Climate Change Reconsidered II

Fossil Fuels

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NIPCC

NONGOVERNMENTAL INTERNATIONAL PANEL
ON CLIMATE CHANGE

Reviews of *Climate Change Reconsidered II: Physical Science*

"I fully support the efforts of the Nongovernmental International Panel on Climate Change (NIPCC) and publication of its latest report, *Climate Change Reconsidered II: Physical Science,* to help the general public to understand the reality of global climate change."

Kumar Raina, Former Deputy Director General
Geological Survey of India

"*Climate Change Reconsidered II* fulfills an important role in countering the IPCC part by part, highlighting crucial things they ignore such as the Little Ice Age and the recovery (warming) which began in 1800–1850. In contrast to the IPCC, which often ignores evidence of past changes, the authors of the NIPCC report recognize that climatology requires studying past changes to infer future changes."

Syun-Ichi Akasofu, Founding Director & Professor of Physics Emeritus
International Arctic Research Center, University of Alaska Fairbanks

"The work of the NIPCC to present the evidence for natural climate warming and climate change is an essential counter-balance to the biased reporting of the IPCC. They have brought to focus a range of peer-reviewed publications showing that natural forces have in the past and continue today to dominate the climate signal."

Ian Clark, Department of Earth Sciences
University of Ottawa, Canada

"The CCR-II report correctly explains that most of the reports on global warming and its impacts on sea-level rise, ice melts, glacial retreats, impact on crop production, extreme weather events, rainfall changes, etc. have not properly considered factors such as physical impacts of human activities, natural variability in climate, lopsided models used in the prediction of production estimates, etc. There is a need to look into these phenomena at local and regional scales before sensationalization of global warming-related studies."

S. Jeevananda Reddy, Former Chief Technical Advisor
United Nations World Meteorological Organization

"Library shelves are cluttered with books on global warming. The problem is identifying which ones are worth reading. The NIPCC's CCR-II report is one of these. Its coverage of the topic is comprehensive without being superficial. It sorts through conflicting claims made by scientists and highlights mounting evidence that climate sensitivity to carbon dioxide increase is lower than climate models have until now assumed."

Chris de Freitas, School of Environment
The University of Auckland, New Zealand

"Rather than coming from a pre-determined politicized position that is typical of the IPCC, the NIPCC constrains itself to the scientific process so as to provide objective information. If we (scientists) are honest, we understand that the study of atmospheric processes/dynamics is in its infancy. Consequently, the work of the NIPCC and its most recent report is very important."

Bruce Borders, Professor of Forest Biometrics
Warnell School of Forestry and Natural Resources, University of Georgia

"I support [the work of the NIPCC] because I am convinced that the whole field of climate and climate change urgently needs an open debate between several 'schools of thought,' in science as well as other disciplines, many of which jumped on the IPCC bandwagon far too readily. Climate, and even more so impacts and responses, are far too complex and important to be left to an official body like the IPCC."

Sonja A. Boehmer-Christiansen
Reader Emeritus, Department of Geography, Hull University
Editor, *Energy & Environment*

Climate Change Reconsidered II

Fossil Fuels

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Foreword

The release of this volume in the Climate Change Reconsidered (CCR) series ends a five-year pause following the release of *Climate Change Reconsidered II: Biological Impacts.* Several shorter reports were released in the interim, most notably *Why Scientists Disagree about Global Warming* (first edition in 2015, second edition in 2016). While it was never our intention to issue a CCR volume every year, hope did exist that this volume would emerge sooner than it has.

This volume is the product of the Nongovernmental International Panel on Climate Change (NIPCC), a joint project of three nonprofit organizations, The Heartland Institute, the Center for the Study of Carbon Dioxide and Global Change, and the Science and Environmental Policy Project (SEPP). Two of NIPCC's cosponsoring organizations experienced leadership changes since 2014 that affected the release of this new volume.

Joseph Bast and Diane Bast, editors of this volume and previous volumes in the series (as well as the authors of this foreword) retired in early 2018. Joseph Bast was president and CEO of The Heartland Institute and Diane Bast was senior editor, which meant time that might otherwise have been dedicated to this book was devoted to managing a successful corporate succession instead.

Dr. S. Fred Singer, the founder and previously president and chairman of the Science and Environmental Policy Project (SEPP), also handed over the reins to a younger generation of leaders, in his case to Kenneth Haappala the new president and Thomas Sheahan the new chairman. At 93 years young, Dr. Singer insists he is not retiring. He continues to be published in popular and scientific journals and contributed substantially to this volume.

One of the lead authors of the three most recent volumes in the CCR series passed away in January 2016. Dr. Robert Carter's unexpected departure was a heavy blow to everyone – his family, of course, as well as colleagues and friends in Australia, America, and around the world. Just weeks before he passed, Dr. Carter agreed to take this final volume "across the finish line" and was starting to reach out to his extensive global networks of climate scientists for help. So devastated were we that fully a year passed after his death before work resumed on the book. This book is dedicated to his memory.

Amidst all these changes, we also found new partners who made this volume possible. Dr. Roger Bezdek, a distinguished economist specializing in energy and climate issues, stepped in to provide insights and skills that our usual stable of physicists, biologists, and climatologists lacked. With him came nearly two dozen economists and a similar number of engineers with deep expertise in the economic and environmental impacts of fossil fuels and their alternatives, the focus of this book.

Also new for this volume is Dr. David Legates, professor of climatology in the Department of Geography at the University of Delaware and an adjunct professor at the university's Physical Ocean Science and Engineering Program and in the Department of Applied Economics. Dr. Legates is a "scientist's scientist," a recognized authority in his field, and, like Dr. Carter and Dr. Singer, unafraid to speak the truth on the controversial subject of climate change, even at the cost of damaging a promising academic career.

As we said of previous volumes in the CCR series, the sheer size of this volume – 700 pages containing references to thousands of articles and books – suggests what an extraordinary research, writing, and editing endeavor this turned out to be. The topic of this volume – broadly, the benefits and costs of fossil fuels – required reviewing scientific and economic literature on organic chemistry, climate science, public health, economic history, human security, and theoretical studies based on integrated assessment models (IAMs) and cost-benefit analysis. Much of this literature resides outside peer-reviewed academic journals. Consequently readers will see a heavier reliance than in previous volumes on books, government and think tank reports, and sometimes newspaper and magazine reports of news events.

We extend our sincere thanks and appreciation to the 117 scientists, engineers, economists, and other experts who helped write and review this report, as well as the thousands more who conducted the original research that is summarized and cited. Funding for this effort once again came from three family foundations, none of them having any commercial interest in the topic. We thank them for their generosity as well as their patience. No government or corporate funds were solicited or received to support this project.

Diane Carol Bast
Executive Editor
The Heartland Institute

Joseph L. Bast
Director and Senior Fellow
The Heartland Institute

Preface

This new volume, *Climate Change Reconsidered II: Fossil Fuels*, assesses the costs and benefits of the use of fossil fuels with a special focus on concerns related to anthropogenic climate change. It is the fifth volume in the Climate Change Reconsidered (CCR) series produced by the Nongovernmental International Panel on Climate Change (NIPCC).

NIPCC was created by Dr. S. Fred Singer in 2003 to provide an independent review of the reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC). Unlike the IPCC and as its name suggests, NIPCC is a private association of scientists and other experts and nonprofit organizations. It is not a government entity and is not beholden to any political benefactors. This and previous volumes in the CCR series, along with other publications and information about NIPCC, are available for free on NIPCC's website at www.climatechangereconsidered.org.

Summary of Findings

The NIPCC authors, building on previous reports in the CCR series as well as new literature reviews, find that while climate change is occurring and a human impact on climate is likely, there is no consensus on the size of that impact relative to natural variability, the *net* benefits or costs of the impacts of climate change, or whether future climate trends can be predicted with sufficient confidence to guide public policies today. Consequently, concern over climate change is not a sufficient scientific or economic basis for restricting the use of fossil fuels.

The NIPCC authors do something their IPCC counterparts never did: conduct an even-handed cost-benefit analysis of the use of fossil fuels. Despite calling for the end of reliance on fossil fuels by 2100, the IPCC never produced an accounting of the *opportunity cost* of restricting or banning their use. That cost, a literature review shows, would be enormous. Estimates of the cost of reducing anthropogenic greenhouse gas (GHG) emissions by the amounts said by the IPCC to be necessary to avoid causing ~2°C warming in the year 2050 range from the IPCC's own estimate of 3.4% to as high as 81% of projected global gross domestic product (GDP) in 2050, the latter estimate nullifying all the gains in human well-being made in the past century. Cost-benefit ratios range from the IPCC's own estimate of 6.8:1 to an alarming 162:1. The costs of specific emission mitigation programs range from 7.4 times to 7,000 times more than the benefits, even assuming the IPCC's faulty science and tenuous associations are correct.

The NIPCC authors conclude, "The global war on energy freedom, which commenced in earnest in the 1980s and reached a fever pitch in the second decade of the twenty-first century, was never founded on sound science or economics. The world's policymakers ought to acknowledge this truth and end that war."

Organization of Inquiry

Since economics can provide insights into the alleged impacts of climate change, this volume begins with a chapter describing how economic principles can be applied to environmental issues. The authors explain how economists use observational data (prices, profits and losses, investment and consumption decisions, etc.) to measure and monetize costs and benefits, to understand how people respond to and solve challenges, and to understand why private as well as government efforts to protect the environment sometimes fail to achieve their objectives.

Chapter 2 updates the literature review of climate science in previous CCR volumes. Most notably, the authors say the IPCC has exaggerated the amount of warming likely to occur if the concentration of atmospheric carbon dioxide (CO_2) were to double and such warming as occurs is likely to be modest and cause no net harm to the global environment or to human well-being. Chapters 3, 4, and 5 catalogue the beneficial impacts of fossil fuels on human prosperity, human health, and the environment. These benefits are enormous – imagine, for a moment, life without electricity, modern medicine, or cars, trucks, and airplanes – yet these benefits are missing from the IPCC's massive tomes. A true accounting of the costs and benefits of ending humanity's reliance on fossil fuels must include the opportunity cost of forgoing these benefits.

Chapters 6 and 7 address two types of costs or harms said to be created by the use of fossil fuels: air pollution and what the IPCC calls threats to "human security." The NIPCC authors show the alleged effects of air pollution have been grossly exaggerated by the U.S. Environmental Protection Agency and the World Health Organization. Similarly, the IPCC's own literature review shows how weak is the case for claiming climate change intensifies "risk factors" such as loss of property and livelihoods, forced migration, and violent conflict. Chapter 8, the final chapter of the book, critiques the IPCC's claim that the cost of reducing the use of fossil fuels is justified by the benefits of a slightly cooler world a century hence. New cost-benefit analyses of climate change, fossil fuels, and regulations demonstrate how adaptation to climate change is invariably the better path than attempting to mitigate it by reducing greenhouse gas emissions.

Acknowledgements

We thank the more-than-100 scientists, scholars, and experts who participated over the course of four years in writing, reviewing, editing, and proofreading this volume. This was a huge undertaking that involved thousands of hours of effort, the vast majority of it unpaid. The result exceeded our hopes, and we trust it meets your expectations.

The NIPCC authors cite thousands of books, scholarly articles, and reports that contradict the IPCC's alarmist narrative. We once again tried to remain true to the facts when representing the findings of others, often by quoting directly and at some length from original sources and describing the methodology used and qualifications that accompanied the stated conclusions. The result may seem tedious at times, but we believe this was necessary and appropriate for a reference work challenging many popular beliefs.

We acknowledge that not every scientist, economist, or historian whose work we cite disagrees with IPCC positions or supports ours, even though their research points in that direction. We recognize there may be some experts we quote who are dismayed to see their work cited in a book written by "skeptics." We ask them to read this book with an open mind and ask themselves how much of what they think they know to be true is based on trust, perhaps misplaced, in claims propagated by the IPCC. Even scientists need to be reminded sometimes that skepticism, not conformity, is the higher value in the pursuit of knowledge.

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Dedication

Photo credit: Hans H.J. Labohm

Robert M. Carter (left) with S. Fred Singer (right), photo taken in October 2013 in The Hague, Netherlands.

We dedicate this report to the memory of Robert M. Carter, who helped write and edit previous volumes in the Climate Change Reconsidered series but passed away in 2016 as the current volume was only beginning to come together. It would have been a far better work had he lived to help direct our efforts. Bob was a palaeontologist, stratigrapher, marine geologist, and environmental scientist with a long and distinguished career in the academy. He was a mentor and friend to hundreds of young scientists and many non-scientists. He proved by personal example that science in the end does not tolerate corruption, and that what matters most of all is personal integrity.

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Summary for Policymakers

Introduction

Climate Change Reconsidered II: Fossil Fuels, produced by the Nongovernmental International Panel on Climate Change (NIPCC), assesses the costs and benefits of the use of fossil fuels[1] by reviewing scientific and economic literature on organic chemistry, climate science, public health, economic history, human security, and theoretical studies based on integrated assessment models (IAMs) and cost-benefit analysis (CBA). It is the fifth volume in the Climate Change Reconsidered series (NIPCC 2009, 2011, 2013, 2014) and, like the preceding volumes, it focuses on research overlooked or ignored by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

In its 2013 volume titled *Climate Change Reconsidered II: Physical Science,* NIPCC refuted the scientific basis of the IPCC's claim that dangerous human interference with the climate system is occurring. In its 2014 volume titled *Climate Change Reconsidered II: Biological Impacts,* NIPCC addressed and refuted the IPCC's claim that climate change negatively affects plants, wildlife, and human health.

In this new volume, 117 scientists, economists, and other experts address and refute the IPCC's claim that the impacts of climate change on human well-being and the natural environment justify dramatic reductions in the use of fossil fuels. Specifically, the NIPCC authors critique two recent IPCC reports: *Climate Change 2014: Impacts, Adaptation, and Vulnerability,* the Working Group II contribution to the IPCC's Fifth Assessment Report (AR5), and *Climate Change 2014: Mitigation of Climate Change,* the Working Group III contribution to AR5 (IPCC, 2014a, 2014b).

The organization of this Summary for Policymakers tracks the organization of the full report. Citations to supporting research and documentation are scant for want of space but can be found at the end of the document. More than 2,000 references appear in the full report.

[1] This report follows conventional usage by using "fossil fuels" to refer to hydrocarbons, principally coal, oil, and natural gas, used by humanity to generate power. We recognize that not all hydrocarbons may be derived from animal or plant sources.

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Part I. Foundations

The most consequential issues in the climate change debate are "whether the warming since 1950 has been dominated by human causes, how much the planet will warm in the 21st century, whether warming is 'dangerous,' whether we can afford to radically reduce CO_2 emissions, and whether reduction will improve the climate" (Curry, 2015). Addressing these issues requires foundations in environmental economics and climate science. Part I of *Climate Change Reconsidered II: Fossil Fuels* provides those foundations.

1. Environmental Economics

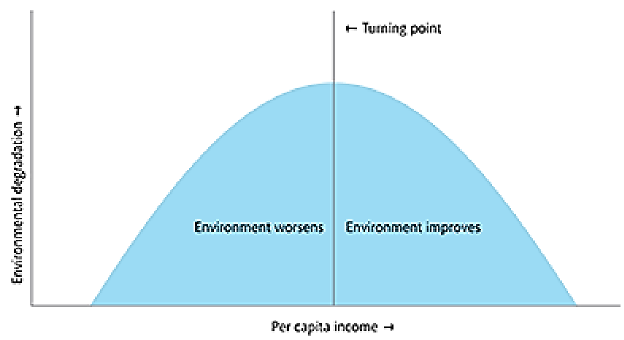
Many environmentalists and climate scientists are not familiar with economic research on environmental issues and have only vague ideas about what economics can bring to the climate change debate. Many economists make a different mistake, accepting unsubstantiated claims that the "science is settled" regarding the causes and consequences of climate change and then limiting their role in the debate to finding the most efficient way to reduce "carbon pollution." Both audiences need to be aware of what economists can bring to the climate change debate.

The most valuable concept economists bring is *opportunity cost*, the value of something that must be given up to acquire or achieve something else. Every choice has a corresponding opportunity cost. By revealing those costs, economics can help policymakers discover cost-effective responses to environmental problems, including climate change (Block, 1990; Markandya and Richardson, 1992; Libecap and Steckel, 2011).

A second key concept is the Environmental Kuznets Curve (EKC), pictured in Figure SPM.1. Fossil fuels and the technologies they power make it possible to use fewer resources and less surface space to meet human needs while also allowing environmental protection to become a positive and widely shared social value and objective. EKCs have been documented for a wide range of countries and air quality, water quality, and other measures of environmental protection (Yandle *et al*., 2004; Goklany, 2012; Bertinelli *et al.*, 2012).

Economists can help compassionate people reconcile the real-world trade-offs of protecting the environment while using natural resources to produce the goods and services needed by humankind (McKitrick, 2010; Morris and Butler, 2013; Anderson and Leal, 2015). They have demonstrated how committed environmentalists can better achieve their goals by recognizing fundamental economic principles such as discount rates and marginal costs (Anderson and Huggins, 2008). They have shown how entrepreneurs can use private property, price signals, and markets to discover new ways to protect the environment (Anderson and Leal, 1997; Huggins, 2013).

Figure SPM.1
A typical Environmental Kuznets Curve



Source: Ho and Wang, 2015, p. 42.

Economists have pointed out the economic and political pitfalls facing renewable and carbon-neutral energies (Morriss *et al.*, 2011; Yonk *et al.*, 2012). Economists have explained how proposals to force a transition away from fossil fuels advanced without an understanding of the true costs and implications of alternative fuels can lead to unnecessary expenses and minimal or even no net reduction in greenhouse gas emissions (Lomborg, 2010; van Kooten, 2013; Heal, 2017; Lemoine and Rudik, 2017).

Economists describe how common resources can be degraded by overuse by "free riders," but also how they can be effectively managed by individuals and nongovernment organizations using their knowledge of local opportunities and costs, the kind of knowledge national and international organizations typically lack (Coase, 1994). These market-based solutions exhibit the sort of spontaneous order that Hayek (1988) often wrote about, a coordination that is not dictated or controlled by a central planner. Ostrom (2010) identified eight design principles shared by entities most successful at managing common-pool resources.

The prosperity made possible by the use of fossil fuels has made environmental protection a social value in countries around the world (Hartwell and Coursey, 2015). The value-creating power of private property rights, prices, profits and losses, and voluntary trade can turn climate change from a possible *tragedy* of the commons into an *opportunity* of the commons (Boettke, 2009). Energy freedom, not government intervention, can balance the interests and needs of today with those of tomorrow. It alone can access the local knowledge needed to find efficient win-win responses to climate change.

2. Climate Science

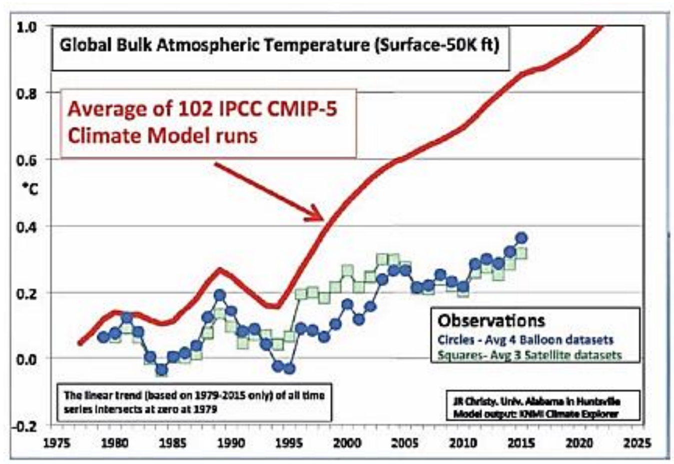
Chapter 2 provides an overview of the current state of climate science beginning with an explanation of the Scientific Method, which imposes restrictions and duties on scientists intended to ensure the quality, objectivity, utility, and integrity of their work. Key elements of the Scientific Method include experimentation, the testing of competing hypotheses, objective and careful peer review, discerning correlation from causation, and controlling for natural variability. In each of these areas, the IPCC and many scientists whose work is prominent in climate science have been shown to fall short (Essex and McKitrick, 2007; Darwall, 2013; Lewin, 2017; Armstrong and Green, 2018).

Two other topics concerning methodology are the role of consensus in science and ways to manage and communicate uncertainty. Consensus may have a place in science when it is achieved over an extended period of time by independent scientists following the conventions of the Scientific Method. This is not the context in which it is invoked in climate science, and consequently it has been the cause of controversy and polarization of views (Curry, 2012; Lindzen, 2017). Uncertainty is unavoidable in science, but it can be reduced using techniques such as Bayesian inference and honestly communicated to other researchers and the public. Instead of following best practices, the IPCC and its followers make many unmerited declarative statements and issue seemingly confident predictions without error bars (Essex and McKitrick, 2007; Frank, 2015).

The unique chemistry of carbon explains why fossil fuels, composed mainly of carbon and hydrogen, are so widely used as fuel. Kiefer (2013) writes, "Carbon transforms hydrogen from a diffuse and explosive gas that will only become liquid at -423° F [-253° C] into an easily handled, room-temperature liquid with 63% more hydrogen atoms per gallon than pure liquid hydrogen, 3.5 times the volumetric energy density (joules per gallon), and the ideal characteristics of a combustion fuel. … A perfect combustion fuel possesses the desirable characteristics of easy storage and transport, inertness and low toxicity for safe handling, measured and adjustable volatility for easy mixing with air, stability across a broad range of environmental temperatures and pressures, and high energy density. Because of sweeping advantages across all these parameters, liquid hydrocarbons have risen to dominate the global economy" (p. 117).

Climate models are a subject of controversy in climate science. General circulation models (GCMs) "run hot," meaning they predict more warming than actually occurred or is likely to occur in the future (Monckton *et al*., 2015). They hindcast twice as much warming from 1979 to 2016 as actually occurred (Christy, 2018). See Figure SPM.2. Climate models are unable to reproduce many important climate phenomena (Legates, 2014) and are "tuned" to produce results that fall into an "acceptable range" of outputs (Hourdin *et al.,* 2017).

Figure SPM.2
Failure of climate models to hindcast global temperatures, 1979–2015



Source: Christy, 2016.

The accuracy of temperature records since pre-industrial times is a second area of controversy. Records from surface stations are known to contain systematic errors due to instrument and recording errors, physical changes in the instrumentation, and database mismanagement, making them too unreliable to form the basis of scientific research, yet they are seldom questioned (Frank, 2015; McLean, 2018). More accurate satellite-based temperature records, which reach back only to 1979, reveal a range of near-global warming of approximately

0.07°C to 0.13°C per decade from 1979 to 2016 (Christy *et al.*, 2018).

Equilibrium climate sensitivity (ECS), a measure of expected warming when CO_2 concentrations in the atmosphere double, is yet another source of controversy in climate science. The IPCC's estimate of ECS is one-third higher than most recent estimates in the scientific literature (Michaels, 2017). There is so much uncertainty in climate models and so many new discoveries being made that a single "true" estimate of ECS is probably impossible to calculate.

Scientists also disagree about whether climate change is negatively affecting human well-being or the natural world. Despite headlines and documentary films claiming the opposite, there is little or no evidence of trends that lie outside natural variability in severe weather events, droughts, forest fires, melting ice, sea-level rise, and adverse effects on plant life. In some cases, the historical record reveals just the opposite: more mild weather and fewer droughts, for example, than in the pre-industrial past. Most plants are known to flourish in a warmer environment with higher levels of CO_2 (Idso and Idso, 2015).

Why do scientists disagree? Partly because *skepticism*, not consensus, is the heart of science. Sources of disagreement can be found in the interdisciplinary character of the issue, fundamental uncertainties concerning climate science (Curry, 2015; Lindzen, 2017), the failure of the IPCC to be an independent and reliable source of research on the subject (IAC, 2010; Laframboise, 2011, 2013), and tunnel vision (bias) among researchers (Kabat, 2008; Berezow and Campbell, 2012).

The final section of Chapter 2 critiques the claim that "97% of scientists agree" that climate change is mostly or entirely the result of the human presence and is dangerous. Surveys, literature reviews, and petitions demonstrate a lively debate is occurring in the scientific community over the basic science and economics of climate change (Solomon, 2010; Curry, 2012; Friends of Science, 2014; Tol, 2014a; Legates *et al.*, 2015; Global Warming Petition Project, n.d.).

In conclusion, fundamental uncertainties arising from insufficient observational evidence and disagreements over how to interpret data and set the parameters of models prevent science from determining whether human greenhouse gas emissions are having effects on Earth's atmosphere that could endanger life on the planet. There is no compelling scientific evidence of long-term trends in global mean temperatures or climate impacts that exceed the bounds of natural variability.

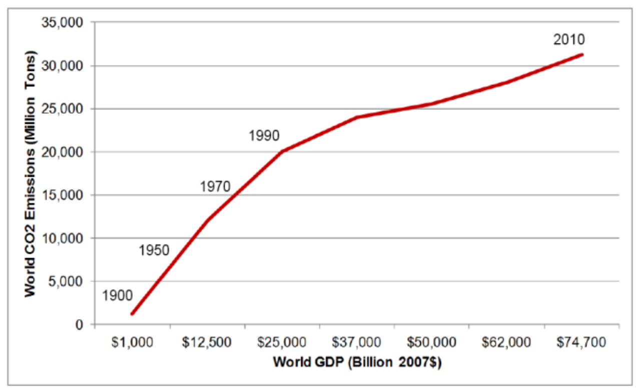
Part II. The Benefits of Fossil Fuels

Part II presents an accounting of the benefits created by the use of fossil fuels. Chapters 3, 4, and 5 address human prosperity, human health benefits, and environmental benefits, respectively.

3. Human Prosperity

The primary reason humans burn fossil fuels is to produce the goods and services that make human prosperity possible. Put another way, humans burn fossil fuels to live more comfortable, safer, and higher-quality lives. Chapter 3 documents the many ways in which fossil fuels contribute to human prosperity.

Figure SPM.3
Relationship between world GDP and CO_2 emissions



Source: Bezdek, 2014, p. 127.

The role played by fossil fuels in the dramatic rise in human prosperity is revealed by the close correlation between carbon dioxide (CO_2) emissions and world gross domestic product (GDP) shown in Figure SPM.3. Fossil fuels were responsible for such revolutionary technologies as the steam engine and cotton gin, early railroads and steamships, electrification and the electric grid, the internal combustion engine, and the computer and Internet revolution. In particular, the spread of electrification made possible by fossil fuels has transformed the modern world, making possible many of the devices, services, comforts, and freedoms we take for granted (Smil, 2005, 2010; Goklany, 2012; Gordon, 2016).

Today, fossil fuels supply 81% of global primary energy and 78% of U.S. primary energy. They are required to power the revolving turbine electric generators that supply dispatchable energy to electric grids, making electricity available on demand in the quantities needed, not only when the sun shines and the wind blows. Fossil fuels are also essential for fertilizer production and the manufacture of concrete and steel. Access to affordable, plentiful, and reliable energy is closely associated with key measures of global human development, including per-capita GDP, consumption expenditure, urbanization rate, life expectancy at birth, and the adult literacy rate (United Nations Development Program, 2010; Šlaus and Jacobs, 2011). Research reveals a positive relationship between low energy prices and human prosperity (Clemente, 2010; Bezdek, 2014; 2015).

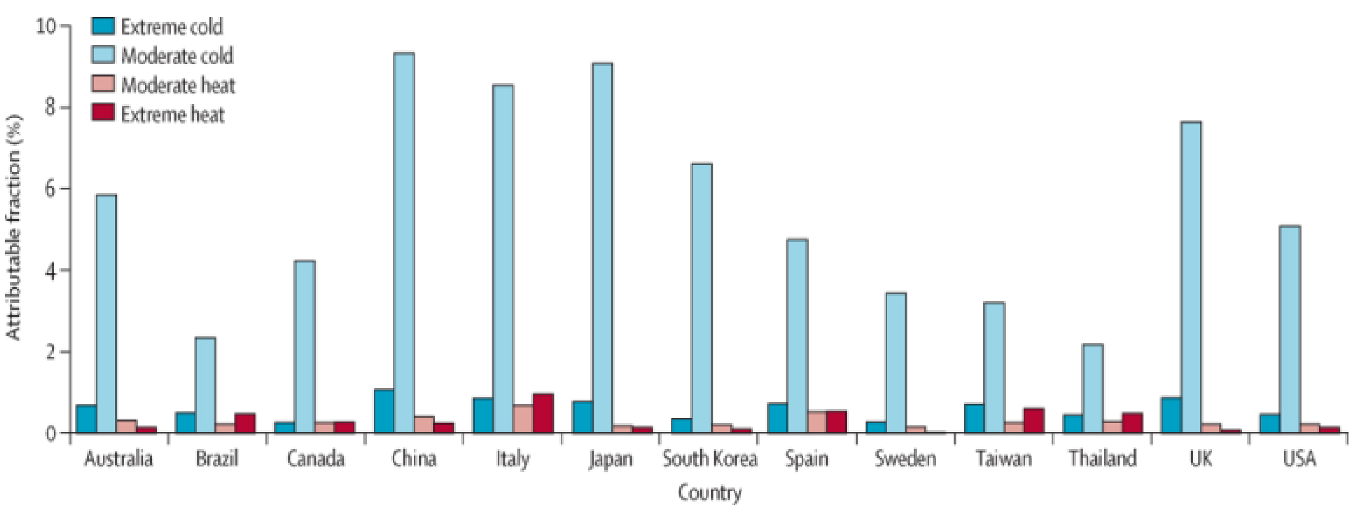
A similar level of human prosperity is not possible by relying on alternative fuels such as solar and wind power. Wind and solar power are intermittent and unreliable, much more expensive than fossil fuels, cannot be deployed without the use of fossil fuels to build them and to provide back-up power, cannot power most modes of transportation, and cannot increase dispatchable capacity sufficiently to meet more than a small part of the rising demand for electricity (Rasmussen, 2010; Bryce, 2010; Smil, 2010, 2016; Stacy and Taylor, 2016).

The contribution of fossil fuels to human prosperity can be estimated in numerous ways, making agreement on a single cost estimate difficult. However, estimates converge on very high amounts: Coal delivered economic benefits in the United States alone worth between $1.275 trillion and $1.76 trillion in 2015 and supported approximately 6.8 million jobs (Rose and Wei, 2006). Reducing reliance on fossil fuels in the United States by 40% from 2012 to 2030 would cost $478 billion and an average of 224,000 jobs each year (U.S. Chamber of Commerce, 2014).

4. Human Health Benefits

Chapter 4 presents the human health benefits of fossil fuels. Historically, humankind was besieged by epidemics and other disasters that caused frequent widespread deaths and kept the average lifespan to less than 35 years (Omran, 1971). The average lifespan among the ancient Greeks was apparently just 18 years, and among the Romans, 22 years (Bryce, 2014, p. 59, citing Steckel and Rose, 2002). Today, according to the U.S. Census Bureau (2016), "The world average age of death has increased by 35 years since 1970, with declines in death rates in all age groups, including those aged 60 and older. From 1970 to 2010, the average age of death increased by 30 years in East Asia and 32 years in tropical Latin America, and in contrast, by less than 10 years in western, southern, and central Sub-Saharan Africa. … [A]ll regions have had increases in mean age at death, particularly East Asia and tropical Latin America" (pp. 31–3).

Figure SPM.4
Deaths caused by cold vs. heat



Source: Gasparrini *et al.*, 2015, p. 369.

Fossil fuels have lifted billions of people out of poverty, reducing the negative effects of poverty on human health (Moore and Simon, 2000). They improve human well-being and safety by powering labor-saving and life-protecting technologies such as air conditioning, modern medicine, cars, trucks, and airplanes (Goklany, 2007). Fossil fuels made possible electrification of heating, lighting, manufacturing, and other processes, resulting in protection of human health and extended lives (Bryce, 2014). Fossil fuels also increased the quantity and improved the reliability and safety of the food supply (Moore and White, 2016).

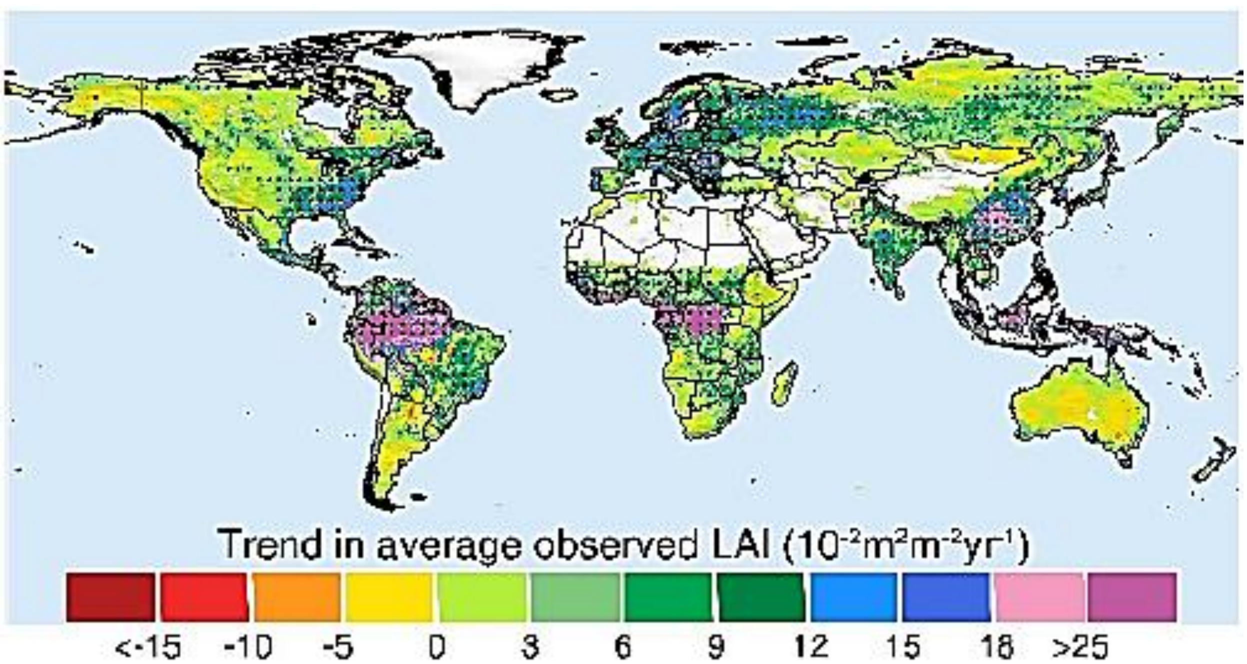
Fossil fuels may also affect human health by contributing to some part of the global warming experienced during the twentieth century or forecast by GCMs for the twenty-first century and beyond. Medical science and observational research in Asia, Australia, Europe, and North America confirm that warming is associated with lower, not higher, temperature-related mortality rates (Keatinge and Donaldson, 2004; Gasparrini *et al.*, 2015; White, 2017). See Figure SPM.4. Research shows warmer temperatures lead to decreases in premature deaths due to cardiovascular and respiratory disease and stroke occurrences (Nafstad *et al.*, 2001; Gill *et al.*, 2012; Song *et al.*, 2018), while warmer temperatures have little if any influence on mosquito- or tick-borne diseases (Murdock *et al.*, 2016).

5. Environmental Benefits

Chapter 5 reviews evidence showing how human use of fossil fuels benefits the environment. The scientific literature on the impacts of warmer temperatures and rising atmospheric CO_2 concentrations on plants finds them to be overwhelmingly positive. This extends to rates of photosynthesis and biomass production and the efficiency with which plants and trees utilize water (Ainsworth and Long, 2005; Bourgault *et al*., 2017). The result is a remarkable and beneficial Greening of the Earth shown in Figure SPM.5 (Zhu *et al.* 2016; Campbell *et al.*, 2017; Cheng *et al.*, 2017).

Similarly, the impacts of global warming on terrestrial animals is likely to be net positive. Wildlife benefit from expanding habitats, and real-world data

Figure SPM.5
Greening of the Earth, 1982 to 2009, trend in average observed leaf area index (LAI)



Source: Zhu *et al.,* 2016.

indicate warmer temperatures have not been harmful to wildlife (Willis *et al*., 2010). Laboratory and field studies of the impact of warmer temperatures and reduced water pH levels (so-called "acidification") on aquatic life find tolerance and adaptation and even examples of benefits (Pandolfi *et al.*, 2011; Baker, 2014).

The fact that carbon and hydrogen are ubiquitous in the natural world helps to explain why the rest of the physical world is compatible with them and even depends on them for life itself (Smil, 2016). The *carbon cycle* minimizes the environmental impact of human emissions of CO_2 by reforming it into other compounds and sequestering it in the oceans, plants, and rocks. According to the IPCC, the residual of the human contribution of CO_2 that remains in the atmosphere after natural processes move the rest to other reservoirs is as little as 0.53% of the carbon entering the air each year and 0.195% of the total amount of carbon thought to be in the atmosphere (IPCC, 2013, p. 471).

The high power density of fossil fuels enable humanity to meet its ever-rising need for food and natural resources while using less surface space, thereby rescuing precious wildlife habitat from development. In 2010, fossil fuels, thermal, and hydropower required less than 0.2% of the Earth's ice-free land, and nearly half that amount was surface covered by water for reservoirs (Smil, 2016, pp. 211–212). Fossil fuels required roughly the same surface area as devoted to renewable energy sources (solar photovoltaic, wind, and liquid biofuels), yet delivered *110 times as much power* (*Ibid.*).

Acid rain, once thought to be a serious environmental threat, is no longer considered one (NAPAP, 1998). Human contributions of oil to the oceans via leakage and spills are trivial in relation to natural sources and quickly disperse and biodegrade (NRC, 2003). The damage caused by oil spills is a net cost of using oil, but not a major environmental problem.

In conclusion, fossil fuels directly benefit the environment by making possible huge (orders of magnitude) advances in efficiency, making it possible to meet human needs while using fewer natural resources. Fossil fuels make it possible for humanity to flourish while still preserving much of the land needed by wildlife to survive. And the prosperity made possible by fossil fuels has made environmental protection both highly valued and financially possible, producing a world that is cleaner and safer than it would have been in their absence.

Part III. Costs of Fossil Fuels

Part III presents an accounting of the costs of using fossil fuels. Chapters 6 and 7 address impacts on air quality and human security. Chapter 8 reviews the literature on cost-benefit analysis (CBA), integrated assessment models (IAMs), and the "social cost of carbon" (SCC), providing new CBAs for global warming, fossil fuels, and emission mitigation programs.

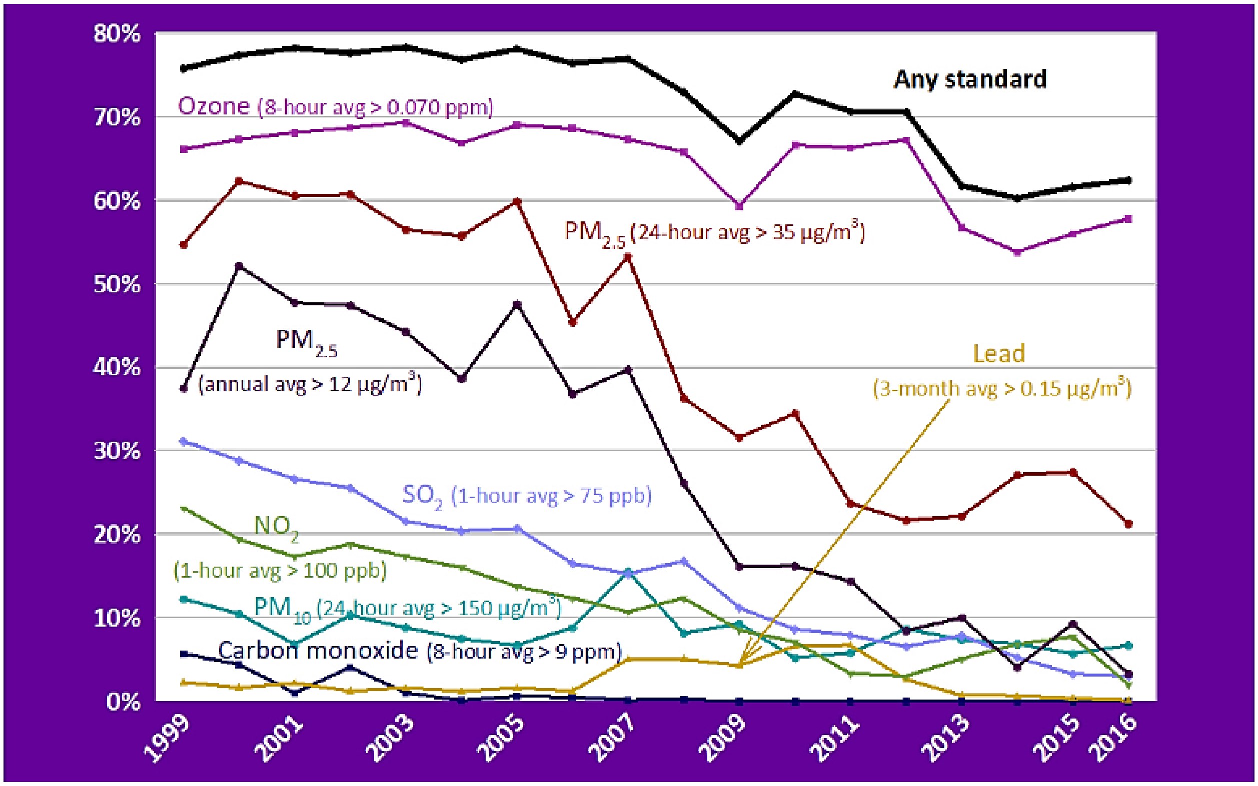
6. Air Quality

The U.S. Environmental Protection Agency (EPA) claims public health is endangered by exposure to particulate matter (PM), ozone, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), methylmercury, and hydrogen chloride attributed to the combustion of fossil fuels. Other harms include visibility impairment (haze), corrosion of building materials, negative effects on vegetation due to ozone, acid rain, and nitrogen deposition, and negative effects on ecosystems from methylmercury (EPA, 2013).

A review of the evidence shows the EPA and other government agencies exaggerate the public health threat posed by fossil fuels. While the combustion of fossil fuels without pollution abatement technology does release chemicals that could be harmful to humans, other animal life, and plants, the most important issue is not the quantity of emissions but *levels of exposure* (Calabrese and Baldwin, 2003; Calabrese, 2005, 2015). By all accounts, air quality improved in the United States and other developed countries throughout the twentieth century and the trend continues in the twenty-first century (Goklany 2012; EPA, 2018a).

By the EPA's own measures, only 3% of children in the United States live in counties where they might be exposed to what the agency deems "unhealthy air" (EPA, 2018b). Also according to the EPA, 0% of children live in counties in which they might be exposed to harmful levels of carbon monoxide in outdoor air, only 0.1% live in counties where lead exposure might be a threat, 2% live where nitrogen dioxide is a problem, and 3% live where sulfur dioxide is a problem (*Ibid.*). (See Figure SPM.6.)

Figure SPM.6
Percentage of children ages 0 to 17 years living in counties with pollutant concentrations above the levels of the current air quality standards, 1999–2016



Source: EPA, 2018b, p. 11.

Even these estimates inflate the real public health risk by assuming all children are continuously exposed to the worst air quality measured in the county in which they reside, and by relying on air quality standards that are orders of magnitude lower than medically needed to be protective of human health (Arnett, 2006; Schwartz and Hayward, 2007; Avery, 2010; Belzer, 2017).

The EPA claims PM and ozone remain public health problems in the United States, saying 7% (for PM_{10}) to 21% (for $PM_{2.5}$) of children live in counties where they might be exposed to unhealthy levels of PM and 58% are threatened by ozone. But it is precisely with respect to these two alleged health threats that the EPA's misconduct and violation of sound methodology are most apparent. The agency violated the Bradford Hill Criteria, resisted transparency and accountability for its actions, and even violated the law as it set National Ambient Air Quality Standards (NAAQS) for PM and ozone (Schwartz, 2003; U.S. Senate Committee on Environment and Public Works, 2014; Milloy, 2016).

The EPA's claim that PM kills hundreds of thousands of Americans annually (EPA, 2010, p. G7) is classic scaremongering based on unreliable research (Enstrom, 2005; Milloy and Dunn, 2012; Wolff and Heuss, 2012). The EPA's own measurements show average exposure in the United States to both PM_{10} and $PM_{2.5}$ has fallen steeply since the 1990s and is now below its NAAQS (EPA, 2018a).

The authors of Chapter 6 conclude that air pollution caused by fossil fuels is unlikely to kill *anyone* in the United States in the twenty-first century, though it may be a legitimate health concern in rapidly growing developing countries that rely on biofuels and burning coal without modern emission control technologies.

7. Human Security

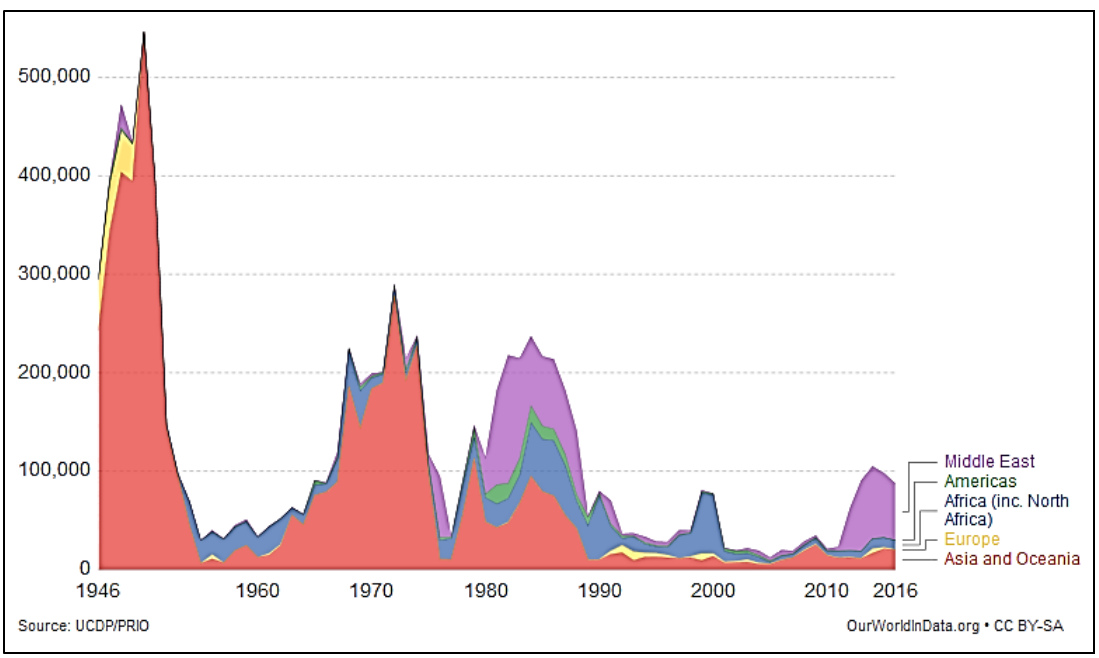
Similar to how the EPA exaggerates the harmful effects of air pollution, the IPCC exaggerates the harmful effects of climate change on "human security," which it defines as "a condition that exists when the vital core of human lives is protected, and when people have the freedom and the capacity to live with dignity" (IPCC, 2014a, p. 759). It collects circumstantial evidence to build a case linking climate change to an almost endless list of maladies, but it never actually tests the null hypothesis that these maladies are due to natural causes. The result is a long and superficially impressive report relying on assumptions and tenuous associations that fall far short of science (Lindzen, 2013; Gleditsch and Nordås, 2014; Tol, 2014b).

Fossil fuels make human prosperity possible (see Chapter 3 and Goklany, 2012). Prosperity in turn, as Benjamin Friedman writes, "more often than not fosters greater opportunity, tolerance of diversity, social mobility, commitment to fairness, and dedication to democracy" (Friedman, 2006, p. 15). All of this serves to protect, not threaten, human security. Prosperity also promotes democracy, and democracies have lower rates of violence and go to war less frequently than any other form of government (Halperin *et al.*, 2004, p. 12).

The cost of wars fought in the Middle East is sometimes attributed to the industrial nations' "addiction to oil." But many of those conflicts have origins and justifications unrelated to oil (Bacevich, 2017; Glaser and Kelanic, 2016; Glaser, 2017). On the verge of becoming a net energy exporter, the United States could withdraw from the region, but it is likely to remain for other geopolitical reasons. If global consumption of oil were to fall as a result of concerns over climate change, the Middle East could become more, not less, violent (Pipes, 2018, p. 21).

Empirical research shows no direct association between climate change and violent conflicts (Salehyan, 2014; Gleditsch and Nordås, 2014). The warming of the second half of the twentieth and early twenty-first centuries coincided with a dramatic decline in the number of fatalities due to warfare. (See Figure SPM.7.) In fact, extensive historical research in China and elsewhere reveals close and positive relationships between a warmer climate and peace and prosperity, and between a cooler climate

Figure SPM.7
Battle-related deaths in state-based conflicts since 1946, by world region



Source: Our World in Data, n.d.

and war and poverty (Yin *et al*., 2016; Lee *et al.*, 2017). A warmer world is likely to be more prosperous and peaceful than is the world today. Climate change does not pose a military threat to the United States (Kueter, 2012; Hayward *et al*., 2014). Forcing America's military leaders to utilize costly biofuels, prepare for climate-related humanitarian disasters, and harden military bases for possible changes in weather or sea level attributed to climate change wastes scarce resources and reduces military preparedness (Kiefer, 2013; Smith, 2015).

The authors of Chapter 7 conclude it is probably impossible to attribute to the human impact on climate *any* negative impacts on human security. Deaths and loss of income due to storms, flooding, and other weather-related phenomena are and always have been part of the human condition. Real-world evidence demonstrates warmer weather is closely associated with peace and prosperity, and cooler weather with war and poverty. A warmer world, should it occur, is therefore more likely to bring about peace and prosperity than war and poverty.

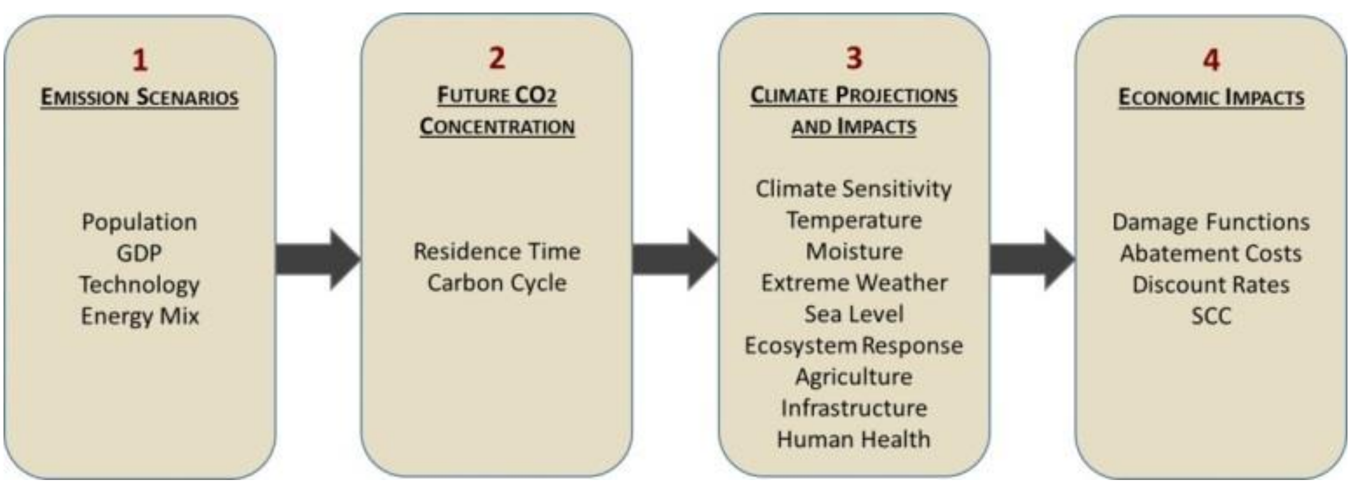
8. Cost-Benefit Analysis

Cost-benefit analysis (CBA), sometimes and more accurately called benefit-cost ratio analysis, is an economic tool that can help determine if the financial benefits over the lifetime of a project exceed its costs. Its use is mandated by executive order for regulations in the United States. In the climate change debate, cost-benefit analysis is used to estimate the net benefits or costs that could result from unabated global warming, from replacing fossil fuels with alternative energy sources, and of particular programs aimed at reducing greenhouse gas emissions or sequestering CO_2. CBA is also employed to estimate the "social cost of carbon."

Chapter 8 starts with a brief tutorial on cost-benefit analysis including its history and use in public policy and the order of "blocks" or "modules" in integrated assessment models (IAMs) (shown in Figure SPM.8). The biggest problem facing the use of IAMs in the climate change debate is the problem of propagation of error, the mounting uncertainty with each step in a complex formula where variables and processes are not known with certainty (Curry, 2011; Frank, 2015, 2016; Heal, 2017). This "cascading uncertainty" makes IAMs "close to useless" for policymakers (Pindyck, 2013). In such cases, the most reliable method of forecasting is not to rely on expert opinion, but to project a simple linear continuation of past trends (Armstrong, 2001).

Two prominent efforts to conduct CBAs of climate change, the U.S. Interagency Working Group on the Social Cost of Carbon (IWG, 2015; since disbanded) and the British Stern Review (Stern, 2007), were severely handicapped by un-

Figure SPM.8
Simplified linear causal chain of an IAM illustrating the basic steps required to obtain SCC estimates



Source: Modified from Parson *et al.*, 2007, Figure ES-1, p. 1.

acknowledged uncertainties, low discount rates, and reliance on the IPCC's flawed climate science (IER, 2014; Byatt, 2006; Mendelsohn, 2006; Tapia Granados and Carpintero, 2013). The complexity of climate science and economics makes conducting any of these CBAs a difficult and perhaps even impossible challenge (Ceronsky *et al.*, 2011). Harvard University Professor of Economics Martin Weitzman remarked, "the economics of climate change is a problem from hell," adding that "trying to do a benefit-cost analysis (BCA) of climate change policies bends and stretches the capability of our standard economist's toolkit up to, and perhaps beyond, the breaking point" (Weitzman, 2015).

Research presented in previous chapters shows how errors or uncertainties in choosing emission scenarios, estimating the amount of carbon dioxide that stays in the atmosphere, the likelihood of increases in flooding and extreme weather, and other inputs render IAMs unreliable guides for policymakers. Correcting the shortcomings of two of the leading IAMs – the DICE and FUND models – results in a superior analysis that, unsurprisingly, arrives at a very different conclusion, a "social cost of carbon" that is either zero or negative, meaning the social benefits of each additional unit of CO_2 emitted exceed its social costs (Dayaratna *et al*., 2017).

Figure SPM.9 summarizes evidence presented in previous chapters for all the costs and benefits of fossil fuels. While not exhaustive, the list of impacts in Figure SPM.9 includes most of the topics addressed by the IPCC's Working Group II and can be compared to Assessment Box SPM.2 Table 1 in its Summary for Policymakers (IPCC, 2014a, pp. 21–5). The new review finds 16 of 25 impacts are net benefits, only one is a net cost, and the rest are either unknown or likely to have no net impact.

Figure SPM.9
Impact of fossil fuels on human well-being

Impact	Benefit or Cost	Observations	Chapter References
Acid rain	No net impact	Once feared to be a major environmental threat, the deposition of sulfuric and nitric acid due to smokestack emissions, so-called "acid rain," was later found not to be a threat to forest health and to affect only a few bodies of water, where remediation with lime is an inexpensive solution. The fertilizing effect of nitrogen deposition more than offsets its harms to vegetation. Dramatic reductions in SO_2 and NO_2 emissions since the 1980s mean "acid rain" has no net impact on human well-being today.	5.1, 6.1
Agriculture	Benefit	Fossil fuels have contributed to the enormous improvement in crop yields by making artificial fertilizers, mechanization, and modern food processing techniques possible. Higher atmospheric CO_2 levels are causing plants to grow better and require less water. Numerous studies show the aerial fertilization effect of CO_2 is improving global agricultural productivity, on average by 15%.	3.3, 4.1, 5.2, 5.3, 7.2, 8.2
Air quality	Benefit	Exposure to potentially harmful chemicals in the air has fallen dramatically during the modern era thanks to the prosperity, technologies, and values made possible by fossil fuels. Safe and clean fossil fuels made it possible to rapidly increase energy consumption while improving air quality.	5.2, Chapter 6
Catastrophes	Unknown	No scientific forecasts of possible catastrophes triggered by global warming have been made. CO_2 is not a "trigger" for abrupt climate change. Inexpensive fossil fuel energy greatly facilitates recovery.	7.2, 8.2
Conflict	Benefit	The occurrence of violent conflicts around the world has fallen dramatically thanks to prosperity and the spread of democracy made possible by affordable and reliable energy and a secure food supply.	7.1, 7.3, 8.2
Democracy	Benefit	Prosperity is closely correlated with the values and institutions that	7.1

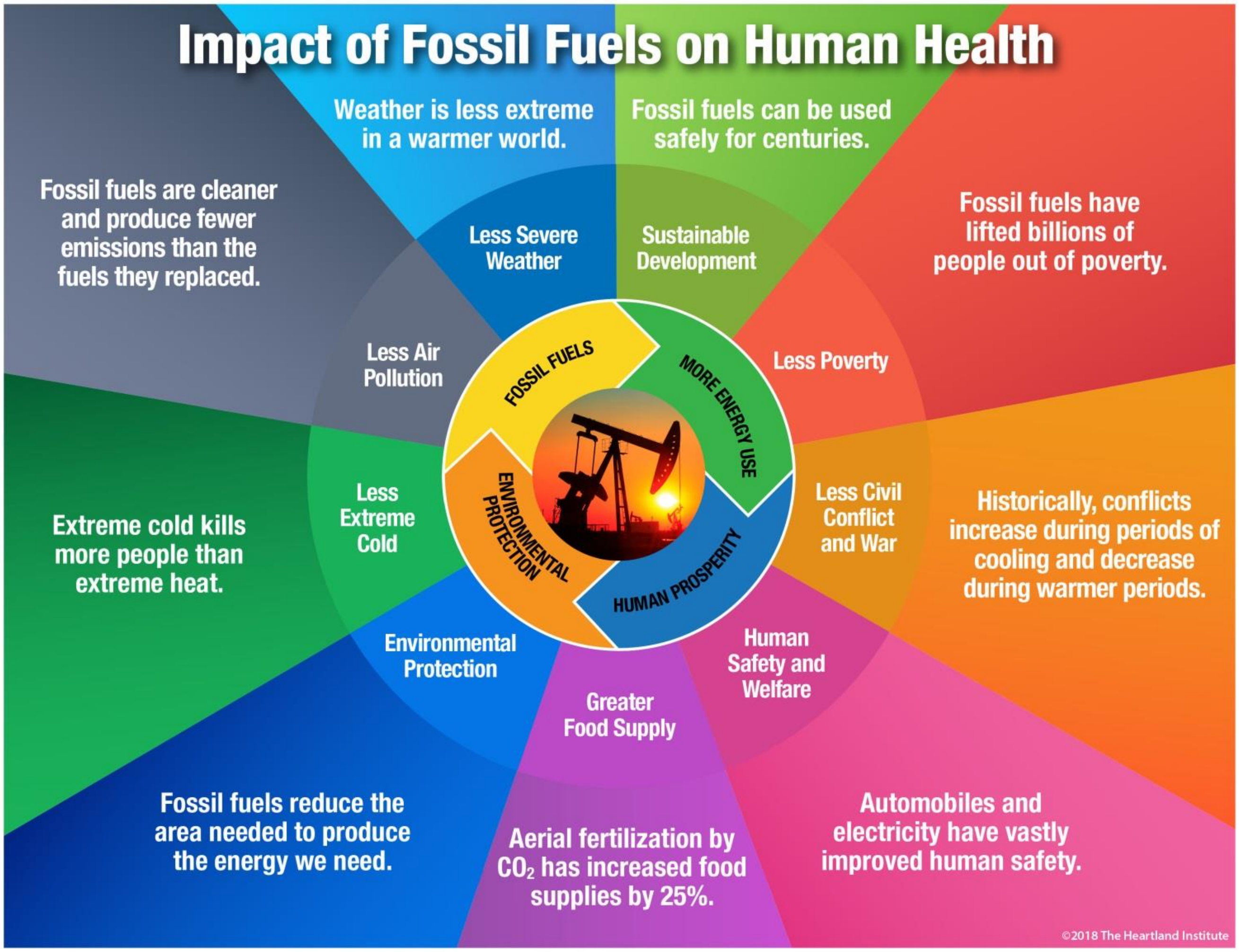
Impact	Benefit or Cost	Observations	Chapter References
		sustain democratic governments. Tyranny promoted by zero-sum wealth is eliminated. Without fossil fuels, there would be fewer democracies in the world.	
Drought	No net impact	There has been no increase in the frequency or intensity of drought in the modern era. Rising CO_2 lets plants use water more efficiently, helping them overcome stressful conditions imposed by drought.	2.3, 5.3
Economic growth (consumption)	Benefit	Affordable and reliable energy is positively correlated with economic growth rates everywhere in the world. Fossil fuels were indispensable to the three Industrial Revolutions that produced the unprecedented global rise in human prosperity.	Chapter 3, 4.1, 5.2, 7.1, 7.2
Electrification	Benefit	Transmitted electricity, one of the greatest inventions in human history, protects human health in many ways. Fossil fuels directly produce some 80% of electric power in the world. Without fossil fuels, alternative energies could not be built or relied on for continuous power.	Chapter 3, 4.1
Environmental protection	Benefit	Fossil fuels power the technologies that make it possible to meet human needs while using fewer natural resources and less surface space. The aerial CO_2 fertilization effect has produced a substantial net greening of the planet, especially in arid areas, that has been measured using satellites.	1.3, Chapter 5
Extreme weather	No net impact	There has been no increase in the frequency or intensity of extreme weather in the modern era, and therefore no reason to expect any economic damages to result from CO_2 emissions.	2.3, 8.2
Forestry	Benefit	Fossil fuels made it possible to replace horses as the primary means of transportation, saving millions of acres of land for forests. Elevated CO_2 concentrations have positive effects on forest growth and health, including efficiency of water use. Rising CO_2 has reduced and overridden the negative effects of ozone pollution on the photosynthesis, growth, and yield of nearly all the trees that have been evaluated experimentally.	5.3
Human development	Benefit	Affordable energy and electrification, better derived from fossil fuels than from renewable energies, are closely correlated with the United Nations' Human Development Index and advance what the IPCC labels "human capital."	3.2, 4.1, 7.2
Human health	Benefit	Fossil fuels contribute strongly to the dramatic lengthening of average lifespans in all parts of the world by improving nutrition, health care, and human safety and welfare. (See also "Air quality.")	3.2, Chapter 4, 5.2
Human settlements/ migration	Unknown	Forced migrations due to sea-level rise or hydrological changes attributable to man-made climate change have yet to be documented and are unlikely since the global average rate of sea-level rise has not accelerated. Climate change is as likely to decrease as increase the number of people forced to migrate.	7.3
Ocean acidification	Unknown	Many laboratory and field studies demonstrate growth and developmental improvements in aquatic life in response to higher temperatures and reduced water pH levels. Other research illustrates the capability of both marine and freshwater species to tolerate and adapt to the rising temperature and pH decline of the planet's water bodies.	5.5
Oil spills	Cost	Oil spills can harm fish and other aquatic life and contaminate drinking water. The harm is minimized because petroleum is typically reformed by dispersion, evaporation, sinking, dissolution, emulsification, photo-oxidation, resurfacing, tar-ball formation, and biodegradation.	5.1
Other market	No net impact	The losses incurred by some businesses due to climate change,	1.2, 7.2

Impact	Benefit or Cost	Observations	Chapter References
sectors		whether man-made or natural, will be offset by profits made by other businesses taking advantage of new opportunities to meet consumer wants. Institutional adaptation, including of markets, to a small and slow warming is likely.	
Polar ice melting	Unknown	What melting is occurring in mountain glaciers, Arctic sea ice, and polar icecaps is not occurring at "unnatural" rates and does not constitute evidence of a human impact on the climate. Global sea-ice cover remains similar in area to that at the start of satellite observations in 1979, with ice shrinkage in the Arctic Ocean offset by growth around Antarctica.	2.3
Sea-level rise	No net impact	There has been no increase in the rate of increase in global average sea level in the modern era, and therefore no reason to expect any economic damages to result from it. Local sea levels change in response to factors other than climate.	2.3, 8.2
Sustainability	Benefit	Fossil fuels are a sustainable source of energy today and for the foreseeable future. Their impacts do not endanger human health or the environment. A market-based transition to alternative fuels will occur when supply and demand require it.	1.5, 5.2
Temperature-related mortality	Benefit	Cold weather kills more people than warm weather, and fossil fuels enable people to protect themselves from temperature extremes. A world made warmer and more prosperous by fossil fuels would see a net decrease in temperature-related mortality.	4.2
Transportation	Benefit	Fossil fuels revolutionized society by making transportation faster, less expensive, and safer for everyone. The increase in human, raw material, and product mobility was a huge boon for humanity, with implications for agriculture, education, health care, and economic development.	4.1
Vector-borne diseases	No net impact	Warming will have no impact on insect-borne diseases because temperature plays only a small role in the spread of these diseases. The technologies and prosperity made possible by fossil fuels eliminated the threat of malaria in developed countries and could do the same in developing countries regardless of climate change.	4.6
Water resources	Benefit	While access to water is limited by climate and other factors in many locations around the world, there is little evidence warming would have a net negative effect on the situation. Fossil fuels made it possible for water quality in the United States and other industrial countries to improve substantially while improving water use efficiency by about 30% over the past 35 years. Aerial CO_2 fertilization improves plant water use efficiency, reducing the demand for irrigation.	5.2, 5.3

The IPCC's Working Group II says CO_2 emissions must be cut by between 40% and 70% from 2010 levels by 2050 in order to prevent the ~2°C of warming (since pre-industrial times) that would otherwise occur by that year (IPCC, 2014b, pp. 10, 12). Since economic growth is closely related to CO_2 emissions (a proxy for the use of fossil fuels to generate primary energy), the opportunity cost of reducing greenhouse gas (GHG) emissions includes the lost economic prosperity that otherwise would have occurred. Original analysis for this book shows that when this factor is accounted for, reducing GHGs to 70% below 2010 levels by 2050 would lower world GDP in 2050 by 21% from baseline forecasts. World GDP would be about $231 trillion instead of the $292 trillion now forecast by the World Bank, a loss of $61 trillion.

The IPCC also overlooked the physical limits wind and solar energy face preventing them from generating enough dispatchable energy (available on demand 24/7) to entirely replace fossil fuels, so energy consumption must fall in order for emissions to fall. If global population continues to grow, then per-capita energy consumption must decline even faster. One estimate that takes this factor into account finds reducing GHG emissions by 80% by 2050

Figure SPM.10
Impact of fossil fuels on human health



would reduce GDP by 81%, plunging the world into permanent economic recession and undoing all the progress made since 1905 (Tverberg, 2012).

The IPCC estimates the cost of unabated climate change to be between 0.2% and 2% of GDP in 2050 (IPCC, 2014a, p. 663) while the models it relies on produce an average estimate of 0.5%. That is the expected *benefit* of avoiding ~ 2°C of warming by 2050. Since the cost of reducing CO_2 emissions by 70% is approximately 21% of projected GDP that year, the cost-benefit ratio is 42:1 (21 / 0.5). In other words, reducing anthropogenic GHG emissions enough to avoid a 2°C warming by 2050 would cost 42 times as much as the benefits. The estimate by Tverberg (2012) taking into account the physical limits that prevent alternative energy sources from completely replacing fossil fuels produces an alarming cost-benefit ratio of 162:1 (81 / 0.5).

Cost-benefit analysis can also be applied to greenhouse gas mitigation programs to produce like-to-like comparisons of their cost-effectiveness. The cap-and-trade bill considered by the U.S. Congress in 2009, for example, would have cost 7.4 times more than its benefits, even assuming all of the IPCC's assumptions and claims about climate science were correct. Other bills and programs already in effect have costs exceeding benefits by factors up to 7,000 (Monckton, 2016). In short, even accepting the

IPCC's flawed science and scenarios, there is no justification for adopting GHG emission mitigation programs.

Conclusion

Fossil fuels have benefited humanity by making possible the prosperity that occurred since the first Industrial Revolution, which made possible investments in goods and services that are essential to protecting human health and prolonging human life. Fossil fuels also power the technologies that reduce the environmental impact of a growing human population, saving space for wildlife.

The IPCC and national governments around the world claim the negative impacts of global warming on human health and security, occurring now or likely to occur in the future, more than offset the benefits that come from the use of fossil fuels. This claim lacks any scientific or economic basis. The benefits of fossil fuels are nowhere reported in the IPCC's assessment reports. The analysis conducted here for the first time finds nearly all the impacts of fossil fuel use on human well-being are net positive (benefits minus costs), near zero (no net benefit or cost), or are simply unknown.

The alleged negative human health impacts due to air pollution are exaggerated by researchers who violate the Bradford Hill Criteria and rely too heavily on epidemiological studies finding weak relative risks. The alleged negative impacts on human security due to climate change depend on tenuous chains of causality that find little support in the peer-reviewed literature.

In conclusion, the IPCC and its national counterparts have not conducted proper cost-benefit analyses of fossil fuels, global warming, or regulations designed to force a transition away from fossil fuels. The global war on fossil fuels, which commenced in earnest in the 1980s and reached a fever pitch in the second decade of the twenty-first century, was never founded on sound science or economics. The authors of and contributors to *Climate Change Reconsidered II: Fossil Fuels* urge the world's policymakers to acknowledge this truth and end that war.

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Key Findings

Key findings appear at the top of each chapter and many chapter sections. The following tables collect all the key findings for easier reviewing.

1. Environmental Economics	
Introduction	No one should assume the “science is settled” regarding anthropogenic climate change or that the only role for economists is to recommend the most efficient way to reduce “carbon pollution.”
1.1 History	
	Economists have been addressing environmental issues since the discipline was founded in the eighteenth century.
	Economies and ecological systems have many commonalities, with the result that economics and ecology share many key concepts.
	Economists have shown markets can manage access to common-pool resources better than government agencies.
1.2 Key Concepts	
1.2.1 Opportunity Cost	The cost of any choice is the value of forgone uses of the funds or time spent. Economists call this “opportunity cost.”
1.2.2 Competing Values	Climate change is not a conflict between people who are selfish and those who are altruistic. People who oppose immediate action to reduce greenhouse gas emissions are just as ethical or moral as those who support such action.
1.2.3 Prices	Market prices capture and make public local knowledge that is complex, dispersed, and constantly changing.
1.2.4 Incentives	Most human action can be understood by understanding the incentives people face. “Moral hazard” occurs when people are able to escape full responsibility for their actions.
1.2.5 Trade	Trade creates value by making both parties better off.
1.2.6 Profits and Losses	Profits and losses direct investments to their highest and best uses.
1.2.7 Unintended Consequences	The art of economics consists in looking not merely at the immediate but at the longer-term effects of any act or policy.
1.2.8 Discount Rates	Discount rates, sometimes referred to as the “social rate of time preference,” are used to determine the current value of future costs and benefits.
1.2.9 Cost-benefit Analysis	Cost-benefit analysis, when performed correctly, can lead to better public policy decisions.

1.3 Private Environmental Protection	
1.3.1 Common-pool Resources	Common-pool resources have been successfully protected by tort and nuisance laws and managed by nongovernmental organizations.
1.3.2 Cooperation	Voluntary cooperation can generate efficient solutions to conflicts involving negative externalities.
1.3.3 Prosperity	Prosperity leads to environmental protection becoming a higher social value and provides the resources needed to make it possible.
1.3.4 Local Knowledge	The information needed to anticipate changes and decide how best to respond is local knowledge and the most efficient responses will be local solutions.
1.3.5 Ecological Economics	“Ecological economics” is not a reliable substitute for rigorous mainstream environmental economics.
1.4 Government Environmental Protection	
1.4.1 Property Rights	Governments can protect the environment by helping to define and enforce property rights.
1.4.2 Regulation	Regulations often fail to achieve their objectives due to the conflicting incentives of individuals in governments and the absence of reliable and local knowledge.
	Evidence of “market failure” does not mean government intervention can improve market outcomes.
1.4.3 Bureaucracy	Government bureaucracies predictably fall victim to regulatory capture, tunnel vision, moral hazard, and corruption.
1.4.4 Rational Ignorance	Voters have little incentive to become knowledgeable about many public policy issues. Economists call this “rational ignorance.”
1.4.5 Rent-seeking Behavior	Government’s ability to promote the goals of some citizens at the expense of others leads to resources being diverted from production into political action. Economists call this “rent-seeking behavior.”
1.4.6 Displacement	Government policies that erode the protection of property rights reduce the incentive and ability of owners to protect and conserve their resources. Those policies displace, rather than improve or add to, private environmental protection.
1.4.7 Leakage	“Leakage” occurs when the emissions reduced by a regulation are partially or entirely offset by changes in behavior.
1.5 Future Generations	
1.5.1 Conservation and Protection	Capital markets create information, signals, and incentives to manage assets for long-term value.
1.5.2 Innovation	Markets reward innovations that protect the environment by using less energy and fewer raw materials per unit of output.
1.5.3 Small versus Big Mistakes	Mistakes made in markets tend to be small and self-correcting. Mistakes made by governments tend to be big and more likely to have catastrophic effects.
1.6 Conclusion	
	Climate change is not a problem to be solved by markets or government intervention. It is a complex phenomenon involving choices made by millions or even billions of people producing countless externalities both positive and negative.
	The best responses to climate change are likely to arise from voluntary cooperation mediated by nongovernmental entities using knowledge of local costs and opportunities.
	Energy freedom – allowing markets rather than governments to make important choices about which fuels to use – can turn climate change from a possible *tragedy* of the commons into an *opportunity* of the commons.

2. Climate Science	
2.1 A Science Tutorial	
2.1.1 Methodology	The Scientific Method is a series of requirements imposed on scientists to ensure the integrity of their work. The IPCC has not followed established rules that guide scientific research.
	Appealing to consensus may have a place in science, but should never be used as a means of shutting down debate.
	Uncertainty in science is unavoidable but must be acknowledged. Many declaratory and predictive statements about the global climate that appear in the IPCC's reports are not warranted by science.
2.1.2 Observations	Surface air temperature is governed by energy flow from the Sun to Earth and from Earth back into space. Whatever diminishes or intensifies this energy flow can change air temperature.
	Levels of carbon dioxide (CO_2) and methane (CH_4) in the atmosphere are governed by processes of the carbon cycle. Exchange rates and other climatological processes are poorly understood.
	The geological record shows temperatures and CO_2 levels in the atmosphere have not been stable, making untenable the IPCC's assumption that they would be stable in the future in the absence of human emissions.
	Water vapor is the dominant greenhouse gas owing to its abundance in the atmosphere and the wide range of spectra in which it absorbs radiation. Carbon dioxide absorbs energy only in a very narrow range of the longwave infrared spectrum.
2.2 Controversies	
2.2.1 Temperature Records	Reconstructions of average global surface temperature differ depending on the methodology used. The warming of the twentieth and early twenty-first centuries has not been shown to be beyond the bounds of natural variability.
2.2.2 Climate Models	General circulation models (GCMs) are unable to accurately depict complex climate processes. They do not accurately hindcast or forecast the climate effects of anthropogenic greenhouse gas emissions.
2.2.3 Climate Sensitivity	Estimates of equilibrium climate sensitivity (the amount of warming that would occur following a doubling of atmospheric CO_2 level) range widely. The IPCC's estimate is higher than many recent estimates.
2.2.4 Solar Influence	Solar irradiance, magnetic fields, UV fluxes, cosmic rays, and other solar activity may have greater influence on climate than climate models and the IPCC currently assume.
2.3 Climate Impacts	
2.3.1 Severe Weather Events	There is little evidence that the warming of the twentieth and early twenty-first centuries has caused a general increase in severe weather events. Meteorological science suggests a warmer world would see milder weather patterns.
	The link between warming and drought is weak, and by some measures drought decreased over the twentieth century. Changes in the hydrosphere of this type are regionally highly variable and show a closer correlation with multidecadal climate rhythmicity than they do with global temperature.
2.3.2 Melting Ice	The Antarctic ice sheet is likely to be unchanged or is gaining ice mass. Antarctic sea ice is gaining in extent, not retreating. Recent trends in the Greenland ice sheet mass and Arctic sea ice are not outside natural variability.
2.3.3 Sea-level Rise	Long-running coastal tide gauges show the rate of sea-level rise is not accelerating. Local and regional sea levels exhibit typical natural variability.
2.3.4 Harm to Plant Life	The effects of elevated CO_2 on plant characteristics are net positive, including increasing rates of photosynthesis and biomass production.
2.4 Why Scientists Disagree	

2.4.1 Scientific Uncertainties	Fundamental uncertainties and disagreements prevent science from determining whether human greenhouse gas emissions are having effects on Earth's atmosphere that could endanger life on the planet.
2.4.2 An Interdisciplinary Subject	Climate is an interdisciplinary subject requiring insights from many fields of study. Very few scholars have mastery of more than one or two of these disciplines.
2.4.3 Failure of the IPCC	Many scientists trust the Intergovernmental Panel on Climate Change (IPCC) to objectively report the latest scientific findings on climate change, but it has failed to produce balanced reports and has allowed its findings to be misrepresented to the public.
2.4.4 Tunnel Vision	Climate scientists, like all humans, can have tunnel vision. Bias, even or especially if subconscious, can be especially pernicious when data are equivocal and allow multiple interpretations, as in climatology.
2.5 Appeals to Consensus	
2.5.1 Flawed Surveys	Surveys and abstract-counting exercises that are said to show a "scientific consensus" on the causes and consequences of climate change invariably ask the wrong questions or the wrong people. No survey data exist supporting claims of consensus on important scientific questions.
2.5.2 Evidence of Lack of Consensus	Some survey data, petitions, and peer-reviewed research show deep disagreement among scientists on issues that must be resolved before the anthropogenic global warming hypothesis can be accepted.
2.5.3 Petition Project	Some 31,000 scientists have signed a petition saying "there is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate."
2.5.4 Conclusion	Because scientists disagree, policymakers must exercise special care in choosing where they turn for advice.
2.6 Conclusion	
	Fundamental uncertainties arising from insufficient observational evidence and disagreements over how to interpret data and set the parameters of models prevent science from determining whether human greenhouse gas emissions are having effects on Earth's atmosphere that could endanger life on the planet.
	There is no compelling scientific evidence of long-term trends in global mean temperatures or climate impacts that exceed natural variability.

3. Human Prosperity	
3.1 An Energy Tutorial	
3.1.1 Definitions	Some key concepts include energy, power, watts, joules, and power density.
3.1.2 Efficiency	Advances in efficiency mean we live lives surrounded by the latest conveniences, yet we use only about 3.5 times as much energy per capita as did our ancestors in George Washington's time.
3.1.3 Energy Uses	Increased use of energy and greater energy efficiency have enabled great advances in artificial light, heat generation, and transportation.
3.1.4 Energy Sources	Fossil fuels supply 81% of the primary energy consumed globally and 78% of energy consumed in the United States.
3.1.5 Intermittency	Due to the nature of wind and sunlight, wind turbines and solar photovoltaic (PV) cells can produce power only intermittently.
3.2 Three Industrial Revolutions	
3.2.1 Creating Modernity	Fossil fuels make possible such transformative technologies as nitrogen fertilizer, concrete, the steam engine and cotton gin, electrification, the internal combustion engine, and the computer and Internet revolution.

3.2.2 Electrification	Electricity powered by fossil fuels has made the world a healthier, safer, and more productive place.
3.2.3 Human Well-being	Access to energy is closely associated with key measures of global human development including per-capita GDP, consumption expenditure, urbanization rate, life expectancy at birth, and the adult literacy rate.
3.3 Food Production	
3.3.1 Fertilizer and Mechanization	Fossil fuels have greatly increased farm worker productivity thanks to nitrogen fertilizer created by the Haber-Bosch process and farm machinery built with and fueled by fossil fuels.
3.3.2 Aerial Fertilization	Higher levels of carbon dioxide (CO_2) in the atmosphere act as fertilizer for the world's plants.
3.3.3 Economic Value of Aerial Fertilization	The aerial fertilization effect of rising levels of atmospheric CO_2 produced global economic benefits of $3.2 trillion from 1961 to 2011 and currently amount to approximately $170 billion annually.
3.3.4 Future Value of Aerial Fertilization	Over the period 2012 through 2050, the cumulative global economic benefit of aerial fertilization will be approximately $9.8 trillion.
3.3.5 Proposals to Reduce CO_2	Reducing global CO_2 emissions by 28% from 2005 levels, the reduction President Barack Obama proposed in 2015 for the United States, would reduce aerial fertilization benefits by $78 billion annually.
3.4 Why Fossil Fuels?	
3.4.1 Power Density	Fossil fuels have higher power density than all alternative energy sources except nuclear power.
3.4.2 Sufficient Supply	Fossil fuels are the only sources of fuel available in sufficient quantities to meet the needs of modern civilization.
3.4.3 Flexibility	Fossil fuels provide energy in the forms needed to make electricity dispatchable (available on demand 24/7), and they can be economically transported to or stored near the places where energy is needed.
3.4.4 Inexpensive	Fossil fuels in the United States are so inexpensive that they make home heating, electricity, and transportation affordable for even low-income households.
3.5 Alternatives to Fossil Fuels	
3.5.1 Lower Power Density	The low power density of alternatives to fossil fuels is a crippling deficiency that prevents them from ever replacing fossil fuels in most applications.
3.5.2 Limited Supply	Wind, solar, and biofuels cannot be produced and delivered where needed in sufficient quantities to meet current and projected energy needs.
3.5.3 Intermittency	Due to their intermittency, solar and wind cannot power the revolving turbine generators needed to create dispatchable energy.
3.5.4 High Cost	Electricity from new wind capacity costs approximately 2.7 times as much as electricity from existing coal, 3 times more than natural gas, and 3.7 times more than nuclear power.
3.5.5 Future Cost	The cost of alternative energies will fall too slowly to close the gap with fossil fuels before hitting physical limits on their capacity.
3.6 Economic Value of Fossil Fuels	
3.6.1 Energy and GDP	Abundant and affordable energy supplies play a key role in enabling economic growth.
3.6.2 Estimates of Economic Value	Estimates of the value of fossil fuels vary but converge on very high numbers. Coal alone delivered economic benefits worth between $1.3 trillion and $1.8 trillion of U.S. GDP in 2015.
	Reducing global reliance on fossil fuels by 80% by 2050 would probably reduce global GDP by $137.5 trillion from baselines projections.

4. Human Health Benefits	
4.1 Modernity and Public Health	
4.1.1 Technology and Health	Fossil fuels improved human well-being and safety by powering labor-saving and life-protecting technologies such as cars and trucks, plastics, and modern medicine.
4.1.2 Public Health Trends	Fossil fuels play a key and indispensable role in the global increase in life expectancy.
4.2 Morality Rates	
	Cold weather kills more people than warm weather. A warmer world would see a net decrease in temperature-related mortality in virtually all parts of the world, even those with tropical climates.
	Weather is less extreme in a warmer world, resulting in fewer injuries and deaths due to storms, hurricanes, flooding, etc.
4.3 Cardiovascular Disease	
	Higher surface temperatures would reduce the incidence of fatal coronary events related to low temperatures and wintry weather by a greater degree than they would increase the incidence associated with high temperatures and summer heat waves.
	Non-fatal myocardial infarction is also less frequent during unseasonably warm periods than during unseasonably cold periods.
4.4 Respiratory Disease	
	Climate change is not increasing the incidence of death, hospital visits, or loss of work or school time due to respiratory disease.
	Low minimum temperatures are a greater risk factor than high temperatures for outpatient visits for respiratory diseases.
4.5 Stroke	
	Higher surface temperatures would reduce the incidence of death due to stroke in many parts of the world, including Africa, Asia, Australia, the Caribbean, Europe, Japan, Korea, Latin America, and Russia.
	Low minimum temperatures are a greater risk factor than high temperatures for stroke incidence and hospitalization.
4.6 Insect-borne Diseases	
	Higher surface temperatures are not leading to increases in mosquito-transmitted and tick-borne diseases such as malaria, yellow fever, viral encephalitis, and dengue fever.
4.6.1 Malaria	Extensive scientific information and experimental research contradict the claim that malaria will expand across the globe and intensify as a result of CO_2-induced warming.
4.6.2 Dengue Fever	Concerns over large increases in dengue fever as a result of rising temperatures are unfounded and unsupported by the scientific literature, as climatic indices are poor predictors for dengue fever.
4.6.3 Tick-borne Diseases	Climate change has not been the most significant factor driving recent changes in the distribution or incidence of tick-borne diseases.
4.7 Conclusion	
	Fossil fuels directly benefit human health and longevity by powering labor-saving and life-protecting technologies and perhaps indirectly by contributing to a warmer world.

5. Environmental Benefits	
5.1 Fossil Fuels in the Environment	
	Fossil fuels are composed mainly of carbon and hydrogen atoms (and oxygen, in the case of low-grade coal). Carbon and hydrogen appear abundantly throughout the universe and on Earth.

	In addition to mining and drilling, hydrocarbons also enter the environment through natural seepage, industrial and municipal effluent and run-off, leakage from underground storage or wells, and spills and other accidental releases.
	The chemical characteristics of fossil fuels make them uniquely potent sources of fuel. They are more abundant, compact, and reliable, and cheaper and safer to use, than other energy sources.
5.2 Direct Benefits	
5.2.1 Efficiency	The greater efficiency made possible by technologies powered by fossil fuels makes it possible to meet human needs while using fewer natural resources, thereby benefiting the environment.
5.2.2 Saving Land for Wildlife	Fossil fuels make it possible for humanity to flourish while still preserving much of the land needed by wildlife to survive.
5.2.3 Prosperity	The prosperity made possible by fossil fuels has made environmental protection both highly valued and financially possible, producing a world that is cleaner and safer than it would have been in their absence.
5.3. Impact on Plants	
5.3.1 Introduction	
5.3.2 Ecosystem Effects	Elevated CO_2 improves the productivity of ecosystems both in plant tissues aboveground and in the soils beneath them.
5.3.3 Plants under Stress	Atmospheric CO_2 enrichment ameliorates the negative effects of a number of environmental plant stresses including high temperatures, air and soil pollutants, herbivory, nitrogen deprivation, and high levels of soil salinity.
5.3.4 Water Use Efficiency	Exposure to elevated levels of atmospheric CO_2 prompts plants to increase the efficiency of their use of water, enabling them to grow and reproduce where it previously has been too dry for them to exist.
5.3.5 Future Impacts on Plants	The productivity of the biosphere is increasing in large measure due to the aerial fertilization effect of rising atmospheric CO_2.
	The benefits of CO_2 enrichment will continue even if atmospheric CO_2 rises to levels far beyond those forecast by the IPCC.
5.4 Impact on Terrestrial Animals	
	The IPCC's forecasts of possible extinctions of terrestrial animals are based on computer models that have been falsified by data on temperature changes, other climatic conditions, and real-world changes in wildlife populations.
5.4.1 Evidence of Ability to Adapt	Animal species are capable of migrating, evolving, and otherwise adapting to changes in climate that are greater and more sudden than what is likely to result from the human impact on the global climate.
5.4.2 Future Impacts on Terrestrial Animals	Although there likely will be some changes in terrestrial animal population dynamics, few if any will be driven even close to extinction.
5.5 Impact on Aquatic Life	
	The IPCC's forecasts of dire consequences for life in the world's oceans rely on falsified computer models and are contradicted by real-world observations.
5.5.1 Evidence of Ability to Adapt	Aquatic life demonstrates tolerance, adaptation, and even growth and developmental improvements in response to higher temperatures and reduced water pH levels ("acidification").
5.5.2 Future Impacts on Aquatic Life	The pessimistic projections of the IPCC give way to considerable optimism with respect to the future of the planet's marine life.
5.6 Conclusion	
	Combustion of fossil fuels has helped and will continue to help plants and animals thrive leading to shrinking deserts, expanded habitat for wildlife, and greater biodiversity.

6. Air Quality	
6.1 An Air Quality Tutorial	
6.1.1 Chemistry	The combustion of fossil fuels without air pollution abatement technology releases chemicals known to be harmful to humans, other animal life, and plants.
6.1.2 Exposure	At low levels of exposure, the chemical compounds produced by burning fossil fuels are not known to be toxic.
6.1.3 Trends	Exposure to potentially harmful emissions from the burning of fossil fuels in the United States declined rapidly in recent decades and is now at nearly undetectable levels.
6.1.4 Interpreting Exposure Data	Exposure to chemical compounds produced during the combustion of fossil fuels is unlikely to cause any fatalities in the United States.
6.2 Failure of the EPA	
6.2.1 A Faulty Mission	Due to its faulty mission, flawed paradigm, and political pressures on it to chase the impossible goal of zero risk, the U.S. Environmental Protection Agency (EPA) is an unreliable source of research on air quality and its impact on human health.
6.2.2 Violating the Scientific Method	The EPA makes many assumptions about relationships between air quality and human health, often in violation of the Bradford Hill Criteria and other basic requirements of the Scientific Method.
6.2.3 Lack of Integrity and Transparency	The EPA has relied on research that cannot be replicated and violates basic protocols for conflict of interest, peer review, and transparency.
	By conducting human experiments involving exposure to levels of particulate matter and other pollutants it claims to be deadly, the EPA reveals it doesn't believe its own epidemiology-based claims of a deadly threat to public health.
	While the new administration has pledged to improve matters, some current regulations and ambient air quality standards are based on flawed data.
6.3 Observational Studies	
6.3.1 Reliance on Observational Studies	Observational studies are easily manipulated, cannot prove causation, and often do not support a hypothesis of toxicity with the small associations found in uncontrolled observational studies.
	Observational studies cited by the EPA fail to show relative risks (RR) that would suggest a causal relationship between chemical compounds released during the combustion of fossil fuels and adverse human health effects.
6.3.2 The Particulate Matter Scare	Real-world data and common sense contradict claims that ambient levels of particulate matter kill hundreds of thousands of Americans and millions of people around the world annually.
6.4 Circumstantial Evidence	
	Circumstantial evidence cited by the EPA and other air quality regulators is easily refuted by pointing to contradictory evidence.
	EPA cannot point to any cases of death due to inhaling particulate matter, even in environments where its National Ambient Air Quality Standard (NAAQS) is exceeded by orders of magnitude.
	Life expectancy continues to rise in the United States and globally despite what should be a huge death toll, said to be equal to the entire death toll caused by cancer, attributed by the EPA and WHO to just a single pollutant, particulate matter.
6.5 Conclusion	
	It is unlikely that the chemical compounds created during the combustion of fossil fuels kill or harm anyone in the United States, though it may be a legitimate health concern in third-world countries that rely on burning biofuels and fossil fuels without modern emission control technologies.

7. Human Security	
7.1 Fossil Fuels	
7.1.1 Prosperity	As the world has grown more prosperous, threats to human security have become less common. The prosperity that fossil fuels make possible, including helping produce sufficient food for a growing global population, is a major reason the world is safer than ever before.
7.1.2 Democracy	Prosperity is closely correlated with democracy, and democracies have lower rates of violence and go to war less frequently than any other form of government. Because fossil fuels make the spread of democracy possible, they contribute to human security.
7.1.3 Wars for Oil	The cost of wars fought in the Middle East is not properly counted as one of the “social costs of carbon” as those conflicts have origins and justifications unrelated to oil.
	Limiting access to affordable energy threatens to prolong and exacerbate poverty in developing countries, increasing the likelihood of domestic violence, state failure, and regional conflict.
7.2 Climate Change	
7.2.1 The IPCC’s Perspective	The IPCC claims global warming threatens “the vital core of human lives” in multiple ways, many of them unquantifiable, unproven, and uncertain. The narrative in Chapter 12 of the Fifth Assessment Report illustrates the IPCC’s misuse of language to hide uncertainty and exaggerate risks.
7.2.2 Extreme Weather	Real-world data offer little support for predictions that CO_2-induced global warming will increase either the frequency or intensity of extreme weather events.
7.2.3 Sea-level Rise	Little real-world evidence supports the claim that global sea level is currently affected by atmospheric CO_2 concentrations, and there is little reason to believe future impacts would be distinguishable from local changes in sea level due to non-climate related factors.
7.2.4 Agriculture	Alleged threats to agriculture and food security are contradicted by biological science and empirical data regarding crop yields and human hunger.
7.2.5 Human Capital	Alleged threats to human capital – human health, education, and longevity – are almost entirely speculative and undocumented. There is no evidence climate change has eroded or will erode livelihoods or human progress.
7.3 Violent Conflict	
7.3.1 Empirical Research	Empirical research shows no direct association between climate change and violent conflicts.
7.3.2 Methodological Problems	The climate-conflict hypothesis is a series of arguments linked together in a chain, so if any one of the links is disproven, the hypothesis is invalidated. The academic literature on the relationship between climate and social conflict reveals at least six methodological problems that affect efforts to connect the two.
7.3.3 Alleged Sources of Conflict	The scholarly literature does not support the IPCC’s claim that climate change intensifies alleged sources of violent conflict including abrupt climate changes, access to water, famine, resource scarcity, and refugee flows.
7.3.4 U.S. Military Policy	Climate change does not pose a military threat to the United States. President Donald Trump was right to remove it from the Pentagon’s list of threats to national security.
7.3.5 Conclusion	Predictions that climate change will lead directly or indirectly to violent conflict are not testable. They presume mediating institutions and human capital will not resolve conflicts before they escalate to violence.
7.4 Human History	
7.4.1 China	Extensive historical research in China reveals a close and positive relationship between a warmer climate and peace and prosperity, and between a cooler climate and war and poverty.
7.4.2 Rest of the World	The IPCC relies on second- or third-hand information with little empirical backing when commenting on the implications of climate change for conflict.
7.5 Conclusion	
	It is probably impossible to attribute to the human impact on climate any negative impacts on

	human security. Deaths and loss of income due to storms, flooding, and other weather-related phenomena are and always have been part of the human condition.
	Real-world evidence demonstrates warmer weather is closely associated with peace and prosperity, and cooler weather with war and poverty. A warmer world, should it occur, is therefore more likely to bring about peace and prosperity than war and poverty.

8. Cost-Benefit Analysis	
8.1 CBA Basics	
	Cost-benefit analysis (CBA) is an economic tool that can help determine if the financial benefits over the lifetime of a project exceed its costs.
8.1.1 Use in the Climate Change Debate	In the climate change debate, CBA is used to answer four distinct questions about the costs and benefits of fossil fuels and the costs of measures to mitigate, rather than adapt to, climate change.
8.1.2 Integrated Assessment Models	Integrated assessment models (IAMs) are a key element of cost-benefit analysis in the climate change debate. They are enormously complex and can be programmed to arrive at widely varying conclusions.
8.1.2.1 Background and Structure	A typical IAM has four steps: emission scenarios, future CO_2 concentrations, climate projections and impacts, and economic impacts.
8.1.2.2 Propagation of Error	IAMs suffer from propagation of error, sometimes called cascading uncertainties, whereby uncertainty in each stage of the analysis compounds, resulting in wide uncertainty bars surrounding any eventual results.
8.1.3 IWG Reports	The widely cited “social cost of carbon” calculations produced during the Obama administration by the Interagency Working Group on the Social Cost of Carbon have been withdrawn and are not reliable guides for policymakers.
8.1.4 Stern Review	The widely cited “Stern Review” was an important early attempt to apply cost-benefit analysis to climate change. Its authors focused on worst-case scenarios and failed to report profound uncertainties.
8.2 Assumptions and Controversies	
8.2.1 Emission Scenarios	Most IAMs rely on emission scenarios that are little more than guesses and speculative “storylines.” Even current greenhouse gas emissions cannot be measured accurately, and technology is likely to change future emissions in ways that cannot be predicted.
8.2.2 Carbon Cycle	IAMs falsely assume the carbon cycle is sufficiently understood and measured with sufficient accuracy as to make possible precise predictions of future levels of carbon dioxide (CO_2) in the atmosphere.
8.2.3 Climate Sensitivity	Many IAMs rely on estimates of climate sensitivity – the amount of warming likely to occur from a doubling of the concentration of atmospheric carbon dioxide – that are too high, resulting in inflated estimates of future temperature change.
8.2.4 Climate Impacts	Many IAMs ignore the extensive scholarly research showing climate change will not lead to more extreme weather, flooding, droughts, or heat waves.
8.2.5 Economic Impacts	The “social cost of carbon” (SCC) derived from IAMs is an accounting fiction created to justify regulation of fossil fuels. It should not be used in serious conversations about how to address the possible threat of man-made climate change.
8.2.5.1 The IPCC’s Findings	The IPCC acknowledges great uncertainty over estimates of the “social cost of carbon” and estimates the impact of climate change on human welfare is small relative to many other factors and will barely affect global economic growth rates.
8.2.5.2 Discount Rates	Many IAMs apply discount rates to future costs and benefits that are much lower than the rates conventionally used in cost-benefit analysis and which are mandated by the U.S. Office of Management and Budget (OMB) for use by federal agencies.
8.3 Climate Change	
8.3.1 The IPCC’s Findings	By the IPCC’s own estimates, the cost of reducing emissions in 2050 by enough to avoid a warming of ~2° C would be 6.8 times as much as the benefits would be worth.

8.3.2 DICE and FUND Models	Changing only three assumptions in two leading IAMs – the DICE and FUND models – reduces the SCC by an order of magnitude for the first and changes the sign from positive to negative for the second.
8.3.3 A Negative SCC	Under very reasonable assumptions, IAMs can suggest the SCC is more likely than not to be negative, even though they have many assumptions and biases that tend to exaggerate the negative effects of GHG emissions.
8.4 Fossil Fuels	
8.4.1 Impacts of Fossil Fuels	Sixteen of 25 possible impacts of fossil fuels on human well-being are net benefits, only one is a net cost, and the rest are either unknown or likely to have no net impact.
8.4.2 Cost of Mitigation	Wind and solar cannot generate enough dispatchable energy (available on demand 24/7) to replace fossil fuels, so energy consumption must fall in order for emissions to fall.
8.4.2.1 High Cost of Reducing Emissions	Transitioning from a world energy system dependent on fossil fuels to one relying on alternative energies would cost trillions of dollars and take decades to implement.
8.4.2.2 High Cost of Reducing Energy Consumption	Reducing greenhouse gas emissions to levels suggested by the IPCC or the goal set by the European Union would be prohibitively expensive.
8.4.3 New Cost-benefit Ratios	The evidence seems compelling that the costs of restricting use of fossil fuels greatly exceed the benefits, even accepting many of the IPCC's very questionable assumptions.
8.5 Regulations	
	Cost-benefit analysis applied to greenhouse gas mitigation programs can produce like-to-like comparisons of their cost-effectiveness.
	The cap-and-trade bill considered by the U.S. Congress in 2009 would have cost 7.4 times more than its benefits, even assuming all of the IPCC's assumptions and claims about climate science were correct.
	Other bills and programs already in effect have costs exceeding benefits by factors up to 7,000. In short, even accepting the IPCC's flawed science and scenarios, there is no justification for adopting expensive emission mitigation programs.
8.6 Conclusion	
	The benefits of fossil fuels far outweigh their costs. Various scenarios of reducing greenhouse gas emissions have costs that exceed benefits by ratios ranging from 6.8:1 to 162:1.