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The first book to focus on the legal aspects of climate engineering, making recommendations for future laws and governance.

This book is a printed edition of the Special Issue "Control of Energy Storage" that was published in Energies

Climate change poses many challenges that affect society and the natural world. With these challenges, however, come opportunities to respond. By taking steps to adapt to and mitigate

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climate change, the risks to society and the impacts of continued climate change can be lessened. The National Climate Assessment, coordinated by the U.S. Global Change Research Program, is a mandated report intended to inform response decisions. Required to be developed every four years, these reports provide the most comprehensive and up-to-date evaluation of climate change impacts available for the United States, making them a unique and important climate change document. The draft Fourth National Climate Assessment (NCA4) report reviewed here addresses a wide range of topics of high importance to the

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United States and society more broadly, extending from human health and community well-being, to the built environment, to businesses and economies, to ecosystems and natural resources. This report evaluates the draft NCA4 to determine if it meets the requirements of the federal mandate, whether it provides accurate information grounded in the scientific literature, and whether it effectively communicates climate science, impacts, and responses for general audiences including the public, decision makers, and other stakeholders.

*Advancing the Science of Climate
Change*

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*Foresight For
Geoengineering, Parts I, II, and III
Reflecting Sunlight
Scientific and Technical Aerospace
Reports*

*Reflecting Sunlight to Cool Earth
Future of solar photovoltaic*

Do you find it strange that some airplanes leave lines in the sky while others don't? Ever heard the word "chemtrails"? Well, something is happening up there in the sky. This book details the history of weather modification, the dangers it has to our environment, and also includes health related issues and offers advice about living with geoengineering. An introduction to the many covert operations not related to climate control that will be

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possible should the public accept
planes spraying the sky are included.

Read on and find out what you can
do to help The Fight Against
Geoengineering.

Catalog of reports, decisions and
opinions, testimonies and speeches.

The Royal Society has published the
findings of a major study into
geoengineering the climate. The
study, chaired by Professor John
Shepherd FRS, was researched and
written over a period of twelve
months by twelve leading academics
representing science, economics,
law and social science. Man-made
climate change is happening and its
impacts and costs will be large,
serious and unevenly spread. The

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impacts may be reduced by adaptation and moderated by mitigation, especially by reducing emissions of greenhouse gases. However, global efforts to reduce emissions have not yet been sufficiently successful to provide confidence that the reductions needed to avoid dangerous climate change will be achieved. This has led to growing interest in geoengineering, defined here as the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change. However, despite this interest, there has been a lack of accessible, high quality information on the proposed geoengineering

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techniques which remain unproven and potentially dangerous. This study provides a detailed assessment of the various methods and considers the potential efficiency and unintended consequences they may pose. It divides geoengineering methods into two basic categories:

1. Carbon Dioxide Removal (CDR) techniques, which remove CO₂ from the atmosphere. As they address the root cause of climate change, rising CO₂ concentrations, they have relatively low uncertainties and risks. However, these techniques work slowly to reduce global temperatures.
2. Solar Radiation Management (SRM) techniques, which reflect a small

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percentage of the sun's light and heat back into space. These methods act quickly, and so may represent the only way to lower global temperatures quickly in the event of a climate crisis. However, they only reduce some, but not all, effects of climate change, while possibly creating other problems . They also do not affect CO₂ levels and therefore fail to address the wider effects of rising CO₂, including ocean acidification. The report recommends: Parties to the UNFCCC should make increased efforts towards mitigating and adapting to climate change and in particular to agreeing to global emissions reductions of at least 50%

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on 1990 levels by 2050 and more thereafter; CDR and SRM geoengineering methods should only be considered as part of a wider package of options for addressing climate change. CDR methods should be regarded as preferable to SRM methods. Relevant UK government departments, in association with the UK Research Councils, should together fund a 10 year geoengineering research programme at a level of the order of £10M per annum. The Royal Society, in collaboration with international science partners, should develop a code of practice for geoengineering research and provide recommendations to the

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international scientific community for a voluntary research governance framework. The Royal Society issued a call for submissions and convened a small ethics workshop as part of the evidence gathering process. More information is available in the main report.

Recommendations for Solar
Geoengineering Research and
Research Governance

CHAPTER FROM THE ENERGY
AND ENVIRONMENT ANNUAL
REPORT 1979

A Bibliography Issued by the
Comptroller General of the United
States

Energy Research Abstracts

Review of the Draft Fourth National

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Foresight For Climate Assessment

Limiting the Magnitude of Future Climate Change

Climate Intervention Reflecting Sunlight to Cool Earth National Academies Press

The growing problem of changing environmental conditions caused by climate destabilization is well recognized as one of the defining issues of our time. The root problem is greenhouse gas emissions, and the fundamental solution is curbing those emissions. Climate geoengineering has often been considered to be a "last-ditch" response to climate change, to be used only if climate change damage should produce extreme hardship. Although the likelihood of

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eventually needing to resort to these efforts grows with every year of inaction on emissions control, there is a lack of information on these ways of potentially intervening in the climate system. As one of a two-book report, this volume of Climate Intervention discusses albedo modification - changing the fraction of incoming solar radiation that reaches the surface. This approach would deliberately modify the energy budget of Earth to produce a cooling designed to compensate for some of the effects of warming associated with greenhouse gas increases. The prospect of large-scale albedo modification raises political and governance issues at

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national and global levels, as well as ethical concerns. *Climate Intervention: Reflecting Sunlight to Cool Earth* discusses some of the social, political, and legal issues surrounding these proposed techniques. It is far easier to modify Earth's albedo than to determine whether it should be done or what the consequences might be of such an action. One serious concern is that such an action could be unilaterally undertaken by a small nation or smaller entity for its own benefit without international sanction and regardless of international consequences. Transparency in discussing this subject is critical. In the spirit of that transparency, *Climate Intervention:*

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Reflecting Sunlight to Cool Earth was based on peer-reviewed literature and the judgments of the authoring committee; no new research was done as part of this study and all data and information used are from entirely open sources. By helping to bring light to this topic area, this book will help leaders to be far more knowledgeable about the consequences of albedo modification approaches before they face a decision whether or not to use them.

Net zero emissions is only the beginning. Smith explains the need for carbon dioxide removal and even solar radiation management to preserve our societies and

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ecosystems.

Turning Knowledge Into Action

Index

A Directory

Cultures of Prediction in

Atmospheric and Climate Science

The Hopes and Hazards of Climate

Intervention

Pandora's Toolbox

*Nanotechnology, clean
technology, and geoengineering
span the scale of human
ingenuity, from the imperceptibly
small to the unimaginably large.*

*Yet they are united by a
commonality of ethics that
permeates how and why they are
developed, and how the resulting
consequences are managed. The
articles in this volume provide a*

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comprehensive account of current thinking around the ethics of development and use within each of the technological domains, and addresses challenges and opportunities that cut across all three. In particular, the collection provides unique insights into the ethics of 'noumenal' technologies - technologies that are impossible to see or detect or conceive of with human senses or conventional tools. This collection will be of relevance to anyone who is actively involved with ensuring the responsible and sustainable development of nanotechnology, geoengineering or clean technology.

In Resilience: The Science of

Adaptation to Climate Change leading experts analyze and question ongoing adaptation interventions. Contributions span different disciplinary perspectives, from law to engineering, and cover different regions from Africa to the Pacific. Chapters assess the need for adaptation, highlighting climate change impacts such as sea level rise, increases in temperature, changing hydrological variability, and threats to food security. The book then discusses the state of global legislation and means of tracking progress. It reviews ways to build resilience in a range of contexts— from the Arctic, to small island states, to urban

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areas, across food and energy systems. Critical tools for adaptation planning are highlighted - from social capital and ethics, to decision support systems, to innovative finance and risk transfer mechanisms.

Controversies related to geoengineering and migration are also discussed. This book is an indispensable resource for scientists, practitioners, and policy makers working in climate change adaptation, sustainable development, ecosystem management, and urban planning. Provides a summary of tools and methods used in adaptation including recent innovations Includes chapters from a diverse

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range of authors from academic institutions, humanitarian organizations, and the United Nations Evaluates adaptation options, highlighting gaps in knowledge where further research or new tools are needed

Climate change is occurring, is caused largely by human activities, and poses significant risks for--and in many cases is already affecting--a broad range of human and natural systems. The compelling case for these conclusions is provided in Advancing the Science of Climate Change, part of a congressionally requested suite of studies known as America's Climate Choices. While noting that there is always

more to learn and that the scientific process is never closed, the book shows that hypotheses about climate change are supported by multiple lines of evidence and have stood firm in the face of serious debate and careful evaluation of alternative explanations. As decision makers respond to these risks, the nation's scientific enterprise can contribute through research that improves understanding of the causes and consequences of climate change and also is useful to decision makers at the local, regional, national, and international levels. The book identifies decisions being made in 12 sectors, ranging from

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agriculture to transportation, to identify decisions being made in response to climate change.

Advancing the Science of Climate Change calls for a single federal entity or program to coordinate a national, multidisciplinary research effort aimed at improving both understanding and responses to climate change.

Seven cross-cutting research themes are identified to support this scientific enterprise. In addition, leaders of federal climate research should redouble efforts to deploy a comprehensive climate observing system, improve climate models and other analytical tools, invest in human capital, and improve linkages

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between research and decisions by forming partnerships with action-oriented programs.

Ethics, Politics, and Governance

Solar Energy Update

America's Climate Choices

Accessions of Unlimited

Distribution Reports

Federal Evaluations

Government Reports Annual Index

In recent decades, science has experienced a revolutionary shift. The development and extensive application of computer modelling and simulation has transformed the knowledge making practices of scientific fields as diverse as astro physics, genetics, robotics and demography. This epistemic

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transformation has brought with it a simultaneous heightening of political relevance and a renewal of international policy agendas, raising crucial questions about the nature and application of simulation knowledges throughout public policy. Through a diverse range of case studies, spanning over a century of theoretical and practical developments in the atmospheric and environmental sciences, this book argues that computer modelling and simulation have substantially changed scientific and cultural practices and shaped the emergence of novel ‘cultures of prediction’. Making an innovative, interdisciplinary contribution to understanding the impact of

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computer modelling on research practice, institutional configurations and broader cultures, this volume will be essential reading for anyone interested in the past, present and future of climate change and the environmental sciences.

If the detrimental impacts of human-induced climate change continue to mount, technologies for geoengineering our climate – i.e. deliberate modifying of the Earth's climate system at a large scale – are likely to receive ever greater attention from countries and societies worldwide. Geoengineering technologies could have profound ramifications for our societies, and yet agreeing on an international

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governance framework in which even serious research into these planetary-altering technologies can take place presents an immense international political challenge. In this important book, a diverse collection of internationally respected scientists, philosophers, legal scholars, policymakers, and civil society representatives examine and reflect upon the global geoengineering debate they have helped shape. Opening with essays examining the historic origins of contemporary geoengineering ideas, the book goes on to explore varying perspectives from across the first decade of this global discourse since 2006. These essays methodically cover: the

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practical and ethical dilemmas
geoengineering poses; the evolving
geoengineering research agenda; the
challenges geoengineering
technologies present to current
international legal and political
frameworks; and differing perceptions
of geoengineering from around the
world. The book concludes with a
series of forward looking essays, some
drawing lessons from precedents for
governing other global issues, others
proposing how geoengineering
technologies might be governed if/as
they begin to emerge from the lab into
the real world. This book is an
indispensable resource for scientists,
activists, policymakers, and political
figures aiming to engage in the

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emerging debate about
geoengineering our climate.

The National Research Council
report *Climate Intervention:
Reflecting Sunlight to Cool Earth*
(NRC, 2015) reviewed the state of the
science and provided high-level
findings and recommendations
regarding SG methods. This current
study was tasked to update the 2015
assessment of the state of
understanding and to provide
recommendations for how to
establish a research program, what to
encompass in the research agenda,
and what mechanisms to employ for
governing this research.

A Continuing Bibliography with
Indexes

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Foresight For
Global Climate Change

Monthly Catalog of United States

Government Publications

Solar Energy Program

Energy Reporter

Energy

Describes reports required of executive branch agencies by the Congress on a recurring basis.

Contains an inventory of evaluation reports produced by and for selected Federal agencies, including GAO evaluation reports that relate to the programs of those agencies.

The science of climate change is a complex subject that balances the physical record and scientific fact with politics, policy, and ethics - and is of particular importance to the geosciences. This thoughtfully crafted new text and accompanying media

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encourage non-science majors to practice critical thinking, analysis, and discourse about climate change themes. Taking a cross-disciplinary approach, acclaimed educator and researcher, David Kitchen, examines not only the physical science, but the social, economic, political, energy, and environmental issues surrounding climate change. His goal: to turn knowledge into action, equipping students with the knowledge and critical skills to make informed decisions, separate facts from fiction, and participate in the public debate.

ERDA Energy Research Abstracts
Hearing Before the Committee on
Science and Technology, House of
Representatives, One Hundred
Eleventh Congress, First Session and
Second Session, November 5, 2009,

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February 4, 2010, and March 18, 2010

Recurring Reports to the Congress

Control of Energy Storage

Energy Abstracts for Policy Analysis

Epistemic and Cultural Shifts in

Computer-based Modelling and

Simulation

Solar energy has become a major alternative for supplying a substantial fraction of the nation's future energy needs. The U.S. Department of Energy (DOE) supports activities ranging from the demonstration of existing technology to research on future possibilities. At Lawrence Berkeley Laboratory (LBL), projects are in progress that span a wide range of activities, with the emphasis on research to extend the scientific basis for solar energy applications, and on preliminary development of new

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approaches to solar energy conversion. To assess various solar applications, it is important to quantify the solar resource. Special instruments have been developed and are now in use to measure both direct solar radiation and circum-solar radiation, i.e., the radiation from near the sun resulting from the scattering of sunlight by small particles in the atmosphere. These measurements serve to predict the performance of solar designs that use focusing collectors employing mirrors or lenses to concentrate the sunlight. Efforts have continued at a low level to assist DOE in demonstrating existing solar technology by providing the San Francisco Operations Office (SAN) with technical support for its management of commercial-building

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solar demonstration projects. Also, a hot water and space-heating system has been installed on an LBL building as part of the DOE facilities Solar Demonstration Program. LBL continues to provide support for the DOE Appropriate Energy Technology grants program. Evaluations are made of the program's effectiveness by, for example, estimating the resulting potential energy savings. LBL also documents innovative features and improvements in economic feasibility as compared to existing conventional systems or applications. In the near future, we expect that LBL research will have a substantial impact in the areas of solar heating and cooling. Conventional and new types of high-performance absorption air

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conditioners are being developed that are air-cooled and suitable for use with flat plate or higher-temperature collectors. Operation of the controls test facility and computer modeling of collector loop and building load dynamics are yielding quantitative evaluations of the performance of different control strategies for active solar-heating systems. Research is continuing on "passive" approaches to solar heating and cooling, where careful considerations of architectural design, construction materials, and the environment are used to moderate a building's interior climate. Computer models of passive concepts are being developed and incorporated into building energy analysis computer programs which are in the public

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domain. The resulting passive analysis capabilities are used in systems studies leading to design tools and in the design of commercial buildings on a case study basis. The investigation of specific passive cooling methods is an ongoing project; for example, a process is being studied in which heat-storage material would be cooled by radiation to the night sky, and would then provide "coolness" to the building. Laboratory personnel involved in the solar cooling, controls, and passive projects are also providing technical support to the Active Heating and Cooling Division and the Passive and Hybrid Division of DOE in developing program plans, evaluating proposals, and making technical reviews of projects at other institutions and in

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industry. Low-grade heat is a widespread energy resource that could make a significant contribution to energy needs if economical methods can be developed for converting it to useful work. Investigations continued this year on the feasibility of using the "shape-memory" alloy, Nitinol, as a basis for constructing heat engines that could operate from energy sources, such as solar-heated water, industrial waste heat, geothermal brines, and ocean thermal gradients. Several projects are investigating longer-term possibilities for utilizing solar energy. One project involves the development of a new type of solar thermal receiver that would be placed at the focus of a central receiver system or a parabolic dish. The conversion of the

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concentrated sunlight to thermal energy would be accomplished by the absorption of the light by a dispersion of very small particles suspended in a gas. Another project is exploring biological systems. In particular, we are investigating the possibility of developing a photovoltaic cell, based on a catalyst (bacteriorhodopsin) which converts light to electrical ion flow across the cell membrane of a particular bacteria.

Solar energy has become a major alternative for supplying a substantial fraction of the nation's future energy needs. The Department of Energy (DOE) supports activities ranging from the demonstration of existing technology to research on future possibilities; and at LBL projects are in

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progress which span that range of activities. To assess various solar applications it is important to quantify the solar resource. In one project, LBL is cooperating with the Pacific Gas and Electric Company in the implementation and operation of a solar radiation data collection network in northern California. Special instruments have been developed and are now in use to measure the solar and circumsolar (around the sun) radiation. These measurements serve to predict the performance of solar designs which use focusing collectors (mirrors or lenses) to concentrate the sunlight. Efforts are being made to assist DOE in demonstrating existing solar technology. DOE's San Francisco Operations Office (SAN) has been

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given technical support for its management of commercial-building solar demonstration projects. The installation of a solar hot water and space heating system on an LBL building established model techniques and procedures as part of the DOE Facilities Solar Demonstration Program. Technical support is also provided for SAN in a DOE small scale technology pilot program in which grants are awarded to individuals and organizations to develop and demonstrate solar technologies appropriate to small scale use. In the near future it is expected that research will exert a substantial impact in the areas of solar heating and cooling. An absorption air conditioner is being developed that is air cooled yet suitable

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for use with temperatures available from flat plate collectors. With inexpensive but sophisticated micro-electronics to control their operation, the performance of many-component solar heating and cooling systems may be improved, and work is under way to develop such a controller and to evaluate commercially available units. Research is continuing on 'passive' approaches to solar heating and cooling where careful considerations of architectural design, construction materials, and the environment are used to moderate a building's interior climate. Computer models of passive concepts are being developed in a collaborative project with Los Alamos Scientific Laboratory. These models will be incorporated into public

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domain building energy analysis computer programs to be used in systems studies and in the design of commercial buildings on a case study basis. The investigation of specific passive cooling methods is an ongoing project; for example, a process is being studied in which heat storage material would be cooled by radiation to the night sky, then provide 'coolness' to the building. The laboratory personnel involved in the solar cooling, controls, and passive projects are also providing technical support to the Solar Heating and Cooling Research and Development Branch of DOE in developing program plans, evaluating proposals, and making technical reviews of projects at other institutions and in industry. Low grade heat is a

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widespread energy resource that could make a significant contribution to energy needs if economical methods can be developed for converting it to useful work. Investigations continued this year on the feasibility of using the 'shape-memory' alloy, Nitinol, as a basis for constructing heat engines that could operate from energy sources such as solar heated water, industrial waste heat, geothermal brines, and ocean thermal gradients. Several projects are investigating longer-term possibilities for utilizing solar energy. One project involves the development of a new type of solar thermal receiver that would be placed at the focus of a central receiver system or a parabolic dish. The conversion of the concentrated sunlight to thermal energy would be

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accomplished by the absorption of the light by a dispersion of very small particles suspended in a gas. Work continued this year on chemical storage processes (such as $2\text{SO}_3 = 2\text{SO}_2 + \text{O}_2$) that could play an important role in providing long-term storage for high temperature power generation cycles. Another project is exploring biological systems. The possibility is being explored of developing a photovoltaic cell, based on a catalyst (bacteriorhodopsin) which converts light to electrical ion flow across the cell membrane of a particular bacteria. This study presents options to fully unlock the world ' s vast solar PV potential over the period until 2050. It builds on IRENA ' s global roadmap to scale up renewables and meet

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climate goals.

Chapter from the Energy and
Environmental Division Annual Report
1980

Climate Intervention

Abstracts of AIT Reports and
Publications on Renewable Energy
Resources

GAO Energy Digest

The Science of Adaptation to Climate
Change

SOLAR ENERGY PROGRAM

*Climate change is
occurring. It is very
likely caused by the
emission of greenhouse
gases from human
activities, and poses
significant risks for a
range of human and natural*

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systems. And these emissions continue to increase, which will result in further change and greater risks. America's Climate Choices makes the case that the environmental, economic, and humanitarian risks posed by climate change indicate a pressing need for substantial action now to limit the magnitude of climate change and to prepare for adapting to its impacts. Although there is some uncertainty about future risk, acting now will reduce the risks posed by climate change

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and the pressure to make larger, more rapid, and potentially more expensive reductions later. Most actions taken to reduce vulnerability to climate change impacts are common sense investments that will offer protection against natural climate variations and extreme events. In addition, crucial investment decisions made now about equipment and infrastructure can "lock in" commitments to greenhouse gas emissions for decades to come. Finally, while it may be

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possible to scale back or reverse many responses to climate change, it is difficult or impossible to "undo" climate change, once manifested. Current efforts of local, state, and private-sector actors are important, but not likely to yield progress comparable to what could be achieved with the addition of strong federal policies that establish coherent national goals and incentives, and that promote strong U.S. engagement in international-level response efforts. The

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inherent complexities and uncertainties of climate change are best met by applying an iterative risk management framework and making efforts to significantly reduce greenhouse gas emissions; prepare for adapting to impacts; invest in scientific research, technology development, and information systems; and facilitate engagement between scientific and technical experts and the many types of stakeholders making America's climate choices.

Climate change, driven by

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the increasing concentration of greenhouse gases in the atmosphere, poses serious, wide-ranging threats to human societies and natural ecosystems around the world. The largest overall source of greenhouse gas emissions is the burning of fossil fuels. The global atmospheric concentration of carbon dioxide, the dominant greenhouse gas of concern, is increasing by roughly two parts per million per year, and the United States is currently the second-largest

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contributor to global emissions behind China. Limiting the Magnitude of Future Climate Change, part of the congressionally requested America's Climate Choices suite of studies, focuses on the role of the United States in the global effort to reduce greenhouse gas emissions. The book concludes that in order to ensure that all levels of government, the private sector, and millions of households and individuals are contributing to shared national goals, the United

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States should establish a "budget" that sets a limit on total domestic greenhouse emissions from 2010-2050. Meeting such a budget would require a major departure from business as usual in the way the nation produces and uses energy-and that the nation act now to aggressively deploy all available energy efficiencies and less carbon-intensive technologies and to develop new ones. With no financial incentives or regulatory pressure, the nation will continue to

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rely upon and "lock in" carbon-intensive technologies and systems unless a carbon pricing system is established—either cap-and-trade, a system of taxing emissions, or a combination of the two. Complementary policies are also needed to accelerate progress in key areas: developing more efficient, less carbon-intensive energy sources in electricity and transportation; advancing full-scale development of new-generation nuclear power, carbon capture, and storage systems; and

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amending emissions-
intensive energy
infrastructure. Research
and development of new
technologies that could
help reduce emissions more
cost effectively than
current options is also
strongly recommended.
Sections 1-2. Keyword
Index.--Section 3.
Personal author
index.--Section 4.
Corporate author index.--
Section 5. Contract/grant
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Foresight For

*The Ethics of
Nanotechnology,
Geoengineering, and Clean
Energy*

*Science, Governance and
Uncertainty*

*Best Practices Handbook
for the Collection and Use
of Solar Resource Data for
Solar Energy Applications
Geoengineering our
Climate?*

*Cumulative index
Management*