment Agency, 2010. Assessing an IPCC assessment: An analysis of statements on projected regional impacts in the 2007 report. Available at http://www.pbl.nl/images/500216002_tcm61-48119.pdf

[321] InterAcademy Council, 2010, Climate change assessments: Review of the processes and procedures of the IPCC. Available at http://reviewipcc.interacademycouncil.net/report.html

[322] Select Committee, Hearing on *Climate Science in the Political Arena* .(May 20, 2010) Available at http://globalwarming.house.gov/pubs?id=0019#main_content

Part III: The Economic Challenge: Jobs and Clean Tech Growth

The United States stands at a critical moment with regard to the relationship between our economy and our energy system. Our economic future is threatened by continued dependence on foreign oil and other fossil fuels. Our electric grid and transportation system are inefficient. We are losing the lead in development of alternative energy technologies to countries like Germany and China. We are vulnerable to volatility and speculation in our energy markets. In short, the United States cannot continue business as usual and expect to maintain our current level of economic competitiveness.

Fortunately, the energy and climate challenges we are facing represent an unprecedented opportunity for an innovation-driven economic revival in which clean energy solutions—built by American workers—are marketed around the world. Investments in renewable energy create, on average, three to five times as many jobs as similar investments in fossil-fuel energy systems.[323] Rather than energy dollars going to expensive fuels that are quickly burned up, energy dollars that go into renewable energy systems go to actual workers building machines that, once assembled, run on free fuel for their operating lifetimes.[324]

The world will need to invest $26 trillion over the next 2 decades in order to meet our energy needs.[325] Clean energy is likely make up an increasing share of this investment with each passing year, and the International Energy Agency estimates that, globally, $5.7 trillion will be invested in renewable electricity generation alone between 2010 and 2035.[326] The nations that move aggressively to support their young clean energy industry and workers will have a leg up in leading this key growth sector. With more than 90 percent of the increase in global energy demand coming from outside the 34 wealthy industrial,[327] the clean energy sector represents an opportunity to help countries develop alternatives to the fossil fuel development pathway followed by the United States and other developed countries. Further, with half of the current U.S. trade deficit coming from imported oil, clean energy represents a huge export market that has the potential to reverse our energy-driven trade imbalance.

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323 Kammen, Kapadia and Fripp, Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?(2004) Available at http://www.ewea.org/fileadmin/ewea_documents/documents/policy/external_documents/040413_renewables_berkeley.pdf

324 In the case of biomass, there are fuel costs but these fuels are renewable and prices are less volatile.

325 International Energy Agency, World Energy Outlook 2009 Available at http://www.worldenergyoutlook.org/

326 International Energy Agency, World Energy Outlook 2010, Available at http://www.worldenergyoutlook.org/

327 Id

Clean energy is already an important player in the world's energy markets. For example, the 2009 market for wind turbine installations was worth $63 billion and more than 600,000 people are now directly employed in the industry.[328] [329] In the U.S., there were 39 new announced or expanded wind manufacturing facilities in 2009, and more than 200 facilities in production.[330] Over 60 percent of the value of wind turbines installed in America is now produced domestically, an increase from 25 percent in 2004.[331] Total U.S. wind turbine manufacturing capacity is expected to reach 12,000 megawatts per year by 2012.[332] Coal mining jobs have dropped precipitously - by more than 60 percent - over the past 30 years (246,300 in 1980 to 80,000 in 2010). Meanwhile, the wind industry has taken off. Since 2007, wind jobs have increased 70 percent and have surpassed coal mining jobs to employ 85,000 workers across all 50 states. [333] The solar industry doubled the number of people working in the industry in the United States from 2009 to 2010, to 93,000 workers in all 50 states.[334]

The energy efficiency sector is a huge untapped resource with the potential to increase economic productivity and save U.S. consumers money. McKinsey & Company research has found that the U.S. economy has the potential to reduce annual non-transportation energy consumption by roughly 23 percent within a decade. Such action would eliminate more than $1.2 trillion in waste, far more than the $520 billion in required upfront investment. California regulators have similarly found that state

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[328] Global Wind Energy Council, Global Wind 2009 Report, March 2010 available at *http://www.gwec.net/fileadmin/documents/Publications/Global_Wind_2007_report/GWEC_Global_Wind_2009_Report_LOWRES_15th.%20Apr..pdf*

[329] Global Wind Energy Council. Latest News: Wind power to provide a fifth of world's electricity by 2030 (Dec 10, 2010) Available at: *http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews[tt_news]=270&tx_ttnews[backPid]=4&cHash=97741fa57b*

[330] American Wind Energy Association, U.S. Wind Industry Annual Market Report – Year Ending 2009, available at *http://e360.yale.edu/images/digest/Annual_Market_Report_Wind.pdf*

[331] American Wind Energy Association, Fact sheet: *Wind Energy Manufacturing: Rapid Growth in the United States (2010)*.

[332] Bloomberg New Energy Finance, *Joined at the Hip: the US-China Clean Energy Relationship* (2010) Available at bnef.com/free-publications/white-papers

[333] Coal mining jobs data includes employees engaged in production, preparation, processing, development, maintenance, repair, shop or yard work at mining operations. Excludes office workers and mines producing less than 10,000 short tons annually and preparation plants with less than 5,000 employee hours. Wind jobs total includes turbine component manufacturing, construction and installation of wind turbines, wind turbine operations and maintenance, legal and marketing services. See Energy Information Administration, Coal Data: A Reference, page 79 *Table 22. U.S. Coal Mining Average Employment, Hours Worked, and Earnings, Selected Years* available at http://tonto.eia.doe.gov/FTPROOT/coal/006493.pdf; and American Wind Energy Association, http://www1.eere.energy.gov/windandhydro/news_detail.html?news_id=15927

[334] The Solar Foundation, National Solar Job Census 2010, (October 2010) available at http://www.environmentwashington.org/uploads/21/d0/21d00a2f59894f096c52d4c6567f0e64/Final-TSF-National-Solar-Jobs-Census-2010-Web-Version.pdf

efficiency programs produce savings at a rate of two dollars or more for every dollar invested.[335] According to the Union of Concerned Scientists, a requirement on utilities to meet a certain share of their load through energy efficiency measures, in combination with an RES, would reap huge savings for U.S. consumers. The average U.S. household would save nearly $100 annually on their energy costs in 2030, and electricity and natural gas expenditures would be reduced by a total of $113 billion through 2030.[336]

The Pew Environment Group has found that clean energy jobs grew 2.5 times faster than jobs in the U.S. overall between 1998 to 2007, and 770,000 people are now employed in clean energy jobs across the country.[337] China is estimated to now have more than 1 million people employed directly through the clean energy sector.[338] The German renewable energy sector increased to more than 300,000 in 2009, nearly half in the last five years.[339]

While opponents of clean energy and climate protection have proliferated arguments intended to undermine the scientific consensus on climate change and stall policy action, many in the financial community that put real investment capital at risk have analyzed the climate change threat, drawn clear conclusions, and moved capital to the markets where policies reflect this threat. One large financial institution, Deutsche Bank, went so far as to partner with the expert scientists at the Earth Institute at Columbia University to determine the validity of climate skeptic claims. The central conclusion of this large institutional investor was clear: "the primary claims of the skeptics do not undermine the assertion that human-made climate change is already happening and is a serious long-term threat."[340] It is therefore no surprise that Deutsche Bank, with nearly $7 billion in climate change-related investments under management, has placed only about $45 million into that sector in the United States, instead focusing investments in China and Western Europe.[341]

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[335] See, e.g., California Public Utilities Commission and California Energy Commission, Energy Efficiency – California's Highest Priority Resource (Aug. 2006), available at *ftp://ftp.cpuc.ca.gov/Egy_Efficiency/CalCleanEng-English-Aug2006.pdf*.

[336] Union of Concerned Scientists, A Better Climate Bill (2010) Available at http://www.ucsusa.org/clean_energy/solutions/big_picture_solutions/a-better-climate-bill.html

[337] Pew Environment Group, Who's Winning the Clean Energy Race? (2010)http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf?n=5939)

[338] Bradsher, Keith, New York Times, *On Clean Energy, China Skirts Rules* (September 8, 2010) Available at *http://www.nytimes.com/2010/09/09/business/global/09trade.html?pagewanted=all*)

[339] Bloomberg New Energy Finance**,** *Global Trends in Sustainable Energy Investment 2010 Report* (2010) Available *http://bnef.com/free-publications/white-papers*

[340] Deutsche Bank Climate Change Advisors, Climate Change: Addressing the Major Skeptic Arguments (September 2010) Available at http://www.dbcca.com/dbcca/EN/_media/DBCCAColumbiaSkepticPaper090710.pdf

[341] Reuters*, Deutsche Bank spurns U.S. for climate investment,* (Aug 11, 2010) Available at http://www.reuters.com/article/idUSTRE67A3JK20100811

The United States has fallen behind China in building a robust clean energy sector. In 2009, $35 billion was invested in the Chinese clean energy sector, nearly twice the amount invested in the United States. During the coming decade, China has pledged to support $738 billion in investment in their domestic clean energy sector.[342] In less than a decade, China has gone from manufacturing less than 1 percent of the world's solar panels to nearly half. Upwards of 95 percent of these solar modules are exported. This $15 billion in solar exports is more valuable than America's corn, beef, and chicken exports combined.

Some of China's clean energy programs may be illegal violations of international trade agreements. On September 9, 2010, the United Steelworkers union filed a comprehensive trade case with the United States Trade Representative (USTR) alleging an array of Chinese policies and practices that threaten the future of America's clean energy sector.[343] The case, which USTR began officially investigating on October 15, 2010,[344] alleges that China has utilized hundreds of billions of dollars in subsidies, performance requirements, preferential practices and other illegal trade activities to advance its control of the sector. The Select Committee is very concerned about China's use of unfair trade practices to bolster the competitiveness of its industries and urges prompt action to address violations found through the US Trade Representative's investigation.[345]

One aspect of the Steelworkers' petition relates to China's restrictions on access to rare earth elements and other critical materials, an issue that intensified in late 2010 and demonstrated the unacceptably high strategic value these critical materials have reached.[346] China currently produces 95 percent of the world's rare earth elements and in September 2010, began restricting export of these materials to Japan in retaliation for Japan's detention of a Chinese fishing boat captain that was operating in disputed territorial waters. China has also increased export duties and cut 2010 export quotas by

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342 Bloomberg, *China May Spend $738 Billion on Clean Energy Projects*, (July 20, 2010) Available at http://www.businessweek.com/news/2010-07-20/china-may-spend-738-billion-on-clean-energy-projects.html

343 United Steelworkers, USW Files Trade Case to Preserve Clean, Green Manufacturing Jobs in America (September 9, 2010) available at http://www.usw.org/media_center/releases_advisories?id=0327

344 United States Trade Representative, United States Launches Section 301 Investigation into China's Policies Affecting Trade and Investment in Green Technologies, available at http://www.ustr.gov/node/6227

345 Chairman Edward J. Markey, Select Committee Opening Statement: Hearing on "The Global Clean Energy Race" (September 22, 2010) available at http://globalwarming.house.gov/files/HRG/092210Global/markeyOpening.pdf

346 Rare earth elements are a collection of 17 elements that are indispensable to a wide range of military, electronic, and industrial applications, as well as a variety of clean energy technologies, such as wind turbines, hybrid vehicles, solar panels and energy efficient light bulbs.

40 percent compared to 2009 levels.[347] With demand for critical materials growing rapidly and China becoming an increasingly unreliable global supplier, taking steps to encourage the development of critical material production outside of China will be important in bolstering U.S. energy independence.

As mature industries increasingly move overseas to access cheaper labor, technology and innovation-driven sectors will become the key to sustaining economic growth and creating good jobs. It has been estimated that over 90 percent of new economic growth results from public and private sector investments in innovation.[348] By this measure, the established energy industry now dominated by massive companies and outdated business models is decidedly not a high-growth, job-creating, innovation-oriented sector. While investment in research and development (R&D) is roughly 3 percent of gross domestic product, it is roughly one-tenth that level in the energy sector. By contrast, R&D investments in the medical and biotechnology field are roughly 15 percent of sales, almost *40 times* more than in the energy field.[349] Policies that increase competition and open markets to new technologies and business models will accelerate the transition to an innovation-oriented, job-creating energy sector.

Meanwhile, the Big Five oil and gas companies are raking in record-breaking profits—$321 billion between 2007 and 2009.[350] Instead of favoring greater exploration or alternative energy investments as the price of oil has raced upwards, the oil majors have preferred to increase stock buybacks, which grew from $10 billion in 2003 to $60 billion in 2006. Exploration spending from the five largest oil companies was flat or decreased during this period. In 2009, the major oil companies invested more than $56 billion in dividends and stock repurchases and less than $4 billion on all types of research and development.[351]

Putting Americans back to work on retrofitting buildings to improve energy efficiency, expanding mass transit and freight rail, constructing a "smart" electrical grid,

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[347] Secretary Chu, Secretary Locke, U.S. Trade Representative Kirk, *Responses to Questions from Representative Markey,* (December 13, 2010) available at http://globalwarming.house.gov/files/SHARE/12-13-10_RareEarthMaterials.pdf

[348] Dan Kammen, Testimony for Select Committee Hearing "Investing in the Future: R&D Needs to Meet America's Energy and Climate Challenges" on September 10, 2008. Available at http://globalwarming.house.gov/tools/2q08materials/files/0147.pdf

[349] Dan Kammen, Testimony for Select Committee Hearing "Investing in the Future: R&D Needs to Meet America's Energy and Climate Challenges" on September 10, 2008. Available at http://globalwarming.house.gov/tools/2q08materials/files/0147.pdf

[350] Excludes ConocoPhillips's one-time write downs of more than $34 billion in domestic oil exploration and production and investments in the Russian oil company Lukoil, which led to its reported $16 billion loss in 2008. See Weiss, Daniel and Alexandra Kougentakis, Center for American Progress, "Big Oil Misers" (March 31, 2009), available at http://www.americanprogress.org/issues/2009/03/big_oil_misers.html; and 10-K, Proxy Statements, and 20-F forms for BP, PLC, Exxon Mobil, ConocoPhillips, Chevron, and R.D. Shell

[351] Weiss, Daniel and Alexandra Kougentakis, Center for American Progress, "Big Oil Misers" (March 31, 2009), available at: http://www.americanprogress.org/issues/2009/03/big_oil_misers.html

building and installing wind and solar energy systems, as well as developing next-generation biofuels would ensure the clean energy technology revolution brings working Americans along with it.

SELECT COMMITTEE ACTIVITIES

I. Investigation into the BP Deepwater Horizon Oil Spill

The Select Committee, together with the Energy and Commerce Committee, Subcommittee on Energy and Environment, conducted an extensive, groundbreaking investigation into the BP Deepwater Horizon Oil spill. As a result of this investigation the Congress and the public gained a much better understanding of the true amount of oil spilled and its actual effects on the Gulf of Mexico. The investigation also forced BP to make publicly available its live video feed of the spill occurring 5000 feet below the ocean surface and revealed many instances of BP's and other oil companies' lack of preparation and inadequate response plans.

Summary of Incident

On April 20, 2010, at about 10 p.m., an explosion occurred on the Deepwater Horizon oil drilling rig in the Gulf of Mexico. There were 126 people on board at the time. Fifteen people were injured and eleven workers were killed. The Deepwater Horizon, owned by Transocean Ltd., was under a contract with BP to drill an exploratory well. BP was the lessee of the area in which the rig was operating. At the time of the explosion, BP and Transocean were in the process of temporarily closing the well, in anticipation of returning to the well in the future for commercial production. Halliburton had completed some cementing of casings in the well less than 24 hours prior to the accident. On April 22, 2010, the Deepwater Horizon rig sank and two days later, Remotely Operated Vehicles (ROVs) found oil leaking from the broken riser pipe.

Ultimately, oil would continue leaking from the Macondo well for 87 days before the well was finally capped on July 15, 2010. The government's Flow Rate Technical Group (FTRG) concluded that during that period, oil had been leaking into the Gulf of Mexico at a rate beginning at 62,000 barrels per day and ending at 53,000 barrels per day prior to the well being capped.[352] According to the FRTG, a total of 4.1 million barrels of oil were spilled into the Gulf of Mexico, with an addition 800,000 barrels having been

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[352] National Incident Command's Flow Rate Technical Group (2010) Available at http://www.doi.gov/news/pressreleases/US-Scientific-Teams-Refine-Estimates-of-Oil-Flow-from-BP-Well-Prior-to-Capping.cfm

captured aboard containment ships responding to the crisis.[353] The BP Deepwater Horizon oil spill ultimately became the largest oil spill in the history of the United States.

Summary of Chairman Markey's Investigation

Chairman Markey helped lead the investigation in Congress into the causes of and response to the BP Deepwater Horizon disaster. Chairman Markey's investigation focused on a number of key areas.

Forced BP to Make Live Video of the Oil Spill Available to the Public

It took 23 days for BP to produce underwater images from ROVs at the leak site. After the first shocking images appeared, Chairman Markey pressured BP to release a live video feed of the leak from the ocean floor. This live video feed from the "Spillcam" appeared on the Select Committee website on May 19, 2010. Within a few days, more than a million people had visited the Select Committee website to see the images of the spill.

Uncovered the Truth about the Size of the Oil Spill

BP initially claimed that oil was spilling into the Gulf of Mexico at the rate of 1,000 barrels a day. However, Chairman Markey uncovered documents from BP that showed as early as April 27, 2010, the company knew that the spill could be as large as 14,0266 barrels per day and its "best guess" was that 5,758 barrels were leaking. Despite this knowledge, BP's top official in the Gulf continued to maintain that the spill was 1,000 barrels per day and resist efforts to increase the estimate to 5,000 barrels per day.

Chairman Markey also convened the first briefing on Capitol Hill with officials from BP, Halliburton and Transocean on May 4, 2010. During the closed door briefing, BP officials admitted that a worst case scenario from the Macondo well would be a spill of 60,000 barrels per day. Chairman Markey was later able to provide video images of the spill to scientific experts, who warned Congress that based on those images, the spill might be much larger than what BP was asserting. The size of the spill was critical information not only to inform response efforts but also to ultimately decide BP's financial liability.

Creation of an Independent Panel to Investigate the Spill

Chairman Markey was the first Member of Congress to call on President Obama to create an independent, blue-ribbon commission to investigate the causes of the BP oil

[353] National Incident Command's Flow Rate Technical Group (2010) Available at http://www.doi.gov/news/pressreleases/US-Scientific-Teams-Refine-Estimates-of-Oil-Flow-from-BP-Well-Prior-to-Capping.cfm

spill and to make safety recommendations on deep water drilling moving forward. The President responded by establishing the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling through executive order on May 21, 2010.[354] This bipartisan commission was headed by former Sen. Bob Graham and former EPA Administrator William Reilly.

Chairman Markey further pushed for legislation to grant this bipartisan panel subpoena power, which was not possible through executive order. On June 23, 2010, the House passed legislation to give the commission subpoena power in an overwhelming, bipartisan vote of 420-1. However, consideration of that legislation, H.R. 5481, was ultimately blocked in the Senate.

Uncovered Flawed Oil Spill Response Plans from all Major Oil Companies

In examining the Gulf of Mexico oil spill response plans for the five major oil companies, ExxonMobil, Chevron, BP, Shell and ConocoPhillips, Chairman Markey found that none of these companies were any better prepared to respond to a deepwater blowout than was BP. In fact, these five companies had response plans that were virtually identical.

The oil spill response plans cited identical response capabilities and touted identical ineffective equipment. In some cases, they used the exact same words. Like BP, three other companies include references to protecting walruses, which have not been found in the Gulf of Mexico home for 3 million years. BP and two other companies all listed a scientific expert as a resource who had died years earlier. All in all, the response plans for these companies were 90 percent identical.

The First Congressional Delegation to the Region

On May 7, 2010, Chairman Markey led the first Congressional Delegation to the Gulf Coast following the BP Deepwater Horizon Incident. Members flew over the spill site to view the impacts, met with the officials leading the response efforts at the Unified Command Center in Robert, LA, and visited a staging area on the coast.

Oversight of efforts by EPA and the Coast Guard to Curb BP's Use of Dangerous Chemical Dispersants

Despite the assertions made by BP that dispersants could be safely used on the surface and at the sea floor, Congressman Markey conducted considerable oversight of the manner in which the 1.8 million gallons of dispersants were applied to Gulf of

[354] Executive Order 13543. Available at http://m.whitehouse.gov/the-press-office/executive-order-national-commission-bp-deepwater-horizon-oil-spill-and-offshore-dri

Mexico waters. Congress warned of potential harm that long-term use of these chemicals could have on the marine environment, the food chain and families living in the Gulf of Mexico, particularly since BP decided to use the least effective and most toxic formulation of dispersants to combat the effects of the spill.

As a result of concerns expressed by Chairman Markey regarding their use and EPA's analysis of these risks, on May 26, 2010 EPA and the Coast Guard directed BP to completely eliminate surface application of dispersants except in "rare cases" when an exemption might be needed.[355] EPA and the Coast Guard further directed BP to reduce the overall volume of dispersant by 75 percent from the maximum daily amount used (70,000 gallons per day) and to limit subsurface application to no more than 15,000 gallons per day. If BP wished to deviate from these instructions, it was required to make a written request and obtain approval from the Federal On-Scene Coordinator, which was the Coast Guard in this case. On July 30, 2010, Chairman Markey released analysis of the actual volumes applied following this directive, which indicated that the Coast Guard approved requests to use dispersants on an almost-daily basis, despite the directive that these approvals be issued in only "rare" cases.[356] Chairman Markey also conducted extensive oversight to ensure that seafood was being examined to ensure that it was not contaminated with dispersants.

Monitoring the Effects of Dispersants and Oil on Seafood

Chairman Markey also conducted extensive oversight to ensure that seafood harvested from the Gulf of Mexico was being appropriately monitored for the presence of dispersants, oil and other byproducts of the oil spill, such as toxic heavy metals. A series of letters to the FDA prodded FDA to do more to monitor the long-term consequences of the spill on food safety to ensure that the public has confidence in the safety of seafood from the Gulf. As a result of these concerns, the FDA developed a chemical test to detect the presence of dispersant in fish, oysters, crab and shrimp, which was announced on October 29, and subsequently used as a part of the protocol to reopen waters in the Gulf to fishing.

Creation of a $500 Million Research Fund

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[355] Letter from Lisa Jackson to David Rainey, BP vice president of Gulf of Mexico Exploration, attaching Addendum 3 to the "Dispersant Monitoring and Assessment Directive." (May 26, 2010)

[356] Letter from Chairman Edward J. Markey to Admiral Thad Allen (July, 30, 2010) Available at http://markey.house.gov/docs/07-30-10ejmtocgdispersants.pdf

Chairman Markey called on the companies responsible for the disaster to pay for outside research by independent scientists to analyze the environmental impacts of the spill. Following Chairman Markey's request, BP pledged on May 24, 2010 to donate $500 million to establish this fund which will also assess the ecological impacts on the Gulf. However, only $40 million of the $500 million pledged has been disbursed by BP to date, hindering the efforts of scientists to understand the full consequences of the spill.[357],[358] Future disbursements will be determined by a board assembled by BP and the Gulf of Mexico Alliance; it still remains unclear to what extent grants will be awarded on the basis of scientific merit versus geographic proximity to the spill.[359]

II Accomplishments

Introduction

The 111th Congress – and particularly the House of Representatives – was intensely active in addressing energy security and climate change. As detailed below, the American Recovery and Reinvestment Act, passed by Congress, established the largest public investment in clean energy technology in history. The House passed historic comprehensive energy and climate legislation, a major bill responding to the BP oil spill, and an array of bills addressing other energy security and climate-related issues. The Select Committee played a substantial role in each of these legislative efforts.

Collectively, they represent a broad vision of energy and climate solutions that have been a major focus of the Select Committee's work. During the same period, the United States under the Obama Administration returned to a leadership role in the international climate negotiations, resulting in some significant initial steps forward, discussed below.

American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act (ARRA) was enacted on February 17, 2009. This legislation was a direct response to the economic crisis, intended to preserve and create jobs, promote economic recovery, and assist those most impacted by the recession, in large part through the provision of needed investments in infrastructure and technology that will also generate long-term economic benefits. The bill included $288 billion in tax cuts and benefits for families and businesses; $224 billion in increased

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[357] BP, p.l.c., (2010) Available at: http://www.piersystem.com/go/doc/1927/910403

[358] Schenkman, Lauren (2010) BP Releases Long-Awaited Plan for $500 Million for Gulf Research. Available at http://news.sciencemag.org/scienceinsider/2010/09/bp-releases-long-awaited-plan-fo.html

[359] Schenkman, Lauren (2010) BP Releases Long-Awaited Plan for $500 Million for Gulf Research. Available at http://news.sciencemag.org/scienceinsider/2010/09/bp-releases-long-awaited-plan-fo.html

federal funding for education, healthcare, and extended unemployment benefits; and $275 billion in federal contracts, grants and loans.

Roughly $90 billion, or 11 percent, of ARRA investments targeted clean energy and energy efficiency initiatives, such as tax credits, grants, loan guarantees, and other programs for energy efficiency, electricity generation from renewable sources, electric grid modernization, advanced vehicles and fuels technology, traditional mass transit and high-speed rail, carbon capture and sequestration, green innovation and job training, and clean energy equipment manufacturing. Collectively, this represents the largest public investment in clean energy technology in history.

As of July 2010, two-thirds of appropriated ARRA funds had been obligated and more than one-quarter had been spent. The Council of Economic Advisers (CEA) estimates this public investment has already saved or created more than 800,000 jobs, with 190,000 of those occurring in the clean energy category. CEA also reports that ARRA clean energy funds have been successful in leveraging private investment. For example, the Energy Cash Assistance Program has disbursed $4.7 billion, supporting over $13 billion in total investment activity, and the Smart Grid Program has leveraged $6 billion in outside investment with their initial investment of $4.5 billion.[360]

Both demand for ARRA programs and the impact they are making are significant. For example, the $14 billion in competitive grants that the Department of Energy is now distributing are over-subscribed with projects, with only one in five applications receiving an award.[361] ARRA clean energy programs are putting the United States on track to double non-hydro renewable electricity generating capacity and double advanced energy equipment manufacturing by 2012.[362] In 2009, a year in which many were forecasting declines in renewable deployments, the wind industry grew its total installed capacity nearly 40 percent from the previous year.[363]

American Clean Energy and Security Act

On June 26, 2009, the U.S. House of Representatives passed the American Clean Energy and Security Act (H.R. 2454), also known as the "Waxman-Markey" bill. This is the first and only comprehensive legislation to combat climate change to be passed by a

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360 Council of Economic Advisers. The Economic Impact of the American Recovery and Reinvestment Act of 2009. Fourth Quarterly Report. (Jul 14 2010) Available at http://www.whitehouse.gov/administration/eop/cea/factsheets-reports/economic-impact-arra-4th-quarterly-report/summary

361 Rogers, Matthew. Testimony for U.S. Senate Energy and Natural Resources Committee Hearing: *To examine the Department of Energy's implementation of programs authorized and funded under the American Recovery and Reinvestment Act of 2009*. (March 4, 2010)

362 *Id.*

363 Mouawad, Jad. *Wind Power Grows 39% for the Year*. New York Times. (January 26, 2010). Available at http://www.nytimes.com/2010/01/26/business/energy-environment/26wind.html

full chamber of Congress in the United States. If enacted, the Waxman-Markey bill would create millions of new clean energy jobs, enhance America's energy independence, and protect the environment – all without increasing the federal deficit.[364]

The bill would unleash private sector investment in clean energy to create millions of new jobs that can't be shipped overseas. One recent study concluded that H.R. 2454 and the American Recovery and Reinvestment Act would together create 1.7 million new clean energy jobs.[365] The energy efficiency provisions of the Waxman-Markey bill alone would generate 770,000 jobs by 2030.[366] The bill would also protect America's current jobs by helping energy-intensive industries like the steel, iron, and paper industries transition to a cleaner, more profitable future.

To enhance America's energy independence, the Waxman-Markey bill promotes all forms of American clean energy. The bill would make a landmark investment in the future of the country by providing $190 billion through 2025 to increase our efficiency and deploy cutting-edge technologies, such as carbon capture and sequestration, renewable energy, and electric and other advanced technology vehicles. As a result, enactment of the bill would cut America's use of foreign oil by more than 5 million barrels per day in 2030 – as much as we currently import from the Middle East and Venezuela – when combined with vehicle efficiency and biofuels standards enacted in 2007 and updated by President Obama.

To protect the environment, the Waxman-Markey bill would limit global warming emissions from electric utilities, oil refineries, and other major sources, and reward companies as they use cleaner technology. The bill would reduce total global warming emissions 83 percent below 2005 levels by 2050. According to the World Resources Institute, the bill would slash global warming pollution by 2,265 million metric tons in the year 2020 alone.[367]

The Waxman-Markey bill enjoyed support from a broad range of stakeholders, including representatives of industry, labor, environment, and faith groups, and the bill was careful to protect consumers from higher energy prices. In fact, the American

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[364] The Congressional Budget Office estimates that H.R. 2454 would raise federal revenues by $873 billion over ten years and increase direct spending by $864 billion, resulting in a net $9 billion reduction in the federal budget deficit.

[365] Center for American Progress, *The Economic Benefits of Investing in Clean Energy* (June 2009) Available at http://www.americanprogress.org/issues/2009/06/pdf/peri_report.pdf

[366] American Council for an Energy-Efficient Economy, *Savings Estimates for Jobs Bill,* (2010) available at http://www.aceee.org/energy/national/Jobs_Analysis_0309.pdf.

[367] World Resources Institute, *Emissions Reductions Under the American Clean Energy and Security Act* (May 19, 2009) Available at http://www.wri.org/publication/usclimatetargets

Council for an Energy Efficient Economy concluded that the energy efficiency provisions in the bill would save consumers $1050 per household by 2020.[368]

Unleashing a U.S.-led clean energy revolution and cutting U.S. global warming pollution remains critical unfinished business and should be among the top priorities of the new Congress and the Administration. The Waxman-Markey bill remains the most comprehensive and detailed roadmap established to date, and should be a touchstone for future efforts in this sphere.

Gulf Oil Spill Legislation

In response to the BP oil spill in the Gulf of Mexico, discussed at length above, the House enacted broad legislation to hold BP and other parties fully accountable for the spill, to help restore the Gulf, and to reform offshore oil and gas drilling to ensure that a spill of this kind never happens again.

On July 30, 2010, the House passed the Consolidated Land Energy and Aquatic Resources (CLEAR) Act (H.R. 3534). This legislation includes the following elements:

- strong new safety measures, including independent certification of critical offshore drilling equipment.
- removal of the $75 million cap on economic damages to be paid by companies like BP and other responsible parties to families and businesses harmed by an oil spill.
- elimination of the scandal-ridden Minerals Management Service; establishment of a new structure within the Department of Interior for offshore oil and gas leasing, revenue collection, and safety and environmental regulation; and establishment of tougher ethics standards for Federal officials overseeing offshore drilling.
- Strengthening of the President's Commission on the Deepwater Horizon spill by giving the Commission subpoena power to ensure cooperation in its investigation. This portion of the legislation was introduced by Rep. Lois Capps and Chairman Markey as H.R. 5481.
- Closing of the royalty loopholes that allow oil companies to drill for free on public lands during times of high oil prices, saving American taxpayers on the up to 53 billion. This provision was introduced by Chairman Markey and has passed the House multiple times.

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[368]American Council for an Energy-Efficient Economy, *Savings Estimates for Jobs Bill,* (2010) available at http://www.aceee.org/energy/national/Jobs_Analysis_0309.pdf [

- Establishment of a Gulf of Mexico Restoration Program to coordinate efforts to return the Gulf to health following the spill, and measures to ensure that a portion of the fees from offshore drilling are used to protect and improve our oceans.
- Provisions to ensure full funding, using offshore oil and gas drilling fees, for the Land and Water Conservation Fund and the Historic Preservation Fund, which help protect high quality natural, recreational, and historical areas.

The CLEAR Act built on other legislation separately passed by the House, including:

- Legislation, co-sponsored by House Education and Labor Committee Chairman George Miller and Chairman Markey, to protect whistleblowers working on offshore oil and gas drilling operations (H.R. 5851 – the Offshore Oil and Gas Whistleblower Protection Act).
- Legislation to ensure fair compensation to the families of those killed or injured in the BP spill (H.R. 5503 – the Securing Protections for the Injured from Limitations on Liability (SPILL) Act).
- Legislation supporting research and development of new technologies and practices for the prevention and cleanup of oil spills. (H.R. 5716, the Safer Oil and Natural Gas Drilling Technology Research and Development Act; H.R. 2693, the Oil Pollution Research and Development Program Reauthorization Act).

Although the Obama Administration has taken a number of critical steps to address these issues, many of the elements of this House-passed legislation should remain key priorities for the next Congress

Cash for Clunkers

On June 24, 2009, President Obama signed into law legislation originally passed in the House as the "Consumer Assistance to Recycle and Save Act of 2009," authorizing the creation of the successful "Cash for Clunkers" program. The framework for this legislation had previously been negotiated, as part of the American Clean Energy and Security Act, by Democratic Members of Congress led by Chairman Markey, Energy and Commerce Committee Chairman Henry Waxman, and Reps. Betty Sutton, Jay Inslee, John Dingell, and Bart Stupak.

Under this legislation, Congress ultimately provided $3 billion in funds to encourage consumers to trade in their old gas-guzzler for a new, more fuel efficient vehicle, thereby reducing our dangerous dependence on imported oil, saving consumers money at the gas pump and providing meaningful assistance to get the struggling American auto industry back on its feet. The program provided consumers purchasing qualifying new vehicles with $3,500-$4,500 vouchers, in connection with the purchase of almost 700,000 new vehicles.

These new vehicles:

- averaged about 9.2 miles per gallon (about 60 percent) more efficient than the gas guzzlers that were traded in, far exceeding the minimum fuel efficiency requirements imposed by the legislation.
- are estimated to reduce the need for 33 million gallons of gasoline annually
- Are estimated to reduce GHG emissions by 9 million metric tons over the next twenty-five years

The program was also estimated to have created or saved more than 60,000 jobs and added $3.8-$6.8 billion to the GDP.

HomeStar – Creating Jobs through Building Energy Efficiency Retrofits

On May 4, 2010, the House passed the HomeStar Energy Retrofit Act of 2010 (H.R. 5019) to address the issues of job creation in the construction sector and building energy efficiency. Similar to the "Cash for Clunkers" program, this legislation would authorize the establishment of a national rebate program to encourage homeowners to improve home energy efficiency through measures such as installation of new insulation, more efficient windows and doors, and so on.

Under the program, homeowners can participate in either a "Silver Star" program that provides rebates for a pre-approved list of specific energy-saving measures, or the "Gold Star" program that provides rebates for whole-home retrofits that achieve at least a 20 percent increase in the overall energy efficiency of the home.

If funded at the authorized level of $6 billion, the HomeStar program would create or save 168,000 jobs – helping to address high unemployment rate in the construction industry, which is near 25 percent.[369] Ninety percent of the retrofit products that would be purchased under the program are made in the United States, such that it would also provide a much-needed stimulus for domestic manufacturing.[370] The program would also save homeowners $9.2 billion on energy bills, and would save an amount of electricity equivalent to the output of four 300 megawatt power plants and an amount of natural gas and home heating oil equivalent to 6.8 million barrels of home heating oil.[371]

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[369] American Council for an Energy-Efficient Economy, *Savings Estimates for Jobs Bill,* (2010) available at http://www.aceee.org/energy/national/Jobs_Analysis_0309.pdf.

[370] New York Times, *Made in the U.S.A: Efficiency Materials,* (March 12, 2010) Available at http://green.blogs.nytimes.com/2010/03/12/made-in-the-u-s-a-efficiency-materials/

[371] American Council for an Energy-Efficient Economy, *Savings Estimates for Jobs Bill,* (2010) available at http://www.aceee.org/energy/national/Jobs_Analysis_0309.pdf..

The GRID Act – Securing America's Electricity Grid

Another critical issue addressed by the House of Representatives during the 111th Congress is the security of America's electric grid – a key element of America's energy security. Right now, America's electric grid is vulnerable to cyber or other attacks by terrorists or hostile countries. Our adversaries are actively probing these weaknesses and already have the capacity to exploit them. The consequences of such an attack could be devastating. The commercially operated grid provides 99 percent of the power used by our defense facilities. Every one of our Nation's critical civilian systems – water, communications, healthcare, transportation, law enforcement, and financial services – depends on the grid. Classified Member briefings convened by Chairman Markey during the 111th Congress underscored the urgency of this threat.

On June 9, 2010, the House passed – by unanimous voice vote – H.R. 5026, the Grid Reliability and Infrastructure Defense (GRID) Act, sponsored by Chairman Markey and Rep. Fred Upton. This bipartisan legislation would establish critical new Federal authority to protect the Nation's electric grid against a range of threats and vulnerabilities – including cyber attacks, electromagnetic weapons, solar storms, and the supply of critical large transformers produced exclusively overseas. Without the establishment of this new authority, the Federal government has limited authority to protect the grid. This remains a front-burner issue for the next Congress.

International Negotiations

The past two years have seen substantial new developments with regard to international climate negotiations. With more than 120 heads of government in attendance, the United Nations Climate Change Summit in Copenhagen in December 2009 was the largest meeting of world leaders in history. Speaker Nancy Pelosi led a high-profile, bipartisan delegation of 21 Members of the House of Representatives, including Majority Leader Steny Hoyer, Chairman Markey and four other Chairmen of House Committees, to attend the summit.

President Obama and other world leaders gathered at the Copenhagen summit reached a significant new agreement known as the Copenhagen Accord. This Accord, which has now been signed by 140 countries, including those accounting for the vast majority of global greenhouse gas emissions, provides for explicit emission pledges by all the major economies. It also outlined an aspirational goal of limiting global temperature increase to 2 degrees Celsius and broad terms for the reporting and verification of countries' actions.[372] For the first time, the United States, China and other major emitters committed to strong reductions in greenhouse gas emissions on a national level.

The Copenhagen Accord also included an unprecedented commitment of funds for global adaptation and mitigation. The United States and other developed countries made a collective commitment of $30 billion in 2010-2012 to help developing countries reduce emissions, preserve forests, and adapt to climate change, and a goal of mobilizing $100 billion a year in public and private finance by 2020 to address developing county needs. The United States, the world's second largest greenhouse gas emitter, committed to 17 percent below 2005 levels by 2020, 42 percent below 2005 levels by 2030, and 83 percent below 2005 levels by 2050. These targets are aligned with the ACES legislation passed by the House of Representatives.[373]

At the 16th Conference of the Parties to the UN Framework Convention on Climate Change in Cancun, Mexico in December 2010, the international community took another important step forward through the establishment of the Cancun Agreements. These agreements make substantial progress in implementing all of the major pillars of the Copenhagen Accord, including Mitigation, Monitoring, Reporting and Verification and International Consultation and Analysis (MRV/ICA), Adaptation, Finance, Technology, and Reduced Emissions from Deforestation and Degradation (REDD).[374] Notably, the agreements "anchor" the emission reduction pledges made by major developed and developing countries under the Copenhagen Accord in a new decision of the Conference of the Parties and confirm the climate financing pledges made by developed countries. Further, major developing countries agreed to take a substantial step forward in establishing an international regime to ensure transparency in measuring, reporting and verifying their compliance with emission reduction pledges, including through periodic international consultation and analysis.

Using New Media Tools to Engage the Public:

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[372] United Nations Framework Convention on Climate Change, *Report of the Conference of the Parties on its fifteenth session, held in Copenhagen from 7 to 19 December 2009*. Available at http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600005735#beg

[373] United Nations Framework Convention on Climate Change, *Submission of the United States of America, Organization of Work of the AWG/LCA in 2010 (*February 26 2010) Available at http://unfccc.int/files/meetings/ad_hoc_working_groups/application/pdf/usawp2010_lca.pdf

[374] See Draft Decision -/CP.16*, Outcome of the work of work of the Ad Hoc Working Group on Long-Term Cooperative Action* (December 2010) Available at http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf); and Draft Decision -/CMP.6, *Outcome of the work of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol at its fifteenth session* (December 2010) Available at http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_kp.pdf

In the 111th Congress, the Select Committee on Energy Independence and Global Warming continued to use technology, online internet tools and social media to break new ground in Congressional communication with the public.

The Select Committee website received a Golden Mouse Award from the Congressional Management Foundation. Chairman Markey was the first to use YouTube to address and respond to President Obama's initial climate speech. The Select Committee used Twitter to broadcast live vote tallies from each and every vote on the historic Waxman-Markey committee mark-up and floor vote. In December, 2010, the Select Committee became the first Congressional committee to broadcast a hearing live on Facebook.

Conclusion

In April of 2007, the Select Committee on Energy Independence and Global Warming held its first hearing. At that inaugural gathering, the Select Committee discussed the twin challenges of climate change and our dependence on foreign oil.

Since that day, Congress passed historic improvements in vehicle fuel economy standards and made major investments in clean energy technologies, including renewable energy, electric vehicle, and advanced battery technologies as well as building and appliance efficiency measures that will save families and small business billions of dollars. The House passed a comprehensive energy and climate bill. America held two historic national elections. The world –including China and India – committed to reduce carbon pollution in the Copenhagen Accord and the Cancun Agreements. U.S. troops continue to fight bravely in Iraq and Afghanistan, regions where our energy and national security interests remain entangled. The Gulf of Mexico was sullied by BP's oil spill, which became the worst environmental disaster in U.S. history. The Select Committee has been a central forum for discussion and debate of all these issues.

Over the life of the Select Committee, the politics of energy and climate change have shifted back and forth as have the issues that dominate media and public attention. What has not changed is the array of challenges we face as a nation and as a planet.

The national security challenges from our dependence on oil are not going away. The Select Committee heard from Vice Admiral Dennis McGinn, who was a witness at the very first Select Committee hearing first hearing and at the very last Select Committee hearing. He made clear the price of our dependence on foreign oil, borne out not in this rhetorical battlefield, but in the theater of actual war, where bullets and bombs are spent to defend or acquire barrels of oil.

The national security threats from climate change are not going away. During the first Select Committee hearing, we discussed the drought-influenced Somali conflict that to the events recounted in the film "Blackhawk Down." . A warming world exacerbated a military hot spot. In September of 2010, the Select Committee hosted the Pakistani Ambassador to discuss his country's devastating floods. He discussed how his country diverted resources like helicopters away from fighting Al Qaeda to assist in the flood response. An increasingly destabilized climate will invariably lead to more of these destabilizing geopolitical events.

The economic security threats stemming from America's lack of an energy plan are not going away. China is pushing ahead with clean energy investments, along with other emerging technologies like carbon capture. Twice as much money was invested in clean energy in China as was invested in the United States last year. As we heard from the private investment community, this move by China will attract trillions in private capital –money that could be invested in jobs here at home.

And China is not alone. Germany, Japan, South Korea, and other countries recognize that dominating the trillion dollar market of tomorrow requires foresight and public investment, supported for forward-looking public policy, today. For the United States, second place in the clean energy race is an unacceptable goal. Just as we cannot afford to continue our dangerous dependence on foreign oil, we cannot afford to concede this economic opportunity.

The carbon pollution that we have already spewed into the atmosphere, warming our Earth, is not going away anytime soon. The pollution we emit today will still be in the atmosphere centuries from now. Every day that we wait to act to stem the tide of carbon emissions will be felt for decades and centuries to come. While some Members of Congress dispute the science of global warming, the rest of the world does not. As the world's climate community gathered for the U.N. climate change conference in Mexico this year, virtually all the countries of the world accepted that cutting carbon pollution is this generation's responsibility. The threat that climate change poses is too dangerous and too urgent, for us to retreat into cynicism, skepticism, or inaction.

Speaker Nancy Pelosi created the Select Committee with her grandchildren in mind, hoping to ensure that the world we leave behind is safe and prosperous and that its natural treasures remain undiminished for generations to come. The Select Committee held 80 hearings and briefings, focusing on developing solutions to end our dangerous addiction to foreign oil, combat climate change, create millions of new clean energy jobs here in the United States, and save American consumers billions in energy costs. The Committee heard testimony from a diverse group of literally hundreds of the world's leading energy and national security experts – from military generals, energy CEOs, Nobel Prize-winning scientists, local, State, Federal and international officials, private sector investors, clean energy and environmental advocates, and entrepreneurs and innovators who are creating the next generation of clean energy technology. Collectively, these business, science, military, government, and civil society leaders made a compelling case for the urgent need for the United States to embrace a clean energy future.

In considering the future, it is instructive to keep in mind a few key numbers:

1. $1.3 Trillion

That is the amount of money consumers have shipped overseas for foreign oil since the Select Committee was created in 2007. Imported oil represents nearly half of our trade deficit. This massive transfer of wealth is an albatross on our economy and boon for terrorist activities around the globe.

As long as foreign oil continues to jeopardize our national and economic security – Congress's is not done..

2. $738 Billion.

That is the amount of money China plans to invest in clean energy over the next decade. This will generate jobs that should be created here in the United States. . The United States has the technological advantage and the entrepreneurial spirit. But unless the United States marshalls the political will to adopt policies that will spur a clean energy revolution, we will continue to lose our innovation and manufacturing edge.

3. $4 Dollars.

In the summer of 2008 that was the price of gasoline that focused this nation like a laser on finding alternatives to oil. As the global economy recovers, China and India continue to grow, and supplies remain tight, it is inevitable that these prices will return. The United States must act to continue the transition away from oil dependence..

4. And finally, the number 1.

We have one planet. We all share it. We are all responsible for it.

2010 is on track to be the hottest year on record, following the warmest decade on record. We have heard the warnings from scientists. We have seen the damage with our own eyes.

Someday, our children and grandchildren will look back on the record of the Select Committee. That record will reflect a respectful and rigorous debate and an unprecedented understanding of the challenges before us. Whether or not they will see that this generation has taken the bold action required by these challenges remains to be seen.

Appendix A

HEARINGS AND BRIEFINGS OF THE SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

January 15, 2009
Stimulus Package and Energy: Creating Jobs, Opportunities for All

Witness List:

- Mr. Van Jones, Director, Founding President, Green For All
- The Honorable Michael Nutter, Mayor, City of Philadelphia
- The Honorable Douglas Palmer, Mayor, City of Trenton
- Denise Bode, CEO, American Wind Energy Association
- Mr. Trevor Houser, Visiting Fellow at the Peterson Institute for International Economics and Partner, Rhodium Group, LLC (RHG)
- Dr. David Kreutzer, Senior Policy Analyst in Energy Economics and Climate Change at the Heritage Foundation

February 4, 2009
Roadmap from Poznan to Copenhagen – Preconditions for Success

Witness List:

- Mr. John Bruton, Delegation of the European Commission and Ambassador to the U.S.*
- Mr. Elliot Diringer, Vice President of International Strategies, Pew Center on Global Climate Change
- Mr. Rob Bradley, Director of the International Climate Policy Initiative, World Resources Institute
- Ms. Karen Alderman Harbert, President and CEO, Institute for 21st Century Energy.

*Mr. Bruton's testimony was presented in a briefing format and immediately following his testimony the formal hearing commenced.

February 25, 2009

Get Smart on the Smart Grid: How Technology Can Revolutionize Efficiency and Renewable Solutions

Witness List:

- Mr. Allan Schurr, Vice President, IBM
- Mr. Robert Gilligan, Vice President, General Electric
- Mr. Tom Casey, CEO, CURRENT Group, LLC
- Ms. Shirley Coates Brostmeyer, CEO, Florida Turbine Technologies, Inc.
- Mr. Charles Zimmerman, Vice President, Wal-Mart
- Mr. James Hoecker, Hoecker Energy Law & Policy

March 2, 2009

Briefing: Youth Climate: Green Jobs, Clean Futures

Witness List:

- Ms. Jessy Tolkan

March 4, 2009

Preparing for Copenhagen: How Developing Countries Are Fighting Climate Change

Witness List:

- Mr. Carter Roberts, President and CEO, World Wildlife Fund (WWF)
- Ms. Barbara Finamore, China Program Director, Natural Resources Defense Council (NRDC)
- Mr. Ned Helme, President, Center for Clean Air Policy (CCAP)
- Mr. Lee Lane, Resident Fellow, American Enterprise Institute (AEI)

March 19, 2009

Constructing a Green Transportation Policy: Transit Modes and Infrastructure

Witness List:

- Mr. Peter Varga, CEO, Interurban Transit Partnership, Grand Rapids, Michigan
- Mr. Andy Clark, Executive Director, League of American Bicyclists
- Mr. Chris Zimmerman, Arlington County, Virginia Board Member
- Mr. John Boesel, President and CEO, CalStart

June 18, 2009

Global Warming's Growing Concerns: Impacts on Agriculture and Forestry

Witness List:

- Mr. Jerry Hatfield, Supervisory Plant Physiologist, USDA
- Ms. Heather Cooley, Senior Researcher, Pacific Institute
- Mr. Tom Troxel, Director, Black Hills Forest Resource Association
- Dr. Johannes Lehmann, Associate Professor of Soil Fertility Management/Soil Biogeochemistry, Cornell University
- Mr. Ford B. West, President, The Fertilizer Institute

July 28, 2009

New Technologies: What's Around the Corner

Witness List:

- Dr. Greg Kunkel: Vice President for Environmental Affairs, Tenaska Inc.
- Mr. Frank Smith: Chief Executive Officer, PURGeN One LLC
- Dr. Brent Constantz: Chief Executive Officer, Calera Corporation
- Dr. Emanuel Sachs: Chief Technical Officer, 1366 Technologies Inc.
- Mr. Sean Gallagher: Vice President, Tessera Solar
- Mr. Gary Spitznogle: Manager IGCC and Gas Plant Engineering, American Electric Power

July 29, 2009

Climate for Innovation: Technology and Intellectual Property in Global Climate Solutions

Witness List

- Mr. Govi Rao, Chairman, Lighting Science Group Corporation
- Mr. Robert T. Nelsen, Co-founder and Managing Director, ARCH Venture Partners
- Ms. Jennifer Haverkamp, Managing Director for International Policy & Negotiations, Environmental Defense Fund
- Dr. Mark Esper, Executive Vice President Global Intellectual Property Center, U.S. Chamber of Commerce

September 10, 2009
Roadmap to Copenhagen – Driving towards Success

Witness List:
- Mr. Todd Stern, U.S. Special Envoy for Climate Change, U.S. Department of State.

September 24, 2009
Solar Heats Up: Accelerating Widespread Deployment

Witness List:
- Dr. Stephanie A. Burns, Chairman, President and Chief Executive Officer, Dow Corning
- Mr. Frank De Rosa, Chief Executive Officer, NextLight Renewable Power
- Mr. Steve Kline, Vice President for Corporate Environmental and Federal Affairs, Pacific Gas & Electric
- Ms. Nada Culver, Esq., Senior Counsel, The Wilderness Society
- Dr. Gabriel Calzada, Economics Professor, King Juan Carlos University

October 22, 2009
Building U.S. Resilience to Global Warming Impacts

Witness List:
- Mr. John Stephenson, Natural Resources and Environment, Government Accountability Office
- Mr. Eric Schwaab, Deputy Secretary of the Maryland Department of Natural Resources
- Mr. Stephen Seidel, V.P. for Policy Analysis & Gen. Counsel, Pew Center on Global Climate Change
- Kenneth Green, Resident Scholar, American Enterprise Institute

October 29, 2010
Fraudulent Letters Opposing Clean Energy Legislation

Witness List:
- Representative Tom Perriello, U.S. House of Representatives
- Mr. Jack Bonner, Bonner & Associates
- Mr. Steve Miller, President and CEO, American Coalition for Clean Coal Electricity

- Ms. Lisa M. Maatz, Director of Public Policy and Government Relations, American Association of University Women
- Mr. Hilary O. Shelton, Director and Senior Vice President for Advocacy and Policy, NAACP Washington Bureau

December 2, 2009
The State of Climate Science

Witness List:
- Dr. John Holdren, Director, Office of Science and Technology Policy
- Dr. Jane Lubchenco, Administrator, National Oceanic and Atmospheric Administration

March 10, 2010
The Clean Energy Recovery: Creating Jobs, Building New Industries and Saving Money

Witness List:
- Ms. Lisa Patt-McDaniel, Director, Ohio Department of Development
- Mr. Bryan Ashley, Chief Marketing Officer, Suniva Inc.
- Mr. Paul Gaynor, Chief Executive Officer, First Wind Holdings LLC
- Ms. Mary Ann Wright, Vice President and Managing Director, Business Accelerator Project, Johnson Controls, Inc.
- Mr. Brian M. Johnson, Federal Affairs Manager, Americans for Tax Reform & Executive Director, Alliance for Worker Freedom

March 16, 2010
Clearing the Smoke: Understanding the Impacts of Black Carbon Pollution

Witness List:
- Dr. Tami Bond, Professor, University of Illinois at Urbana-Champaign
- Dr. Veerabhadran Ramanathan, Professor, Scripps Institution of Oceanography
- Dr. Drew Shindell, Senior Scientist, NASA Goddard Institute for Space Studies
- Mr. Conrad Schneider, Advocacy Director, Clean Air Task Force

April 14, 2010
The Role of Coal in a New Energy Age

Witness List:

- Mr. Gregory Boyce, President and Chief Executive Officer, Peabody Energy Corporation
- Mr. Steven F. Leer, Chairman and Chief Executive Officer, Arch Coal, Inc.
- Mr. Preston Chiaro, Chief Executive for Energy and Minerals, Rio Tinto
- Mr. Michael Carey, President, Ohio Coal Association

May 6, 2010

The Foundation of Climate Science

Witness List:

- Dr. Lisa Graumlich, Director, School of Natural Resources and the Environment, University of Arizona, and member of the "Oxburgh Inquiry" panel
- Dr. Chris Field, Director, Department of Global Ecology, Carnegie Institution of Washington, and co-chair of "Impacts, Adaptation and Vulnerability" portion of new IPCC report due in 2014
- Dr. James McCarthy, Professor of Biological Oceanography, Harvard University, past President and Chair of the American Association for the Advancement of Science, co-chair of "Impacts, Adaptation and Vulnerability" portion of IPCC report published in 2001
- Dr. James Hurrell, Senior Scientist, National Center for Atmospheric Research, contributor to IPCC reports
- Lord Christopher Monckton, Chief Policy Adviser, Science and Public Policy Institute

May 20, 2010

Climate Science in the Political Arena

Witness List:

- Dr. Ralph Cicerone, President of the National Academy of Sciences and Chair of the National Research Council
- Dr. Mario Molina, Nobel Laureate in Chemistry and Professor, University of California at San Diego
- Dr. Stephen Schneider, Professor, Stanford University
- Dr. Ben Santer, Research Scientist, Lawrence Livermore National Laboratory
- Dr. William Happer, Professor, Princeton University

August 10, 2010

Briefing: The Greenland Ice Sheet: Global Warming's Impacts on the Arctic Region

Witness List:

- Dr. Richard B. Alley, Professor of Geosciences, and Earth and Environmental Systems, The Pennsylvania State University
- Dr. Robert Bindschadler, Senior Research Scientist at University of Maryland Baltimore County, who has 30 years of service with NASA
- Dr. Andreas Muenchow, Professor of Physical Ocean Science and Engineering, University of Delaware

September 16, 2010

Briefing: Progressive Auto X PRIZE: How Entrepreneurs Are Driving the Future of Jobs and Energy Security

Witness List:

- Dr. Peter H. Diamandis, Chairman and CEO, X PRIZE Foundation
- Mr. Oliver Kuttner, Founder and CEO, Edison2, Team Edison2 Team Leader
- Mr. Ron Cerven, Project development engineer, Li-Ion Motors Corp, Team Li-Ion Team Leader
- Mr. Jim Lorimer, US Sales Representative, 21st Century Motoring, Team X-Tracer Team Member

September 22, 2010

The Global Clean Energy Race

Witness List:

- Mr. Mark Fulton, Global Head of Climate Change Investment Research, Deutsche Bank
- Mr. Michael Liebreich, Chief Executive, Bloomberg New Energy Finance
- Dr. Ravi Viswanathan, General Partner, New Energy Associates
- Mr. Tom Carbone, Chief Executive Officer, Nordic Windpower

September 23, 2010

Briefing: Extreme Weather in a Warming World

Witness List:

- Ambassador Husain Haqqani, Pakistan's Ambassador to the United States
- Dr. Michael Oppenheimer, Professor, Princeton University
- Dr. Thomas Peterson, Chief Scientist, NOAA's National Climatic Data Center
- Dr. Michael Wehner, Staff Scientist, Lawrence Berkeley National Laboratory

December 1, 2010

Not Going Away: America's Energy Security, Jobs and Climate Challenges.

<u>Witness List:</u>

- General Wesley K. Clark, US Army (Ret.), NATO Supreme Allied Commander Europe 1997-2000*
- Vice Admiral Dennis McGinn, U.S. Navy (Ret.)
- Mr. Robert F. Kennedy, Jr., Chairman of the Waterkeepers Alliance
- Richard L. Kauffman, Chairman of the Board, Levi Strauss & Co.
- Peter Gleick, Pacific Institute for Studies in Development, Environment, and Security
- Kenneth Green, American Enterprise Institute

*General Clark was not able to attend the hearing but his full written testimony was included for the record.

Appendix B

BP Deepwater Horizon Correspondence