

HOW TO AVOID A CLIMATE DISASTER

By Bill Gates

Reviewed by Kenneth A. Barry*

I. INTRODUCTION

The first question Bill Gates confronts in his new book, *How to Avoid a Climate Disaster* (subtitled “The Solutions We Have and the Breakthroughs We Need”)¹ is why a world-famous, unimaginably wealthy computer software innovator with no specific credentials in climate change science is authoring a book on this sprawling – and unquestionably vexing – subject. He explains that the project sprang from his charitable foundation’s work in developing nations, including addressing “energy poverty.” Apprehending that these communities could not reach goals to improve their education, health, and economies while burning wood and candles to cook, heat, or read, Gates initiated his search for practical solutions.²

At roughly the same time, Gates was drawn into the work of former Microsoft colleagues on the linkages between energy consumption and global warming. Merging these two projects, Gates was struck that the third-world challenge was two-fold: poor countries not only needed new, affordable, and reliable sources of energy, but these resources had to be “clean,” particularly since much of the increasing demand for energy would be coming from developing nations.³

As Gates launched a self-guided study of climate science, he shed his initial skepticism that the accumulation of atmospheric greenhouse gases (GHG) would, if unabated, place the planet on an irreversible course towards unsustainably high temperatures.⁴ The author emerged with four conclusions that have since shaped his new, self-appointed role as a climate change solutions activist and investor:⁵

- Not enough is currently being done to spur widescale deployment of wind and solar energy;
- Regardless of that deficit, these technologies alone will be insufficient to reach the net zero-carbon goal Gates has embraced;

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1. BILL GATES, *HOW TO AVOID A CLIMATE DISASTER: THE SOLUTIONS WE HAVE AND THE BREAKTHROUGHS WE NEED* (2021).

2. *Id.* at 4-5.

3. *Id.* at 6-7.

4. *Id.* at 7. Amusingly, the celebrated author here notes that an invaluable text in accelerating his learning curve was *Weather for Dummies*.

5. *Id.* at 8.

- Since power generation accounts for only slightly over a quarter of global GHG emissions,⁶ the focus of curtailing emissions has to go far beyond the electric power industry;
- New, “breakthrough” technologies across a wide front must be developed and deployed, through a synergistic coalescence of public policy and private investment.

Gates’s journey to becoming a dedicated climate change advocate also evolved from his earlier activity as a venture capitalist placing bets on clean energy concepts (including “next-generation” nuclear power).⁷ Around 2015, he was drawn into the politics of global warming by (1) student protests against institutions investing in fossil fuel companies (including his own Gates Foundation); and (2) overtures from heads-of-state as the December 2015 date of the Paris climate change approached.⁸ The latter triggered an abiding interest – one at the heart of *How to Avoid a Climate Disaster* – in the intersection between governmental policy, public funding of clean energy research, and private investment in decarbonizing product development.⁹ Soon, Gates found himself organizing a large circle of wealthy investors – dubbed the Energy Breakthrough Coalition – providing badly needed venture capital to promising clean energy technologies, as well as interfacing with political leaders to enhance national R&D budgets.¹⁰ In short, Gates had found his niche in the clean energy game.

But how can a multi-billionaire with an extravagant lifestyle develop “street cred” with the environmental community? In a preemptive strike, Gates pleads guilty to being a super-emitter in his personal and business life, owning multiple large residences and regularly globe-trotting in private jets.¹¹ However, he asserts that (1) he has more than made up for these sins with his investments – now totaling over \$1 billion – in technologies to produce low or zero-carbon energy (and other products); and (2) he knows of no one who has invested more heavily in methods to remove carbon dioxide directly from the atmosphere.¹²

II. SETTING THE TABLE

Near the outset, Gates suggests that two crucial components for avoiding a climate disaster are already present: (1) public enthusiasm – exemplified by “a growing global movement led by young people;” and (2) an increasing level of commitment from national and local leaders.¹³ What Gates finds most lacking is

6. Gates’s use of the terms GHG and “carbon” emissions includes not only the carbon dioxide associated with burning fossil fuels, but also other, more potent GHG emissions such as methane.

7. GATES, *supra* note 1, at 8.

8. *Id.* at 9-10. Gates explains that he wasn’t swayed by the protests, as the world’s energy industry was deeply entrenched and divestment – the goal of the protests – was an empty gesture. However, he later divested, simply so he wouldn’t have a personal incentive at crosscurrents with his efforts to incubate new, cleaner technologies.

9. *Id.* at 11.

10. *Id.* Gates here reports that the governmental budget reboot stimulated by the Paris climate change accords was a signal success that “unlocked \$4.6 billion a year in new money for clean energy research.”

11. *Id.* at 15.

12. GATES, *supra* note 1, at 15.

13. *Id.* at 17.

a “concrete plan” that pulls together the numerous scientific, engineering, and financial disciplines necessary to realize his ambitious goal of zero net carbon emissions by mid-century.¹⁴ Filling this gap is a core mission of *How to Avoid a Climate Disaster*.

But prior to delineating the path to planetary salvation, Gates gives us a tour of the living hell awaiting civilization if it doesn’t act, radically and urgently, to decelerate emissions causing global warming. His first chapter, “Why Zero?”, is a catalog of environmental calamities climate change researchers have been predicting for years should warming continue much beyond the one degree Celsius rise already recorded since pre-industrial times.¹⁵ This part of the book is obviously derivative – Gates accepts, rather than reassesses, the projections of legions of climate scientists – but he does do an effective job of blending them into a coherent tableau, embellished with photographs and relatively uncomplicated charts. The picture is one of increasingly frequent weather abnormalities and ecological dislocations, in which agriculture and livestock rearing become more challenging, storms more intense, beaches and low-lying cities less inhabitable, marine life stressed, and entire communities splintered or uprooted. Along with more prolonged heat waves, shifting rainfall patterns either soak or parch the land; settlements and nations most dependent on subsistence farming perversely become the hardest hit; and forced population migrations far exceed current levels.¹⁶

Gates acknowledges the inherent uncertainty in the welter of climate change prognostications, conceding scientists still have “a lot to learn about how and why the climate is changing.”¹⁷ But he does not mince words on the bottom line: “The earth is warming, it’s warming because of human activity, and the impact is bad and will get much worse. We have every reason to believe . . . the impact will be catastrophic.”¹⁸

Gates hedges somewhat on his early suggestion that the cornerstones of public enthusiasm and political commitment are already firmly in place. In the chapter titled “This Will be Hard,” he first observes that existing environmental laws in the U.S. are “outdated” with respect to climate change¹⁹ and that the nation’s quadrennial election cycles are prone to put ongoing government support for long-term investments in green technologies on a shaky footing.²⁰ He’s concerned that “[t]here isn’t as much of a climate consensus as you might think.”²¹ His contention here is that, while many now recognize climate change as a valid concern, when it comes to “investing large amounts of money in breakthroughs,” public support tends to wane, or take a back seat to investing in education and

14. *Id.*

15. *Id.* at 18 *et seq.* Gates notes that, while the global average increase is just one degree Celsius so far, some places in continental interiors have seen a two-degree rise. *Id.* at 21.

16. *Id.* at 25-34.

17. GATES, *supra* note 1, at 24.

18. *Id.* at 25.

19. *Id.* at 48.

20. *Id.*

21. *Id.* at 49-51.

health.²² In the same vein, Gates asserts that global cooperation – a critical element in any truly comprehensive climate change strategy – is “notoriously difficult.” He bluntly concludes: “We need to build a consensus that doesn’t exist and create public policies to push a transition that would not happen otherwise.”²³

III. GETTING ARMS AROUND THE PROBLEM

Gates offers in a chapter entitled “Five Questions to Ask in Every Climate Conversation” various frameworks and tools for evaluating potential investments in GHG emission solutions, helping him to cut through the mass of data.²⁴ One organizing principle is to boil down all sources of emissions into five broadly simplified categories, listed in order of their relative contributions to total GHG emissions. His matter-of-fact labels for these categories are: (1) *Making things* (31%); (2) *Plugging in* (27%); (3) *Growing things* (19%); (4) *Getting around* (16%); and (5) *Keeping warm and cool* (7%). As to the electric generation sector that draws so much attention in climate change discussions – *i.e.*, “Plugging in” – Gates proposes that this category can contribute more to reducing GHG emissions than its 27% proportionate contribution would indicate. He sees such potential not just in displacing fossil fuel-burning generation with low-carbon power, but also in electrifying energy utilization in other categories (*e.g.*, transportation, space heating/cooling, natural gas-based processes in manufacturing).²⁵

Another analytic tool Gates enthusiastically recommends is what he calls the “Green Premium.” As a realistic businessman, Gates does not advocate embracing new technologies simply because they are “greener.” Rather, he wants to pinpoint the Green Premium: what the incremental cost may be to substitute a low-carbon energy application for one using fossil fuels. If the premium is small, or even negative (*i.e.*, cheaper than fossil fuels), that supports the case for near-term investment and deployment. However, if the premium is sizeable, that signals the need for “breakthrough” technologies along with the investment to attain them.²⁶ Notably, Gates resists the premise that zero-carbon power generation (*i.e.*, wind and solar) are already fully competitive with conventional fuels. “By and large,” he states, our current energy technologies are “the cheapest ones available [s]o moving our immense energy economy from ‘dirty’ . . . technologies to ones with zero emissions will cost something.”²⁷

22. GATES, *supra* note 1, at 49-51.

23. *Id.* at 51. While this warning about the difficulty of getting broad global commitment seems to cut against Gates’s previous proclamation that world leader commitment is growing, the distinction seems to be in getting universal buy-in. Thus, his disappointment in the Trump Administration’s withdrawal from the 2015 Paris Accords (reversed in 2021 by the new Biden Administration): Gates concedes that the national commitments in Paris were not nearly deep enough to stem climate change but were at least “a starting point that proved global cooperation is possible.”

24. *Id.* at 52-55.

25. *Id.* at 55.

26. *Id.* at 59-61.

27. GATES, *supra* note 1, at 58. Gates does not distinguish here between existing, conventional power plants and newbuilds in his generalization that current, fossil-fuel energy technologies are the cheapest. He

He uses the Green Premium to illustrate the expense hump airlines (or their customers) would face in converting from conventional, petroleum-based jet fuel to available, but over twice-as-expensive “advanced biofuels,” rhetorically asking, “How much are we willing to pay to go green?”²⁸ The Green Premium tool is nonetheless “a fantastic lens,” Gates enthuses, for making practical decisions on whether to deploy existing low-carbon technologies or continue the quest for more affordable breakthroughs.²⁹ As a caveat, Gates points out that some Green Premiums may be presently affordable for wealthier countries but not for middle- or low-income ones.³⁰

IV. GREENING UP THE GRID

The chapter titled “How We Plug In” – Gate’s outlook for decarbonizing the electric grid – may be of the most interest to readers of the *Energy Law Journal*, especially given his belief that the power sector can make an outsized contribution in reducing overall GHG emissions. Here, Gates treads carefully. Perhaps to the disappointment of some environmental advocates, he dwells on the limitations of solar and wind energy in shouldering the bulk of generation, given the intermittency of these technologies and the insistence of modern civilization on near-perfect reliability.

After laying out some electricity basics for lay readers, Gates digs into the problem by underscoring that, currently, about two-thirds of the world’s energy is generated with fossil fuels (largely coal and natural gas)³¹ – mainly because “fossil fuels are cheap.”³² Plus, he relates, it is an *increasing* trend, as China has, since 2000, been building coal-fired capacity apace, tripling the amount of coal power it uses.³³ On the other hand, Gates suggests that it is feasible, at least for the United States and Europe, to “eliminate our emissions with only a modest Green Premium.”³⁴ It is important to keep in mind, however, that the decarbonized generation fleet Gates envisions *includes* nuclear stations and fossil fuel-burning units equipped with carbon capture technologies.³⁵

In asserting that the Green Premium is manageable in the United States, Gates calculates that the typical household bill would go up by only around 15%,

does underscore that his cost comparisons do not take into account any harm caused to the environment by burning hydrocarbons.

28. *Id.* at 60.

29. *Id.* at 61.

30. As a self-described “thought experiment,” Gates also imagines what it would cost to remove the annual global GHG emissions – currently 51 billion tons – via direct air capture (DAC), and comes up with a ballpark figure of \$5.1 trillion/year. DAC would be much less expensive than shutting down entire segments of the world economy, as happened in the Covid-19 crisis, Gates observes, but he doesn’t see it as practical solution anytime soon. *Id.* at 63-64.

31. *Id.* at 70.

32. GATES, *supra* note 1, at 70.

33. *Id.* at 72. Gates adds that this is “more capacity than in the United States, Mexico, and Canada combined.” though he doesn’t clarify whether he means all types of installed generation capacity or just coal, nor does he distinguish between “use” and “capacity.”

34. *Id.*

35. *Id.*

or \$18/month.³⁶ Other countries, he posits, may not be so lucky, as their solar and wind resources may not be as favorable as those in the United States. Moreover, Gates worries about China marketing its own business model – building inexpensive coal-fired plants – to the rest of the developing world to grow their power industries.³⁷ If third-world nations follow in China's footsteps, Gates opines, "it'll be a disaster for the climate."³⁸ This bleak prospect propels Gates's relentless pursuit of *affordable* green generation options.

The next question Gates tackles is why solar and wind generation entail *any* Green Premium, since their "fuel" comes free?³⁹ He advances several reasons, but the "biggest driver," he states, is "the curse of intermittency," coupled with the expectation of high reliability in first-world nations.⁴⁰ His analysis touches on the challenges – cost and otherwise – of massively augmenting the transmission network, along with the prohibitive (in Gates's view) expense of batteries systems robust enough to offset the intermittency of solar and wind resources.⁴¹ Diurnal and seasonal swings in solar and wind output are a related problem; Gates cites Germany as a case study in the dislocations caused by both over- and under-generation of renewables, when a country commits to producing more than half of its energy with such resources.⁴²

Having sketched out the inherent difficulties in relying too heavily on solar and wind power, Gates recognizes these technologies still need to play "a substantial role in getting us to zero" and therefore recommends the removal of barriers to deploying them "wherever it's economical."⁴³ He closes the discussion with a plea for more national planning of transmission grids, and upgrading the existing transmission and distribution networks, if there is any hope for states (such as New York and California) reaching their lofty goals for green energy dominance within a decade.⁴⁴

In a pitch for increasing reliance on nuclear energy, Gates maintains "it's hard to foresee a future where we decarbonize our power grid affordably without using more nuclear power."⁴⁵ As a founder of TerraPower, a company devoted to creating advanced nuclear designs capable of addressing the well-publicized

36. *Id.* Gates includes the "wires" cost – which can compose half or more of the total household power bill – in the denominator to calculate just a 15% Green Premium. If delivery costs are set aside, the projected Green Premium would be about double. Either way, the Green Premium would be higher for industrial and commercial end users with their typically higher load factors, as their generation-driven costs compose a larger percentage of the total bill.

37. Gates notes that Chinese companies "drove down the cost of a coal plant by a remarkable 75%." GATES, *supra* note 1, at 73.

38. *Id.* at 74.

39. *Id.*

40. *Id.* at 75.

41. *Id.* at 75-79.

42. Over-generation in Germany in the summer of 2018, he relates, caused the dual problems of straining the grid connections with its European neighbors to the south and "causing unpredictable swings" in energy costs. GATES, *supra* note 1, at 78.

43. *Id.* at 81.

44. *Id.* at 82-84.

45. *Id.* at 85.

safety and cost concerns about nuclear,⁴⁶ Gates qualifies as an informed proponent. His survey continues with a series of pocket-sized profiles on still other emerging technologies: nuclear fusion, offshore wind, geothermal generation, and storage methods (batteries, pumped hydro, thermal storage, and hydrogen fuel cells).⁴⁷ Notwithstanding Gates's fondness for engineering innovation, there is nothing starry-eyed about these capsule summaries; he touches on the potential, but also the obstacles facing each concept in becoming a mainstream contributor to the grid.

V. DECARBONIZING TRANSPORTATION

Yet another tough nut to crack in Gates's view is the prevalence of oil-derived fuels for cars, trucks, ships, and airplanes. While the transportation sector is only the fourth-largest contributor to GHG emissions, he notes (coming in at 16%), it ranks as the largest emitter in the United States – where gas is “remarkably cheap.”⁴⁸ It adds to the challenge that the growth in emissions among OECD nations⁴⁹ is not in the automobile and light truck sector – that is falling in the United States and the European Union – but rather in the modes of transportation least susceptible to electrification: aviation, trucking, and shipping.⁵⁰ Meanwhile, most of the growth in transportation-driven emissions is coming from the less-developed countries whose populations are growing and economies expanding, meaning more people are buying personal vehicles.⁵¹

Electrification of the ground vehicle fleet is the most obvious answer, and Gates notes that a lengthy roster of global manufacturers is producing electric vehicles (EVs).⁵² Moreover, as efficiencies in batteries have improved and costs have come down (Gates mentions an 87% decrease since 2010), the Green Premium is “modest,” he declares. In the pertinent chapter, Gates offers a comprehensive look at the advantages and drawbacks, along with the remaining challenges, of introducing EVs to the market in quantity.⁵³ Moreover, given that a billion or so cars are already on the road and the vast majority of these are *not* EVs,⁵⁴ the chapter considers the development of liquid biofuels and “electro-fuels” capable of running internal combustion engines. Although Gates sees little environmental benefit in corn-based ethanol, he is excited by the prospect of “advanced, second-generation” biofuels produced from other crops.⁵⁵

Examining the current Green Premiums for these emerging biofuels, however, Gates shows that the incremental costs are too sizeable for widespread

46. *Id.* at 86-87.

47. GATES, *supra* note 1, at 84-94.

48. *Id.* at 130-131.

49. The acronym stands of “Organization for Economic Cooperation and Development” and includes the United States and other developed nations.

50. GATES, *supra* note 1, at 132-133.

51. *Id.* at 133.

52. *Id.* at 135.

53. *Id.* at 135-137.

54. *Id.* at 135.

55. GATES, *supra* note 1, at 138.

adoption and, hence, more investment in their development is required. As to larger vehicles, Gates distinguishes between garbage trucks and city buses – whose medium size and predictable routes lend themselves to electrification – and 18-wheelers or long-distance buses, whose size and long-haul routes do not, at least with current battery technology and charging infrastructure.⁵⁶

As to ships and airplanes, Gates’s analysis likewise shows that batteries aren’t up to the job, and the Green Premiums for alternate, low-carbon liquid fuels are too great for commercial adoption. His book calls for innovation to reduce these differentials, and floats the idea of nuclear-powered container ships, despite the conceded risks.⁵⁷

VI. MANUFACTURING AND SPACE HEATING/COOLING⁵⁸

Gates provides an extensive discussion of manufacturing processes that produce substantial amounts of GHG gas emissions – he focuses on steel, cement, and plastics to make his points – and on methods for heating and cooling buildings. While the book does not provide a deep dive into current and emerging technologies, Gates has enough to say on each of these topics to give readers a feel for the challenges and opportunities. A recurrent theme in the book is sounded loudly in the passages on manufacturing: the role of fossil fuels is pervasive, and reversing this is technically and economically daunting. However, this does not prevent Gates from suggesting innovations on the cusp of introduction or at least being contemplated in laboratories.⁵⁹

Gates’s advice is to:⁶⁰

- Electrify everything capable of being electrified in the manufacturing process;
- Make sure the electricity being employed is decarbonized;
- Deploy carbon capture technologies to remove the rest of the emissions;
- Make more efficient use of materials.

Every one of these advancements is going to require “lots of innovation,” he adds.⁶¹

On the space heating and cooling front, the Green Premium fares better, to the extent people have or will install electric heat pump equipment. Generally in the United States, this technology affords a *negative* Green Premium; in other words, its life-cycle costs are actually lower than the combination of a natural

56. *Id.* at 140-141.

57. *Id.* at 147.

58. For brevity, we will omit a discussion of agriculture and livestock rearing, a category which contributes a not inconsiderable 19% of total GHG emissions. However, it should be noted Gates applies the same comprehensive, pragmatic approach to challenges and opportunities in this as to the four other emissions categories more directly implicating the energy industry. Readers interested in climate change causes and solutions generally will find the relevant chapter, “How We Grow Things” (pp. 112-129) absorbing.

59. GATES, *supra* note 1, at 98-111.

60. *Id.* at 111.

61. *Id.*

gas furnace and electric air conditioning.⁶² However, there are two thorny problems; first, heat pumps are currently in only 11% of American homes, while half run on natural gas; and second, their environmental benefits are realized only to the extent the electric generation fleet is decarbonized.⁶³

These facts lead Gates to redouble his claim that advanced biofuels and electrofuels must be brought down to more affordable levels, so that furnaces designed to run on natural gas or fuel oil can be decarbonized.

The urgency of the issue is underscored by the accelerating deployment of air conditioning in developing countries, Gates notes. As the planet grows warmer, the growing demand for air conditioning exacerbates the problem of warming – a vicious cycle – unless the remedies outlined in the book take hold,⁶⁴

VII. EXPANDING THE ROLE OF GOVERNMENT

In a chapter dissecting the critical role of government policymaking in combatting climate change, Gates admits to a touch of hypocrisy. It may seem “ironic,” he acknowledges, that the former CEO of Microsoft, who regarded government and politics so warily and felt these forces only prevented his company “from doing our best work,” is now attesting to the need for “more government intervention.”⁶⁵ Gates offers a selective inventory of successful historic government interventions supporting his current thinking.⁶⁶

Whatever one may think of the government’s track record, Gates contends that “when it comes to massive undertakings . . . [such as] decarbonizing the global economy – we need the government to play a huge role in creating the right incentives and making sure the overall system will work for everyone.”⁶⁷ National leaders must “articulate a vision,” he argues, and “can write rules regarding how much carbon power plants, cars, and factories are allowed to emit.”⁶⁸

This may be strong stuff for readers who come at technological and economic problems from the point of view that markets are better at solving them than politicians and policy implementers, however well-intentioned. Nevertheless, *How to Avoid a Climate Crisis* makes its case by insisting that nations and the global economy are on a perilous course and that radical government intervention – characterized by well-conceived incentives as much as command-and-control measures, and crafted to catalyze private industry’s skill at product development and commercialization – is necessary to pull out of the tailspin.

Gates maintains that the energy sector (utilities in particular) has a history of underinvesting in research and development compared with other industries.⁶⁹ And given the long lead times to perfect energy innovations, as well as the con-

62. *Id.* at 154.

63. *Id.* at 154-155.

64. GATES, *supra* note 1, at 150.

65. *Id.* at 183.

66. *Id.* at 182.

67. *Id.* at 183.

68. *Id.*

69. GATES, *supra* note 1, at 184-185.

siderable risk of failures, he envisions a major role for government in funding and spurring the kind of innovation necessary to make clean energy technologies affordable and thus competitive with systems they would replace.⁷⁰

Coupled with Gates's cheerleading for investment in innovation to bring down the Green Premium is a somewhat contrary strain: Gates argues that governmental policy can "level the playing field" by imposing cost of externalities – that is, the assumed social cost of carbon to the environment – on fossil fuels or their products.⁷¹ This would reduce the "Green Premium" – by increasing the cost of what "clean" energy applications and products must compete against. Gates defends this as a strategy to "nudge producers and consumers toward more efficient decisions" while encouraging innovation.⁷² "You're a lot more likely to try to invent a new kind of electrofuel," he posits, "if you know it won't be undercut by artificially cheap gasoline."⁷³ Critics may assail this as moving the goalposts if you can't hit the field goal, but it is undeniably a policy tool governments worried about climate change are inclined to wield.

In his "Adapting to a Warmer World" chapter, Gates raises another haunting question: what if, despite all efforts, strenuous or not, we see climate change approaching dangerous levels? Should more drastic measures be employed if, as climate scientists have hypothesized, the planet reaches a "tipping point" that "could dramatically increase the rate at which climate change happens"?⁷⁴ Lest this happen, Gates advocates studying and potentially exploring "geoengineering" – meaning, the intentional release of fine particulars that would, at least in theory, deflect some of the sun, much like releases from a volcanic eruption, with cooling impact.⁷⁵ The author realizes this constitutes heresy to some environmentalists, but reveals he has been funding such studies, and submits the concepts are "worthy studying and debating while we have the [time for the] luxury of study and debate."⁷⁶

VIII. CONCLUSION

Gates tells us a "concrete plan" is badly needed to organize and orchestrate meaningful GHG emission reductions, and he offers one.⁷⁷ He cautions against today's rhetoric urging "deep decarbonization" by 2030. This is "unrealistic," in his view, given how thoroughly fossil fuels permeate and enable modern existence,⁷⁸ and could be counterproductive.

70. *Id.*

71. *Id.* at 186.

72. *Id.*

73. *Id.*

74. GATES, *supra* note 1, at 176.

75. *Id.* at 176-177.

76. *Id.*

77. *Id.* at 196-217. Gates also refers readers to the website of his green venture capital coalition for more detail. See breakthroughenergy.org.

78. *Id.*

Instead, Gates advocates adopting *policies* in the near term that would put the world on a path to deep decarbonization by 2050.⁷⁹ Some interim goals for the coming decade – *e.g.*, pushing ahead with carbon-free generation and electrifying vehicles or industrial processes – are consistent with “zero carbon” by 2050, he maintains, so long as we avoid halfway measures that could cripple the 2050 goal.⁸⁰ Now is the time, Gates says, for nations to prioritize innovation in science and engineering, in supply chains and markets, to pave the way for a net zero carbon future.⁸¹

Gates’s plan is not a treasure map – that would be too much to expect – but rather a business-oriented way of the laying the pathway. Drawing on his Microsoft experience, Gates divides the task into two main parts: expanding the *supply* of innovation, while nurturing and conditioning *demand* for it. After offering a long list of needed technologies, he prescribes a major ramp-up of public investment to pursue them and guidance on how to select priorities while forming “partnerships” with industry.⁸² The same kinds of meticulous steps, coupled with market-sensitive incentives, must be taken in preparing the demand side (*i.e.*, customers) for the uptake of “good ideas.”⁸³ And government must take a lead role in building the infrastructure so that customers may access the benefits of new technology.⁸⁴

In sum, Bill Gates has provided a determined yet realistic vision, a goldmine of facts, and an arsenal of recommendations to the indubitably complex task of confronting climate change across its many fronts. The book is surprising in its comprehensiveness and grasp of detail, while refreshing in avoiding the academic cant and the alphabet soup of acronyms that can so easily discourage non-specialist readers.⁸⁵ The diction and sentence structure are consistently plain and straightforward – especially helpful in a context involving such a myriad of technical information and concepts – occasionally accented with a dab of humor.

People who are already immersed in the science behind *How to Avoid a Climate Crisis* may disagree with some of Gates’s assertions, and energy law specialists may trip across an error or two regarding their own field; but much credit is due to Gates for rolling up his sleeves and lending his name (and a good chunk of his fortune) to assessing and, he hopes, solving an issue as perplexing

79. GATES, *supra* note 1, at 196-217.

80. *Id.* at 197.

81. *Id.* at 198.

82. *Id.* at 200-202.

83. *Id.* at 203-204.

84. GATES, *supra* note 1, at 205. The “Plan for Getting to Zero” usefully delineates the important, sometimes overlapping, roles of the federal, state, and local governments and agencies – including the Federal Energy Regulatory Commission and the public utility commissions of the several states. Here, Gates praises state coalitions that picked up the fallen banner of the Paris accords, after President Trump withdrew the U.S. *See id.* at 210-214.

85. The reader may feel baffled how one person, especially someone whose early-to-middle career has been spent in other complex fields, can pull together such an informative and lucid work. At the end, in an “Acknowledgements” section, one learns that Gates has levered the work of many advisers, researchers, and a “writing partner,” Josh Daniel, to accomplish his mission.

as any facing mankind in the 21st century. As an entry-level guide to the morass of information, predictions, and political hurdles surrounding climate change, it is ideal.