

Environmental Degradation I: Energy Utilization

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Since the discovery of fire, people have harnessed energy, but in modern times the scale of energy consumption has exploded. *Per capita* energy consumption in the US exceeds human metabolic energy output by a factor of 100. The large material flows supporting energy infrastructures degrade the environment through pollution and extensive land use. Population growth and economic growth raise energy consumption, while improved living standards tend to enhance environmental awareness. Taken together these trends drive technological advances in cleaning up energy operations first for strong pollutants gradually progressing towards cleanup of large volumes of weak pollutants. Open combustion of coal or peat with ash and soot billowing into the air has been very much curtailed in developed countries. Sulfur and NO_x emission reductions are still being phased in. Regulations on fine particulates and heavy metals are still debated. However, the biggest challenge to fossil power generation is carbon itself. CO₂ emissions, harmless in small quantities, are driving climate change. Even though carbon resources are large, natural reservoirs are too small to absorb the likely emissions of the 21st century. Sequestration technologies could capture CO₂, either at the source or from the air, and dispose of it safely and permanently. However, carbon neutral energy will come at a price, ill afforded in the early stages of development and historically not paid by the industrialized countries. Leapfrogging to clean technology would put an enormous burden on development and could derail the global transition to a wealthy society, with devastating consequences for all. How could energy development be guided so that the needs of people – including one to two billion without any access to electricity – can be met without destruction of the environment?