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The Heated Energy Debate

Assessing John Holdren's Attack on Bjørn Lomborg's *The Skeptical Environmentalist*

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Executive Summary

In September 2001, Cambridge University Press published Bjørn Lomborg's *The Skeptical Environmentalist: Measuring the True State of the World*. The book's comprehensiveness (515 pages; 2,930 footnotes), the author's green credentials (a former Greenpeace member, Lomborg began the book's research to debunk Julian Simon's forecasts of continuing environmental improvement), and Lomborg's powerful refutation of the doomsday "litany of our ever-deteriorating environment," sparked considerable interest. Favorable reviews followed in the *New York Times*, *Washington Post*, and *Economist*. When the book became an international best seller, ideological environmentalists launched an angry counter-attack. Among the key figures to impugn Lomborg's scholarship is the subject of this paper: Harvard Professor John P. Holdren.

Holdren, a Clinton-era leader of climate policy and energy technology task forces, is now the leading academic member of the *National Commission on Energy Policy*, a $10 million, two-year project tasked with formulating a "centrist" energy policy. Holdren is also one of four authors to denounce Lomborg in the January 2002 issue of *Scientific American*, in a feature article pretentiously titled, "Science Defends Itself Against *The Skeptical Environmentalist*."

A more accurate title would be "Environmental Establishment Fears to Debate Bjørn Lomborg," because *Scientific American* refused to publish Lomborg's replies to his critics. *Scientific American's* one-sided presentation of evidence, while claiming to defend science from just such abuse, easily qualifies as Orwellian.

In January 2003, a group calling itself the Danish Committees on Scientific Dishonesty issued an official denunciation of Lomborg, alleging that his book "is contrary to standards of good scientific practice" because it offers a "systematically biased representation" of environmental data. Yet, rather than conduct an independent investigation, the Committee simply rehashed the four attacks published in *Scientific American*. And just as *Scientific American* refused to publish Lomborg's 34-page rebuttal, so the Committee declined to evaluate it. A more honest name for this panel would be the Committees *for* Scientific Dishonesty.

The present paper, written by energy historian and policy expert, Robert L. Bradley, Jr., President of the Institute for Energy Research and senior research fellow at the University of Houston, confines itself to the task of examining the Holdren-Lomborg debate on energy issues. It demonstrates that Holdren's critique of Lomborg fails dismally. Insofar as the Danish panel relies on Holdren's allegations, it is retailing falsehoods and exaggeration in the name of science.

Holdren's attack on Lomborg in *Scientific American* reveals major shortcomings in Holdren's analysis and understanding of scientific discourse:

- Holdren falsely accuses Lomborg of debunking a straw man (the notion of an impending physical or geological exhaustion of petroleum supplies), while

controversially forecasting increasing *scarcity* of oil as an economically recoverable resource over the medium to longer term. (Would he like to wager?)

- Holdren fails to appreciate the technological innovations that are commercializing crude oil substitutes like Alberta oil sands and Venezuelan orimulsion, sustaining the petroleum era beyond even optimistic forecasts of recoverable crude reserves.

- Holdren refuses to consider the reasons for climate optimism: enhanced CO_2 fertilization and a moderate, predominantly nighttime warming under realistic climate scenarios. Instead, he naively endorses full-scale government energy planning in the quixotic quest to "stabilize climate."

- Holdren's charge that Lomborg's energy analysis "careens far across the line that divides respectable (even if controversial science) from thoroughgoing and unrepentant incompetence" applies not to Lomborg but to Holdren himself.

  In addition, Bradley documents shortcomings and outright errors in Holdren's 30-year career as a physicist-turned-energy-polemicist.

- Holdren in the 1970s forecast major ecological and economic crises absent a "revolution in human behavior" and a massive political campaign to "de-develop" the United States.

- Holdren has not outgrown his 1970s opinion that, "Our limited knowledge of the details of air pollution permits little hope for early relief." He continues today to call air pollution "acute," belittling the tremendous gains in air quality *trends* in cities from Los Angeles to Houston to New York due to remarkable advances in oil, gas, and coal technologies and mostly incremental regulation.

- Holdren once predicted that as many as one billion people could perish by 2020 from man-made climate change. He now hedges: "That the impacts of global climate disruption may not become the dominant sources of environmental harm to humans for yet a few more decades cannot be a great consolation." Yet he remains firmly in the alarmist camp.

As Bradley documents, Holdren's publication record over 30 years reveals a penchant for exaggeration, error, and now wholesale intolerance of reasoned dissent. Holdren's criticisms of Lomborg should be dismissed as inadequate and troubling, and the *National Commission on Energy Policy* should consider Holdren's track record and reconsider Holdren's leadership role in devising a "centrist" approach to U.S. energy policy.

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Introduction

In September 2001, Cambridge University Press published Bjørn Lomborg's *The Skeptical Environmentalist: Measuring the True State of the World*. The comprehensive book (515 pages; 2,930 footnotes) and the author's green credentials (a former Greenpeace member, Lomborg began the book's research as a Malthusian) attracted considerable interest. Favorable reviews followed in a variety of publications, including the *New York Times*, *Washington Post*, and *Economist*.

The treatise is a significant achievement for a young scholar. Building on the work of the late Julian Simon, Lomborg documents many areas of environmental improvement and warns against major government interventions in the economy (such as implementation of the Kyoto Protocol) that are likely to be ineffective and counterproductive. There are important environmental issues to be sure, Lomborg notes, but public policy must focus on the most important and *real* problems to put scarce resources to their best use.

After first ignoring the book, mainstream environmentalists fired back. The intellectual leader of the hydrocarbon energy critics, Harvard University's John Holdren,[1] criticized Lomborg's 19-page energy chapter[2] as part of a four-part criticism of *The Skeptical Environmentalist* in *Scientific American*.[3] Lomborg replied to Holdren on his web site (www.lomborg.org). In response, Holdren wrote a lengthy rebuttal (posted at www.sciam.com) where he expanded his criticisms and stepped up his personal attack on Lomborg. Holdren complained about Lomborg's "thoroughgoing and unrepentant incompetence" and accused his adversary of "massive violations of the scientists' code of

[1] For a review of Holdren's lofty credentials within academia and the environmental movement, see Appendix A.

[2] Bjørn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), pp. 118-36.

[3] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, pp. 65-67. The other critics in this issue of *Scientific American* addition to Holdren in this issue were Stephen Schneider (on climate change), John Bongaarts (on population), and Tom Lovejoy (on biodiversity).

conduct."[4] Holdren also complained that he and his colleagues were forced to waste valuable time rebutting Lomborg in the first place.

Holdren's very serious charges put both scholars' reputations on the line. My review of this exchange concludes that Holdren has identified minor errors in Lomborg's chapter, and Lomborg can improve his analysis by clearing up some ambiguities and dealing with Holdren's alleged "energy problem" in more detail. However, Holdren's attempt to discredit the chapter, and by implication the whole book, fails. Many of Holdren's positions are part of the "environmental litany" that the book takes on; his positions could be criticized more, not less, in any future edition of *The Skeptical Environmentalist*.

One note before I begin. Some of the crossfire between Holdren and Lomborg involves ambiguities and moving targets. Thus I have probably been over-inclusive with my arguments and quotations to make some points. But my general point is the same as that of Lomborg: *The different "sustainability" arguments made against the hydrocarbon-based energy economy are exaggerated.* The trends are positive—and will continue to be so short of major government intervention in markets based on exaggerated concerns about depletion, pollution, reliability, or climate change. As in the past, the true threat to energy sustainability is misguided government intervention in energy markets, not voluntary actions in the marketplace.

Part I: Holdren's Critique

Attacking a "Straw Man" By Creating One

Lomborg's chapter, "Energy," explains why hydrocarbon energies, and oil in particular, are becoming more abundant over time as measured by prices and supply. He notes the working of a market process whereby high prices encourage additional production and

[4] John Holdren, "A Response to Bjorn Lomborg's Response to My Critique of His Energy Chapter," April 9, 2002. Available at www.sciam.com/explorations/2002/041502lomborg/holdren.html.

conservation to bring prices down—and low prices encourage less production and more consumption to bring prices up.[5]

Lomborg adds that, "Sooner or later it will no longer be profitable to use oil as the primary fuel for the world" because "the price of oil will eventually increase and/or the price [of] the other energy sources will fall."[6] Still, this day is a long way off—long enough to allow substitutes to come into play to avoid price shocks for consumers.

Lomborg is careful to note that energy itself is virtually inexhaustible. He reminds the reader, "The solar influx [to earth] is equivalent of about 7,000 times our present global energy consumption."[7] Lomborg is also extremely bullish that renewable energies will be competitive with hydrocarbons, something he envisions occurring by mid-century. This position, as discussed below, is his most controversial and is not necessary to uphold the other positions of his chapter.[8]

Holdren criticizes Lomborg for focusing on a straw man—the idea that "the world is running out of energy"—an issue that "few if any environmentalists" believe.[9] Holdren adds that the "energy problem" is not depletion but "environmental impacts and sociopolitical risks—and, potentially, of rising monetary costs for energy when its environmental and sociopolitical hazards are adequately internalized and insured against."[10] He contends that this distinction has been the mainstream environmentalist view for decades and his own view since his inaugural book on energy was published in 1971.[11]

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[5] Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), p. 122. Price statistics for the U.S. and production and reserve statistics for the world are presented on pp. 122-24.

[6] Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World*, p. 120.

[7] Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World*, p. 133.

[8] See below, pp. 24-28.

[9] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, p. 65.

[10] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, p. 65.

[11] Holdren stated back in 1977: "Civilization is not running out of energy; but it is running out of cheap energy, out of environmental tolerance for disruptive energy technologies, and out of time in which to do something about it." Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 928.

Holdren confuses the oil depletion issue by making a distinction between running out of oil in an absolute physical sense (*exhaustionism*) versus running out of low-cost or affordable oil (*depletionism*). Yet the age-old mirage of "running out of oil" has always been an *economic argument* based on a fundamental change in supply relative to demand, not a geologic argument about how much *physical oil* might remain. M.A. Adelman explains an "energy economics 101" principle that Holdren violates to create his own straw man:

> Oil and other minerals will never be exhausted. If and when consumers will not pay enough to induce investment in new reserves and capacity, the producing industry will dwindle and disappear. Nobody will ever know, or even want to know, how much is still in the ground. Only cost and price matter.[12]

Lomborg explicitly describes how most oil production from commercial reservoirs remains in the ground after the economic limit of production has been reached.[13] Lomborg makes this point in the wider context of the difference between absolute physical supply and changing scarcity, but Holdren fails to grasp it.[14]

The founder of natural resource economics, William Stanley Jevons, made this distinction explicit in the introduction to the second edition of his influential book, *The Coal Question*, published in 1866:

> The expression "exhaustion of our coal mines" states the subject in the briefest form, but is sure to convey erroneous notions.... It is almost needless to say, however, that our mines are literally inexhaustible. We cannot get to the bottom of them; and though we may some day have to pay dear for fuel, it will never be positively wanting.[15]

Erich Zimmermann, the economist who refuted Jevons's depletionism model in the 1930s, makes the same sharp distinction (and is almost speaking directly to physicist Holdren):

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[12] M.A. Adelman, *The Genie Out of the Bottle* (Cambridge, MA: The MIT Press, 1995), p. 1.

[13] Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), p. 125.

[14] A historian of thought might interpret Holdren's misconception as stemming from his training as a physicist rather than an economist.

[15] W. Stanley Jevons, "Preface to the Second Edition," (1866) in Jevons, The Coal Question (New York: Augustus M. Kelley, 1906, 1965), p. xxix.

> To the physicist the law of the conservation of matter and energy is basic. The economist, however, is less interested in the totality of the supply than in its availability.[16]

Within the oil industry, it has been known for many decades that much oil remains in the ground after the economic limit of production has been reached. For example, a study of oil supply and demand in the United States published by the American Petroleum Institute in 1925 stated,

> It is the general opinion of executives, engineers, and geologists throughout the country, that there will still remain in the ground after all pumping and flowing have ceased more than twenty-six billion (26,000,000,000) barrels of additional oil. That is to say, there will remain in the ground after present flowing and pumping methods cease about two barrels of oil for each barrel previously produced.[17]

Adding currently producing wells and an estimate of future reserves and resources would produce a physical estimate of remaining supply. Yet neither Lomborg nor anyone else is debating about whether we will run out of such a quantity. The age-old intellectual debate concerns *changing economic scarcity over time*: supply relative to demand now and in the future.

Holdren's current view (as it was back in the 1970s) is classic depletionism. He states in his initial criticism of Lomborg:

> Concerns about declining availability and rising prices have long been more salient for oil than of the other fossil fuels. There is, accordingly, a serious technical literature (produced mainly by geologists and economists) exploring the questions of when world oil production will peak and decline and what the price of oil might be in 2010, 2030, and 2050.[18]

Yes, and these speculations are part of the litany of oil-supply alarmism that has proven wrong again and again. Has Holdren forgotten about his lost wager with Julian

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[16] Erich Zimmermann, *World Resources and Industries* (New York: Harper & Brothers, 1933), p. 45.

[17] A Report to the Board of Directors of The American Petroleum Institute by a Committee of Eleven Members of the Board, *American Petroleum: Supply and Demand* ((New York: McGraw-Hill Book Company, 1925), pp. 48-49.

[18] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, pp. 65-66. Few, if any, bona fide energy economists hold the depletionist position.

Simon in 1990 over the future direction of natural resource prices?[19] Would Holdren bet that the inflation-adjusted price of oil (or another resource) will increase by 2010, 2020, or 2030? Julian Simon offered this follow-up bet to Ehrlich, Holdren *et al*. in his lifetime (he had no takers), and others might wager the same in Simon's absence today.

Holdren's weakness is viewing the hydrocarbon world in the prism of a *bell curve* of known total supply where production increases, peaks, and declines (what he calls "Hubbert's Pimple"). In his 1977 treatise co-authored with Paul Ehrlich and Anne Ehrlich, Holdren explains his attraction to this exhaustion curve.

> The most realistic approach seems to be one devised by geologist M. King Hubbert. He notes that the production cycle for any stock-limited resource is likely to be characterized by several phases: first, increasingly rapid growth in the rate of exploitation as demand rises, production becomes more efficient, and costs per unit of material fall; then a leveling-off of production as the resource becomes scarcer and starts to rise in price; and finally a continuous decline in the rate of exploitation, as increasing scarcity and declining quality proceed more rapidly than can be compensated for by improving technology, and as substitutes are brought fully to bear. Hubbert's approach incorporates explicitly the fact that society never really runs out of anything suddenly or completely; it merely uses the most concentrated and accessible supplies first and then gradually works its way into material of declining quality, until what remains is so dilute or so deep or so hard to find that it no longer pays to look for it and extract it.[20]

This is the *wrong way* to view the issue. A more realistic and less misleading approach to understand hydrocarbon supply dynamics than a bell (exhaustion) curve is through a bottomless *resource pyramid* where increasing substitution, particularly within the hydrocarbon family, makes energy more plentiful and affordable for an open-ended future.[21]

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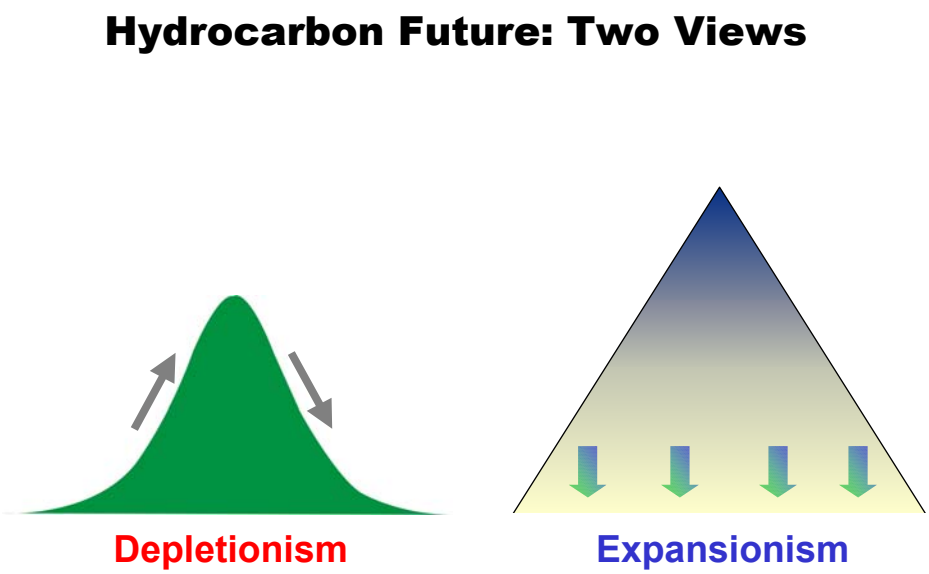
[19] See below, pp. 28-29.

[20] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 401.

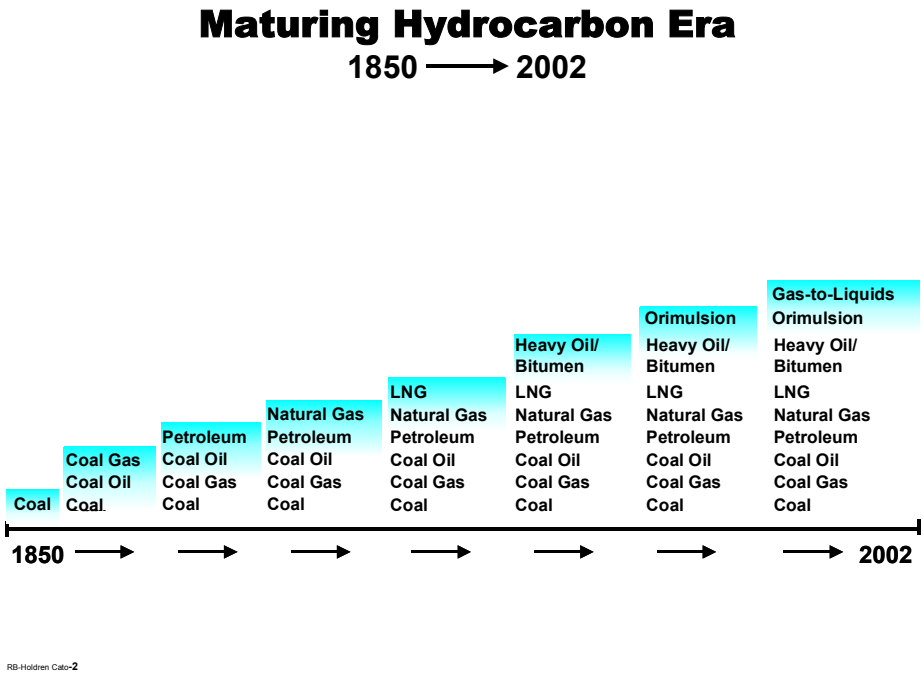
[21] See my *Julian Simon and Triumph of Energy Sustainability* (Washington: American Legislative Exchange Council, 2000), pp. 42-47. Also see the discussion below, pp. 8-15.

Figure 1



Technological progress has enhanced the hydrocarbon energy age in many ways. New members of the hydrocarbon family have been born, and technology has enhanced our ability to upgrade or change the different hydrocarbons into relatively more valuable forms. Figure 2 shows how hydrocarbons have progressed from coal and coal-derived gas and oil in the early-to-mid 19th century to liquefied natural gas (LNG), gas-to-liquids, oil sands, and orimulsion today.

Figure 2



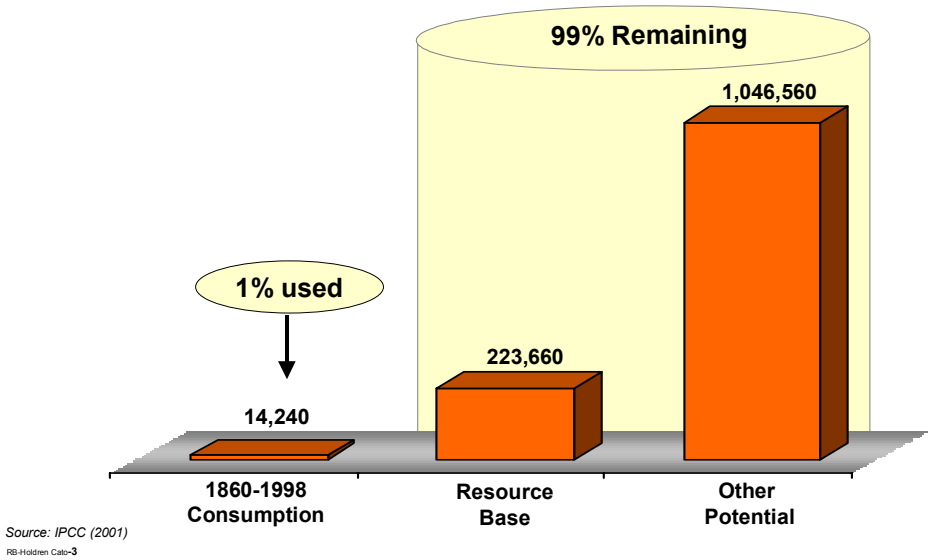
Future decades will witness new forms of hydrocarbon substitution. As shown in Figure 3, the Intergovernmental Panel on Climate Change estimates that some 99 percent of the world's raw hydrocarbons remain in the earth after 150 years of production and consumption.[22]

[22] IPCC, *Climate Change 2001: Mitigation* (Cambridge, UK: Cambridge University Press, 2001), p. 236. Lomborg calculates (ibid., p. 128) that in energy equivalents, oil shale is over 5,000 times greater than the world's current annual energy consumption.

Figure 3

Hydrocarbon Usage and Potential Supply

(Quadrillion Btu's)



Holden's depletionist view leads him to predict a "hard landing" between fuel substitutions as new energies take over from the dominant hydrocarbons. Oil supplies in particular, he forecasts, will run low before a new source can pick up the slack.[23] Yet energy substitutions over the centuries have been "remarkably orderly."[24] The real lesson about prolonged price instability and mal-coordination concerns government intervention in energy markets that can turn temporary supply/demand imbalances into damaging shortages and energy crises. This turns the argument around, as Holden is actually arguing for substantially higher energy taxes and government mandates to make hydrocarbons (oil and coal now; natural gas later) less available and affordable to increase the market share of his favored low-carbon or carbon-free energies.

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[23] "[Lomborg] seems not to recognize that the transition from oil to other sources will not necessarily be smooth or occur at prices as low as those enjoyed by oil consumers today." John Holdren, "Energy: Asking the Wrong Question," p. 66. Holdren backs up his claim in his April 15, 2002, rebuttal (p. 3) by citing cost estimates showing that replacement oil is more expensive to find and/or extract than current supply. He overlooks the fact that improving technology tends to reduce the cost of oil extraction over time. See below, pp. 18-19.

[24] Vaclav Smil, "Perils of Long-Range Energy Forecasting: Reflections on Looking Far Ahead," *Technological Forecasting and Economic Change*, vol. 65 (2000), p. 257. Smil refers to the historical research done by Cesare Marchetti (at fn. 37, p. 264).

The Kyoto Protocol (which would require the United States to reduce future carbon emissions to 7 percent below 1990 levels as part of a developed-world reduction of 5 percent below 1990 levels) would begin Holdren's policy-induced energy scarcity. But this is not due to the natural state of affairs—human ingenuity applied to the physical world via market ordering—but coercion based on Holdren's highly debatable theories.[25] Holdren himself thinks that his worldview must be enforced despite the potential loss of basic freedoms.[26]

The depletionist (also termed Malthusian) school remains alive and well among mainstream environmentalists and Holdren himself[27]—although Holdren seems to think that this view is no longer pertinent. David Nemtzow states that Lomborg's critique "is an energetic rebuttal to the Malthusian perspective offered in the 1970s . . . that hardly anyone is making anymore."[28] Yet Lomborg in his chapter cites an example of how old thinking is still new by comparing the depletion message of *Limits to Growth* (1972) to *Beyond the Limits* (1992).[29]

Lomborg could have mentioned other examples as well. Christopher Flavin of the Worldwatch Institute stated in 1985, "At the 1985 rate of consumption, the ultimate depletion of world oil resources is between 50 and 88 years away" and "little of the world's petroleum

[25] Holdren perceives himself as being in the minority even among his peers: "I believe that most people—by which I mean not only most members of the public, most journalists, and most policy-makers, but also a great many natural scientists, social scientists, and technologists—continue to underestimate the problem of human-induced disruption of global climate." John Holdren, "Six Reasons to Take Action," *Foreign Service Journal*, March 1999, p. 21.

[26] "[The] cost of energy supply [include] . . . undesirable social or political change (for example, loss of civil liberties as a part of government's response to technology-induced vulnerability)." John Holdren, "Energy Costs as Potential Limits to Growth," in Dennis Pirages, ed, *The Sustainable Society: Implications for Limited Growth* (New York: Praeger Publishers, 1977), p. 59. He adds elsewhere: "People are the bane of rational energy planning." John Holdren, "Coal in Context: Its Role in the National Energy Future," *University of Houston Law Review*, July 1978, p. 1089.

[27] "We find ourselves firmly in the neo-Malthusian camp. We hold this view not because we believe the world to be running out of materials in an absolute sense, but rather because the barriers to continued material growth, in the form of problems of economics, logistics, management, and environmental impact, are so formidable." Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 954.

[28] David Nemtzow, "More Power to You: On Bjørn Lomborg and Energy," *GristMagazine.com*, December 12, 2001.

[29] Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World*, pp. 120-21.

is likely to remain by the bicentennial of the world's first oil well in the year 2059."[30] James MacKenzie of the World Resources Institute warned a decade later that "there are . . . geology-based arguments suggesting that global oil production may be only a decade or so away from . . . its inevitable decline."[31] Paul Ehrlich, despite the approaching due date of his Waterloo wager with Julian Simon, opined, "By the 1980s, the depletion of accessible reserves of many nonrenewable resources—notably, but not exclusively, petroleum—was becoming more and more evident."[32]

Geologist-environmentalist Colin Campbell[33] has been sounding the depletion alarm for years despite falsified predictions along the way. In 1989 he wrote, "Shortages seem to be inevitable by the late 1990s, but knowledge of an impending supply shortfall may trigger an earlier price response."[34] In a 1998 *Scientific American* article, he predicted, "Within the next decade, the supply of conventional oil will be unable to keep up with demand."[35] He has also more specifically warned that a "permanent doubling or more in the price of oil, followed by growing physical shortages, must lead to a major economic and political discontinuity in the way the world lives."[36] This led one critic of "Hubbert's Peak" to conclude,

> What is remarkable is the similarity between [Colin] Campbell's 1989, 1991, and 1997-1998 forecasts [of oil scarcity]. Always, the peak is imminent. But this precisely conforms to my argument of 1996 that this method almost always produces a near-term peak, no matter when or where it is applied, and thus constantly needs to be revised upward. . . . [Campbell's] Hubbert method fails because it takes recoverable—not

[30] Christopher Flavin, "World Oil: Coping With the Dangers of Success," *Worldwatch Paper 66,* Worldwatch Institute, July 1985, p. 25.

[31] James MacKenzie, "Oil as a Finite Resource: When is Global Production Likely to Peak?" *World Resources Institute*, March 1996, p. 3. He specifies elsewhere, "Global production is likely to peak between the years 2007 and 2014." MacKenzie, "Heading Off the Permanent Oil Crisis," *Issues in Science and Technology*, Summer 1996, p. 48.

[32] Paul Ehrlich and Anne Ehrlich, *The Population Explosion* (New York: Simon & Schuster, 1990), p. 57.

[33] The energy-environmental alarmism of Campbell is evident from his statement, "From the ashes of the oil crisis may arise a better and more sustainable planet. It must at least become more sustainable as Mankind lives out his allotted life-span in the fossil record. Whether or not it is better depends on how well we manage the transition. We don't have long to prepare." C. J. Campbell, *The Coming Oil Crisis* (Essex, England: Multi-Science Publishing Company & Petroconsultants S.A., 1997), p. 1.

[34] Colin Campbell, "Oil Price Leap in the Early Nineties," *Noroil*, December 1989, p. 38.

[35] Colin Campbell and Jean Laherrère, "The End of Cheap Oil," *Scientific American,* March 1998, p. 78.

[36] C. J. Campbell, *The Coming Oil Crisis*, (Essex, England: Multi-Science Publishing Company & Petroconsultants S.A., 1997), p. 177.

> total—resources as fixed and assumes that to be the areas under the curve of total production. When the estimate of the area under the curve is increased, the entire increase must be applied to future production.[37]

A new petroleum prophet with an environmental message, Kenneth Deffeyes, has warned, "A global oil shortage may be only a few years away" when OPEC "can market their remaining oil at mind-boggling prices."[38] He adds that society should greatly increase conservation and alternate fuel development to prepare for the "unprecedented crisis [that] is just over the horizon."[39]

Holdren has been a lifetime depletionist as these predictions—now all proven incorrect—from the 1970s attest.

> [I]t is fair to conclude that under almost any assumptions, the supplies of crude petroleum and natural gas are severely limited. The bulk of energy likely to flow from these sources may have been tapped within the lifetime of many of the present population.[40]
>
> Today the frontiers are gone, and the evidence is mounting that technology cannot hold the law of diminishing returns at bay much longer. Resources being stressed today are often being stressed globally; they will not be replenished from outside the "system."[41]
>
> The rapacious depletion of our fossil fuels is already forcing us to consider more expensive mining techniques to gain access to lower-grade deposits, such as the oil shales, and even the status of our high-grade uranium ore reserves is not clear-cut.[42]
>
> There is little reason to believe that energy will get cheaper.[43]

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[37] Michael Lynch, "Crying Wolf: Warnings about Oil Supply," *Petroleum Intelligence Weekly*, April 6, 1998, p. 9.

[38] Kenneth Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton: Princeton University Press, 2001), p. 7.

[39] Kenneth Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton: Princeton University Press, 2001), pp. 10-11.

[40] John Holdren and Philip Herrera, *Energy: A Crisis in Power*, (New York: Sierra Club, 1971), p. 29.

[41] John Holdren and Paul Ehrlich, "Resource Realities," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 8.

[42] John Holdren and Paul Ehrlich, "Population and Panaceas: A Technological Perspective," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 18.

[43] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 954.

In a 1973 book, Holdren, Paul Ehrlich, and Anne Ehrlich endorsed a proposal by Herman Daly for placing "strict *depletion quotas* on the natural resources of the United States" to counteract depletion and encourage recycling and pollution abatement.[44]

Holdren edited a volume with Paul Ehrlich in 1988 where no dissent was offered to the depletionist views of the chapter authors. Here are some samples from that book:

> We can point to new discoveries but must also note the declining rate of discovery as [M. K.] Hubbert has done especially for petroleum. While we can shrug off the distinction between "proved reserve" and "resource," we can get wide agreement that we have probably found most of the concentrated ores of these materials. A few more spectacular discoveries will turn up, but less and less frequently. It is becoming a tougher ball game by the decade.[45]

> We believe that there are compelling reasons to expect natural resources to become more expensive, reasons that are geochemical, geophysical, and energetic. Rising cost is the other face of the warning stage of the depletion history of an earth resource, including mined soil, after technology and the economies of scale start to lose the battle against greater depth and decreasing natural concentrations of useful materials.[46]

> Faced with evidence of possible severe future shortages of resources and of environmental degradation, together with uncontrolled population increases, we would like to believe that John Wayne and his technological cavalry will come riding over the hill in time. Others may prefer to rely on the 'magic' of the marketplace. Both views are romantic, which means in conflict with reason. But, then, when did we allow reason to stand in the way of what we want to believe?[47]

The depletionist view holds that at any point in time low-cost oil has been found, and oil prices are destined to increase in the next decades as demand outraces higher-cost supply.

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[44] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Human Ecology: Problems and Solutions* (San Francisco: W.H. Freeman and Company, 1973), p. 264. Also see Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), pp. 851-52.

[45] Daniel Luten, "Energy and Material Resources," in Paul Ehrlich and John Holdren, eds., *The Cassandra Conference: Resources and the Human Predicament* (College Station: Texas A&M University Press, 1988), p. 105.

[46] Violetta Burke Cook and Earl Cook, "Romance and Resources," in Paul Ehrlich and John Holdren, eds., *The Cassandra Conference: Resources and the Human Predicament* (College Station: Texas A&M University Press, 1988), p. 308.

[47] Violetta Burke Cook and Earl Cook, "Romance and Resources," in Paul Ehrlich and John Holdren, eds., *The Cassandra Conference: Resources and the Human Predicament* (College Station: Texas A&M University Press, 1988), p. 315.

It is this static, holistic view that Lomborg rightly criticizes. What was high cost yesterday has become "low cost" today—and what is high cost today will be "low cost" tomorrow—because of technological dynamism. Holdren not only fails to understand this on a theoretical basis but stumbles on his own example. He erroneously states in his second rebuttal to Lomborg:

> Resources of tar sands and shale oil that would be economically exploitable only at prices around $30 per barrel are in fact more expensive than oil has been for nearly all of the last century. They could be considered "reserves"—material that is exploitable with current technology at current prices—only in circumstances under which the price of conventional oil had risen to well above what has been usual for the past century, which as exactly my point.[48]

In fact, tar sand (also called oil sand or synthetic oil) resources *can* be economically produced into refinery feedstocks and are a competitive substitute for conventional crude oil. Over one-half of Canada's oil output has been unconventional since 1996; by 2025 it could be as high as 90 percent. The upgraded oil that cost $35 per barrel to produce in the 1970s fell to under $13 per barrel in the late 1990s and is expected to decline to $10 per barrel by 2004. Oil-sand expenditures of $11 billion to date could be joined by $40 billion in capital investment by 2010, which could increase tar sand output from today's 600,000 barrels per day to over 2 million barrels by 2010. Some 2.5 trillion barrels of oil sands are believed to be in place, 300 billion barrels of which are currently considered economically recoverable. This is equivalent to all of the conventional oil of Saudi Arabia—and it is located in an area governed by the North American Free Trade Agreement, the Canadian province of Alberta.[49] While economic uncertainties—and political uncertainties related to Canada's ratification of the Kyoto Protocol—may postpone such development until after 2010, the message is the same. The resource base of oil substitutes is prolific.

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[48] John Holdren, "A Response to Bjorn Lomborg's Response to My Critique of His Energy Chapter," April 9, 2002. Available at www.sciam.com/explorations/2002/041502lomborg/holdren.html. (Hereafter called 4/9/02 Rebuttal)

[49] Petroleum Community Foundation, *Canada's Oil Sands and Heavy Oil*, April 2000, pp. 4, 21-22, 34 -35; "Oil Sands Overview," *Global Energy Business*, March/April 2002, p. 12; *Opportunity: Alberta Energy Resources* (Winnipeg: Fleet Publications, 2001), pp. 6-7.

A similar story can be told about orimulsion in Venezuela, where technology has allowed the once backstop hydrocarbon to be commercialized. Why have most depletionists failed to look under their nose at such industry developments? Greenpeace has. They have protested oil sand development precisely because they know what it means about the long-term affordability of oil as a primary driver of the transportation market.[50] And the news gets worse for the depletionists (and better for consumers). Production costs of oil sands and orimulsion will continue to fall, and a point will be reached when even oil shale—an even more massive resource—will become economic to produce without an increase in overall energy costs from the crude oil age.

Holdren's "Energy Problem"

Holdren integrates three arguments as part of the "nuanced" energy problem that he claims Lomborg fails to grasp. One is the aforementioned depletionist argument that we are running out of affordable oil.

The second argument is that we are running out of *secure* oil—a classic national security argument with petroleum that emerged in the 1950s and gained many adherents following the 1973/74 Arab embargo. Holdren argues, "The bulk of [crude oil] resources appears to lie in the politically volatile Middle East; much of the rest lies offshore and in other difficult or environmentally fragile locations; and it is likely that the most abundant potential replacements for conventional oil will be more expensive than oil has been."[51]

Holdren then adds a third argument of environmental externalities/policy correction when he defines the energy problem as being "environmental impacts and sociopolitical risks" that could involve "rising monetary costs for energy when its environmental and sociopolitical hazards are adequately internalized and insured against."[52]

[50] "Greenpeace Vows Long War on Tar Sands," *Edmonton Journal*, March 16, 2000, p. B3.
[51] John Holdren, "Energy: Asking the Wrong Question," in *Scientific American*, January 2002, p. 65.
[52] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, p. 65.

Holdren's tripartite *energy sustainability problem* belongs in the "litany of our ever-deteriorating environment" that Lomborg systematically challenges. We are not running out of cheap oil, as argued above, or "secure" oil, as argued below. Increasing energy usage is not worsening the environment so that growing externalities must be internalized via expanding government intervention. The good news about environmental impacts, as Lomborg documents, is that significantly higher and continually increasing (hydrocarbon-dominated) energy usage has nevertheless resulted in *less* air and water pollution in the developed world. Lomborg is very clear on this point,[53] as are the statistics from the U.S. Environmental Protection Agency and other sources. Lomborg also indicates how rising living standards in the developing world can be expected to result in the same air quality improvement.[54] Only a lack of appreciation of trends (time series data) and institutional factors (capitalism and rule of law) can lead to Holdren to complain about "acute air pollution … in the outdoor environment of the world's cities (to which problem the hydrocarbons and particulates emitted in burning fossil and biomass fuels are invariably major contributors, albeit not the only ones)."[55]

A less alarmist and more constructive approach would be to champion openly the progress made in U.S. air quality[56] and to at least *consider* the link between *affordable, plentiful energy, societal wealth, and environmental progress*. To do so, however, would cast a new harsh light on activist energy policies and to put Holdren at odds with himself.

[53] Bjørn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), chapters 15 and 19.

[54] Bjørn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), pp. 175-77.

[55] John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works* (Cambridge, MA: The MIT Press, 1998), p. 304.

[56] "Since 1970, aggregate emissions of six principal pollutants tracked nationally have been cut 25 percent. During that same time period, U.S. Gross Domestic Product increased 161 percent, energy consumption increased 42 percent, and vehicle miles traveled have increased 149 percent." U.S. Environmental Protection Agency, *Latest Findings on National Air Quality: 2001 Status and Trends*, September 2002, p. 1, available at www.epa.gov/air/aqtrnd01.

Climate change from hydrocarbon-related greenhouse gas (GHG) emissions is a different issue entirely, and Lomborg makes a reasonable case that the balance of evidence is toward lower, benign warming scenarios that have benefits as well as costs.[57]

While Lomborg is thinking about carbon doubling ("2x") scenarios, his optimism can be extended to a 3x scenario in the next century as well. Holdren concedes that a 2x warming might be manageable but argues that greater GHG forcing scenarios will not be. "Although there is room for debate about whether the impacts of doubling the pre-industrial concentration would be unmanageable," he states in his published letter to President Bush, "any basis for optimism shrinks when the postulated CO_2 level moves to a tripling or a quadrupling."[58]

Setting up the crisis scenario in a *future century* is, indeed, the last refuge of the alarmist. Human-induced (anthropogenic) climate change is the last energy sustainability issue to cling to given the hard data concerning resources, pollution, and reliability (security). Climate alarmists must go beyond what might happen a half century from now to get late into the 21st century and early 22nd century to make their case. Indeed, due to the work of climate economists such as Robert Mendelsohn, there is much debate over whether the net effect of the human influence on climate will be positive or negative fifty or sixty years out (the anticipated date when GHG "forcing" will double the pre-industrial level).[59] The contribution of CO_2 fertilization to a greener biosphere, the effect of longer growing seasons on agriculture, the favorable distribution of the warming toward nights and winter months,

[57] Bjørn Lomborg, *The Skeptical Environmentalist: Measuring the True State of the World* (Cambridge: Cambridge University Press, 2001), chapter 24. It should be emphasized, however, that Lomborg is working within the IPCC framework where climate model predictions are taken at face value. As I have argued elsewhere, model difficulties with feedback effects inherently bias their warming estimates upward. See Robert Bradley, *Julian Simon and the Triumph of Energy Sustainability* (Washington: American Legislative Exchange Council, 2000, pp. 100-104; and idem, *Climate Alarmism or Climate Realism?* (Institute of Economic Affairs, forthcoming).

[58] John Holdren, "The Energy-Climate Challenge," in Donald Kennedy and John Riggs, ed., *U.S. Policy and the Global Environment* (Aspen: The Aspen Institute, 2000), p. 29.

[59] See Robert Mendelsohn and James Neumann, eds., *The Impact of Climate Change on the United States Economy* (Cambridge, UK: Cambridge University Press, 1999); Mendelsohn, *The Greening of Global Warming* (Washington: The American Enterprise Institute, 1999); and Mendelsohn, *Global Warming and the American Economy* (Northampton, MA: Edward Elgar, 2001), p. 189.

the warming bias in climate model estimates, the cumulative effect of adaptation in energy-rich economies—these factors encourage optimism many decades out.

Extrapolating higher GHG forcing scenarios in the deep future does not necessarily imply a doomsday scenario as Holdren believes. The effect of GHG forcing on temperature is not linear but logarithmic. This means that the warming effect of GHG forcing reduces as more GHGs enter the atmosphere. In such a long time frame, hard-wired strategies for carbon suppression in the near term represent a pretense of knowledge on what the problems and solutions are. If human ingenuity brought mankind from horse-and-buggy carriage to moon flights in under a hundred years, what weather modification and geo-engineering strategies might develop to manage the carbon cycle over the next 100-150 years—assuming that the carbon cycle needs to be managed? Holdren does not welcome such high-technology approaches that might allow a bright future for the hydrocarbon economy; he is a technological optimist only toward his favored "solutions" such as wind and solar power, fuel cell vehicles, and energy efficiency designs.[60] Most are consumer unfriendly technologies and must rely on a heavy government research and development program, which puts Holdren in the shoes of a central planner.[61]

Holdren's "sociopolitical risks" relating to oil are more imagined than real in a world where market-based institutions are functioning. Lomborg documents the positive price trend with oil, which does not indicate any historical trend toward increasing "sociopolitical risk." This partly reflects the fact that non-OPEC oil production and reserves are not depleting but expanding rapidly. It also reflects the aforementioned fact that new oil varieties are being commercialized make the crude oil "bell curve" obsolete. OPEC crude oil is facing new competition from the aforementioned crude oil substitutes—a development that Lomborg can develop further in his future writings.

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[60] See, generally, John Holdren, "The Energy-Climate Challenge," in Donald Kennedy and John Riggs, ed., *U.S. Policy and the Global Environment*, pp. 21-44.

[61] Holdren complains: "The United States government does not have an energy R&D program remotely commensurate with the magnitude of the energy-linked challenges likely to emerge in the next century to the economic, environmental, and international-security dimensions of our well-being." John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works*, p. 326.

The hydrocarbon energy sector has spent record amounts of money to *internalize* environmental and safety externalities, and more is yet to come.[62] Oil, gas, and coal remain affordable thanks to improving technology and regulation that for the most part has been measured rather than disruptive. Holdren's concern about the security impacts of oil is a "sustainability issue" that Lomborg should address, but the good news is that new market institutions such as futures markets have arisen to deal with price and supply uncertainty.[63] The major risk to well-functioning oil markets—and energy sustainability in general—is pervasive regulation that causes shortages and/or price spikes.[64] Another risk, which Lomborg counsels against in his book, is Kyoto-compliant energy price increases. Holdren himself should be wary of the socioeconomic and sociopolitical risk of interventionist energy policies that fail to heed what he has concluded elsewhere, "Affordable energy in ample quantities is the lifeblood of the industrial societies and a prerequisite for the economic development of the others."[65]

Short of major government intervention, piecemeal regulation can make Holdren's concerns self-fulfilling. By continually determining frontier areas to be "ecologically sensitive," non-OPEC supplies can be curtailed. The debate over opening the Arctic National Wildlife Refuge (ANWR), where Holdren sided firmly against drilling and development, [66] is a prominent example of the environmentalist strategy of using the political means to create an

[62] The U.S. oil and gas industry spent almost $100 billion between 1990 and 2001 on environmental matters. See Hazem Arafa, "U.S. Oil and Natural Gas Industry's Environmental Expenditures: 1990-2000 (Washington: American Petroleum Institute, 2002).1. Available at http://www.api.org/ehsbench/files/filespdf/EES%201990-2000.pdf

[63] See my *Julian Simon and the Triumph of Energy Sustainability* (Washington: American Legislative Exchange Council, 2000), pp. 57-60. For a general reconsideration of the oil security argument against oil imports, see my *The Mirage of Oil Protection* (Lanham, MA: University Press of America, 1989).

[64] Disruptive regulation that turned increased scarcity into price spikes and/or shortages include petroleum price and allocation controls during World War I, World War II, and the 1970s; EPA-mandated "boutique" gasoline in the Midwest in some recent summers, and California retail electricity caps in 2000/01. Indeed, it is hard to find an energy crisis outside of a price-regulated situation.

[65] John Holdren, "Meeting the Energy Challenge," *Science,* February 9, 2001, p. 945. See Appendix C for a collection of Holdren's other realistic energy pronouncements.

[66] Holdren dismisses ANWR's potential contribution of between 4 billion and 12 billion barrels, as much oil as has been developed at Prudhoe Bay over several decades, as insufficient to justify "the certain environmental damage of exploring for oil in this unique and fragile habitat and the risk of even larger impacts from oil production if oil is found." [John Holdren, "Searching for a National Energy Policy," *Issues in Science and Technology*, Spring 2001, pp. 43-50]. Yet this assertion could have been used against much of today's production yesterday and can be used against most new provinces today—despite the significant improvements in oil drilling and midstream and downstream operations (which Holdren does not seriously consider).

artificial scarcity with nature's bounty—and then claim that markets are at fault rather than politics. Advances in drilling technology under today's best practices can overcome ecological constraints, and any desire to maintain pristine ecological conditions can also be invoked to oppose the development of renewable projects such as offshore wind farms. In fact, given siting constraints, a case can be made that renewable energy is "depleting" more than hydrocarbon energy—and "green energy" is not so green.[67] Holdren's own views point toward the environmental problems of "green energy" (see below), but he always concludes that they are manageable unlike with the hydrocarbons.

Nit-Picking—With Little Success

Holdren has identified two factual errors in Lomborg's energy chapter, which is hardly surprising given the vast sweep of issues with which the *Skeptical Environmentalist* deals. Lomborg, true to his scholarly approach, has acknowledged the mistakes and posted corrections on his web site.

What were the errors? One was using *catalyze* instead of *electrolyze* in conjunction with a discussion about hydrogen (a translation error from Danish, it appears). The other was using a figure for total energy use that should have been for electricity usage only.

Past this, Holdren identifies some technical ambiguities (e.g., Lomborg's unit for estimating future coal supplies) and incomplete discussions (e.g., the relationship between intermittent wind output and peak demand). The reader can read their back-and-forth exchange on issues, but none affects Lomborg's central thesis that virtually all major energy and energy-environmental trends are positive. The nit picks are certainly no reason to discredit Lomborg's wider effort. John Holdren's own ambiguities and unsupported

[67] For a review of the environmental tradeoffs of renewable energy alternatives, see Robert Bradley, "Green Energy," in John Zummerchik, ed., *Macmillan Encyclopedia of Energy* (New York: Macmillan, 2001), vol. 2, pp. 598-601. Also see Peter Huber, *Hard Green: Saving the Environment from the Environmentalists* (New York: Basic Books, 1999), pp. 103-08.

statements—which would require a separate essay to detail[68]—should inspire more humility and less audacity on his part.

One ambiguity in Lomborg's chapter that Holdren painstakingly focuses upon deserves special attention.

Lomborg stated, "Typically, coal pollutes quite a lot, but in developed economies switches to low-sulfur coal, scrubbers and other anti-pollution control devices have today removed the vast part of sulfur dioxide and nitrogen dioxide emissions."[69] Is Lomborg talking about emissions from individual power plants that have made these upgrades? Or is he speaking about the universe of plant emissions in developed countries, some plants of which have been modified and others that have not? My reading tends more toward the former. Yet Holdren pounces on Lomborg by stating that such emissions from U.S. power plants have declined by 23 percent and 11 percent between 1980 and 1998—"moderate reductions, welcome but hardly the 'vast part' of the emissions."[70] Lomborg responded that he had per unit emissions from coal plants in mind, which would increase Holden's percentage decline numbers significantly, since electricity produced from coal in the U.S. increased 60 percent between 1980 and 1998.[71]

Consider the other interpretation that Lomborg was driving at—that a "vast" decrease in air pollution is possible in new state-of-the-art coal plants. The Bush Administration's White Paper on energy reported last year:[72]

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[68] For example, Holdren complains ["Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works*, p. 325] about "an allergy to energy taxes, which although they are seen as sensible by virtually all energy economists and virtually all environmentalists are nonetheless seen as unspeakable if not unthinkable by contemporary politicians." Which taxes? What level of taxation? Which economists?

[69] Lomborg, *The Skeptical Environmentalist*, p. 127.

[70] Holdren, "Energy: Asking the Wrong Question," p. 67.

[71] U.S. Energy Information Administration, *Annual Energy Review* 2000 (Washington: Department of Energy, 2001), p. 221.

[72] Report of the National Energy Policy Development Group to the Honorable George W. Bush, *National Energy Policy: Reliable, Affordable, and Environmentally Sound Energy for America's Future*, May 2001, pp. 3-4—3-6.

> The estimated cost of using a scrubber on a coal-fired power plant to remove one ton of SO_2 has dropped approximately 40 percent in four years, from $474/ton in a 1993 estimate to $282/ton in a 1997 estimate, and continues to decline. Other existing control technologies for coal-fired plants can reduce NO_X emissions by more than 90 percent. A recently permitted state-of-the art coal-fired unit, for example, at a Kansas City Power & Light facility, has 88 percent lower NO_X, 99 percent lower particulate matter, and 92 percent lower SO_2 emissions than would an uncontrolled facility.
>
> Several companies are developing [coal-fired power plants with] a single control technology to reduce multiple air pollutants to levels equivalent to those achieved by conventional controls. For example, a First Energy plant in New Hampshire recently pilot-tested state-of-the-art technology that has cut NO_X emissions by 76 percent, SO_2 by 44 percent, total particulate matter by 99.94 percent, and mercury by 81 percent. . . . The process uses electrically charged particles instead of catalysts to oxidize the air pollutants into products that are easily removed and can be converted to gypsum, fertilizer, and concentrated acids.
>
> Two plants demonstrating coal gasification technology have already been built in the United States and have achieved over 98 percent SO_2 reduction, 90 percent NO_X reduction, particulate emissions below detectable levels, and approximately 38 percent efficiency. EPA believes that lessons learned will enable the next plant of this design to achieve 42 percent efficiency, and the research goal is to achieve 60 percent efficiency for plants introduced after 2015.

Power magazine reported that $40-billion of capital investment in the last quarter century in "fabric filters, flue-gas desulfurization systems, selective catalytic reduction technology, and the like" has produced "amazing reductions of 70 and 94% . . . of SO_2 and particulate matter—the two pollutants of principal concern from coal-fired plants."[73]

Lomborg's much-maligned sentence was followed by the statement, "Coal, however, is still a cause of considerable pollution globally, and it is estimated that many more than 10,000 people die each year because of coal, partly from pollution and partly because coal extraction even today is quite dangerous."[74]

Is Lomborg terribly off track or trying to fool the reader about air emissions from coal plants? Or is Holdren exaggerating the problems of Lomborg's chapter—and therefore casting

[73] Robert Swanekamp, "Emissions-Control Technologies Continue to Clear the Air," *Power*, May/June 2002, p. 29.
[74] Bjørn Lomborg, *The Skeptical Environmentalist*, p. 127.

doubt on the entire book—to mislead readers who do not have time to investigate the issues personally? And why didn't Holdren at least in passing tell the reader how dramatically coal plants are able to reduce air pollution under current best practices? In fact, Holdren has acknowledged a role for coal in the near and medium term energy supply mix.[75]

The above issues identified by Holdren are hardly the grist for a major rebuttal and wholesale rejection of Lomborg's energy views. They are the helpful corrections and suggestions that one usually finds at the end of a positive review after the reviewer has covered the main points of the entire book. Holdren's nit picks are hardly reason to insinuate that all of Lomborg's 500-page tome is marred by "random incompetence."[76] *The Skeptical Environmentalist* is not a long, skinny chain of argumentation that is vulnerable to its weakest link(s). It is a fortress of fact and analysis whose dents have not compromised a strong edifice.

Ad Hominem Squared

Holdren's distain for Lomborg boils over near the end of his second rebuttal. He states:

> The practice of science, which includes the packaging of findings from science for use in the public-policy arena, is governed by an unwritten code of conduct that includes such elements as mastering the relevant fundamental concepts before venturing into print in the professional or public arena, learning and observing proper practices for presenting ranges of respectable opinion and uncertainty, avoiding the selection of data to fit pre-conceived conclusions, reading the references one cites and representing their content accurately and fairly, and acknowledging and correcting the errors that have crept into one's work (some of which are, of course, inevitable) after they are discovered by oneself or by others.
>
> Most scientists follow this code of conduct as best they can out of self respect and respect for the integrity of science itself. . . . Lomborg's performance careens far

[75] "In the context of the near-term and medium-term alternatives, coal is too good not to use. Coal, coupled with a large measure of energy conservation and requisite environmental safeguards, can make an important contribution as we steer a judicious course between the twin perils of too little energy and too much." John Holdren, "Coal in Context: Its Role in the National Energy Future," *University of Houston Law Review*, July 1978, p. 1109.

[76] John Holdren, "A Response to Bjørn Lomborg's Response to My Critique of His Energy Chapter," p. 7.

> across the line that divides respectable (even if controversial science) from thoroughgoing and unrepentant incompetence. He has failed thoroughly to master his subject. He has committed, with appalling frequency and brazen abandon, exactly the kinds of mistakes and misrepresentations of which he accuses his adversaries. He has needlessly muddled public understanding and wasted immense amounts of the time of capable people who have had to take on the task of rebutting him. And he has done so at the particular intersection of science with public policy – environment and the human condition – where public and policy-maker confusion about the realities is more dangerous for the future of society than on any other science-and-policy question excepting, possibly, the dangers from weapons of mass destruction. It is a lot to answer for.

One can agree with the first paragraph and completely disagree with the second. One can also apply the first paragraph (can it be called the "Holdren Doctrine"?) critically to Holden himself in the context of the energy policy debate.

Holdren's lack of professionalism toward *The Skeptical Environmentalist* borders on *intellectual authoritarianism*. It reveals much about the anti-intellectual emotionalism and quasi-religious nature of the energy policy debate today where some ideological natural-turned-social scientists have dominated the discussion in such publications as *Science*, *Nature*, and *Scientific American*. Because of his "green" credentials and impressive scholarship, Lomborg threatens to accomplish what Julian Simon, the real trailblazer, could not quite do in his lifetime. And at least some of the old guard are disturbed at the prospect of losing their momentum in an intellectual fight where emotionalism, *ad hominem* questioning, and political positioning (particularly in the Clinton/Gore era) were thought to have brought victory.

A Substantive Criticism: The Mirage of Renewable Energy

Holdren predictably blessed Lomborg's weakest energy position—the belief that the hydrocarbon age would phase down by mid-century due to the superior economics of renewables. In Holdren's words, "Lomborg has some generally sensible things to say about the large contributions that are possible from increased energy end-use efficiency and from

renewable energy—on these topics he seems, to his credit, to be more a contributor to the 'environmental litany' than a critic of it."[77]

Lomborg should reconsider this prediction.

Holdren himself has teed up some of the problems of widespread reliance on renewable energy as follows.

> Solar collectors, biomass plantations, and hydroelectric reservoirs can occupy a lot of land; overharvesting biomass can cause deforestation and soil degradation, and processing and burning biomass fuels can pollute water and air; lining mountain ridges and coastal promontories with windmills may offend aesthetic sensibilities; manufacturing photovoltaic cells can involve substantial quantities of toxic substances.[78]
>
> The very dilution of the largest natural energy flows, which makes them seem "gentle" in comparison with nonrenewables, means that large structures (e.g. collector fields, arrays of windmills) ordinarily are required to harness them in interesting amounts. This property tends to mean significant use of land and heavy materials requirements for the collecting systems. Land use for energy systems can preempt other economic activities. . . . Such land use also can disrupt ecosystems and offend aesthetic sensibilities. Extraction, transport, and processing of materials can produce their own hazards to ecosystems as well as to health and safety.[79]

More of Holdren's caveats with renewables—which in sum point toward such sources being niche supplies rather than primary energies for an industrial society—are presented in Appendix C.[80]

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[77] John Holdren, "Energy: Asking the Wrong Question," *Scientific American*, January 2002, p. 67.

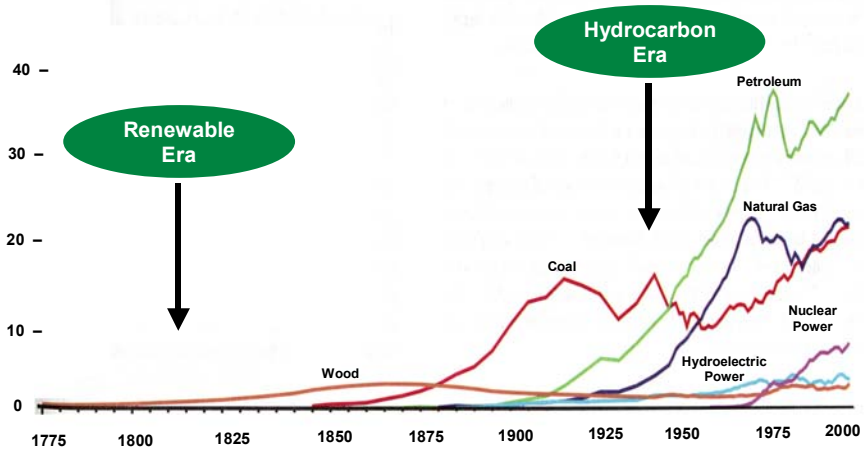
[78] John Holdren, "Solar and Other Renewable Energy Sources," in Ruth Eblen and William Eblen, eds. *The Encyclopedia of the Environment* (New York: Houghton Mifflin, 1994), pp. 660-61.

[79] John Holdren, "Environmental Aspects of Renewable Energy Sources," *Annual Review of Energy*, Vol. 5, 1980, p. 248.

[80] Also see Martin Hoffert et al., "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," *Science*, November 1, 2002, pp. 981-87.

Figure 4

U.S. Energy Consumption: 1775-2000



Source: U.S. Energy Information Administration

RB-Holdren Cato-4

The "forthcoming" competitiveness of certain politically favored renewables (but not hydroelectricity!) *is* part of the environmental litany. Yet the age of renewable energy has come and gone. Renewables supplemented human and muscle power for centuries and before the mid-19th century held a virtual lock on the inanimate energy market.[81] When technology advanced to bring coal, oil, and natural gas into play, the less efficient and poorer quality energy from biomass, wind, falling water and solar were displaced. Electric vehicles, once dominant at the turn of the century, lost out to the oil-powered internal combustion engine.[82] The concept of the hydrogen fuel cell, formulated back in 1839, has also been kept on the sideline by competitive realities—although for decades it has been touted as the next big thing.[83]

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[81] For example, see Roger Fouquet and Peter Pearson, "A Thousand Years of Energy Use in the United Kingdom," *The Energy Journal*, Vol. 19, No. 4, 1998, p. 7.

[82] "Nothing fails like failure. Following the collapse of the Electric Vehicle Company, internal combustion began to assume a dominant position in the developing motor vehicle market." David Kirsch, *The Electric Vehicle and the Burden of History* (New Brunswick, New Jersey: Rutgers University Press, 2000), p. 238.

[83] Back in 1977 Holdren et al stated, "Much research and development remains to be done before hydrogen and its derivatives see widespread use as fuel, but enthusiasts see such advantages that they already have coined the term *the hydrogen economy* to describe a hydrogen-centered energy system of the future." Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 482.

John Holdren has been too optimistic about the coming renewable energy age. In a 1981 essay he wrote:

> If government research support, subsidies, and other incentives for renewables are withdrawn, or if the prices of nonrenewable energy supplies somehow fall significantly, the contribution of renewables other than hydropower and geothermal in the year 2000 could be perhaps 3-4 quads. . . . If, by contrast, a societal commitment to the rapid expansion of renewables were made and maintained, the year-2000 contribution probably could be doubled from the "1980 program" figure, reaching 12-18 quads and conceivably more. With 3-4 quads from hydro . . . the renewables total in this "societal commitment" scenario would be 15-22 quads in the year 2000.[84]

Total U.S. production and consumption of renewables in 2000 totaled 6.6 quads and 6.8 quads respectively. Renewables other than hydro and geothermal contributed 3.6 quads.[85] Yet in no sense have states or the federal government abandoned renewable subsidies, which range from generous tax breaks for production to research and development grants.[86] And the massive subsidy continues with eleven states now having quota mandates and targets for favored renewables for electric generation.

Holdren has complained mightily against "inadequate" energy research and development expenditures. He states, "Cheap oil and gas, which contributed 63 percent of U.S. energy supply in 1995, are probably the most important single reason for the decline in energy R&D in both the public and private sectors."[87] Yet *cheap oil and gas are the very product of a technological revolution and major research and development effort that Holdren does not recognize.* The refutation of depletionism—or the law of diminishing returns as applied to a "fixed" resource—is the best evidence that a research and

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[84] John Holdren, "Renewables in the U.S. Energy Future: How Much, How Fast?" *Energy*, Vol. 6, No. 9 (1981), p. 913.

[85] Energy Information Administration, *Annual Energy Review 2000* (Washington: U.S. Department of Energy, 2001), pp. 5, 7-8.

[86] For a review of the myriad of renewable subsidies, state and federal in the last decade, see Mark Gielecki, Fred Mayes, and Lawrence Prete, *Incentives, Mandates, and Government Programs for Promoting Renewable Energy*, available at http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/incent.html. At the same time, a study by Resources for the Future claims that renewables met their cost objectives that were promised in return for the public subsidies. See James McVeigh et al, "Winner, Loser, or Innocent Victim? Has Renewable Energy Performed as Expected?," Discussion Paper 99-28, June 1999.

[87] John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works* (Cambridge, MA: The MIT Press, 1998), p. 322.

development problem does not exist except in the minds of those who think R&D only applies to their definition of "good" energy.

Inverting history, hydrocarbon critics would have modern society revert to renewables despite their higher cost and unpredictable output (variability and intermittency). Since the political movement for renewables began in the mid-1970s, environmentalists have claimed that economic viability was just around the corner. Barry Commoner stated in the mid-1970s, "Mixed solar/conventional installations could become the most economical alternative in most parts of the United States within the next few years."[88] Christopher Flavin of Worldwatch stated in 1984: "Tax credits have been essential to the economic viability of wind farms so far, but will not be needed within a few years."[89] Flavin's pie-in-the-sky predictions of imminent viability have extended to fuel cells[90] and biomass.[91] Like Holdren, they have been wrong time and again.

Part II: Holdren's Energy Past

Who is John Holdren, the Harvard professor who has staked out a position in the debate as a learned energy expert who has been greatly troubled for having even to participate in the debate with a rank amateur like Bjørn Lomborg?

Holdren as an energy analyst/polemicist carries much of the same baggage as his controversial mentor, Paul Ehrlich.[92] Indeed, Holdren and Ehrlich have co-authored and co-

[88] Barry Commoner, *The Poverty of Power* (New York: Alfred A. Knopf, 1976), p. 151.

[89] Christopher Flavin, "Electricity's Future: The Shift to Efficiency and Small-Scale Power," *Worldwatch Paper 61*, Worldwatch Institute, November 1984, p. 35. Two years later he added, "Early evidence indicates that wind power will soon take its place as decentralized power source that is economical in many areas." Christopher Flavin, "Electricity for a Developing World: New Directions," *Worldwatch Paper 70,* Worldwatch Institute, June 1986, p. 53.

[90] "Fuel cells that run on natural gas, hydrogen, or some other fuel are now projected to be a practical household or industry energy technology." Christopher Flavin, "Electricity's Future: The Shift to Efficiency and Small-Scale Power," *Worldwatch Paper 61*, Worldwatch Institute, November 1984, p. 39.

[91] "Since 1973 wood had made a notable comeback as a residential and industrial fuel in North America, most of it serving as a direct substitute for oil. Hydropower generation is growing rapidly as well." Christopher Flavin, "World Oil: Coping With the Dangers of Success," *Worldwatch Paper 66,* Worldwatch Institute, July 1985, p. 42.

[92] For a review of Ehrlich's energy polemics, see Robert Bradley, *Julian Simon and the Triumph of Energy Sustainability* (Washington: American Legislative Exchange Council, 2000), pp. 126-49. One Lomborg book

edited books and been alarmist comrades-in-arms since the 1970s (see Appendix A). When Julian Simon challenged Paul Ehrlich to bet on the future scarcity of natural resource prices, Holden jumped in with Ehrlich—and lost.[93] And now Ehrlich and Holdren have something else in common. Just as Ehrlich used a number of regrettable epithets against Julian Simon in the heat of battle many years ago, Holdren has lost his composure with Lomborg in a public way. This might over time prove to be as damaging to Holdren's reputation as the lost wager with Julian Simon was to Ehrlich's.

Holdren has been as wrong about society's will and technological ability to reduce *air pollution* as he has been about resource depletion. In 1971, Holdren told us, "Our limited knowledge of the details of air pollution permits little hope for early relief."[94] The trend was portrayed as negative with no end in sight. "Virtually every major metropolis in the world has an air pollution problem, and the rate of expansion of urban complexes everywhere is rapidly making the brown pall and smarting eyes ubiquitous symbols of 'progress.'"[95] More recently, he has referred to the air pollution problem as "acute" with the "dangers" of "air-basin-wide smogs … acidic hazes and fogs."[96] The very idea of progress in the 1970s was alien to the physicist turned energy analyst, and one can only imagine what draconian public policies he might have imposed to satisfy his alarmism (such as phasing out the internal combustion engine). And today he ignores air quality *trends* to whip up negative connotations toward today's hydrocarbon-based energy economy.

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reviewer in *Science* tried to distance the modern environmental movement from the "perennially exaggerated" claims of such writers as Paul Ehrlich. Michael Grubb, "Relying on Manna from Heaven?," *Science*, November 9, 2001, p. 1285.

[93] Holdren was part of the Paul Ehrlich team that lost a wager with Julian Simon on the future of natural resource prices (scarcity). Simon challenged Ehrlich to pick any "depletable" natural resource, and Simon would bet that the future price adjusted for inflation would be less than the present price. Five metals were picked in 1980 by the Ehrlich team, and Simon won on all five when the bet came due in 1990. See John Tierney, "Betting the Planet," *New York Times Magazine*, December 2, 1990, pp. 52-53, 75-79. As it turned out, Simon would have won with hydrocarbons and almost every other natural resource. See Stephen Moore, "The Coming Age of Abundance," in Ronald Bailey, ed., *The True State of the Planet* (New York: The Free Press, 1995), pp. 129-32.

[94] John Holdren and Paul Ehrlich, "Environmental Roulette, Overpopulation and Potential for Ecocide," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 66.

[95] John Holdren and Paul Ehrlich, "Environmental Roulette, Overpopulation and Potential for Ecocide," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 66.

[96] John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works* (Cambridge, MA: The MIT Press, 1998), p. 304.

Holdren since the 1970s has openly talked about the need for "much tighter control of the energy industry"[97] and a potential "loss of civil liberties"[98] from a perceived coming energy apocalypse. Holdren and Ehrlich also quote Harrison Brown to make their point, "It seems clear that the first major penalty man will have to pay for his rapid consumption of the earth's nonrenewable resources will be that of having to live in a world where his thoughts and actions are ever more strongly limited, where social organization has become all pervasive, complex, and inflexible, and where the state completely dominates the actions of the individual."[99]

Back in the 1970s, Holdren feared both global cooling and warming because, presumably, the natural climate was optimal. "If man survives the comparatively short-term threat of making the planet too cold," he stated, "there is every indication he is quite capable of making it too warm not long thereafter."[100] In 1977 he seemed to be against warming, cooling, and both at the same time—only because it was due to a perceived human influence on climate. The hard questions must be asked: is nature and only nature optimal?

> There can be scant consolation in the idea that a man-made warming trend might cancel out a natural cooling trend. Since the different factors producing the two trends do so by influencing different parts of Earth's complicated climatic machinery, it is most unlikely that the associated effects on circulation patterns would cancel each other.[101]

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[97] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 860.

[98] John Holdren, "Energy Costs as Potential Limits to Growth," in Dennis Pirages, ed, *The Sustainable Society: Implications for Limited Growth* (New York: Praeger Publishers, 1977), p. 59.

[99] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 388.

[100] John Holdren and Paul Ehrlich, "Environmental Roulette, Overpopulation and Potential for Ecocide," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 77.

[101] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 687. Holdren's *is equals ought* view of ecology reflects a worldview of statism, which believes that "a good future . . . must be . . . either the product of detailed, technocratic blueprints or the return to an idealized, stable past." Virginia Postrel, *The Future and Its Enemies* (New York: The Free Press, 1998), p. xii. Holdren's view reflects "an unstated myth in ecology that natural conditions must be optimal. That is, we must be at the top of the hill now. Of course, given the wide distribution of temperatures across the earth, that cannot be true for everyone." Robert Mendelsohn, *The Greening of Global Warming* (Washington: The AEI Press, 1999), p. 12.

Holdren's catastrophist view of climate change was noted by Paul Ehrlich, "As University of California physicist John Holdren has said, it is possible that carbon dioxide-induced famines could kill as many as a billion people before the year 2020."[102] What does Holdren think now? He says, "That the impacts of global climate disruption may not become the dominant sources of environmental harm to humans for yet a few more decades cannot be a great consolation."[103] This new view is part of Holdren's retreat to distant warming scenarios, examined above.[104]

Holdren, who once recommended that "a massive campaign must be launched to . . . de-develop the United States" to control energy usage,[105] has more recently said (quite sensibly), "Affordable energy in ample quantities is the lifeblood of the industrial societies and a prerequisite for the economic development of the others."[106] Whether or not Holdren really understands that energy abundance and alarmist public policies do not mix is another question.

Part III: Conclusion

John Holdren and Paul Ehrlich in a moment of modesty once wrote, "We have been warned by our more cautious colleagues that those who discuss threats of sociological and ecological disaster run the risk of being 'discredited' if those threats fail to materialize on schedule."[107] Over thirty years later, the publication record shows Holdren, like Ehrlich, to be prone to hyperbole, exaggeration, and error.

Yet today, Holdren is convinced that today's hydrocarbon-based energy economy is unsustainable and that the earth hangs in the balance. "A 'Business-as-Usual' energy future," his (biased) panel of experts recently concluded for him, "would be problem plagued and

[102] Paul Ehrlich, *The Machinery of Nature* (New York: Simon and Schuster, 1986), p. 274.
[103] John Holdren, "Memorandum to the President: The Energy-Climate Challenge," in Donald Kennedy and John Riggs, eds., *U.S. Policy and the Global Environment: Memos to the President* (Washington: The Aspen Institute, 2000), p. 23.
[104] See p. 17, above.
[105] John Holdren, Anne Ehrlich, and Paul Ehrlich, *Human Ecology: Problems and Solutions* (San Francisco; W.H. Freeman and Company, 1973), p. 279.
[106] John Holdren, "Meeting the Energy Challenge," *Science,* February 9, 2001, p. 945.
[107] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 6.

potentially disastrous."[108] He himself stated as recently as 1998, "A 'business as usual' energy future … is so likely to be massively problematic economically, environmentally, and politically that it cannot be achieved even [if] it is attempted."[109] He brings this ingrained bias to the National Commission on Energy Policy. Yet the statistics on virtually every direct indicator of human welfare related to energy prove to be positive, whether concerning supply, consumption, affordability, efficiency, safety, land usage, air pollution, water pollution, or noise pollution. *The chief sustainability threats come not from natural market outcomes but from government intervention in energy markets in the name of "solving" unfounded and speculative problems.* And that is where John Holdren as a policy maker becomes the enemy of true energy sustainability.

John Holdren's alleged interest in "defending science" against the analysis of Bjørn Lomborg can be turned around. A basic tenet of the scientific method is that valid theories must be able to generate correct predictions. Hypotheses that generate bad predictions should be questioned and replaced by better ones. Julian Simon and now Lomborg offer Holdren an alternative to his deeply embedded Malthusian worldview. The time has come for Holdren to review his failed thirty-year record as an energy policy analyst, separate the real wheat from the chaff, and focus his analysis and influence on *real* energy problems and *real* solutions.

The Skeptical Environmentalist lives on. But this master work should be a beginning rather than an end. Bjørn Lomborg should perfect and expand his analysis to examine thoroughly Holdren's "energy problem" and to consider more explicitly an alternative paradigm of energy thought and action for the 21st century—the continuing forward march of the *sustainable* enhanced hydrocarbon energy age.

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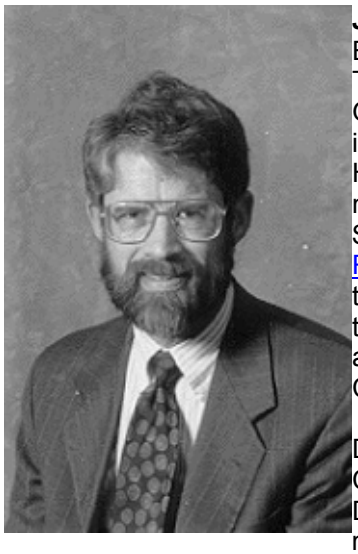
[108] Panel on International Cooperation in Energy Research, Development, Demonstration, and Deployment, *Powerful Partnerships: The Federal Role in International Cooperation on Energy Innovation* (Washington: Executive Office of the President of the United States, June 1999), p. ES-9.

[109] John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works* (Cambridge, MA: The MIT Press, 1998), p. 309.

Appendix A: John Holdren Web Page Description

http://ksgnotes1.harvard.edu/BCSIA/BCSIA.nsf/bios/HoldrenJohn



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Dr. Holdren is Chair of the Committee on International Security and Arms Control of the National Academy of Sciences, a member of the Board of Directors of the John D. and Catherine T. MacArthur Foundation, and a member of President Clinton's Committee of Advisors on Science and Technology (PCAST). He has chaired PCAST panels on protection of nuclear-bomb-materials (1995), the U.S. fusion-energy R&D program (1995), U.S. energy R&D strategy (1997), and international cooperation on energy (1999); and in 1996-7 he co-chaired with E. Velikhov the U.S.-Russian Independent Scientific Commission on Plutonium Disposition (reporting to Presidents Clinton and Yeltsin). He also chairs National Academy panels on the spent-fuel standard for plutonium disposition, on technical issues related to the Comprehensive Test Ban Treaty, and on US-India energy cooperation.

He is the author of about 300 articles and reports on plasma physics, fusion energy technology, energy and resource options in industrial and developing countries, global environmental problems, impacts of population growth, and international security and arms control, and he has co-authored and co-edited fourteen books on these topics — including *Energy* (1971), *Human Ecology* (1973), *Ecoscience* (1977), *Energy in Transition* (1980), *Earth and the Human Future* (1986), *Strategic Defences and the Future of the Arms Race* (1987), *Building Global Security Through Cooperation* (1990), *Management and Disposition of Excess Weapons Plutonium* (2 vols., 1994 & 1995), and *The Future of U.S. Nuclear Weapons Policy* (1997).

Holdren earned bachelors and masters degrees from M.I.T. in aeronautics and astronautics (1965 and 1966) and the Ph.D. from Stanford University in aeronautics/astronautics and theoretical plasma physics (1970). Before going to UC Berkeley in 1973, he worked on missile technology at the Lockheed Corporation, as a plasma physicist at the Lawrence Livermore Laboratory, and as a Senior Research Fellow in the Environmental Quality Laboratory and the Division of Humanities and Social Sciences at the California Institute of Technology.

He is a member of the National Academy of Sciences and the National Academy of Engineering, and a Fellow of the American Academy of Arts

and Sciences, the American Physical Society, the American Association for the Advancement of Science, and the California Academy of Sciences. In 1981 he received one of the first MacArthur Foundation Prize Fellowships; in 1993 he shared the Volvo Environment Prize with Paul Ehrlich; and in 1994 he received the Forum Award of the American Physical Society ("for promoting public understanding of the relation of physics to society"). In December 1995 he delivered the Nobel Peace Prize acceptance lecture on behalf of the Pugwash Conferences on Science and World Affairs, which he served as Chair of the Executive Committee from 1987 to 1997. He received the 1999 Kaul Foundation Award for Excellence in Science and Environmental Policy, the 2000 Tyler Prize for Environmental Achievement, , and the 2001 Heinz Prize in Public Policy.

Appendix B: Holdren's Time-Honored Alarmism

John Holdren's manifold predictions of doom and gloom are part of the "environmental litany" that Bjørn Lomborg ably challenges in *The Skeptical Environmentalist*. Here is a sampling of Holdren's views that he perfected back in the 1970s. Until he repudiates these statements, Holdren remains accountable for them.

> "The world faces today a multiplicity of crises: explosive political and ideological conflicts, rampant malnutrition, grinding poverty, and inexorable erosion of the capacity of the natural environment to support life. . . . Together they preclude a humane and fruitful existence for a considerable fraction of the world's inhabitants, they bid fair to destroy such worthwhile values as today's civilization may embody, and in their most sinister aspects they imperil even the habitability of the planet."[110]

> "Neither green revolutions, nor population control, nor all the technology man can muster will alone salvage the future. What is required is no less than a revolution in human behavior, one which embodies fundamental reforms in our economic and political institutions, coupled with the wisest technological enterprises, the necessary ingredient of population control, and a new perception of man's place in nature."[111]

> "There are still individuals whose childlike faith in science permits no concession to the finite ability of this planet to support people."[112]

[110] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 1.
[111] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 1.
[112] John Holdren, "Global Thermal Pollution," in Holdren and Paul Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 85.

"The spectacle of headlong mechanization and urbanization of growing populations has been accompanied by a veritable cacophony of ever louder and more discordant sounds."[113]

"We hope this book will offer a sense of the scope of man's predicament, the inadequacy of the piecemeal measures, now being touted as 'solutions,' and the radical implications of viewing the situation in a unified context. . . . To the demonstration that the revolution we advocate—the anxiety and hazards of rapid change notwithstanding—is preferable by far to the alternatives."[114]

"We are not, of course, optimistic about our chances of success. Some form of ecocatastrophe, if not thermonuclear war, seems almost certain to overtake us before the end of the century. (The inability to forecast exactly which one—whether plague, famine, the poisoning of the oceans, drastic climatic change, or some disaster entirely unforeseen—is hardly grounds for complacency.)"[115]

"Anyone who feels more hopeful about getting past the nightmares of the 1970's has only to look beyond them to the monsters of pollution and population rising up in the 1980's and 1990's. Whether we have 10 years or more like 20 to 30, unless we systematically find new large-scale solutions, we are in the gravest danger of destroying our society, our world, and ourselves in any of a number of different ways well before the end of this century."[116]

"The global ecosystem shows symptoms of overloading today; to subject it to several times the strain by making our industrial atrocities universal would surely be suicidal. And, by any reasonable criteria—crime rates, incidence of stress-related diseases, quality of both urban and suburban environments—the quality of life has been declining in the 'developed' countries for some time. That this decline has for the most part escaped widespread notice is a tribute to the adaptability of man."[117]

"A massive campaign must be launched to restore a high-quality environment in North America and to de-develop the United States. . . . Resources and energy must be diverted from frivolous and wasteful uses in overdeveloped countries to filling the genuine needs of underdeveloped countries. This effort must be largely political."[118]

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[113] John Holdren and Paul Ehrlich, "Environmental Roulette, Overpopulation and Potential for Ecocide," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), pp. 69-70.

[114] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 2.

[115] John Holdren and Paul Ehrlich, "What We Must Do, and the Cost of Failure," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 279.

[116] John Platt, "What We Must Do," in John Holdren and Paul Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 282.

[117] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 3.

[118] John Holdren, Anne Ehrlich, and Paul Ehrlich, *Human Ecology: Problems and Solutions* (San Francisco; W.H. Freeman and Company, 1973), p. 279.

"Today the frontiers are gone, and the evidence is mounting that technology cannot hold the law of diminishing returns at bay much longer. Resources being stressed today are often being stressed globally; they will not be replenished from outside the 'system.'"[119]

"The rapacious depletion of our fossil fuels is already forcing us to consider more expensive mining techniques to gain access to lower-grade deposits, such as the oil shales, and even the status of our high-grade uranium ore reserves is not clear-cut."[120]

"In an agricultural or a technological society, each human individual has a negative impact on his or her environment. He is responsible for some of the simplification and resulting destabilization of ecological systems which result from the practice of agriculture. He also participates in the utilization of both renewable and nonrenewable resources."[121]

"Only one rational path is open to us—simultaneous de-development of the [over developed countries] and semi-development of the underdeveloped countries (UDC's), in order to approach a decent and ecologically sustainable standard of living for all in between. By de-development we mean lower per-capita energy consumption, fewer gadgets, and the abolition of planned obsolescence."[122]

"Economists as a group have been guiltier than most in perpetuating the most dangerous myths of this troubled age. . . . Mineral economists rely on the cornucopian dream, in which advancing technology conjures up ever cheaper minerals while consuming ever increasing amounts of energy and the earth's crust to do it."[123]

"We find ourselves firmly in the neo-Malthusian camp. We hold this view not because we believe the world to be running out of materials in an absolute sense, but rather because the barriers to continued material growth, in the form of problems of economics, logistics, management, and environmental impact, are so formidable."[124]

"There is little reason to believe that energy will get cheaper."[125]

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[119] John Holdren and Paul Ehrlich, "Resource Realities," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 8.

[120] John Holdren and Paul Ehrlich, "Population and Panaceas: A Technological Perspective," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 18.

[121] Paul Ehrlich and John Holdren, "Population Growth and Environmental Deterioration," in Paul Ehrlich and Richard Harriman, *How To Be a Survivor* (Rivercity, Mass: Rivercity Press, 1971, 1975), p. 161.

[122] John Holdren and Paul Ehrlich, "Introduction," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 3.

[123] John Holdren and Paul Ehrlich, "Prospects for a Sane Economics," in Holdren and Ehrlich, eds., *Global Ecology* (New York: Harcourt Brace Jovanovich, 1971), p. 177.

[124] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 954.

[125] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 954.

"A 'business as usual' energy future … is so likely to be massively problematic economically, environmentally, and politically that it cannot be achieved even [if] it is attempted."[126]

Appendix C: Holdren and Energy Realism

John Holdren in his role as energy policy analyst has taken positions that have typically been unduly pessimistic, alarmist, and, with the passage of time, wrong. But some statements and positions have informed the debate. This section considers Holdren's *energy realism*—quotations that can often be used against his analysis elsewhere—as well as against his penchant for government activism that would make energy *less* plentiful and *less* affordable.

"Fossil fuels supply more than three-quarters of primary energy worldwide and 85 percent of primary energy in the United States, and they will remain a mainstay of energy supply for many decades to come."[127]

"In the context of the near-term and medium-term alternatives, coal is too good not to use. Coal, coupled with a large measure of energy conservation and requisite environmental safeguards, can make an important contribution as we steer a judicious course between the twin perils of too little energy and too much."[128]

"Variability has been the hallmark of climate over the millennia. The one statement about future climate that can be made with complete assurance is that it will be variable."[129]

"Probably the least sophisticated approach to the analysis of depletion is to estimate the lifetime of the supply by dividing present proved reserves by the present rate of consumption."[130]

"Unlike energy's economic costs and benefits, its environmental liabilities usually do not lend themselves to monetary characterization. Some environmental effects are resistant to quantification of any sort. Others are susceptible to quantification in principle but pose difficulties in practice because the links between cause and effect are poorly understood. And

[126] John Holdren, "Federal Energy Research and Development for the Challenges of the 21st Century," in Lewis Branscomb and James Keller, eds., *Investing in Innovation: Creating a Research and Innovation Policy That Works* (Cambridge, MA: The MIT Press, 1998), p. 309.

[127] John Holdren, Harvard University, testimony in *National Energy Issues*, Hearing before the Committee on Energy and Natural Resources, United States Senate, 107th Cong., 1st Sess. (Washington: Government Printing Office, 2001), p. 165.

[128] John Holdren, "Coal in Context: Its Role in the National Energy Future," *University of Houston Law Review*, July 1978, p. 1109.

[129] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 58.

[130] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 400.

even when environmental damages can be quantified rather precisely, it can be difficult or impossible to compare one category of harm with the next."[131]

The Benefits of Affordable Energy

"When energy is scarce or expensive, people can suffer material deprivation and economic hardship."[132]

"Energy is an indispensable ingredient of material prosperity. . . . Where and when energy is in short supply or too expensive, people suffer from lack of direct energy services (such as cooking, heating, lighting, and transport) and from inflation, unemployment, and reduced economic output."[133]

"Supplying energy to the economy contributes to the production of a stream of economic goods and services generally supportive of well-being."[134]

"A reliable and affordable supply of energy is absolutely critical to maintaining and expanding economic prosperity where such prosperity already exists and to creating it where it does not."[135]

"Affordable energy in ample quantities is the lifeblood of the industrial societies and a prerequisite for the economic development of the others."[136]

"Energy is the prime mover of technology and an essential ingredient in fashioning a decent standard of living."[137]

Renewable Energy Limits

"There is no energy technology presently known or imagined (solar energy not excepted) with negligible environmental impact."[138]

Solar

"The solar option will not be entirely free of significant impacts. For example, materials requirements for covering large areas with collectors will be significant; extracting and processing those materials will produce some environmental disruption. Extensive land use itself, pre-empting other uses, is a significant effect. Installation of large solar-electric plants in

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[131] John Holdren, "Energy Hazards: What to Measure, What to Compare," *Technology Review*, April 1982, pp. 33-34.

[132] John Holdren, "Population and the Energy Problem," *Population and Environment: A Journal of Interdisciplinary Studies*, Spring 1991, p. 231.

[133] John Holdren, Population and the Energy Problem," *Population and Environment: A Journal of Interdisciplinary Studies*, Spring 1991, p. 232.

[134] John Holdren, "Coal in Context: Its Role in the National Energy Future," *University of Houston Law Review*, July 1978, p. 1089.

[135] John Holdren, "Memorandum to the President: The Energy-Climate Challenge," in Donald Kennedy and John Riggs, eds., *U.S. Policy and the Global Environment: Memos to the President* (Washington, D.C.: The Aspen Institute, 2000), p. 21.

[136] John Holdren, "Meeting the Energy Challenge," *Science,* February 9, 2001, p. 945.

[137] Paul Ehrlich and John Holdren, "The Energy Crisis," *Saturday Review*, August 7, 1971, p. 50.

[138] John Holdren, "Energy Costs as Potential Limits to Growth," in Dennis Pirages, ed, *The Sustainable Society: Implications for Limited Growth* (New York: Praeger Publishers, 1977), p. 71.

the sunny Southwest would probably encourage extensive industrial and residential development of fragile and scenic desert areas there."[139]

"Solar energy is unevenly distributed, dilute, and presently expensive to harness."[140]

"Using sunlight to make electricity with photovoltaic cells remains 3 to 5 times more expensive than fossil-fueled electricity generation, despite very substantial reductions in the costs of photovoltaics over the last two decades."[141]

"Solar collectors, biomass plantations, and hydroelectric reservoirs can occupy a lot of land; overharvesting biomass can cause deforestation and soil degradation, and processing and burning biomass fuels can pollute water and air; lining mountain ridges and coastal promontories with windmills may offend aesthetic sensibilities; manufacturing photovoltaic cells can involve substantial quantities of toxic substances."[142]

"The attractions of sunlight as an energy source have been offset by its diluteness (requiring large collector areas if large amounts are to be captured) and its intermittency (requiring some form of energy storage or back-up supply if energy needs at night and in cloudy weather). These characteristics have tended to make solar energy (and wind, which shares them) more expensive than hydropower and biomass—and, until now, more expensive than fossil fuels."[143]

"It is nonsense to argue, as [Barry] Commoner does, that no [population] limit could possibly be near because the sunlight reaching the land area of the planet is more than a thousand times the current rate of energy use by civilization. In reality, it is far from obvious that civilization could harness more than a few percent of this flow (which, after conversion to electricity and fluid fuels, would represent a much smaller quantity of usable energy) without intolerable disruption of the critical ecological and geophysical processes that are driven by solar energy."[144]

Windpower

"Windmills have been used to pump water and turn grindstones for centuries, and they are still in extensive use for pumping in many parts of the world today."[145]

"Windpower at the best sites has monetary costs not dissimilar to those of new hydro development—in the range of 1 to 1.5 times the costs of electricity generation from fossil fuels—but much smaller ecological impacts."[146]

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[139] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 471.

[140] Paul Ehrlich and John Holdren, "The Energy Crisis," *Saturday Review*, August 7, 1971, p. 50.

[141] John Holdren, "The Transition to Costlier Energy," in Lee Schipper, Stephen Meyers, et al, *Energy Efficiency and Human Activity: Past, Trends, Future Prospects* (Cambridge, UK: Cambridge University Press, 1992), p. 32.

[142] John Holdren, "Solar and Other Renewable Energy Sources," in Ruth Eblen and William Eblen, eds. *The Encyclopedia of the Environment* (New York: Houghton Mifflin, 1994), pp. 660-61.

[143] John Holdren, "Solar and Renewable Energy Sources," in Ruth Eblen and William Eblen, eds. *The Encyclopedia of the Environment* (New York: Houghton Mifflin, 1994), p. 660.

[144] John Holdren, Population and the Energy Problem," *Population and Environment: A Journal of Interdisciplinary Studies*, Spring 1991, p. 252.

[145] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 477.

"For basic physical reasons, windmills cannot extract all the energy that passes through the swept area. The theoretical maximum is about 60 percent for windmills with horizontal axes, and only a fraction of that theoretical limit can actually be attained by existing machines."[147]

Hydrogen

"Much research and development remains to be done before hydrogen and its derivatives see widespread use as fuel, but enthusiasts see such advantages that they already have coined the term *the hydrogen economy* to describe a hydrogen-centered energy system of the future."[148]

Hydropower

"Much of the potential of specific hydroelectric sites is typically destroyed within one to three centuries when the reservoirs fill with silt. No real solution for this problem is yet known."[149]

"Hydropower is clearly a renewable energy source, but some studies have not included it in their tabulations, either because it is a 'conventional' technology or because it seems less obviously 'solar' than, say photovoltaic cells or direct use of sunlight for heated buildings. Whether geothermal energy should be considered 'renewable' is arguable; most studies tabulate it separately, but some lump it together with hydropower. Biomass energy sometimes is not included at all and often is covered very incompletely—a situation not difficult to understand in view of the diversity of biomass forms and processes that might be used to supply energy. Popular accounts summarizing studies of the potential contribution of 'solar' or 'renewable' energy sources rarely are specific about what was actually included, so anyone interested in sorting out the differences must delve into the (often obscure) original reports."[150]

"Hydroelectric plants are not without adverse environmental and social impacts. The spawning grounds of migratory fishes of commercial and recreational importance, such as salmon, are often destroyed by hydroelectric facilities, or the fishes are prevented from reaching them. Other wildlife habitat and valuable farmland may be destroyed, and long-time human residents forced to move. Seepage from reservoirs can raise a water table and bring subsurface salts with it, impairing the fertility of the soil. Stream conditions downstream from dams can be greatly altered, and estuaries and the associated fisheries can be affected. Rapid fluctuations of river levels with the intermittent operation of the hydro plants—which are especially cherished by utilities for their ability to start rapidly when the need arises—can be especially disruptive."[151]

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[146] John Holdren, "The Transition to Costlier Energy," in Lee Schipper, Stephen Meyers, et al, *Energy Efficiency and Human Activity: Past, Trends, Future Prospects* (Cambridge, UK: Cambridge University Press, 1992), p. 32.

[147] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 477.

[148] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 482.

[149] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 476.

[150] John Holdren, "Renewables in the U.S. Energy Future: How Much, How Fast?" *Energy*, Vol. 6, No. 9 (1981), pp. 902-03.

[151] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 476.

"The very dilution of the largest natural energy flows, which makes them seem 'gentle' in comparison with nonrenewables, means that large structures (e.g. collector fields, arrays of windmills) ordinarily are required to harness them in interesting amounts. This property tends to mean significant use of land and heavy materials requirements for the collecting systems. Land use for energy systems can preempt other economic activities. . . . Such land use also can disrupt ecosystems and offend aesthetic sensibilities. Extraction, transport, and processing of materials can produce their own hazards to ecosystems as well as to health and safety."[152]

"Construction of new large dams for hydropower is arguably the worst electricity option in terms of damage to ecosystems per unit of electrical energy or generating capacity provided. Dam construction alters drastically—effectively consumes—an increasingly scarce ecological resource: free-flowing rivers and the bottomland in river valleys."[153]

"Unexploited hydroelectric sites are in limited supply, and their development compromises other values."[154]

Geothermal

"Geothermal energy . . . ranges in its various manifestations from nonrenewable to effectively renewable."[155]

Biomass

"Biomass fuels that rank next in importance behind fossil fuels as contributors to world energy supply are themselves significant air polluters as well as contributors, in many circumstances, to deforestation and impoverishment or erosion of soils."[156]

"Biomass energy, if replaced continuously by new growth, avoids the problem of net CO_2 production, but the costs of controlling the other environmental impacts of cultivation, harvesting, conversion and combustion of biomass will be substantial."[157]

Indoor Air Pollution

"Most people spend most of their time in places where air quality is neither monitored nor regulated—in homes, offices, classrooms, stores, cars, buses, planes, and other enclosed places. Ironically, the concentrations of air pollutants in these heavily used indoor environments often exceed those that are permitted outdoors."[158]

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[152] John Holdren, "Environmental Aspects of Renewable Energy Sources," *Annual Review of Energy*, Vol. 5, 1980, p. 248.

[153] John Holdren, "Environmental Aspects of Renewable Energy Sources," *Annual Review of Energy*, Vol. 5, 1980, p. 254.

[154] Paul Ehrlich and John Holdren, "The Energy Crisis," *Saturday Review*, August 7, 1971, p. 50.

[155] John Holdren, "Environmental Aspects of Renewable Energy Sources," *Annual Review of Energy*, Vol. 5, 1980, p. 281.

[156] John Holdren, Population and the Energy Problem," *Population and Environment: A Journal of Interdisciplinary Studies*, Spring 1991, p. 233.

[157] John Holdren, "Energy in Transition," *Scientific American*, September, 1990, p. 161.

[158] Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, and Environment* (San Francisco: W. H. Freeman and Company, 1977), p. 552.

"Considerably more certain . . . [than] the external public-health damages from coal-fired and nuclear-electricity generation, although unmentioned by most energy analysts, is the tremendous public-health menace represented by indoor air pollution created by the traditional fuels widely used for cooking and water heating in the rural Third World."[159]

"Perhaps 80 percent of global exposure to particulate air pollution occurs indoors in developing countries, where the smoke from primitive stoves is heavily laden with carcinogenic benzopyrene and other dangerous hydrocarbons. A disproportionate share of this burden is borne, moreover, by women (who do the cooking) and small children (who are indoors with their mothers)."[160]

Economic-Environmental Link

"Countries straining to keep up with feeding, housing, educating, and providing jobs and medical care for populations doubling every 20 to 40 years are unlikely to marshal the managerial and technical resources needed to minimize energy's environmental impacts."[161]

[159] John Holdren, "The Transition to Costlier Energy," in Lee Schipper, Stephen Meyers, et al, *Energy Efficiency and Human Activity: Past, Trends, Future Prospects* (Cambridge, UK: Cambridge University Press, 1992), p. 17.

[160] John Holdren, "Energy in Transition," *Scientific American*, September, 1990, p. 160.

[161] John Holdren, Population and the Energy Problem," *Population and Environment: A Journal of Interdisciplinary Studies*, Spring 1991, p. 249.