Agenda *for Climate Action*

PEW CENTER ON Global CLIMATE CHANGE

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Prepared by the Pew Center on Global Climate Change

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Over the past seven years, the Pew Center has published more than 60 reports on the science, economics, solutions, and policy options related to global climate change. Over that time, the scientific consensus on this issue has only strengthened, but there is, as yet, no consensus on the appropriate portfolio of policies that are required to address global climate change successfully. This Agenda for Climate Action is the Pew Center's attempt to fill that gap. It takes a comprehensive look at a suite of climate, energy, and technology policies that could provide meaningful reductions in greenhouse gas emissions throughout the economy.

This report finds six areas in which the U.S. must take action: (I) science and technology research, (II) market-based emissions management, (III) emissions reductions in key sectors, (IV) energy production and use, (V) adaptation, and (VI) international engagement. In the areas of science and technology research, we call for increased stable funding for both, along with innovative approaches to distribute funds efficiently. We propose a mandatory GHG reporting system, which can form the basis for tracking voluntary reductions, accompanied by a large-source, economy-wide cap-and-trade program for greenhouse gases. This combination of technology investment and market development will provide for the most cost-effective reductions in greenhouse gases, as well as create a market for GHG-reducing technologies.

While these broader efforts are critical, sector-specific actions are also needed. To address emissions from the transportation sector, we propose converting the struggling Corporate Average Fuel Economy (CAFE) program into a more ambitious but tradable GHG standard, along with increased support for low-emission vehicles and fuels. For the industrial sector, we encourage greater outreach and incentives for improvements in process efficiency and the manufacture of low-GHG products. In the agriculture sector, biological sequestration programs in Farm Bill legislation must receive proper funding and prioritization. Because energy is at the heart of this issue, we tackle this sector separately, making recommendations for each major energy source. To enable continued use of coal in a climate-friendly manner, we promote aggressive research and development on carbon separation and capture technologies, development of a regulatory framework for geologic sequestration, and advanced generation coal plants. Natural gas is an important transition fuel, and we support the expansion of natural gas transportation infrastructure and production. We propose extending incentives for renewable fuels and electricity generation, an increased focus on biomass, and federal-level support for renewable credit-trading programs. We also support continued use of nuclear power generation, pending resolution of issues such as safety and waste storage. There are vast opportunities for improving efficiency on an economy-wide basis, so we promote improved efficiency in electricity production (through distributed generation, combined heat and power technologies), in electricity transmission (through test beds for an advanced grid), and during energy use (through building codes, product standards, and manufacturing process improvements).

Because none of these efforts will fully prevent all potential effects of climate change (indeed, many impacts are already being observed), we propose the development of a national adaptation strategy and the funding of early warning systems. Last but not least, while the Agenda focuses on domestic actions, it argues for greater participation by the U.S. in international negotiations to engage all major emitters in a global solution.

Despite the specificity of many of the steps included here, there is still much room for ongoing refinement and elaboration of these recommendations. While we have consulted with many stakeholders in the development of this report, we look forward to building upon the suggestions described here through further outreach and consultation.

This report follows the publication of *International Climate Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico,* an examination of options for advancing the international climate effort post-2012. Taken together, these two documents offer a promising path forward for the U.S. and the world in tackling global climate change.

Executive Summary

Climate change is one of the most complex issues that the world will face in this century. Concentrations of greenhouse gases in the atmosphere have already reached levels unprecedented for hundreds of thousands of years, causing changes not only in global temperature but also resulting in observable impacts throughout the world, and these changes are happening more quickly than expected. The broad consensus of established scientific experts both internationally and domestically is that most of the warming in recent decades can be attributed to human activities. In addition, the rate and severity of these changes will increase in the absense of significant steps to reduce greenhouse gas emissions (GHGs). Stabilizing greenhouse gas concentrations will require a fundamental shift in our energy system, but this transition will have other benefits as well, including improved competitiveness, security, air quality, public health, and job creation. This transition will not be easy, but it is crucial to begin now.

This Agenda is the Pew Center's attempt to develop and articulate a responsible course of action for addressing climate change. It identifies fifteen actions that should be started now, including U.S. domestic reductions and engagement in the international negotiation process. It includes both broad and specific policies, combining recommendations on technology development, scientific research, energy supply, economy-wide markets, and adaptation with steps that can be taken by key sectors. While reductions across all sectors and sources of emissions are key, the steps listed here are not likely to happen simultaneously, nor without costs. However, these recommendations have been designed to be both cost-effective and comprehensive.

Recommendations

Invest in science and technology research.

1. Ensure a robust research program though the Climate Change Science Program.
2. Offer long-term, stable funds—in the form of a reverse auction—to GHG-related technology research and development.

Establish mandatory limits on greenhouse gas emissions and harness market mechanisms for economy-wide reductions.

3. Create a mandatory GHG reporting system as a basis for an economy-wide emissions trading program.
4. Implement a large-source, economy-wide cap-and-trade program for greenhouse gases.

Stimulate innovation across key economic sectors.

5. **Transportation:** Convert the Corporate Average Fuel Economy (CAFE) program into strengthened, tradable corporate average emissions standards. Support biofuels, hydrogen, and other low-GHG fuel alternatives.
6. **Manufacturing:** Provide outreach and incentives to manufacturers for improvements in industrial efficiency and low-GHG technologies, and support the production of low-GHG products.
7. **Agriculture:** Raise the priority and funding levels for Farm Bill programs and other federal initiatives on carbon sequestration.

Drive the energy system toward greater efficiency, lower-carbon energy sources, and carbon capture technologies.

8. **Coal and Carbon Sequestration:** Provide funding for tests of geologic carbon sequestration and for research, development and demonstration (RD&D) projects on separation and capture technologies, in combination with advanced generation coal plants. Establish an appropriate regulatory framework for carbon storage.
9. **Natural Gas:** Expand natural gas transportation infrastructure and production.
10. **Renewables:** Significantly "ramp up" renewables for electricity and fuels, including an extension and expansion of the production tax credit, a uniform system for tracking renewable energy credits, and increased emphasis on biomass.
11. **Nuclear Power:** Provide opportunities for nuclear power to play a continuing role in a future low-carbon electricity sector.
12. **Efficient Energy Production and Distribution:** Support the development and use of combined heat and power installations, distributed generation technologies, and test beds for an upgraded electricity grid.
13. **Efficient Energy Usage:** Reduce energy consumption through policies that spur efficiency, including appliance and equipment standards, building R&D and codes, and consumer education.

Begin now to adapt to the inevitable consequences of climate change.

14. Develop a national adaptation strategy through the Climate Change Science Program and Climate Change Technology Program, and fund development of early-warning systems for related threats.

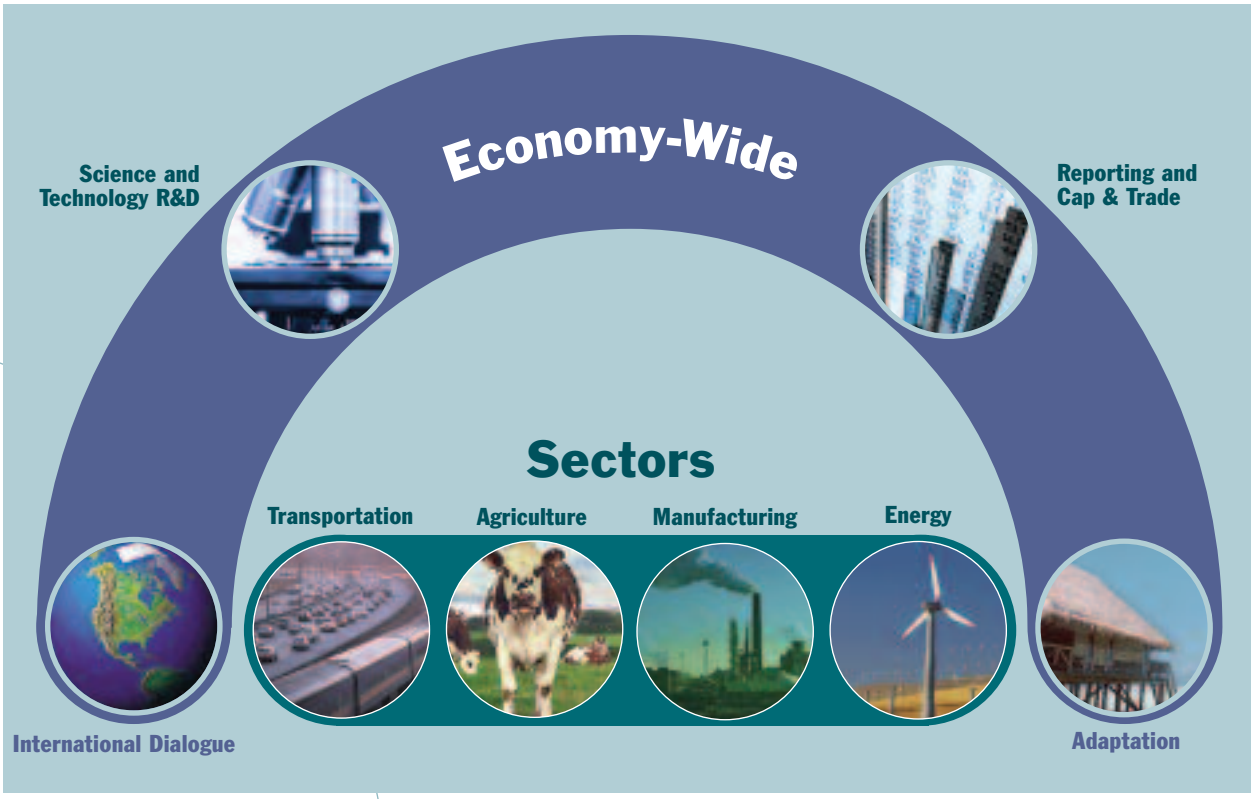
Engage in negotiations to strengthen the international climate effort.

15. Review options for a new or modified agreement to ensure fair and timely action by all major emitting countries, and participate in negotiations to establish binding climate commitments consistent with domestic interests.

These fifteen recommendations are not the only means of achieving a lower-carbon future, but taken together, they chart a climate-friendly path for the United States. Putting this Agenda into practice will take political will and policy action. All recommendations require government leadership and private sector commitment and time. Nonetheless, the details of specific recommendations in this Agenda are less critical than the compelling need to get started. Further delay will only make the challenge before us more daunting and costly.

Figure 1

Agenda for Climate Action Overview of Recommendations



Agenda for Climate Action

Climate change is one of the most complex issues that the world will face in this century. Because of the increasing impact of humans on the earth's climate, decisions made in upcoming decades will significantly shape our world's weather, geography, distribution of plant and animal life, and even human health and migration patterns.

Temperatures have risen over the last century and are expected to continue to do so at an increasing rate. The well-established link between increasing temperatures and human activities such as fossil fuel combustion and deforestation makes it necessary to act now to curb our influence on the earth's climate. Concentrations of greenhouse gases (GHGs) in the atmosphere have already reached levels unprecedented for hundreds of thousands of years (see CO_2 concentration in Figure 2), causing changes not only in global temperature, but also in precipitation, sea-level rise and other observable impacts throughout the world, and these changes are happening more quickly than expected. The broad consensus of established scientific experts both internationally[1] and domestically[2] is that most of the warming in recent decades can be attributed to human activities. In addition, the rate and severity of these changes will increase in the absence of significant steps to reduce greenhouse gas emissions to the atmosphere.

Stabilizing greenhouse gas concentrations will require a fundamental shift from an economy based on traditional burning of fossil fuels to one based on more efficient energy production, generation and use; increased use of low-carbon energy sources; and the capture and storage of carbon from fossil fuels. Such a transition will have other benefits as well. Increasing the efficiency of U.S. industry will improve businesses' competitiveness at home and abroad. Reducing demand for oil is a key step in improving energy security. The use of lower-carbon energy sources will reduce air pollution and enhance public health. If approached thoughtfully, this transition can provide advantages for future economic growth, create jobs in new manufacturing and service industries, and provide support for U.S. agriculture and forestry. Many companies and state and local governments have recognized these needs and opportunities and have begun to take action, but more is needed. This transition will not be easy, but it is crucial to begin now.

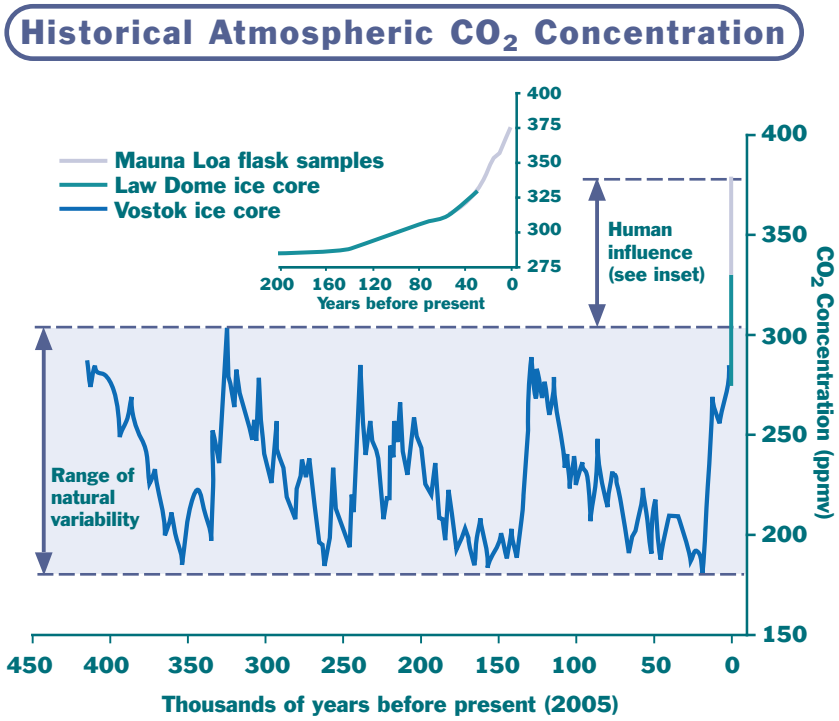
This Agenda is the Pew Center's attempt to develop and articulate a responsible course of action for addressing climate change. It identifies fifteen actions that should be started now, including U.S. domestic reductions and engagement in the international negotiation process. Tackling climate change will require both broad and specific policies addressing a wide range of activities and sectors. We recommend the development of an integrated national climate change strategy that combines technology development with broad policies addressing mitigation, scientific research, energy policy, economy-wide markets, and adaptation. We also identify critical steps key sectors must take in order to address their contributions to this problem, and the need for a broad

international framework that includes all major emitters. This effort builds upon seven years of Pew Center analysis and experience with leading businesses and policymakers. It represents our best effort to outline an ambitious yet pragmatic approach to addressing this serious issue.

Our approach aims to engage all major emitting sectors, make use of both market mechanisms and activity-based approaches, accelerate technological development and diffusion, assure credit for early actions, promote public education, and couple both near-term and long-term goals. While reductions across sectors and sources of emissions are key, the steps listed here are not likely to happen simultaneously. Some recommendations provide an important foundation for more ambitious changes that will require additional time, technological progress and investment.

Addressing climate change is not a cost-free proposal. In order to achieve the dramatic reductions of greenhouse gases (GHGs) that will be needed without disrupting the economy, design and implementation of reduction programs must take into account capital stock turnover and provide for flexibility in reaching targets. The fifteen steps outlined here have been designed to allow for cost-effective reductions in greenhouse gases. Taken together, they would allow all economic sectors to play a role in addressing climate change.

Figure 2



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Recommendations

Invest in science research to improve understanding of the climate system and causes of warming, and in technology research to stimulate innovations to reduce, avoid, and sequester greenhouse gas emissions.

1. Ensure a robust research program though the Climate Change Science Program (CCSP).

In the absence of greater federal commitments to science, the CCSP has a limited ability to reduce the remaining scientific uncertainties and improve decision making with respect to climate change. Funding should be increased to allow the CCSP to complete a research infrastructure management plan, to focus on the remaining scientific uncertainties (e.g., specific regional impacts, quantification of carbon storage in sinks, and adaptation), and to share and integrate results. An independent scientific and stakeholder entity should be created for review of priorities, budgets, and products.

2. Offer long-term, stable funds—in the form of a reverse auction—to GHG-related technology research and development.

Long-term, stable funding should be available for pre-commercial research, with projects selected through a "reverse auction"[3] in which proposals for reduction projects compete on a level playing field for funding. An auction could specify technology categories (such as those discussed in other sections of this Agenda) as well as offer a broad competition to elicit new, as-yet-unknown technologies. Other funding alternatives include forward funding,[4] technology prizes,[5] tax rebates, and public-private partnerships.

Other actions might include removing barriers to patent registration, upgrading the scientific and technological level of the U.S. workforce, shifting one or more national weapons labs to energy efficiency and renewable energy projects, and considering GHG emissions in the Department of Defense's research selection process.

Establish mandatory limits on GHG emissions and harness market mechanisms to spur the most cost-effective reductions throughout the economy.

3. Create a mandatory GHG reporting system as a basis for an economy-wide emissions trading program.

The first step in any domestic program to address climate change is a reliable and credible system for tracking and reporting greenhouse gas emissions. A mandatory GHG reporting program should require the reporting

of emissions of at least six GHGs—CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6[6]—by the largest emitters of these gases and other entities that choose to "opt in." Reports would include direct emissions from facilities, although vehicle fleet emissions and indirect emissions[7] associated with the use of electricity, heat and steam could be reported voluntarily. A mandatory GHG reporting program would provide a solid foundation for a future U.S. GHG reduction program, as well as offer a basis for government assurances that companies would not be penalized for early reductions (baseline protection), and provide an incentive to make these reductions. Most importantly, a mandatory reporting program would stimulate voluntary reductions across the entire economy.[8] The program would also provide policy-makers with a strong data-driven foundation on which to develop a comprehensive climate change strategy.

4. Implement a large-source, economy-wide cap-and-trade program for greenhouse gases.

Experience suggests that while voluntary programs may be effective at the company level, they have had little impact on the overall growth in U.S. GHG emissions. To be effective and affordable, a long-term emissions reduction program must combine mandatory GHG reductions with technology development and market mechanisms. A cap on emissions would send an economy-wide signal favoring reductions, and emissions trading would ensure that reductions are achieved at the lowest cost possible. The program would cover all GHGs in all major emitting sectors and include all measurable, verifiable reductions and offset measures without restrictions on trading.[9] An absolute cap for the national program should be set at a modest level and announced sufficiently far in advance to allow for planning (e.g., a return to current levels within a five- to ten-year period). Further reductions could be phased in over time as new technologies come online and capital stock turns over.

In a large-source, downstream cap-and-trade program, GHG emissions from large industrial sources and electricity generators would be capped at pre-determined levels. Tradable allowances, each representing the right to emit one ton of GHGs, would be distributed to the sources, with the total number of allowances equaling the overall cap. Because individual sectors have different sensitivities to the price of carbon and are growing at different rates, sector-specific limits or allocations within the overall cap could be established. At the end of a year, each emitter would be required to surrender allowances equal to its emissions.[10] Emitters whose cost of reducing emissions was more than the price of an allowance could buy allowances. Emitters whose cost of abating emissions was lower than the allowance price could sell allowances or "bank" them for future use.[11] This flexibility allows for the most cost-effective emissions reductions.

Initially, most permits could be allocated free to existing sources with a limited number set aside for auction.[12] Auctioned permits would allow for new entrants and would also generate funds that could be used to support research and development (R&D) and other programs as needed (e.g., transition programs for affected workers and communities, end-use efficiency investments, or addressing increased consumer costs). Over

time, the proportion of allowances auctioned could increase. Emissions reductions from sources not covered by the program—including carbon sinks, small sources, and international emitters—that could be quantified and verified should qualify as offsets and receive credits to trade within the system. The banking of allowances to be used in future years should also be permitted, since this flexibility has shown to be particularly important in previous programs.[13] Credit should be given to "early actors" who make quantifiable reductions before the start of the program, protecting the baseline from which reductions were made.

Stimulate innovation across key economic sectors.

Transportation

5. Convert the Corporate Average Fuel Economy (CAFE) program into strengthened, tradable corporate average CO_2 (or GHG) emissions standards. Address fuels and infrastructure by supporting biofuels, hydrogen, and other low-GHG fuel alternatives.

Under a market-based system, average fuel economy standards under the current CAFE program could be replaced by corporate average CO_2 emission standards (in terms of average CO_2 emissions/mile) for each manufacturer's combined sales of cars and light trucks. A manufacturer that "overachieves" (whose average emissions are below the standard) in a given year would earn allowances based on the reduction in projected lifetime emissions from vehicles produced in that year. These allowances could be banked, sold to other manufacturers or sold into the broader, economy-wide GHG cap-and-trade program described in Recommendation 4. A manufacturer that does not meet its CO_2 standard would purchase allowances to cover its shortfall. In order not to penalize any companies at the start, efforts of those who invested early and exceeded standards would be recognized (e.g., through credit allocation) with adequate time provided for other companies to catch up, recognizing the time needed to develop and market new automobiles. Concerns about a lack of responsiveness within the transportation sector driving up costs of overall domestic permits could be addressed by keeping this program separate from the broader cap-and-trade program, or by requiring a certain amount of reductions from within the sector.

Additionally, incentives for the deployment of zero- and low-GHG-emitting vehicles and associated infrastructure (e.g., hydrogen-based fuel cell vehicles and fueling stations) should be increased, along with R&D on low-carbon fuels (e.g., biofuels) and energy storage options. To support state and local planning efforts, climate change and system efficiency considerations should be incorporated into federal infrastructure and transportation funding.

Manufacturing

6. Provide outreach and incentives to manufacturers for improvements in industrial efficiency and low-GHG technologies, and support the production of low-GHG products.

Accompanying the reporting program described in Recommendation 3, outreach should include technical information supporting corporate greenhouse gas reduction programs and overall energy and process efficiencies. The U.S. Department of Energy (DOE) has a large portfolio of technical information that could be applied for this purpose if a focused national outreach effort were put in place. Additionally, industrial process improvements should be made eligible for the reverse auction proceeds described in Recommendation 2. Outreach and support should also address GHG characteristics of the products manufactured, and could start with increased promotion of the Environmental Protection Agency's *Design For Environment* program and other "green design" initiatives.

Agriculture

7. Raise the priority and funding levels for Farm Bill programs and other federal initiatives on carbon sequestration.

The 2002 Farm Bill made important additions to a number of programs, starting a process of shifting subsidies from simple crop support to support of environmentally beneficial practices. Included among the programs were many practices that would encourage carbon sequestration.[14] At present, although "on the books," these initiatives are under-funded and not being pursued aggressively.[15] Before undertaking new initiatives to encourage carbon sequestration on agricultural and forest lands, existing programs should be funded at levels that would enable them to be pursued aggressively across the nation. The impact of these programs on carbon sequestration and other greenhouse gases should be thoroughly evaluated as they are implemented, and determinations of whether to expand, alter, or replace them should be based on their effectiveness at reducing GHGs at a reasonable cost. Evaluations should consider not only the extent to which desired practices have been adopted but also the extent to which practices have resulted in carbon stock increases, the net life-cycle GHG impacts, and the costs.

Carbon storage should also be encouraged by including land-based sequestration offsets in a cap-and-trade program (see Recommendation 4) and continuing to improve techniques for quantifying and verifying these reductions. Additionally, to improve energy crops' viability and competitiveness with fossil fuels, agricultural policies should promote research on and production of biomass. (See Recommendation 5 on the transportation sector and Recommendation 10 on renewable energy.)

Drive the energy system toward greater efficiency, lower-carbon energy sources, and technologies such as carbon capture.

8. Coal and Carbon Sequestration: Provide funding for tests of geologic carbon sequestration and for research, development and demonstration (RD&D) projects on separation and capture technologies, in combination with advanced generation coal plants. Establish an appropriate regulatory framework for carbon storage.

Public investment and policy direction are needed to promote carbon capture and storage (CCS) technologies, both for domestic use and for export worldwide, particularly to countries with large coal resources such as China and India. Since it is likely that large-scale implementation of CCS will be needed if climate change is to be addressed at a meaningful level, it is critical to begin to develop a suitable regulatory system while testing the feasibility of geologic sequestration. The first step toward continued use of coal within a broad climate strategy is to demonstrate the viability of geologic storage of CO_2 in a variety of settings. A serious effort would likely require four to six large-scale[16] tests of geological sequestration at reservoirs with diverse characteristics. Federal projects in this area are beginning,[17] but further work and funding are necessary. Such demonstrations are necessary to increase understanding of trapping mechanisms, to test and improve monitoring techniques, and to gain public acceptance for this concept. Early demonstrations of CO_2 injection will likely be in profitable enhanced oil and gas recovery projects. As confidence in geologic sequestration is gained, demonstrations should be undertaken to join the capture of CO_2 from full-scale, coal-fired electric generation plants with geologic storage. Demonstrations should include new, full-scale integrated gasification combined cycle (IGCC) plants[18] using pre-combustion separation of CO_2, as well as other advanced generation technologies (including novel, low-cost oxygen technologies and polygeneration) and retrofits of existing pulverized coal plants (e.g., supercritical boiler conversion with oxyfuel) and post-combustion CO_2 separation. To ensure that geological sequestration demonstrations and research on separation and capture technologies move forward in a timely and efficient manner, alternatives to the appropriations funding process should be explored. (See Recommendation 2.)

A regulatory framework for carbon storage is needed and should include proper site selection, permitting processes, monitoring requirements, and public participation. The U.S. can build on its experience in regulating underground injection of wastes, short-term storage of natural gas, and long-term waste storage; however, long-term storage of large amounts of CO_2 presents unique challenges.[19]

9. Natural Gas: Expand natural gas transportation infrastructure and production.

Natural gas,[20] which yields lower GHG emissions than oil or coal when combusted, is an important transition fuel for addressing climate change. Policies designed to expand the natural gas infrastructure (along with those to encourage its efficient use) will increase delivery capability for natural gas and lower its price.[21] These policies could include rate incentives, streamlined permitting for pipeline and liquefied natural gas (LNG) facilities,[22] expedited approvals for construction of an Alaska natural gas pipeline,[23] and enhanced pipeline and storage infrastructure in the lower 48 states. Although the need for incentives will vary with market price, tax incentives, royalty relief, and access to public land for resource development (while protecting environmentally sensitive areas) would increase production of natural gas in North America and further lower its price. Expanded production from non-conventional sources should also be explored, and research and development in these areas can play a significant role in increasing the supply of natural gas. Options include coal bed methane and gas from deep water and wells. Landfill gas seems to be a particularly attractive alternative.[24] As with coal, R&D on geologic sequestration of carbon derived from natural gas combustion and projects demonstrating the technologies' viability are also needed.

Given current supply constraints, a near-term focus on greater efficiency in natural gas use is needed. A federal system benefit fund, collecting money through electric and gas rates to pay for efficiency improvements; expanded funding for research, development and deployment of efficient technologies; and the measures described in Recommendations 12 and 13 would all help ease the pressures on natural gas supply.

10. Renewables: Significantly "ramp up" renewables for electricity and fuels, including an extension and expansion of the production tax credit, a uniform system for tracking renewable energy credits, and increased emphasis on biomass.

A significant expansion of renewable capacity will likely require a mix of policies to encourage generation and production and to reduce barriers for distributed sources. Congress should enact legislation to grant a longer-term extension of the federal production tax credit (PTC) currently available to some GHG-emission-free generation,[25] extend the same credit to other zero-GHG electricity sources, and create incentives for uniform grid interconnection standards at the state level. A uniform system should also be established to track renewable energy credits (RECs) in a consistent way across the country and to facilitate trading between programs.[26] While an economy-wide GHG program would be preferable, sector-specific programs like a national Renewable Portfolio Standard (RPS) or Renewable Fuels Standard (RFS)[27] may evolve first. In designing such systems, Congress should recognize the regional differences in renewable resources and existing state-level policy actions.

Federal policies and R&D funding should support the use of ethanol and biodiesel today, and drive toward more advanced uses of biomass in the future. Biomass can be used for very low-GHG energy in a large number of

ways, including direct combustion, gasification, and conversion of cellulosic material using enzymes. To be viable on a larger scale, and to become cost-competitive with fossil fuels, a significant, sustained R&D effort will be required both on conversion technologies and on energy crop yields and characteristics.

11. Nuclear Power: Provide opportunities for nuclear power to play a continuing role in a future low-carbon electricity sector.

Because nuclear power is one of the few options for no-carbon electricity production, efforts should be made to preserve this option.[28] However, nuclear power's ability to contribute significantly to a low-carbon future over the next 50 years depends on the ability of the nuclear industry to start expanding nuclear generating capacity in the next 10-15 years, as well as on the resolution of cost, safety, and waste storage issues.[29] Congress should enact legislation to encourage new "first mover"[30] nuclear plants using advanced technologies, contingent on the resolution of these issues. Financial incentives such as a production tax credit, an investment tax credit, loan guarantees, and other mechanisms including those in the Energy Policy Act of 2005 will increase opportunities for new plants.[31] To address proliferation concerns, Congress and the President should work together with the international community to restructure the worldwide nuclear non-proliferation regime to restrict the spread of fuel cycle technologies. Additionally, Congress should restructure DOE's nuclear R&D funding to focus on the "once-through" fuel cycle.[32] Research on advanced proliferation-resistant fuel cycles should focus on basic research and engineering. To address spent fuel management and waste storage issues, the scope of U.S. Department of Energy nuclear waste R&D should expand to include options beyond Yucca Mountain.

12. Efficient Energy Production and Distribution: Support the development and use of combined heat and power installations, distributed generation technologies, and test beds for an upgraded electricity grid.

Public policies to promote combined heat and power (CHP, which uses the waste heat from electricity generation for industrial processes, heating, and cooling) and distributed generation (DG, the generation of electricity and heat at or close to the point of use) should be developed in tandem. In order to maximize reductions of CO_2, DG installations should utilize a low-carbon fuel (e.g., biomass or natural gas),[33] and be run as efficiently as possible through waste heat recovery (e.g., CHP). Energy services companies can operate and monitor many DG installations from a central location, allowing a portfolio of DG units to be combined and included in a cap-and-trade program. Provisions in the Energy Policy Act of 2005 to support net metering, which allows distributed generators to sell electricity back to the grid, and the removal of interconnection restrictions are promising. These policies should be coordinated with wider efforts to improve the efficacy, flexibility and security of the U.S. electricity grid.[34] National test beds for new electricity grid systems, which combine

promising technologies in various configurations to experiment with the system effects, would allow for future improvements to the grid to support DG and CHP.[35] Designing a "smart grid" is difficult to do if individual technologies are deployed in isolation; test beds would enable a broader set of power supply options, including intermittent and distributed energy and combined heat and power.[36]

13. Efficient Energy Usage: Reduce energy consumption through policies that spur efficiency, including appliance and equipment standards, building R&D and codes, and consumer education.

Emissions not covered by the large-source cap-and-trade program could be addressed through expanded and tightened product—including building and vehicle—standards, focusing on those that would result in significant GHG reductions through reduced energy use.[37] In the Energy Policy Act of 2005, Congress established federal efficiency standards for exit signs, traffic signals, torchiere lights, compact fluorescent lightbulbs, and other products. These and other efficiency standards could be made tradable and/or converted to GHG emission standards.[38] Manufacturers outperforming the standards would earn credits to trade within this system. Additionally, industrial process improvements should be made eligible for the reverse auction proceeds described in Recommendation 2.

Building codes can require that new buildings meet a certain level of energy efficiency, maximizing efficiency opportunities during construction.[39] Policies to encourage states to adopt enhanced or updated building codes could include linking a state's adoption of model codes to its receipt of federal funds (e.g., weatherization assistance and federal support for state public benefit funds). Incentives could come in the form of a minimum requirement to receive federal funding (i.e., states would be required to adopt a certain standard level to be eligible for any funding), or as encouragement to receive additional or "bonus" funding (i.e., above the level that a non-adopting state receives). Increasing the funding level for the DOE's building energy code program would also facilitate GHG emissions reductions from further building code adoption—by providing stakeholders with technical assistance such as software tools to help builders, designers, and code officials upgrade and comply with energy codes.[40] Likewise, continued funding for R&D on advanced materials and cost-reduction opportunities for on-site renewable generation can have a considerable impact.

Outreach to state and local governments could improve awareness of opportunities to increase the efficiency of street and highway lighting. Increasing funding levels of the appliance and building ENERGY STAR® programs, the Rebuild America Program, and the Building America Program would improve consumer, builder, and state/local government awareness of energy efficiency opportunities. Outreach should also include technical information supporting corporate greenhouse gas reduction programs and overall process efficiencies. The U.S. Department of Energy (DOE) has a large portfolio of technical information that could be applied for this purpose if a focused national outreach effort were put in place.

Begin now to adapt to the inevitable consequences of climate change.

14. Develop a national adaptation strategy through the Climate Change Science Program and Climate Change Technology Program, and fund development of early-warning systems for related threats.

This strategy would create the institutions, partnerships, and funding necessary to stimulate decision-making regarding U.S. adaptation to climate variability and change. It should promote guidelines or standards for infrastructure planning that incorporate information about climate change (e.g., water resource systems, extreme temperatures, sea-level rise) into design and management plans, and reform existing policies that promote maladaptive behavior. The strategy should include enhanced efforts to expand habitat preservation areas and to develop migration corridors for U.S. plant and animal species. It should also ease adaptation at local, state, and regional levels within the U.S. through information and financial assistance, and should facilitate U.S. participation in international negotiations to help developing nations obtain the technical and capital resources needed for adaptation. Additionally, funding should be provided for the development of early-warning systems for heat waves and other related threats, enhanced monitoring of infectious diseases, and evaluations of the implications of climate change for disaster management.

Engage in negotiations to strengthen the international climate effort.

15. Review options for a new or modified agreement to ensure fair and timely action by all major emitting countries, and participate in negotiations to establish binding climate commitments consistent with domestic interests.

The United States should declare its intention to work with other countries to strengthen the multilateral framework for climate action. As a party to the 1992 Framework Convention on Climate Change, the United States should seek a new or modified agreement that: establishes binding international commitments consistent with domestic U.S. policies of the type recommended here; promotes equitable efforts by all major emitting countries; and allows for a range of commitments and approaches.

While the Kyoto Protocol will guide mitigation efforts by most industrialized countries through 2012, new approaches will be needed, in particular to achieve stronger mitigation commitments by the United States and by major developing countries. An effort successfully engaging all major emitters will require greater flexibility to accommodate different national circumstances and strategies. Possible approaches include alternative types of national emissions targets, long-term technology agreements, sectoral agreements, and strategies to integrate climate and development goals. A strengthened international effort also will require new steps to address climate adaptation. Specific options and recommendations for advancing the international effort are contained in *International Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico*.[41]

To inform the U.S. position, and to contribute to international deliberations, the Executive Branch should analyze the full range of options and their potential consequences, and share this analysis with the public and with other countries.

Conclusions

These fifteen recommendations are not the only means of achieving a lower-carbon future, but taken together, they would put the U.S. on a climate-friendly path. In many cases, variations or alternative policies are presented to demonstrate the range of options available. While some of the recommendations could be implemented before others, it is important that over time all sectors make significant cuts in GHG emissions.

Putting this Agenda into practice will take political will and policy action. While some steps can be undertaken rather easily under existing law, many of these proposals will require legislative activity and Congressional appropriations. All require government leadership and private sector commitment. This will take time. Nonetheless, the details of specific recommendations in this Agenda are less critical than the compelling need to get started. Further delay will only make the challenge before us more daunting and more costly.

Endnotes

1. For a statement of international scientific consensus, see the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change. 2001. *Climate Change 2001: The Scientific Basis.* Cambridge: Cambridge University Press.

2. The U.S. National Academy of Sciences joined 10 other nations' science academies in a June 2005 statement on the need to address climate change. See the "Joint-science academies' statement: Global response to climate change" at http://nationalacademies.org/onpi/06072005.pdf.

3. Unlike a traditional auction, in which buyers bid against each other to purchase an item (resulting in the highest price that the market will bear), a "reverse auction" allows providers of goods or services to bid for the right to provide their product, resulting in the lowest price that the market will bear. A request for goods or services is offered along with a suggested price or price cap, and potential suppliers bid against each other to secure the funds. The low bidder who meets all other qualifications receives the award.

4. Forward funding is "a type of multiyear appropriation that is made available in the middle or toward the end of a fiscal year and remains available through the next fiscal year: for example, from July 1 of one year through September 30 of the next" (see http://www.rules.house.gov/archives/glossary_fbp.htm). Forward funding removes some of the uncertainty, delay, and earmarking associated with the standard Congressional appropriations process.

5. A technology prize grants a monetary award for a specific goal in R&D to spur innovative step-changes in technologies. The best-known example has been the 2004 "ANSARI X PRIZE," which was awarded for the first successful private space flight.

6. A phased approach, beginning with only CO_2 but eventually incorporating all six gases, may be the most feasible. In the long run, however, a comprehensive strategy requires consideration of all six Kyoto gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride).

7. While double-counting should be avoided in any crediting system, double-reporting of indirect emissions can increase transparency.

8. This has been the case with the Toxic Release Inventory (TRI) program, which has spurred actions as corporations attempt to reduce the emissions that are subject to public disclosure (see http://www.epa.gov/region1/enforcement/epcra/tridata.html). Firms that have conducted internal inventories have demonstrated similar results. Loreti, C., W. Westcott, and M. Isenberg. 2000. *An Overview of Greenhouse Gas Emissions Inventory Issues.* Arlington, VA: Pew Center on Global Climate Change.

9. The recommendation for a mandatory cap-and-trade program is more specific than others in this document. The details suggested here were developed in a workshop of diverse participants held at the Aspen Institute in November 2003. Claussen, E., and R. Fri, co-chairs. 2004. *A Climate Policy Framework: Balancing Policy and Politics.* Ed. J. Riggs. Report of an Aspen Institute Climate Change Policy Dialogue, November 14-17, 2003. Washington DC: The Aspen Institute.

10. Nordhaus, R., and K. Danish. 2003. *Designing a Mandatory Greenhouse Gas Reduction Program for the U.S.,* Arlington, VA: Pew Center on Global Climate Change, p. 17.

11. Nordhaus and Danish 2003, p. 20.

12. The Aspen Dialogue concluded that a good starting point might be 5% auctioned.

13. Ellerman, A., P. Joskow, and D. Harrison, Jr. 2003. *Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases.* Arlington, VA: Pew Center on Global Climate Change, p. 45.

14. Relevant programs include the Forest Land Enhancement Program, the Environmental Quality Incentives Program, the Conservation Security Program, the Wildlife Habitat Incentives Program, and the Conservation Reserve Program.

15. For example, the funds for the Forest Land Enhancement Program have been diverted to firefighting, the Conservation Security Program is restricted to a handful of small watersheds, and the 1605(b) guideline revisions have fallen behind schedule.

16. A large-scale test would store approximately one million metric tons of CO_2 per year.

17. See the Department of Energy's "Key R&D Programs and Initiatives" at http://www.fossil.energy.gov/programs/sequestration/index.html and the Energy Policy Act of 2005 (P.L. 109-58).

18. Other fuels (e.g., petcoke and biomass) can also be subject to gasification and should be explored as well.

19. Intercovernmental Panel on Climate Change. 2005. *Carbon Dioxide Capture and Storage, Summary for Policymakers and Technical Summary.* Intergovernmental Panel on Climate Change, p. 32.

20. While the term "natural gas" appears here due to its common usage, the term "methane" would refer more accurately to both natural and landfill gas.

21. Smith, D., R. Nordhaus, T. Roberts, et al., and M. Chupka. 2002. *Designing a Climate-Friendly Energy Policy: Options for the Near Term.* Arlington, VA: Pew Center on Global Climate Change, p. 20.

22. Expanded use of LNG depends on the resolution of two security issues: safety risks associated with its transport and storage, and further dependence on non-U.S. energy supplies.

23. Siting of new pipeline facilities may raise concerns about safety and environmental issues, and is therefore contentious.

24. There are currently 335 landfill methane recovery projects in the U.S. with a total generating capacity of about 1,000 MW. Some of these projects were built as a result of tax credits, while others are the result of more stringent landfill air pollution emissions standards introduced in 1996. The U.S. Environmental Protection Agency estimates that there may be 500 additional landfill sites that are candidates for methane recovery and energy utilization projects. (Smith, et al 2002, 20)

25. The PTC is currently 1.9¢ per kWh, and is available to wind, solar power, geothermal, biomass, small irrigation, municipal solid waste power, and some hydropower.

26. At the regional level, the Western Governors Association is currently creating the Western Renewable Energy Generation Information System (WREGIS) to track renewable energy credits across 11 western states. In the east, the PJM (Pennsylvania, New Jersey, Maryland) Interconnection is creating the Generator Attribute Tracking System (GATS) to track the environmental attributes of generation and support reporting and verification requirements related to environmental compliance and related markets. Attributes of these models could be the basis for implementation of a national tracking system.

27. An RFS was included in the Energy Policy Act of 2005.

28. See Massachusetts Institute of Technology (MIT). 2003. *The Future of Nuclear Power.* Cambridge, MA: Massachusetts Institute of Technology, p. 1. The other options are increased efficiency in the electricity sector including demand-side mechanisms, use of renewables, and large-scale carbon capture and sequestration.

29. MIT 2003, p. 2.

30. "First-mover" plants are the first entities to initiate construction on nuclear plants. Under a limited-subsidy regulatory system, the maximum subsidy limit would be set by Congress, and thus only a few "first-mover" plants would qualify for the subsidy. (MIT 2003, p. 77).

31. The Energy Policy Act of 2005 provides a tax credit of 1.8¢ per kWh for new nuclear power facilities during their first eight years of operation, as well as financial support for to up to six new nuclear power reactors in case of unforeseen construction delays.

32. The "once-through" fuel cycle refers to use of nuclear fuel only once; i.e., there is no reprocessing of spent fuel after completion of the first cycle. (MIT 2003, p. 75).

33. Biomass and other fuels that are supplied locally also reduce the need for transport as well as the associated costs and emissions.

34. For more information, see Morgan, G., J. Apt, L. Lave. 2005. *The U.S. Electric Power Sector and Climate Change Mitigation.* Arlington, VA: Pew Center on Global Climate Change.

35. Anderson, R. 2004. "The Distributed Storage-Generation 'Smart' Electric Grid of the Future." Paper prepared for the Pew/NCEP "10-50 Solution" workshop. Washington DC, March 25-26, 2004, p. 5.

36. Anderson 2004, p. 5.

37. Examples include boilers and furnaces, digital cable and satellite TV boxes, and digital converter TV boxes. Nadel, S. 2003. "Appliance and Equipment Efficiency Standards in the U.S.: Accomplishments, Next Steps and Lessons Learned", *ECEEE 2002 Summer Study Proceedings,* European Council for an Energy Efficient Economy, 1: 75-86.

38. The conversion would be based on the national average of GHG emissions per unit of electricity consumed. For more information, see Nordhaus and Danish 2003.

39. For more information, see Brown, M., F. Southworth, and T. Stovall. 2005. *Towards a Climate-Friendly Built Environment.* Arlington, VA: Pew Center on Global Climate Change.

40. The Building Energy Code Program also provides financial and technical assistance to help states adopt, implement, and enforce building energy codes. For more information, see http://www.energycodes.gov/.

41. The Climate Dialogue at Pocantico, convened by the Pew Center, brought together senior policy-makers and stakeholders from 15 countries to examine options for advancing the international climate effort post-2012. The group's report and additional background on the dialogue are available at http://www.pewclimate.org/global-warming-in-depth/international/reports/pocantico_release.cfm.

The Pew Center on Global Climate Change was established by the Pew Charitable Trusts to bring a new cooperative approach and critical scientific, economic, and technological expertise to the global climate change debate. We intend to inform this debate through wide-ranging analyses that will add new facts and perspectives in four areas: policy (domestic and international), economics, environment, and solutions.

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