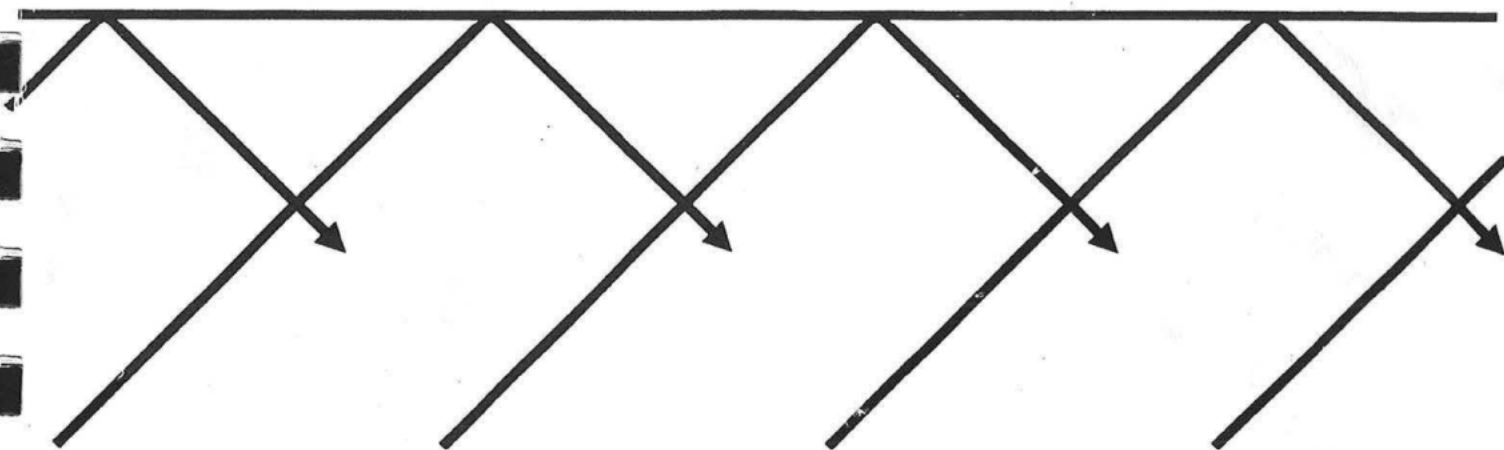


SCENARIOS

1989 – 2010

challenge
and
response



CONFIDENTIAL
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The Environmental Agenda

Global Climate Change

Environmental damage has been evident on a local, even a regional scale, for some time. Damage is now being perceived on the global scale. For example:

Global	Regional	Local
● Ozone depletion	● Acid rain	● Urban air quality
● Climate change	● Forest burnings	● Solid wastes
	● Polluted rivers	● Contaminated waters

Only 20 percent of the world is industrialised, and those that are not, want to be. That seems less and less possible unless the path is different. Many of the problems forcing a change in the path arise from the treating of the environment as a near-free good.

Although there are many areas of environmental concern, climate change – the greenhouse effect, global warming – is of especial significance because:

It is the most global of environmental problems.

It is directly tied to man's economic activities by the use of energy.

Hence, it could be the most important issue for the energy industry.

The idea that mankind and his activities could affect the climate is relatively new. But evidence that they do is strong and accumulating fast. We are confronted with the possibility that global temperature could increase because of increasing concentrations of the greenhouse gases in the atmosphere, particularly CO₂.

From ice core measurements, we know that over the ages there has been a clear relationship between global mean temperature and CO₂ concentration in the earth's atmosphere. We know, too, that CO₂ concentration has been increasing and continues to increase about 0.4 per cent per year. The dominant contributors to the increasing CO₂ concentration are the combustion of fossil fuels and the clearing and burning of tropical forests. However, although the mean temperature is about 0.7°C higher than 50 years ago, it is not certain that the earth will continue to warm.

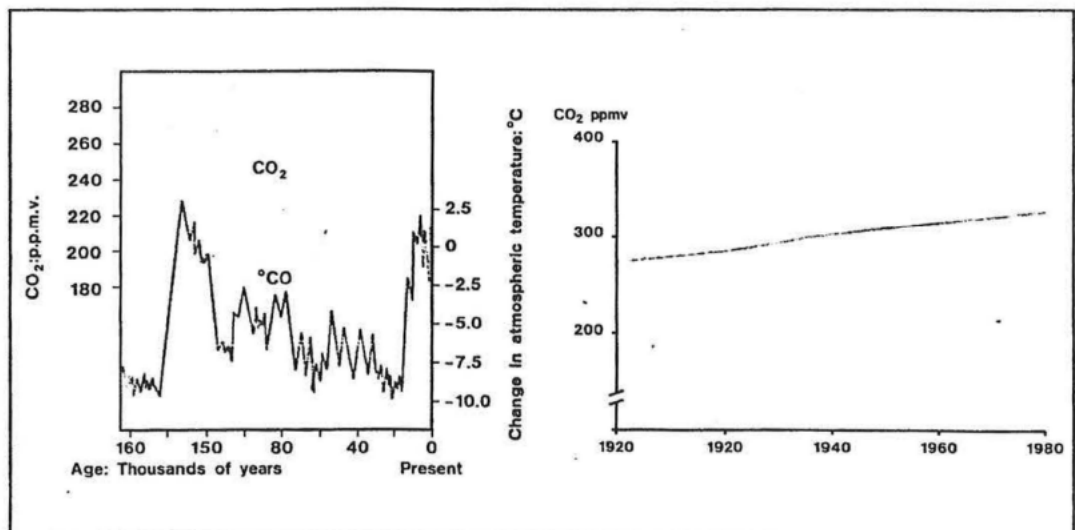


Chart 14

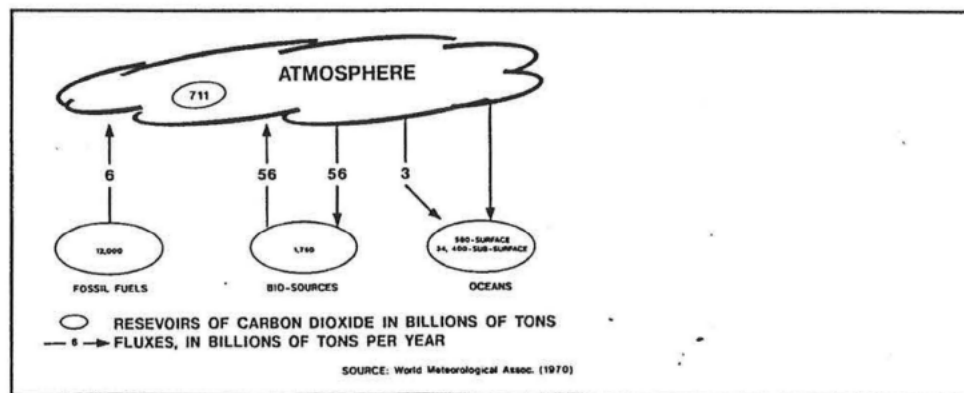
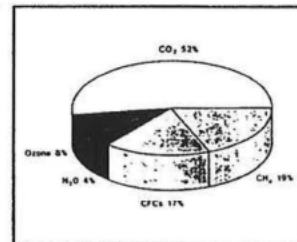
Global Warming

The Greenhouse gases, CO₂, CH₄, CFCs, N₂O and ozone, present in the atmosphere warm the earth by trapping infra-red heat radiated from the earth's surface. For example, if today's 350 ppm of CO₂ were not present in the atmosphere, the global mean temperature of the earth would be about 40°C lower – unlivable. During the Ice Age of 10000 years ago, the global temperature was 7°C lower and the CO₂ level then was 200 ppm.

- The concentrations of Greenhouse gases in the atmosphere have increased dramatically in the past 50 years – mostly as the result of industrial activity:

	1940	1989	Effect Relative to CO ₂	Principal Source
CO ₂	310 ppm	350 ppm	1	Fossil fuel combustion.
CH ₄	1.1 ppm	1.65 ppm	25	Rice and cattle production up.
CFCs	0	0.5 ppb	17,000	Use as refrigerant, aerosols, etc.
N ₂ O	0.29 ppm	0.31 ppm	150	Fossil fuel combustion.

- Each of these gases trap re-radiated heat with different efficiencies; for example, 1 part of chlorofluorocarbon has the same effect as 17 000 parts of CO₂ in the atmosphere. The combination of concentration in the atmosphere and 'greenhouse power' leads to these percentage contributions to today's Greenhouse Effect:
- But while the concentration build-ups are real and the sources are known, it is highly uncertain by how much the earth will be warmed further. Attempts to model the globe are complicated by the complexity of the system.
- For example, only about one-half of the 6 gigatonnes of carbon emissions per year ends-up in the atmosphere; about 3 GtC is taken up by absorption in oceans. That process is not well understood but part of it seems to be by the formation of phytoplankton at ocean surfaces in the spring of the year and, these, later, end up as carbonates on ocean floors – truly taken out of the exchange system. However, the process of CO₂ absorption by phytoplankton growth is now being found to be slowed by higher water temperature. Reports that North Atlantic surface temperature has increased by 1°C in the past ten years may explain why temperature change – once started – goes at a rapid pace,



- The consequences of high global temperature – should that result – are vastly different weather patterns, particularly in the temperate zones and flooding of coastal plains.
- Counter-measures
 - Ban the use of CFCs completely.
 - Vast increases in efficiency of energy use.
 - End forest burnings
 - Plant additional forests
 - Shift from coal to natural gas, and to non-fossil fuels

The Scenario Extensions to 2050

A key difference between the scenarios is CO₂ emissions. SUSTAINABLE WORLD addresses the potential problem and greatly reduces emissions compared to GLOBAL MERCANTILISM.

Changing the emission levels of CO₂ and changing atmospheric CO₂ concentration has been likened to turning around a VLCC. In spite of substantial efforts in SUSTAINABLE WORLD and the force-back of CO₂ emissions by 2010 to almost today's levels, there is hardly any impact on CO₂ concentration.

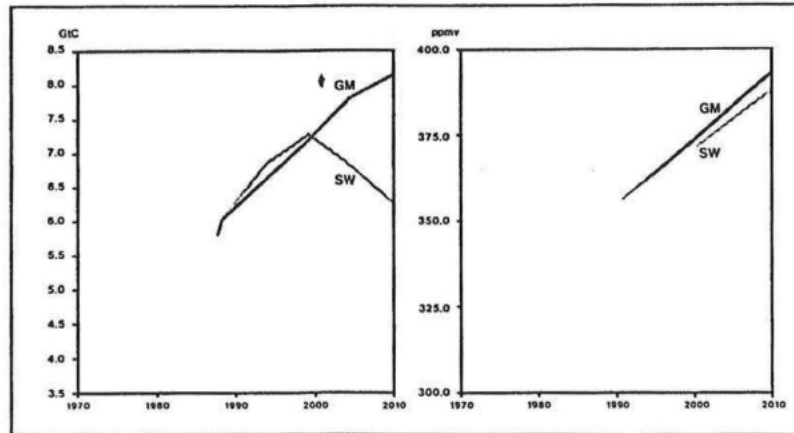


Chart 15: Global Fossil Fuel CO₂ Production to 2010

To see differences in CO₂ concentration, we extended SUSTAINABLE WORLD and GLOBAL MERCANTILISM out to the year 2050. CO₂ emissions from fossil fuels in GLOBAL MERCANTILISM are, then, almost twice today's level. For SUSTAINABLE WORLD, they are well below today's emissions – back to about 1972 emission levels. The impact on global CO₂ concentration is now strikingly different and CO₂ concentration in SW stabilises but at a level still higher than today's.

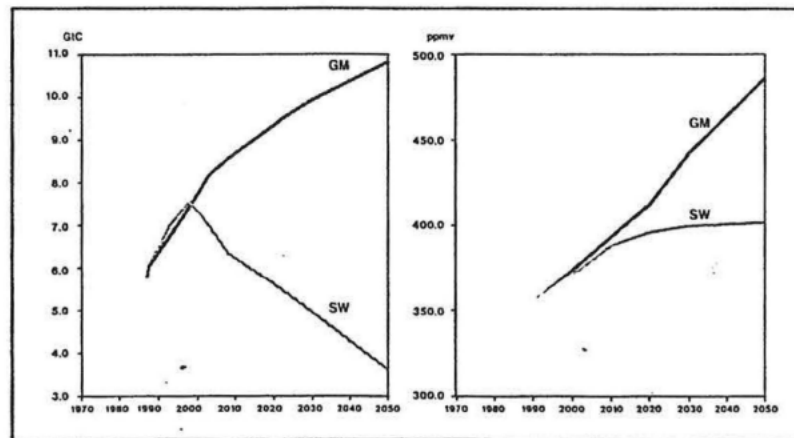


Chart 16: Global CO₂ Production to 2050

The conventional and probably conservative wisdom is that global mean temperature will rise between 0.5 and 1.5°C in the next 30 years from CO₂ concentration increases that have already occurred. It is unlikely to rise by much less even in SUSTAINABLE WORLD, but it

could rise considerably more in GLOBAL MERCANTILISM. So, SUSTAINABLE WORLD will not prevent the problem arising, but it could mitigate the problem.

These seem small changes but they mask more dramatic temperature changes which would take place at temperate latitudes. There would be more violent weather – more storms, more droughts, more deluges. Mean sea level would rise at least 30 cm. Agricultural patterns would be most dramatically changed. Something as simple as a moderate change in rainfall pattern disrupts eco-systems, and many species of trees, plants, animals and insects would not be able to move and adapt.

The changes would, however, most impact on humans. In earlier times, man was able to respond with his feet. Today, there is no place to go because people already stand there. Perhaps those in industrial countries could cope with a rise in sea level (the Dutch example) but for poor countries such defences are not possible. The potential refugee problem in GLOBAL MERCANTILISM could be unprecedented. Africans would push into Europe, Chinese into the Soviet Union, Latins into the United States, Indonesians into Australia. Boundaries would count for little – overwhelmed by the numbers. Conflicts would abound. Civilisation could prove a fragile thing. The logic of SUSTAINABLE WORLD is a society choosing to channel some investments into environmental maintenance against this contingency.

Don't Just Stand There. Plant A Tree

A tree is a CO₂ collector. Scientists, foresters, and environmentalists are exploring the feasibility of planting enough trees on a crash basis to ease the threat of global warming. The size of the job appears daunting – one estimate is that enough more trees to cover an area one-half the size of the USA are needed to absorb today's CO₂ emissions. but undertaking large-scale tree planting programmes on degraded tropical lands, encouraging farmers to plant trees on erodable set-aside land, and making urban areas more green with trees are some of the proposals.

A model effort is one announced a year ago. Applied Energy Services of Arlington, Virginia, is helping to pay for the planting of 52 million trees on plantations and farm plots in Guatemala. That number of trees are claimed to be able to absorb as much CO₂ as will be emitted by a new coal-fired generating plant AES is building in Connecticut. This 180 megawatt plant will emit an estimated 15 million tonnes of CO₂ over its 40 year lifetime.

Governance

The environment as a near-free good is the global manifestation of the 'tragedy of the commons' – an individual (or a country) taking just a bit more of the common resource because the cost or disadvantage to the individual seems small. The individual is not able to impose adequate restraint – the benefits are obvious, there seem no costs. As has been discovered many times in history, however, whether with the village well or the commons grazing area, there are collective costs, when individuals together exhaust the resource.

An individual may be powerless to impose restraint under these circumstances, but, collectively, society is not. Rules can be devised, agreed upon, and enforced so that the capacity of the commons is not exceeded and access to the commons is equitably distributed.

A starting point is assessing how quickly environmental resources are being run down. Countries are considering setting up national environmental accounts so environmental degradation costs and environmental maintenance expenditures can be totalled.