

# Contents

<i>Foreword by Anthony F. Earley Jr.</i>	<i>page xi</i>
<i>Foreword by G.P. “Bud” Peterson</i>	xv
<i>Foreword by Arun Majumdar</i>	xvii
<i>Preface</i>	xxi
<i>Acknowledgments</i>	xxvii
<i>Abbreviations</i>	xxix
1 Energy, economics, and climate change . . . . .	1
1.1 <i>Energy: an indispensable resource</i>	1
1.2 <i>Energy 101: a taxonomy</i>	2
1.3 <i>Energy and economic growth</i>	5
1.4 <i>Energy, greenhouse gases, and the environment</i>	8
1.5 <i>Energy, economy, the environment, and sustainability</i>	11
1.6 <i>A wicked problem</i>	13
1.7 <i>Summary</i>	15
2 The Earth’s climate system . . . . .	18
2.1 <i>Weather and climate</i>	18
2.2 <i>Natural agents of climate change</i>	20
2.3 <i>Earth’s global energy budget and the         greenhouse effect</i>	23
2.4 <i>Summary</i>	29
3 Greenhouse gases . . . . .	30
3.1 <i>Distinguishing features</i>	30
Atmospheric concentrations	31
Atmospheric lifetimes and global warming potentials	36
Radiative forcings	37
3.2 <i>Greenhouse gas emissions: recent trends</i>	42

3.3	<i>A macro view of contributing factors</i>	45
3.4	<i>Whither emissions?</i>	47
3.5	<i>The carbon cycle</i>	51
3.6	<i>Summary</i>	53
4	Global warming . . . . .	55
4.1	<i>The Earth's temperature history</i>	55
	Proxy and instrument records	55
	Not without controversy	59
	The CO <sub>2</sub> –temperature linkage	61
	Temperature stasis	62
	The instrument record redux	67
4.2	<i>Climate models and future warming</i>	71
4.3	<i>Feedback mechanisms</i>	74
	Effect of atmospheric water vapor	74
	Effect of ice cover on the Earth's albedo	75
	Decomposition of organic matter	76
4.4	<i>Summary</i>	77
5	Consequences of global warming . . . . .	80
5.1	<i>The Arctic: canary in a mine shaft</i>	80
5.2	<i>Changing sea levels</i>	83
	The effect of glaciers	83
	The effect of ice sheets	84
	Rising seas	87
5.3	<i>Extreme weather events</i>	90
5.4	<i>The built environment</i>	94
5.5	<i>The natural environment</i>	96
5.6	<i>Food production</i>	98
5.7	<i>Human health and security</i>	101
5.8	<i>Abrupt climate change</i>	102
5.9	<i>Summary</i>	105
6	Mitigation, adaptation, and geoengineering . . . . .	108
6.1	<i>Energy efficiency and conservation</i>	109
6.2	<i>Decarbonization of electric power: coal – the</i>	
	<i>800-pound gorilla</i>	111
	The natural gas conundrum	111
	Nuclear and renewable energy	116
6.3	<i>Decarbonization of transportation</i>	120
	Electric vehicles: back to the future	121
	Biofuels: some better than others	122

6.4	<i>Carbon capture and sequestration: the CCS challenge</i>	124
6.5	<i>A sobering perspective: the notion of wedges</i>	129
6.6	<i>Economic factors</i>	134
6.7	<i>Adaptation</i>	137
6.8	<i>Geoengineering</i>	141
	Solar radiation management	141
	Carbon dioxide removal	142
	Ramifications and risks	143
6.9	<i>Summary</i>	145
7	<i>Public policy options</i> . . . . .	148
7.1	<i>Cap-and-trade</i>	148
7.2	<i>A carbon tax</i>	150
7.3	<i>Cap-and-trade or a carbon tax?</i>	154
7.4	<i>Regulatory options</i>	156
7.5	<i>Financial incentives</i>	158
7.6	<i>Summary</i>	159
8	<i>The politics of global warming: a history lesson and future prospects</i> . . . . .	161
8.1	<i>The Intergovernmental Panel on Climate Change</i>	162
8.2	<i>The Kyoto Protocol</i>	163
8.3	<i>Implementation of the Kyoto Protocol</i>	166
8.4	<i>Beyond Kyoto</i>	169
8.5	<i>Copenhagen and subsequent meetings</i>	172
8.6	<i>The Washington debate</i>	177
	Tilting at congressional windmills	177
	Another lever to pull: enter the EPA	180
8.7	<i>China: serious about emissions</i>	184
8.8	<i>From the bottom up</i>	186
	State and city governments	186
	The corporate sector	191
8.9	<i>Summary</i>	196
9	<i>Dissenting opinions: the great hoax</i> . . . . .	199
9.1	<i>The political-corporate axis</i>	199
9.2	<i>Science or pseudoscience – credible or conspiratorial?</i>	202
9.3	<i>The human element</i>	208
9.4	<i>An analogy</i>	212
9.5	<i>Summary</i>	213

10	The ethics of climate change . . . . .	214
10.1	<i>Ethical dimensions of climate change</i>	214
10.2	<i>Ethical theories and principles</i>	217
	Imperatives	217
	Consequences	219
	Values and virtues	220
	Aristotle or Rand?	222
	The Precautionary Principle	226
	The bottom line	227
10.3	<i>Religious traditions</i>	228
10.4	<i>A role for ethics</i>	234
10.5	<i>Summary</i>	239
11	A way forward . . . . .	242
11.1	<i>Economic realities and unlikely outcomes</i>	243
11.2	<i>Elements of an action plan: mitigation and adaptation</i>	246
	Mitigation	246
	Pathways to deep decarbonization	250
	Adaptation	250
11.3	<i>Elements of an action plan: public policy</i>	251
11.4	<i>Elements of an action plan: personal and social values</i>	254
11.5	<i>Epilogue</i>	257
	<i>Appendix A Units and conversion factors</i>	259
	<i>Appendix B Fossil fuels</i>	261
	<i>Appendix C Anthropogenic sources of natural gas and methane</i>	267
	<i>Appendix D Environmental time scales and inertia</i>	271
	<i>Appendix E Coal-fired power plants: operating conditions and costs of carbon capture and sequestration</i>	275
	<i>Notes</i>	283
	<i>References</i>	305
	<i>Index</i>	333

*Color plates follow page 160*