

NOTE: This document includes the abstract, preface, table of contents, summaries of Parts A and B, the first recommendation and main conclusions from my book on global warming. Those should give a good indication of what the book contains. The full 400-page book with about 180 charts and numerous quotes should be available in e-book format from some major retailers like Amazon in early 2020.



# Global Warming

**The technical, social, economic, and  
political actions needed to defeat  
climate change**

**Richard C. Harkness, PhD**

## **Description provided to publisher:**

This book provides a comprehensive briefing or tutorial on the global-warming or climate-change situation because it covers not only the scientific and technical side of this issue but also the human, economic and political side.

Part A covers the causes and impacts of global warming, and remedies like BECCS, solar power, and reforestation. It explains the mitigation pathways the IPCC says we must follow to limit warming to an acceptable level.. It highlights the carbon budget, which will be expended in just the next ten years unless we rapidly cut CO2 emissions about 40 % by 2030. It discusses carbon taxes or caps, plus industry resistance to them. It notes that despite 40 years of advanced warning the US government incredibly has no commitment to fight climate change much less any detailed plan for doing so.

Part B is an in-depth analysis of the psychological, social, economic and political reasons why we aren't taking the problem seriously, plus some ideas for overcoming them. It posits that the main problem today is not global warming per se but rather that we, and especially the current Federal administration, aren't taking it seriously enough. It explains how President Trump is engaged in "wrong thinking". A partial remedy for this is suggested. For the first time this book proposes that a serious effort to fight global warming offers a massive opportunity to remedy a number of social and national ills in non-obvious ways tied to the Maslow hierarchy of needs. It highlights the importance of good presidential leadership and how the legacies of national presidents as well as our own will be determined by how well they and we fight this existential threat. It suggests that how humans engage with global warming in the years ahead will become humanity's greatest drama.

Its intended for thoughtful, analytically minded individuals, climate organizations, journalists, and those outside government with power to pursue the ideas suggested herein.

## **Abstract**

This book provides a comprehensive overview of the climate-change or global-warming crisis. It describes global warming and humanity's response to it from a multidisciplinary systems viewpoint, wherein the total system is comprised of Earth's natural systems interacting with human social, economic, and political systems.

Its objectives are to provide a detailed briefing on the entire global warming issue to those with a serious interest, and to suggest some specific ways to defeat or limit this threat.

It's a story about how humanity has disturbed Earth's natural systems, how they in turn are beginning to threaten us, and then, what humanity must do to mitigate that threat. Thus, Part A pulls together facts from a wide variety of sources—including the recent IPCC report—to describe the causes, impacts, and potential technical remedies for global warming. It highlights a key concept called the “carbon budget,” which requires global CO<sub>2</sub> emissions to drop by about 40% in just the next ten years to keep the Earth from warming excessively. It explains complex scientific findings in a clear manner. It's a resource that includes many quotes, charts and diagrams. It summarizes previous but inadequate efforts to curb warming. It's mainly about the physical or physics side of this situation, not the human side.

The main problem today is not climate change per se, but rather that we are not taking it seriously enough. Thus, Part B is an original analysis of the various psychological, social, economic, and political reasons, plus suggestions for overcoming them. The main focus is on our dysfunctional political system and lack of proper presidential leadership. It uses a systems approach to explain how different stakeholders in that system affect Federal policies and how the balance of power in Washington needs to change quickly to avoid exceeding the carbon budget and causing excessive warming. It argues that some national leaders are engaged in a form of “wrong thinking” that puts all of humanity at risk.

It explains why a massive global effort to fight climate change would—as a side benefit—help satisfy a range of other societal needs better than the often wasteful or destructive methods used today, and therefore presents a large, previously unrecognized opportunity to improve the social welfare.

Finally, it includes specific suggestions for how the fight against global warming could be accelerated by those outside government while the Trump administration denies that there is even a problem.

## **Table of Contents**

Acknowledgements

Preface

### **Part A: The problem, potential technical solutions, and progress to date**

Summary of Part A

#### Ch. 1: Introduction

- 1.1 Objective
- 1.2 My approach
- 1.3 Humans have disturbed Earth systems
- 1.4 The scope and nature of consequences
- 1.5 A personal note

#### Ch. 2: Global warming

- 2.1 Temperature trends
- 2.2 Natural variation
- 2.3 How global warming affects natural variation

#### Ch. 3: Reasons for warming

- 3.1 Caused by humans
- 3.2 Different greenhouse gases
- 3.3 Physics of warming
- 3.4 Warming correlates with CO<sub>2</sub>
- 3.5 Deforestation
- 3.6 Positive feedback concerns
- 3.7 Other causes of temperature change

#### Ch. 4: Details on CO<sub>2</sub> emissions

- 4.1 Emissions by economic sector
- 4.2 Emissions from generating electricity
- 4.3 Emissions from transport sector
- 4.4 Emissions from cows and concrete
- 4.5 Emissions by region and nation

#### Ch. 5: Impacts of global warming

- 5.1 Editorial comment
- 5.2 Impacts in general
- 5.3 US regional impacts
- 5.4 Impacts on US national security
- 5.5 Prospects for and impacts of over +3 degrees of warming
- 5.6 The human cost of delay
- 5.7 A leaky boat analogy

## 5.8 A grim end-game scenario

### Ch. 6: Warnings and responses

- 6.1 Early warnings
- 6.2 The political response to warnings
- 6.3 A focus on US promises and plans

### Ch. 7: How global warming can be limited

- 7.1 Overview
- 7.2 Scenarios or pathways to limit global warming
- 7.3 The required reversal of emissions
- 7.4 The carbon budget
- 7.5 IPCC scenarios for reducing CO<sub>2</sub>
  - 7.5.1 Emission source reduction pathways
  - 7.5.2 Mitigation technology pathways
- 7.6 Least-cost planning
- 7.7 A closer look at some emitters and remedies
  - 7.7.1 Solar
  - 7.7.2 Nuclear
  - 7.7.3 Transport
  - 7.7.4 Forests
  - 7.7.5 BECCS
  - 7.7.6 Geo-engineering

### Ch. 8: Cost, forcing change, and decision delay

- 8.1 The financial cost of limiting global warming
- 8.2 Cost of US Clean Power Plan
- 8.3 Cost of powering the US by solar
- 8.4 Relative costs of different ways of generating electricity
- 8.5 It takes GHG to save GHG
- 8.6 Ways to force conversion to a carbon-free economy
- 8.7 Where will the money come from?
- 8.8 Carbon caps and national carbon budgets
  - 8.8.1 Determining the size of national carbon budgets
  - 8.8.2 Relation of carbon budgets to carbon caps
- 8.9 Is using more natural gas a good bridge toward saving GHG?
- 8.10 Decision-making delay
- 8.11 Fairness to underdeveloped countries

### Ch. 9: Progress to date

- 9.1 National and international level
- 9.2 Local level
- 9.3 Some encouraging things

## **Part B: What is needed socially, economically, and politically to fix the global warming problem**

### Summary of Part B

#### Ch. 10: Analysis of our dysfunctional societal system

- 10.1 Chapter objective and approach
- 10.2 Earth interacts with humanity
- 10.3 What are societal systems and why do they exist?
- 10.4 Societal systems have become dysfunctional
- 10.5 The political change needed to fix global warming

#### Ch. 10: A holistic systems view of the situation

- 10.1 Introduction to Part B
- 10.2 A brief introduction to systems
- 10.3 How our societal system evolved to what it is today
- 10.4 Today's societal system is sick and malfunctioning
- 10.5 Diagrams of US socio/economic/political system
- 10.6 Systems don't change without passion, effort, and pressure

#### Ch. 11: Stakeholder attitudes and actions

- 11.1 Introduction
- 11.2 Scientists
- 11.3 Climate activists
- 11.4 The general public
  - 11.4.1 Attitude survey results
  - 11.4.2 Mental models and attitudes
  - 11.4.3 The six key attitudes needed
  - 11.4.4 Calm weather could relieve pressure for change
  - 11.4.5 The next election won't be a referendum on climate change
  - 11.4.6 Pressure is needed to force behavioral change
  - 11.4.7 Summary of sub-section about the general public
- 11.5 Some state governments, industries, and utilities
- 11.6 Business and industry
- 11.7 China
- 11.8 Blue-collar voters
- 11.9 Southern and farm-state residents
- 11.10 Anti-migration voters
- 11.11 Young Republican voters
- 11.12 Weakly Republican voters
- 11.13 Climate-change deniers
- 11.14 Trump/GOP Administration
- 11.15 News and information media
- 11.16 Major corporate stockowners

Ch. 12: Global warming offers opportunity

- 12.1 Introduction
- 12.2 Maslow hierarchy of needs
- 12.3 Current and better ways to meet those needs
- 12.4 Chapter conclusion

Ch. 13: Fixing our dysfunctional societal systems

- 13.1 Overview
- 13.2 The dysfunctional societal system in the US
  - 13.2.1 Two specific system defects
  - 13.2.2 Wrong-thinking and right-thinking
  - 13.2.3 Remedies for wrong-thinking
  - 13.2.4 The burden lies partly with ordinary citizens
- 13.3 The vital need for good leadership
- 13.4 Legacies are at stake

Ch. 14: Thoughts on what might help

- 14.1 Creating an unofficial US national plan
- 14.2 Stressing that global warming presents a huge opportunity
- 14.3 Raising the level of fear
- 14.4 Posting the carbon price of products and projects
- 14.5 Institutionalizing right-thinking
- 14.6 Stressing the need for a common, uniting cause
- 14.7 Determining why the social/economic/political system is dysfunctional
- 14.8 Fully engaging the media
- 14.9 Demonstrating benefit via a certain pilot project
- 14.10 Electing the right leaders
- 14.11 Handbook with answers to climate skeptics

Ch. 15: Conclusions

Appendix A: Solar-power calculations

Appendix B: Estimate of new forest needed to offset CO<sub>2</sub> emitted by aircraft

Appendix C: A brief introduction to systems theory

Author's Biography



## Preface

This e-book on global warming started out as an effort to write the final chapter in a still unfinished book about the formation and behavior of systems I have been working on for about five years. It sought to identify the basic laws of systems formation and behavior that apply across all types of systems. To discover them I started by analyzing the earliest systems to form and ended with the most recent to evolve. This journey took me from atoms and galaxies created at the dawn of the universe to molecules, first life, humans, and on to societal systems like the one we are living in today. The overall objective was to gain new insights into how we could better manage today's social, economic, and political systems. One can't cover all aspects of our complex societal systems, so I elected to write a "case-study" chapter on the causes of WWI because it is a historical example of a social/economic/political system that went terribly wrong, killing millions. Then I turned to global warming, because today's social/economic/political system is malfunctioning again with potentially even more dire consequences. Along the way I decided to expand the nascent chapter on global warming into this e-book since the issue is so important and timely. I hope it will help educate analytically minded readers who are seriously interested in a broad overview of the climate-change situation, which by necessity must include an analysis of why society isn't actively fighting this threat despite its seriousness and despite over 50 years of warning.

# **Part A**

**The problem, potential technical solutions,  
and progress to date**

## Summary of Part A

Humanity's greatest problem today is not global warming or climate change per se, but rather our failure to take it seriously enough. Therefore, this book is divided into two parts. The objective of Part A is to describe in easy-to-understand terms the global warming problem in considerably more detail than is found in the popular literature but in less detail—and with a broader scope—than is found in the massive Intergovernmental Panel on Climate Change (IPCC) report or the technical literature about climate change. Part A describes:

- what we did to the planet (emit CO<sub>2</sub>)
- what the planet is doing to us (getting warmer)
- what we could do to limit what the planet is doing to us (stop emitting CO<sub>2</sub>)
- what we have accomplished so far (not nearly enough)

Part B analyzes the reasons that society has not taken the problem seriously enough and makes some recommendations about what might improve that unfortunate situation. It is addressed mainly to thought leaders, activists, policymakers, and those with influence.

There are six main emotions people need to feel before they will take adequate action to limit global warming:

- fear
- urgency
- anger
- responsibility
- hope
- sense of opportunity

Reading Part A should evoke the first two. Part B will address the others. The contents of Part A are summarized just below.

A rapid growth in human population coupled with the use of fossil fuel has emitted a large amount of greenhouse gas (GHG), mostly CO<sub>2</sub>, into the atmosphere, thereby destabilizing the Earth's atmospheric, oceanographic, terrestrial, and bio-systems. Deforestation has also emitted Greenhouse gas (GHG). Greenhouse gas blocks outgoing heat radiation so that an increase in GHG causes the planet to warm. Emissions over the last two hundred years have

already warmed the Earth by about 1 degree C above its pre-industrial level. As a result, sea levels have risen and extreme weather events like storms, floods, and droughts have become more frequent and intense. The current level of CO<sub>2</sub> in the atmosphere greatly exceeds that during the last four-hundred-thousand years, so it is certain that Earth's physical systems, ecosystems, and human socio/economic/political systems will be forced to change significantly as they seek equilibrium with that new level of CO<sub>2</sub>.

Climate scientists first warned governments about global warming over 50 years ago. Recently they summarized their latest assessment of the effects of a further increase in GHG in a large authoritative report prepared by the UN-sponsored International Panel on Climate Change (IPCC). That report highlighted the dangers of global warming and designed a number of alternate strategies, scenarios, or pathways by which further warming could be limited to some reasonably tolerable level like +1.5 degrees C.—that is if nations implemented the needed mitigation measures, such as creating a carbon-free economy based on renewable energy, replanting forests, and taking other measures.

These mitigation scenarios would cost trillions of dollars to implement but that is affordable because it is a relatively small fraction of the global economy. The cost would be offset over time by avoiding misery and premature death, and avoiding the need to repair storm damage or invest in adaptations like sea walls.

All the IPCC scenarios centered around something called the global “carbon budget,” which is a measure of how much additional CO<sub>2</sub> humans can emit before the globe would warm beyond +1.5 degrees C. As of 2019, the remaining carbon budget is about 400 billion metric tons (GTs) of CO<sub>2</sub>. It is currently being emitted at the rate of about 42 GTs per year, and due to increased development and fossil fuel used, that emissions rate has been growing for decades. However, if it were to level off at 42 GTs/yr., the remaining carbon budget for +1.5 degrees of warming would be expended in only about ten more years, by 2030. The IPCC scenarios or pathways require starting to reduce emission emissions immediately and achieving zero net emissions by about 2050. That might suggest we have several decades to get serious about reducing emissions, but actually the IPCC pathways require very large reductions in the next decade. One typical IPCC pathway requires a 40% reduction by 2030. This is one of the facts that citizens, the media, and policymakers should be most focused on. It would require massive investments in solar, wind, and nuclear power, plus a near total switchover to electric vehicles and a great deal more. More problematic than the technical challenge is the social and political challenge of generating the will to make these investments. Strong responsible leadership is essential. Meantime, the clock is ticking on our depletion of the remaining carbon budget.

It would take a powerful force to make emissions decline rapidly. A carbon cap or tax is the method most discussed and most likely to succeed, although mandates to make cars more efficient and for utilities to use more renewable power would help.

There have been various international forums seeking action to fight climate change. One of the most recent resulted in the Paris Accord, wherein different nations made pledges to reduce emissions. Unfortunately, even if these pledges were honored, it would not be sufficient. And the Trump administration has even sought to back out of that accord. In a nutshell, neither the US nor the world has anywhere near an adequate commitment or plan to fight climate change.

It's also unfortunate that the laws of physics do not accept excuses for why humans aren't acting. All that the laws of physics and the planet "care" about is how much CO<sub>2</sub> we are emitting.

Thus, the big problem today is not global warming per se, but rather the fact that we aren't fighting it nearly aggressively enough.

The IPCC does not specify any particular temperature beyond which impacts would get suddenly and dramatically worse. Instead most issues seem to get worse gradually, which has the perverse effect of not being able to specify some particular temperature we really can't exceed. If a hard threshold did exist and was publicized, it would galvanize action because society reacts most strongly to sudden or imminent threats. Pearl Harbor and the World Trade Center come to mind. Since global warming happens relatively slowly, there may not be some sudden point where indifference switches to a strong passion for action. There will always be voices saying "there are too many other pressing issues to act now on climate; we can surely wait awhile."

This presents another vexing problem because, if society waits for conditions to become intolerable before it starts to implement mitigation measures in a serious way, warming will get considerably worse in the years it would take to implement those measures and cease emitting CO<sub>2</sub>.

The IPCC does not warn strongly of any large geo-physical tipping point when warming or some harmful impact would get out of control due to a positive feedback situation. However, there are several areas of concern. We know warming is melting some permafrost, which then releases methane, a greenhouse gas dozens of times more potent than CO<sub>2</sub>. Released methane will increase temperatures, thus melting still more permafrost and causing still more warming, and so forth. The IPCC also expresses concern over a potential destabilization of the Antarctic ice sheet, which could cause a sudden and significant rise in sea level, and over Greenland melt-water which might upset ocean currents in the North Atlantic. Apparently, scientists don't think any of these are immediate threats, but admit they aren't certain.

Tipping points occur when some system variable is pushed beyond a certain value. The main variable changing now is global temperature. Thus, if there are tipping points for runaway permafrost melting, Antarctic ice destabilization, or ocean current upsets, they may be reached if temperature rises beyond a certain but unknown level. Clearly, it is dangerous to run an experiment with the entire planet to find out if those tipping points do in fact exist.

This book does not dwell overly long describing the impacts of global warming because they have been widely publicized elsewhere. They include: more frequent and intense weather events like storms, floods, and droughts; forest fires; sea-level rise; species and coral reef die-off; misery and premature human death caused by more intense heat waves; and spread of tropical diseases. Clearly every natural and man-made system on Earth will be impacted either directly or indirectly, either strongly or weakly.

One IPCC finding of note is that the impacts of global warming will vary in different regions across the globe and even within the US. Some areas will get generally wetter or dryer. The Arctic will get significantly warmer. Some areas like the US Southeast will experience more extreme heat waves. The best areas to grow certain crops like corn will shift. Food production will decline in certain nations, probably triggering forced mass migrations. Even sea level will not rise uniformly.

Extreme weather events like 500-year floods have occurred randomly in the past due to what is called “natural variation.” Natural variation will continue as the globe warms, but on average—as measured over several decades—they are expected to get more frequent and more intense. Surveys show that people grow concerned about climate change when they have experienced or read about extreme events such as the recent mid-west flooding or hurricane Katrina. On the other hand, if by chance there are no extreme events for a few years, people may become less concerned, while climate skeptics have a field day.

The sources of global CO<sub>2</sub> are as follows: electricity and heat 25%, agriculture and forestry 24%, industry 21%, transportation 14%, and all others the remaining 16%. About 38% of global electricity comes from burning coal, 23% from natural gas, 16% from hydro, 10% from nuclear, 4% from oil, and 8% from non-hydro renewables like solar and wind. The US gets 33% of its electricity from coal, 33% from natural gas, 20% from nuclear, 6% from hydro, 5% from wind, and just 0.6 % from solar. Coal power plants are bad because coal emits twice as much CO<sub>2</sub> as natural gas to produce a given amount of electricity. Thus, converting existing coal power plants to use natural gas—before replacing them with solar, wind or nuclear—is one of the best ways to reduce emissions in the short term.

The United States and Europe have emitted most of the CO<sub>2</sub> now in the atmosphere, but the largest emitter today is China, followed by the United States, India and Russia. China’s high emission rate is largely a result of using coal. Surprisingly, if the cement industry were a country, it would be the world’s third largest emitter of CO<sub>2</sub>. There is apparently no known, feasible way to greatly reduce the emissions from producing concrete. Another source says cattle are the world’s third largest emitter of GHG, mainly in the form of methane.

Per-capita emissions are greatest in the US but followed closely by Australia, Canada, and Russia. Per-capita emissions in Europe are roughly a third of those in the US. Those in less-developed nations like India are far lower. This inequality complicates agreements on how much each nation should reduce its emissions going forward.

It takes energy to make the technical products—like wind turbines—needed to reduce future emissions. So, different mitigation technologies should be evaluated partly on a metric called the “energy return on investment.” It turns out that electric cars now require twice as much energy to manufacture as regular cars. Given this, they only save energy if used enough to recover the extra energy needed to build them. However, this depends on how the energy used to make them was produced, which is changing as we move toward renewables.

Mitigation technologies also differ in their cost-effectiveness. Thus, the cheapest mixture of technologies to cure global warming could be identified by a technique called least-cost-planning (LCP). Basically, LCP exploits the lowest-cost technology—like better home insulation or LED light bulbs—to its fullest extent before moving on to the next most cost-efficient. Utility-scale solar farms would be preferred over residential roof-top solar because the former are roughly 5 times more cost-effective. Methods that would actually take CO<sub>2</sub> out of the atmosphere are the least cost-effective by far.

All of the IPCC scenarios recognize that it’s not possible to stop emissions from aircraft, and probably not from heavy trucks, ships, or farm machinery. Therefore, the IPCC scenarios depend on massively deploying techniques for taking CO<sub>2</sub> back out of the atmosphere so the world can reach zero *net* emissions by about 2050. One of those “offset” techniques is reforestation and another is “bio-energy with carbon capture and sequestration,” or BECCS. The former would require reforesting very large amounts of land, thus probably competing with that used for food production or cattle grazing. BECCS involves growing plants suited for burning in power plants to produce electricity, and then injecting the resulting CO<sub>2</sub> deep underground where it would be absorbed in the rock. While appealing in concept, there are only two BECCS plants in the US now, and the IPCC expresses considerable concern about the land-use feasibility of implementing BECCS on the massive scale required. CCS is also one of the most expensive remedies. If you have a short list of climate change issues to worry about, add the feasibility of reforestation and BECCS to your list.

Perhaps one overall message from the material above is that finding the best technical plan to fight climate change is complex and will take detailed techno/economic analyses. What seems obvious may be wrong.

Progress to date has been discouraging, especially in light of about 50 years of advance warning. What nations have done so far, while useful, is still insufficient. The Paris Accord, while a significant step, is inadequate and unenforceable. The US has no meaningful carbon cap or tax to force change, nor even any detailed plan.

As noted above, it is very important to start reducing emissions right away. The IPCC pathways require a steep decline starting in 2020 and emissions to be 40% lower by 2030. Of great concern is the time it will take for nations to agree on how much and how fast each will reduce emissions, for industry to settle disputes about how a carbon cap or tax is implemented, for government to implement these measures, and then—once all the agreements are reached—for the additional time needed to actually build the requisite solar and wind farms,

nuclear plants, electric cars, and other mitigation measures. If that process got started in 2020, it would take years before emissions would decline at the needed rate. It is hard to overemphasize that a very key obstacle to limiting global warming is the time it takes for decisions to be made, both in people's minds and in the social/economic/political realm.

The combination of technical difficulties and decision-making difficulties are two reasons why global warming is an unprecedented challenge for humanity. Another is that individuals and governments are being asked to expend effort now to forestall a massive problem that's mainly unseen, mainly unfelt, and lies largely in the future.

This book proposes that humanity's engagement with climate change is becoming the greatest drama humanity may ever experience. Whether it will end in triumph or tragedy is not certain.

Why do I call it a drama? It's because it is fundamentally about human behavior. It's because the term is a metaphor that simplifies an otherwise huge and complex situation so it is more easily grasped. An alien looking down on the human race from some viewpoint in space, or a person looking down on the human stage from the third balcony, would see a variety of players interacting. In Shakespearian terms, national leaders are kings, corporate CEOs are princes, legislators are nobles, and ordinary citizens are divided into crowds of peasants. Some crowds would be on one side, some on another, and still others blissfully ignorant and unengaged. There would be good and bad people, smart and dumb ones. For simplicity's sake organizations and corporations would be personified. There would be some powerful threat disturbing the status quo. Each player would be pursuing their ambitions or protecting what it already possessed, wisely or foolishly.

Whether this drama will end in triumph or tragedy for humanity is unknown. The stakes are high. Tragedy would destroy our way of life if not our existence. Triumph would leave us safe and proud of what we had accomplished. With concern for the problem finally growing rapidly, we may be at the end of act one.



# **Part B**

**What's needed socially, economically, and politically to fix the global warming problem**

## Part B Summary

**Chapter 10** explores why our social, economic and political systems are not yet taking global warming seriously enough to fight it with nearly the level of effort needed. In this respect, they are dysfunctional in fighting humanity's greatest threat, despite about 50 years of advance warning. They evolved into this state of dysfunctionality. Prior to 50 years ago, no one ever thought the burning of fossil fuel and the resulting CO<sub>2</sub> emissions were going to cause any harm, so they did nothing to curb them. In particular, they did not force coal, oil and gas companies to include the cost of environmental damage into the price they charged for fossil fuels, or pass laws to limit CO<sub>2</sub> emissions. Thus, fossil fuel was far cheaper and available than it should have been. Individual behavior and indeed our entire economy were and are based on cheap energy. The fact that fossil fuel was artificially cheap is arguably the root cause for why we have gotten into the situation we are in today; namely, a warming globe and a societal system that resists doing what's necessary to fix it.

But today we've evolved to where individuals and our societal systems know about the problem but are still not taking it seriously enough. We are still addicted to cheap fossil fuel energy, and it's a very hard habit to shake.

Since societal systems are complex and have many interacting parts, there is no single reason why they are dysfunctional at this time, and have not imposed that carbon tax or cap. Thus, we are faced with a systems problem. Solving it requires changes in people's attitudes, changes in corporate behavior, and changes in the political system. Individuals are beginning to realize the problem, but won't take it seriously unless someone they trust tells them they must and government policy forces them to. Neither of these exist today. The economic system thrives on cheap energy and resists any change in the status quo.

Government has the fundamental responsibility for protecting citizens and advancing the general welfare. It has the technical resources to detect problems before citizens become aware of them. Thus, government should lead in doing this forward thinking and promoting what is necessary to counter emerging threats. But today's government is chiefly to blame for not recognizing the seriousness of climate change, enacting the necessary legislation and getting ordinary citizens to support it. The necessary legislation would probably include a carbon tax or cap. Then, behavior throughout the system would change in the appropriate manner.

Because the societal system has evolved into this dysfunctional state, several short and long-term ways are proposed to fix the current dysfunction and prevent it from happening again when other serious problems arise. The short-term remedy for dysfunction is to elect people other than Trump and his congressional supporters in 2020. One long-term remedy—namely, creating a CBO-like organization to objectively evaluate presidential policies—is introduced here but elaborated in chapter 13.

In sum, the most important step toward solving the climate change crisis is to change the balance of power in Washington so that the current regime that wants to maintain the status quo is replaced by a president and congress that will make fighting climate change their top priority. This will require some stakeholders in the political system to intensify their pro-environmental efforts and others to change who they vote for.

**Chapter 11** discusses the attitudes and actions of all the major players or stakeholders in the US political system one by one. It suggests reasons why some who previously supported Trump in 2016 will desert him in 2020 when they realize his climate policies are going to hurt them especially hard or otherwise frustrate their desires. Impacts of extreme weather events on the Midwest and South are highlighted, as is a likely increase in mass migrations. It describes the business community's attempts to maintain the status quo regarding fossil fuel production. It lists many of the actions the Trump administration has taken to reverse progress made during the Obama era. It discusses the role of the media and how wealthy individuals or organizations could influence the election and/or act while the Trump administration denies there is even a problem.

**Chapter 12** is perhaps the most innovative in this book because it explains why a serious effort to curb global warming offers a massive upside opportunity to not only fix global warming, but also improve people's lives. That's something that has apparently not been recognized or written about elsewhere. It's based on the Maslow hierarchy of human needs for security, food, pride, esteem, belonging, and self-actualization. It argues that today's attempts to meet those needs via nationalism, hate, an emphasis on international competition as opposed to cooperation, lack of any common unifying national purpose, and ignoring climate change would be better met if society were involved in a WW II level effort to fight climate change.

**Chapter 13** discusses the danger of giving one individual—the US president—so much power to shape the fate of humanity, because that person may not happen to be suitable for the task. Therefore, it proposes creating a Congressional Budget-like organization to, in effect, second guess the president by objectively evaluating presidential policies and seeing if the ways societal needs are being met today could be better met in some other way. This chapter also focuses on the critical need for good national leaders by describing two ways that national leaders can shape policies and pronouncements. One that I call “wrong-thinking” reinforces destructive behaviors and underestimates the dangers of their policies. The other, which I call “right-thinking,” does the opposite. Right-thinking would have identified and promoted the opportunity discussed in the prior chapter. Chapter 13 also stresses that it is vitally important to have national leaders with the right communication skills and altruistic motives if society is to fight global warming effectively. It argues that their legacies will be judged by history mainly in terms of how well they fought global warming.

**Chapter 14** lists a number of recommendations for things that could be done to accelerate the battle we must fight against global warming. Some could be done outside government while the current administration back-pedals.

**Chapter 15** contains the book's conclusions, which are already compact enough that they don't merit repeating here.

## Chapter 14: Thoughts on what might help

This chapter describes a few things that would help in the fight against climate change, especially since they don't depend on cooperation from the federal government. The first is fairly detailed, but the rest are briefer.

### 14.1 Creating an un-official US national plan

In this section, I advocate for the creation of an unofficial US plan to limit global warming. It would not be simply a goal saying we should reduce emissions by X%, but rather a relatively detailed design for the electric grid and all the other things that need to be done to create a carbon-free economy. Goals and objectives are not plans. In WW II, landing an army in France was a goal, but the Normandy landings required a detailed plan specifying what needed to be done, how it would be done, who would do it, when it would be done, and how much it would cost. Having a technically feasible plan, which identified and resolved most of the practical problems of such an enterprise, demonstrated that it could be done, and was critical to its success.

As a result of our dysfunctional social/economic/political system, the US doesn't have such a plan. It's incredibly irresponsible. It's a reality that is hard to reconcile with the fact we've had 50 years of warming and the fact that global warming is so serious. As mentioned earlier, the Obama era "Clean Power Plan" wasn't a plan at all, just a delegation of the task to state governments. And, even now, Trump is trying to repeal that small step toward a plan.

If Trump is re-elected, the federal government surely won't prepare such a plan over the next five years, and even if he isn't, it may still take time for the federal government to fund the development of such a plan because there are so many stakeholders who will debate how it's done. Given the urgency of the situation, I therefore suggest that wealthy individuals, trusts, or other organizations—who feel the urgency of moving the process along as quickly as possible—step forward to organize and fund such a plan. Since it would be prepared by those outside government, and with little help or endorsement by the federal government, it would be an unofficial plan.

There are two overall benefits from having such a plan. First, it would provide hope (i.e., confidence) that limiting global warming was technically possible. Second, it would reduce the time that will expire between when the federal government imposes a carbon tax or cap—which it eventually must—and when construction of a carbon-free economy can actually get underway. Given that there are only ten years when emissions must drop by 40% and only thirty years before they need to reach zero in 2050, every year of unnecessary delay must be avoided. Projects, or at least the rough designs for them, should be as close to "shovel ready" as possible when the carbon tax or cap is imposed.

The overall plan would have two components: a technical plan and an implementation scenario.

What follows are my ideas or specifications for what a plan should contain and the ground rules for developing it. If this idea catches on with those who might sponsor it, then they would no doubt refine and revise these specifications.

**Technical plan:** A US national plan to limit global warming would be a fairly detailed description and design for a set of mitigation measures that, if implemented, would reduce US CO<sub>2</sub> emissions to net zero by 2050. The design selected would not be the only way to achieve that goal, but rather one that would do it at the lowest cost, the best engineering solution as it were. It would essentially give detail to one of the "mitigation pathways" envisioned by the IPCC. One part of the plan would be a design for a carbon-free national power grid.

The plan would be internally self-consistent; for example, by making sure the amount of renewable electric generation capacity is sufficient to support the number of electric cars, the electric grid goes to where the solar farms are, and enough generation or storage is available to supply power when it's dark or the wind isn't blowing.

One key part of the plan would be a map of the US showing approximately where all the solar farms, wind farms, and bioelectric plants (BECCS) should be located to comprise the most cost-effective overall system. BECCS plants need the best location relative to the market for electricity, available transmission lines, biofuel sources, and geology receptive to drilling CO<sub>2</sub> injection wells. Another part of the plan would specify the number of new electric cars needed and their efficiency, as well as estimating the number and size of factories needed to manufacture them. Many, if not most, of the mitigation measures listed in the least-cost diagram shown previously would probably be included.

One ground rule is that the plan would rely on existing technology, not assume something better will be invented. It will use real-world cost and performance data from existing solar farms and BECCS pilot projects, for instance. The likely cost of each element in the plan would be estimated, then added to get a grand total. The plan should be constructed such that if the cost of some technology, like electricity storage, drops, the plan could be easily modified to use more of it and less of something else. Perhaps the plan would be like a spreadsheet in that respect.

Some hope that we will be saved by the invention of new technologies. Hopefully that will happen, but it is not prudent to count on it. If it does happen, and is proven feasible for large-scale deployment, the plan could always be revised accordingly.

Another ground rule is that the plan will not count on or require changes in behavior that reduce the US standard of living. For instance, it will assume the current level of travel demand will continue, provide the energy to support that, and include what's needed to offset any unavoidable CO<sub>2</sub> emissions. Why start by assuming that we can solve the problem without

changing our behavior? It is simply to avoid saying up front that it might be necessary. Let's begin by showing how the problem could be solved without changing behavior. If such a plan seems too expensive, then everyone will realize that there's no alternative to some behavioral changes. It is assumed that the central plan would be supplemented by somewhat different alternatives.

The plan would be time-phased to specify how many remedial actions or projects must be completed each year in order to reduce emissions per one of the IPCC pathways. For instance, it would specify how many megawatts of wind power should come online each year and about where those wind farms should be built. If this unofficial plan is eventually officially adopted, then yearly progress in implementing it would be tracked. For instance, each of the needed solar farms might be colored red on a master map when it's built. If things are not done on schedule, the plan would be adjusted as needed to fit the new reality.

The general idea is that the plan should have sufficient detail that it could be sent to major utilities and industries, and they could implement it. It will have sufficient cost information so utilities and industries can begin to estimate how to finance their likely parts.

It is important to reiterate that this plan would be the least-cost or most economical way that the US could reduce CO<sub>2</sub> emissions along a reduction pathway similar to what the IPCC suggested. As such, it is an engineering solution. Although much more complex, it is somewhat similar in concept to asking engineers to design the least costly way to provide all the electrical power in California using only renewable sources.

One could argue that the most rational way and the least expensive way for the US to reduce emissions would be to do just what this plan proposes. However, being the most economic plan does not mean it's the most politically acceptable plan, or even what market forces might do in reaction to a carbon tax or cap.

**Implementation Scenario:** The technical plan describes what engineers would do if given the money to implement it. It is conceptually similar to what a general contractor with an architect's plan in hand would do if given the funds. But that is not the process that will be followed in this case. What will happen is that the federal government will impose a carbon tax or cap, and the economy will change its behavior in response to it. That market response will, of course, be affected by government mandates, such as requiring electric cars, and forcing utilities to buy more renewable power. But, for simplicity, let us ignore mandates.

The objective of developing an implementation scenario is to anticipate how the economic system will behave when a carbon tax or cap is imposed, and whether that will result in market forces implementing something similar to the technical plan recommended by the engineers. In theory it should, since the engineers designed their plan to be the least expensive way to deal with the situation, and market forces should end up picking the most efficient solutions also.

To see if this is true, I suggest creating a team of business people and economists to map out how the effects of a carbon tax or cap would propagate down through the economy and what actions various firms or organizations would take. Presumably, the first effect would be a rise in fossil fuel prices. That should incentivize auto companies to make more electric cars. But what do we know about the price elasticity of demand for cars? Maybe people will hang on to cheaper gasoline models for longer than the engineers assumed. Higher prices of fossil fuels or their limited availability will presumably force coal and gas electric plants to raise their prices. Investors, calculating that they could build solar, wind, and nuclear plants, and undercut those prices, will do so knowing that utilities will switch to them even if not mandated to do so. These results seem easy enough to predict, but they need to be quantified. Things like long-term energy purchase contracts need to be considered. What airlines will do is less clear. Could they offset their emissions by funding carbon-capture schemes such as BECCS or re-forestation? If not, who would fund those schemes? Could they raise ticket prices enough to fund a new generation of more fuel-efficient aircraft? How long would that take? Would higher ticket prices make Elon Musk's tube train feasible? Would businesses substitute teleconferencing for business trips?

A systematic analysis of this would at least create a straw man scenario that businesses, and investors, could start to incorporate into their planning.

**Suggestive not mandatory:** The plan is essentially a straw man, a feasibility study. Government would not mandate its implementation or directly fund it. However, it might be helpful for government to mandate certain aspects, such as requiring utilities to convert to renewables according to a schedule. What government *would* need to do is implement either cap and trade, or carbon taxes. The market would then cause many of the needed changes to occur. Then, since the planners that developed this plan had already figured out the most cost-effective way to reach the goal, the market (i.e., business and industry) would probably end up following it approximately.

**Revision:** If someone found a better way to do something, like capture and sequester carbon, or make electric cars less expensive, the plan would be revised and re-optimized. From time to time, it would also be revised to account for any political decisions, for example mandating that more homes be retrofitted with better insulation than was originally assumed, or a decision to buy solar power from Mexico. In short, the plan could be a living document, always showing the most cost-effective way to get from the current reality to the goal.

**Benefit to society:** Society would gain confidence that there was indeed a technically possible and financially realistic way to limit global warming. There is little point in ringing the alarm bell about global warming if people don't have any hope we can fix it. Things like talking about percentage of CO2 deduction needed are abstractions. This plan would make the new way of doing things more tangible. People could begin to anticipate the impact on themselves, especially when utilities estimate how much they would need to increase rates to finance new renewable sources. People could see how it would create many jobs. Businesses will sense opportunity. In short, having this plan is key to having hope.



Perhaps most important, having a plan in place would encourage cities, states, and the federal government to face and resolve a host of inevitable issues sooner rather than later. Ideally “shovel ready” plans should be in place, so they can begin immediately after the government formally implements either cap and trade or a carbon tax. We all know that years of environmental studies, zoning appeals, permitting and the like usually precede actual construction on any large factory or civic works project. In short, having even an approximate and revisable plan in place would likely shorten the time that elapses before the new system is in place and begins to reduce CO2 emissions.

**Benefits to utilities and industries:** Both could see what was probably going to happen, indeed must happen, and plan accordingly. Industry hates uncertainty, especially when deciding whether to invest billions in a new factory for electric cars.

**Who would do it?** A fairly large team of engineers and economists could readily take this on. They would, no doubt, like the challenge. It would, of course, not be easy, since there are so many things that interact with and affect each other. For instance, the cost of electricity from solar plants will affect the number of wind farms that make sense. The cost of drafting this plan would be relatively modest.

**Who would fund or sponsor it?** The US Congress *could* in theory fund this plan and an enlightened US President *could* approve it. This seems extremely unlikely, given the current US President and congressional makeup. Thus, it’s possible this planning effort would be organized and funded outside government, by a combination of wealthy individuals, foundations, small donors, and perhaps even crowdsourcing. Given the urgency of having such a plan, this may be the only way to get it done in a reasonable time. It is possible utilities would contribute their engineers’ time. Some state governments might also contribute and cooperate.

**Next steps:** The idea for a plan like this should be floated to a broad range of stakeholders to see if anyone would take the lead in making this happen.

## 14.2 Stressing that global warming presents a huge opportunity

((((((( the rest of the recommendations have been deleted from this web summary )))))

## Chapter 15: Conclusions

### Primary conclusions:

1) The main problem today is not global warming per-se, but rather that we aren't taking it seriously and doing nearly enough to limit it. Figuring out why we aren't and trying to fix it should become the main focus of everyone worried about climate change. In other words, the problem is not with the planet, the problem is with us: our dysfunctional attitudes and societal systems. To discuss the global warming situation, it is necessary to address its social, economic and, especially, its political dimensions.

2) If President Trump is re-elected in 2020, it will be virtually impossible to keep global warming below +1.5 degrees C, a level that scientists think should not be exceeded. This is because humans can only emit about 400 gigatons more CO<sub>2</sub> after YE 2109 before the planet will warm beyond +1.5 degrees C. Four-hundred gigatons is the remaining "carbon budget." At the current emissions rate of about 42 gigatons/year, these 400 gigatons would be emitted in just the next 10 years. If Trump gets re-elected in 2020 and continues to ignore global warning and reverse what little progress has made to date, the carbon budget will be down to 240 gigatons by the end of his second term. Then it would be virtually impossible to ramp emissions down fast enough to keep from exceeding those remaining 240 gigatons. It follows then, that the most important way to keep global warming from reaching dangerous levels is to elect someone beside Trump in 2020.

3) Until a responsible US president is elected, and even thereafter, ordinary citizens must pressure the federal government to impose a powerful carbon cap or tax. Meanwhile, all the "little" things we've done to increase renewable energy, make electric cars, etc., while helpful, are far from sufficient.

4) Scientists stress that CO<sub>2</sub> emissions must reach net zero by 2050 to keep warming from exceeding +1.5 degrees. That's true, but myopically focusing on this fact gives the misleading impression we have several more decades to get serious. We don't, since the IPCC's "middle of the road" pathway requires emissions to drop 40 % by 2030 on its way to net zero by 2050. Thus, media and policymakers should switch from saying we need to reach "net zero by 2050" to saying that we need to "cut emissions 40% by 2030." This would emphasize the need for urgency, and get people thinking about what a 40% cut implies.

5) The planet does not “care” what excuses humans might have for not reducing GHG emissions. Per the laws of physics, it *only* cares about how much GHG we are emitting. It doesn’t accept excuses such as: the time is not right to act because we are engaged in trade wars, or we fear a recession, or we are dealing with hurricane damage, or Iraq or Russian meddling. It doesn’t care if we are unwilling to act until other nations do. It doesn’t care that an election is coming up. The carbon clock keeps ticking and the planet keeps warming while we procrastinate, no matter what excuses we give ourselves.

6) No one has invented a practical way to take large amounts of CO<sub>2</sub> back out of the atmosphere and thus reverse global warming once it has occurred. CO<sub>2</sub> acts like a thermostat that can be turned up but never down. The level of pain at whatever temperature the planet reaches may continue for a very long time. This is another reason why humanity must stop emitting more CO<sub>2</sub> as soon as possible.

7) At some point, at some temperature, and at some level of pain, societies will conclude they must stop CO<sub>2</sub> emissions. The question is how painful things will become before they reach that conclusion. Will it be now, when we reach +1.5 degrees, +2 degrees, +3 degrees, or +5 degrees? Keep in mind that the problem will get worse during the additional years it takes to actually “turn off the CO<sub>2</sub> emissions valve” by building renewable power plants, planting forests, eliminating gasoline powered cars, etc. In other words, if we decide to act when warming reaches +1.5 degrees, it will probably exceed +2 or +3 before it levels off.

8) How humanity faces the threat of global warming will play out as humanity’s greatest drama. Whether it will end in triumph or tragedy for the human race is uncertain. We, and our institutions, are all players in this great drama. Our legacies and our fates depend on how well we perform.

9) Our social, economic, and political systems have evolved over the millennia to help people meet their basic needs better than could individuals acting alone. However, they have not evolved to the point where they are protecting us against the unprecedented threat of global warming. Otherwise they would not be failing to do so after having 50 years of advance warning. We must rapidly identify and fix the defects in these dysfunctional systems. One reason for this and other failures in our societal systems is that technical and demographic change is occurring so rapidly that they haven’t kept up.

**10) The global warming problem has developed fairly quickly and must be resolved even more quickly. It developed quickly because half the greenhouse gas humans ever emitted was emitted within just the last 40 years. It must be resolved quickly because emissions must drop about 40% in just the next ten years.**

**11) We humans are solely responsible for controlling global warming. The cosmos contains billions of planets serenely orbiting billions of stars. It does not care if life happened to emerge on one we call Earth, flourished for a while, and then self-destructs. It matters only to us.**

**12) There are six main emotions people must feel before they will fully engage in fighting global warming:**

- **Fear:** that the impacts of unfettered global warming would be devastating
- **Anger:** with our leaders because they are not taking action to protect us
- **Urgency:** realization that we must act quickly to reduce emissions
- **Hope:** knowing that technical solutions do exist if only we implement them
- **Responsibility:** that it's up to us to fix the problem, not leave it to our children
- **Opportunity:** realization that the very act of fighting global warming would improve other aspects of life, not just clean up a mess bringing us back to where we were before. In short, we need a vision of a better world to pull us forward. Global warming might be an unrecognized catalyst helping to enable it.

**There are many reasons for why global warming is not being taken seriously and each needs to be addressed using fact-based arguments or education in order to elicit those six emotions.**

**13) What makes this problem especially hard to solve is that it's necessary to rally the social and political will to expend effort now to prevent a problem that is not causing much pain yet and won't for several more decades. It is far easier to "kick the can down the road." At a very fundamental level, this drama about global warming is all about human behavior in the face of any threat or challenge. It is about people's unwillingness to take action now to forestall a future problem. It has been a psychological and political weakness for millennia, and created tragedies throughout history.**

**14) Global warming is very much a moral issue in terms of how much of the burden we just pass to our children and future generations.**

**15) This is a complex problem in virtually every way: there are many reasons why we aren't taking climate change seriously; warming will have a wide variety of impacts in a wide variety of places; and there are many aspects of the technical and economic solutions. In short, the story can't be told simply. The reader must immerse himself or herself in this topic to become reasonably well informed and see how dauntingly complex this situation is.**

**16) Thinking about this day and night for over a year has altered my consciousness. I'm taken into different world. Conversion to a carbon-free economy is a massive changing of gears, and they will grind in the process. I see so many issues that need to be resolved at the detail level. Sometimes I feel like I've been moved forward in time into Act II of this drama, when society can't avoid the issue any longer and is fully engaged in deciding what to do. I don't know how bad things will be at that time, but somehow I slip into internalizing the stress and turmoil that may emerge as powerful stakeholders battle to preserve what they have, and individuals reluctantly face up to possible lifestyle changes, such as emergency regulations on travel or raising gasoline prices. Sometimes it gets scary, and I feel I'm peering into the abyss wondering if humanity will be able to overcome this challenge. At other times, I look around through now altered lenses and see everyone behaving like they are in some kind of a Kabuki dance, in blissful ignorance of what's going on in the background and the new reality that's emerging. But still, if we can gather the social and political will, I am confident the problem can be solved.**

**17) We will not come face to face with reality until we complete detailed national plans for limiting warming to +1.5 degrees and see how much effort will be needed, and how soon things need to be done.**

**18) Despite the seriousness of the threat and 40 years of advance warning the United States government does not have a formal commitment to limit global warming, much less any detailed plan for doing so.**

**((( secondary conclusions not included with this web summary )))**



