

A CRITICAL LOOK AT "THE MORAL CASE FOR FOSSIL FUELS"

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Synopsis: This article provides a critical review of Alex Epstein's provocative book, *The Moral Case for Fossil Fuels*, which offers a robust defense of the fossil energy industry and a stinging rebuke to those who would advocate shifting to a cleaner global energy supply. Epstein argues that fossil energy has been the main driver of human flourishing historically and that it is uniquely capable of continuing to support human flourishing in perpetuity, making it the morally preferable global energy choice for the future. Epstein makes numerous highly controversial claims about science, technology, risk, cost, and morality. He argues or implies, among other things, that renewable energy has virtually no potential to supplement or compete with fossil energy; that environmentalists care more about nature than people; that climate change is entirely manageable without curbing fossil fuel use; that the costs of fossil energy are vastly overstated and the benefits badly understated; and that favoring cleaner energy amounts to opposing the developed world. This article carefully examines Epstein's main arguments, assessing their persuasiveness in light of both logic and the best evidence available. It provides many examples of instances in which Epstein selectively relies on evidence that supports his worldview; presents false, incomplete, or misleading data; mischaracterizes his opponents' claims; and dismisses or ignores serious and substantive counter-arguments. The article disputes Epstein's central claim that because fossil energy has delivered enormous social benefits in the past, there is absolutely no reason to change course and diversify our energy supply in the future.

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I. INTRODUCTION

Many insiders in the oil and gas industry have warmly received Alex Epstein's book, *The Moral Case for Fossil Fuels*, which argues, as its title suggests, that the industry has gotten a bum rap. Epstein's central claim is that fossil energy has been the principal driver of human flourishing, and remains the only source of energy that can ensure our quality of life going forward. Fossil fuels are far more abundant, cheap, and reliable than any other source of energy, he argues, and nothing can rival their advantages. Moreover, according to Epstein, there is no good reason to change course. Contrary to what many so-called experts have claimed, he says there are no significant downsides to continuing to rely so heavily on fossil energy. Public health has in fact improved as fossil fuel consumption has increased, and will continue to do so, he claims. Climate change, in Epstein's view, is entirely manageable, if it poses any risk at all.[1] Epstein faults environmentalists, thought leaders, and public officials for overstating the costs and understating the benefits of fossil energy, and for unfairly vilifying energy companies. In rebuttal to what he views as their highly skewed portrayal, Epstein's book "explains why humanity's use of fossil fuels is actually a healthy, moral choice."[2]

Reviews in the *Wall Street Journal*, the *National Review*, and other conservative outlets have heaped praise upon Epstein's book, calling it, "a full-throated defense of . . . the American way of life"[3] and a "powerful, systematic, and relentlessly logical philosophical case for the moral value of the fossil-fuel industry, and the fundamentally immoral basis of the movement that is seeking to demonize and destroy it."[4]

Scientists and environmentalists who know of Epstein's book are likely to shrug it off as a polemic. Yet it would be a mistake to dismiss Epstein's book simply because it is partisan. *The Moral Case for Fossil Fuels* has struck a chord with many in the oil and gas community who feel underappreciated—and they deserve a serious response.

Fossil energy has indisputably delivered enormous benefits to society. Industrialization, fueled largely by coal, gas, and oil, has indeed brought with it advances in health, higher standards of living, and tremendous social progress (even if not every ounce of that progress can be attributed directly to fossil energy). And we continue to be hugely dependent on the fossil fuel industry for our quality of life. Much of the developed world relies predominantly on fossil fuels for transportation, and in the production of food, clothing, and many other goods and services. Countries like China, India, Brazil, and South Africa have fueled their

1. Indeed, "Every climate model based on CO2 as a major climate driver," Epstein says, "has been a failure." ALEX EPSTEIN, THE MORAL CASE FOR FOSSIL FUELS 103 (2014).

2. Fossil energy allows us to "transform the world around us into a place that is far safer from any health hazards (man-made or natural), far safer from any climate change (man-made or natural), and far richer in resources now and in the future." *Id.* at 33–34.

3. Philip Delves Broughton, *Making* '*The Moral Case for Fossil Fuels*,' WALL ST. J. (Dec. 1, 2014, 6:51 PM), http://www.wsj.com/articles/book-review-the-moral-case-for-fossil-fuels-by-alex-epstein-1417477909.

4. Robert Zubrin, *Fossil Fuels and Morality*, NAT'L REV. (Nov. 12, 2014, 4:00 AM), http://www.nationalreview.com/article/392503/fossil-fuels-and-morality-robert-zubrin.

rise overwhelmingly with fossil energy, and the ensuing economic growth has lifted millions of people out of poverty.[5]

Moreover, Epstein is quite right that we will not be running out of fossil fuels anytime soon.[6] The "shale revolution," which was enabled by hydraulic fracturing and horizontal drilling, has rendered billions of barrels of oil and trillions of cubic feet of natural gas once thought inaccessible economically recoverable.[7] As a result, the United States is poised, barring major price swings, to become a net energy exporter for the first time since the 1950s.[8] These developments only underscore that the oil and gas industry is among the most creative and technically proficient industries in the world.

Yet as many members of the oil and gas community know, the industry does not seem to reap the full reputational benefits of this technological preeminence. And perhaps Epstein would say that this has something to do with what he believes are unfounded attacks by fossil energy's opponents. Apple, Google, and General Electric are among the world's most admired companies, but not ExxonMobil.[9] A 2014 survey, published in the *Harvard Business Review*, shows that college graduates most prize jobs at technology companies, consulting firms, and entertainment giants, but not in coal, or oil and gas.[10] Not a single major fossil fuel company appears on *Fortune*'s list of the best 100 places to work.[11] To those who are exasperated by this state of affairs, Epstein's book no doubt feels like a breath of fresh air.

Still, it is incumbent on even sympathetic readers to ask whether Epstein's arguments are tenable. Is it true that, since fossil energy has been a central driver

5. *See generally* U.N. INDUS. DEV. ORG., STRUCTURAL CHANGE, POVERTY REDUCTION AND INDUSTRIAL POLICY IN THE BRICS (2012), http://www10.iadb.org/intal/intalcdi/PE/2013/10846.pdf (attributing the economic rise of BRIC nations and resultant poverty reduction in part to increased manufacturing and noting that manufacturing industry is largest energy user); *see also* Tong Wu, *China, BRICs, and the Environment*, THE DIPLOMAT (Nov. 7, 2011), http://thediplomat.com/2011/11/china-brics-and-the-environment/ ("The rapid rise of the BRIC economies has been driven by a breakneck pace of industrialization. . . . Like the modernization of Europe and the United States during the 19th century, economic development in Brazil, India, and China has been powered by the prodigious use of fossil fuels."); Li Minqi, *Peak Energy and the Limits to Economic Growth: China and the World*, *in* THE RISE OF CHINA AND THE CAPITALIST WORLD ORDER 118–20 (ed. Li Xing 2010) ("China's economic growth has been heavily energy intensive and arguably the single most important factor behind the rapid growth of global energy demand and greenhouse gases emission in recent years. . . . From 1980 to 2007, China's energy consumption more than quadrupled and grew at an average annual rate of 5.6%. During the same period, China's GDP grew at an average annual rate of 10 percent. . . . China is now the world's second largest consumer [of oil].").

6. *U.S. Crude Oil and Natural Gas Proved Reserves, 2013*, U.S. ENERGY INFO. ADMIN. (Dec. 4, 2014), http://www.eia.gov/naturalgas/crudeoilreserves/.

7. James McBride & Mohammed Aly Sergy, *Hydraulic Fracturing (Fracking)*, COUNCIL ON FOREIGN RELATIONS (June, 10, 2015), http://www.cfr.org/energy-and-environment/hydraulic-fracturing-fracking/p31559.

8. *U.S. Energy Imports and Exports to come into Balance for First Time since 1950s*, U.S. ENERGY INFO. ADMIN. (Apr. 15, 2015), http://www.eia.gov/todayinenergy/detail.cfm?id=20812 (projecting that U.S. energy imports and exports will come into balance starting in 2028).

9. Karl Utermohlen, *Fortune: 10 Most Admired Companies in the World 2015*, INVESTORPLACE (Mar. 3, 2015, 1:13 PM), http://investorplace.com/2015/03/most-admired-companies/#.VZr2oKYmA-8.

10. Sanjeev Agrawal, *How Companies Can Attract the Best College Talent*, HARV. BUS. REV. (Mar. 17, 2014), https://hbr.org/2014/03/how-companies-can-attract-the-best-college-talent/.

11. *100 Best Companies to Work For*, FORTUNE, http://fortune.com/best-companies/ (last visited July 13, 2015). NuStar Energy, a pipeline and terminal company, does however rank as number 18.

of economic growth and prosperity in the past, it is the healthy and moral choice for the future? Is it correct, as Epstein claims, that experts have systematically overstated the costs of fossil fuels and understated their benefits? Are the climate models all complete failures? Do environmentalists care more about preserving a pristine natural environment than they do about protecting human health and welfare? And is it right that other forms of energy could not deliver the kind of prosperity to which we have become accustomed? This article asks whether these claims of Epstein's are defensible when one looks closely at their internal logic and tests them against the available evidence.

A. Is the Past Prologue?

One of Epstein's main themes is that society does not adequately credit fossil fuel companies for the many benefits they have provided.[12] Fossil energy has what Epstein calls, "a special place in human productivity, prosperity, and progress."[13] It is the "master industry"[14] because it supports all other industries, including agriculture, health care, and pharmaceuticals. Energy is, he declares, "a great enabler of happiness."[15] Indeed, rather than "condemn" fossil fuel companies "as evil,"[16] we should apologize to them[17] and express gratitude "for industrial civilization."[18] Moreover, fossil energy should continue to be the energy of choice for the future because its benefits overwhelmingly outweigh its costs. No other fuel can ever be as plentiful, reliable, and cheap as fossil energy, according to Epstein, and none can promise to deliver anything close to the same degree of net human benefit.[19]

There are two arguments here that require separation: the claim about the past and the one about the future. It is entirely possible to agree that fossil energy has delivered enormous social benefits historically and yet reasonably ask whether the costs and risks associated with *continued* dependence on fossil fuels are so great that it makes sense now to shift to a cleaner energy supply. Indeed, many people, including most environmentalists, would immediately acknowledge that fossil energy has been a powerful engine of economic growth. The question, however, is whether to change course, and how, going forward.

The answer to this question must turn in part on the potential to develop alternative fuels that will sustain human welfare acceptably well—alternatives that can be deployed at a scale, over time, which can *effectively* substitute for fossil energy. Epstein is indisputably correct that global society requires vast amounts

12. EPSTEIN, *supra* note 1, at 125, 135-36, 140, 169, 198, 201.

13. *Id.* at 84.

14. *Id.*

15. *Id.*

16. *Id.* at 135.

17. EPSTEIN, *supra* note 1, at 136 ("I believe that we owe the fossil fuel industry an apology. While the industry has been producing the energy to make our climate more livable, we have treated it as a villain. We owe it the kind of gratitude that we owe anyone who makes our lives much, much better.").

18. *Id.* at 135.

19. *Id.* at 88 ("Fossil fuel energy is, for the foreseeable future, necessary to life. The more of it we produce, the more people will have the ability to improve their lives. The less of it we produce, the more preventable suffering and death will exist. To not use fossil fuels, therefore, is beyond a risk—it is certain mortal peril for mankind.").

of energy. But does that inevitably mean that the supply must be primarily fossil energy in perpetuity? Epstein sees no reason to pursue a different path for two primary reasons: (1) he believes there are no viable substitutes, and (2) he sees no significant downsides to fossil fuels. His message in a nutshell is that there is absolutely no reason to do anything different.

B. Are Alternative Energy Sources Non-Starters?

Epstein claims that wind, solar, and biomass are not sufficiently reliable, cost-effective, and scalable sources of energy to sustain economic growth.[20] As a result, he argues, pursuing alternative energy sources—even as a mere supplement to fossil fuels— would jeopardize our quality of life.[21] But this bleak assessment runs counter to recent studies—which Epstein never considers or acknowledges, even though many were published prior to his book—showing that such sources are contributing significantly in certain areas today, and if invested in over time, can play a substantial role in meeting national and global demand.

Contrary to Epstein's argument that renewable energy sources cannot even meaningfully "supplement" fossil energy, in many jurisdictions around the world, they already do.[22] For example, Germany has satisfied close to 30% of its annual electricity consumption with renewable energy.[23] Brazil has long relied on hydro for electricity[24] and sugar ethanol for transportation fuel.[25] Costa Rica has often turned to hydroelectricity instead of fossil fuels,[26] and Iceland has, for many years, obtained most of its electricity from hydro and geothermal sources.[27] This just shows that where such sources of energy are available, they can be put to use.

Some regions of the United States already rely to a meaningful extent on renewable sources of energy. For example, in 2014, California procured 25% of

20. *Id.* at 46–57.

21. *Id.* at 87–88.

22. EPSTEIN, *supra* note 1, at 57.

23. Dr. Bruno Burger, *Power Generation from Renewable Energy in Germany—Assessment of First Half of 2015*, FRAUNHOFER ISE 3 (Aug. 19, 2015), https://www.ise.fraunhofer.de/en/downloads-englisch/pdf-files-englisch/data-nivc-/power-generation-from-renewable-energy-in-germany-assessment-of-first-half-of-2015.pdf; *Germany: Electricity and Heat for 2012*, INT'L ENERGY AGENCY, http://www.iea.org/statistics/statisticssearch/report/?country=GERMANY=&product=electricityandheat&year=Select.

24. *See generally* Antonio Carlos Caetano de Souza, *Assessment and Statistics of Brazilian Hydroelectric Power Plants: Dam Areas Versus Installed and Firm Power*, 12 RENEWABLE & SUSTAINABLE ENERGY REV. 1843 (2008), *available at* http://www.sciencedirect.com/science/article/pii/S1364032107000536 (abstract).

25. Dr. Robert Wisner, *Brazil Ethanol Developments & Implications for the U.S. Ethanol Industry*, AGRIC. MARKETING RESOURCE CTR. (Oct. 2012), http://www.agmrc.org/renewable_energy/ethanol/brazil-ethanol-developments—implications-for-the-us-ethanol-industry/.

26. *See generally* Elizabeth P. Anderson et al., *Transforming Tropical Rivers: An Environmental Perspective on Hydropower Development in Costa Rica*, 16 AQUATIC CONSERVATION: MARINE & FRESHWATER ECOSYSTEMS 679 (2006), http://www.researchgate.net/publication/230261607_Transforming_tropical_rivers_An_environmental_perspective_on_hydropower_development_in_Costa_Rica.

27. *Power Under the Sea*, ECONOMIST (Jan. 20, 2014, 9:05 PM), http://www.economist.com/blogs/schumpeter/2014/01/icelandic-electricity ("Iceland is in a unique position with regard to energy: it has in effect unlimited power, both geothermal and hydroelectric.").

its electricity from renewables,[28] while Texas drew 10.6% of its electricity from wind alone.[29] Going forward, we can expect these numbers to grow substantially. Many states have implemented aggressive renewable portfolio standards by which they require their electricity suppliers to secure a minimum quantity of renewable electricity. California recently enacted a 50% requirement by 2030, Vermont adopted a 75% mandate by 2032 and Hawaii committed to 100% renewables mandate by 2045.[30]

Moreover, studies show that the modern grid can accommodate a substantial amount of intermittent renewables, contrary to suggestions otherwise. A recent analysis by General Electric Energy Consulting concluded that the PJM grid system—a regional transmission organization that coordinates the movement of wholesale electricity in 13 states and the District of Columbia—"will not have any significant issues operating with up to 30% of its energy provided by wind and solar generation," so long as there is "adequate transmission expansion and additional regulating reserves."[31] Likewise, a Department of Energy study found that it is both "viable and economically compelling" for wind to supply 10% of national end-use electricity demand by 2020, 20% by 2030, and 35% by 2050.[32]

It is true that, in the United States, solar and wind energy can cost more per kilowatt-hour than fossil fuel-fired power. But fossil fuels are at a much more mature stage of development, and the price of renewable energy already has come down over time with greater investment and innovation.[33] Onshore wind and solar power, for example, continue to make progress toward greater price parity with electricity generated by conventional fossil sources like coal.[34] At a minimum, the relative price of renewable and fossil energy depends on location, a nuance

28. *Total System Power*, CA.GOV, http://energyalmanac.ca.gov/electricity/total_system_power.html (last updated Sept. 10, 2015); California Energy Comm'n, *Tracking Progress: Renewable Energy*, CA.GOV, http://energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf (last updated Sept. 3, 2015).

29. *2014 Total Energy Use in ERCOT Region Up by 2.5 Percent from 2013*, ELECTRIC RELIABILITY COUNCIL OF TEXAS (Jan. 22, 2015), http://www.ercot.com/news/press_releases/show/51654.

30. Michael R. Blood & Judy Lin, *California Wants Renewable Energy for Half Its Power by 2030*, THE BIG STORY (Oct. 8, 2015, 3:31 AM), http://bigstory.ap.org/article/6b461f2dfe4046d9bd32ecb70d27f0dd/california-wants-renewable-energy-half-its-power-2030; *see also Hawaii and Vermont Set High Renewable Portfolio Standard Targets*, U.S. ENERGY INFO. ADMIN. (June 29, 2015), http://www.eia.gov/todayinenergy/detail.cfm?id=21852.

31. GE ENERGY CONSULTING, PJM RENEWABLE INTEGRATION STUDY: EXECUTIVE SUMMARY REPORT 6-7 (Feb. 28, 2014), https://www.pjm.com/~/media/committees-groups/committees/mic/20140303/20140303-pris-executive-summary.ashx.

32. U.S. DEP'T OF ENERGY, WIND VISION: A NEW ERA FOR WIND POWER IN THE UNITED STATES xxiv (Mar. 12, 2015), http://energy.gov/sites/prod/files/WindVision_Report_final.pdf.

33. For solar prices tracked over time, see generally GALEN L. BARBOSE ET AL., LAWRENCE BERKELEY NAT'L LAB., TRACKING THE SUN VII: AN HISTORICAL SUMMARY OF THE INSTALLED PRICE OF PHOTOVOLTAICS IN THE UNITED STATES FROM 1998-2013 (2014), http://emp.lbl.gov/publications/tracking-sun-vii-historical-summary-installed-price-photovoltaics-united-states-1998-20; for wind prices, *see also* U.S. DEP'T OF ENERGY, 2014 WIND TECHNOLOGIES MARKET REPORT 48, 53, 56–59 (2014), http://energy.gov/sites/prod/files/2015/08/f25/2014-Wind-Technologies-Market-Report-8.7.pdf.

34. For a comparison of the levelized cost of electricity from different types of new generation, see generally U.S. ENERGY INFO. ADMIN., LEVELIZED COST AND LEVELIZED AVOIDED COST OF NEW GENERATION RESOURCES IN THE ANNUAL ENERGY OUTLOOK 2015, (Apr. 14, 2015), http://www.eia.gov/forecasts/aeo/electricity_generation.cfm.

Epstein simply ignores.[35] It is common sense, for instance, that for a population with plentiful sunshine, not located near a coal, gas, or oil supply, solar could be the cheapest energy option.

Perhaps most importantly, prices for renewable energy, particularly solar power, are falling so fast that comparisons with fossil fuels become rapidly out of date. Since 2009, installation costs for utility, residential and commercial-scale solar have fallen 50%, with recent annual declines of about 10% per year for residential systems and 20% per year for commercial systems.[36] Prices have fallen to such an extent that in some markets—such as Arizona, California, and New Mexico—solar providers are selling electricity to utilities at prices below what fuel alone would cost at a natural gas-fired power plant.[37] And notably, many solar power plants are entering markets that do not have renewable portfolio standards—such as Georgia, Alabama, and Arkansas.[38]

Yet even if renewable energy continued to be somewhat more costly than fossil fuels in most markets, the relevant question is whether the price difference would be worth paying given the benefits. And that calculation depends on what value ought to be placed on avoided public health risk and environmental harm, including mitigation of climate change risk through reduced emissions of greenhouse gases. There are doubtless a number of ways to make such a calculation. But Epstein refuses even to engage in such an analysis, asserting with no credible basis that renewable energy could *never* be worthwhile.

Likewise, Epstein ignores the potential for energy efficiency to help reduce fossil energy demand, despite the fact that this resource meets all of his criteria by being plentiful, cheap, and reliable.[39] Estimates show that energy efficiency could play a much greater role in reducing fossil fuel consumption economy-wide without compromising our way of life as Epstein fears,[40] and that any up-front investments would be recouped by even greater savings.[41] Epstein is also

35. Unsurprisingly, Hawaii—where the cost of fossil fuels is extremely high—has recently passed legislation setting a target of 100% renewable electricity by 2045. *Hawaii and Vermont Set High Renewable Portfolio Standard Targets*, U.S. ENERGY INFO. ADMIN. (June 29, 2015), http://www.eia.gov/todayinenergy/detail.cfm?id=21852.

36. MARK BOLINGER & JOACHIM SEEL, LAWRENCE BERKELEY NAT'L LAB., UTILITY-SCALE SOLAR 2014, at i (2015); GALEN BARBOSE & NAIM DARGHOUTH, LAWRENCE BERKELEY NAT'L LAB., TRACKING THE SUN VIII: THE INSTALLED PRICE OF RESIDENTIAL AND NON-RESIDENTIAL PHOTOVOLTAIC SYSTEMS IN THE UNITED STATES 15 (2015).

37. BOLINGER & SEEL, *supra* note 35, at 35.

38. *Id.* at 37.

39. Hannah Choi Granade et al., *Unlocking Energy Efficiency in the U.S. Economy*, MCKINSEY & COMPANY, at iii (July 2009), http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy ("Energy efficiency offers a vast, low-cost energy resource for the U.S. economy—but only if the nation can craft a comprehensive and innovative approach to unlock it.").

40. *Id.* at 4 (study that "[a]ssumed no material change in consumer utility or lifestyle preferences" concluded that energy efficiency could "produce energy savings that double upfront investment on an economy wide basis.").

41. Numerous studies show the potential for investments in energy efficiency to yield significant savings while providing the same level of service or functionality. *See generally* HARVEY MICHAELS, MIT ENERGY EFFICIENCY STRATEGY PROJECT, PATHWAYS TO ENERGY EFFICIENCY AT GREATER SCALE IN MULTIFAMILY HOUSING (AUG. 2013), http://web.mit.edu/energy-efficiency/docs/EESP_Michaels_PathwaysInMultiFamilyHousing.pdf (proposing innovations that would

surprisingly dismissive of the possibility that technological innovation and human ingenuity will produce alternatives to fossil energy in coming decades. This pessimism seems plainly inconsistent with his faith that technology will, at the same time, ensure an endless supply of fossil fuels and allow us to effectively and perpetually remediate climate change.[42] It is hard to see, logically, how he can have it both ways.[43]

Nevertheless, Epstein reasons that because most countries *currently* do not derive much energy from renewable sources, they will *never* be able to do so.[44] The conclusion simply does not follow from the premise. Growth in renewable energy production is accelerating, and, on a percentage basis, renewables are the fastest growing source of power globally.[45] The numbers on an absolute basis are unquestionably still small, but they will not remain static. Epstein's argument fails to recognize the obvious: most countries are still in the process of building and developing the infrastructure necessary to derive power from renewable energy sources.[46] Compared to the fossil fuel industry, we are still in the relatively early days of renewable energy technology.

Perhaps most importantly, no one is suggesting that a transition to more renewable energy could occur without a long period of still-substantial dependence on "bridge fuels" like natural gas. Epstein repeatedly suggests that environmentalists and scientists would shut off traditional fossil sources as if turning off the lights, before ensuring that the substitutes would work.[47] This is nonsense. If Epstein had made the more nuanced argument that no *single* source of alternative energy could *immediately* supplant coal, natural gas, and oil without modern industrialized life grinding to a halt, it would be impossible to disagree. Yet it is entirely conceivable that some combination of zero or lower-carbon sources of energy could, over time, replace a substantial share of fossil energy without reducing our quality of life, and perhaps might even improve it.

Moreover, shifting to renewable energy sources does not necessarily require lowering energy consumption. Nor is there reason to think that reconfiguring the energy supply must necessarily mean less growth or human prosperity.[48] Some

dramatically increase the scale of efficiency upgrades in multifamily buildings while simultaneously reducing program costs for utility efficiency programs, when compared to the level of energy savings achieved).

42. EPSTEIN, *supra* note 1, at 179-80 (arguing that, through human ingenuity, we will always be able to extract fossil fuels from the earth, and, therefore, our reliance on fossil fuels is sustainable).

43. *Id.* at 142, 153-54, 157-58.

44. *Id.* at 48.

45. INT'L ENERGY AGENCY, RENEWABLE ENERGY MEDIUM-TERM MARKET REPORT 2013 3, http://www.iea.org/textbase/npsum/mtrenew2013sum.pdf ("As global renewable electricity generation expands in absolute terms, it is expected to surpass that from natural gas and double that from nuclear power by 2016, becoming the second most important global electricity source, after coal. Globally, renewable generation is estimated to rise to 25% of gross power generation in 2018, up from 20% in 2011 as deployment spreads out globally.").

46. Even Germany, a world leader in renewable energy, is still in the beginning stages of its energy transformation, which it does not expect to be complete until 2050. Kiley Kroh, *Germany Sets New Record, Generating 74 Percent of Power Needs from Renewable Energy*, CLIMATE PROGRESS (May 13, 2014, 11:16 AM), http://thinkprogress.org/climate/2014/05/13/3436923/germany-energy-records/.

47. EPSTEIN, *supra* note 1, at 54, 55, 194-95.

48. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FIFTH ASSESSMENT REPORT ON CLIMATE CHANGE: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS 22 (2014),

scientists have estimated that, with strategic investment, the world could transition to a zero-carbon economy in less than a century, by, among other things, decoupling transportation from fossil fuel use,[49] and that this could be done at a cost of less than two percent of GDP over the entire period.[50] That would mean losing just two years of growth over a one-hundred-year time span in order to greatly enhance the wellbeing and safety of future generations.

The point is that renewable energy sources, including the intermittent sources that Epstein especially disdains, together with energy efficiency, have far more potential than Epstein claims, since he argues they are *inherently* incapable of meeting demand[51]—which is surely not the case. Energy transitions take time.[52] There is no doubt that solar, wind, and other forms of renewable energy *work* in the engineering sense that they can generate electric power. Nor is there any doubt that electricity and biofuels, or some combination, can substitute for petroleum in the transportation sector (because even if only to a very small extent, they already do). The hard questions—and they are hard—have to do with cost, scale, infrastructure, and storage, but these are all surmountable challenges providing one has what Epstein claims he has, which is faith in technology and ingenuity. Many energy policy experts (not just environmentalists) would argue, for example, that a breakthrough in energy storage making intermittent sources more reliable would be a game-changer, fundamentally altering the economics of wind and solar energy.[53] Still, Epstein is right that investing heavily in these sources

http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf ("Mitigation strategies, when associated with non-climate policies at all government levels, can help decouple transport GHG emissions from economic growth in all regions.") [hereinafter FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS]; David Keith, *Dangerous Abundance*, *in* CARBON SHIFT: HOW THE TWIN CRISES OF OIL DEPLETION AND CLIMATE CHANGE WILL DEFINE THE FUTURE 13 (Thomas Homer-Dixon & Nick Garrison eds. 2009), *available at* http://keith.seas.harvard.edu/papers/114.Keith.Dangerous.Abundance.e.pdf ("Cutting carbon emissions need not, therefore, mean cutting energy use. Indeed, one can imagine futures where emissions are cut and energy use accelerates. Decoupling energy from carbon means either switching to non-carbon energy sources such as solar, wind, biomass and nuclear power, or finding ways to use fossil energy reserves without leaving the carbon in the atmosphere by capturing carbon dioxide from energy transformations and disposing of it safely underground.").

49. Keith, *supra* note 47, at 16.

50. *Id.* (comparing 2% of GDP to the amount we spend on the military, and noting that it is much less than we spend on healthcare or education); *see also* FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47, at 15 (estimating aggregate consumption costs of mitigation of climate change as between 1% and 11% over a century).

51. EPSTEIN, supra note 1, at 57 ("There is zero evidence that solar, wind, and biomass energy can meaningfully *supplement* fossil fuel energy, let alone replace it, let alone provide the energy *growth* that is desperately needed.").

52. Vaclav Smil, *Energy Transitions*, WORLD ECON. FORUM, http://www.vaclavsmil.com/wp-content/uploads/WEF_EN_IndustryVision-12.pdf (last visited July 22, 2015) ("Energy transitions are not sudden revolutionary advances that follow periods of prolonged stagnation, but rather continuously unfolding processes that gradually change the composition of sources used to generate heat, motion and light.").

53. Daniel Yergin, *Daniel Yergin on the Next Energy Revolution*, MCKINSEY QUARTERLY (April 2014), http://www.mckinsey.com/insights/energy_resources_materials/daniel_yergin_on_the_next_energy_revolution ("Another big area is electricity storage. If there's a holy grail out there these days, it's storage, because innovations in electricity storage would change the economics of wind and solar power."); *see also* Jon R. Luma, *The Challenge for Green Energy: How to Store Excess Electricity*, YALE ENV'T 360 (July 13, 2009), http://e360.yale.edu/feature/the_challenge_for_green_energy_how_to_store_excess_electricity/2170/ ("[W]ith grid parity [for wind and solar] now looming, finding ways to store millions of watts of excess electricity for times when the wind doesn't blow and the sun doesn't shine is the new Holy Grail.").

will never happen unless society believes that the benefits of shifting to a greater share of renewable energy are worth the costs.

C. Is There Reason to Doubt Climate Change Science?

Clearly Epstein sees no need for such a shift because in his account, fossil energy has no significant downsides. He dismisses climate change as a reason to curtail fossil fuel use, for example, declaring every climate model to be a "complete failure."[54] In Epstein's telling, the world has experienced only a mild surface temperature increase, and even that, he says, has leveled off in recent years.[55] Since there is no persuasive evidence that any warming effect is associated with greenhouse gas concentrations in the atmosphere, Epstein claims there is no basis to believe predictions about likely warming in the future.[56]

It is important to pause and carefully scrutinize these arguments because Epstein's perspective on climate science is so central to the book's larger argument that production and consumption of fossil energy is a moral imperative. First, it is striking that, in a breezy few pages, Epstein summarily dismisses a voluminous body of scientific evidence.[57] And even his short treatment of the science handles the evidence shoddily. Consider, for example, his use of two Tables to make the point that climate models are all failures. The first one depicts an older climate model designed by James Hansen (the former NASA scientist who is an outspoken advocate for reducing fossil fuel dependence), which Epstein says shows a noticeable gap between what Hansen predicted and what the temperature has done. The implication is that this gap proves the model is worthless. But the difference between the model's projections and the earth's temperature over the ten-year period Epstein isolates do not reveal Hansen's model to be a failure, let alone imply that all models are poor, because a single decade is simply too short a time

54. EPSTEIN, *supra* note 1, at 104. Scientists, he says, "cannot predict climate" and have "deliberately tried to manipulate us into equating the greenhouse effect with the predictions of [their] invalid computer models." This is "unethical" but unfortunately, "rampant." *Id.* at 108.

55. *Id.* at 105.

56. *Id.* at 98–99, 101–02.

57. *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 40 (2014), http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf ("Human influence on the climate system is clear. . . . Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.") [hereinafter FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT]; THE NAT'L RESEARCH COUNCIL, AMERICA'S CLIMATE CHOICES 1 (Nat'l Acad. of Sci. 2011), http://dels.nas.edu/Report/Americas-Climate-Choices/12781 ("Climate change is occurring, is very likely caused primarily by the emission of greenhouse gases from human activities, and poses significant risks for a range of human and natural systems."); *Observed Change*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/report/our-changing-climate/observed-change (last visited Sept. 26, 2015) ("Global climate is changing . . . [and] the global warming of the past 50 years is primarily due to human activities."); U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES 9 (2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf ("Observations show that warming of the climate is unequivocal."); *Climate and Security 101: Why the U.S. National Security Establishment Takes Climate Change Seriously*, THE CENTER FOR CLIMATE & SEC. (last visited Sept. 26, 2015), http://climateandsecurity.org/2012/04/25/climate-and-security-101-why-the-u-s-national-security-establishment-takes-climate-change-seriously/ (last visited Sept. 26, 2015) ("[C]limate change is a national security threat.").

period on which to base conclusions about long-term climate trends.[58] It is, in fact, fairly common to see relatively short-term variations in temperature data, including flattening, or even cooling periods, that might seem to contradict the warming thesis if viewed in isolation. But these short periods shrink to insignificance when viewed against the clear and consistent upward temperature trend over a longer period of time.[59] Epstein conspicuously fails to show a readily available chart of this longer-term trend,[60] which at least would have put Hansen's model in context. Nor does he refer to models of more recent vintage that have improved upon Hansen's model, which would have been the more intellectually honest thing to do.[61]

The second Table Epstein invokes purports to show a record of the earth's temperature over time, which he again uses to show that climate models don't work. But his argument is glaringly misleading because this Table does not concern the average temperature at the surface of the earth. The Table that Epstein relies on is instead about temperatures in the *atmosphere*, at altitudes above the earth's surface, which is viewed by scientists as far more unreliable than temperature records of surface temperature.[62] To claim to show one thing and actually show another displays carelessness at best, and disrespect for the audience at worst.

Having dispensed with the scientific consensus in this way, Epstein summarizes what he says has "actually happened" to the climate, an account with

58. No model is perfectly predictive, which all scientists would acknowledge, because models necessarily simplify complex phenomena. Still, they can be valuable in one of at least three ways: for sensitivity tests, to determine how adjusting certain factors can influence outcomes; for projection, to predict what will happen in the future; or for hindcasting, to see how well a model predicted events that already have occurred in the past. *See generally* Naomi Oreskes et al., *Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences*, 263 SCIENCE 641 (1994), *available at* http://www.nssl.noaa.gov/users/brooks/public_html/feda/papers/Oreskes1.pdf.

59. Indeed, a short-term variation of ten, fifteen, or even thirty years could be explained by any number of factors that might affect the earth's temperature *in the short term*, including natural events like El Nino weather patterns, or human ones like intensive sulfur production from short-term upswings in coal burning. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 2 ("Due to . . . natural variability, trends based on short records are very sensitive to the beginning and end dates and do not in general reflect long-term climate trends."). To draw from one ten-year period of temperature flattening the conclusion *that all climate models are utter failures* is just not credible. *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, WORKING GROUP I, FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS 7 (2013), http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf [hereinafter FIFTH ASSESSMENT REPORT: THE PHYSICAL SCIENCE BASIS].

60. For example, the IPCC published such a chart in 2007. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FOURTH ASSESSMENT REPORT ON CLIMATE CHANGE: THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS Fig. SPM.3.1 (2007), https://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-3-1-figure-1.html; *see also* Press Release, *Warming Trend Continues in 2014*, WORLD METEOROLOGICAL ORG. (Feb. 2, 2015), https://www.wmo.int/media/?q=content/warming-trend-continues-2014.

61. *See e.g.*, Gerald A. Meehl, et al., *Climate Model Simulations of the Observed Early-2000s Hiatus of Global Warming*, 4 NATURE CLIMATE CHANGE 898 (2014). A recent study claims to have debunked the thesis that there has been a hiatus from warming in this century. *See generally* Balat Rajaratram et al., *Debunking the Climate Hiatus*, CLIMATIC CHANGE, (Sept. 17, 2015), http://link.springer.com/article/10.1007/s10584-015-1495-y (showing that hiatus theory lacks a reliable statistical foundation).

62. Dennis L. Hartmann et al., *Observations: Atmosphere and Surface*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE IPCC 159, 187-89 (Stocker, T.F. et al. eds., 2013).

which, he says, nearly every climate scientist would have to agree. But they would not agree because his summary does not reflect the scientific record. For example, Epstein claims that surface temperature increases like the warming observed since industrialization have happened many times in history. But what the record actually shows contradicts him: during warm periods, including at least two thousand years before industrialization, global temperature does not appear to have undergone changes as large and rapid as the current warming. And this is important because it is the pace and scale of the current warming that so worries scientists.[63]

Moreover, the models Epstein dismisses as "failures," have actually performed well. When scientists compare what the models show with what actually happened (a process they call hindcasting), the models match reality: global surface temperature rise tracks the rise in atmospheric greenhouse gas concentrations over the same period, both in the observed world and according to the models.[64] Importantly, there is no explanation for this temperature rise *other* than greenhouse gases—that is, if you eliminate them as a driver from the model, the observed temperature effect freezes. And the models track not only what has happened to global temperature rise, but also nicely mirror what temperatures have done regionally on each continent. Moreover, Epstein's claim that the climate is *not* sensitive to CO_2 concentrations is contradicted by both the climate models and physical data about past climates, which scientists have collected from a variety of sources, including CO_2 concentrations found in ice cores and sedimentary data on the ocean floor.[65] Epstein brushes off the models, and never discusses any of the physical evidence.

At this point, a reader might be tempted to throw up their hands and say, "Well, I am not an expert and this is getting complicated and I choose to believe Epstein." But one does not need to be a scientist to see that Epstein has selectively used sources that favor his worldview, and in doing so has been highly misleading. The bottom line is that there is a robust response to each of his claims, yet he fails even to acknowledge the counter-arguments, let alone engage them. To present evidence so partially is a sin by his own standards, so it is all the more surprising that he repeatedly commits it.[66]

Putting climate models aside, Epstein's claim that the world has not experienced warming at all puts him in a very small group of outliers, and is demonstrably wrong on the facts. According to the UN World Meteorological Organization, fourteen of the fifteen hottest years on record have occurred since

63. Valérie Masson-Delmotte et al., *Information from Paleoclimate Archives*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE IPCC 383, 409 (Stocker, T.F. et al. eds., 2013).

64. This result is shown once studies take other variables into account like the thermal inertia of the ocean. *See, e.g.*, FIFTH ASSESSMENT REPORT: THE PHYSICAL SCIENCE BASIS, *supra* note 58, at 4.

65. PALEOSENS Project Members, *Making Sense of Paleoclimate Sensitivity*, 491 NATURE 683, 686 (2012).

66. EPSTEIN, *supra* note 1, at 27-29 ("[W]e need experts to explain to us how they reached their conclusions, [to enable us to] make sure they are not overstepping the bounds of their knowledge. . . . An honest and responsible expert recognizes [the limits of his expertise] and so he takes care to explain his views and his reasons for them clearly, he is upfront about any reasons there may be for doubting his conclusions, and he responds patiently to questions and criticism. He strives to give the public access to as much information as possible about his data, calculations, and reasoning.").

2000.[67] Global sea level has risen about 8 inches since the late 1800s, with the rate since 1992 nearly doubling the rate over the last century as a whole.[68] Low-lying island nations are already feeling the effects of this sea-level rise—some are already anticipating being forced to evacuate their populations within a decade.[69] The number of record high-temperature events and intense rainfall events in the United States has been increasing.[70] All of these trends can be felt now. In addition, several recent studies by NASA's Jet Propulsion Laboratory, among other highly reputable institutions, suggest that the world's large ice sheets are less stable and melting at a faster rate than previously projected.[71] Epstein refers to none of these facts or studies and spends no time grappling with their implications.

While Epstein is right that catastrophic warming has yet to occur, it makes no sense to say that this discredits climate science generally. Scientists have long predicted that global warming would be gradual; only in Hollywood does the earth suddenly heat up overnight. The leading international and governmental reports discuss the risk of warming, and its most likely impacts, as they are expected to unfold over the course of the 21st century.[72] As a result, Epstein's short-term-focused arguments—*e.g.*, that "there has been little change in the trends of various types of storms" between 1970 and 2010—are unpersuasive.[73]

D. Are the Risks of Fossil Fuel Use Entirely Manageable with Technology?

Epstein argues that technology and human ingenuity will enable us to continue using fossil fuels perpetually with virtually no serious adverse impacts.

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67. *Warming Trend Continues in 2014*, *supra* note 59; *see also* FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 2 ("The period from 1983 to 2012 was very likely the warmest 30-year period of the last 800 years in the Northern Hemisphere . . . .") (emphasis removed).

68. *Sea Level Rise*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/report/our-changing-climate/sea-level-rise.

69. Jo Confino, *Climate Change May Force Evacuation of Vulnerable Island States Within a Decade*, THE GUARDIAN (Oct. 4, 2012, 8:16 AM), http://www.theguardian.com/sustainable-business/blog/polar-arctic-greenland-ice-climate-change (quoting Michael Mann, director of the Earth System Science Center at Pennsylvania State University and member of the Intergovernmental Panel on Climate Change).

70. *Climate Extremes Index (CEI): Introduction*, NAT'L CENTERS FOR ENVTL. INFO., http://www.ncdc.noaa.gov/extremes/cei/index.html (last visited July 19, 2015). Extreme weather events, such as heat waves, coastal flooding, extreme precipitation, and severe droughts, also have become more prevalent although there remains uncertainty over the extent to which their increased frequency can be attributed to climate change. *Extreme Weather*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/highlights/report-findings/extreme-weather#intro-section-2 (last visited July 19, 2015).

71. J.S. Greenbaum et al., *Ocean Access to a Cavity Beneath Totten Glacier in East Antarctica*, 8 NATURE GEOSCIENCE 294 (2015), *available at* http://www.nature.com/articles/ngeo2388.epdf?referrer_access_token=NUdDXWvnwyLY5trtXvcH9RgN0jAjWel9jnR3ZoTv0M6FkI2Id53a8a4YoVhkHdRG78d4BhJ6vjwvD1uMRYSSalfeJcO4JHUmSf9diwpj9CKIC5esHxs3hcTyqhbbYwTDdrjBlckGmuanh3BSuDLSyGbBMHbzODoAjlD0f6cGFA6aJXgEo_Ec3K-qTNga2lF7BSHPCTLpSZr_-jPzEJrwTf-GZ2eCtU4v4bnHghhEAcKA8GeqnAeXk2iKf1rURVcNSUXwyhxa1mBt_kpe5Tyuoge7XLGZ4WPjS-vv6eOKL8%3D&tracking_referrer=www.washingtonpost.com.

72. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 10 ("The increase of global mean surface temperature by the *end of the 21st century* (2081–2100) relative to 1986–2005 is likely to be 0.3°C to 1.7°C under RCP2.6, 1.1°C to 2.6°C under RCP4.5, 1.4°C to 3.1°C under RCP6.0 and 2.6°C to 4.8°C under RCP8.59. The Arctic region will continue to warm more rapidly than the global mean." (emphasis added)).

73. EPSTEIN, *supra* note 1, at 105.

And he contrasts his faith in technological innovation with the view of "experts," who he says, "almost always focus on the risks of a technology and never the benefits."[74] In the first place, this characterization conveniently overlooks the fact that many scientists, researchers and environmentalists who support a transition to cleaner energy strongly believe that technological innovation can deliver safe, affordable, and reliable energy from alternative sources. They expect to see breakthroughs in energy storage that will permit greater deployment of intermittent energy sources like wind and solar power; advances in battery technology that could enable deeper penetration of electric vehicles; and new information technology that will support a "Smart Grid," among other things. They prize human ingenuity and innovation just as much as Epstein does, so it is curious that he implies they are luddites.

More importantly, however, Epstein eschews the need for any such alternatives, because of his conviction that technology can mitigate many of the side effects of fossil fuels. "It's clearly possible," he writes, "to increase fossil fuel use while decreasing pollution."[75] But whatever the success of technologies like scrubbers and filters, which are capable of controlling *conventional* air pollution from coal and natural gas combustion,[76] there is no equivalent equipment add-on currently widely and affordably available that can do the same for carbon emissions, a fact that Epstein fails to mention.[77] Conceivably, carbon capture and sequestration (CCS) from fossil fuel-fired plants could be part of a comprehensive

74. *Id.* at 15.

75. *Id.* at 158.

76. In 1970, the Clean Air Act for the first time required the EPA to set and all states to meet national air pollution standards. The law also required new large stationary sources of air pollution to meet minimum performance standards and for mobile sources like cars and trucks to also control their emissions. DANIEL A. FARBER, JODY FREEMAN & ANN E. CARLSON, ENVIRONMENTAL LAW 540–55 (8th ed. 2010) (providing overview of Clean Air Act programs). Although Epstein is reluctant to admit it, these legal requirements are responsible for huge gains in public health. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT FROM 1990 TO 2020: SUMMARY REPORT, (Mar. 2011), http://www2.epa.gov/sites/production/files/2015-07/documents/summaryreport.pdf (explaining that the Clean Air Act has led to substantial air quality improvements and concomitant gains in public health and welfare). They also led directly to widespread adoption of technology like the catalytic converter, which reduces pollution from vehicles, and to filters and scrubbers, which reduce pollution from stationary sources like power plants. Whitman v. Am. Trucking Ass'ns, 531 U.S. 457, 492 (2001) (Breyer, J., concurring) ("Technology-forcing hopes can prove realistic. Those persons, for example, who opposed the 1970 [Clean Air] Act's insistence on a 90% reduction in auto emission pollutants, on the ground of excessive cost, saw the development of catalytic converter technology that helped achieve substantial reductions without the economic catastrophe that some had feared."); *see also* Arnold Reitze, *Mobile Source Air Pollution Control*, 6 ENV'T. L. 309, 326–327 (2000) (discussing the development of the catalytic converter).

77. David Biello, *Can Carbon Capture Technology Be Part of the Climate Solution?*, YALE ENV'T 360 (Sept. 8, 2014), http://e360.yale.edu/feature/can_carbon_capture_technology_be_part_of_the_climate_solution/2800/ (noting both the potential of CCS to help combat climate change, as well as its probable lack of feasibility and high cost). To be sure, there have been a few CCS success stories—most notably, the Sleipner project beneath the North Sea. *CO2 Storage—Sleipner Field Beneath the North Sea*, BRITISH GEOLOGICAL SURVEY, http://www.bgs.ac.uk/science/CO2/home.html (last visited July 19, 2015). However, as of April 2015, at least 36 CCS projects have either been cancelled or put on hold, suggesting that we are far away from a revolutionary expansion of this technology. *Cancelled and Inactive Projects*, CARBON CAPTURE & SEQUESTRATION TECH. AT MIT, http://sequestration.mit.edu/tools/projects/index_cancelled.html (last visited July 19, 2015).

approach to greenhouse gas mitigation.[78] Yet, even if CCS were readily accessible,[79] and assuming the political will to spur its adoption through carbon control measures, CCS does not address the root cause of the problem, which is that the world is producing more greenhouse gases than its natural systems can absorb.

Other technologies have more speculative prospects. Direct CO2 capture from the atmosphere is often proposed as a technical fix for climate change.[80] However, this approach, which often involves manipulating the biosphere on a grand scale, is likely to have unknown side effects and to be extremely expensive.[81] Likewise "geo-engineering," (through so-called solar radiation management) poses significant risks to the climate because of secondary effects, and could provoke international conflict.[82] Geo-engineering is also limited: it

78. FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47, at 14 (describing CCS as one part of a comprehensive solution to reducing atmospheric concentration levels of CO2). To many experts, CCS is a very attractive prospect because it would allow society to continue to burn fossil fuels at least temporarily, while transitioning to a cleaner energy supply over time. EPA has estimated that CCS technology could remove up to 90% of greenhouse gas emissions from power plants, for example. For EPA's view of CCS basics, see generally *Carbon Dioxide Capture and Sequestration*, ENVTL. PROT. AGENCY, http://www.epa.gov/climatechange/ccs/ (last visited July 19, 2015).

79. Biello, *supra* note 76. A number of challenges must be overcome before CCS can be widely used. Sequestration of CO_2 in the necessary quantities over the necessary time periods will require an enormous amount of pore space and significant new pipeline infrastructure, not just in the United States but worldwide. Vaclav Smil, *Global Energy: The Latest Infatuations*, 99 AM. SCIENTIST 212, 219 (2011), *available at* http://www.vaclavsmil.com/wp-content/uploads/docs/smil-article-2011-AMSCI.11.pdf ("[I]n order to sequester just a fifth of current CO_2 emissions we would have to create an entirely new worldwide absorption-gathering-compression-transportation-storage industry whose annual throughput would have to be about 70 percent larger than the annual volume now handled by the global crude oil industry . . . ."). Also, little is known about the effectiveness of long-term sequestration at particular geologic sites so more research would be necessary and a monitoring regime would be required to ensure the integrity of the numerous storage sites (significant leakage of course would reverse the effects of having captured the CO_2 in the first place, and could lead to quite sudden warming.) *See generally*, Wendy B. Jacobs, *Carbon Capture and Sequestration*, *in* GLOBAL CLIMATE CHANGE AND U.S. LAW, at 581 (Michael Gerrard & Jody Freeman eds., 2d ed. 2014).

80. *See, e.g.*, Ken Caldeira et al., *The Science of Geoengineering*, 41 ANN. REV. EARTH & PLANET. SCI. 231 (2013) (describing a range of technologies that have been proposed, including ocean fertilization, bio-energy carbon sequestration, increased mineral weathering, and direct air capture through chemical processes); Leon Clarke et al., *Assessing Transformation Pathways*, *in* CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE. CONTRIBUTION OF WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT OF THE IPCC 413, 485 (Edenhofer, O. et al. eds., 2014).

81. Examples include stimulating ocean uptake of CO_2 by dumping large quantities of iron into the oceans in the hope of "fertilizing" iron-deprived plankton, and the purposeful harvesting, processing, and subsequent burial of large quantities of fast-growing timber. CALDEIRA, *supra* note 79, at 246-48; CLARKE, *supra* note 79, at 485.

82. Scientists have suggested that we could manage the earth's temperature by reducing the amount of sunlight that strikes the earth. Proposed techniques include, for example, shooting large quantities of sulfur dioxide into the atmosphere on a continuous basis (known as solar radiation management), or by placing a giant mirrors in space between the earth and sun to serve as a sun shield. *See, e.g.*, Douglas G. MacMartin, Ken Caldeira & David W. Keith, *Solar Geoengineering to Limit the Rate of Temperature Change*, PHIL. TRANSACTIONS OF THE ROYAL SOC'Y (Nov. 2014), *available at* http://keith.seas.harvard.edu/papers/172.MacMartin.Caldeira.Keith.SolarGeoengineeringtoLimittheRateofTemperatureChange.pdf. None of these ideas has moved beyond the earliest stages of speculation and initial inquiry. *See generally*, Albert C. Lin, *Geoengineering*, *in* GLOBAL CLIMATE CHANGE AND U.S. LAW 715 (Michael Gerrard & Jody Freeman eds., 2d ed. 2014); *see also* CLIMATE INTERVENTION: CARBON DIOXIDE REMOVAL AND RELIABLE SEQUESTRATION, NAT'L ACADEMIES PRESS (2015), *available at*

would only lower the earth's surface temperature, but would not address the other effects of increased CO2 concentration, such as ocean acidification.[83] There is no way around the fact that confronting the fundamentals of climate change requires a transition to a cleaner energy supply.

Yet Epstein casually asserts that we can "master" whatever warming might materialize through human ingenuity.[84] If sea levels were to rise to a point that is "truly concerning," he says, we should "liberate any and every technology that could help, from seawall technology to dike technology to durable building technology to CO2-free technology [referring to nuclear technology while affirmatively rejecting solar, wind or biofuels]."[85] But Epstein overlooks the likelihood that it will be futile to begin building nuclear power plants at this point as the full effect of CO2 emissions will not be felt until decades after emissions are stopped. And his breezy optimism asks us to ignore the enormous human and financial costs of responding to disaster, instead of working to avoid it.[86]

He also fails to confront the serious concern among scientists that the extent of projected warming may exceed our ability to adapt.[87] Sea-level rise may be greater than even the best-built seawalls can manage. Extreme weather events, such as hurricanes and floods, could be severe enough to lead to the dislocation of large populations, which can't easily be returned home.[88] Drought and heat waves

http://www.nap.edu/catalog/18805/climate-intervention-carbon-dioxide-removal-and-reliable-sequestration; CLIMATE INTERVENTION: REFLECTING SUNLIGHT TO COOL EARTH, NAT'L ACADEMIES PRESS (2015), *available at* http://www.nap.edu/catalog/18988/climate-intervention-reflecting-sunlight-to-cool-earth; Resistance to such proposals is based on a variety of concerns, including that such interventions, if they were tried, would introduce new and serious risks of their own, from disrupting precipitation patterns around the world, to increasing acid deposition and depleting the ozone layer (all of which negatively impact humans), while doing nothing whatever to remediate ocean acidification, which is a consequence of increased CO_2 concentration (and, to be clear, impacts humans). A. Robock et al., *Benefits, Risks, and Costs of Stratospheric Geoenineering*, 36 GEOPHYS. RES. LETT. L19703 (2009), http://onlinelibrary.wiley.com/doi/10.1029/2009GL039209/epdf; GLOBAL OCEAN COMM'N, POLICY OPTIONS PAPER #2: CLIMATE CHANGE, OCEAN ACIDIFICATION AND GEO-ENGINEERING 5 (Nov. 2013), http://www.globaloceancommission.org/wp-content/uploads/GOC-paper02-climate-change.pdf. Even if such technologies could work, deployment at scale to counteract global warming without a concurrent reduction in fossil fuel use would commit humanity to perpetual, and ever increasing, atmospheric intervention. A sudden stop in geo-engineering would result in a sudden change in climate which would likely be far more disruptive than the change without geo-engineering because it would not allow time for humans and other species to adapt.

83. BOARD ON ATMOSPHERIC SCIENCES AND CLIMATE, NAT'L ACAD. OF SCIS., REPORT IN BRIEF: CLIMATE INTERVENTION (2015), http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/climate-intervention-brief-final.pdf (explaining that geo-engineering would not "counteract impacts of elevated concentrations of carbon dioxide in the atmosphere").

84. EPSTEIN, *supra* note 1, at 132.

85. *Id.* at 134-35.

86. GERNOT WAGNER & MARTIN L. WEITZMAN, CLIMATE SHOCK 53-56, 78-79 (2015) (arguing that even a 10% risk of catastrophic climate change in the form of warming as much as 6 degrees Celsius justifies a significant economic investment in up-front mitigation to avoid much more costly consequences and human suffering).

87. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 20 ("Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits (high confidence). Limits to adaptation emerge from the interaction among climate change and biophysical and/or socio-economic constraints.") (emphasis removed).

88. Syed Zain Al-Mahmood, *Flooding in Bangladesh Leaves Nearly Half a Million People Homeless*, WALL ST. J. (Aug. 25, 2014, 8:20 AM), http://www.wsj.com/articles/flooding-in-bangladesh-leaves-nearly-half-

could affect crop and meat production, disrupting the food supply.[89] Changes to ecosystems may cause the extinction of highly valuable plant and animal species, the benefit of which would be lost forever.[90] Although some of these effects might be managed, and others tolerated, there is no guarantee that societies can react quickly or effectively enough to do so without significant suffering.[91] Of course, these consequences pose a direct threat to human flourishing, which is Epstein's very measure of morality.

Epstein is right that the worst consequences of climate change are not *certain* to occur if we continue to rely on fossil fuels. But the major scientific reports do not even pretend to claim absolute certainty about what the potential impacts might be.[92] Instead they estimate the *likelihood* of different scenarios with different degrees of confidence.[93] This well-established scientific methodology should be entirely familiar to readers with experience in the oil and gas industry, who are accustomed to considering alternative scenarios, and making judgments about acceptable risks based on probability estimates. At the low end, current models predict a global average temperature rise of one degree Celsius, and at the

a-million-people-homeless-1408969241; *Pakistan Floods: Thousands Flee After Dyke Breached*, BBC NEWS (Sept. 10, 2014), http://www.bbc.com/news/world-asia-india-29137789.

89. Increased levels of carbon dioxide in the environment can interfere with plants' ability to process nitrates into proteins, thereby diminishing the nutritional quality of food crops. *Food Quality Will Suffer With Rising Carbon Dioxide, Field Study Shows*, SCI. DAILY (Apr. 6, 2014), *available at* www.sciencedaily.com/releases/2014/04/140406162420.htm (citing Arnold J. Bloom, et al, *Nitrate Assimilation is Inhibited by Elevated CO2 in Field-Grown Wheat*, NATURE CLIMATE CHANGE (2014), http://www.nature.com/nclimate/journal/v4/n6/full/nclimate2183.html).

90. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 13 ("A large fraction of species faces increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors (high confidence). Most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes; most small mammals and freshwater mollusks will not be able to keep up at the rates projected under RCP4.5 and above in flat landscapes in this century (high confidence).") (emphasis removed).

91. Indeed, even highly developed American cities may have difficulties adapting to the initial effects of climate change. *Infrastructure*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/highlights/report-findings/infrastructure (last visited July 19, 2015) ("Climate change poses a series of interrelated challenges to the country's most densely populated places: its cities. The U.S. is highly urbanized, with about 80% of its population living in cities and metropolitan areas. Cities depend on infrastructure, like water and sewage systems, roads, bridges, and power plants, much of which is aging and in need of repair or replacement. These issues will be compounded by rising sea levels, storm surges, heat waves, and extreme weather events, stressing or even overwhelming essential services."); *see also* U.S. DEP'T OF ENERGY, CLIMATE CHANGE AND ENERGY SUPPLY AND USE viii (Feb. 29, 2012), http://www.esd.ornl.gov/eess/EnergySupplyUse.pdf ("Impacts from weather phenomena associated with climate change pose risks of economic costs to energy suppliers and users. Increases in average temperatures and temperature extremes will mean increasing demand for electricity for cooling in every US region, along with reductions in energy demands for space heating. Impacts of climate change are risks to many oil and gas supply activities in vulnerable coastal areas, offshore production areas, and tundra areas. Both climate change and rising concentrations of atmospheric carbon dioxide will affect bioenergy production potentials. Expected seasonal and/or chronic water scarcity represent risks of electricity supply disruptions in many US regions.").

92. For a thorough treatment of the many uncertainties in predicting the ultimate impacts of warming and the attendant costs, along with a strong argument that they should *not* be an impediment to prudent investment in risk mitigation, see GERNOT WAGNER & MARTIN L. WEITZMAN, CLIMATE SHOCK 51–67 (2015).

93. FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47, at 10 (predicting different levels of temperature change by 2100 based on different mitigation scenarios).

high end, a rise of approximately five degrees—a temperature rise more than half as great as the one that occurred between the ice age and the present day, and over a much smaller amount of time.[94] Indeed, climate scientists have done precisely what Epstein says is ethically required, but fails himself to do throughout his book, which is to explain what is known with what degree of certainty, and to acknowledge what is not yet known.[95] It would be one thing for Epstein to say that he recognizes the risks but wants to roll the dice anyway—at least this admission would allow readers to decide whether they really want to take that gamble with him. But Epstein entirely ducks the knowns and the unknowns alike, never pausing to take the evidence even halfway seriously.

Most importantly, acknowledging uncertainty does not mean that nothing is known. What scientists *have* said is that they have high confidence that, "Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally."[96] Even acknowledging the remaining uncertainty then, we have sufficient information already to justify making some investments in mitigation now.[97] Prudent risk management is hardly a radical idea—it is core to the oil and gas business and many other industries. Indeed we insure ourselves against many risks in our everyday lives. In the face of the risks of warming, then, is it really morally defensible—let alone morally imperative as Epstein claims—to change precisely nothing about the global energy system?

E. Are the Costs of Fossil Energy Exaggerated and the Benefits Undervalued?

Epstein chastises his opponents for overstating the costs of fossil energy. He repeatedly belittles the notion that fossil fuels have any significant downsides. To make this case, he strongly implies that the overwhelming amount of public health data linking air pollution from fossil fuel combustion to increased morbidity and mortality is skewed, exaggerated or fake. But his treatment of the evidence does not withstand close scrutiny.

For example, Epstein says that particulate matter from coal burning does not cause asthma,[98]as if this discredits the claim that burning fossil fuels for electricity has adverse health effects. First, for the record, air pollution from coal exacerbates

94. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 10.

95. *See, e.g.*, ROYAL SOCIETY & U.S. NAT'L ACAD. OF SCI., CLIMATE CHANGE: EVIDENCE & CAUSES (2014), http://dels.nas.edu/resources/static-assets/exec-office-other/climate-change-full.pdf [hereinafter CLIMATE CHANGE: EVIDENCE & CAUSES].

96. FIFTH ASSESSMENT REPORT: SYNTHESIS REPORT, *supra* note 56, at 17.

97. WAGNER & WEITZMAN, *supra* note 85, at 53–56, 78–79 (arguing that even a 10% risk of catastrophic climate change in the form of warming as much as 6 degrees Celsius justifies a significant economic investment in up-front mitigation to avoid much more costly consequences and human suffering).

98. EPSTEIN, *supra* note 1, at 165–66.

asthma[99] and can trigger deaths in especially vulnerable populations.[100] But Epstein's asthma point is a red herring anyway,[101] because asthma aside, air pollution from burning fossil fuels indisputably contributes to serious lung and heart disease.[102]

Epstein also claims that mercury is not a threat to public health when understood "in context."[103] But whatever context he has in mind, he is flatly wrong, because mercury emissions from coal-burning power plants are a proven neurotoxin, which is dangerous even at low levels, and especially risky to pregnant women and their fetuses.[104] Epstein also says downright silly things—like his claim that coal-heavy Kentucky "has less mercury" than the southwestern United States. Whether Kentucky "has less" mercury than jurisdictions that burn less coal is irrelevant because mercury emitted from coal burning power plants travels hundreds, even thousands, of miles.[105] In fact, much mercury pollution from coal-fired power plants is deposited in the ocean, converted to methyl mercury, and

99. DAVID B. PEDEN, UNIV. OF N.C. CTR. FOR ENVTL. MED., ASTHMA & LUNG BIOLOGY, BOARD OF SCI. COUNS., ENVTL. PROT. AGENCY, DOES PARTICULATE MATTER CAUSE OR EXACERBATE ASTHMA (2009), http://archive.epa.gov/sciencenotebook/web/pdf/peden_final_poster.pdf.

100. Air pollution is a known trigger of attacks in asthmatic patients, which can lead to tragic, avoidable deaths especially among the young and elderly. *See generally* Michael Guarnieri & John R. Balmes, *Outdoor Air Pollution and Asthma*, 383 LANCET 1581 (2014).

101. Epstein's example of East and West Germany is entirely beside the point. Coal use *is* associated with respiratory disease in children, but the disease is bronchitis, not asthma. Douglas W. Dockery et al., *Health Effects of Acid Aerosols on North American Children*, 104 ENVTL. HEALTH PERSP. 500 (1996); Douglas W. Dockery et al., *Effects of Inhalable Particles on Respiratory Health of Children*, 139 AM. REV. OF RESPIRATORY DISEASE 587 (1989). Epstein's claim that coal burning doesn't cause asthma because asthma rates were higher in West Germany than they were in coal-intensive East Germany is just wrong. Asthma rates were higher in West Germany because of air pollution from *traffic* (not coal) and traffic was of course much more concentrated in the West prior to unification. Francesc Castro-Giner et al., *Traffic-Related Air Pollution, Oxidative Stress Genes, and Asthma (ECHRS)*, 117 ENVTL. HEALTH PERSP. 1919 (2009). And the data from Germany show that when coal use in East Germany declined after unification, so did bronchitis rates. Joachim Heinrich et al., *Improved Air Quality in Reunified Germany and Decreases in Respiratory Symptoms*, 13 EPIDEMIOLOGY 394 (2002).

102. Particulate air pollution contributes to chronic respiratory disease, particularly chronic obstructive lung disease, the fourth leading cause of death in the United States and the only major cause of death that is on the rise. David M. Mannino et al., *Chronic Obstructive Pulmonary Disease Surveillance—United States, 1971-2000*, 51 MORBIDITY & MORTALITY WKLY. REP. SURVEILLANCE SUMMARIES 1 (2002); Nicole Blair Johnson et al., *CDC National Health Report: Leading Causes of Morbidity and Mortality and Associated Behavioral Risk and Protective Factors—United States, 2005-2013*, 63 MORBIDITY & MORTALITY WKLY. REP. SURVEILLANCE SUMMARIES 3 (2014). *See also*, Ananth P. Chikkatur et al., *Coal Power Impacts, Technology and Policy: Connecting the Dots*, 36 ANN. REV. ENV'T & RESOURCES 101 (2011); Robert D. Brook et al., *Particulate Matter Air Pollution and Cariovascular Disease: An Update to the Scientific Statement from the American Heart Association*, 121 CIRCULATION 2331, 2333 (2010); CLEAN AIR TASK FORCE, THE TOLL FROM COAL (Sept. 2010), http://www.catf.us/resources/publications/view/138 (pointing to statistics showing prevalence of premature death and heart attacks caused by pollution from coal-fired power plants); Kuenzli N. et al., *Ambient Air Pollution and Atherosclerosis in Los Angeles*, 113 ENVTL. HEALTH PERSP. 201, 201-06 (Feb. 2005) (showing link between particular matter and birth defects).

103. EPSTEIN, *supra* note 1, at 165–66.

104. JAMES E. MCCARTHY, CONG. RESEARCH SERV., MERCURY EMISSIONS FROM ELECTRIC POWER PLANTS: STATES ARE SETTING STRICTER LIMITS 1 (2006); *see also* Michigan v. EPA, 135 S. Ct. 2699, 2716 (2015) (Kagan, J., dissenting) (discussing EPA's findings regarding the health risks posed by mercury emissions from power plants).

105. Carl H. Lamborg, *A Global Ocean Inventory of Anthropogenic Mercury Based on Water Column Measurements*, 512 NATURE 65, 65 (2014).

accumulates up the food chain until humans eat fish with high mercury content.[106] The public health problem is not exposure to mercury in the air, but mercury *consumption* by humans (who may not live in Kentucky).

More broadly, Epstein asserts that public health studies are "often completely bogus" because "it's hard to prove cause and effect."[107] It can certainly be hard to prove cause and effect, but that doesn't support Epstein's implication that public health data is a sham. There is voluminous epidemiological, laboratory and clinical data clearly linking pollution from fossil fuel combustion to increased disease incidence in the population,[108] even if the cause of any one *particular* illness cannot be fingerprinted back to a *particular* source of pollution.[109] Epstein goes even further, suggesting that public health experts routinely ignore the importance of dosage and threshold in estimating impacts.[110] That statement is just demonstrably wrong if one actually looks at public health studies.[111] In some cases, though, it's true that thresholds don't matter. But that is because certain pollutants have been shown to be harmful at very low levels of exposure. (For example, prenatal exposure to even low levels of methyl mercury has been shown to affect cognitive function.)[112]

106. *Id.*

107. EPSTEIN, *supra* note 1, at 164–65.

108. *See, e.g.*, Michael J. Daniels et al., *Estimating Particulate Matter Mortality Dose-Response Curves and Threshold Levels: An Analysis of Daily Time Series for the 20 Largest U.S. Cities*, 152 AM. J. OF EPIDEMIOLOGY (2000), http://aje.oxfordjournals.org/content/152/5/397.full; Joel Schwartz & Antonella Zanobetti, *Using Meta-Smoothing to Estimate Dose-Response Trends Across Multiple Studies, With Application to Air Pollution and Daily Death*, 11 EPIDEMIOLOGY 666 (2000), http://journals.lww.com/epidem/Abstract/2000/11000/Using_Meta_Smoothing_to_Estimate_Dose_Response.9.aspx; Joel Schwartz & Douglas W. Dockery, *Increased Mortality in Philadelphia Associated With Daily Air Pollution Concentrations*, 145 AM. REV. OF RESPIRATORY DISEASE 600 (1992), http://www.atsjournals.org/doi/abs/10.1164/ajrccm/145.3.600#.VcqrskUmA-8; Chit-Ming Wong et al., *Public Health and Air Pollution in Asia (PAPA)*, 116 ENVTL. HEALTH PERSP. 1195 (2008) http://ehp.niehs.nih.gov/11257/; *see also*, Edward Wong, *Air Pollution Linked to 1.2 Million Premature Deaths in China*, N.Y. TIMES (Apr. 1, 2013), http://www.nytimes.com/2013/04/02/world/asia/air-pollution-linked-to-1.2-million-deaths-in-china.html?_r=0; Companies are now offering hazard pay to workers to live in highly polluted countries like China. *Panasonic Will Pay Their Employees Extra for Living with Pollution*, BUS. INSIDER (Mar. 13, 2014, 7:22 AM), http://www.businessinsider.com/panasonic-will-pay-their-employees-in-china-extra-for-living-with-pollution-2014-3.

109. Research since 1998 shows strong evidence for consistency of the observational and experimental science and evidence of mechanistic, biological pathways for the public health effects of particulate air pollution. *See, e.g.*, NAT'L RESEARCH COUNCIL, RESEARCH PRIORITIES FOR AIRBORNE PARTICULATE MATTER IV (Nat'l Academies Press 2004); NAT'L RESEARCH COUNCIL, RESEARCH PRIORITIES FOR AIRBORNE PARTICULATE MATTER III (Nat'l Academies Press 2001); Robert D. Brook et al., *Particulate Matter Air Pollution and Cardiovascular Disease*, 121 CIRCULATION 2332 (2010); Robert D. Brook et al., *Air Pollution and Cardiovascular Disease*, 109 CIRCULATION 2655 (2004).

110. EPSTEIN, *supra* note 1, at 168 ("When one treats something as poisonous regardless of dosage he is denying the existence of a threshold at which a substance goes from being benign to harmful. If you deny a threshold, you can make a case for banning anything.").

111. *See generally* studies cited in *supra*, notes 107 & 108.

112. Project VIVA demonstrated effects of prenatal exposure on cognitive function in offspring at very low exposure levels. Emily Oken et al, *Maternal Fish Intake during Pregnancy, Blood Mercury Levels, and Child Cognition at Age 3 Years in a US Cohort*, 167 AM. J. EPIDEMIOLOGY 1171, 1172 (2008). For some pollutants, studies have established no threshold below which adverse effects do not occur. *See, e.g.*, Schwartz J., *Low-Level Lead Exposure and Children's IQ: a Meta-Analysis and Search for a Threshold*, 65 ENVTL. RES. 42 (1994).

The point is that Epstein systematically understates the costs of fossil fuel use by distorting the evidence, so if anyone is skewing the cost benefit analysis, it is he. His assertions range from highly misleading to entirely spurious. And this can be shown over and over, if one spends enough time unraveling his claims.

In addition, while Epstein minimizes the environmental and public health costs of fossil energy, he goes even further with climate change, seemingly discounting its costs to zero.[113] In doing so, he ignores a chorus of voices, including leading economists,[114] respected public figures on the right,[115] and the United States military,[116] all of which have acknowledged that climate change impacts could be very costly indeed. Epstein spends no time grappling with mainstream economic models showing that unmitigated climate change would be extremely costly for global society[117] and that adaptation costs are difficult to predict at the upper bounds of warming, since they could accelerate so quickly.[118] To someone concerned about human flourishing, it seems especially callous to completely ignore these costs, since they will fall so disproportionately on future generations.[119] Economists have argued that it would be far more cost effective to invest in reasonable mitigation now rather than doing so later, and that reasonable mitigation would have negligible effects on global economic growth.[120]

113. EPSTEIN, *supra* note 1, at 122–23, 126. For example, he claims that climate-related deaths have *dropped* as fossil-fuel use has increased, implying that such a trend will continue in perpetuity. But his method entirely ignores the fact that most of the effects of climate change, and thus any deaths attributable to it, will occur in the future. And his count does not reflect the many adverse impacts on human welfare (illness, dislocation, food shortages) attributable to the effects of warming, that fall short of death.

114. William D. Nordhaus, *Why the Global Warming Skeptics Are Wrong*, N.Y. REV. OF BOOKS (Mar. 12, 2012), http://www.nybooks.com/articles/archives/2012/mar/22/why-global-warming-skeptics-are-wrong/ ("My study is just one of many economic studies showing that economic efficiency would point to the need to reduce CO2 and other greenhouse gas emissions right now, and not to wait for a half-century.").

115. *See, e.g.*, Henry M. Paulson, Jr., *The Coming Climate Crash*, N.Y. TIMES (June 21, 2014), http://www.nytimes.com/2014/06/22/opinion/sunday/lessons-for-climate-change-in-the-2008-recession.html?ref=opinion/&_r=0; George P. Shultz, *A Reagan Approach to Climate Change*, WASH. POST (Mar. 13, 2015), http://www.washingtonpost.com/opinions/a-reagan-model-on-climate-change/2015/03/13/4f4182e2-c6a8-11e4-b2a1-bed1aaea2816_story.html. The Governor of the Bank of England has also warned of the costs of climate change. Benjamin Hulac, *Bank of England Head Warns Insurers, Investors, Markets of Mounting Climate Risks*, CLIMATEWIRE (Sept. 30, 2015), http://www.eenews.net/climatewire/2015/09/30/stories/1060025569.

116. DEP'T OF DEF., 2014 CLIMATE CHANGE ADAPTATION ROADMAP 1 (2014), http://www.acq.osd.mil/ie/download/CCARprint_wForeword_c.pdf ("Climate change will affect the Department of Defense's ability to defend the Nation and poses immediate risks to U.S. national security.").

117. *See e.g.*, William Nordhaus & Paul Sztorc, *Dice 2013R: Introduction and User's Manual* (2d ed. Oct. 31, 2013), http://www.econ.yale.edu/~nordhaus/homepage/documents/DICE_Manual_103113r2.pdf.

118. Dana Nuccitelli, *Climate Dollars and Sense – Preventing Global Warming is the Cheap Option*, THE GUARDIAN (Apr. 22, 2014, 10:16 AM), http://www.theguardian.com/environment/climate-consensus-97-per-cent/2014/apr/22/preventing-global-warming-cheaper-than-adapting (comparing claims made in the second and third IPCC Reports and concluding that it is impossible to predict costs in the upper bound of projected temperature rise; and citing Nordhaus saying same).

119. CLIMATE CHANGE: EVIDENCE & CAUSES, *supra* note 94, at 22.

120. *See generally* WILLIAM NORDHAUS, THE CLIMATE CASINO (2013); *see also* FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47, at 15–16 ("[M]itigation scenarios that reach atmospheric concentrations of about 450ppm CO2eq by 2100 entail losses in global consumption—not including benefits of reduced climate change as well as co-benefits and adverse side-effects of mitigation . . . [that] correspond to an annualized reduction of consumption growth by 0.04 to 0.14

Epstein's critics no doubt would argue that there are a host of other potential costs associated with fossil energy, including economic exposure to price volatility and the geo-political risk of dependence on oil exporting countries, in addition to the military costs of having to ensure global access to oil. There may be good counter-arguments to these concerns—perhaps Epstein would respond that such costs are not so great in the grand scheme of things. But he fails even to acknowledge them, which is another reason to believe that his own cost-benefit calculation is skewed toward his conclusion.

F. Are Arguments Against Fossil Fuels and For Sustainability Immoral?

This takes us, finally, to the heart of the matter: Epstein's argument that exclusive reliance on fossil fuels is the superior moral approach because it best promotes human flourishing. Epstein adopts what he terms a "human standard of value" and faults environmentalists for adopting instead a "non-impact" standard, which he defines as prioritizing a pristine environment over human welfare.[121] Environmentalists would deprive society, he says, of "the energy of life"[122] in order to preserve the natural world.

Now, even if one does not much care for environmentalists, such assertions are extremely unfair and perhaps even insulting. Many people of faith believe that we have an obligation to be good stewards of the natural world.[123] And in any event, contrary to Epstein's assertions, the mainstream environmental movement is overwhelmingly concerned with human welfare, viewing climate change as a significant threat to people.[124] Indeed, the specific environmentalists Epstein derides for not caring about human welfare clearly do, as reflected by the very quotes he uses.[125] The view that nature and humanity are inextricably bound together more accurately captures the environmental perspective. And this view appears to be quite mainstream. It is reflected, for example, in the Pope's recent encyclical, in which he argues that climate change portends, among other things, "an unprecedented destruction of ecosystems, with serious consequences for all of

(median: 0.06) percentage points over the century relative to annualized consumption growth in the baseline that is between 1.6% and 3% per year.").

121. EPSTEIN, *supra* note 1, at 29–33. "Human life is not their operating standard of value; nonimpact is." *Id.* at 135-136.

122. *Id.* at 90-91.

123. For example, many evangelicals believe in "creation care," an ethical obligation to protect the earth bequeathed to us by God. *See, e.g.*, Ben Whitford, *Evangelical Environmentalists*, THE ECOLOGIST (Feb. 22, 2013), http://www.theecologist.org/News/news_analysis/1819960/evangelical_environmentalists.html.

124. *See, e.g.*, *The NRDC Story*, NAT'L RES. DEF. COUNCIL, http://www.nrdc.org/about/nrdc-story.asp (last visited July 19, 2015) ("Clean air and clean water are basic human rights, along with a safe food supply and healthy communities in which to raise our families."); *Climate Change: Catastrophe in the Making*, ENVTL. DEF. FUND, http://www.edf.org/climate/climate-facts-dangers-and-what-you-can-do (last visited July 19, 2015) (emphasizing as catastrophic impact of climate change the damage to homes and cities caused by Hurricane Sandy).

125. Epstein quotes James Hansen referring to "*humanity* and nature." EPSTEIN, *supra* note 1, at 135-36 (emphasis added). And Fred Krupp—who leads a famously business-friendly environmental organization, the Environmental Defense Fund—as saying that fixing global warming will unleash new wealth—which presumably means wealth for humans. *Id.* at 136.

us."[126] Those who argue for a shift to cleaner energy are not working to save the planet for its own sake but rather to avoid disastrous long-term consequences to *humans*. When Epstein denigrates environmentalists as anti-humanity, he is vanquishing a straw man.

Most arresting of all is Epstein's pronouncement that, "[t]o oppose fossil fuels is to oppose the underdeveloped world."[127] It would be morally wrong, he says, to deny the developing world access to the same sources of energy that the world's industrialized economies have enjoyed historically.[128] Here again, as he does throughout the book, Epstein conflates energy with fossil energy. But the equivalence is false. There is no doubt that the developing world requires more energy to raise standards of living. But it does not follow that its energy supply, especially looking forward fifty or more years, must consist exclusively or even disproportionately of fossil fuels. Many emerging economies will have the opportunity to develop a more diverse energy mix, including renewables and other low carbon sources. There is simply no reason to believe that the developing world must follow in lockstep the precise path taken by the world's developed economies, when emerging economies can benefit from what we have learned, and take advantage of the low carbon technologies we have invented.

Thus, there is an alternative to Epstein's moral perspective. Perhaps the developed world has a moral obligation to help developing economies grow in a way that will not put their populations at greater risk in the future. Such an approach might consist of helping them convert their energy supply over time to an increasing share of low-carbon sources; reducing their vulnerability to climate change through technology transfer and expertise-sharing; and protecting them from the worst potential risks of climate disruption by stabilizing and then reducing global greenhouse gas emissions. Epstein never even pauses to consider, let alone seriously engage with, this alternative moral perspective. Indeed, he overlooks the disproportionate impact that climate change will have on the developing world, much of which is located in warmer climates more vulnerable to rising sea levels, and characterized by a vulnerable agricultural sector[129] and

126. Pope Francis, *Encyclical Letter of the Holy Father: On Care for Our Common Home*, http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html (last visited July 19, 2015).

127. EPSTEIN, *supra* note 1, at 136-37.

128. *Id.* at 174–76.

129. Climate change is expected to further erode food security, lead to increased displacement of peoples, and exacerbate public health problems in impoverished countries. Michael Greenstone, *Paying the Cost of Climate Change*, BROOKINGS INST. (Sept. 19, 2014, 1:55 PM), http://www.brookings.edu/blogs/planetpolicy/posts/2014/09/19-paying-cost-of-climate-change-greenstone (explaining that although most Americans may have sufficient wealth to protect themselves from the worst climate change impacts, "[t]his is not the case in the world's poorest countries where climate change is projected to dramatically reduce incomes for the most affected"); Studies project that poorer nations are at risk of being impacted to a greater extent by the effects of global warming. WORLD BANK, TURN DOWN THE HEAT: CLIMATE EXTREMES, REGIONAL IMPACTS, AND THE CASE FOR RESILIENCE (2013), http://documents.worldbank.org/curated/en/2013/06/17862361/turn-down-heat-climate-extremes-regional-impacts-case-resilience-full-report (examining present and likely effects of global warming on Sub-Saharan Africa, South East Asia, and South Asia and finding that "promoting economic growth and the eradication of poverty and inequality will . . . be an increasingly challenging task under future climate change"). *Id.* at xv; *Country Rankings*, NOTRE DAME GLOBAL ADAPTATION INDEX, http://index.gain.org/ranking/vulnerability (last visited July 19, 2015) (ranking the nations as most vulnerable to climate change: Somalia, Solomon Islands,

lack of essential infrastructure.[130] Credit-rating agencies are expected to consider lower rankings for many of these countries due to the predicted detrimental effects these impacts will have on their economies.[131]

Finally, it misses the point to argue, as Epstein does, that fossil fuels are so plentiful as to be unlimited. Environmentalists, scientists, and energy policy experts surely would concede that supplies are abundant, but they are not primarily concerned about the limits of supply. Rather, as should be clear by now, they worry about the cumulative effects of near-exclusive dependence on fossil energy in perpetuity. Epstein's response is to say repeatedly that these harms and risks are either wholly invented by his opponents, or shrink to zero when viewed against all the progress humanity has made since industrialization. But that comparison is inapposite. The question is not whether, with the help of fossil fuels, we have improved life expectancy and raised standards of living. Surely we have. The question, rather, is what to do *moving forward*.

II. CONCLUSION

Part of the appeal of *The Moral Case for Fossil Fuels* is Epstein's easy, conversational writing style. And his book has the *aesthetic* of a reasonable argument, proceeding the way such arguments normally do: Epstein characterizes his opponents' position and then appears to show it to be terribly wrong, citing what seems to be relevant evidence. But upon closer scrutiny, Epstein's characterizations are often straw men; his own assertions are strikingly misleading or demonstrably wrong; and his evidence is typically weak and selective or completely beside the point. Sometimes Epstein makes an initial claim that is true,

Burundi, Niger, Chad, Liberia, Mali, Eritrea, Sierra Leone, Afghanistan, and Sudan); Nations that tend to have a greater share of their populations living in coastal areas and a greater percentage of their national GDP based in agriculture are particularly at risk. *Id.*

130. FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47, at 26; In contrast, accounting for infrastructural and economic resilience, no American city falls within the top ten most vulnerable cities to the effects of climate change. GROSVENOR, RESILIENT CITIES 12 (2014), http://www.grosvenor.com/getattachment/194bb2f9-d778-4701-a0ed-5cb451044ab1/ResilientCitiesResearchReport.pdf (least resilient cities include: Jakarta, Dhaka, Mumbai, Manila, Guangzhou, Cairo, and Mexico City); Still, even within the United States, the impacts are expected to fall disproportionately on indigent and indigenous populations. Native peoples' ceremonies, food sources, and cultural practices are often intimately linked to their environment and are therefore uniquely threatened by changes to it. *Indigenous Peoples*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/highlights/report-findings/indigenous-peoples#intro-section-2 (last visited July 19, 2015). These environmental effects are expected to force relocation of tribal communities, particularly in coastal locations. Moreover, poverty and social inequality cause significant disparities in individuals' abilities to prepare for and respond to heat waves, flooding, hurricanes, and other severe weather resulting from climate change. *Urban Systems, Infrastructure, and Vulnerability*, NAT'L CLIMATE ASSESSMENT 2014, http://nca2014.globalchange.gov/report/sectors/urban (last visited July 19, 2015) ("Those characteristics that most often influence differential impacts [in vulnerability to climate change] include socioeconomic status (wealth or poverty), age, gender, special needs, race, and ethnicity.").

131. *Climate Change is a Global Mega-Trend for Sovereign Risk*, STANDARD & POOR (May 15, 2014), https://www.globalcreditportal.com/ratingsdirect/renderArticle.do?articleId=1318252&SctArtId=236925&from=CM&nsl_code=LIME&sourceObjectId=8606813&sourceRevId=1&fee_ind=N&exp_date=20240514-20:34:43 (ranking as particularly vulnerable: Cambodia, Vietnam, Bangladesh, Senegal, Mozambique, Fiji, and the Philippines).

but then infers from it something that is not.[132] Or he attacks a minor aspect of his opponent's argument while ignoring its more important and substantial thrust.[133] Sometimes he simply shadowboxes with hypothetical arguments that no one is seriously making—for example that "*any* amount of impact on air, water and land should be illegal."[134] This latter technique is particularly shrewd. By indirectly suggesting that his opponents argue such silly things, he leaves the impression that they are, as a general matter, unreasonable and extreme.

Epstein strongly implies, for example, that scientists are calling for an immediate halt to fossil fuel use, "unconcerned by what will happen if and when they are wrong and nothing can make up for the energy they've taken away from us."[135] He repeatedly contends that the goal of the environmental movement is a "pristine" environment at the expense of human welfare.[136] But such portrayals badly misstate what mainstream policymakers and advocates actually propose. Scientists have called for investments that, over time, will shift us to as close to a zero-carbon output economy as possible.[137] Their intent is not to dramatically reduce energy use to the point of deprivation, nor to leave nature entirely unaltered. Their aim instead is to develop alternative energy technologies that will enable growth and prosperity while at the same time addressing a host of public health and environmental impacts, including the risks of climate change.[138] Epstein misses or chooses to ignore this more comprehensive moral perspective.

The Moral Case follows in a well-established tradition of tracts that seek to debunk the conventional wisdom about the environment by finally telling "the

132. For example, he argues that because climate-related deaths have decreased as CO_2 emissions have increased, greater use of fossil fuels will further decrease the threat extreme weather poses to human life. EPSTEIN, *supra* note 1, at 121-25. And that because renewables have not yet replaced fossil fuels in providing a large portion of the world energy supply, they will never be reliable sources of energy. *Id.* at 50-53, 55-58.

133. *Id.* at 50-53 (criticizing intermittency of solar and wind power in Germany without addressing the argument that this growth, regardless of intermittency issues, is a positive signal for future development of these alternative sources); *Id.* at 165–66 (arguing that no direct link between asthma and coal has been found, while ignoring that traffic pollution, in particular the ultrafine particles from Diesel engines, *have* consistently been associated with asthma incidence in dozens of studies in the U.S. and Europe. *See, e.g.*, Francesc Castro-Giner et al., *Traffic-Related Air Pollution, Oxidative Stress Genes, and Asthma (ECHRS)*, 117 ENVTL. HEALTH PERSP. 1919 (2009). And that a link between coal and bronchitis *has* been demonstrated. *See also* Heinrich J, Hoelscher, et al. *Improved Air Quality in Reunified Germany and Decreases in Respiratory Symptoms*, 13 EPIDEMIOLOGY 394 (2002)).

134. EPSTEIN, *supra* note 1, at 160.

135. *Id.* at 194-95; *see also id.* at 10 ("[T]oday's leading thinkers and leading ideas about fossil fuels . . . are calling for the abolition of our most popular form of energy."); *Id.* at 58 ("[O]ur leaders propose massive bans on fossil fuels.").

136. *Id.* at 195.

137. *See, e.g.*, David Keith, *supra* note 47, at 13, 16; *see also* SUSTAINABLE DEV. SOLUTIONS NETWORK & INST. FOR SUSTAINABLE DEV. AND INT'L REL., PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED KINGDOM, (2014), http://deepdecarbonization.org/downloads/DDPP_GBR_Digit.pdf; The European Union has committed to and is on track to move to a "low carbon economy" by 2050. *Roadmap for Moving to a Low-Carbon Economy by 2050*, EUR. COMM'N, http://ec.europa.eu/clima/policies/strategies/2050/index_en.htm (last visited July 19, 2015).

138. *See, e.g.*, FIFTH ASSESSMENT REPORT: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, *supra* note 47; *What We Do*, U.N. ENV'T PROGRAMME, http://www.unep.org/energy/About/tabid/1060071/Default.aspx (last visited July 19, 2015); EXECUTIVE OFF. OF THE PRESIDENT, THE PRESIDENT'S CLIMATE ACTION PLAN (2013), https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.

truth" about the state of the world, and which are welcomed by audiences eager to hear that business can continue as usual. Epstein's strategy and some of his content is reminiscent of Bjorn Lomborg, who in 2001 published the "The Skeptical Environmentalist."[139] Lomborg too, claimed that the scientists and experts had it all wrong—that health and welfare globally had only improved with development, that most environmental problems were under control, and that the threat from global-warming was much exaggerated. Lomborg's book, far longer and more heavily footnoted than Epstein's, had the appearance of serious academic work. But upon close scrutiny, it was shown to be the opposite of rigorous science. Lomborg consistently misused and misinterpreted data and selectively relied on literature that supported his worldview while ignoring evidence that contradicted him. His assertions and logic were demonstrably flawed.[140] The same is true, as I have argued, of Epstein. For some audiences, none of these shortcomings will matter because the message is so badly wanted. But serious readers—anyone who claims to believe in facts and reason—will want to think twice before embracing this book.

Setting Epstein aside, there are very good reasons to think that fossil energy will be critical to the global economy for decades to come. World energy demand is projected to double by 2040 as the developing world industrializes,[141] and even the aggressive pursuit of low-carbon alternatives and energy efficiency will take time. Barring major political disruptions and granting inevitable price volatility, fossil fuels remain reliable, and they are more plentiful than ever thanks to the shale revolution. Indeed, the United States appears to be a new energy superpower, which many observers see as having salutary national security benefits, at least in the short term.[142] And certainly, fossil energy does seem relatively cheap compared to the alternatives for now (although the gap might shrink somewhat if externalities were fully accounted for). In any event, the world cannot suddenly abandon the multi-trillion dollar global infrastructure already in place to extract, process, transport, and combust fossil energy. And at least thus far, governments are only slowly reacting to the threat of climate change.[143] Still, these are contingent facts, not moral arguments.

139. BJORN LOMBORG, THE SKEPTICAL ENVIRONMENTALIST (Cambridge Univ. Press, 2001). The book was originally published in Danish in 1998. BJORN LOMBORG, VERDENS SANDE TILSTAND (1998).

140. *See e.g.*, Peter H. Gleick, *Is the Skeptic All Wet?*, ENV'T, July/Aug. 2002, at 36 (critiquing the validity of Lomborg's claims on evidentiary and logical grounds).

141. *EIA Projects World Energy Consumption Will Increase 56% by 2040*, U.S. ENERGY INFO. ADMIN. (July 25, 2013), http://www.eia.gov/todayinenergy/detail.cfm?id=12251.

142. *Remarks by Tom Donilon, National Security Advisor to the President at the Launch of Columbia University's Center on Global Energy Policy*, WHITEHOUSE.GOV (Apr. 24, 2013), https://www.whitehouse.gov/the-press-office/2013/04/24/remarks-tom-donilon-national-security-advisor-president-launch-columbia-; *see also* Meghan L. O'Sullivan, *The Entanglement of Energy, Grand Strategy, and International Security*, *in* THE HANDBOOK OF GLOBAL ENERGY POLICY (Andreas Goldthau, ed. 2013), *available at* http://belfercenter.ksg.harvard.edu/files/The%20Entanglement%20of%20Energy%20Grand%20Strategy%20and%20International%20Security.pdf (suggesting that the recent American energy boom may or may not make the country more energy secure, depending on the extent to which it will allow the country to scale back its military presence in the Middle East, be less vulnerable to political shocks in other parts of the world, and allow it a freer hand in other policy areas).

143. Parties to the 1992 United Nations Framework Convention on Climate Change will meet in Paris in November, 2015, for the 21st Conference of the Parties to negotiate a new international agreement to reduce

Indeed, in his rigidity, Epstein seems out of step with the oil and gas industry itself. Six international oil companies (the BG Group, BP, Eni, Royal Dutch Shell, Statoil and Total) recently issued a letter calling for governments to adopt a carbon tax.[144] Many companies include a shadow carbon price in their models when making investment decisions, and some use scenario planning that takes into account the possibility of carbon constraints.[145] These steps are in part concessions to a changing political reality,[146] but they are also indications that the industry has a much more sophisticated understanding of climate change than Epstein seems to have.

Epstein is right about one thing: global energy policy going forward must be concerned about human flourishing. But he is wrong that this inevitably must mean fossil fuels and only fossil fuels, forever. The real moral imperative, for serious people and serious energy companies alike, will be how to power the world reliably, affordably, and sustainably for the foreseeable future and beyond.

global greenhouse gas emissions. A new agreement would replace the Kyoto Protocol, which expires in 2020. As of October, 2015, 125 countries representing 86% of global emissions, including the United States, China, the European Union, Brazil and India, had filed their national pledges to reduce emissions (known as "intended nationally determined contributions"), which range from commitments to make absolute greenhouse gas reductions over a baseline level; achieve carbon intensity targets; meet non-fossil and renewable energy goals; and peak emissions by certain deadlines. *Pre-2020 Pledges Map*, *CAIT Climate Data Explorer*, WORLD RES. INST., http://cait.wri.org/pledges/ (last visited Oct. 21, 2015). The U.S. has pledged to reduce emissions between 26 and 28% by 2030, and China has committed to peak emissions by 2030. China has also announced that it will adopt an economy-wide cap and trade scheme by 2017. Julie Hirschfeld Davis & Coral Davenport, *China to Announce Cap-and-Trade Program to Limit Emissions*, N.Y. TIMES (Sept. 24, 2015), http://www.nytimes.com/2015/09/25/world/asia/xi-jinping-china-president-obama-summit.html?ref=topics ("President Xi Jinping of China will make a landmark commitment . . . to start a national program in 2017 that will limit and put a price on greenhouse gas emissions . . . .").

144. Letter from BG Group, BP, Eni, Royal Dutch Shell, Statoil, and Total to Christiana Figueres, Executive Secretary of the UNFCCC, and Laurent Fabius, President of COP21 (May 29, 2015), http://www.bp.com/content/dam/bp/pdf/Press/paying_for_carbon.pdf.

145. *See, e.g.*, *Unburnable Carbon*, BP, http://www.bp.com/en/global/corporate/sustainability/the-energy-future/climate-change/unburnable-carbon.html (last visited Aug. 16, 2015); *Managing Climate Risk*, CHEVRON, http://www.chevron.com/globalissues/climatechange/managingclimaterisk/ (last visited Aug. 16, 2015).

146. Many jurisdictions around the world impose a price on carbon, so companies with operations in those countries must already internalize that cost. *See, e.g.*, *The EU Emissions Trading System (EU ETS)*, EUR. COMM'N, http://ec.europa.edu/clima/policies/ets/index_en.htm, (last visited Sept. 28, 2015) ("By putting a price on carbon and thereby giving a financial value to each tonne of emissions saved, the EU ETS has placed climate change on the agenda of company boards and their financial departments across Europe."); Simon Doyle, *Alberta Doubles Carbon Tax on Large Emitters by 2017*, FIN. TIMES (June 25, 2015), http://www.ft.com/cms/s/0/c26a04ae-1b64-11e5-8201-cbdb03d71480.html#axzz3n4Y1Hbdh (citing energy executives discussing the increased stringency of the regulations and resulting costs). In 2010, the U.S. Securities and Exchange Commission issued a legally binding guidance document requiring companies to disclose impacts to their business of actual and proposed climate legislation and regulations. This includes the business impact of treaties or international accords related to climate change and the indirect consequences of regulation or business trends, including decreased demands for goods that produce significant GHG emissions, increased demand for alternative energy, and decreased demand for services related to carbon-based energy sources. Interpretation, Guidance Regarding Disclosure Related to Climate Change, 75 Fed. Reg. 6290, 6297 (Feb. 8, 2010) (to be codified at 17 C.F.R. pts. 211, 231, 241).