

Robert A. Meyers (Ed.)

Encyclopedia of Sustainability Science and Technology

With 5917 Figures and 1553 Tables



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Editor
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Preface



Editor in chief Bob Meyers at the Aranal Volcano in Costa Rica

Our team consisted of nearly 1,000 chemists, biologists, environmentalists, agronomists, physicists, mathematicians, and engineers who have prepared, supervised, or peer reviewed the content of this *Encyclopedia*. Our magnum opus is a 18-volume 12555-page resource available in both print and online, of over 550 peer-reviewed, detailed articles defining the science and technology basis for providing for the sustainability of the earth as global population and the needs of that population increase dramatically. We plan to continually update our articles as new technology and data become available such that this *Encyclopedia* will remain the most up-to-date compendium of sustainability science and technology available. This encyclopedic treatment has been prepared by scientists and engineers for other scientists and engineers as well as planners and evaluators, in a format which allows experts in one field to easily understand detailed treatments of fields not within their area of expertise. These entries form a scientific basis for the huge volume of sustainability evaluations and studies as well as research and business decisions, being performed within thousands of institutions worldwide. This new *Encyclopedia* is a natural follow-on and is symbiotic with our recently completed *Encyclopedia of Complexity and Systems Science*, which provides key mathematical and modeling tools for understanding such diverse complex systems as cosmology, earthquakes, volcanoes, tsunamis, molecular biology, traffic management, and robotics as well as econometrics and sustainability of the earth.

We have established an advisory board of nineteen of the most prominent experts in sustainability which includes five Nobel Laureates and a co-recipient of the Nobel Peace Prize for climate change research, as well as a group of 41 section editors who have overseen the content of each of the 38 topical areas and coordinated the near 1,000 authors and peer reviewers who prepared and reviewed the entries.

The content of the *Encyclopedia* includes:

- Solar energy (thermal, photovoltaic, thermal electric)
- Renewables (wind, ocean thermal, biomass, ethanol, and other biofuels)
- Geothermal
- Fossil energy technologies (extraction, production, storage, transport)
- Nuclear energy
- Electrical generation and transmission

- Green chemistry and engineering
- Transportation
- Conservation
- Science and technology of the sustainable built environment
- Pollution sources, statistics, measurement, and control
- Natural resources
- Food production and technology
- Oceans farming and oceans and human health
- Fresh water resources, water purification, and desalinization
- Social ecological systems
- Biological ecological systems
- Green practices
- Climate change data, mitigation, and modeling
- Earth system monitoring
- Earth system modeling and economics
- Health and infectious diseases and epidemiology

This list of topics clearly sets our project apart from compendia and publications which now exist, in both extent and depth. In fact, current compendia of the science and technology of several of these topics do not presently exist and yet the content is crucial to any evaluation and planning for the sustainability of the earth.

Vital scientific issues include: human and animal ecological support systems, energy supply, and effects; the planet's climate system; systems of agriculture, industry, forestry, and fisheries; the ocean, fresh water, and human communities; waste disposal, transportation, and the built environment in general and the various systems on which they depend; and the balance of all of these with sustainability. In this context, sustainability is a characteristic of a process or state that can be maintained at a certain level indefinitely even as global population increases toward 9 billion by 2050. The population growth, and the hope for increase in wealth, implies something like a 50% increase in food demand by as early as 2030. At the same time, the proportion of the population that lives in an urban environment will go up from about 47 to 60%. Global economic activity is expected to grow 500%, and global energy and materials use is expected to increase by 300% over this period. That means there are going to be some real problems for energy, agriculture, and water, and it is increasingly clear that conflicting demands among biofuels, food crops, and environmental protection will be difficult to reconcile. The "green revolution" was heavily dependent on fertilizers which are manufactured using increasingly expensive and diminishing reserves of fossil fuels. In addition, about 70% of available freshwater is used by agriculture. Clearly, many natural resources will become either depleted or scarce relative to population. This *Encyclopedia* is founded on two major assumptions. First, we acknowledge that any true measure of sustainability must include some consideration of the number of people to be supported and at what standard of living. In this respect, population is a linchpin in attempts to understand and achieve sustainability. While top-down approaches to controlling population growth, maintaining biodiversity, etc., certainly do exist, science and technology and the resulting innovation economy is a bottom-up affair involving individuals and teams of individuals in publicly funded scientific laboratories and private corporations. This process is essentially unpredictable, resulting in a great range of promising technologies that are individually dwarfed by the scope of the challenge but represent essential contributions to sustainability.

While there are many Web-based and even some print encyclopedic treatments of sustainability science in the broad sense, none are comprehensive and rise to the university or professional scientist and engineer level needed to support real progress from the bottom up. The emphasis for the *Encyclopedia of Sustainability Science and Technology* team is on science and technology and not on policy and positions. Rather, this *Encyclopedia* is a comprehensive and authoritative resource for policy makers who want to understand how scientific and technological innovations

in all fields map onto the true scope of the sustainability challenge and will also be a major resource for scientists and engineers in developing new technologies and for applying existing technologies to sustainability. Further, we plan to maintain our 1,000-scientist and engineer team to continually update our content.

Among the topics covered are: the chemistry, physics, modeling, and engineering of green chemistry for industry, water use, and recovery; crop production including precision farming, genetic modification of crops, with forest maintenance; all types of energy production, electric utility as well as small-scale electric generation (fossil fuel as well as nuclear fission and fusion, solar electric and thermal and renewable) and mass and personal transportation with fuel modification, power source variation, pollution control, and waste disposition; solid waste utilization, recycle, and disposition; urban planning and the built environment; environmental quality; engineering mitigation, adaptation, and forecasting of global warming, and any possible cooling due to solar-earth insolation dimming; geoengineering and greenhouse effect mitigation measures; measurement and observation systems (terrestrial and from space); analytical chemistry methods for the biosphere, including indoor pollution and industrial hygiene; disease prevention and treatment; and catastrophic event (e.g., volcanic eruption, tsunamis, cyclones, tornadoes) measurement and mitigation.

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Robert A. Meyers
Editor in Chief
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