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JOHN BRADEMAS CENTER FOR THE STUDY OF CONGRESS

Research Brief – Number 2

Creating Constituencies for Long-Term, Radical Change

March 2007

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On September 27, 2006, California Governor Arnold Schwarzenegger signed into law Assembly Bill 32 committing California to aggressive emissions-reduction goals for addressing the climate change challenge. The new law requires the state to reduce its climate-altering greenhouse gas emissions to 1990 levels by 2020. The governor has further committed to reducing emissions to 80% below 1990 levels by the year 2050.

California's actions provide a dramatic example of the transformation of the climate change debate in the United States. Retreating glaciers, the melting artic ice cap, massive hurricanes, and increases in extreme weather now provide many Americans with vivid examples of the solidifying scientific consensus that human emissions of carbon dioxide and other greenhouse gases have begun to adversely affect the Earth's climate. Polls show that a large majority of Americans want their government to take action. Other states and U.S. cities have, like California, adopted ambitious emissions-reduction goals. Increasing numbers of American corporations, from GE to GM, claim that addressing climate change has become an important part of their mission.

It is thus no surprise that the 110th Congress shows heightened interest in legislation that would, if it becomes law, help reduce U.S. emissions of greenhouse gases. Several bills before Congress would set ambitious goals for reducing U.S. emissions by roughly 80% below 1990 levels by 2050 and set in motion near-term policies designed to meet those goals.[1]

Such proposed legislation raises the question of how Congress, an institution with a largely short-term focus, can craft effective policies of the scale and long-lasting influence

The Legislating for the Future Project is an initiative of New York University's John Brademas Center for the Study of Congress and the Organizational Performance Initiative, and is co-sponsored by the Brookings Institution and the RAND Corporation. The project will examine the capacity of Congress to address long-term problems facing the nation, probe the public's attitudes towards Congress' ability to make long-term decisions for the 21st Century, and analyze specific long-term policy issues. The Legislating for the Future Project will convene experts for discussions of specific long-term issues, such as global warming, and seek to generate strategies to make Congress more flexible and adaptive to future problems. The Advisory Committee for the project is headed by Former Representative Lee H. Hamilton. The project is funded by the John Brademas Center for the Study of Congress, the Smith Richardson Foundation and the Carnegie Corporation. For more information, please visit: www.nyu.edu/wagner/performance and www.nyu.edu/brademas.

necessary to make any significant difference to the long-term global challenge posed by climate change. Halting climate change would require lowering net global greenhouse gas emissions to near zero, a truly radical change in the way the world fuels its economy—one that will take many decades to achieve.[2] Today's Congress faces a public with seemingly little willingness to pay for actions whose main environmental benefits may occur decades in the future and as an institution has little power to bind its successors to the task of eliminating greenhouse gas emissions. Deep emissions reductions in the United States (much less California) will also make little difference to future climate change if China, India, and other developing nations do not ultimately follow suit.

This essay will argue that long-term emissions reduction goals like the ones currently proposed before Congress at best only highlight the magnitude of the climate change challenge, without contributing much to a solution.[3] Rather Congress might craft a robust, long-term greenhouse gas reductions strategy by taking near-term actions designed to shape the options available to future decision makers and the incentives influencing their choices. Appropriate combinations of policies already under consideration – including increased R&D on low-emitting technologies, focused incentives to bring such new technologies to market, and a properly configured cap and trade system – could empower innovators to invest in and deploy emissions-reducing technologies and practices and could encourage future Congresses to appropriately lower the emissions cap. After describing the potential difficulties with long-term emissions-reduction goals, this essay provides a scenario analysis based on new quantitative approaches to long-term policy analysis. This analysis suggests that, more than any attempt to lead with a declaration of long-term goals, a focus on shaping the incentives on future innovators and legislatures could provide today's Congress a robust approach to launching and sustaining the long-term radical change needed to address climate change over the 21st century.

Current Climate Proposals Emphasize Long-Term Emissions Reduction Goals

The 1992 Framework Convention on Climate Change (FCCC)[4] provides the long-term international goal and the basic conceptual framework underlying today's international climate change policy regime. This agreement, ratified by 189 nations including the United States, crafts its long-term goal cognizant of the basic parameters of the climate change challenge. In brief, the Earth's atmosphere contains a natural blanket of greenhouse gases such as carbon dioxide and methane, transparent to sunlight but absorbing of heat. This natural "greenhouse" effect controls the Earth's temperature, keeping it warm enough to support life. Human activities, primarily the combustion of fossil fuels, emit additional greenhouse gases, slowly thickening this blanket and warming the Earth. To avoid a wide range of potentially adverse impacts, human emissions will need to be significantly reduced over the 21st century.

The FCCC addresses this challenge by setting the ambitious, long-term goal of stabilizing atmospheric concentrations of greenhouse gases "at a level that would prevent dangerous anthropogenic interference with the climate system." The Convention does not define what concentration level would prove dangerous, in part to facilitate political agreement and in

part due to the tremendous uncertainties surrounding climate change's timing, magnitude, and regional patterns, which greatly complicate any assessment of what constitutes such dangerous interference. The FCCC nonetheless envisions a policy process that evolves over time in response to the long-term stabilization goal. Nations are to take initial actions, periodically review the emerging understanding of climate change, and adjust their actions accordingly.

The first major step under the FCCC was the 1997 Kyoto Protocol, which set the binding, near-term goal for developed nations to reduce their emissions on average 5% below 1990 levels by 2008-2012. The European Union, Japan, and other developed nations are currently implementing national greenhouse gas mitigation policies aimed at meeting these commitments. Widely understood as only a first step, the Protocol envisions future agreements that will specify deeper reduction goals for currently developed nations and also include targets for developing nations such as fast-growing China and India.

While the Kyoto Protocol has generated much controversy, the FCCC's call to stabilize greenhouse gas concentrations at some safe level remains an official long-term climate policy goal of the United States and most other governments. In recent years, many researchers have attempted to quantify the Framework Convention's goals. While the uncertainties remain huge, many scientists advocate stabilizing concentrations at a level somewhere between 450 parts per million (ppm) to 650 ppm, roughly twice the pre-industrial (mid 18th century) concentration of 280 ppm. Achieving such goals would require cutting projected global emissions by well over half during the course of the 21st century.

Such reductions represent a major challenge, since fossil fuels power the vast majority of human industry, transportation, and buildings. The challenge is global because all countries contribute emissions, but each is affected differently because they have different levels of current emissions, different levels of economic development, and different vulnerabilities to climate change. Worldwide since the industrial revolution, burning fossil fuels has been intimately associated with economic wealth. U.S. carbon dioxide emissions have grown inexorably since Americans first began burning large amounts of coal in the 19th century. Today a billion citizens of the richest countries use about ten times the energy per capita as the five billion citizens of the poorest. Countries like China and India are striving hard to catch up. China is already poised to surpass the U.S. as the world's largest emitter within a decade or two. If today's poor nations grow rich using current technology, greenhouse gas emissions will grow tenfold over the 21st century.

The past need not be prologue. For instance, an International Energy Agency (IEA) report produced in response to the 2005 G-8 meeting envisions returning global greenhouse gas emissions to their current levels by 2050 consistent with rapid growth of energy demand in developing world.[5] Almost half these reductions would come from increases in efficiency. About 20% would come from the new and yet unproven technology of carbon sequestration – capturing carbon dioxide produced by combustion and recycling it or burying it in the ground. The rest would come from renewables, nuclear power, and switching from coal to

natural gas. Scenarios from other reports suggest how such paths could be continued, taking net emissions down towards zero by the end of the century.

Such numbers have come to underlie the long-term climate targets of some governments. In addition to California and the bills before Congress, the UK has also proposed reducing its greenhouse gas emissions by 60% below1990 levels by 2050.[6] To meet these long-term climate goals, these governments put forward a portfolio of policies including enhanced government funding of research and development on emissions-reducing energy technologies; market incentives such as tax credits, subsidies, standards, and government procurement to accelerate penetration of these technologies; and national caps on greenhouse gas emissions. Emissions caps typically would be implemented with economically efficient mechanisms such as a "cap-and-trade" system where firms require a permit to emit each ton of greenhouse gases. The government issues a fixed number of permits (the cap), which firms can then buy and sell. These strategies generally lay out a schedule for reducing the cap over the coming decades to achieve the prescribed long-term emissions reduction goal.

Long-Term Goals May Prove Insufficient for a Successful Climate Policy

In principle such long-term climate strategies make perfect sense, but implementing them may prove very difficult for Congress. The most salient features of the climate change mitigation challenge are the need for radical, decades-long changes in the way humans fuel their economy; long lag times between emissions reductions and the environmental benefits they produce; and deep uncertainty about climate change impacts and mitigation costs. As described by other essays in this series, these features pose a challenge for Congressional actions given the way policy typically is designed and implemented.[7] The flood of near-term crises demands much of Congress' attention. Congress' committee structure can make it hard to see the big picture and thus implement coherent, system-wide action. The constant pressure of the next election, combined with legislators' strong desire to return to office, make it hard for Congress to impose direct costs on special interests, even if such costs produce more significant but diffuse benefits for all. Congress also has a domestic jurisdiction, but U.S. reductions will mean little if other nations do not participate.

In particular, these characteristics may make it difficult for Congress to take the actions needed today to ensure that any greenhouse gas emissions cap continues on a downwards path over the 21st century.

First, climate dynamics impose long lags between any actions to reduce emissions and the environmental benefits they produce. Human greenhouse gas emissions over the last century have already committed the Earth to decades of climate change.[8] Our generation will experience climate change mostly due to our parents' and grandparents' emissions. Today's emissions reduction decisions will mostly affect our children's and grandchildren's climate. Thus Congress' willingness to impose climate-related costs on Americans may be limited by the fact that even if policy somehow eliminated greenhouse gas emissions

tomorrow, the costs would occur immediately while climate change would continue until most of its members were long retired.[9]

Second, there exist many well-understood and low-cost options for making initial emissions reductions, while the means to make the deeper cuts needed to stabilize concentrations at some safe level remain uncertain and potentially expensive. Exploiting these low-cost options is certainly important, but Congress may overly focus on them while neglecting the preparations needed to ensure that their successors can continue with even deeper emissions reductions in the future. Most greenhouse gas emissions emanate from society's long-lived, emissions-producing capital stock – cars, buildings, power plants, factories, and patterns of land use in cities and suburbs – that prove very costly to retire before serving their long useful lives. Thus today's investment decisions could lock-in higher emissions for decades. For instance, the Chinese currently plan to build hundreds of new, high-emitting, coal-fired power plants. Some U.S. utilities plan less dramatic but still significant expansions of their coal-generation capability over the next few years. If such investments are not modified or slowed sufficiently, future generations may view our own as having taken only easy actions and left the hardest ones to them.

Third, Congress's ability to set and meet such long-term climate goals is also plagued by severe limits on the inability to predict the long-term future. Both the costs and benefits of reducing greenhouse gas emissions remain deeply uncertain.

The benefits of reducing emissions remain deeply uncertain because the impacts of this warming and people's response to it remain impossible to predict with any significant accuracy. Climate impacts are virtually certain to include more intense storms, rising sea levels, changes in precipitation, and significant damage to the Earth's ecosystems. Natural systems are likely to be especially at risk. Humans' ability to adapt to future changes represents a crucial uncertainty. In part, this ability depends on how quickly the climate changes. Computer simulation models used to predict future climate typically assume gradual change, but in recent years scientists have increasingly observed climate changes such as melting artic ice occurring faster than they ever anticipated. The recent IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report predicts sea levels could rise 7 to 23 inches over the 21st century.[10] But in the unlikely event the Greenland ice sheet disintegrates quickly, sea level could rise by meters.

The costs of reducing emissions remain at least as uncertain as the impacts. Projections such as the IEA's combine detailed economic and technology data to sketch what a low carbon economy might look like a half century from today and how much it may cost to get there. Despite their best efforts, such scenarios rarely do much more than extrapolate variations on current trends. Similar projections of energy use today made in the mid-20th century have proved consistently wrong,[11] missing the significant increases in energy efficiency engendered by the oil shocks of the 1970s, and the market revolutions that have sent energy demand in China and India surging. Moreover, energy forecasting over the last half-century may have been relatively easy because energy technology remained fundamentally stable. The fifty years from 1890 to 1940 saw profound technological change

as electricity and the automobile radically altered U.S. energy use. In contrast, our society today still relies on and burns coal and oil in fundamentally the same way as when Eisenhower was president.

As we look forward over the next fifty years, accurately forecasting the underlying trends influencing greenhouse gas emissions may be even more difficult than in the past. Will energy technology change mostly incrementally, or will the converging revolutions of information, bio, and nanotechnology change the landscape even more radically than did electricity and the internal combustion engine? Will the outlines of the international economy be similar to today's, or will the coming decades bring even greater economic and political instability? Will sudden climatic instabilities, or changes in values, dramatically increase peoples' willingness to pay for steep and rapid reductions in greenhouse gases?

This deep uncertainty greatly complicates Congress's ability to choose and achieve long-term climate goals. Climate change fundamentally presents a challenge of competing surprises. On the one hand, climate impacts may emerge differently and faster than expected. On the other hand, history suggests that energy-economic systems are full of surprises that may allow emissions to drop – or rise – with unanticipated speed. As a deliberative body that moves towards consensus and often seeks to minimize uncertainty, Congress faces a hard challenge in grappling with such circumstances. It will tend to gravitate towards the areas of least controversy and most certainty. Where it has most power – for example, over near-term U.S. emissions reduction goals – Congress may follow past precedents by setting targets that affected industries can fairly easily achieve, neglecting unexpected ability or need for more dramatic advances. Congress also may also set ambitious long-term goals, but without adequate measures to ensure they will be met. Economic analysis suggests emissions-reduction paths generally should begin mainly with more inexpensive reductions and tackle more difficult reductions in the future.[12] While this pattern makes good economic sense, it may reinforce the tendency for today's policy makers to take only relatively easy, inexpensive steps today while leaving more difficult ones to their successors.

The European Union has already begun to struggle with this dynamic as it strives to reach its Kyoto emissions reductions targets. Initially, the EU enjoyed large, one-time reductions due to factors unrelated to climate change. German and UK emissions dropped significantly as the former absorbed the former East Germany, retiring its hugely inefficient industrial stock, and as the latter closed down antiquated coalfields, switching to North Sea natural gas. The EU achieved additional reductions by cleaning up its solid waste dumps and modifying some agricultural practices. These easy tasks done, it now faces the challenge of reducing emissions in its fast-growing, already fairly efficient electricity, industrial, and transportation sectors.

These difficulties all combine to make it hard for Congress to ensure the United States can meet specific long-term emissions reduction goals. Today's Congress will find it hard to impose significant costs for the benefit of future generations. It has no real ability to bind future Congresses to take the more significant actions that may be necessary to continue

reducing towards an ambitious long-term goal. Against this backdrop, it becomes easy to imagine a scenario in which Congress rides a wave of contemporary public concern to legislate long-term climate goals with associated near-term milestones. In the near-term the US succeeds in slowing its emissions. But in a few years time one can imagine a future where the costs of further domestic reductions begin to rise, emissions in China and India grow, and public confidence in a solution begins to flag. Hearing mostly from industries under pressure to make costly reductions, future Congresses may turn away from the ambitious goals offered them by their predecessors.

A New Approach Can Help Congress Implement a Long-Term Climate Policy

Over the last decade, our group at RAND has been developing new methods to improve the practice of formal, long-term policy analysis. Enabled by the power of new computer technology, these Robust Decision Making (RDM) methods emphasize the use of imperfect data, simulation models, and scientific understanding, not to better predict the future, but to think creatively about near-term actions that will achieve our goals no matter what future comes to pass.[13] The insights highlighted by these new methods suggest how Congress might effectively address the long-term climate change challenge.

The traditional analytic tools used to evaluate policy options emphasize predictions. Thus documents like the recent IPCC Fourth Assessment Report offer forecasts from computer models of climate change over the 21st century, and documents like the IEA's use energy models and engineering data to describe particular long-term energy futures in great detail. Such analyses reinforce the tendency to equate long-term policy-making with setting specific long-term goals and evaluating policies against a few defined scenarios to find the "best" options.

In contrast, RDM uses data and computer models to trace out hundreds to millions of plausible futures, each distinguished by different combinations of assumptions about how the future might evolve. Alternative strategies are then stress-tested against these multiple futures, paying particular attention to how these strategies might change over time in response to different circumstances and new information. An RDM analysis helps identify the futures where particular strategies perform poorly, and then suggests how they might be modified, or replaced, to make them less vulnerable.[14] Rather than choose the strategy that performs best in the most likely futures, RDM helps decision-makers identify *robust* strategies that perform relatively well across many futures. Often such robust strategies emphasize near-term shaping actions, designed to make desired outcomes more likely; hedging actions, designed to soften the impacts of undesirable futures; and signposts, which give early warning that certain futures have become more likely so that near-term policy ought to be adjusted.[15] A robust strategy doesn't offer good news in all futures. Rather it performs well compared to the alternatives over almost all plausible futures. Some futures offer good outcomes. In these futures a robust strategy should perform along with the best possible choice. Other futures offer only bleak possibilities. In these a robust strategy ought to number among the best of the worst.

In short, rather than ask, "What will the long-term future bring?" RDM helps decision-makers inquire, "How can we choose actions today that will be consistent with our long-term interests in a way that is relatively insensitive to whatever future circumstances come to pass?"

This latter question focuses attention on perhaps the most salient and uncertain, if often overlooked, challenge facing any successful long-term policy – the choices to be made by people in the future. At best, today's policy-makers can emphasize shaping the opportunities and constraints facing their successors, thereby encouraging the latter to follow a path that the former would deem favorable. A key challenge for successful long-term policy-making then is to identify, assess, and choose among near-term actions that shape options available to future generations.

On occasion, Congress has successfully shaped the options available to their successors. Past Congresses have built physical infrastructure -- such as the interstate highways, ports, and dams -- that both enrich future generations and help determine where and how they live. Past Congresses has also expanded the options we currently have available with investments in education and scientific research. Current U.S. climate policy already funds research and development programs on technologies, from carbon sequestration to advanced bio fuels, designed to expand the menu of low-cost, emissions-reduction options available to future decision makers. But numerous studies suggest government investment still remains far below the scale of the opportunity and the scale of the need. Despite the tremendous demands raised by climate change and energy security and the potentially huge technological advances in energy systems promised by information, nano, and bio technologies, energy funding in the U.S. and across the developed world remains roughly 40% below its peak levels in the mid-1970s.[16] Market incentives for new technologies, from tax credits on hybrid cars to renewable portfolio standards for renewable electricity generation, may also be important for a robust long-term climate policy; however the success of these programs in targeting close-to-market-ready technologies remains a subject of debate.[17]

Past Congresses have also effectively shaped their successors' options by creating constituencies with self-interest in pursuing some public good and in advocating for certain actions and values.[18] For example, in the 1960s Congress aimed to break down centuries of racial discrimination. Civil rights legislation, especially the Voting Rights Act, helped launched significant long-term change by creating incentives for politicians to pay attention to previously ignored constituencies. In the late 1860s, Congress aimed to create a railroad across North America. Rather than plan the route and direct the construction, Congress offered massive financial incentives for entrepreneurs willing to build risky and expensive transcontinental lines. The resulting process, rife with determination, thievery, heroism, cruelty, and corruption, nonetheless over the decades accomplished precisely what was intended, a transcontinental rail network that unified the country and enabled the first and still the strongest continental economy.

Congress could similarly help create constituencies for addressing climate change with appropriate mechanisms for placing a price on greenhouse gas emissions. There is near unanimity that price-based mechanisms can increase the efficiency of environmental regulation. Accordingly, many economists favor carbon taxes as the most cost effective means to encourage businesses and consumers to adjust their investments and choices in light of their estimated contributions to climate change. Nonetheless, the bills before Congress propose as an alternative a cap and trade system – where the government sets a cap on emissions, divides that cap into individual permits that firms can buy and sell, and requires each firm to hold permits equal to its emissions. In contrast to a tax, a cap and trade system may be more complex to administer and does not limit the potential costs to the economy of emissions regulations. Legislators may favor a cap and trade system because, unlike environmental taxes, it promises to limit emissions to some fixed level and because it may make it more difficult for voters to notice the connection between Congressional action and any increased costs. Less recognized, a cap and trade system might also help Congress address its most difficult challenge in enacting an effective long-term climate policy. Properly configured, a trading system may create a dynamic that over time would accelerate innovation and shape the incentives on future Congresses to continue on a path to further drive down greenhouse gas emissions. [19]

For instance, a cap and trade system, such as the one successfully implemented to reduce acid-rain-causing sulfur dioxide emissions under the 1990 Clean Air Act, would provide a strong incentive within firms to accelerate development of greenhouse gas emissions-reducing technologies and de-accelerate the development of high-emitting ones. Whatever the public positions or actual beliefs among executives of individual firms, a cap and trade system shifts some of the risks of underestimating the likelihood of a low-carbon future from society to the businesses that generate greenhouse gases. Every CEO will feel pressure to pursue emissions-reducing projects, knowing they cannot risk being left behind by a competitor who might achieve a market-altering breakthrough. In addition, firms considering investments in long-lived, high-emitting infrastructure such as coal-fired electric plants will be forced to weigh the risks that such plants may become considerable more expensive to operate in the future.

More so than environmental taxes, a cap and trade system may also create a business constituency for reducing the national emissions cap over time. The trade in permits could be large. Priced at $50/ton, permits for current U.S. emissions might create hundreds of billion dollars in annual trades. Firms and divisions of firms will form to exploit this market. The most successful may become advocates for tightening the cap, making permits more scarce and valuable. Congressional hearings on lowering emissions caps will no longer pit only those segments of society who lose most from climate regulations against environmental groups and scientists representing a diffuse general good. Rather, specific commercial interests will be eager to testify that deeper reductions are possible and economically beneficial. This dynamic has already begun to appear in Europe. The current EU trading program's mandate ends in 2012 along with the Kyoto Protocol. Despite deep uncertainty about the form of international agreement that will follow Kyoto, there seems much confidence that the European trading program will continue, fueled in part by the

corporations that want to protect their revenues from investments made under the current system.

A cap and trade program also creates a currency that Congress can use to offset high costs of compliance for politically sensitive constituencies, while also expanding the range of non-business constituents with direct financial interest in reducing greenhouse gas emissions. One bill before Congress[20] would, for instance, establish a non-profit corporation financed by the sale of emissions permits awarded to it by the government. The corporation would use these revenues to fund assistance programs for citizens unduly affected by higher fuel costs or workers displaced by the transition to a low-carbon economy. Even more directly, some non-profit groups have proposed a system allowing low-income residences to generate marketable "carbon offsets" by improving the energy efficiency of their housing. These efficiency improvements would generate future emissions reductions that the residences could sell to businesses seeking reduce their own compliance costs.

Finally, a cap and trade system might allow Congress to create constituencies overseas that may help draw other nations into an international greenhouse gas reductions regime. One of the most interesting innovations in the EU cap and trade system is a program called the Clean Development Mechanism. This CDM allows companies in Europe to satisfy part of their emissions reduction obligations by making emission-reducing investments in developing countries. For instance, a European company might invest in a Chinese wind farm and gain credit for the emissions that would have come from an equivalent coal plant. This not only saves the European company money, such programs may help create a constituency within China for engagement in an international greenhouse gas regulatory regime. At present, the number of offsets in China has been limited, and some have gone to questionable projects. To the extent that offsets can be used to create industries in China whose profitability is enhanced by a low carbon path, it can only help move China towards eventual inclusion in international agreements that limit greenhouse gas emissions.

Is Creating Constituencies a Robust Strategy?

Climate change presents a global, long-term policy challenge. Over the last decade, the dominant framework for climate change policy has emphasized a global international agreement that catalyzes change by defining a safe level at which to stabilize atmospheric concentrations of greenhouse gases and setting binding targets for each nation along a path towards that goal. Similarly, many Americans now hope Congress will take a leadership role in setting long-term emissions-reduction goals for the United States. But such a top-down strategy faces severe challenges. Internationally, no environmental treaty has every forced radical change on the scale needed to address the GHG mitigation challenge.[21] Domestically, given climate change's long lags between action and consequence, Congress will have difficulty agreeing to binding targets the affected industries are unsure they can meet. Given the deep uncertainty and radical change associated with climate change, no sure target is likely adequate to the task. Congress may

well legislate deep, long-term goals for reducing U.S. emissions, but will have difficulty binding future Congresses to the path.

The robust decision making approach suggests that a different framework for long-term climate policy may prove more effective. Rather than emphasize long-term goals, Congress might focus on shaping the options available to its successors. In particular, Congress should expand the menu of viable, low-cost, emissions-reducing technologies and establish a cap and trade system that will reduce near-term emissions but, more importantly, create domestic and international constituencies for an ever-lowering greenhouse cap. Over time, Congress can work with the executive branch to link the U.S. trading system with those emerging in other nations, and then draw in the rest of the world with a mix of carrots and sticks. While this creating constituencies approach cannot guarantee stabilization of atmospheric concentrations of greenhouse gases at any particular level, it offers perhaps the most robust option for a long-term climate policy.

Sketching out an RDM-style analysis can suggest why. Let's compare how the performance of three alternative strategies – binding international emissions caps, an R&D focused strategy, and creating constituencies for radical change -- might evolve over a very small set of future climate change scenarios. Imagine four scenarios describing the climate change challenge, differentiated by the seriousness of future climate change impacts and the potential for radical, low-cost reductions in greenhouse gas emissions. In one scenario, climate change will be rapid and serious, but we sit at the cusp of a technological revolution that will transform the way society produces its energy. In a second scenario, future technology offers only high-carbon fossil fuels, but climate change proves slow and mild. In a third scenario, climate change proves slow and mild and we sit at the cusp of the low carbon technological revolution. In the fourth scenario, we face rapid and serious climate change and only high-carbon fuels.[22]

If Congress knew for certain that it faced the first scenario, with looming and catastrophic climate change and abundant technological solutions, the body might agree to join an international treaty mandating deep reductions in greenhouse gas emissions. In this scenario the R&D strategy would prove disastrously slow. But the creating constituencies strategy would perform nearly as well as the deep-cuts treaty. Even an initially lax cap would help spawn a wave of technology innovation, and a growing chorus of business and environmental groups would encourage Congress to quickly tighten the cap. If Congress knew for sure that it faced the second scenario, with few climate impacts and no alternative to high-emitting fossil fuels, it might decline to cap greenhouse gases at all. In this scenario a deep-cuts treaty could prove economically devastating, but the creating constituencies strategy would minimize any damage. As the costs of moving beyond the initial cap became clear, Congress would back away from its more ambitious emissions-reduction goals. In the third scenario, with few climate impacts and abundant means to reduce greenhouse gases, the R&D strategy might prove most efficient and the deep-cuts treaty a needless burden. The creating constituencies strategy would succeed in gaining the small environmental benefits at a limited cost. In at least one of these three scenarios,

the deep-cuts treaty and R&D focused strategies could each proved seriously flawed. In contrast, the creating constituencies strategy does reasonably well in them all.

The fourth scenario, with looming and catastrophic climate change and no alternative to high-emitting fossil fuels, poses a severe challenge to all three strategies. In this scenario, some type of geo-engineering may offer the only viable option – for instance removing carbon already emitted into the atmosphere[23] or increasing the amount of sunlight reflected from the Earth by pumping sulfur dioxide aerosols directly into the stratosphere. In principle such technology should prove straightforward and low-cost compared to most emissions-reducing options. In contrast to other climate change technologies, geo-engineering could be deployed rapidly, so Congress need today only conduct research to prepare this option for potential use. But geo-engineering also entails a profound risk of unintended consequences. If the time ever came to make a deployment decision, Congress would face a long-term policy decision very different from its other climate change options – balancing near-term benefits against the potential for profound, longer-term risks to the Earth. But for today, across all four of these four climate change scenarios, the creating constituencies strategy, with some geo-engineering research as a hedge, appears to the most robust option Congress has available.

A full RDM analysis could help Congress design a more robust long-term climate policy by identifying the small number of most important, stressing futures against which to hedge and the most important signpost to watch as policies evolve. But even the quick sketch presented here suggests two important points. First, the dynamics of the climate challenge suggest that Congress may need to observe trends in low-emitting (and geo-engineering) technologies at least as carefully as it does trends in the climate. The most serious, long-term impacts of today's emissions may remain so difficult to predict that reducing emissions as quickly as new technology makes economically possible may prove the best means to manage the risk.[24] Second, uncertainties related to the ability of implemented policies to perform as intended may be at least as important to the success of long-term climate strategies as the more-often discussed uncertainties related to underlying trends in the external world.[25]

In this vein it is important to note that the robustness of the creating constituencies strategy may be threatened by vulnerabilities associated with the workings of the United States' legislative branch. Designing a successful cap and trade system is not trivial, and Congress might fail at to create one that functions well. Congress might also fail by succeeding too well in creating constituencies for greenhouse gas mitigation. Future legislators may lower the cap too aggressively, sacrificing too much economic welfare for too little environmental gain. Congress might also fail by creating a system that serves current businesses too well. The cap and trade system might encourage small reductions but prove unable to reward radical changes in emissions-producing technologies that threaten today's incumbent industries and thus fail to create effective constituencies for deeper cuts. These potential failures represent serious challenges, but ones more related to near-term institutional design. At the very least, the creating constituencies strategy transforms an effort of long-

term policy making into the more familiar challenge of enacting effective near-term legislation.

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The Framework Convention on Climate Change calls for periodic meetings of its signatory nations. About once a year thousands of delegates and even more observers gather in a large international conference called the Conference of Parties. Negotiators in private rooms debate implementation of past agreements, distribution of United Nations funds, and future caps on greenhouse gas emissions. Meanwhile in public halls and in venues throughout the host city, large corporations, individual entrepreneurs, and hard-charging NGOs lure audiences with champagne and hors d'oeuvres to promote their latest new technology, service, or social action that will help realize the dream of a zero-carbon-emissions society. The dominant framework for climate change policy assumes that the international negotiations on long-term emissions targets will lead the way. But given the deep uncertainty associated with and the radical change needed to address the greenhouse gas mitigation challenge, the negotiators may most usefully codify what the world's leading firms, cities, and states have already accomplished. Similarly, rather than trying to lead with long-term goals, the United States Congress might most effectively address the long-term, global climate change challenge by creating today a market for greenhouse gas emissions reductions, along with increased investment in research on low-carbon energy technologies. These actions could set in motion a process that provides incentives for radical emissions-reducing innovation, and creates the realistic possibility that innovators who succeed will see their innovations become the world-wide standard.

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1 Parker, Larry (2007). Climate Change: Greenhouse Gas Reduction Bills in the 110th Congress, Congressional Research Service Report for Congress, Jan 31. RL33846.

2 Lempert, Robert J., Steven W. Popper, Susan Resetar, Stuart Hart (2002). Capital Cycles and the Timing of Climate Change Mitigation Policy, Pew Center on Global Climate Change, 60 pp.

3 This essay focuses on mitigation of, not adaptation to, climate change. Both are important but the former may present the more difficult long-term policy challenge for Congress

4 See http://unfccc.int/

5 International Energy Agency (2006). Energy Technology Perspectives -- Scenarios & Strategies to 2050, 484 pages.

6 Cowell, Alan (2007). "Britain Drafts Laws to Slash Carbon Emissions," The New York Times, March 14.

7 Binder, Sarah A. (2006). Can Congress Legislate for the Future? John Brademas Center for the Study of Congress. Research Brief No. 3.

8 IPCC (2007) Climate Change 2007. The Physical Science Basis. Summary for Policymakers from Working Group I of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/.

9 Public opinion surveys suggest the American public is very concerned about climate change, but remains in the "wishful thinking" stage of opinion formation in which they

hope the problem can be solved by someone else without changes in their own behavior. Leiserowiz, A. (2006). "Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery, and Values," Climatic Change 77:45-72.

[10] IPCC, op. cit.

[11] Craig, P.P., A. Gadgil, and J.G. Koomey (2002). "What can history teach us? A retrospective examination of long-term energy forecasts for the United States," Annual Review of Energy and the Environment 27:83-118.

[12] See, for instance, Wigley, T.M.L., Richels, R.G., and Edmonds, J.A. (1996). "Economic and environmental choices in the stabilization of atmospheric CO2 concentrations," Nature 379(6562): 240-243. One important exception to this proposition is when GHG mitigation is especially difficult and there is a high value from learning by doing in the development and use of innovative new technologies. This could be true, for example, in addressing the large and growing emissions from private transportation worldwide.

[13] Lempert, Robert J., Steven W. Popper, Steven C. Bankes (2003). Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis, RAND MR-1626-RPC. Also see Robert J. Lempert and Steven W. Popper (2005). "High-Performance Government in an Uncertain World," in High Performance Government: Structure, Leadership, and Incentives. eds. Robert Klitgaard and Paul Light. Santa Monica: The RAND Corporation

[14] Lempert, Robert J. David G. Groves, Steven W. Popper, Steve C. Bankes (2006). "A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios," Management Science, vol 52, no 4, April.

[15] Dewar, J. A. (2002). Assumption-Based Planning: A Tool for Reducing Avoidable Surprises. Cambridge University Press. 248 pp.

[16] Clery, Daniel et. al. (2007). "A Sustainable Future, If We Pay Up Front," Science 315, 782-3.

[17] National Research Council (2001). Energy Research at DoE: Was It Worth It? National Academy Press, Wash. DC. 224pp.

[18] Political scientist Eric Patashnik examines the conditions under which general interest, legislative policy reforms can be sustained over time. (Patashnik, Eric, 2003. "After the Public Interest Prevails: The Political Sustainability of Policy Reform," Governance vol 16, no 2, April, pp. 203-234.) Such reforms can occur when there forms a temporary linkage between elite and mass sentiment that overcomes the opposition of more narrowly focused interests. But the former often dissipates once the legislation passes while the latter persists. Patashnik argues that "the long-term sustainability of the reforms may depend on the successful reworking of political institutions and the generation of positive policy-feedback effects, especially the empowerment of social groups with a stake in the reform's maintenance."

[19] Lieberman, Joseph (2005). "Taking Global Warming to Market," The American Interest, vol. 1, no 1, Autumn

[20] The Climate Stewardship and Innovation Act of 2007 (S. 280).

[21] Victor, David G, House, Joshua C., and Sarah Joy (2005). "A Madisonian Approach to Climate Policy" Science vol 309, 1820-1821.

[22] Some countries, in particular, the United States and Canada, have large deposits of oil shale, tar sands, and other potential non-conventional sources of oil. These high-carbon resources could in the future become a major source of transportation fuel and without effective sequestration could significantly increase greenhouse gas emissions.

[23] Billionaire Richard Branson recently offered a $25 million prize for new technology that can remove carbon from the atmosphere. See James Kanter "$25 Million to Encourage Cleaner Air," New York Times, Feb 10, 2007.

[24] Lempert, Robert J. Michael E. Schlesinger (2002). "Adaptive Strategies for Climate Change," Innovative Energy Strategies for CO2 Stabilization, Robert Watts, ed., Cambridge University Press, 468 pp.

[25] Groves, David G. and Robert J. Lempert (2007). "A new analytic method for finding policy-relevant scenarios," Global Environmental Change 17, 73-85.