CHAPTER 1
INTRODUCING THE COMFORTS AND CONCERNS OF COMBUSTION

Combustion processes are embedded in today's world. They provide the energy for industrial processes, for keeping people warm, and for generating electricity. Into the future, as today, sustaining our way of life will require us to continue to burn fossil fuels.

But the natural world is very complex; its many facets, living and non-living, interact often to a greater degree than we realize. Our activities involving combustion accordingly have secondary consequences, mainly on the atmospheric environment. (Some of which are shown in Poster 1-1 and Poster 1-2.) Their effects may not be evident to us for a long time. Some are obvious; anyone who has been downwind of a campfire knows about smoke. Others, such as sulphur dioxide emissions, are readily detectable and unpleasant, but their potential to damage forests and acidify lakes was not recognized until much damage had been done. Global warming, yet another potential consequence of combustion processes, has only recently come to light, is still poorly understood, and threatens to inflict the most serious long-term damage. Table 1-1 lists emissions from combustion sources and relates them to the major forms of pollution; smog, acid rain, and global warming.

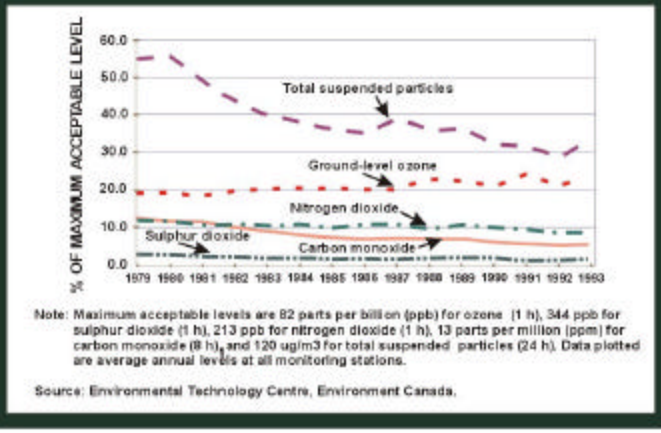
Table 1-1 Emissions from Combustion Systems and Their Effects

Emission	Source	Effect
CO_2 (carbon dioxide)	Complete combustion of carbon in fuel	Global warming
CO (carbon monoxide)	Incomplete combustion of carbon in fuel	Smog
SO_2 (sulphur dioxide)	Combustion of sulphur in fuel	Acid rain Smog
NO_x (nitrogen oxides)	By-product of most combustion processes	Acid rain Smog
N_2O (nitrous oxide)	By-product of some combustion processes	Global warming
VOCs (volatile organic compounds)	Leakage and evaporation of liquid fuels (vehicles, fuel tanks, fuel pumps, refineries)	Smog
CH_4 (methane)	Leakage from gas wells, pipelines and distribution systems	Global warming
H_2O (water vapour)	Combustion of hydrogen in fuel	Localized fog
Particulates (dust, soot, fumes)	Unburned or partially burned carbon or hydrocarbons , also ash and dirt in fuel	Smog Respiratory hazard
Trace elements	Impurities in fuel	Potential carcinogens
Chlorinated compounds	Chlorine compounds (e.g., salt) in fuel or combustion air	Potential carcinogens

So the fuel consumer faces a double challenge; one is economic: to get the best possible value for his fuel budget; the other is environmental: to keep emissions as low as possible, at least within legislated limits. Fortunately, what benefits the first objective usually benefits the second. Minimizing fuel usage saves money and commonly reduces emissions, because emissions are substantially – although not completely – related to the amount of fuel consumed.

Three aspects to minimizing fuel consumption are 1) selection of combustion equipment which effectively and with minimal emissions converts fuel to heat, steam, electricity, etc.; 2) operation of the combustion and heat distribution equipment to minimize losses; and 3) efficient end use of energy, whether it be via well-insulated buildings in heating applications or well-coordinated use of industrial process heat. This guide focuses primarily on the first two. It concerns itself with boilers and heaters, since most combustion processes involve boilers, in which the fuel energy is converted to steam or hot water, or heaters, in which the energy is transferred to another medium such as air or thermal fluid. The principles, however, are applicable to most forms of industrial combustion.

Trends in common air contaminants, 1979-1993.



Note: Maximum acceptable levels are 82 parts per billion (ppb) for ozone (1 h), 344 ppb for sulphur dioxide (1 h), 213 ppb for nitrogen dioxide (1 h), 13 parts per million (ppm) for carbon monoxide (8 h), and 120 ug/m3 for total suspended particles (24 h). Data plotted are average annual levels at all monitoring stations.

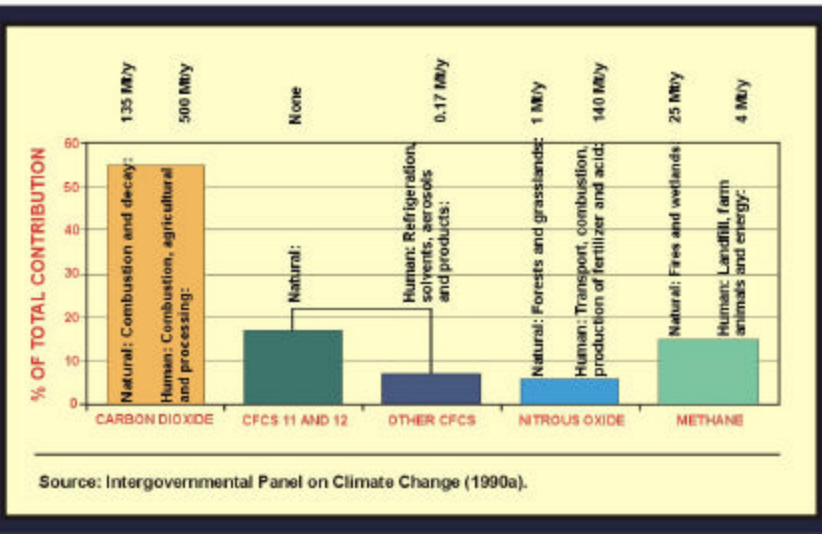
Source: Environmental Technology Centre, Environment Canada.

What is most obvious is not always what is most important.

The picture at the left shows some animals and insects found in Algonquin Park with their size scaled to their relative importance to the ecology.

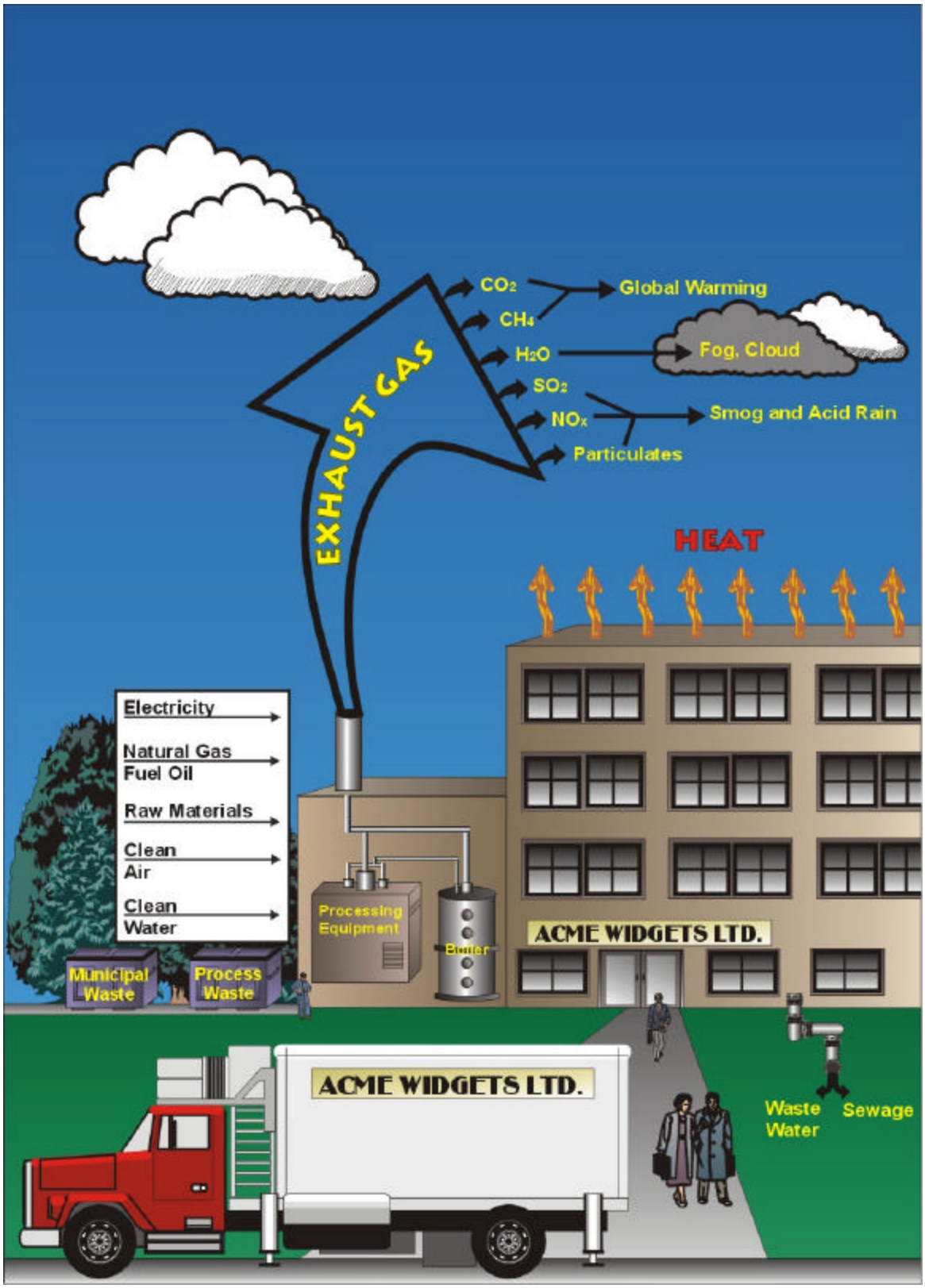
The same is true of atmospheric emissions. What we believe to be minor or neutral may prove to have a major impact.

The relative contribution of greenhouse gases to global warming during the past decade.



Source: Intergovernmental Panel on Climate Change (1990a).

Poster 1-1 Environmental Effects



Poster 1-2 ACME Widgets