

## 15.1: Sustainability and Energy

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Excluding the social and institutional problems of sustainability (as examples those of overpopulation or of vested economic interests that are environmentally counterproductive), sustainability issues are overwhelmingly energy issues. Most environmental and sustainability problems can be solved if abundant sources of energy are available and if they can be used without doing unacceptable harm to the environment. Consider the following:

- Material resources: With abundant energy, materials can be obtained in adequate quantities from sources normally considered to be marginal, such as metals from low-grade ores and organics from unconventional sources (even carbon dioxide can be converted to organics if energy is not an issue).
- Water: Earth has large quantities of water that is not suitable for domestic and other uses. If enough energy is available, saline ocean and ground water can be desalinated by distillation or reverse osmosis and wastewater can be purified to drinking water standards.
- Wastes: With enough energy the volume of municipal wastes can be greatly reduced and converted to a harmless mineral residue. Hazardous wastes can be made nonhazardous, their volume greatly reduced, and placed where they will do no harm.
- Food: Abundant energy enables production of adequate amounts of food. Water desalination, wastewater purification, and pumping water for long distances can provide needed irrigation water. Marginal land can be leveled and terraced and rocks crushed to a size that permits cultivation. High-value specialty foods can be grown in heated greenhouses even during winter.
- Transportation: Sustainable transportation is all about energy and can be achieved with energy-efficient vehicles and electrified rail systems.
- Fuels: Concentrated forms of carbon including biomass and even carbon dioxide can be converted to hydrocarbon fuels for applications for which there are no viable alternatives (such as aircraft) without adding any net amounts of greenhouse-gas carbon dioxide to the atmosphere.
- Dwellings and workplaces: The places where humans live and work can be maintained at comfortable temperatures regardless of harsh conditions outside.

Energy supply as such is not the problem; for example, world coal resources can meet energy needs for several centuries. The problem is that current patterns of energy use are not sustainable. Earth's peak petroleum production has probably already been reached. Using the remaining petroleum and switching to coal will almost certainly lead to global warming that might destroy Earth as we know it. The great challenge, therefore, is to develop sources of energy that are renewable and sustainable and that do not significantly damage Earth and its environment. A top priority must remain conservation of energy and greatly increased efficiency of energy utilization. Energy alternatives include wind, solar, biomass, geothermal, and nuclear energy sources along with some minor sources such as tidal energy. The use of fossil fuels will not cease and may continue for a long time with sequestration of carbon dioxide from combustion. This chapter discusses the energy alternatives listed above with emphasis upon energy sustainability.

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