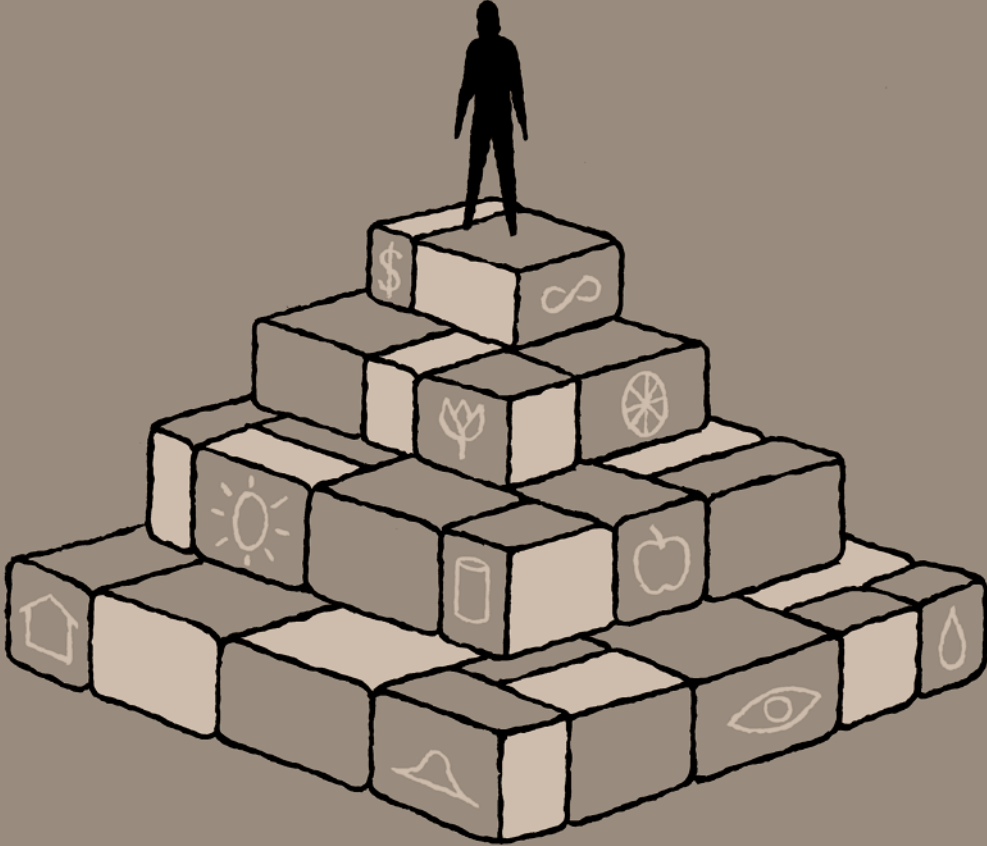


The Post Carbon Reader Series: Foundation Concepts

What Is Sustainability?

By Richard Heinberg



About the Author

Richard Heinberg is widely regarded as one of the world's most effective communicators of the urgent need to transition away from fossil fuels. He is the author of nine books, including *The Party's Over: Oil, War and the Fate of Industrial Societies* (2003), *Powerdown: Options and Actions for a Post-Carbon World* (2004), and *Blackout: Coal, Climate and the Last Energy Crisis* (2009). He has authored scores of essays and articles, is featured in many documentaries, and has appeared on numerous television and radio programs. Heinberg is Senior Fellow-in-Residence at Post Carbon Institute.



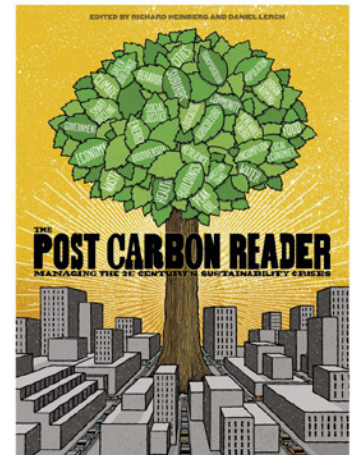
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The word ‘sustainable’ has become widely used to refer merely to practices that are reputed to be more environmentally sound than others.

The essence of the term *sustainable* is “that which can be maintained over time.” By implication, this means that any society that is unsustainable cannot be maintained for long and will cease to function at some point.

Unfortunately, in recent years the word *sustainable* has become widely used to refer merely to practices that are reputed to be more environmentally sound than others. Often the word is used so carelessly as to lead some environmentalists to advise abandoning its use.¹ Nevertheless, the concept is indispensable and should be the cornerstone for all long-range planning.

It is probably safe to assume that no human living arrangement can be maintained forever. Astronomers assure us that in several billion years the Sun will have heated to the point that Earth’s oceans will boil away. Thus *sustainability* is a relative term. It seems reasonable to use as a frame of reference for the durations of prior civilizations, ranging from hundreds to thousands of years. A sustainable society, then, would be able to maintain itself for many centuries at least.

How Do We Define Sustainability?

The concept of sustainability has been embodied in the traditions of many indigenous peoples; for example, it was a precept of the Iroquois Confederacy’s *Gayanashagowa*, or Great Law of Peace, that chiefs

consider the impact of their decisions on the seventh generation to come.

The first known European use of the word *sustainability* (German: *Nachhaltigkeit*) occurred in 1713 in the book *Sylvicultura Oeconomica* by German forester and scientist Hans Carl von Carlowitz. Later, French and English foresters adopted the practice of planting trees as a path to “sustained-yield forestry.”

The term gained widespread usage after 1987, when the Brundtland Report from the United Nations’ World Commission on Environment and Development defined *sustainable development* as development that “meets the needs of the present generation without compromising the ability of future generations to meet their own needs.”² This definition of sustainability has proved extremely influential and is still widely used; nevertheless, it has been criticized for its failure to explicitly note the unsustainability of the use of nonrenewable resources and for its general disregard of the problem of population growth.³

Also in the 1980s, Swedish oncologist Dr. Karl-Henrik Robèrt brought together leading scientists to develop a consensus on requirements for a sustainable society. In 1989 Robèrt formulated this consensus in four system conditions for sustainability, which in turn became the basis for an organization, the Natural Step. Subsequently, many businesses and municipalities around the world

pledged to abide by Natural Step conditions. The four conditions are as follows:

In a sustainable society, nature is not subject to systematically increasing:

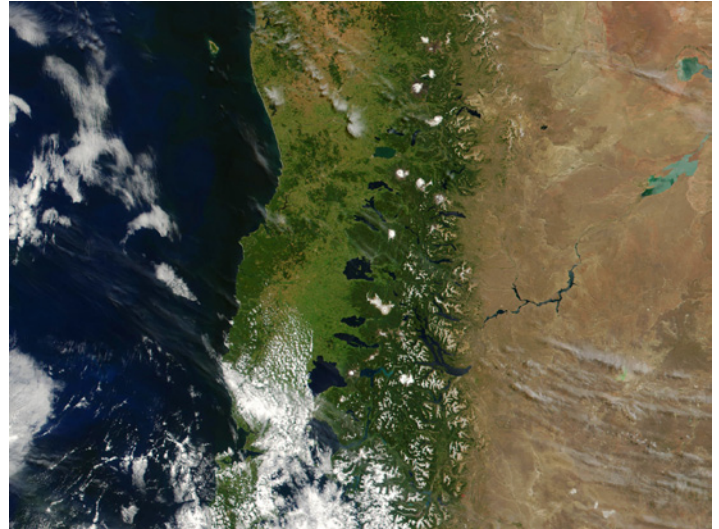
1. concentrations of substances extracted from the earth's crust.
2. concentrations of substances produced by society.
3. degradation by physical means.

And, in that society:

4. people are not subject to conditions that systematically undermine their capacity to meet their needs.⁴

Seeing the need for an accounting or indicator scheme by which to measure sustainability, Canadian ecologist William Rees and graduate student (at the time) Mathis Wackernagel developed in the early 1990s the concept of the "ecological footprint," defined as the amount of land and water area a human population would hypothetically need to provide the resources required to support itself and to absorb its wastes, given prevailing technology.⁵ Implicit in the scheme is the recognition that, for humanity to achieve sustainability, the total world population's footprint must be less than the total land and water area of Earth (that footprint is currently calculated by the Global Footprint Network as being about 40 percent larger than the planet can regenerate, indicating that humankind is to this extent overconsuming resources and operating in an unsustainable manner).

A truly comprehensive historical survey of the usage of the terms *sustainable* and *sustainability* is not feasible. A search of Amazon.com for *sustainability* (April 1, 2010) yielded 8,875 book titles containing the word. A search of journal articles on Google Scholar turned up 108,000 hits, indicating many thousands of scholarly articles with the word *sustainability* in their titles. However, a perusal of the literature suggests that most



of this immense body of work repeats, or is based on, the definitions and conditions described above.

Five Axioms of Sustainability

As a contribution to this ongoing refinement of the concept, I recently formulated five axioms (self-evident truths) of sustainability.⁶ My goal was simply to distill ideas that had been proposed previously and put them into a concise, easy-to-understand form.

In formulating these axioms, my criteria were as follows:

- To qualify as an axiom, a statement must be capable of being tested using the methodology of science.
- Collectively, a set of axioms intended to define *sustainability* must be minimal (with no redundancies).
- At the same time, the axioms must be sufficient, leaving no glaring loopholes.
- The axioms should be worded in terms a layperson can understand.

Here are the axioms, each followed by a brief discussion:

THE FIRST AXIOM

Any society that continues to use critical resources unsustainably will collapse.

***Exception:* A society can avoid collapse by finding replacement resources.**

***Limit to the exception:* In a finite world, the number of possible replacements is also finite.**

Archaeologist Joseph Tainter, in his classic study *The Collapse of Complex Societies* (1988), demonstrated that collapse is a frequent if not universal fate of complex societies and argued that collapse results from declining returns on efforts to support growing levels of societal complexity using energy harvested from the environment.⁷ Jared Diamond's popular book *Collapse: How Societies Choose to Fail or Succeed* (2005) similarly makes the argument that collapse is the common destiny of societies that ignore resource constraints.⁸

This axiom defines sustainability by the consequences of its absence—that is, collapse. Tainter defines *collapse* as a reduction in social complexity—that is, a contraction of society in terms of its population size, the sophistication of its technologies, the consumption rates of its people, and the diversity of its specialized social roles. Historically, *collapse* has often meant a precipitous decline in population brought about by social chaos, warfare, disease, or famine. However, collapse can also occur more gradually over a period of many decades or even centuries. There is also the theoretical possibility that a society could choose to reduce its complexity in a controlled, gradual manner.

While it could be argued that a society can choose to change rather than collapse, the only choices that would substantively affect the outcome would be to cease using critical resources unsustainably or to find alternative resources.

A society that uses resources sustainably may collapse for other reasons, some beyond the society's control (as a result of an overwhelming natural disaster or of conquest by another, more aggressive society, to name just

two of many possibilities), so it cannot be said that a sustainable society is immune to collapse unless many conditions for sustainability are specified. This first axiom focuses on resource consumption because that is a decisive, quantifiable, and, in principle, controllable determinant of a society's long-term survival.

The question of what constitutes sustainable or unsustainable use of resources is addressed in the third and fourth axioms.

Critical resources are those that are essential to the maintenance of life and basic social functions—including (but not necessarily limited to) water and the resources necessary to produce food and usable energy.

The first axiom's "exception" and "limit to the exception" address the common argument of free-market economists that resources are infinitely substitutable, and that therefore modern market-driven societies need never face a depletion-led collapse, even if their consumption rates continue to escalate.⁹ In some instances, substitutes for resources become readily available and are even superior, as was the case in the mid-nineteenth century when kerosene from petroleum was substituted for whale oil as a fuel for lamps. In other cases, substitutes are inferior, as is the case with oil sands as a substitute for conventional petroleum, given that oil sands are less energy dense, require more energy input for processing, and produce more carbon emissions. As time goes on, societies will tend first to exhaust substitutes that are superior and easy to get at, then those that are equivalent, and increasingly will have to rely on ever more inferior substitutes to replace depleting resources—unless rates of consumption are held in check.

THE SECOND AXIOM

Population growth and/or growth in the rates of consumption of resources cannot be sustained.¹⁰

Human population growth has been sustained up to the present. How can we be sure that it cannot be sustained into the indefinite future? Simple arithmetic can be used to show that even small rates of growth,

No continuous rate of use of any nonrenewable resource is sustainable.

if continued, add up to absurdly large—and plainly unsupportable—population sizes and rates of consumption. For example, a simple 1 percent rate of growth in the present human population (less than the actual current rate) would result in a doubling of population each 70 years. Thus in 2075, Earth would be home to 13 billion humans; in 2145, 26 billion; and so on. By the year 3050, there would be one human per square meter of Earth’s land surface (including mountains and deserts). Virtually no one expects this to occur—at some point, population growth will cease. Similar calculations apply to consumption rates.

THE THIRD AXIOM

To be sustainable, the use of *renewable* resources must proceed at a rate that is less than or equal to the rate of natural replenishment.

Renewable resources are exhaustible. Forests can be overcut, resulting in barren landscapes and shortages of wood (as occurred in many parts of Europe in past centuries), and fish can be overharvested, resulting in the extinction or near extinction of many species (as is occurring today globally).

This axiom has been stated (in somewhat different ways) by many economists and ecologists and is the basis for “sustained-yield forestry” (see above) and “maximum-sustainable-yield” fishery management.¹¹

The term “rate of natural replenishment” requires some discussion. The first clue that harvesting is proceeding at a rate greater than that of natural replenishment is the decline of the resource base. However, a resource may be declining for reasons other than overharvesting; for example, a forest that is not being logged may be decimated by disease. Nevertheless, if the resource is declining, pursuit of the goal of sustainability requires that the rate of harvest be reduced, regardless of the cause of resource decline. Sometimes harvests must drop dramatically, at a rate far greater than the rate of resource decline, so that the resource has time to recover. This has been the case with regard to commercial wild whale and fish species that have been overharvested to the point of near extinction; a moratorium on harvesting these species was necessary for them to recover. If the remaining breeding population is too small, however, even a moratorium is insufficient and the species cannot recover.

THE FOURTH AXIOM

To be sustainable, the use of *nonrenewable* resources must proceed at a rate that is declining, and the *rate of decline* must be greater than or equal to the *rate of depletion*.

The *rate of depletion* is defined as the amount being extracted and used during a specified time interval

(usually a year) as a percentage of the amount left to extract.

No continuous rate of use of any nonrenewable resource is sustainable. However, if the rate of use is declining at a rate greater than or equal to the rate of depletion, this can be said to be a sustainable situation because society's dependence on the resource will be reduced to insignificance before the resource is exhausted.¹²

Estimates of the "amount left to extract," mentioned in the axiom, are disputable for all nonrenewable resources. Unrealistically robust estimates would tend to skew the depletion rate in a downward direction, undermining efforts to attain sustainability via a resource-depletion protocol. It may be realistic to assume that people in the future will find ways to extract nonrenewable resources more thoroughly, with amounts that would otherwise be left in the ground becoming economically recoverable as a result of higher commodity prices and improvements in extraction technology. Exploration techniques are likely to improve as well, leading to further discoveries of the resource. Thus, realistic estimates of ultimately recoverable quantities should be greater than what is now known to be extractable using current technology and at current prices. However, it is unrealistic to assume that people in the future will ever be able to economically extract all of a given resource or that limits of declining marginal returns in the extraction process will no longer apply. Moreover, if discovery rates are currently declining, it is probably unrealistic to assume that discovery rates will increase substantially in the future. Thus, for any nonrenewable resource, prudence dictates adhering to conservative estimates of the "amount left to extract."¹³

THE FIFTH AXIOM

Sustainability requires that substances introduced into the environment from human activities be minimized and rendered harmless to biosphere functions.

In cases where pollution from the extraction and consumption of nonrenewable resources has proceeded



at expanding rates for some time and threatens the viability of ecosystems, reduction in the rates of extraction and consumption of those resources may need to occur at a rate greater than the rate of depletion.

If the second, third, and fourth axioms are followed, pollution should be minimized as a result. Nevertheless, these conditions are not sufficient in all cases to avert potentially collapse-inducing impacts.

It is possible for a society to generate serious pollution from the unwise use of renewable resources (the use of natural tanning agents on hides damaged streams during preindustrial times), and such impacts are to be avoided. Likewise, especially where large numbers of humans are concentrated, their biological wastes may pose severe environmental problems; such wastes must be properly composted.

The most serious forms of pollution in the modern world arise from the extraction, processing, and consumption of nonrenewable resources. If (as outlined in the fourth axiom) the consumption of nonrenewable resources declines, pollution should also decline. However, in the current instance, where extraction and consumption of nonrenewable resources have been growing for some time and have resulted in levels

of pollution that threaten basic biosphere functions, heroic measures are called for. This is, of course, the situation with regard to atmospheric concentrations of greenhouse gases, especially in relation to the burning of coal; it is also the case with regard to hormone-mimicking petrochemical pollution, which inhibits reproduction in many vertebrate species. In the first instance: Merely to reduce coal consumption by the global coal-depletion rate would not suffice to avert a climatic catastrophe. The coal-depletion rate is small, climate impacts from coal combustion emissions are building quickly, and annual reductions in those emissions must occur at high rates if ecosystem-threatening consequences are to be avoided. Similarly, in the case of petrochemical pollution, merely to reduce the dispersion of plastics and other petrochemicals into the environment by the annual rate of depletion of oil and natural gas would not suffice to avert environmental harms on a scale potentially leading to the collapse of ecosystems and human societies.

If a reduction in emissions or other pollutants can be obtained without a reduction in consumption of non-renewable resources—for example, by using technological means to capture polluting substances and sequester them harmlessly, or by curtailing the production of certain industrial chemicals—then a reduction in consumption of such resources need only occur at the depletion rate in order to achieve sustainability. However, society should be extremely skeptical and careful about claims that untested technologies can safely sequester polluting substances for very long periods of time.

The Five Axioms and a Society's Sustainability

These axioms are, of course, open to further refinement. I have attempted to anticipate criticisms likely to be leveled at them, which will probably be of the sort that says these axioms are not sufficient to define the concept of sustainability. The most obvious of these is worth mentioning and discussing here: *Why is there no*

axiom relating to social equity (similar to fourth condition of the Natural Step framework as noted above)?

The purpose of the axioms set forth here is not to describe conditions that would lead to a good or just society, merely to a society able to be maintained over time. It is not clear that perfect economic equality or a perfectly egalitarian system of decision-making is necessary to avert societal collapse. Certainly, extreme inequality seems to make societies vulnerable to internal social and political upheaval. On the other hand, it could be argued that a society's adherence to the five axioms as stated will tend to lead to relatively greater levels of economic and political equity, thus obviating the need for a separate axiom in this regard (see box 2.1 for further discussion on approaches to the social dimension of sustainability). In anthropological literature, modest rates of resource consumption and low population sizes relative to the available resource base are correlated with the use of egalitarian decision-making processes and with economic equity—though the correlation is skewed by other variables, such as means of sustenance (hunting-and-gathering societies tend to be highly equitable and egalitarian, whereas herding societies tend to be less so). If such correlations continue to hold, the reversion to lower rates of consumption of resources should lead to a more rather than less egalitarian society.

BOX 2.1

Defining Social Sustainability

by Jesse Dillard, Veronica Dujon, and Mary King

Jesse Dillard, Veronica Dujon, and Mary King are faculty members at Portland State University and co-editors of *Understanding the Social Dimension of Sustainability* (2009), one of the first books in the otherwise ecology- and economics-dominated sustainability literature to explore and define the key elements of social sustainability. Dillard is the Retzlaff Chair in Accounting and director of the Center for Professional Integrity and Accountability; Dujon is chair of the department of sociology; and King is a professor of economics.

Sustainability is often thought of as composed of three overlapping, mutually dependent goals:

- a) to live in a way that is environmentally sustainable, or viable over the very long-term,
- b) to live in a way that is economically sustainable, maintaining living standards over the long-term, and
- c) to live in a way that is socially sustainable, now and in the future.

To date, concerns with environmental and economic sustainability have eclipsed efforts to understand the social aspects of sustainability. As noted by several of the authors of chapters in *Understanding the Social Dimension of Sustainability*, thinking on the social aspect of sustainability has been relatively neglected and is by far the least developed. Yet an increasing number of people are attempting to integrate social concerns into their work on sustainability, both theoretically and in practice. That anthology provides guidance for a developing field of thought from a variety of perspectives.

At present consensus does not exist even on a definition of social sustainability. Polese and Stren, writing up the findings of a UNESCO project on the “social sustainability of cities,” identify social sustainability as “policies and institutions that have the overall effect of integrating diverse groups and cultural practices in a just and equitable fashion.”¹

Many analysts have followed Robert Putnam in an exploration of “social capital,” asserted by the World Bank, among others, to consist of “the norms and networks that enable collective action.”² Researchers working in this vein have understood social capital to result from participation in civic institutions. Presumably social sustainability would require that social capital be

maintained at “sustainable” levels for future generations, perhaps requiring social support of effective civic institutions to this end.

Most business sustainability efforts appear to construe social sustainability as charity, performed as an act of public relations. These are “policies that encourage community involvement, volunteering, [and] development of local communities.”³ According to a recent PricewaterhouseCoopers survey of large U.S. businesses, three-quarters of the firms that responded to the survey were implementing some sustainable business practices, though relatively few are pursuing the social leg of the “triple bottom line”—corporate language for meeting financial, environmental, and social objectives as an organization.⁴ Where businesses are attending to the social aspect of sustainability, they are interpreting it as corporate philanthropy and sometimes as policies to help employees achieve “work/family balance” or to avoid burnout.

In urban planning circles, the tripartite understanding of sustainability is sometimes referred to as “the three ‘E’s, environment, economy, and equity.” Social sustainability is conceived of as “equity,” without much thought as to what that might require or whether equity alone is sufficient for social sustainability.

A more thought-out and satisfactory definition of social sustainability is provided by Harris and Goodwin: “A socially sustainable system must achieve fairness in distribution and opportunity, adequate provision of social services, including health and education, gender equity, and political accountability and participation.”⁵ While more solid, this definition still misses the social process required to achieve economic and environmental sustainability that concerns many.

Environmental economists have focused substantial attention on the issue of property rights, with the idea that clear ownership facilitates better environmental management. However, social institutions conducive to better environmental outcomes may have adverse social consequences. Often these social considerations are overlooked, as in the case of ecologists pointing out the ecological advantages of collective management of group resources without noting that the group governance is not democratic, but empowers only a small portion of the community.⁶

Consequently, several contributors to *Understanding the Social Dimension of Sustainability* use a working definition of the social aspect of sustainability developed

over time in our workshops and graduate seminars:

The social dimension of sustainability should be understood as both

a) the processes that generate social health and well-being now and in the future,

and

b) those social institutions that facilitate environmental and economic sustainability now and for the future.

The processes are both a means to, and an end of, social sustainability. Indeed, for the social aspect of sustainability in particular, processes may often be more important than outcomes. For instance, high rates of literacy achieved by a citizenry engaged in a democratic planning process, as in Kerala, India, may be far more socially sustainable than even higher rates of literacy accomplished in an authoritarian fashion.⁷ However, an adequate working definition of the social aspect of sustainability represents only the first step in developing an understanding of the concept.

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- 10 This is Albert Bartlett's first law of sustainability, reproduced verbatim—I found it impossible to improve upon. Albert A. Bartlett, "Reflections on Sustainability, Population Growth, and the Environment," *Population & Environment* 16, no. 1 (September 1994), 5–35.
- 11 Efforts to refine this essential principle of sustainability are ongoing.
- 12 This principle was first stated, in a more generalized and more mathematically rigorous form, by Albert A. Bartlett in his 1986 paper "Sustained Availability: A Management Program for Non-Renewable Resources," *American Journal of Physics* 54 (May 1986), 398–402. The article's abstract notes: "If the rate of extraction declines at a fixed fraction per unit time, the rate of extraction will approach zero, but the integrated total of the extracted resource between $t = 0$ and $t = \text{infinity}$ will remain finite. If we choose a rate of decline of the rate of extraction of the resource such that the integrated total of all future extraction equals the present size of the remaining resource then we have a program that will allow the resource to be available in declining amounts for use forever." Annually reducing the rate of extraction of a given nonrenewable resource by its yearly rate of depletion effectively accomplishes the same thing, but requires only simple arithmetic and layperson's terms for its explanation.
- 13 The fourth axiom encapsulates Bartlett's seventh and eighth laws of sustainability. It is also the basis for the Oil Depletion Protocol, first suggested by petroleum geologist Colin J. Campbell in 1996 and the subject of one of my books: Richard Heinberg, *The Oil Depletion Protocol: A Plan to Avert Oil Wars, Terrorism and Economic Collapse* (Gabriola, BC: New Society, 2006). The aim of the oil-depletion protocol is to reduce global consumption of petroleum to avert the crises likely to ensue as a result of declining supply—including economic collapse and resource wars. Under the terms of the oil-depletion protocol, oil-importing countries would reduce their imports by the world oil-depletion rate (calculated by Campbell at 2.5 percent per year); producers would reduce their domestic production by their national depletion rates.

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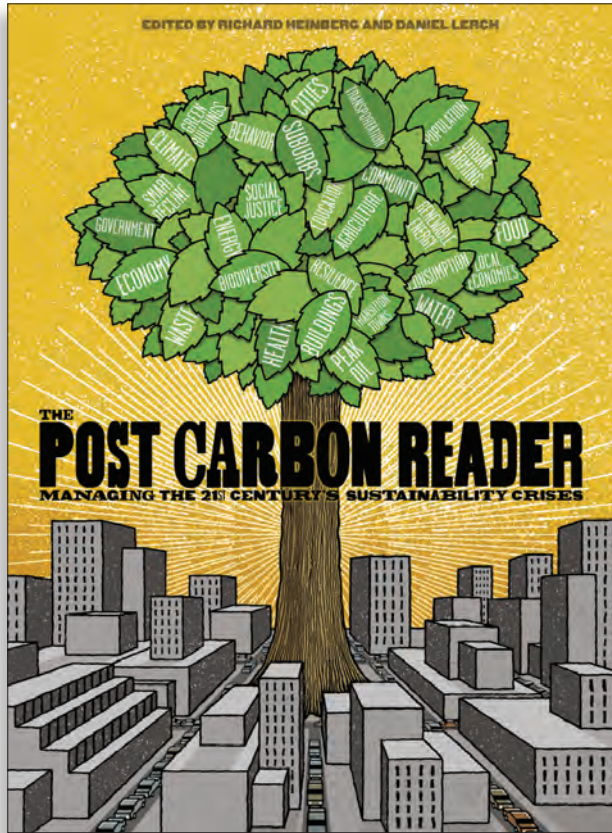
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The Post Carbon Reader

Managing the 21st Century's Sustainability Crises

Edited by **RICHARD HEINBERG** and **DANIEL LERCH**

In the 20th century, cheap and abundant energy brought previously unimaginable advances in health, wealth, and technology, and fed an explosion in population and consumption. But this growth came at an incredible cost. Climate change, peak oil, freshwater depletion, species extinction, and a host of economic and social problems now challenge us as never before. *The Post Carbon Reader* features articles by some of the world's most provocative thinkers on the key drivers shaping this new century, from renewable energy and urban agriculture to social justice and systems resilience. This unprecedented collection takes a hard-nosed look at the interconnected threats of our global sustainability quandary—as well as the most promising responses. *The Post Carbon Reader* is a valuable resource for policymakers, college classrooms, and concerned citizens.

Richard Heinberg is Senior Fellow in Residence at Post Carbon Institute and the author of nine books, including *The Party's Over* and *Peak Everything*. **Daniel Lerch** is the author of *Post Carbon Cities*.

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