CLIMATE CHANGE 2: CANDIAN TECHNOLOGY DEVELOPMENT CONFERENCE
Toronto, Ontario October 4, 2001

"HUMAN ENERGY USE AND THE CARBON CYCLE"

Presenter: **Stuart L. Smith, M.D.**
Chair
National Round Table on the Environment and the Economy

I. The Carbon Cycle

Carbon, the basis for all organic molecules, is derived from the earth's atmosphere where it exists as Carbon Dioxide. The energy of the sun is used by plants via photosynthesis to take up Carbon Dioxide, store the Carbon and release the Oxygen. That same energy is made available when Carbon and Oxygen recombine, as in plant and animal respiration or in the burning of Carbon-based fuels. The movement of Carbon from the atmosphere to organic (living) matter and then back to the atmosphere is called the Carbon Cycle and can be considered the basic infrastructure for life itself. In the process, some of the organic matter becomes trapped in the earth and in the oceans; some of what is trapped becomes, over millions of years, Carbon-based fuels known as "fossil fuels".

Looked at in greater detail, the balance between the amount of Carbon taken from the atmosphere and the amount released back to the atmosphere varies from time to time, depending on many circumstances (not all of which are well understood).

Factors which increase the rate of photosynthesis ON LAND, thereby **removing Carbon from the atmosphere,** include the following: solar radiation, nutrients (especially Nitrogen in an active form), water, and suitable soil, as well as warmth and the concentration of Carbon Dioxide itself. Photosynthesis in THE SEA is extremely important and is increased with temperature and nutrients, including co-factors such as certain minerals such as Iron. In addition, a very tiny amount of Carbon each year is permanently sequestered in the form of organic matter and in mineralized structures.

On the other hand, there are factors which increase the rate of respiration or combustion whereby Carbon is oxidized (or converted to Methane) and **released back into the atmosphere**. Such factors include actions to release organic Carbon from soil or vegetation (such as deforestation and tilling of soil for agriculture), temperature and, most of all, the burning of fossil fuels. It is estimated in a recent report by the Suzuki Foundation and the Westcoast Environmental Law Association that fossil fuel burning is responsible for twice as much release of Carbon as occurs due to deforestation and agriculture.

II. Imbalance in the Carbon Cycle and Effect on Climate

Over millions of years, there have been large variations in the Carbon cycle, presumably based mainly on variations in solar radiation. Since the advent of agriculture, the cycle has been gradually shifted into a negative balance (i.e. more release of Carbon) with soil tillage and the removal of trees. After the discovery and use of fossil fuels, however, i.e. with the Industrial

Revolution, the Carbon Cycle has become grossly unbalanced because huge amounts of Carbon that were deposited in the earth as organic matter millions of years ago are now being released to the atmosphere. Current patterns of fossil fuel combustion are predicted to lead to a doubling and tripling of atmospheric Carbon Dioxide in the next few decades.

Warming of the earth is currently occurring and is expected to result in climatic and environmental disturbances with extremely serious consequences throughout the globe. These phenomena are complex and are incompletely understood but are referred to in a kind of shorthand as **Climate Change**. The vast majority of scientists believe that the accumulation in the atmosphere of Carbon Dioxide (and Methane, as well as other gases, all termed collectively "Greenhouse Gases [GHGs]") acts to trap heat and contributes to Climate Change. Not all the global warming can be attributed to Greenhouse Gases; for example, some is thought to be a consequence of increased solar activity. Furthermore, there are still arguments among scientists as to whether increased GHG concentration will lead to a vicious cycle of accelerating warming (due to such factors as the heat trapping by water vapour) or to a self-correcting mechanism (such as heat blocking by increased cloud formation). Nonetheless, the vast majority believes the contribution of GHGs to be very significant and strongly recommends action to curtail the build-up of GHGs in the atmosphere.

The main imperative is to reduce the use of fossil fuel or to find some way to offset such use by measures that will reverse the imbalance created in the Carbon cycle. Of course there are two other reasons why reducing the use of fossil fuel would be a good thing. First, in the case of oil and gas, those substances are the basis for fertilizer and pesticides which are essential to the agricultural productivity required by the large human population. Conservation of those fuels for petrochemical purposes makes sense, just as the late Shah of Iran used to say. Secondly, current methods of combustion of fossil fuels have a deleterious effect on air quality, particularly in cities. Reduced combustion would have a beneficial benefit on such air quality.

All of this means that **Climate Change is primarily an Energy problem, not a pollution problem.** Our citizens do not know this. As a result, while surveys indicate that they favour steps to combat Climate Change, it can be predicted that they will balk at measures which attack their right to use energy rather than attack pollutant releases. Carbon Dioxide, essential to life on earth, cannot sensibly be called a pollutant in the way that smog components can. There is a huge need to **educate the public** to understand the GHG argument and to clarify that we are not dealing with smog or with Ozone-depletion!

Can we Manage with Less Energy Consumption?

Abundant cheap energy has allowed technological progress and population growth on a scale that was unimaginable a few centuries ago. If one thinks about it, most technological advance has based on the very crude use of cheap fuel to bash the earth to produce materials and to propel people and goods huge distances. Our knowledge, marvelous as it seemed, has really been quite superficial and our methods have been crude and wasteful.

There is, however, some reason for optimism based on the great recent advances in knowledge of all kinds. As our knowledge of matter now penetrates more deeply, to the level of atoms, molecular structures, microchips and genes, it becomes possible to achieve many of our goals with less damage to the planet and with less need to consume huge amounts of energy. Biotechnology, for example, can lead to improvement in agricultural productivity with less need for oil or gas-based chemicals. In the most advanced nations, we are starting to see that Gross Domestic Product is becoming less reliant on energy consumption.

On the other hand, the economic advances that resulted have until recently been confined to a minority of humans and there is now an enormous population that is intent on following a similar path of development. Despite advances in energy efficiency, increased demand from developing nations will ensure a continuing growth in global energy demand. One particularly important and rapidly growing need for energy in many parts of the world is to **desalinate water.** Some speak of diverting Northern rivers southwards to get the water where the sunshine is in order to grow crops. This would be unacceptable since it is extremely disruptive to the environment; it is also wildly expensive, compared to desalination.

Similarly, the need to use energy to maintain food production will not diminish, given the world's population growth. The global economy also relies ever more heavily on energy for transportation.

In other words, even with the introduction of greater efficiencies and conservation practices, there are still only three possible ways forward, **each of which relies on human ingenuity**, research and the development of better technology. The three possibilities are:

1) to develop and use energy sources other than the combustion of fossil fuels;
2) to use fossil fuels in a way that does not permit Carbon Dioxide to escape into the atmosphere; and
3) to find ways to remove Carbon Dioxide from the atmosphere and permanently sequester it (so-called "sinks").

III. Need for Research and Technology

1) Renewables are crucial but we must also include **fission** and **fusion** in our thinking. For fission, issues of lower cost and safer disposal of wastes need more research but it is far too important a technology to be ruled out when facing a challenge like Climate Change. For fusion, much more R&D is needed if anything practical is to be developed but I have recently seen some very promising results.
2) Burning fossil fuel without releasing Carbon Dioxide is hard to imagine but we will hear later about the **Zero Emission Coal** project and other analogous ideas may follow.
3) Terrestrial sinks are unlikely to make much dent but **oceanic sinks** might turn out to be important. As noted earlier, the addition of very small amounts of Iron to parts of the ocean surface where other nutrients are present is said to lead to the production of large amounts of phytoplankton with the growth of other life forms as a result. This, it is claimed, can result in the permanent sequestration of huge amounts of Carbon. Oceans are too important to the planet to be trifled with but serious research work should continue and be given due consideration at the right time.

We cannot wait for the situation to worsen before we make substantial investments in research in the three areas listed above, as well as in renewables, efficiency and conservation. Waiting may mean irreversibility. Furthermore, the costs of **adapting to Climate Change** are likely to be huge as we cope with refugees from flooded areas and dislocations in agriculture, fisheries and forestry. Even health and military spending may have to increase drastically. Waiting may mean funds are unavailable since we will be spending them on adaptation.