

NATIONAL RESEARCH COUNCIL  
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# America's Climate Choices



**America's  
CLIMATE  
CHOICES**



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Committee on America's Climate Choices

Board on Atmospheric Sciences and Climate

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL  
OF THE NATIONAL ACADEMIES

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## *Foreword: America's Climate Choices*

Convened by the National Research Council in response to a request from Congress (P.L. 110-161), *America's Climate Choices* is a suite of coordinated activities designed to study the serious and sweeping issues associated with global climate change, including the science and technology challenges involved, and provide advice on the most effective steps and most promising strategies that can be taken to respond. The study builds on an extensive foundation of previous and ongoing work, including current and past National Research Council reports, assessments from other national and international organizations, the current scientific literature, climate action plans by various entities, and other sources.

A Summit on America's Climate Choices was convened on March 30–31, 2009, to help frame the study, provide an opportunity for high-level participation and input on key issues, and hear about relevant work carried out by others. Additional outside viewpoints and perspectives were obtained via public events and workshops, invited presentations at meetings, and comments and questions received through the study website <http://americasclimatechoices.org>.

The Panel on Limiting the Magnitude of Future Climate Change was charged to describe, analyze, and assess strategies for reducing the net future human influence on climate, including both technology and policy options. The panel's report focuses on actions to reduce domestic greenhouse gas emissions and other human drivers of climate change, such as changes in land use, but also considers the international dimensions of limiting the magnitude of climate change.

The Panel on Adapting to the Impacts of Climate Change was charged to describe, analyze, and assess actions and strategies to reduce vulnerability, increase adaptive capacity, improve resilience, and promote successful adaptation to climate change in different regions, sectors, systems, and populations. The panel's report draws on a wide range of sources and case studies to identify lessons learned from past experiences, promising current approaches, and potential new directions.

The Panel on Advancing the Science of Climate Change was charged to provide a concise overview of current understanding of past, present, and future climate change, including its causes and its impacts, then recommend steps to advance our current

understanding, including new observations, research programs, next-generation models, and the physical and human assets needed to support these and other activities. The panel's report focuses on the scientific advances needed both to improve our understanding of the integrated human-climate system and to devise more effective responses to climate change.

The Panel on Informing Effective Decisions and Actions Related to Climate Change was charged to describe and assess different activities, products, strategies, and tools for informing decision makers about climate change and helping them plan and execute effective, integrated responses. The panel's report describes the different types of climate change-related decisions and actions being taken at various levels and in different sectors and regions; and it develops a framework, tools, and practical advice for ensuring that the best available technical knowledge about climate change is used to inform these decisions and actions.

The Committee on America's Climate Choices was responsible for providing overall direction, coordination, and integration of the *America's Climate Choices* suite of activities and ensuring that these activities provide well-supported, action-oriented, and useful advice to the nation. The Committee was also charged with writing a final report—this document—that builds on the four panel reports and other sources to answer the following four overarching questions:

- What short-term actions can be taken to respond effectively to climate change?
- What promising long-term strategies, investments, and opportunities could be pursued to respond to climate change?
- What are the major scientific and technological advances needed to better understand and respond to climate change?
- What are the major impediments (e.g., practical, institutional, economic, ethical, intergenerational) to responding effectively to climate change, and what can be done to overcome these impediments?

Collectively, the *America's Climate Choices* suite of activities involved more than 90 volunteers from a range of communities including academia, various levels of government, business and industry, other nongovernmental organizations, and the international community. Study participants were charged to write consensus reports that provide broad, action-oriented, and authoritative analyses to inform and guide responses to climate change across the nation. Responsibility for the final content of each report rests solely with the authoring group and the National Research Council. However, the development of each report included input from and interactions with members of all five study groups; the membership of each group is listed in Appendix A.



## Preface

**H**ow should the United States respond to the challenges posed by climate change? This is the fundamental question addressed by *America's Climate Choices*—a suite of activities requested by the U.S. Congress and conducted by the U.S. National Research Council. Book shelves and the internet are replete with studies of climate change: Why conduct another one? First among the reasons to do so is that the body of scientific knowledge about climate change is growing rapidly and, as it does, so too does our understanding of the nature and severity of potential consequences. Second, unlike most previous studies, this study looks across the full range of response options and the interactions among them. Third, this work goes beyond analysis of the problem and, in accordance with its Statement of Task, provides “action-oriented advice on what can be done to respond most effectively to climate change. . .” Toward that end, the committee membership was not limited to physical and social scientists but also included people with expertise and experience in public policy, government, and the private sector.

Numerous substantive and procedural questions arose in the course of the committee’s work—for instance, regarding the primary audience to which the final report would be directed. The Statement of Task calls upon the committee to “advise the nation,” which indicates an extremely broad audience. Ultimately, the committee chose to view as its audience decision makers at all levels who will influence America’s response to climate change. Hence this report’s focus on formulating decisions to be made and on strategies for making them. Although this study is focused on America’s climate choices and is accordingly directed to American decision makers, the committee’s analyses and advice were formulated with full consideration of the international context within which U.S. responses to climate change must be selected and implemented. Another consideration was the analytical framework to use in identifying America’s climate choices. Although no single option was selected a priori, the panels and the committee all concluded that iterative risk management is the most useful framework for dealing with the many complexities and uncertainties that are inherent to climate change.

A final example of an issue that required resolution by the committee stems from the assigned task to “provide targeted, action-oriented advice.” Some natural and social scientists believe their appropriate role is to provide the best available scientific information, to formulate options for decision makers, and to describe the relative

advantages and disadvantages of each of the options. In the views of these individuals, recommending a particular option would carry them beyond objectivity and into advocacy. Others consider it appropriate to inform decision makers of their considered judgments, properly labeled as such. This issue was not resolved in the abstract; rather, the members of the committee sought to achieve consensus on a case-by-case basis. We do recommend specific courses of action where there is substantial evidence supporting the need for such actions, but this advice is fairly general in nature, in a deliberate effort to avoid being “policy prescriptive.” Recommendations that deal with government function, such as responsibilities to be assigned to specific federal agencies, were deemed to be beyond the scope of the committee.

Since the time that the Committee began its work, the economic and political context in which climate change decisions are being made has changed a great deal, both domestically and internationally. Within the United States, Congress has considered several substantive proposals for federal legislation related to climate change, but none has become law. The committee did not attempt to analyze these specific proposals or to weigh in with views on other specific political developments taking place during the course of the study.

We hope that the efforts of the panels and this committee will prove useful to the nation as it confronts the complex challenges of climate change in the near term and in the decades ahead. We wish to thank numerous people who provided valuable input to this study, including the following people who were invited guest speakers at the committee’s meetings: Anthony Janetos, Joint Global Change Research Institute; Steven Seidel, Harvard University; Jonathan Pershing, U.S. Department of State; Anand Patwardhan, Indian Institute of Technology-Bombay; Richard Suttmeier, University of Oregon; Nicole DeWandre, European Commission; Rik Leemans, Wageningen University; Yvo de Boer, UNFCCC; Franklin Moore, USAID; Ian Noble, World Bank; Scott Barrett, Columbia University; Michael Grubb, U.K. Carbon Trust; Glenn Prickett, Conservation International; Stephen Gardiner, University of Washington; Steven Vanderheiden, University of Colorado; Manuel Pastor, University of Southern California; and Michel Gelobter, Cooler, Inc. Special thanks to Gary Yohe (Wesleyan University; member of the ACC Panel on Adapting to the Impacts of Climate Change) for substantial contributions to the committee’s discussions about the concept of risk management. Numerous additional people provided input through participation in the America’s Climate Choices Summit and the Geoengineering workshop (see Appendix D for Summit agenda.).

Essential contributions to this project were made by knowledgeable, skilled, and accommodating members of the National Research Council staff, and we are deeply

grateful to them. Ian Kraucunas and Laurie Geller were invaluable in organizing and marshalling the effort and in their substantive engagement. We benefitted immensely from the active participation of other members of the staff, especially the important contributions from Chris Elfring, Paul Stern, and Marlene Kaplan, and the outstanding administrative support from Rita Gaskins and Amanda Purcell. Our gratitude extends also to the members of the ACC panels and to the many others who shared with us the knowledge, perspectives, and wisdom essential to the success of America's Climate Choices.

Albert Carnesale (Chair) and William Chameides (Vice Chair)  
Committee on America's Climate Choices





## Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by **Robert Frosch** (Harvard University) and **Susan Hansen** (Clark University), appointed by the Division on Earth and Life Studies and the Report Review Committee, who were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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# Contents

SUMMARY	1
1 THE CONTEXT FOR AMERICA'S CLIMATE CHOICES	7
Greenhouse Gas Emission Trends, 8	
The Current Context, 11	
2 CAUSES AND CONSEQUENCES OF CLIMATE CHANGE	15
Observed Climate Change, 15	
Future Climate Change, 19	
3 THE UNIQUE CHALLENGES OF CLIMATE CHANGE	29
4 A FRAMEWORK FOR MAKING AMERICA'S CLIMATE CHOICES	39
An Iterative Risk Management Approach to Climate Change, 39	
Decision Criteria in an Iterative Risk Management Framework, 46	
5 KEY ELEMENTS OF AMERICA'S CLIMATE CHOICES	51
Limiting the Magnitude of Climate Change, 51	
Reducing Vulnerability to Climate Change Impacts, 62	
Investing to Expand Options and Improve Choices, 67	
International Engagement, 72	
Toward an Integrated National Response, 74	
NOTES AND REFERENCES	81
APPENDIXES	
A America's Climate Choices Membership Lists	93
B Committee on America's Climate Choices Member Biographical Sketches	97
C Additional Information Regarding the Content of the ACC Panel Reports	109
D Agenda from the Summit on America's Climate Choices	113
E Acronyms and Initialisms	117





## Summary

Climate change is occurring, is very likely caused by human activities, and poses significant risks for a broad range of human and natural systems. Each additional ton of greenhouse gases emitted commits us to further change and greater risks. In the judgment of the Committee on America's Climate Choices, the environmental, economic, and humanitarian risks of climate change indicate a pressing need for substantial action to limit the magnitude of climate change and to prepare to adapt to its impacts.

This report, the final volume of the *America's Climate Choices (ACC)* suite of activities, examines the nation's options for responding to the risks posed by climate change. Although it is crucial to recognize that climate change is inherently an *international* concern that requires response efforts from all countries, this report focuses on the essential elements of an effective *national* response, which includes:

- Enacting policies and programs that reduce risk by limiting the causes of climate change and reducing vulnerability to its impacts;
- Investing in research and development efforts that increase knowledge and improve the number and effectiveness of response options available;
- Developing institutions and processes that ensure pertinent information is collected and that link scientific and technical analysis with public deliberation and decision making;
- Periodically evaluating how response efforts are progressing and updating response goals and strategies in light of new information and understanding.

Given the inherent complexities of the climate system, and the many social, economic, technological, and other factors that affect the climate system, we can expect always to be learning more and to be facing uncertainties regarding future risks. This is not, however, a reason for inaction. Rather, the challenge for society is to acknowledge these uncertainties and respond accordingly, just as is done in many areas of life. For example, people buy home insurance to protect against potential losses, and businesses plan contingently for a range of possible future economic conditions.

Just as in these other areas, a valuable framework for making decisions about America's Climate Choices is **iterative risk management**. This refers to an ongoing process of identifying risks and response options, advancing a portfolio of actions that emphasize risk reduction and are robust across a range of possible futures, and revising

responses over time to take advantage of new knowledge. Iterative risk management strategies must be durable enough to promote sustained progress and long-term investments, yet sufficiently flexible to take advantage of improvements in knowledge, tools, and technologies over time.

In the context of an iterative risk management framework, and building on the analyses in the four ACC panel reports, the committee recommends the following priority actions for an effective and comprehensive national response to climate change:

***Substantially reduce greenhouse gas emissions.*** In the committee's judgment there are many reasons why it is imprudent to delay actions that at least begin the process of substantially reducing emissions. For instance:

- The faster emissions are reduced, the lower the risks posed by climate change. Delays in reducing emissions could commit the planet to a wide range of adverse impacts, especially if the sensitivity of the climate to greenhouse gases is on the higher end of the estimated range.
- Waiting for unacceptable impacts to occur before taking action is imprudent because the effects of greenhouse gas emissions do not fully manifest themselves for decades and, once manifested, many of these changes will persist for hundreds or even thousands of years.
- The sooner that serious efforts to reduce greenhouse gas emissions proceed, the less pressure there will be to make steeper (and thus likely more expensive) emission reductions later.
- The United States and the rest of the world are currently making major investments in new energy infrastructure that will largely determine the trajectory of emissions for decades to come. Getting the relevant incentives and policies in place as soon as possible will provide crucial guidance for these investment decisions.
- In the committee's judgment, the risks associated with doing business as usual are a much greater concern than the risks associated with engaging in strong response efforts. This is because many aspects of an "overly ambitious" policy response could be reversed if needed, through subsequent policy change; whereas adverse changes in the climate system are much more difficult (indeed, on the timescale of our lifetimes, may be impossible) to "undo."

**RECOMMENDATION 1:** In order to minimize the risks of climate change and its adverse impacts, the nation should reduce greenhouse gas emissions substantially over the coming decades. The exact magnitude and speed of emissions reduction depends on societal judgments about how much risk is acceptable. However, given the inertia

of the energy system and long lifetime associated with most infrastructure for energy production and use, it is the committee's judgment that the most effective strategy is to begin ramping down emissions as soon as possible.

Emission reductions can be achieved in part through expanding current local, state, and regional-level efforts, but analyses suggest that the best way to amplify and accelerate such efforts, and to minimize overall costs (for any given national emissions reduction target), is with a comprehensive, nationally uniform, increasing price on CO<sub>2</sub><sup>1</sup> emissions, with a price trajectory sufficient to drive major investments in energy efficiency and low-carbon technologies. In addition, strategically-targeted complementary policies are needed to ensure progress in key areas of opportunity where market failures and institutional barriers can limit the effectiveness of a carbon pricing system.

***Begin mobilizing now for adaptation.*** Aggressive emissions reductions would reduce the need for adaptation, but not eliminate it. Climate change is already happening, and additional changes can be expected for all plausible scenarios of future greenhouse gas emissions. Prudent risk management demands advanced planning to deal with possible adverse outcomes—known and unknown—by increasing the nation's resilience to both gradual changes and the possibility of abrupt disaster events. Effective adaptation will require the development of new tools and institutions to manage climate-related risks across a broad range of sectors and spatial scales. Adaptation decisions will be made and implemented by actors in state and local governments, the private sector, and society at large, but there is also a need for national-level efforts—for instance, to share information and technical resources for evaluating vulnerability and adaptation options, and to develop and implement adaptation plans within the federal agencies and their relevant programs.

**RECOMMENDATION 2:** Adaptation planning and implementation should be initiated at all levels of society. The federal government, in collaboration with other levels of government and with other stakeholders, should immediately undertake the development of a national adaptation strategy and build durable institutions to implement that strategy and improve it over time.

***Invest in science, technology, and information systems.*** Scientific research and technology development can expand the range, and improve the effectiveness of, options to respond to climate change. Systems for collecting and sharing information, including formal and informal education systems, can help ensure that climate-related decisions are informed by the best available knowledge and analysis, and can help us