Testimony of David G. Hawkins

Director, Climate Center

Natural Resources Defense Council

Hearing on "Examining Global Warming Issues in the Power Plant Sector"

Committee on Environment and Public Works

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Mr. Chairman and members of the Committee, thank you for providing the Natural Resources Defense Council (NRDC) the opportunity to present its views on Global Warming Issues in the Power Plant Sector. NRDC is a national, non-profit organization of scientists, lawyers, and environmental specialists, dedicated to protecting public health and the environment. Founded in 1970, NRDC serves more than 1.2 million members and supporters from offices in New York, Washington, Los Angeles, San Francisco, Chicago and Beijing.

NRDC strongly supports enactment of legislation to achieve major reductions in global warming emissions from the key emitting sectors in the U.S. economy. NRDC is a member of the U.S. Climate Action Partnership, which has urged Congress to enact such legislation. Electricity production is a critical feature of our economy and addressing global warming emissions from this sector and others is essential if we are to avoid the worst damages from a radically disrupted climate system.

Electricity has brought us an unequalled quality of life and a thriving economy but it continues to be produced in ways that also bring us large and unnecessary harm to human health and to the environment. The electric generating sector remains the largest single polluting activity in the United States. Electric generators are responsible for two-thirds of America's sulfur dioxide pollution, nearly one-third of its nitrogen oxides, forty percent of carbon dioxide and more than one-third of remaining mercury emissions.

Together these “four horsemen” of power plant pollution cause tens of thousands of premature deaths each year and hundreds of thousands of respiratory illness cases. They also kill lakes and threaten forests, contaminate fish, and fill the skies over national parks with haze. Carbon dioxide from the electric generating industry traps heat in the atmosphere, leading to disruption of the climate that we all depend on to maintain life as we know it on this planet.

If these words strike any of you as familiar, it is because they are the opening paragraphs from my testimony to this Committee on the same subject in 2001. I decided to repeat them here as a reminder that all of us have failed in the past to address this issue with the urgency that is warranted. NRDC is gratified that, in recent months, the sense of urgency has increased in America and we applaud this Committee for its efforts to move forward with greater dispatch.

Legislation that is effective in achieving emissions from all major emitting activities in the U.S. is essential but this hearing focusing on the electric sector is helpful in illuminating a number of issues that are relevant both to the electric sector and to other industries that would be included in multi-sector legislation.

The Importance of the Power Sector

Several factors make it critical to address the electric power sector in any global warming bill. First, there is the sheer size of power’s contribution to global warming emissions: in the U.S. electric power emits about 40 per cent of our total carbon dioxide (CO_2) emissions and the global share is similar. Once emitted, this CO_2 pollution load remains in the atmosphere for centuries. Half of the CO_2 emitted during World War I remains in the atmosphere today. A second feature

of the power sector is the very long life of power generation plants. Some power plants built at the start of World War II are still operating and plants built in the last couple of decades will likely operate for 60 to 80 years. A third feature is that we do not today possess low-cost commercially demonstrated systems for removing CO_2 from our existing fossil power station designs. That may change and might even change rapidly but we cannot ignore the risk that new power plants built today might operate for decades without meaningful reductions in their CO_2 emissions if they are not designed with the need for carbon management in mind.

These facts put a premium on prompt adoption of legislation that will cause electric sector investments to be made in a manner that favors low CO_2 options. Our dependence on coal to generate power, both in the U.S. and globally, makes this challenge even greater. The very attribute of coal that has made it so attractive—its abundance---magnifies the problem we face and requires us to act now, not a decade from now. Until now, coal's abundance has been an economic boon. But today, coal's abundance, absent corrective action, is more bane than boon. Since the dawn of the industrial age, human use of coal has released about 150 billion metric tons of carbon into the atmosphere—about half the total carbon emissions due to fossil fuel use in human history. But that contribution is the tip of the carbon iceberg. Another 4 *trillion* metric tons of carbon are contained in the remaining global coal resources. That is a carbon pool nearly seven times greater than the amount in our pre-industrial atmosphere. Using that coal without capturing and disposing of its carbon means a climate catastrophe.

And the die is being cast for that catastrophe today, not decades from now. Decisions being made today in corporate board rooms, government ministries, and congressional hearing rooms are determining how the next coal-fired power plants will be designed and operated. Power plant investments are enormous in scale, more than $1 billion per plant, and plants built today will

operate for most of this century. The International Energy Agency (IEA) forecasts that more than $5 trillion will be spent globally on new power plants in the next 25 years. Under IEA's forecasts, over 1800 gigawatts (GW) of new coal plants will be built between now and 2030—capacity equivalent to 3000 large coal plants, or an average of ten new coal plants every month for the next quarter century. This new capacity amounts to 1.5 times the total of all the coal plants operating in the world today.

The astounding fact is that under IEA's forecast, 7 out of every 10 coal plants that will be operating in 2030 don't exist today. That fact presents a huge opportunity—many of these coal plants will not need to be built if we invest more in efficiency; additional numbers of these coal plants can be replaced with clean, renewable alternative power sources; and for the remainder, we can build them to capture their CO_2, instead of building them the way our grandfathers built them.

If we decide to do it, the world could build and operate new coal plants so that their CO_2 is returned to the ground rather than polluting the atmosphere. But we are losing that opportunity with every month of delay—10 coal plants were built the old-fashioned way last month somewhere in the world and 10 more old-style plants will be built this month, and the next and the next. Worse still, with current policies in place, none of the 3000 new plants projected by IEA are likely to capture their CO_2.

Each new coal plant that is built carries with it a huge stream of CO_2 emissions that will likely flow for the life of the plant—60 years or more. Suggestions that such plants might be equipped with CO_2 capture devices later in life might come true but there is little reason to count on it.

While commercial technologies exist for pre-combustion capture from gasification-based power plants, most new plants are not using gasification designs and the few that are, are not incorporating capture systems. Installing capture equipment at these new plants after the fact is implausible for traditional coal plant designs and expensive for gasification processes.

If all 3000 of the next wave of coal plants are built with no CO_2 controls, their lifetime emissions will impose an enormous pollution lien on our children and grandchildren. Over a projected 60-year life these plants would likely emit 750 billion tons of CO_2, a total, from just 25 years of investment decisions, that is 30% greater than the total CO_2 emissions from all previous human use of coal.

What Emission Targets Do We Need?

A central question that faces drafters of all environmental legislation is what should the targets be? Because of the long life of greenhouse gases, especially CO_2, in the atmosphere, the long life of energy producing investments and buildings that use energy and the rapid growth in the global economy, we need to design legislation that will set a path that brings emissions down starting soon and persisting over decades in a predictable fashion.

As detailed more fully in Appendix 1 of my statement, to have better than even odds of avoiding truly catastrophic disruption of earth's climate, the United States and other industrial nations need to adopt a declining emissions cap that starts reducing emissions soon and reaches 80 percent below current emission levels by 2050, and developing countries need to promptly reduce their emissions growth and follow suit with similar reductions later in the century.

As discussed in Appendix 1, if national emission reductions start soon, we can stay on a prudent climate protection path with an annual emission reduction rate that gradually ramps up to 3.2% per year. But if we delay a serious start by, for example, 20 years and allow continued emission growth at nearly the business-as-usual rate, the annual emission reduction rate required to stay on this path jumps to 8.2% per year (see Figure 1 in Appendix 1). In short, a slow start forces a crash finish.

Some analysts argue that delay is cheaper because we will develop breakthrough technologies in the interim. But that outcome is implausible for three reasons.

- First, delay dramatically increases the emission reduction rate required later. Cutting emissions by more than 8 percent per year would require deploying advanced low-emission technologies several times faster than conventional technologies have been deployed over recent decades.[1]
- Second, without meaningful near-term market signals, there will be little incentive for the private sector to direct significant R&D resources toward developing the breakthrough technologies. Hope will rest entirely on the federal R&D program, which now is far too small to yield the required results.
- Third, without different market signals, a new generation of conventional power plants, vehicles, and other infrastructure will be built during the next two decades. Our children and grandchildren will then have to bear the costs of prematurely retiring an even bigger stock of highly-emitting capital than exists today. Even with a substantial discount rate, it is virtually impossible that delaying emission reductions will be cheaper than starting now.

[1] Hawkins, D. "Policies to Promote Carbon-less Energy Systems" *Proceedings of the 7th International Conference on Greenhouse Gas Control. Technologies (GHGT7).* September 5-9, 2004, Vancouver, Canada.

Given the power sector's large contribution to annual and cumulative CO_2 emissions, it will be necessary to achieve large reductions in total power sector emissions if we are to achieve reductions in total emissions on the order of 80% by 2050. That said, it is worth noting that the question of where reductions must be achieved is not necessarily identical to the question of how emission reduction costs are best distributed in our society. However, legislation that proposes targets for particular sectors, such as Senator Sanders' bill, S. 1201, which contains targets for the power sector, should specify targets that are sufficiently ambitious to be consistent with where total U.S. emissions need to go. S.1201 would cap power sector emissions at current (2006) levels in 2011, with emissions declining to approximately 10% below current levels by 2015, approximately 25% below current levels by 2020, and approximately 35% below current levels by 2025.

Are reductions like these achievable? Yes, they are. A robust portfolio of energy efficiency, major expansion of renewable generating resources and deployment of CO_2 capture and geologic disposal (CCD) at fossil generating plants can achieve these targets in our view. Some would add increased reliance on nuclear energy to this mix, although the recent Keystone Center report on this subject suggests that high cost of new nuclear power plants, their lengthy construction period, the current dependence on large federal subsidies and incentives to stimulate private investment in the sector, unresolved waste management and disposal issues, and a massive requirement to replace the current installed base of nuclear plants before 2050, will all make it

difficult for nuclear to make a significantly greater contribution to carbon reductions than is already being contributed by today's fleet of nuclear power plants. [2]

We also believe these reductions are affordable. For example, NRDC and colleagues at Princeton estimate that all of the new coal plant capacity forecast to come on line in the U.S. between 2012 and 2020 could be equipped with CO_2 capture and disposal systems at a cost equal to a 2% increase in average retail electricity rates in 2020.

For a strategic sector like power generation, NRDC believes that it is important to combine the driver of broad cap and trade permit program that delivers economic and planning signals to all players with well-designed performance requirements to accelerate the use of low carbon generating technologies. Both S.1201 and S.309, an economy-wide measure sponsored by Senator Sanders and 17 other Senators, contain provisions for a minimum emission performance standard, "birthday" provisions to assure that aging plants clean up or be replaced, and a low-carbon generation requirement. These provisions all would stimulate deployment of CO_2 capture and disposal systems faster than would occur in a cap and trade program alone. NRDC believes that U.S. leadership in this area is an important business opportunity and is essential to shape investment decisions in fast-growing developing countries that plan to use substantial amounts of coal.

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[2] Notwithstanding their low-carbon advantages, the complete cradle-to-grave fuel cycles for nuclear and coal- or natural gas-fired plants with carbon capture have *other* serious *non-carbon* environmental drawbacks that make them inherently less sustainable than increased efficiency and wind, solar, geothermal, combined heat and power, and industrial waste-heat cogeneration options. So our energy strategy should prioritize large-scale deployment of these carbon-displacing options, with fossil energy with CCD and nuclear competing under a cap to supply the remainder of our future electricity requirements.

Distributing Allowances

Another issue of great interest to the power sector and of even greater public policy importance concerns how pollution allowances are allocated or distributed under a cap and trade program. NRDC believes pollution allowances are a public trust. They represent permission to use the limited capacity of the atmosphere, which belongs to all of us, to dispose of global warming pollution. This limited carrying capacity is not a private resource owned by historical emitters.

Emissions allowances will be worth tens of billions of dollars per year, and their value will increase over the first decades of the program as the pollution cap declines. Providing more than a small fraction of the allowances for free to pollution sources would give their shareholders an enormous and undeserved financial windfall.

For these reasons, NRDC opposes grandfathering of emissions allowances to firms based on historical emissions, heat input, fuel sales, or other factors. Grandfathering the allowances would generate huge windfalls and transfers of wealth. Economists at the Congressional Budget Office, Resources for the Future (RFF) and other institutions have determined that grandfathering all emissions allowances would give the recipient companies an asset worth *seven times* the costs that they could not pass on to energy consumers.

Stanford University and RFF economist Larry Goulder has shown that in an economy-wide upstream cap and trade program, it would require only 13% of the allowances to cover the costs that fossil-fuel providers would not be able to pass on to consumers.[3] Dallas Burtraw and RFF

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[3] Morgenstern et al., "The Distributional Impacts of Carbon Mitigation Policies," Issue Brief 02-03 (Resources for the Future, Feb. 2002), http://www.rff.org/Documents/RFF-IB-02-03.pdf.

colleagues have shown similar results for a cap and trade program on electricity generators.[4] The Congressional Budget Office has reached the same conclusion.[5] In the United Kingdom, the government has determined that free allocation of allowances to electric generators has resulted in windfall profits of over $500 billion.[6]

To avoid these windfalls, allowances should be held in trust for the public and distributed in ways that will produce public benefits. This can be done through an auction, with the revenue dispersed according to legislated formulae and criteria, or by distributing the allowances themselves according to the same formulae and criteria. In either approach, the legislation should provide for a public trustee to administer the allowances.

The overarching goals should be (1) to keep the cost of the program as low as possible for residential, commercial and industrial consumers (especially low-income consumers), by encouraging investment in end-use energy efficiency measures and by avoiding wealth transfers from consumers to upstream entities, and (2) to encourage deployment of the technologies needed to significantly reduce emissions in key sectors (e.g., mainstreaming carbon capture and disposal in the electric sector; retooling the auto industry to produce hybrids and other low-emitting vehicles; accelerating deployment of sustainable low-carbon motor fuels and renewable electricity).

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[4] Morgenstern et al., *supra.*

[5] *See e.g.,* Terry Dinan, “Shifting the Cost Burden of a Carbon Cap-and-Trade Program,” (Congressional Budget Office, July 2003); CBO, "Issues in the Design of a Cap-and-Trade Program for Carbon Emissions," (Nov. 25, 2003).

[6] House of Commons, Environmental Audit Committee, “The International Problem of Climate Change: UK Leadership in the G8 and EU,” p. 17 (Mar. 16, 2005).

NRDC believes the allowance resources should be used for four broad objectives (elaborated in Appendix 2):

(1) To reduce overall costs for individual and business consumers (especially low-income consumers) through energy efficiency investments (50%).

(2) To accelerate deployment of the "big change" technologies that we will need to cut emissions in key sectors (25%).

(3) To provide transition assistance to impacted workers and heavily affected firms, and adaptation assistance to communities, farmers, wildlife managers (20%).

(4) To encourage carbon reductions outside the cap, and early reductions, while preserving the cap (5%).

To the extent that any emission allowances are allocated to the electricity industry, rather than auctioned, NRDC recommends that distribution companies receive these allowances rather than generators. The problem with allocating allowances to generators is rooted in equity concerns: about 40 percent of US generation sells its output at market prices into various largely unregulated wholesale markets, while the rest remains subject to diverse forms of cost-of-service price regulation.[7] Impacts of allocations on consumers and shareholders will vary widely and state regulators will not be able to respond to real or perceived inequities. Generators can be expected to pass through the increased price of carbon regulation in their wholesale prices, and also to keep the proceeds from the sale of allowances allocated to them initially. Consumers obviously will see the price signal, but not the benefits from the allowance allocation. The problem has already surfaced in European markets, leading United Kingdom authorities to

[7] This is the estimate of the Electric Power Supply Association, which represents competitive power suppliers.

conclude that initial allocation to electric generators serving competitive markets resulted in large windfall profits.[8]

Electricity distribution companies, by contrast, provide service under continuous price regulation from either state commissions (for investor-owned utilities, accounting for about three-fourths of retail sales) or local boards (for publicly owned utilities and cooperatives, which serve the rest of the nation). The regulators can ensure that the value of these allowances is used for designated public purposes, including energy efficiency programs and rate adjustments.

Congress would have a wide range of options in making allocations, ranging from the carbon content of electricity delivered by distribution companies to the volumes of electricity delivered (with numerous intermediate compromise possibilities). Utilities that distribute mostly coal-fired electricity are likely to advocate an emissions-based formula on the grounds that they will see the largest increase in electricity costs as a result of the CO_2 emissions cap. Utilities that distribute mostly low-emission resources are likely to advocate a formula based on electricity sales on the grounds that their customers are already paying higher prices for a cleaner generation portfolio.

Whether or not the allocations should be updated over time is an independent question. A phase out of any free allocations to the private sector diminishes the case for updating in general (the more rapid the phase out the less need to update the free allocation). Any allocation based on carbon content should definitely not be updated because that would create a perverse incentive to increase emissions in order to obtain a larger allocation, raising the overall cost of achieving the

[8] House of Commons, Environmental Audit Committee, "The International Problem of Climate Change: UK Leadership in the G8 and EU," p. 17 (Mar. 16, 2005).

emission cap (or increasing actual emissions if a safety valve is in effect). There is a better argument for updating a sales-based formula as a matter of equity between high-growth and low-growth areas. Such an approach would need to include an adjustment for independently verified energy efficiency to ensure that updating does not create a disincentive for additional energy efficiency improvements.

The simplest approach would be to allocate based on electricity sales during the same historical period used for allocating to other sectors. If Congress decides to allocate (in part or in whole) based on historical emissions, however, calculating the carbon content of those electricity sales is certainly feasible and should not be seen as an obstacle to allocating to distribution companies. As long as the allocation is to distribution companies (to avoid windfall profits) and is not updated in a way that creates perverse incentives (to avoid raising costs or emissions) then the specific allocation formula is a matter of regional equity and an appropriate subject for negotiations during the legislative process.

Addressing Concerns About Unexpected Costs

Defects of the safety valve. While the cap-and-trade model has worked well for acid rain control, some observers are pushing for a “safety valve” as a safeguard against permit costs exceeding a predetermined level.

The fundamental problem with the safety valve is that it breaks the cap without ever making up for the excess emissions. Simply put, the cap doesn’t decline as needed or, worse, keeps growing. A better approach to cost-control is possible.

“Safety valve” is actually a misleading name. In boiler design, the role of a safety valve is to allow pressures to build within the vessel to working levels, well above atmospheric pressure. A safety valve’s function is to open in the rare occasion when the boiler is pressured beyond its safe operating range, to keep it from exploding. In the life of a well-run boiler, the safety valve may never open.

Imagine, however, a boiler designed with a valve set to open just slightly above normal atmospheric pressure. The valve would always be open, and the boiler would never accomplish any useful work.

That is the problem with the safety valve design in two other proposals advanced by Senator Bingaman and by Representatives Udall and Petri. The valve is set at such a low level that it could be open more than it is closed.

A safety valve also would prevent U.S. participation in international trading systems. The market price of CO_2 in the European Union’s emissions trading scheme, for example, has already exceeded the U.S. safety valve price proposed in the Bingaman and Udall-Petri proposals. If trading were allowed between the EU and the U.S., a major distortion would occur. European firms (acting directly or through brokers) would seek to purchase U.S. lower-priced allowances. Their demand would almost immediately drive the U.S. allowance price to the safety valve level, triggering the “printing” of more American allowances. European demand for newly-minted U.S. safety valve allowances would continue until the EU price dropped to the same level. The net result would be to flood the world market with far more allowances – and far less emission reduction – than anticipated even under the National Commission on Energy Policy recommendations.

Much like other forms of trade barriers, a safety valve distorts the free flow of allowances in an international trading system. A safety valve distorts trade in the same way as when a country fixes the price of its currency and avoids letting its currency find its appropriate exchange rate based on market forces.

A new approach: borrowing. NRDC has proposed a new approach to controlling unexpected costs. In our estimation, the greatest fear of many in industry is that short-run costs will fluctuate unexpectedly, much as natural gas prices have spiked in recent years. Setting a long-term declining emissions cap opens the door to an innovative way to avoid short-term cost volatility: Firms could be allowed to *borrow* emissions allowances from future years, using them early in times of unexpected cost pressure, and paying them back when short-term spikes recede.

Current legislative proposals already allow firms to make reductions in advance when prices are lower than expected and bank allowances for future use. Borrowing would open the opposite possibility.

Absent borrowing, firms can comply only with current or banked allowances. Allowance prices thus reflect the current marginal cost of compliance, and that price can spike in response to short-term conditions (e.g., a delay in bringing on a new technology, or a surge in economic activity). Borrowing would let firms use emissions allowances from future years, stabilizing prices against unexpected short-term fluctuations. The long-term cap will be maintained, because borrowed allowances will be repaid, with interest, by releasing fewer emissions later when the short-run pressures are relieved. Together, banking and borrowing can stabilize long-term costs and eliminate the risk of price spikes while preserving the environmental integrity of the long-term caps.

The combination of a long-term emissions pathway and borrowing has a clear advantage over the safety valve because it does not break the cap and permanently allow excess emissions. (Proposals allowing unlimited "offsets" – credits for emission reductions not covered by the cap – also have the potential to break the cap if credits are awarded for actions taking place anyway, a problem endemic to past offset programs.)

Legislation to permit borrowing will need to include certain safeguards. First, there needs to be an interest payment pegged to be slightly higher than commercial lending rates in order to discourage businesses from treating allowance-borrowing as a no-interest alternative to regular financing. Second, there need to be appropriate mechanisms to secure repayment and guard against defaults. One option is to limit borrowing to five years in advance, with the option to borrow again if repayments are completed. A second option is to require that borrowers be bonded or otherwise secured against defaults.

In summary, it is urgent that we develop and adopt legislation in this Congress that will put the United States on a predictable and manageable path toward greatly reduced global warming emissions. Such a path is completely compatible with a growing economy. Indeed, failure to address global warming now will expose our economy to threats of an unprecedented magnitude as our country and the rest of the world attempt to deal with an unraveling of the hospitable climate that has allowed civilizations to flourish over the past twenty millennia. We know how to design legislation that works for the electric power sector and for the economy as a whole. It is time to begin.

Mr. Chairman and members of the Committee, this concludes my testimony. I am happy to answer any questions you may have.

Appendix 1

Emission Reductions Needed to Prevent Dangerous Climate Disruption

The recent Intergovernmental Panel on Climate Change (IPCC) report states a new degree of the scientific certainty that global warming is happening now and is human-caused. The IPCC assessment highlights how an increase in global temperatures is already affecting climate worldwide and will have far reaching effects on sea levels, ice cover at the poles, heat waves, floods, and droughts. Here are some of the IPCC's key findings:

- The earth will warm by an additional 4-11 degrees Fahrenheit during the 21st Century if energy production is fossil fuel intensive (best estimate 7 degrees).

- The earth will warm by an addition 3-8 degrees Fahrenheit during the 21st Century if emissions follow a mid-range business-as-usual forecast (best estimate 5 degrees).

- The Arctic Ocean could largely be devoid of sea ice during summer later in the century.

- The ocean will continue to become more acidic due to carbon dioxide emissions. Ocean pH has already decreased by 0.1 units and will decline by an additional 0.14 to 0.35 units if emissions are not curtailed.

- The IPCC projects that sea levels will rise by 7 to 23 inches during the 21st Century, but this estimate assumes no acceleration of ice flow in Greenland or Antarctica and does not fully account for some positive feedback processes, such as the release of additional CO_2 from tundra soils as the planet warms. A new study published in *Science* on January 19th projects that sea levels will rise by 20 to 55 inches this century based on recent observations.[1] This study was published after the deadline for consideration by the IPCC.

- The Stern Review of the economics of climate change, conducted for the UK government, "estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more."[2]

At this point, some warming and some impacts are unavoidable, but there is a world of difference between 1 degree and 7 degrees.

Congress needs to enact comprehensive emission limits that will steadily reduce global warming pollution. We still have an opportunity to fix this problem, but only if we act before it's too late.

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[1] Rahmstorf, S. 2007. "A Semi-Empirical Approach to Projecting Future Sea-Level Rise." *Science* 315:368-370.

[2] N. Stern, *et al.*, *The Economics of Climate Change*, p. xv (Cambridge University Press, New York, 2007).

- **There is a growing consensus that allowing more than a 2 degree Fahrenheit increase above today's global average temperature would have clearly dangerous consequences.**[3]

- **To retain even a 50-50 chance that average temperatures more than another 2 degrees Fahrenheit in this century, heat-trapping gas and aerosol concentrations need to be stabilized below 450 ppm CO_2-equivalent.**[4]

- **We can stay below 450 ppm CO_2-equivalent if the United States and other industrial nations adopt a declining emissions cap that starts reducing emissions soon and reaches 80 percent below current emission levels by 2050, and if developing countries promptly reduce their emissions growth and follow suit with similar reductions later in the century.**

Because heat-trapping emissions are cumulative, delaying the decision to reduce emissions will only worsen the problem and make the task of solving it much harder. This is illustrated in the two hypothetical emission reduction scenarios for the U.S. presented below. Either scenario, in concert with comparable action by other nations, is aimed at avoiding atmospheric concentrations higher than 450 ppm CO_2-equivalent. But the two scenarios have vastly different economic implications.

If national emission reductions start soon, we can stay on the 450 ppm path with an annual emission reduction rate that gradually ramps up to 3.2% per year. But if we delay a serious start by, for example, 20 years and allow continued emission growth at nearly the business-as-usual rate, the annual emission reduction rate required to stay on this path jumps to 8.2% per year (see Figure 1). In short, a slow start forces a crash finish.

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[3] Three sources are particular instructive on the dangers inherent in exceeding a 2 degree Celsius (3.6 degree Fahrenheit) increase over pre-industrial levels, which is equivalent to a 2 degree Fahrenheit increase over today's levels:

- Schellnhuber, H., W. Cramer, N. Nakicenovic, T. Wigley, and G. Yohe, eds. *Avoiding Dangerous Climate Change* (Cambridge University Press, New York, 2006).

- J. Hansen *et al.*, Proceedings of the National Academy of Sciences, **103**:14288 (2006).

- R. Warren, *"Solving" Climate Change: Mitigation Targets and the Earth's Climate System,"* presentation to the Center for Clean Air Policy's Climate Policy Initiative Dialogue Meeting, Feb. 13, 2007. Dr. Warren is at the Tyndall Centre for Climate Change Research, University of East Anglia. A copy of Dr. Warren's presentation is attached.

[4] M. Meinshausen "What Does a 2 C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates." in H. Schellnhuber, et al., eds. *Avoiding Dangerous Climate Change* (Cambridge University Press, New York, 2006).

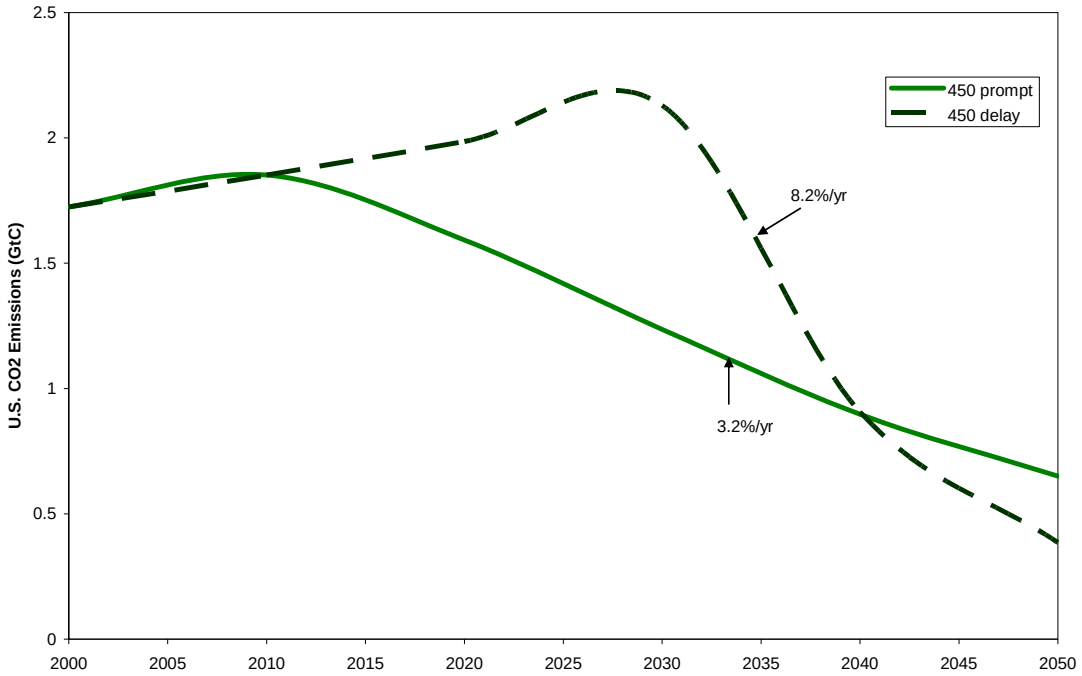

Figure 1: Prompt start and delay pathways consistent with stabilizing heat-trapping gases at 450 ppm CO_2-equivalent. Global emissions 2000-2100 are 480 GtC from Meinshausen's S450Ce scenario (*see* fn. 2, above). The U.S. share of global emissions is assumed to decline from 25% to 5% linearly between 2000 and 2100. This results in an emissions budget for the U.S. of 84 GtC in the 21st Century. In the prompt start case emissions decline by 1.5%/yr from 2010 to 2020, 2.5%/yr from 2020 to 2030 and 3.2%/yr thereafter. The delay case assumes that emissions grow by 0.7%/yr from 2010 to 2030, a reduction of 0.5%/yr compared to the Energy Information Administration forecast;[5] emissions must decline by 8.2%/yr thereafter to limit cumulative 21st Century emissions to 84 GtC. Cumulative emissions 2000-2050 are 68 GtC in the prompt start scenario and 79 GtC in the slow start scenario.

Some analysts argue that delay is cheaper because we will develop breakthrough technologies in the interim. But that outcome is implausible for three reasons.

- First, delay dramatically increases the emission reduction rate required later. Cutting emissions by more than 8 percent per year would require deploying advanced low-emission technologies several times faster than conventional technologies have been deployed over recent decades.[6]

- Second, without meaningful near-term market signals, there will be little incentive for the private sector to direct significant R&D resources toward developing the breakthrough technologies. Hope will rest entirely on the federal R&D program, which now is far too small to yield the required results.

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[5] Reference case from U.S. Department of Energy, Annual Energy Outlook 2006 with Projections to 2030, Report # DOE/EIA-0383(2006).

[6] Hawkins, D. "Policies to Promote Carbon-less Energy Systems" *Proceedings of the 7th International Conference on Greenhouse Gas Control. Technologies (GHGT7).* September 5-9, 2004, Vancouver, Canada.

- Third, without different market signals, a new generation of conventional power plants, vehicles, and other infrastructure will be built during the next two decades. Our children and grandchildren will then have to bear the costs of prematurely retiring an even bigger stock of highly-emitting capital than exists today. Even with a substantial discount rate, it is virtually impossible that delaying emission reductions will be cheaper than starting now.

The Stern Review concludes: "The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly." Where the impacts of unabated climate change could cost 5%, or even 20% of world GDP, the Stern review concludes that achieving a declining cap ultimately reaching an 80% reduction below current emission levels "is a major challenge, but sustained long-term action can achieve it at costs that are low in comparison to the risks of inaction."[7]

Stern estimates the cost of achieving stabilisation between 500 and 550 ppm CO_2 equivalent at "around 1% of global GDP, if we start to take strong action now."[8] Achieving the more demanding target of 450 ppm is still within our reach. Its costs would still compare favorably to the prospect of climate change impacts costing us 5-20% of world GDP.

Thus the "slow start" scenario has shortcomings from both the environmental and business perspectives. From the climate protection standpoint, it risks locking us into dangerous CO_2 concentrations. From the business standpoint, it provides neither economic nor political certainty, and it leads to higher costs later.

[7] Stern Report, *supra* note 2, at p. xvi.

[8] *Id.*

Appendix 2

Using Allowance Resources for Public Benefits

NRDC advocates legislation that would provide four broad public benefit uses for allowances.

(1) 50% of allowances to support cost-saving energy efficiency investments

NRDC proposes that *at least half* of total allowances should be allocated for the benefit of energy consumers, primarily to facilitate investments in using energy more efficiently.

These investments will help reduce overall energy demand without any sacrifice in the quality of energy services. They will tangibly reduce consumers' energy bills and they will substantially reduce the overall cost of a cap-and-trade program.

Despite these clear balance-sheet advantages, individual consumers under-invest in end-use efficiency, resulting in higher energy costs and higher emissions. Energy efficiency programs have a proven track record of overcoming the market barriers that cause this under-investment. Allowances should be used to fund such programs on a much larger scale nationwide than ever before.

Energy efficiency programs supported by allowance allocations should be aimed at both businesses and individual users of energy, with an emphasis on low-income individuals. These programs should promote efficiency in electricity and natural gas use, and in transportation.

Electricity and natural gas. An analysis conducted for the northeast states' Regional Greenhouse Gas Initiative (RGGI) indicates that increasing end-use efficiency is the most effective way to reduce the impact of a carbon cap on electricity rates.[1] Indeed, this analysis demonstrated that by using the proceeds of an allowance auction to promote efficiency, the states could reduce power sector carbon dioxide emissions by 10% from current levels and at the same time save average customers over $100 per year on their energy bills.[2]

A study by the American Council for an Energy Efficiency Economy demonstrated even more dramatic results in the natural gas sector – increasing energy efficiency by 5% could reduce natural gas prices by 20%.[3] Since natural gas-fired electricity generation is at the margin in many regions, increasing the efficiency of natural gas use in non-electric applications will reduce the impact of a carbon cap on both gas prices and electricity rates.

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[1] ICF Consulting "RGGI Electricity Sector Modeling Results, Updated Reference, RGGI Package and Sensitivities," September 21, 2005, available at http://www.rggi.org/docs/ipm_modeling_results_9_21_05.ppt; Economic Development Research Group, "Economic Impacts of RGGI Under Proposed SWG Package Scenarios," September 21, 2005 available at http://www.rggi.org/docs/remi_stakeholder_presentation_11_17_05-final.ppt#492,1,.

[2] Economic Development Research Group, "Economic Impacts of RGGI Under Proposed SWG Package Scenarios," September 21, 2005.

[3] Elliott, Neal R, Anna Monis Shipley, Steve Nadel and Elizabeth Brown, "Impacts of Energy Efficiency and Renewable Energy on Natural Gas Markets," American Council for an Energy Efficient Economy, September 12, 2003.

Transportation. The California Air Resources Board and the National Academy of Sciences have demonstrated the same effect in the motor vehicle sector: Standards to limit global warming emissions or raise fuel economy can provide consumers a net savings through lower fuel and maintenance costs that more than offset higher costs for new vehicles. Improving the efficiency of the vehicle fleet will also help moderate gasoline prices by reducing overall gasoline demand.

Yet there are significant market barriers here too that stand in the way of reaping the full potential benefit of more efficient transportation. To help overcome these barriers, NRDC proposes to use allowances to fund much larger consumer purchase incentives for low-emitting vehicles than government has ever before provided. (These consumer incentives would dovetail with manufacturer retooling incentives.) There are many ways such incentives could be delivered to consumers, and we welcome to discuss these options in greater detail.

(2) <u>25% of allowances for "big change" technology incentives</u>

In order to prevent dangerous global warming it is essential to start making reductions in heat-trapping pollution now and to get on a path toward reducing emissions by 80 percent by mid-century. To accomplish this at reasonable cost, many analyses demonstrate the need for rapid deployment of clean and low-emitting energy technologies in key sectors – especially electricity and transportation, which together make up more than two-thirds of U.S. global warming emissions. Although not an exclusive list, the prime candidate "big change" technologies include:

- Drive-train and related technologies (including hybrid gas-electric engines) in the auto industry;
- Carbon capture and disposal (CCD) in the electric sector; and
- Renewable electricity and sustainable low-carbon fuels for transportation.

But we face a serious dilemma. We need to start rapid deployment of these "big change" technologies *now* in order to hold down the long-term costs of sharply cutting U.S. emissions, yet it is generally agreed that the initial price signals from feasible cap-and-trade programs will not be sufficient alone to jump-start that deployment. The allowance distribution formula can solve this problem, by incentivizing firms to invest in rapid deployment of these key technologies.

For example, CCD deployment requires about $2 billion/yr in investment on a levelized cost basis. A University of Michigan study for NCEP estimates that capital investments of $153 million are required for capacity to produce 200,000 hybrids per year (not including engineering costs).[4] This report shows the long-term cost savings, through job retention, of providing incentives to automotive manufacturers and suppliers to re-tool their existing plants to make in the United States hybrid and advanced diesel engines and components that would otherwise be produced offshore.

[4] "Fuel-Saving Technologies and Facility Conversion: Costs, Benefits and Incentives," Office for the Study of Automotive Transportation, University of Michigan, November 2004.

Funds on this scale for these and other technologies will not be found through tax incentives or appropriations. The allowance distribution formula can solve this problem, by incentivizing firms to invest in rapid deployment of these key technologies.

NRDC proposes to dedicate at least 25 percent of total allowances to incentivize technology deployment and R&D. Although not an exclusive list, the prime candidate "big change" technologies include:

- *Retooling the automobile.* A wide range of improved drive-train technologies, including hybrid gas-electric engines, clean diesels, batteries, fuel cells, and related technologies, are available to dramatically reduce global warming pollution from passenger vehicles and, by extension, many other segments of the transportation sector.

  Incentivizing domestic production of these technologies would assist domestic auto companies in becoming more competitive. An allowance allocation to automakers (and suppliers), coupled with steadily improving performance standards for lower global warming emissions or higher fuel economy would help incentivize and smooth the transition to building advanced, clean technologies. Similarly, allowances could be used to support consumer incentives to purchase clean vehicles at many time the scale of today's tax breaks for hybrids.

- *Carbon capture and disposal (CCD) in the electric sector.* All the components of a comprehensive CCD system rely on proven technologies. CCD is essential if coal is to maintain a vibrant market under a long-term declining cap. Large-scale implementation of CCD in this country would open the door to its application in China and India as well – a key to sustaining development in those nations without unacceptable carbon emissions.

  Despite these factors, investment in CCD is currently limited by two factors. First, many electric generators that see the attractiveness of this technology are waiting for others to undertake the first projects. Second, beyond initial applications associated with enhanced oil recovery, there is a cost differential (compared to conventional coal plants) that is unlikely to be covered by initial allowance prices.

  During this period, incentives in the form of allowance allocations can accelerate the deployment of CCD in meaningful numbers. As indicated above, these incentives should be coupled with an emissions performance standard – e.g., a low-carbon emissions standard for coal-based energy. All coal-based electric generation technologies should be allowed to compete as long as they meet a common CCD performance standard.

- *Renewable electricity and sustainable low-carbon fuels.* A third "big change" technology is renewable energy, both in motor fuels and electricity production. The deployment of cellulosic biofuels has great potential as a replacement for petroleum-derived fuels. Allowance allocations could help mainstream construction of plants to convert cellulosic materials into both transportation fuels and electricity, and could help farmers accelerate the supply of cellulosic feedstocks. In addition to reducing global warming pollution, an allowance allocation for this purpose would help achieve the president's objective of ending our oil addiction. It would also help the farm sector adjust to agricultural subsidy reforms.

Other renewable energy resources, such as wind and solar, should also be supported by allowances. Wind power is competitive in many markets but still suffers from the on-again-off-again nature of the production tax credit, which inhibits the large scale investment in wind that is needed for it to achieve its potential. A more stable funding incentive would markedly increase wind generation's penetration.

- *RD&D.* A portion of these technology-advancement allowances – perhaps five percent of total allowances – should be dedicated to RD&D into breakthrough technologies that are not yet ready for broad deployment assistance. This amount would be sufficient to reverse the dangerous decline in RD&D budgets that has occurred over the past decade and a half. A high priority should be given to joint ventures with the private sector putting up half of the research funds. This will help assure that the research is well targeted. In order to replenish the funding for further RD&D, the statute should provide that the publicly chartered entity will receive an equal share in the patent rights for successful technologies developed with these public funds.

It is important to note that most of the allowances distributed in this way would go without cost to the same industries that typically seek other forms of "free" allocation, but they would go in proportion to those industries' investments in cleaner vehicles and other low-emitting technologies. Distributing allowances this way is far preferable, for example, to allocating allowances on the basis of historical emissions or energy usage.[5] But there is no reason to limit support for clean energy investments to incumbents only. Rather, Congress should ensure the allowance value is available to *any* firm – incumbent or new entrant – that can efficiently and effectively carry out investments in energy efficiency and clean energy technology.

NRDC supports implementing these incentives by allocation formulas written into the statute, or partly by allocating allowances to a publicly chartered entity such as the Climate Change Credit Corporation proposed under the Climate Stewardship Act. Under a long-term declining cap, these technology incentives would have a much larger and more stable long-term source of funding than will come from the authorizations and tax incentives in the Energy Policy Act of 2005. Furthermore, these incentives could be accomplished without any budgetary impact.

(3) <u>20% of allowances for transition and adaptation assistance</u>

NRDC supports allocating 20 percent of allowances for a range of transition and adaptation assistance purposes.

A substantial fraction of allowances should be made available to assist workers and communities that are disproportionately impacted by mitigation measures (e.g., coal-miners and coal-mining communities). We support assistance for communities heavily affected by climate impacts, such as Gulf Coast wetland restoration and Alaskan village relocation. Adaptation resources should also be provided to help manage climate change impacts on fish and wildlife and the ecosystems on which they depend. NRDC does not pretend to be expert in the best mechanisms for

[5] If granted free allowances on a historical basis – or on any basis unlinked to making these investments – there is no guarantee that the firms will use allowance value for those purposes. They may distribute the allowance value to shareholders, or invest in other ventures deemed more profitable than retooling to reduce emissions.

delivering this assistance, but we are eager to work with labor and with leaders of affected communities.

Some have proposed that transition assistance is also needed for energy-intensive industries. We note that energy-intensive electricity and gas consumers would benefit from investments in energy efficiency under part (1) of our proposal. Energy intensive industries could also benefit from allocations made to support big-change technologies under part (2) of our proposal.

As discussed above, NRDC does not support grandfathering allowances to firms that supply or consume highly polluting fuels. Such an allocation would not protect workers in these firms, as it is sometimes claimed, because a grandfathered allocation would allow an energy-intensive firm to shut down its U.S. plants in order to shift production abroad and sell its unused allowances to other sources. Legitimate concerns about the competitiveness of firms that produce internationally-traded energy intensive products should be addressed by other means, such as border tax adjustments or allowance allocations tied to U.S. *employment*. If, however, Congress believes such firms merit some grandfathering of allowances for transitional reasons, this should be tightly limited as discussed above to avoid over-compensation and windfalls.

(4) <u>5% of allowances to encourage reductions outside the cap, and early reductions, while preserving the cap</u>

NRDC supports setting aside 5 percent of total allowances to encourage emission reduction and sequestration activities by sources that are not covered by the cap, and for early reduction activities. Example activities outside the cap could include soil carbon sequestration by farmers and methane capture at small landfills not covered by EPA regulations.

NRDC strongly supports using a set aside of allowances from within the cap for this purpose rather than to create additional "offset" allowances based on these activities. Establishing appropriate emissions baselines for non-covered sources is an inherently uncertain exercise because it is impossible to observe the emissions that would occur from these sources in the absence of the program. Using allowances from within the cap is a good way to create incentives for beneficial activities without risking the environmental integrity of the emissions cap.

As for early reductions, NRDC does not support giving allowances for "reduction" reports under DOE's 1605(b) program. First, early emission reductions are their own reward because they position firms to comply with the cap at the lowest possible cost. Careful review of the emission "reductions" reported under the 1605(b) program shows that most of the reported activities, such as increased output at existing nuclear power plants, were simply business-as-usual actions, and thus deserve no rewards now.[6]

If some early reduction credit is nonetheless warranted, then like the treatment of offsets proposed above, the incentive for early action should come out of this fraction of the allowances.

[6] See http://www.nrdc.org/globalwarming/fmandatory.asp