



Chapter 4

Energy production and its consequences for water and the environment

4.1 IMPACTS

Environmental issues arise from harmful effects of human activity on the biosphere, the part of the world in which life can exist. A significant number of these impacts are associated with energy production and they come in many forms.

Global warming and climate change: the result of introducing large quantities of CO₂, CH₄, and other greenhouse gases into the atmosphere. Adverse impacts of climate change are already being felt, for example, changes in rainfall patterns, droughts, intense storms, rising sea levels, ocean acidification, and migration of disease carriers. Many scientists and others believe that addressing climate change on a coordinated global basis is the most critical challenge currently facing the world. The basics of global warming will be discussed in this chapter; its potential impacts and related policy issues will be discussed in Chapter 10.

Air, water, and soil pollution: arising from the combustion of fossil fuels, heavy use of nitrogen-rich fertilizers, and

agricultural runoff. Fossil fuels, a major source of thermal energy for electricity generation, create a large number of toxic emissions when combusted: carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), heavy metals such as mercury (Hg), and low levels of radioactivity released when coal is burned. Combustion products contaminate the air we breathe and can contaminate water sources unless carefully controlled. Nitrogen-rich fertilizers, now widely used in agriculture, release nitrogen dioxide (NO_2) into the atmosphere; NO_2 is a powerful greenhouse gas, much more so than CO_2 . CH_4 is widely used as a fuel in power generation, and is also a powerful greenhouse gas that can leak into the atmosphere if not carefully contained. In addition, the transport of fossil fuels – as in the movement of petroleum products through pipelines and by rail – has occasionally involved accidents that have spilled large amounts of petroleum, threatened water supplies, and in some cases led to damaging fires.

Deforestation and land degradation: trees are a major sink for CO_2 , which is required for biomass growth. When they are chopped down for energy use or other uses and not replaced systematically, the land is degraded in terms of its water-holding ability and its aesthetic appearance. With less vegetation, less CO_2 is removed from the atmosphere, and combined with the contemporaneous release of CO_2 into the atmosphere from the combustion of fossil fuels the atmosphere's average concentration of CO_2 increases. This enhances the global warming effect. Also, power plants can have large footprints that prevent other uses of surface areas as well as changing the covered ground's reflective properties (albedo), which can also contribute to global warming.

Habitat destruction and loss of biodiversity: the destruction of forests has another impact, the removal of traditional homes/habitats for many species of animals. If these animals cannot move and adapt to new habitats, their numbers

will decline and, in some cases, they may become extinct. One example of such habitat destruction is the cutting down of forests in the Amazon to create new agricultural land for growing crops that can be converted into liquid fuels (e.g., alcohols).

Water requirements: thermal power plants – fossil fuel, nuclear, geothermal, concentrating solar – require large amounts of water for cooling turbine generator exhausts; fracking requires large amounts of water per well to release trapped oil and natural gas; hydropower generators require high water flow rates. These requirements often conflict with other demands for community and agricultural water, creating potential shortages and tensions.

Issues associated with nuclear fission power: while nuclear power offers a large, CO₂-free thermal energy source, its use presents five serious areas of concern:

- (a) safety: nuclear fission creates large amounts of short- and long-lived radioactive waste products that, if released accidentally, can cause serious health effects and long-term abandonment of public areas. The meltdown of the Chernobyl nuclear power plant in Ukraine in 1986 has put a large area around the plant off limits for human occupation for about a century. A similar situation exists around the site of the Fukushima Daichi reactor meltdowns in Japan in 2011.
- (b) the capital requirements and running costs of nuclear-generated electricity;
- (c) the safety of transport of radioactive wastes through communities on the way to temporary or permanent storage;
- (d) the ability to store safely, for long periods of time, highly radioactive wastes with long half-lives; and
- (e) protecting nuclear materials from diversion to use as weapons.

Several of these impacts will be discussed in more detail in succeeding chapters on specific energy technologies.

4.2 MORE ON CLIMATE CHANGE

As mentioned above, climate change has been identified by some as the most important challenge facing mankind. I would pair it with the threat posed by potential use of nuclear weapons in warfare as our most challenging issues. Nevertheless, climate change is worthy of our most careful attention.

What causes global warming and the resulting climate change? It is not hard to understand using only basic physics: it is the same physical process that occurs in a car on a hot day that we all experience. Every warm body radiates energy. The visible light rays from the sun, distributed in a frequency spectrum determined by the Sun's surface temperature (about $5500^{\circ}\text{C}/10,000^{\circ}\text{F}$), easily pass through the car's glass windows and are absorbed by the car's interior, which gets warm and often hot to the touch. These warm or hot surfaces then reradiate in a spectrum different from the sun's radiation because of their vastly different surface temperatures. The basic physics is the same – Planck's Law, first proposed in 1900, specifies the spectral distribution and intensities of the radiation emitted by a black (perfectly emissive) body at temperature T . In a car the energy reradiated from the interior surfaces is mostly in the infrared region, which doesn't pass easily through the glass. This trapping of the reradiated heat causes the car's interior temperature to rise until, owing to the interior's now higher temperature, enough reradiated infrared radiation gets through the glass to provide a balance between the energy of the incoming and outgoing radiation streams.

This is exactly what happens in the Earth's atmosphere, with gases and water vapor in the atmosphere playing the role of the glass windshield and determining the atmosphere's transmission characteristics. Important global warming (greenhouse) gases are CO_2 (much arising from combustion of fossil fuels),

methane (CH₄), and a few others such as NO₂ and certain hydrofluorocarbons. The Earth's current temperature, hospitable to life as we know it, reflects an energy balance between the Sun and the Earth. Venus is an example of a planet where the equilibrium temperature reached by the planet to achieve an energy balance with the Sun is much higher.

4.3 ENVIRONMENT AND RELIGION

An interesting aspect of dealing with environmental issues is the emergence in recent years of academic disciplines studying the relationship between the environment and religion. This emergence reflects a growing understanding that 'the environmental crisis is fundamentally a crisis of 'values'' (18) and that values derive largely from religious teachings. Some scholars trace Western Society's concern for the environment to the fundamental concept of Judaism and the Judeo-Christian tradition that God created the universe and that only God has absolute ownership over Creation. This is the theocentric worldview, as opposed to the anthropocentric viewpoint that emphasizes, as stated in Genesis I, that humans exercise 'dominion' over the Earth. Others point to the Deuteronomic commandment 'bal tashchit' in the Old Testament that is an injunction against unnecessary destruction.

4.3.1 The theocentric worldview

In the theocentric, God-focused, worldview, the environmental implications are that humans must realize that they do not have unrestricted freedom to misuse Creation as it does not belong to them. Everything we own, everything we use, even ourselves, ultimately belongs to God. We are to be stewards of the Earth and the role of mankind is to enhance the world as 'co-partners of God in the work of Creation.' This implies that we must always consider our use of Creation with a view to the larger good in both time (i.e., responsibility to future generations) and

space (i.e., responsibility to others on this world). It also implies that we must think beyond our own species to that of all Creation. There is a Jewish midrash, a rabbinic teaching that fills in perceived ‘gaps’ in the Old Testament, that builds on this concept of co-partnership:

‘In the hour when the Holy one, blessed be He, created the first man,
He took him and let him pass before all the trees of the Garden of Eden
And said to him: ‘See my works, how fine and excellent they are!
Now all that I have created, for you have I created.
Think upon this and do not corrupt and desolate My World,
For if you corrupt it, there is no one to set it right after you.’

4.3.2 The anthropocentric worldview

The anthropocentric worldview, the ‘dominance’ view, focuses on how mankind uses the fruits of Creation to meet its own needs. In a 1966 lecture to the American Academy of Arts and Sciences, subsequently published in 1967 in the journal *Science* (19), the historian Lynn White argued that that the Judeo-Christian heritage arising from the ‘dominion’ commandment is responsible for the current ecological crisis. One response has been a Jewish and Christian environmental movement that was in many ways motivated by the revival of back-to-the-land values in the 1960s and 70s’.

4.3.3 Other worldviews

By the 1990s the debate on environmentalism had expanded to analysis of how nature is valued in other religions. Critical events were the series of ten conferences on Religion and Ecology organized between 1996 and 1998 by two professors at Yale University, Mary Ellen Tucker and John Grim. Papers from the conferences, attended in total by about 2000 people, were then published in a series of ten books, one for each major world religion (20). What becomes clear is that all major religions preach mankind’s harmony with nature. What is all

too real is that there is often a large gap between what is preached and what is practiced.

How is this harmony described in other than Judaism and Christianity? Buddhism emphasizes the interconnectedness of nature and life – damage done to our environment is also done to us. Concern for nature in Hinduism reflects the social thoughts of Mahatma Gandhi, sometimes referred to as the ‘father of Indian environmentalism’. He argued that ‘environmental sustainability and social inequalities should be managed in similar fashions’ (21). Islam treats the environment as sacred and argues that people, as trustees of God, are responsible for protecting the world and its variety of life. Similar messages can be found in the teachings of Taoism, Jainism, and Animism.

Has this common ethic of harmony with nature impacted our use of energy? Firewood has long been a source of energy for individuals and communities, requiring the cutting of trees. In old Muslim cemeteries in Pakistan ancient trees can still be found because they are not allowed to be cut. Similar prohibitions have protected an ancient Maronite forest in Lebanon. Monasteries in Thailand have been built by Monks in endangered forests to make them sacred and safe from logging. The Sikh community in India is reducing its use of fossil fuels in their temples. The Church of Germany has installed solar panels on 300 churches and helped other organizations switch to solar. And as we advance further into the 21st century, protection of the environment has become a powerful political force, as reflected by the energy revolution that is currently underway.