

Appendix

Energy and the Environment

Study Summary

The Issues

1. There are three main global energy related environmental hazards: the greenhouse effect, air pollution, dangers to flora and fauna. These distinctions are important because solutions for one problem often exacerbate the others, a notable example being any intensification of nuclear power construction programmes to curb carbon dioxide emissions. The complexity of finding optimal solutions means that considerable time is likely to elapse before there are consequent changes to overall patterns of energy use.
2. An important distinction between the three hazards is their visibility. Threats to clean air and natural habitats are much more tangible than the as yet unproved impacts of global warming.

The Greenhouse Effect

3. No firm conclusions have been reached within the scientific community, nor are they likely regarding:
 - the extent of accumulation of greenhouse gases;
 - past and future global temperature change;

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- consequent impacts on weather patterns and sea level change.
4. Until conclusive evidence is established, it is highly unlikely that governments will take draconian measures to alter patterns of energy use and consciously or otherwise jeopardize economic growth.
 5. However, political pragmatism has persuaded governments that energy policy decisions should do nothing that would exacerbate the problem. Moreover, policies can be expected to be pursued where they “tie in” with other strategic objectives such as lowering dependency on imported oil, and generating government revenue.
 6. In contrast to most other environmental problems, legislation to curb greenhouse gas emissions is only at a formative stage. This is because to stabilize, let alone reduce emissions of the single major greenhouse gas, CO₂:
 - major energy supply and infrastructure changes would be involved;
 - meaningful progress necessitates multilateral action demanding international agreement;
 - practical mechanisms have yet to be developed to achieve any targeted CO₂ emission reductions.

Thus, only the just completed Rio Conference and its Climate Convention tentatively have established a principle to stabilize CO₂ emissions but fall short of specifying precisely to what extent and in what ways.

7. We thus conclude that for sometime approaches to the greenhouse problem will be developed on unilateral bases with “tie-in” strategies focusing on reducing energy intensity, and carbon intensity in as much as oil use can be substituted by natural gas.
8. It may yet emerge that the high potential costs of attempting to reduce CO₂ emissions result in governments focusing on adapting their economic infrastructure to any temperature changes and associated consequences.
9. In addition perhaps there will probably continue to be greater efforts to curb emissions of other greenhouse gases (including

CFCs, methane) which collectively contribute equally to the greenhouse effect as CO₂ but have less ramifications for the structure of global energy use.

Market Interventions

10. The strategies to curb CO₂ emissions show close similarity to those governments pursued in the 1970s and early 1980s to reduce dependency on OPEC oil. The success in curbing demand for OPEC crude was, however, largely triggered by the massive hike in prices.
11. It thus becomes apparent that, while governments may extol the environmental virtues of energy efficiency improvement and oil and coal substitution, the means have to be found to induce such changes.
12. There are a range of complexities surrounding the necessary *fiscal interventions*, notably carbon taxes:
 - implications for industrial competitiveness;
 - perceived equity in allocation;
 - effectiveness if absorbed/passed through by energy uses;
 - location of taxes;
 - their necessary scale to have anything but a cosmetic impact.
13. For these reasons we conclude that carbon taxes will:
 - for sometime not be international in application;
 - be applied unilaterally, sometimes to generate government revenue, and rarely steeply in ways which can be expected to alter dramatically patterns of energy use.
14. On the other hand we can expect governments to impose *direct regulation* on certain energy markets, particularly in regard to energy efficiency; vehicle fuel efficiency, building and other capital goods standards, especially where there is synergy with the other major environmental objective of attaining clean air.

Clean Air

15. From the point of view of the energy industries and the oil industry in particular, the more important issue than the greenhouse effect over the next few years at least is likely to be necessary responses to curb air pollution from stationary sources and vehicles. Also, intensified government concerns over tanker safety, oil spillage and pollution from industrial wastes are likely to result in policy measures which will pervade corporate strategy and impose considerable burdens on corporate budgets.

Pollution from Stationary Sources

16. We have focused on the most significant airborne pollutant, sulfur dioxide (SO₂) in terms of its creation of acid rain. Although nitrogen dioxide is a contributor, curbing its emissions necessitates changes in burner technology whereas SO₂ has broader ramifications for the quality of fuel use.

17. Within the OECD considerable progress has already been made in reducing SO₂ emissions:

- emissions have fallen by around 30% in the last 10 years;
- international accords are well established.

18. These achievements have been facilitated by:

- the widespread adoption of flue gas desulfurization (FGD) technology in coal burning facilities;
- increased use of natural gas and in some countries nuclear power,
- increased use of low sulfur fuel oil and coal in some markets.

19. New legislation is in various phases of enactment which will require yet further cuts in national SO₂ emissions. In the USA this is a key aspect of the Clean Air Act and in Europe the EEC Directive on Large Combustion Plant Emissions is imposing new strictures on national energy policies.

20. The important feature of these pieces of legislation is that they stipulate target emission levels, leaving the energy user to decide on the appropriate means of attainment. However, the emission limits, especially from new combustion plants, are so stringent as to narrow the options.
21. It would seem necessary for large scale energy users:
- in existing facilities to at least switch from burning high sulfur to low sulfur fuels;
 - in new facilities to install FGD equipment or switch to fuels lower in sulfur than traditional levels of 1% max.
22. We estimate that costs of FGD are in the range \$20–\$30/ton oil input equivalent, dependent on process, and represent 5–10% of the delivered price of electricity output. There are constraints in the extent to which FGD technology may be adapted more widely:
- costs increase for retro-fitting;
 - it is inappropriate for small combustion facilities;
 - there has been little experience with its use in oil fired facilities.
23. In consequence we expect tighter SO₂ emission limits to be met in part by switching to lower sulfur fuel oils. Moreover, some governments are likely to mandate tighter fuel oil specifications where they feel it easier to administrate rather than monitor SO₂ emission levels.

Vehicle Emissions

24. Concern over vehicle pollution has been longstanding, although to different degrees, in virtually all OECD countries. Intensified concern in recent years has arisen out of increased traffic and general public awareness of the broader environmental impact of road congestion.
25. There are two main categories of emissions which have a similar impact on fuel quality:

- lead as a pollutant in its own right and which has prompted legislation to lower and eliminate lead in gasoline;
- exhaust emissions of carbon monoxide, hydrocarbons, particulates and nitrous oxides, whose reduction has necessitated the installation of catalytic convertors in exhaust systems which require the use of unleaded gasoline in order that the catalysts should not be destroyed.

26. The costs of cleaning exhausts from burning traditional vehicle fuels are not excessive:

Equivalent Incremental Fuel Cost from New Technology

	<i>cents / litre</i>
Modified Engines	2.44
Oxidation Catalysts	6.73
Three-way Catalytic Converters	9.93
Lean Burn Engines	1.73
Clean Diesel	10.03

27. A distinction needs to be made between the status of vehicle emissions reduction in the USA and Western Europe (with there also sometimes being considerable differences across European Countries). In Europe progress in cleaning exhaust has been generally slower with legislation only recently beginning to demand use of catalytic convertors on new cars and thus the use of unleaded petrol. Nevertheless unleaded petrol accounts for 40% of total sales compared with 90% in the USA.
28. We project that by the mid 1990s some 60–70% of total European gasoline sales will be unleaded as EEC legislation tightens emission standards, and Non EEC countries (some of which in Scandinavia already operate with tighter U.S. standards) come into line. Equally the EEC is likely to be successful in limiting the sulfur content of automotive diesel.
29. In the USA the Administration is aiming to clean exhaust emissions further than has been achieved through the universal

adoption of catalytic converters. Thus the introduction of reformulated gasoline in those areas most affected by vehicle induced pollution and the tightening of sulfur content specifications for road diesel fuel.

30. The Clean Air Act outlines plans for the use of clean vehicle fuels including methanol. We estimate that the break even oil prices for clean fuels are as follows:

	<i>\$/bbl</i>
LNG	30
Propane	24
Methanol	33

In addition to these high costs there are uncertainties over the sufficiency of gas supplies and the costs to motor manufacturers in design and marketing infrastructure changes.

31. We believe that the net emissions of carbon dioxide of generating electricity for electric vehicles preclude the widespread adoption of this form of transportation at least for the next 10 years or so.
32. We conclude that traditional gasolines and diesel oils will remain, through the 1990s at least, the fuel of choice for road transport, albeit that the physical constitution of these fuels will be adjusted to make them cleaner.
33. In addition to governments aiming to reduce vehicle emissions by curbing exhausts, it can be expected that policies will be pursued to reduce vehicle traffic and fuel use:
- imposing higher vehicle fuel efficiency standards;
 - encouraging greater use of public transport.