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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

AD HOC GROUP ON THE BERLIN MANDATE
Sixth session
Bonn, 3-7 March 1997

IMPLEMENTATION OF THE BERLIN MANDATE

Comments from Parties

Submissions have been received from Ireland, Japan, Netherlands and the United States of America, and from the United Kingdom (on behalf of the Annex I Experts Group on the United Nations Framework Convention on Climate Change (UNFCCC)).

In accordance with the procedure for miscellaneous documents, these submissions are attached and are reproduced in the language in which they were received and without formal editing.

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PAPER NO. 1:

(SUBMISSION FROM IRELAND; JAPAN; NETHERLANDS AND THE UNITED STATES OF AMERICA)

International Energy Agency Statement on The Energy Dimension of Climate Change

INTRODUCTION

Climate change is a major global issue ...

Climate change is a major global issue with profound implications for the way the world produces and consumes energy. The Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that in spite of remaining uncertainty "the balance of evidence suggests that there is a discernible human influence on global climate".

... and IEA Ministers are committed to addressing it

On several occasions, IEA[1] Ministers have expressed commitment to adopt policies aimed at more environmentally friendly forms of energy consumption and production, and sustainable economic development.

This document offers a perspective from energy ministries of IEA Member countries on key energy-related aspects of the Berlin Mandate under the United Nations Framework Convention on Climate Change (UNFCCC).

This statement summarises the main driving forces related to greenhouse gas emissions from energy

The objective of this statement is to summarise for all participants in the UNFCCC process the energy dimension of the climate change issue in a manner that is directly useful in the run-up to the third meeting of the Conference of the Parties (COP-3) under the UNFCCC.

It describes the global context and continued trends in CO_2 emissions from the dynamic perspective of energy-related services. It also provides insights on key parameters to reduce energy-related greenhouse gas (GHG) emissions in a cost-effective, practical manner.

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[1] The International Energy Agency participating countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway (by special agreement), Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities takes part in the work of the IEA.

I. GLOBAL CONTEXT AND TRENDS IN ENERGY-RELATED CO_2 EMISSIONS

While the UNFCCC process covers all countries ...

At the United Nations Conference on Environment and Development in Rio, a balance was struck between the equally pressing global issues of environment and development. It was recognised there that countries had a right to, and should promote, sustainable development, alongside the need to tackle global environmental issues.

... only Annex I Parties are committed to aim to return their greenhouse gas emissions to 1990 levels by the year 2000

The United Nations Framework Convention on Climate Change adopted as a principle that Parties should protect the climate system ... "*on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combatting climate change and the adverse effects thereof* (Article 3)". While the aim, contained in Article 4.2, to return emissions to 1990 levels applies only to Annex I Parties, the UNFCCC also includes Article 4.1, which calls on all Parties, including developing country Parties, to formulate and implement programmes to mitigate climate change and facilitate adaptation to climate change.

The ultimate objective of the UNFCCC, as set out in Article 2, is to stabilise atmospheric GHG concentrations at non-dangerous levels. Analysis of global emission trends shows that the stabilisation of GHG concentrations in the atmosphere cannot be achieved by Annex I countries alone. In the long run, wider participation and efforts to limit emissions and enhance sinks will be required.

Globally, CO_2 is the main anthropogenic greenhouse gas

The UNFCCC calls for a comprehensive approach addressing all greenhouse gases, all sources and sinks, and both mitigation of and adaptation to climate change. The focus of this paper is on mitigation of CO_2, but extends to other greenhouse gases from energy. In the overall context of the Convention, other gases and emitting activities also need to continue to be addressed.

CO_2 is the single most important anthropogenic greenhouse gas; fossil fuel production and use represent about three quarters of man-made CO_2 emissions. Other energy-related greenhouse gases include CH_4 (from production, transportation and use of natural gas and coal), N_2O (primarily from fuel wood use) and other precursors to tropospheric ozone (O_3).

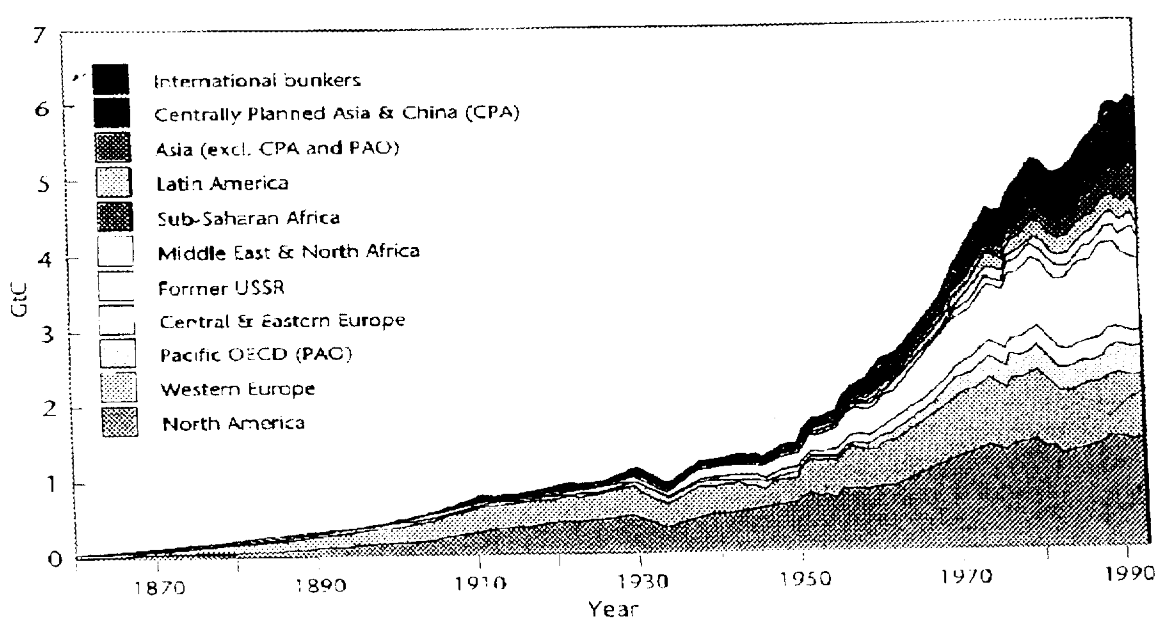
The energy sector (from primary energy extraction to end-uses) has been the major source of CO_2 build-up and can make a significant contribution to address the climate change problem.

Energy has been decisive in both economic development and increased CO_2 emissions from the burning of fossil fuels

Energy is an essential factor of economic activity. It contributes directly to meeting both basic and more sophisticated human needs, whether it takes the form of a primary energy source such as biomass fuel, coal, natural gas, oil, renewable energy sources, or a secondary or transformed form of energy such as refined oil products or electricity (based on fossil fuels, renewables or nuclear energy). Energy is both a traded commodity and an essential factor in moving goods that are traded internationally; as such it also contributes indirectly to economic growth.

Since the beginning of the industrial era, fossil energy has fuelled economic growth, leading to a sharp increase in greenhouse gas emission levels and their build-up in the atmosphere. Fossil fuels currently amount to 84% and 92% of *commercial* energy use in IEA countries and in the rest of the world, respectively.

The following graph from the IPCC shows that energy-related CO_2 emissions have increased substantially over the past 50 years, along with economic development and demographic growth, mostly in the OECD, but increasingly in regions outside OECD over the past two decades.



Global energy-related CO_2 emissions by major world region in billion tons of carbon per year (source: IPCC, 1996)

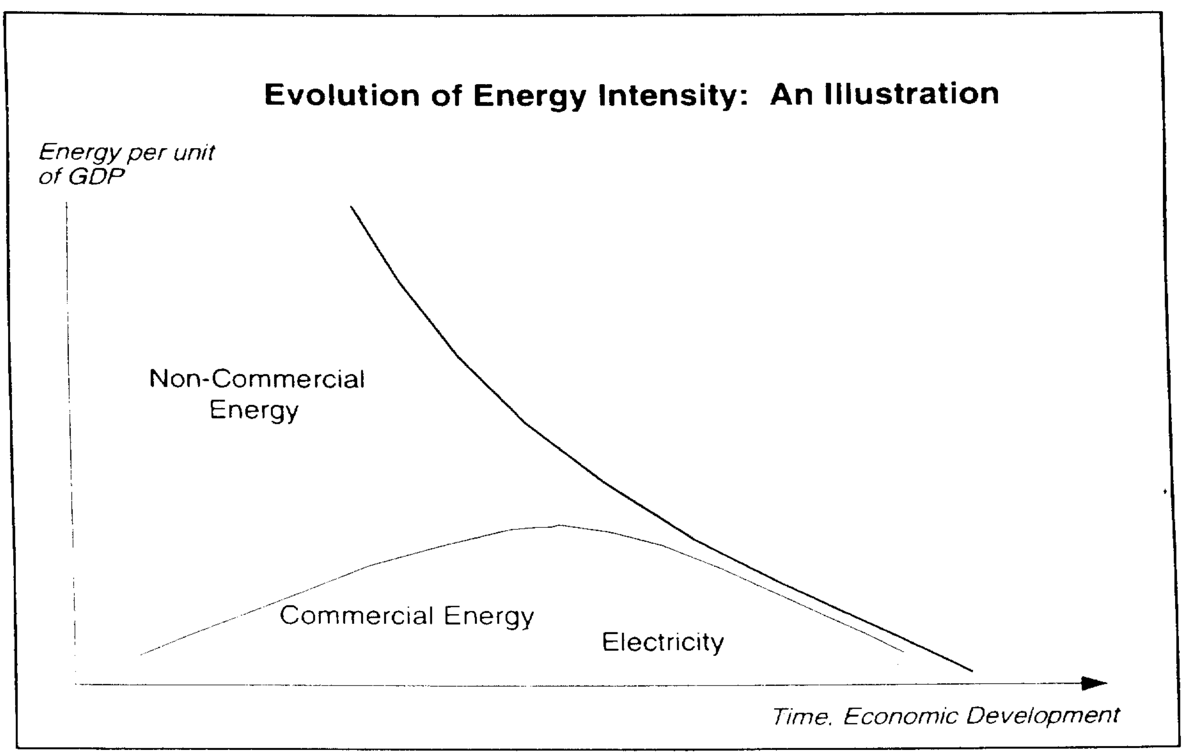
Energy intensity has decreased over time

The close link between energy use and economic activity is by no means "one for one". On the contrary, the experience is that the amount of energy -- non-commercial (e.g., fuelwood) and commercial (marketed fossil fuels and electricity) -- required to produce output in terms of GDP (i.e., "energy intensity") tends to decrease over time.

In particular, shifts from non-commercial to commercial energy sources in the process of economic development and more efficient production processes have generally led to decreasing energy intensity. In this overall process, energy security and environmental protection have also promoted more rational energy uses. In brief, the general dynamics of energy intensity are influenced by three overlapping phases:

-- a shift from non-commercial to commercial energy;
-- an increase in efficiency of commercial energy use;
-- a substitution of electricity for direct fossil fuel uses for many energy services.

Yet there remain differences among countries: some countries with a comparative advantage in energy resources have attracted energy-intensive activities, thus raising their energy intensity.



Evolution of Energy Intensity: An Illustration

Energy intensity varies widely across regions and countries...

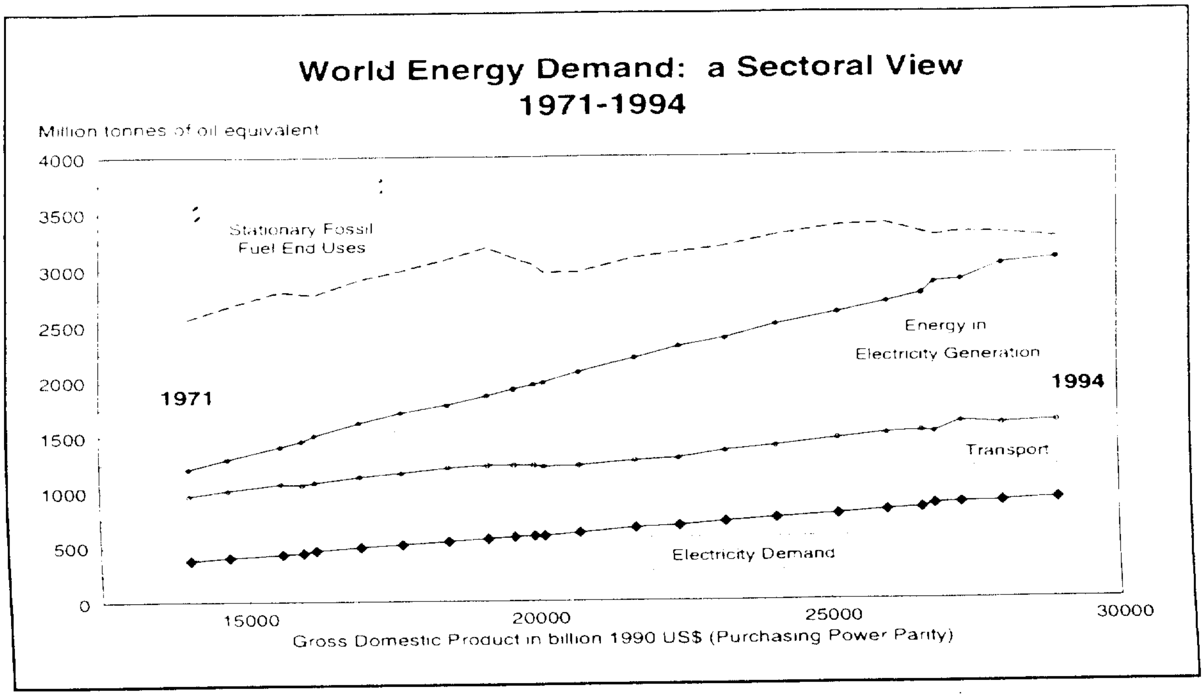
Physical factors such as geography and climate, population density, resource endowments, economic structure and the degree of competition in domestic energy markets influence current energy use across countries, through their effects on local economic activities, mobility needs, heating and cooling of buildings, and the availability and relative cost of energy sources. These local and national circumstances vary widely among IEA countries and are reflected in their level of CO_2 emissions per capita and per unit of GDP.

Furthermore, energy systems of IEA countries show variations in: the composition of primary energy supplies; the structure of electricity grids and other communication networks; the age of the system's components; the density of users; the degree of deregulation; and the division of ownership between the public and private sectors.

... and between energy services

Clear differences between patterns in transportation (demand for mobility), electricity generation, electricity consumption, and other stationary end-uses of fossil fuels point to the need to understand the specific features of each energy service. Without a disaggregated approach which recognises these differences, analysis may have limited relevance to practical response options.

The different dynamics of the main energy services (mobility, electricity use and heat) come from different infrastructures, lifetime of capital stocks, technologies, and the nature and behaviour of involved decision-makers (households versus private companies versus governments, whether at local or national level).



Historically, electricity and transportation fuel demand have closely followed economic growth

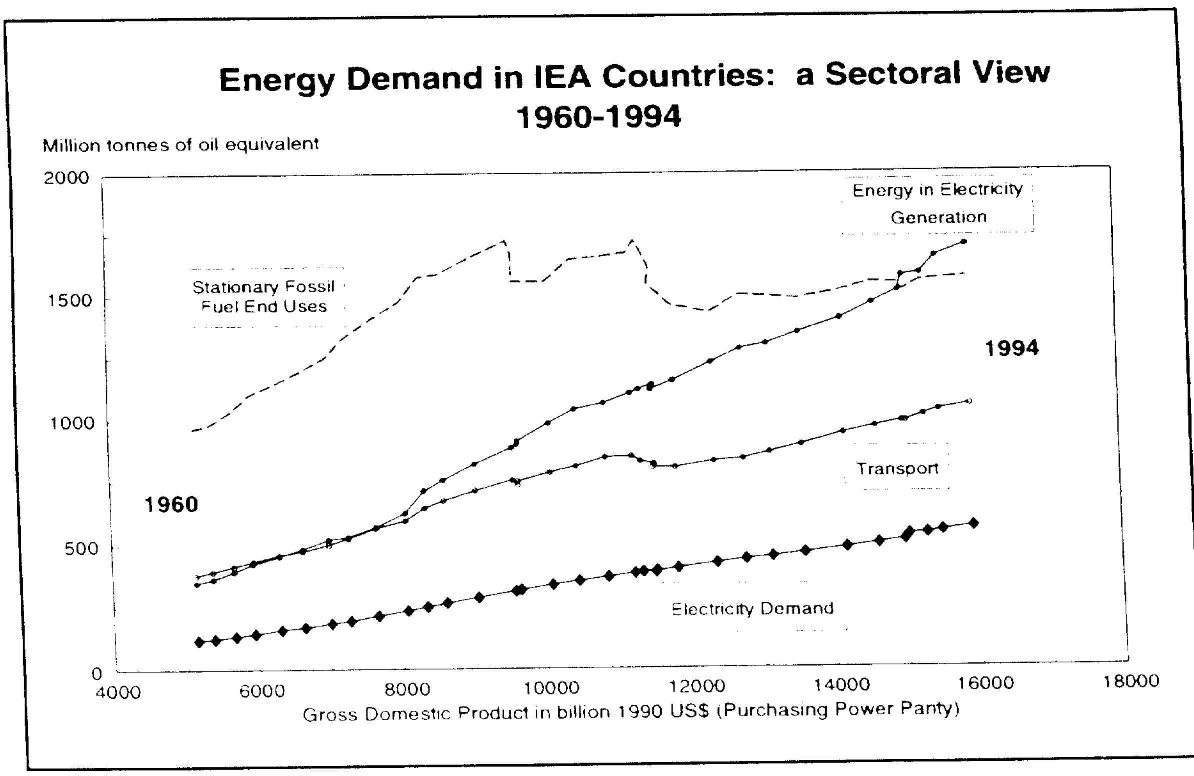
Electricity use and energy use to fulfil mobility needs have closely followed world economic output. The above graph also shows the corresponding energy needed to produce end-use electricity (fossil fuels, nuclear, hydro and other renewable sources). The difference between energy use for electricity generation and demand represents losses from the transformation of primary energy into electricity, and the transportation and distribution of electricity. These losses should decrease somewhat over time as more efficient fossil fuel transformation technologies (gas turbines, combined heat and power generation) are installed.

Demand for heat from fossil fuels presents a more complex picture

Three major events have influenced fossil fuel demand for stationary heat purposes: the 1973 and 1979 oil shocks and the economic restructuring of centrally-planned European economies after 1989. Successful energy efficiency programmes, a shift towards service-oriented activities which require less energy to produce, as well as the relocation of some industrial activities to developing countries explain the stabilisation of heat-related fossil fuel demand in IEA countries as a whole.

Since the late seventies, most of the increase in stationary use of fossil fuels for heat services has taken place outside IEA countries. Economic development is driving the demand for fossil fuel-based heat, especially for industrial activities and also leads to the substitution of commercial fuels for non-marketed traditional fuels.

The following graph illustrates the evolution of energy demand related to mobility, electricity use and other stationary use of fossil fuels for IEA countries over the past 35 years. It shows in particular the stabilisation of fossil fuel demand for stationary end-uses other than electricity.



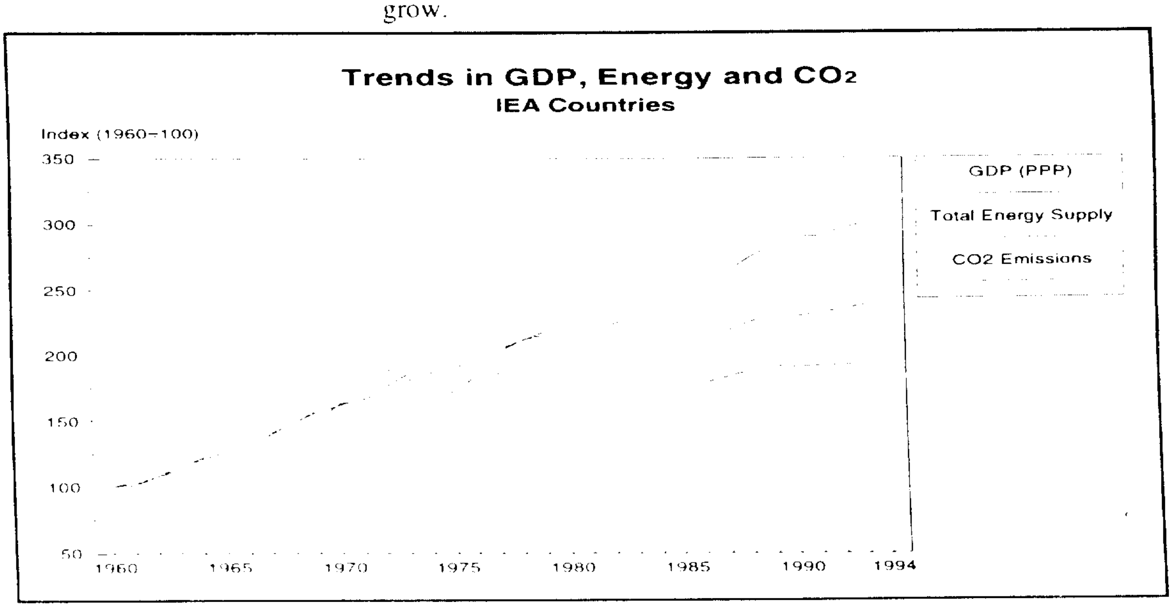
Future economic growth will likely trigger increasing energy-related CO_2 emissions in the absence of new measures ...

In the absence of effective action to address climate change, the IEA World Energy Outlook indicates that, within the range of cases examined, continuing economic growth is likely to lead to growth in energy-related CO_2 emissions in IEA countries over the next 15 years.

The overall carbon content of IEA countries' energy requirements has been decreasing over the past 20 years (see following graph), due in particular to the development of nuclear power in response to energy security concerns after the two oil shocks and to increasing use of natural gas, whose combustion contributes to less GHG emissions than oil and coal.

In the absence of specific responses, the observed rate of "de-carbonisation" of energy in IEA economies is unlikely to be maintained, since nuclear programmes have now been slowed or halted in most countries.

Renewable energy technologies other than hydro are not in most cases cost competitive with major conventional energy sources. They have however undergone dramatic cost reductions and, should this trend continue, could further reduce the carbon content of energy. Their contribution is small today, yet current expectations on relative costs suggest the share of renewables will grow.



... especially in developing countries

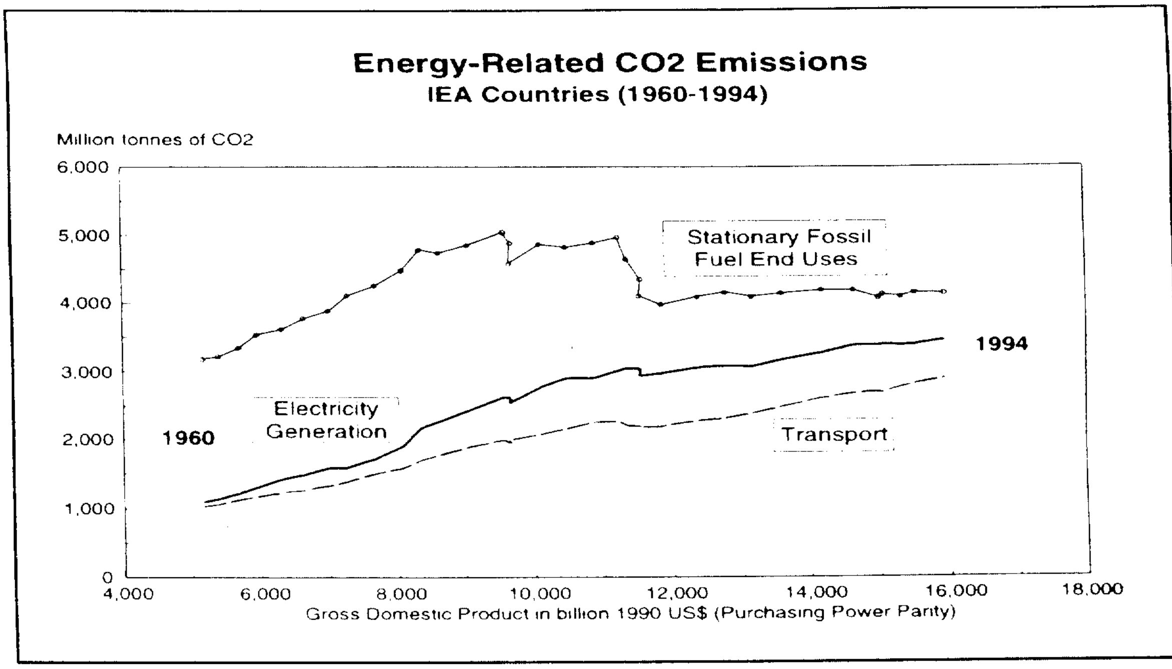
Ongoing economic development in non-Annex I countries will also contribute to rising energy use and related CO_2 emissions, at a faster rate than in developed countries. However, while there is a wide variety of situations in non-Annex I countries with respect to the levels of economic development, energy use, and anthropogenic GHG emissions, on aggregate, per capita energy use and related GHG emissions will remain much lower than those of developed countries for some time to come.

II. DYNAMICS OF ENERGY SUPPLY AND DEMAND IN IEA COUNTRIES

Energy provides services ...

Climate change energy responses should be based on a clear understanding of the factors influencing energy demand and related CO_2 emissions. Energy is consumed not for itself but for the services it provides: mobility, heat, and electricity for a variety of end-uses.

These energy services are produced through a chain of technologies and infrastructures which influence the call for these services in the future and the way they are delivered. For example, cars require roads, but the availability of roads influences patterns of settlement, and thus gives rise to more demand for transportation.



... that consumers may be reluctant to do without

The trends of CO_2 emissions in transportation, electricity and heat show some regularity, except for the reactions to major disruptions such as the two oil shocks (see graph above).

Attempts to constrain energy-related services typically encounter strong resistance from consumers, although reductions can be obtained indirectly through the introduction of end-use technologies which bring the same or better services in a more climate-friendly manner; changes in consumers' behaviour may be more feasible over the long term, as consumers become more attuned to the greenhouse effect.

Infrastructure limits the near-term flexibility of energy systems

The infrastructure which frames energy use (residential and commercial buildings, industrial "shells", roads, energy grids) is capital-intensive. Much of the currently installed energy-using capital stock, with the exception of the 1974-86 period associated with the two oil shocks, was designed and chosen in a context of relatively low energy prices, with little incentive to focus on energy efficiency improvements. Retiring capital stocks before their normal life will in many cases be costly; however, cost-effective reductions in energy use and emissions can be achieved by retrofits especially if carried out for other purposes. The rigidities inherent in existing infrastructure and associated inertia in individual behaviours require ongoing efforts to ensure that choices of infrastructure are taken with full knowledge of their implications on future GHG emissions.

Technological improvements are also constrained in the near-term

The enhanced use of best available technologies could help reduce energy requirements and CO_2 emissions within the constraint of current infrastructure. The barriers to the adoption of currently available and cost-effective technologies will need to be overcome. These include their perceived lower profitability (whenever their environmental benefits are not recognized), awareness of their potential and their reliability, the local knowledge and experience with their operation, and problems associated with the transfer of proprietary technologies. At the end, their ultimate contribution remains limited by their technical potential.

Along with the need to orient infrastructure towards more climate-friendly choices, the development of new technologies and processes for the future is an essential part of a longer term strategy to reduce greenhouse gas emissions. Longer term options exist for the various energy services, but action needs to be pursued vigorously so that more climate-friendly technologies can be assessed, developed and introduced into the market within the next few decades.

Price effects occur within these constraints ...

Energy prices affect the behaviour of energy users in the short run and influence long term infrastructure development and capital investment.

Because the three major services (mobility, electricity use and heat) are different in essence, as well as in terms of underlying infrastructures, sensitivity to the price of energy, and the capacity to react to price changes, vary widely.

... with major sectoral variations

Fossil fuel demand for heat as a whole shows more sensitivity to prices in the short run than the two other energy services (mobility and electricity). Energy-intensive industries, where energy expenditures represent a significant share of production cost, tend to manage their energy use more closely than less energy-intensive industries and non-industrial users.

Even though there has not been either upwards or downwards long-term trends in end-use prices, comparisons across IEA countries show that consistently higher energy prices have led to lower energy demand for related services.

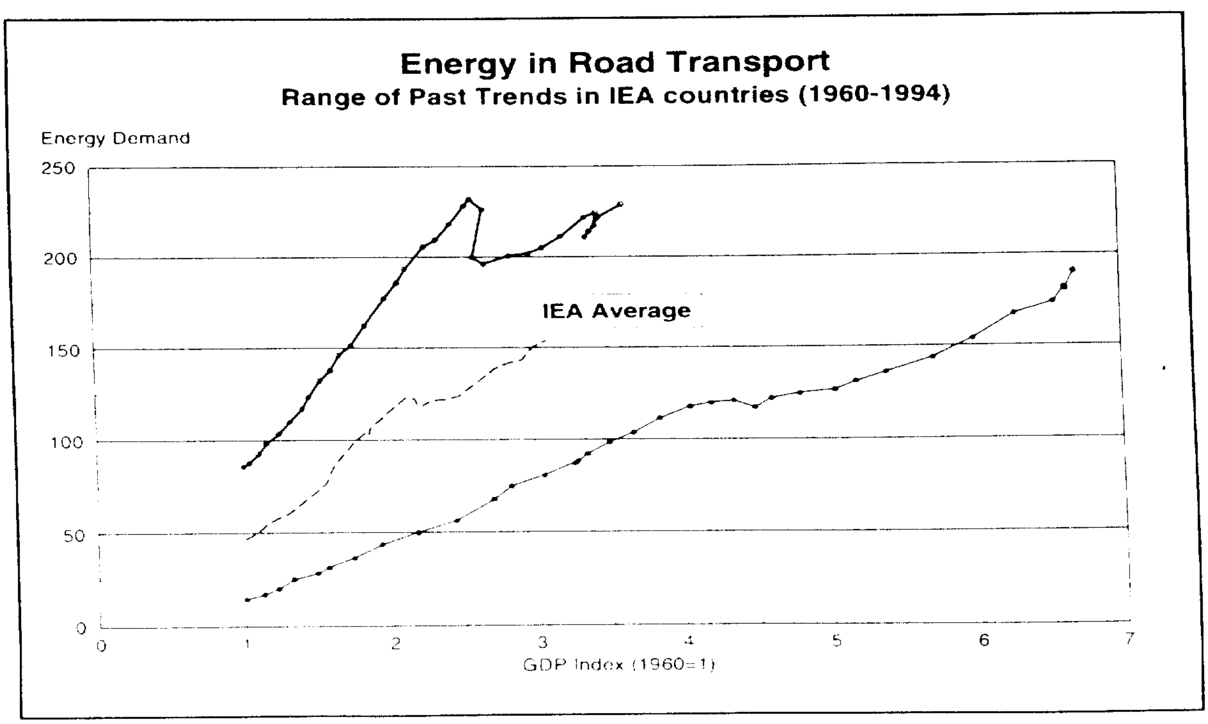
Understanding the dynamics of complex energy systems requires considering the economic level of the country, the motivation of diverse actors and sectors, and other factors. Such understanding is the key to a cost-effective approach to CO_2 emissions reduction.

Mobility patterns reflect infrastructure ...

The mobility of goods and persons is an important component of economic activity in IEA countries. The absolute increase in energy use for transportation is due primarily to personal cars and road freight, and to a lesser extent to sea and air travel. In the overall demand for transportation, patterns of human settlements, population density, and income remain essential factors in explaining differences across IEA countries.

Large investments have been made in the past to support road-transportation, which in turn have shaped population settlements and mobility needs. Thus, in the short to medium term, mobility patterns are largely determined by historic decisions on pricing of transport fuels, cars, and on infra-structural choices (roads versus railroads, for instance). Given the inertia of existing infrastructure, mobility patterns can only be changed in the long run. In the near-term, efficiency improvements in cars and modal shifts (from private to public transportation) can help reduce energy demand for similar mobility needs.

All IEA countries have experienced a rather linear growth in energy demand for mobility, a combination of low specific consumption, higher number of cars, and increased usage. In North America, the introduction of an average fuel economy standard for car manufacturers has had a marked impact on the trend. The following graph indicates the average trend in energy demand for transportation for IEA countries over the 1960-1994 period, along with GDP growth, as well as the range of diverse situations, illustrated by two countries.



... while energy demand also reflects vehicle characteristics and use...

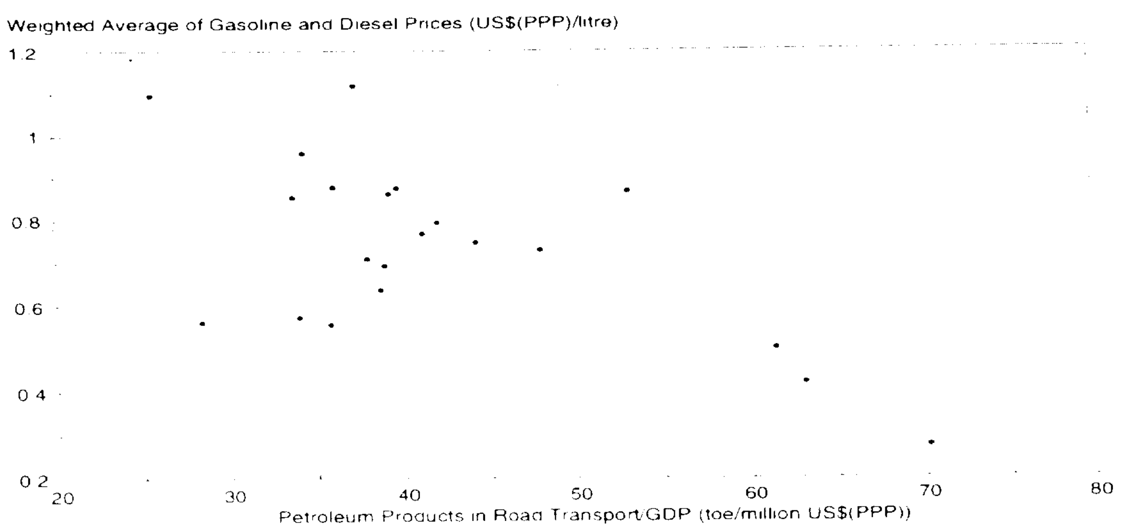
The energy required for any given pattern of mobility is affected by the average efficiency of vehicles which have much shorter lifetimes than transportation infrastructures: most of the effects of any policy or market change will be seen in on-road technology within at most 15 to 20 years (i.e., from technology design to market absorption). This suggests the need to orient research towards more advanced transportation technologies, from vehicles to infrastructure, in order to be able to cope with longer run constraints on CO_2 emissions.

... and end-user prices

Pricing of transportation has been largely related to the historical availability of domestic resources and the reliance on oil imports which differ across IEA countries.

There is clear evidence throughout IEA countries that fuel prices including taxes, taxes on cars, or charges for their use, as well as direct government regulations on car efficiency, can have a strong influence on the intensity of energy demand in the transportation sector per unit of GDP, through the combination of vehicle choice (gasoline versus diesel versus alternative fuels), design (including car size and accessories), their use (vehicle management and annual mileage driven), and the modal split between public and private transportation.

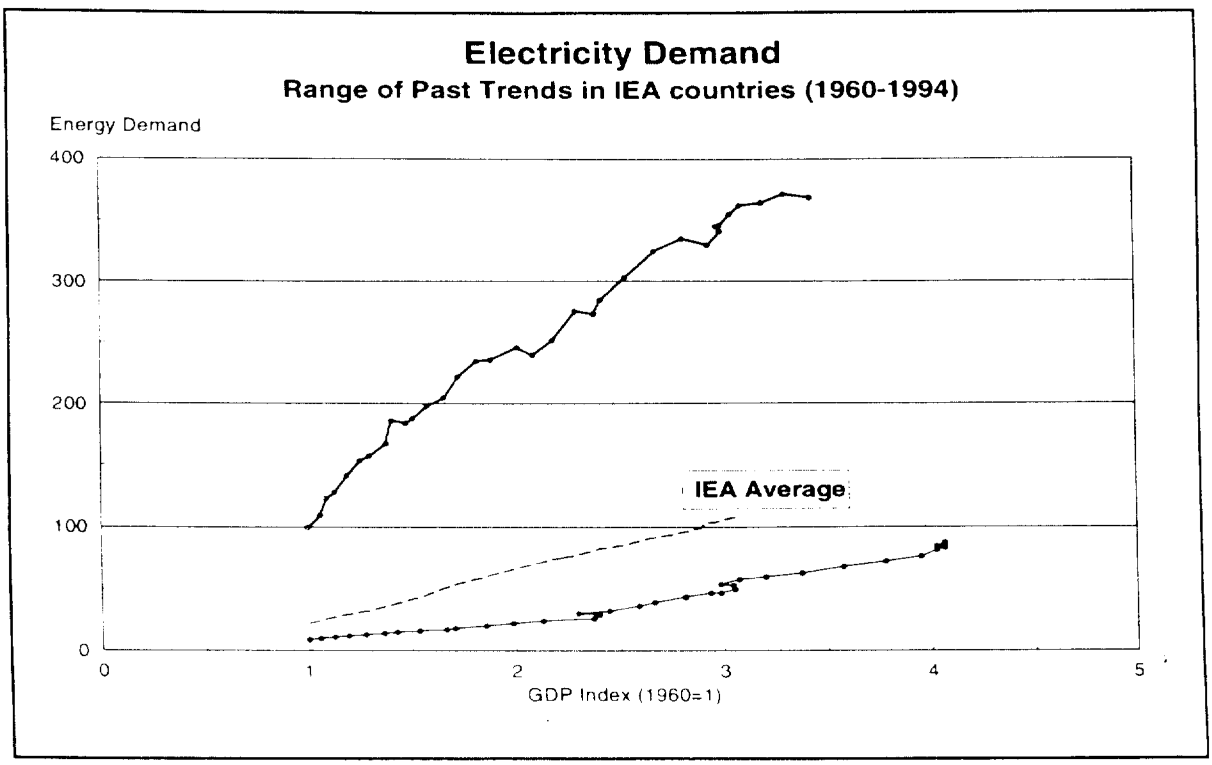
Energy Demand in Transport per unit of GDP and Prices
IEA Countries, 1994



Electricity demand reflects ongoing technological change in a wide variety of activities

Electricity provides the most convenient fuel for a wide range of end-uses, and is currently irreplaceable in many of them. The growth of electricity demand reflects this convenience, the general increase in energy demand, the development of new electricity uses as a result of technological innovation, and substitution away from fossil fuel end-uses. While there is constant improvement of energy efficiency in electric appliances, increasing levels of activities and needs have resulted in the observed increase in electricity demand.

On the electricity production side, baseload generation concentrates on the most readily available supply sources under national circumstances, while peak-load typically uses oil products as the fuel at the margin.

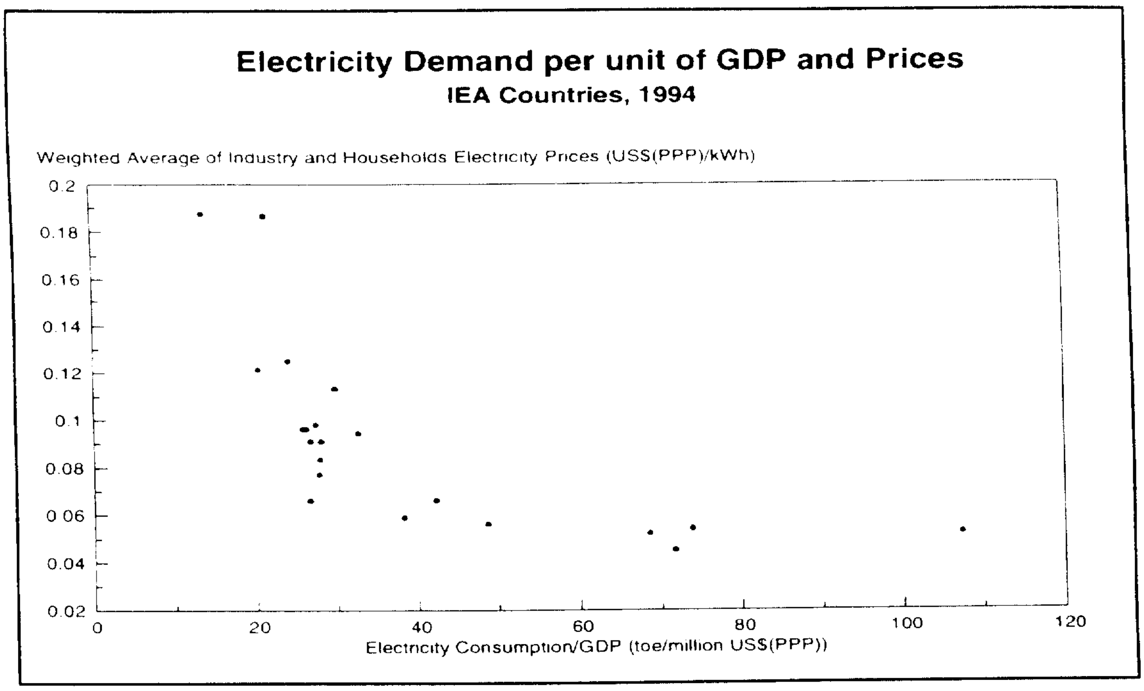


Electricity demand appears to grow constantly with GDP...

The above graph indicates the average trend in electricity demand against GDP for IEA as well as an indication of the range across Member countries.

... with variations depending on the price environment and resource base

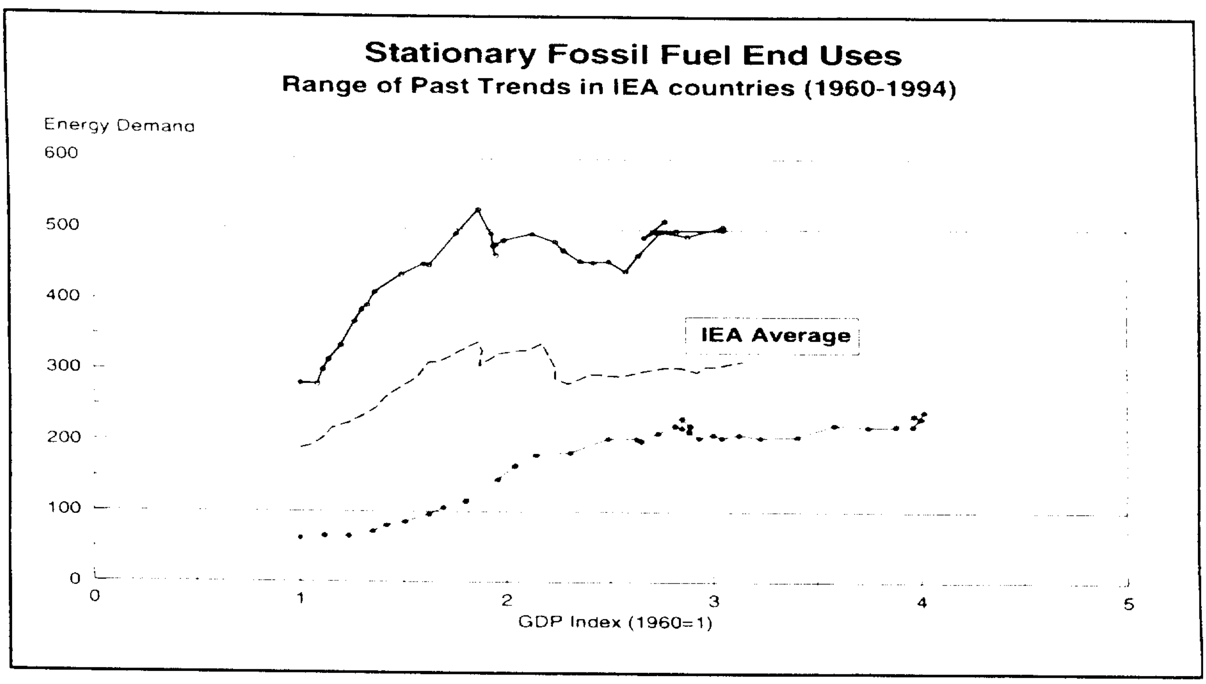
The electricity intensity of IEA economies and the rate of adoption of new electricity uses vary from one country to another with prices faced by industry, services and households. These prices depend on a number of factors such as the availability of domestic primary energy sources, the efficiency of power generation, market structure, etc.



Stationary fossil fuel end-uses are more price-sensitive in the near term

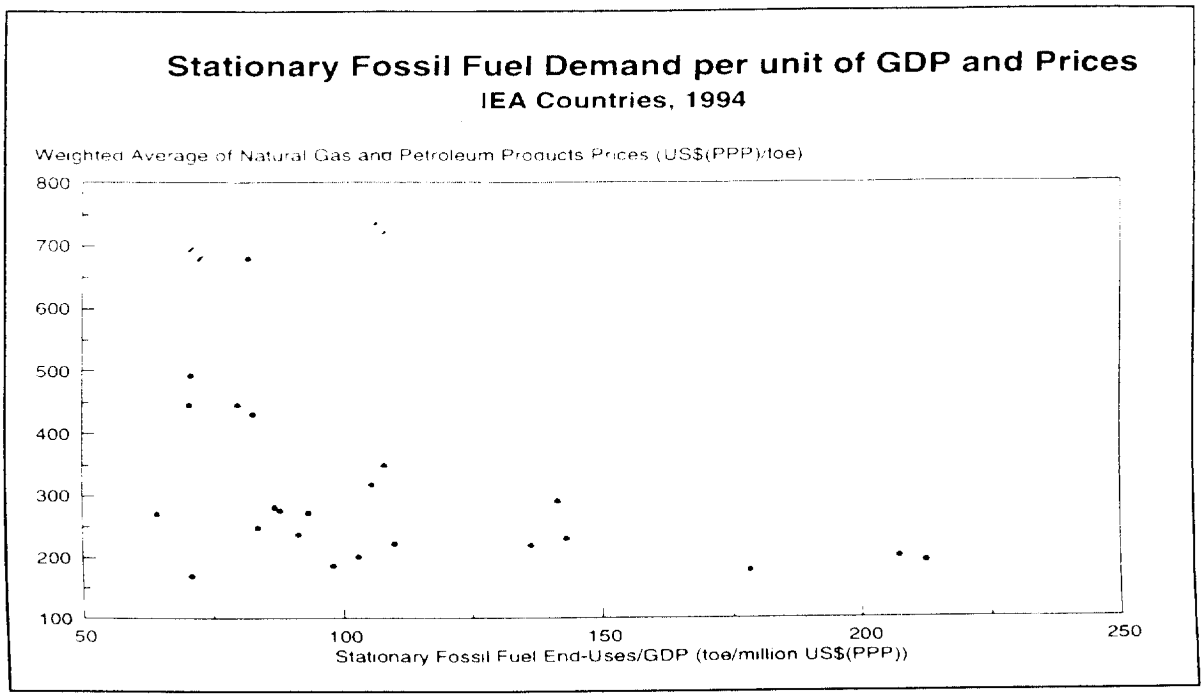
Contrary to transportation and electricity demand, the demand for heat (i.e., stationary fossil fuel end-uses other than for electricity production) has shown significant drops following the oil shocks (see next graph, with an indication of the range among IEA countries). Another feature is the shift of heat demand trends thereafter, leading to a stabilisation of related CO_2 emissions from these end-uses, despite substantially lower oil prices since 1986 (see earlier graph: *Energy-related CO_2 emissions, IEA countries*).

Beyond the overall structural change towards energy services in IEA economies, the current situation was reached through a combination of high concern about security of supply (initially), specific policies, efforts of industries towards energy conservation and industrial relocation.



Since fossil fuels represent a significant share of costs of heat production, fossil fuel prices are a key parameter in production patterns. The 1994 cross-section observation of IEA member countries reveals a clear correlation between end-use prices and heat demand per unit of GDP (see following graph).

Nevertheless, many other factors affect the fossil fuel demand for heat services. For instance, despite low energy prices, some countries continue to achieve low energy intensity by improving efficiency through regulations and voluntary measures. This demonstrates that the trend shift in heat demand is influenced by policy actions.



Actions need to take full benefit of capital stock turnover

The extent and age of existing energy infrastructures constrain the rate at which cost-effective reductions in energy-related emissions can be achieved in the near/medium term. On the other hand, energy systems are constantly changing, as capital stocks are replaced and/or expanded along the full energy chain, from extraction to service provision.

In many cases, there is a large potential for energy efficiency improvement, through the use of best available technologies. Apart from the economics, in many cases favourable, a number of barriers - information, regulatory, institutional, financial- hinder the full uptake of these technologies. It is essential to try to remove such barriers to allow these emerging technologies to establish their operational reliability and cost competitiveness.

Every time energy-using capital stock and infrastructure is installed anywhere in the world, there is a unique opportunity to adopt climate-friendly technologies. If this opportunity is missed, not only will reductions in emissions not take place as early as they could, but potential suppliers of such technologies will have less incentive to develop them.

Early involvement of all actors concerned will help foster appropriate innovations and changes in long-term trends and infrastructures (e.g., in town planning) and to achieve emission reductions at minimum cost. This is all the more important in the context of electricity market liberalisation and deregulation of other energy activities, which may have lasting impacts on end-use energy prices, and uncertain effects on emission levels.

The time frame for reduction in emissions depends on the nature of the energy systems in each sector or country

The time frame to develop new technologies varies considerably depending on the type of existing equipment and underlying infrastructures, from district heating networks, gas-stations and pipelines, to electrified roads for public transport. Energy systems, from the production of energy to its end-use in specialised activities which contribute to economic development, are dynamic but with varying degrees of inertia. IEA countries have different economic structures and energy production and demand patterns, the result of different resource endowments, and choices made over decades. They will take these circumstances into account in the design of the most appropriate strategies for tackling their own GHG emissions.

III. COST-EFFECTIVE AND VIABLE ENERGY RESPONSES TO CLIMATE CHANGE

Preamble

While reading what follows, the reader should keep in mind the past trends of energy demand described earlier. They suggest that responses, as described below, should be assessed against their capacity to have a lasting influence on these trends, and their political acceptability.

Viable responses need to work with market dynamics

The promotion of environmentally sustainable economic growth requires providing and expanding energy services while simultaneously reducing their energy and CO_2 content. Market dynamics, the rigidity of infrastructures and attitudes, and the rate of capital stock turnover define the basic parameters of viable response options, pointing both to certain limitations and significant opportunities.

De-regulation of energy markets in IEA countries can be a vector for cost-effective responses

The current trend in energy market de-regulation in IEA countries should provide a more level playing field. This may not promote lower greenhouse gas emissions in all cases; yet it will provide a more cost-effective basis for actions aimed at reducing greenhouse gas emissions.

Market attitudes to risk shape the vital contribution of technology

Of particular importance are the perceptions of risk that may hinder new technology when it is regarded as compounding the intrinsic uncertainties of market competition. Yet dynamic implementation of the best available technology has a vital role to play in mitigation of the climate impact of the energy chain. A stable, transparent, and level playing field is essential to create clear market signals and to allow new climate-friendly technologies to be selected through normal commercial decision-making.

Policy also has a role to play in technological development. The major challenge is to combine a favourable context for research, development and deployment – both through public funding and an appropriate framework for private activity – with market-based evaluation and implementation mechanisms. The IEA / OECD Climate Technology Initiative (CTI) is exploring this challenge.

In a complex world, no single response option is uniquely viable

In theory, policies which act on prices (e.g., taxes on emissions) and those that act on quantities (e.g., regulations to limit emissions) can achieve equivalent emission reductions. In reality, however, their economic, political and social implications are likely to be very different.

As discussed in sections I and II, sectoral and national diversity, and the economic value of existing capital stock will heavily influence the impacts of such action. Because of widely varying effects of given policy instruments in different national contexts, it is difficult to define in general terms a mix of policies and measures which would be universally applicable. This suggests policies should be part of a learning process, whereby the implementation of responses provides information about their effectiveness and enables improved development of a flexible and adaptable policy framework over time.

Policies and measures can either directly target individual energy-users' behaviour or try to concentrate on a smaller number of institutional actors, government agencies, industrial users and the service sector, which influence individual consumers (e.g., construction companies which provide better insulated housing thanks to building codes). Experience shows that the latter group of actors may be easier to influence, even though in the long term, an effective climate change response will not be possible without support and action from the general public.

Potential policies include a variety of measures, such as: removal of various types of subsidies and price distortions; taxes and charges to raise energy prices; the accelerated introduction of reduced carbon and carbon-free technologies; voluntary agreements, standards and labelling programmes; target-related tradeable permits; and/or joint implementation.

Energy pricing which better reflects costs is potentially a win-win strategy

Privatisation and increased competition will tend to relate price-signals more closely to underlying costs and to introduce closer scrutiny of subsidies. In principle, full-cost pricing is a win-win long-term strategy since it provides an equitable basis for further policies to operate effectively within the market.

In practice, the situation is more complex because it is impossible to identify the "true" cost of all externalities, and an increase in price to reflect these externalities may not be painless in the short term. Nonetheless, moving towards elimination of subsidies and incorporation of identifiable externalities into prices will in general be a key component of climate change responses.

End-use prices are a strong determinant of energy consumption trends

Sectoral analysis indicates, in each end-use market, an inverse relationship between average energy prices and consumption per unit of GDP. This suggests that, even though short-run price-elasticities may be low, prices do influence consumers in selecting equipment and infrastructures, and in their use. Instruments affecting prices would provide a direct lever on consumption patterns, albeit with highly differentiated sectoral impacts. This explains why those IEA countries which have adopted carbon/energy taxation have partly exempted industry on competitiveness grounds.

Indeed, policies on energy prices have a variety of significant knock-on effects - notably on international competitiveness, aggregate welfare and income distribution – that need to be taken into account in their design and the evaluation of their practicality.

Climate-friendly technologies can be used in transport and electricity generation

A variety of options are available which could reduce the CO_2 impact of power generation for the same level of service provision: more efficient fossil technologies (e.g., cogeneration), renewable energies, large hydro dams and nuclear power stations. The drastic changes which have taken place in this area since 1973 indicate that the potential is large. Similarly, in the transportation sector, electrical, hybrid and hydrogen vehicles are available at varying levels of commercial viability.

Their applicability will vary depending on national contexts. In particular, their beneficial impact on CO_2 emissions may be offset by considerations of security of supply or other environmental issues. Furthermore, they have upstream impacts (e.g., dams for hydropower, long-haul natural gas shipping for power generation) that may affect their net GHG balance.

Furthermore, longer-term R&D is needed to develop cleaner and more efficient technologies for energy production and end-use

Cleaner and more efficient technologies can be introduced for energy production and end-use. However, deployment of new technologies is dependent on a mix of market "pull" and technological "push" (whether this triggers incremental improvements or technological breakthroughs). Ongoing technological progress requires commitments to long-term investments in research and development, particularly to achieve further decarbonisation in the power sector (e.g., with renewables or other non-fossil sources), to promote CO_2 capture and storage, to improve the efficiency of fossil fuel use, and to increase end-use energy efficiency.

Voluntary agreements, audits, labels and standards can address certain forms of market failure

When energy costs are a major input to an economic activity, energy consumption will generally be addressed in the most efficient way by private operators.

On the other hand, when energy costs represent a small input – in non-energy-intensive industries, services or households –, operators may neglect profitable energy efficiency measures because they tend to focus on other, more important inputs. In such circumstances, audits together with voluntary agreements, standards, or labelling and information campaigns supported by energy service companies, may raise operators' concerns for the energy implications of their day-to-day operations and investment choices.

There is promising experience of such action, thanks to initiatives of a number of IEA governments promoting cooperation between public or private institutions and industry, services, and the household sector.

Efficiency standards have demonstrated their potential effectiveness

Trends in energy demand and related CO_2 emissions for the three services have shown that improvements in the energy efficiency of specific equipment have been more or less offset by a combination of more and/or larger equipment, as well as increase in use, largely as a result of economic growth.

Energy efficiency standards have been implemented for a range of end-uses (vehicles, building insulation codes, electric appliances, etc.). By accelerating the introduction of more efficient equipment, efficiency standards have had positive effects on both end-users' welfare and energy savings. Past trends suggest that further energy savings can be achieved by limiting the so-called rebound effect (i.e., the increase in use as a result of lower energy costs, which reduces the expected energy savings).

An interesting experience can be found in the US corporate average fuel economy standards for cars and light trucks which produced an overall reduction of 20% in fuel demand for transportation from past trends, mainly attributable to reductions in vehicle weight. Such measures may not be as effective in other countries, where there is much room for an increase in car numbers and use. However, such measures could be employed to promote non-conventional vehicles (natural gas, electric, hybrid...).

An equivalent tool could be a system of feebates / rebates providing a signal on the aggregate level of GHG emissions for each vehicle over their expected lifetime, which would gear consumer choices towards more climate-friendly technologies.

Tradeable permits offer flexibility in mitigation

Tradeable permits have demonstrated their effectiveness in achieving innovative and flexible cost-effective compliance with respect to atmospheric pollutants such as SO_2 and lead in gasoline.

International or national emissions trading offers a potentially efficient means of reducing the marginal and overall cost of controlling greenhouse gas emissions, while providing an incentive for early action by those participants for which it is cost-effective to do so. A further advantage of emissions trading is the incentive it would provide for investment and technology diffusion.

Applying such instruments to CO_2 emissions is attractive in principle, but many important issues have to be resolved: equity concerns in the allocation of emission quotas, potential transaction costs, and the necessity of an international monitoring system.

Joint implementation of projects and activities could complement an emissions trading scheme

Among instruments which either add to or may help to introduce a system of tradeable permits, joint implementation among Annex I countries or Activities Implemented Jointly (AIJ) between Annex I and non-Annex I countries could provide an option, subject to addressing issues such as baselines, performance monitoring, and crediting of avoided emissions. Furthermore, this offers helpful opportunities for cooperation with the developing world, in a way that is consistent with their current energy needs.

Many areas could be envisaged for Activities Implemented Jointly, such as methane leakage in natural gas pipelines, demonstration and deployment of renewable energy, and power-plant efficiency improvements.

Combining such potential instruments over three energy services is a complex task . . .

Although some options are clearly geared specifically towards certain sectors (industry, utilities, services, households...), there are a number of possible combinations leading to different policy packages for the three energy services (transport, electricity, other stationary uses).

Cost-effectiveness is a key objective, but is highly dependent on national and sectoral situations. What is cost-effective in certain national circumstances may not be in others: experience is not necessarily transferable.

... requiring cooperation among IEA countries ...

Cooperation among countries to share their experiences and attitudes will, within the limits imposed by differing national circumstances, bring benefits ranging from replication of actions that have proved successful in one country to actions undertaken as a genuine common policy that might otherwise not be possible at national level.

Policies and measures might include agreement to act together in defined areas, leaving flexibility on how precisely to act; and measures and strategies to minimise the economic consequences of action, e.g., through changes in competitiveness.

... between IEA and non-IEA countries ...

These options are open to developing countries as well as IEA member countries, although, as with IEA member countries, their applicability depends a great deal on each country's economic, social and political circumstances and technical capabilities. Through the Climate Technology Initiative, as well as through other multilateral or bilateral means, IEA member countries are eager to share their experiences in these areas with developing countries.

Yet, the growing share of non-IEA countries in CO_2 emissions implies that, whenever possible, actions should be taken together. In particular, rapid infrastructure growth in developing countries provides important opportunities for cooperative action, including technology and voluntary agreements, labels and standards, and AIJ.

... and within each IEA country

Last but not least, within each individual country, policy packages to tackle the threat of global climate change will need strong cooperation between ministries (environment, energy, transportation, industry, finance, foreign affairs), businesses and the general public.

PAPER NO. 2:

SUBMISSION FROM THE UNITED KINGDOM (ON BEHALF OF THE ANNEX I EXPERT GROUP ON THE UNFCCC)

INTRODUCTION

1. The purpose of this paper is to report on the work activities of the Annex I Expert Group and in particular on a project which has been undertaken by the group on "Policies and Measures for Possible Common Action"[1]. This project was initiated in 1995 at the request of countries listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) and is supported by the secretariats of the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA).

2. In 1996 eight studies were released at UNFCCC AGBM meetings. This year a further seven studies have been, or will be, completed under this project. The full set of studies is listed in the boxes below:

Tranche I and II Common Action Studies

Tranche I Studies:

1. Sustainable Transport Policies: CO2 Emissions from Road Vehicles
2. Reforming Coal and Electricity Subsidies
3. Energy Market Reform: Full Cost Pricing
4. Taxation (i.e. carbon/energy)
5. Energy Efficiency Standards for Traded Products
6. Financing Energy Efficiency in EIT Countries
7. Agriculture and Forestry: Identification of Options for Net GHG Reduction
8. Voluntary Agreements with Industry

Tranche II Studies:

1. International GHG Emission Trading
2. Financing Energy Efficiency in EIT Countries, Part II
3. Marine Bunker Fuel Charges
4. Carbon Charges on Aviation Fuels
5. Innovation in Transport Behaviour and Technology
6. Competitiveness issues related to Carbon/Energy Taxation:

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[1] A description of the objectives and approach of this project is contained in the "Progress Report to the fourth session of the AGBM from the Annex I Expert Group on the UNFCCC" (FCCC/AGBM/1996/MISC.1/Add.2)

3. The studies cover a wide range of policies and measures including: voluntary agreements; economic instruments such as carbon and energy taxes, emissions trading and full cost pricing; sectoral analyses reviewing options in the transport, agricultural and forestry, and electricity sectors; and studies looking at ways to improve financing of energy efficiency in countries with economies in transition. The studies evaluate these polices and measures subject to a number of criteria including: cost-effectiveness; environmental performance; implementation and design issues (administrative and institutional); political feasibility; and broader economic effects, including effects on other (non participating) countries.

4. It should be emphasised that the Common Action project was not intended to be prescriptive or pre-judge nations' preferences on policies and measures. The Annex I Expert Group has not formally approved the individual studies; they are being made available to the AGBM as working papers. The studies are meant to provide background analytical support to Annex I countries in the Berlin Mandate process. The studies provide considerable information which can now be drawn upon by policy makers and others interested in the policy making process. They also provide an opportunity for non-participating countries to share the relevant policy experience of developed countries.

5. Executive summaries for the five completed Tranche II studies are provided in this submission. The full studies from Tranche I and II are available at AGBM 6 and from the OECD[2]. The other two studies (one on competitiveness issues related to carbon/energy taxation and the other on the electricity sector) will be available at AGBM 7. These studies are provided to the AGBM as input to the Berlin Mandate negotiations.

2. International GHG Emission Trading: Executive summary

Aim

6. This study aims to develop a better understanding of how international greenhouse gas (GHG) emission trading could help to meet future commitments under the UN FCCC, and to facilitate the development of options for workable emission trading schemes. The focus of the study is on emission trading among Annex I Parties to the UN FCCC. The study draws on experience with existing tradeable rights schemes (e.g. SO2 allowances, fish quotas, water rights), a review of the literature, and experience from other international agreements. This study does not assess the feasibility of international GHG emission trading, but rather discusses issues and raises questions about design parameters that would be important for any international emission trading system or framework agreement on emission trading.

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[2] For copies of these studies contact Carolyn Sturgeon: email carolyn.sturgeon@oecd.org; fax (33 1) 4525 7876.

What is emission trading?

7. Under an international GHG emission trading system, country emissions would be limited according to their emission targets or "QELROs" commitments[3]. Parties who were subject to such binding emission commitments would be required to hold "GHG units" equivalent to the amount of GHGs they emitted in order to prove that they had not exceeded their entitled quantity of emissions. Parties could set individual emission constraints on emission sources such as industries, which would make it possible for individual sectors or firms to participate in the international trading system. Participants would be able to buy and sell GHG units from each other. For example, if a participant had more GHG units than it needed to cover its GHG emissions it could sell the extra GHG units to another participant who needed them to cover emissions above its entitled level.

Why trade?

8. Efficiency gains (i.e. cost reductions), and implementation flexibility, can be achieved through international GHG emission trading because of differences in the cost of mitigating GHGs in different countries. Emission trading can reduce the cost of GHG mitigation by allowing participants to reduce emissions where (and possibly when) it is least expensive to do so. There is scope for cost-effective savings in all countries, but model results show that differences in mitigation cost range widely between countries. Lowering the cost of GHG mitigation can make more stringent environmental objectives achievable. The location of GHG emission reductions does not affect their global warming effects. Because of this, greenhouse gases are well suited to international emissions trading.

Definitions

9. Clear definition of the terms that are needed to discuss emission trading is essential to avoid confusion. In this study, the term *"participant"* is used to refer to any entity that has a binding obligation or agreement to limit GHG emissions, enhance sinks, or purchase GHG units in order to remain within their entitled level of emissions. Examples of participants are: FCCC Parties; sectors or industries; or individual firms. The term *"GHG unit"* is the generic term used to denote the tradeable unit representing a certain amount of GHG emissions e.g. 1000 tons CO2 equivalent[4]. An *"emission constraint"* is a limit on GHG emissions[5]

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[3] QELROs: Quantified Emission Limitation and Reduction Objectives, i.e. targets and timetables for GHG emissions (ref: Berlin Mandate.)

[4] The term GHG unit is intended to be broad enough to cover concepts in existing schemes and the literature such as "allowances", "credits", "quotas", "tradeable permits" etc.

[5] Emission constraints could be: a "cap" which is a specified constraint on emissions for a specified time period for each participant in the trading system; or a "baseline" from which emission reductions, (or increases) are measured. Examples include: cumulative emission budgets (emissions over a multi-year period); emission reductions from an historical base-year; GHG intensity per unit of Gross Domestic Product (GDP); or baseline

10. Features identified in the study as desirable in an international GHG emissions trading system include: environmental benefits; cost minimisation (facilitated by wide participation and coverage of GHGs); clear rules for changing the overall emission constraint and the entry of new participants; equity; ease of implementation; adequate monitoring, verification and reporting (to help ensure confidence in the market); and political feasibility. Inevitably, there will be trade-offs between these features: for example, a system that includes a wide range of participants and GHG would capture a broader range of GHG mitigation options but would be more difficult to monitor.

Design Parameters

1. <u>Emission Constraint</u>

11. Placing binding emission constraints on participants will create incentives for emission trading. However, if all participants were allocated weak constraints (so that the allowable level of emissions were equal to or above business as usual), or if compliance mechanisms were weak, there would be few incentives to trade. The less strict the constraints, the lower the value of the GHG units would be. Allocation issues, including those related to fairness and redistribution of wealth, are often considered to be the most controversial part of an emission trading system. However, allocation issues are not unique to trading and are not examined in depth in this study. Negotiated emission targets or "QELROs" would provide the basis for determining the individual emission constraints needed for an international GHG emission trading system.

12. An international trading system would have to be designed from the outset to be flexible so as to allow changes that might be required to the emission constraint, for example because of new knowledge on climate change impacts, inclusion of additional GHG sources and/or sinks, or new participants. An international emission trading system may have to accommodate different domestic trading systems (e.g. allowances or credits systems). To provide flexibility, emission constraints for individual participants could be issued periodically in line with UN FCCC commitments. Alternatively, participants could each take a percentage share of any overall emission constraint and thus of any future reduction (or increase) required. To minimise uncertainty for participants, the intended adjustment path would ideally be signalled when the emission constraint is initially decided. Clear rules should be established from the outset for addition of new participants to the trading system.

13. Allowing early GHG reductions to be "banked" for future use would provide flexibility for participants to go further than their required emission constraint in early years if it is cost-effective for them to do so, and to save these extra emission reductions to offset future increases in emissions. This would lower the cost of GHG reductions while contributing to the same environmental outcome reflected in the emission constraint.

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scenarios.

Allowing GHG units to be "borrowed" from the future to meet current emission constraints would also increase flexibility and could lower the economic cost of GHG reductions. Borrowing would allow participants to mitigate GHG emissions at lower cost, if mitigation costs turn out to be lower in future periods, for example if less carbon-intensive technologies develop that reduce abatement costs. However, borrowing raises a number of problematic issues, such as possible 'bankruptcy' of participants who find themselves unable to meet future commitments; and reduced market liquidity if all participants were to borrow against their own future emissions allocations rather than trade. Possible solutions to these issues include: requiring greater future reductions to offset the "borrowed" GHG units; and limiting the amount of GHG units that can be borrowed. Both banking and borrowing are concepts that could apply to Parties' commitments under the FCCC regardless of whether emission trading were to be introduced.

2. GHG units

14. The unit of trade needs to be a clearly-specified type and amount of emissions for a specified period to ensure that participants' rights and obligations are well understood and monitored. Units of trade should be standardised, so that the units are fully exchangeable. However, in order to facilitate accounting of emissions and determine compliance, it may be necessary to identify the country of origin for GHG units, which might reduce the homogeneity of GHG units. If all GHG sources and sinks were included in a trading system, participants would be encouraged to invest in the most cost-effective GHG mitigation reductions wherever they occurred, thus minimising the aggregate cost of mitigation.

15. It might be possible to allow all GHG sources and sinks that can be adequately verified and monitored to be included in a trading system. Participants with sophisticated inventory methodologies could use a comprehensive approach, while other participants might be limited to trading only CO_2 emissions due to difficulties in estimating and monitoring emissions. Another alternative could be to establish separate trading regimes for individual greenhouse gases (with effective monitoring and reporting for each system) to minimise monitoring concerns. On this basis, a trading system could begin with CO_2 emissions from fossil fuel combustion, which are the easiest to estimate and verify (CO_2 from energy is also the single largest contributor to global warming). The trading system could be designed to allow addition of other gases/sources in the future on a global warming potential (GWP) basis as monitoring and verification capacities improve.

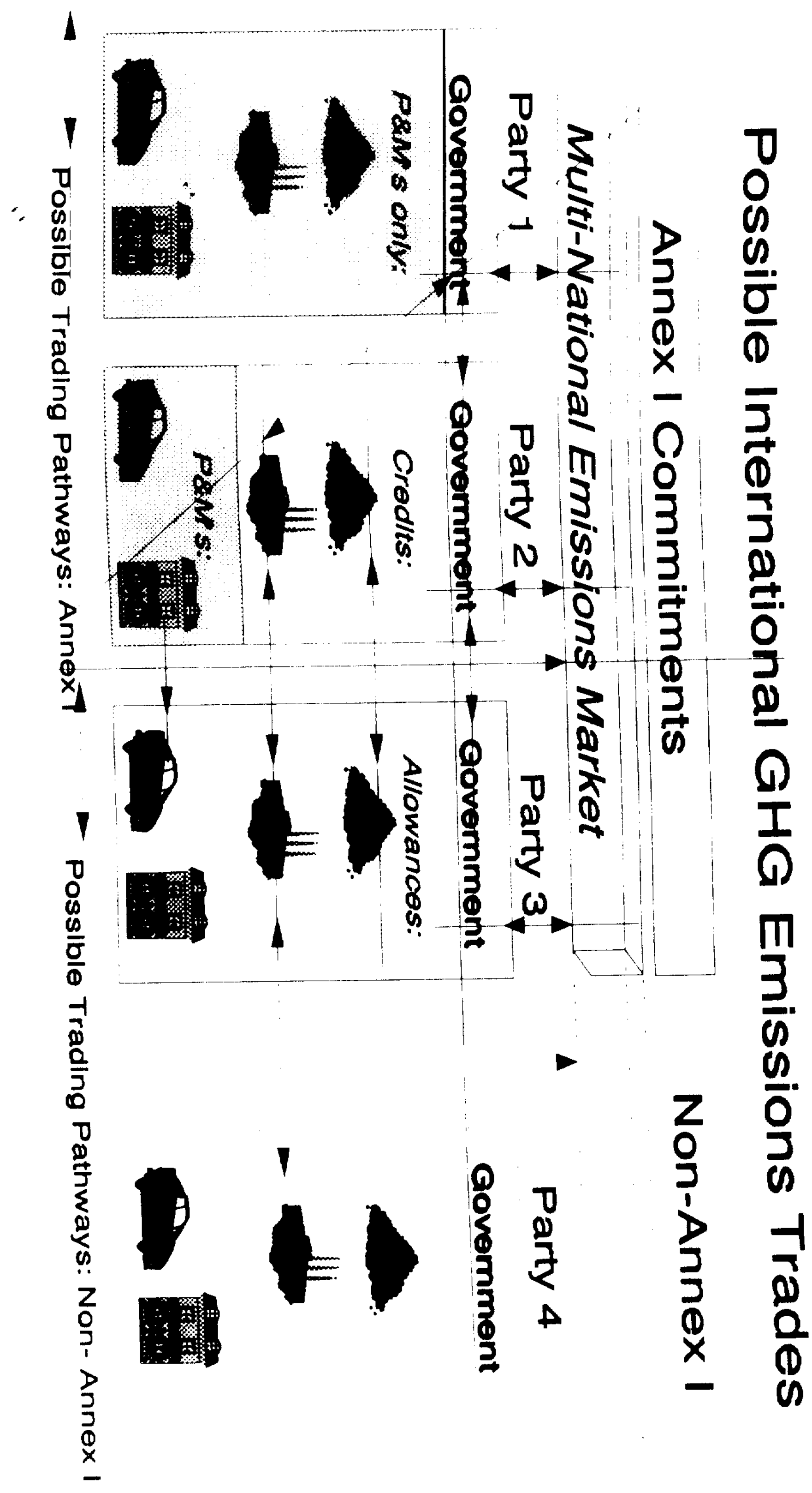
3. Possible participants

16. There would be a larger potential for GHG mitigation cost savings with wide participation of countries. However, initially it may be more realistic to include only countries with quantified emission commitments in an emissions trading system, while leaving the system open to participation by all countries. To encourage wide participation, the trading system should be kept simple. Using a comparable emissions inventory methodology for all countries would facilitate the eventual involvement of a large number of Parties.

Compliance requirements will affect the extent to which different Parties could participate in a trading system. Participation by countries that do not adopt an emission constraint could reduce the value of GHG units and raise the risk that overall GHG emissions reductions will not be achieved.

17. Many trade pathways between different types of market participant are possible (see diagram below). The desirability of including each pathway, or leaving the option open for future inclusion of a pathway, needs to be weighed against the feasibility of doing so.

18. Bilateral trades could be arranged between two governments either through direct negotiations or through intermediaries such as brokers. Such trades would require governments to obtain information on opportunities for and costs of GHG mitigation. Obtaining this type of information may be difficult. Allowing the participation of domestic entities may reduce the need for governments to gather such information, although it could increase the complexity of monitoring and verification requirements.


Possible International GHG Emissions Trades
Annex I Commitments
Non-Annex I
Multi-National Emissions Market
Party 1
Party 2
Party 3
Party 4
Government
Government
Government
Government
P&M's only:
P&M's:
Credits:
Allowances:
Possible Trading Pathways: Annex I
Possible Trading Pathways: Non- Annex I

19. International trading could be possible between industries, sectors, or individual firms if their governments implemented domestic emission trading, or allocated emission constraints to individual sources. For firms to participate in emission trading, appropriate domestic regulatory, monitoring, and implementation arrangements would be necessary. Trade between individual firms would provide strong incentives for them to exploit any cost-effective GHG reduction options that were available to them. Firms could either make money by selling "spare" GHG units, or simply comply with their constraints at least cost. Since Parties (not firms) are bound by international agreements, trades between companies in different countries would have to be accounted for at the national level and be consistent with national emission constraints derived from emission targets under the UNFCCC.

20. It may not be feasible to include very small emission sources in a domestic trading system because of the complexity of setting emission constraints and monitoring emissions. Governments may instead choose to implement other policies and measures for car drivers, small businesses, and households, such as carbon/energy taxes, energy efficiency standards, or voluntary agreements. Domestic policies and measures will vary between countries due to differences in domestic regulatory structures, the political feasibility of different measures, and the costs of particular control options. The design of a trading system should ideally be compatible with existing domestic regulations and policies such as domestic emission fees, regulations, or different domestic emission trading systems.

21. "Leakage" of GHG emissions (i.e. reductions in one region resulting in an increase in emissions in another region) could occur if some countries are required to reduce GHG emissions and others are not. This is a feature of a constraint that does not apply to all Parties. Emission trading could reduce emission leakage by reducing the cost of GHG mitigation (and thus lowering the incentive for GHG emitters to re-locate).

4. Monitoring and Enforcement

22. Monitoring mechanisms will be necessary to ensure compliance with UN FCCC commitments. The ability to trade emissions units internationally will also strongly depend on participants being able to account for their emissions and GHG units at the national level. National monitoring mechanisms could be accredited by the international community and charged with accounting for national emissions and national emission trades. International law does not currently provide a strong legal basis for international monitoring and enforcement. Thus, new mechanisms may be needed to ensure emissions and trades in GHG units are monitored, and to maintain the credibility of the trading system:

- an international emission accounting function to compile and check information on national GHG emissions and the sales and purchases of GHG units between countries;

- standard reporting formats (national inventories based on the IPCC guidelines are already required and could be used as a basis for estimating and reporting GHG emissions under a trading system); and

- a review/audit function to periodically check each country's emission accounts.

23. Given the financial value of GHG units, the importance of accurately estimating and verifying GHG emissions would be much higher under an emission trading system than at present. Different levels of enforcement are possible, depending on the desired stringency of enforcement and the cost of enforcement that participants are willing to bear. Parties could agree to impose fines or penalties for excess emissions, tighten future emission constraints, prevent non-compliers from participating in international trading, or use the FCCC multi-lateral consultative mechanism to resolve disputes on a case-by-case basis.

5. Market Mechanisms

24. A number of existing market mechanisms such as stock exchanges, information services, and payment mechanisms, could be used for GHG emission trading. Others may need to be set up, or could develop, in response to market needs. As in other commodity markets, the types of market mechanisms might include:

- brokers ("middlemen" who match buyers and sellers) could help participants make bilateral trades or to trade on an exchange;
- information services (such as bulletin boards quoting prices and quantities of GHG units sold) which would assist the market to function smoothly by facilitating price convergence and providing greater certainty over the value of GHG units;
- organised exchanges could match willing buyers and sellers, improve market liquidity, provide information on prices;
- standard documentation such as GHG unit transfer forms, confirmation notices and other accounting documents would facilitate trading;
- accreditation bodies (for example to certify national monitoring institutions and exchanges).

25. The greater the administrative or other effort required for making trades, the higher the costs participants will face for trading GHG units. If each project must be examined and approved before GHG units can be traded, the system could have higher on-going administrative costs. To reduce transaction costs the role of governments in any national trading systems should be kept to the minimum necessary to ensure compliance with their international commitments under the UN FCCC (e.g. monitoring and reporting national emissions). These functions would help ensure confidence in an international GHG emission trading system.

26. Large holders of GHG units could have incentives to hoard GHG units to increase the value of their units. The threat of market power would be lower in a market with a large number of diverse participants, in which the GHG units can be easily traded. A strategic reserve or "buffer" of GHG units held by an international entity (perhaps auctioned periodically) would reduce the ability of large participants to prevent new entrants from purchasing GHG units or from hoarding GHG units to drive the price up.

Possible barriers

27. Establishing an international emission trading system would not be simple. Possible impediments include: lack of experience with international emission trading systems; lack of confidence in countries' monitoring systems; or industry opposition to government control of and involvement in the trading process. There could also be a concern that participating countries, in purchasing GHG units from other countries, may neglect to implement (or make progress towards implementing) politically difficult measures at home. To reduce this concern, the percentage of a country's national commitment that could be met through trading could be limited, although this could have adverse effects on the efficiency of the market, reduce the number of trades, and would represent a compromise of countries' flexibility to mitigate GHG emissions.

Conclusions

28. Discussion of international GHG emission trading is still at a preliminary stage. GHGs are well-suited to international trading because the location of GHG emission reductions does not affect global warming. International GHG emission trading among countries with emission constraints (such as QELROs under the UN FCCC) would increase flexibility over where (and possibly when) GHG mitigation can take place, and so reduce the cost of GHG mitigation.

29. Difficulties in monitoring, reporting, and verification might make it impractical to implement an emission trading system covering from the outset all GHG, all sources and sinks, and all Parties. During the delay that such difficulties would cause, opportunities to trade would be lost. An international emission trading market would be more likely to start with a limited number of participants and GHGs that can be adequately monitored. The market could then evolve to become more fully comprehensive and more cost-effective. Existing national market and monitoring institutions could be used to gain experience on trading, while considering the need for any additional international institutions for a longer term, more comprehensive system. Some countries with limited capacity to set up monitoring institutions needed for trading might first begin trading GHG units earned from projects that have emission baseline constraints and adequate monitoring.

30. Further work is needed on the issues discussed in this study to improve understanding of emission trading and to share ideas on key design issues if workable options for international emission trading are to be developed.

3. Financing Energy Efficiency in EIT Countries: Executive summary

Context

31. There is large scope for cost-effective greenhouse gas (GHG) mitigation in Annex I countries making the transition to a market economy ("economies in transition" or EITs[*]). In the short term EIT countries' GHG emissions are likely to remain well below 1990 levels, but GHG emissions could rise steeply in the future unless the correlation between GDP growth and GHG emissions can be broken through improved energy efficiency. At present only a small portion of total finance to EIT countries is spent on energy efficiency, despite the fact that it often provides the most cost-effective opportunities for GHG mitigation.

32. Over the last five years, the general trend in global finance flows has been an increase in private sector finance, while public sector aid has declined. Private capital flows to developing and transition countries increased dramatically during the 1990s, but many EIT countries have not been able to capitalise on this growth in "emerging market" investment. Foreign private sector investment to countries such as Czech Republic, Estonia, Hungary, Poland, and Slovak Republic far outweighs bilateral aid and Multi-lateral Development Bank (MDB) finance. However, private sector finance in other EIT countries has so far been modest, and official development aid is still the largest pool of external finance for some.

Approach

33. This study recognises that private sector investment is the main driving force behind investment decisions in EITs. However, in order to provide input to the Annex I Expert Group in the context of Berlin Mandate negotiations, the study focuses on measures that governments could take to enhance energy efficiency financing in EITs. Two broad categories of measures are addressed in the study:

- capacity building; and
- re-directing current financial flows towards energy efficiency.

General Policy Framework

34. Macro-economic conditions such as unemployment, inflation levels, and budget deficits are significantly influenced by actions of governments. Economic trends and the macro-economic and legislative policies of EIT countries form the basis for the local investment climate. Lack of economic stability is a key obstacle to attracting private capital. The economic situation in EIT countries is changing rapidly. Some EIT countries have already implemented macro-economic policy reforms that are needed to encourage investment, such as currency convertibility, price stability. However, other EIT countries

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[*] Countries that are undergoing the process of transition to a market economy listed in Annex I to the FCCC are: Belarus; Bulgaria; Czechoslovakia (now Czech Republic and Slovakia); Estonia; Hungary; Latvia; Lithuania; Poland; Romania; Russian Federation; and Ukraine.

have not yet taken these steps. Each EIT country has different natural resources, institutional capacities, and historical developments that will influence policy decisions.

35. In the energy sector, uncertainty over privatisation of utilities, low energy prices (such as the residential sector), and general instability of prices continue to cause potential investors to hesitate from investing or defer investments. Many EITs still need to make important energy sector reforms such as removing subsidies from energy prices, privatisation, and providing the market structure and regulations needed for competition between energy suppliers. Initiatives for such reforms should be provided by governments and supported by donor countries by making aid and loans to EITs conditional on policy reforms.

36. The transition process will not be sustainable unless strong institutions emerge to underpin the new markets. Economic reforms create the demand for institutional change, but institutional reform tends to lag behind other reforms. Most EIT countries have not yet fully developed the legal, regulatory and institutional frameworks needed to support investments. Institutional reforms aimed at establishing clear property rights, sound legal and financial frameworks, and effective government, are at different stages in different countries. Sharing experience between EIT countries through workshops and dissemination of information may be all that can be realistically done by Annex I governments to improve institutions in EITs in the short term. OECD governments could second experts to assist EITs to meet the requirements of the World Trade Organisation (WTO) accession process (All EIT countries have applied to join the WTO but the information requirements are extensive. Membership of the WTO will spur domestic institution building and provide strong incentives not to maintain or establish barriers to trade).

37. The most important measures will have to be taken by EIT governments, such as banking reform, debt recovery programs, stronger fiscal discipline, and legislation to provide a supportive commercial and legal framework for investment including judicial institutions and enforcement mechanisms.

Capacity Building Measures

38. Even the relatively small level of finance that is currently available in EIT countries does not get dispersed to projects efficiently because of barriers associated with identifying, developing, managing and financing projects. Capacity building in EIT countries is needed to overcome information and motivation barriers and to help to create a business climate that is attractive to foreign investors and facilitate technology transfer. Possible measures to build capacity are:

- Energy efficiency centres to reinforce or replace the existing Energy Centres (funded by the European Union), most of which are to close in the near future. These centres could be focal points for market assessments, training, information and publicity, demonstration projects, and financing schemes. These centres could be supplemented by a regional "virtual" centre using the internet to draw together information, and provide communication channels between centres, with links to other energy technology, investment and capacity building resources on the internet;

- Annex I Parties could establish accreditation and standard qualifications for training initiatives by a wide variety of bodies - bilateral, local universities, professional associations;

- workshops could be organised by Annex I governments to disseminate ideas for macro-economic and energy sector reform;

- EIT governments and energy efficiency centres could develop promotional material to raise public awareness;

- EIT governments could use the "performance contracts" model to finance improvements in government energy use[7].

- Adoption and promotion of a common (e.g. Annex I wide, or European) energy saving measurement protocol would facilitate energy efficiency investment proposals;

- Development of standard ESCO contracts and financing mechanisms would facilitate ESCO development.

Measures aimed at redirecting current financial flows

39. Measures to re-direct private sector finance from energy supply investments towards energy efficiency and other investments that mitigate GHGs are important because private investment flows are growing rapidly while aid flows are staying at the same level or even being reduced. It is also necessary to improve the effectiveness of existing government finance. Possible measures are:

- Annex I Parties, as shareholders, directors and borrowers could strongly urge MDBs to improve their contribution to GHG mitigation, for example through: project screening for energy efficiency opportunities; co-financing and concessionary finance for energy efficiency; dissemination of policy advice; capacity building both within MDBs and in EITs; and investment appraisal that reflects GHG externalities. It is not enough for MDBs to simply make money available at a 'window' in a lending institution; the finance needs to be actively promoted and support needs to be provided to ensure that it is successfully disbursed.

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[7] Under this model, an outside energy services company expert ("ESCO") expert in energy efficiency improvements make the necessary investments to improve the organisation's energy efficiency. The government would pay the ESCO firm a set rate (equal to or lower than their normal energy bill) for a certain period. Because of the cost savings from energy efficiency improvements, the ESCO firm is likely to make money. The firm ("ESCO") thus has a strong incentive to overcome many of the barriers to energy efficiency in EITs. The ESCO takes on some or all of the risk of the investment. When the performance contract ends, the government will earn the full cost savings from the improved energy efficiency. EIT governments would also create a demand for the services of ESCOs.

- Annex I Parties could urge MDBs to make concessionary finance available to Energy Services Companies (ESCOs) which can act as vehicles for channelling MDB and related private sector finance into energy efficiency ESCOs. In countries where it is difficult to establish private sector ESCOs, it may be possible to develop a publicly owned ESCO which could be privatised at some point in future. This would enable ESCO activity to begin in those EITs that are less well advanced in the process of transition.

- OECD governments could encourage Export Credit Agencies (ECAs), through the OECD Export Credits and Credit Guarantees Group, to take account of environmental considerations when deciding whether to provide official support for projects and to provide information on the environmental impact of the projects they support;

- The lack of government guarantees for major energy efficiency projects is a significant financial barrier. In contrast, guarantees are increasingly used to mobilise private finance for power projects. EIT governments could consider providing guarantees for energy efficiency projects, which could help investors by sharing project risks, extending the length ("term") of a loan, or increasing the equity participation in well capitalised ESCOs. Government guarantees could also enable EIT governments to link efficiency improvements to investments supported by such guarantees, such as house building and renovation, industrial restructuring.

- Annex I government procurement programmes could stimulate markets for energy efficiency. Governments, bilateral aid agencies and MDBs could facilitate the creation of buyers' pools in the private sector. Aggregating energy efficiency investments into larger transactions can reduce transaction costs and help to create a more attractive market for suppliers of energy efficient technologies and services.

- All Annex I Parties could agree in principle that energy sector restructuring in their countries should take account of their commitments under the FCCC. Information could be exchanged on 'best practice' policy initiatives that could be incorporated in energy sector restructuring to reduce GHG emissions (for example, regulation of monopolies, removal of vertical integration and barriers to entry for alternative energy suppliers, tariffs and metering that encourage energy efficiency).

- The Project Preparation Committee, which matches funding from MDBs, bilateral, national funds and the private sector with suitable energy and environmental projects, could be encouraged by Annex I Parties to extend PPC activities to support more projects that mitigate GHG emissions.

- Voluntary agreements between government and the private sector, or between two governments, could stimulate greater investment in energy efficiency and GHG mitigation;

- EIT governments could establish domestic energy efficiency funds;

- EIT governments could encourage greater use of national environmental funds for energy efficiency projects.

1. Conclusions:

40. The private sector clearly has by far the largest role to play in international finance flows that could be used for energy efficiency investments in EIT countries. Donor governments can adjust their own spending priorities in aid plans and through official support provided to their exporters, but can only indirectly influence the vast pool of private sector finance.

41. Many of the most important measures to attract foreign investors are measures that can only be taken by EIT governments, such as reforming macro-economic policy frameworks, reforming energy market structures and pricing, banking reform, debt recovery programs, stronger fiscal discipline, and legislation to provide a supportive commercial and legal framework for investment including judicial institutions and enforcement mechanisms. These are difficult tasks that often involve lengthy political processes.

42. Beyond these measures to improve the general policy framework, there are many measures, including those suggested in this study, that could be used by Annex I governments to improve financing of energy efficiency through building capacity and re-directing current finance flows. The most politically feasible (and hence realistic) measures to improve energy efficiency financing will be those that are in line with domestic priorities in Annex I countries (both EIT and non-EIT). For example, for many EIT countries in central and eastern Europe, high priority is given to "approximation" of domestic policies to bring them closer to European Union policies, energy security, and reduction of local air pollution. Improving finance for energy efficiency investments would facilitate progress towards all three of these priorities. Similarly, in OECD donor countries, enhanced investment opportunities in EIT countries that have beneficial impact on domestic growth are more likely to find favour and funding.

4. Marine Bunker Fuel Charges: Executive Summary

Context

43. Marine bunker fuel combustion in 1990 was responsible globally for approximately 370 million tonnes of CO_2 emissions (102 million tonnes of carbon), rising to 400 million tonnes of CO_2 (109 million tonnes of carbon) in 1994. Bulk carriers (mainly carrying oil, iron ore, bauxite, coal and grain) account for about three quarters of maritime freight traffic, but only a quarter of maritime transport energy use. Most of the rest of the energy is used by container ships, Ro-Ro[illegible] ferries and general cargo ships. This study does not attempt to examine military fuel use: military bunkers are not included in international bunkers in the IPCC inventory guidelines. Bunker demand in 1994, at 130.5 million tonnes, was 50%

[illegible] Roll-on; roll-off. Ro-Ro ferries carry cars and trucks, normally over relatively short distances. They account for a very small share of total maritime freight transport but have a high energy intensity.

higher than in 1983, when demand reached its low point during the period of high oil prices (1974-1985). Much of the increase came from a growth in container, Ro-Ro and other general freight traffic. Annex I countries accounted for the sale of about 60% of bunker fuel sales in 1994.

44. Despite recent rapid growth, maritime transport remains responsible for only 7% of global transport sector CO_2 emissions, or about 2% of global CO_2 emissions from fossil fuel use (see Figure 1a). Shipping is also the most energy-efficient means of freight transport. Air freight, the only alternative for inter-continental and much international trade, has a CO_2 intensity two orders-of-magnitude higher than that of maritime freight (see Figure 1b: note logarithmic scale).

Figure 1a. Share of World Transport CO2 Emissions

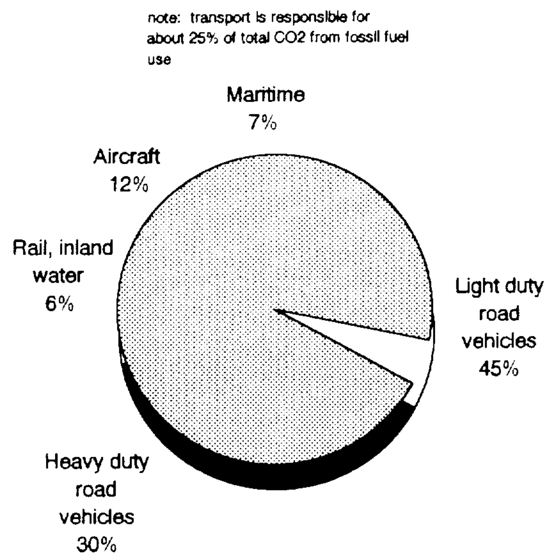
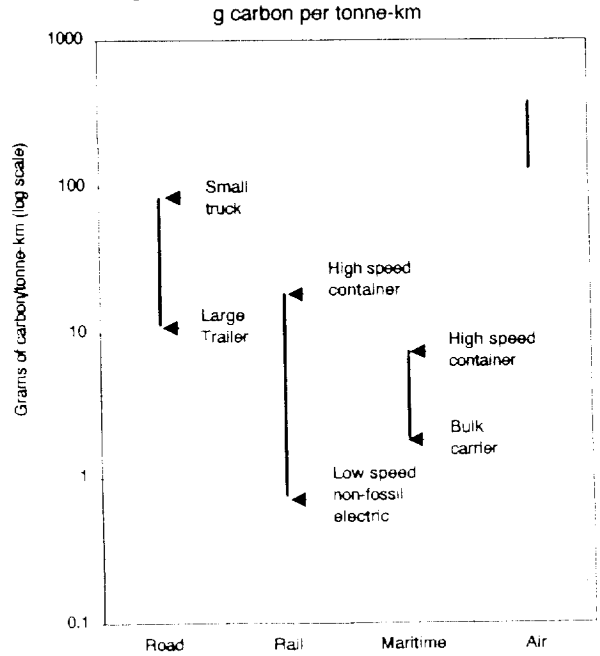


Figure 1b. CO2 Intensity of Freight Transport
g carbon per tonne-km



Description of Measures and their Policy Objectives

45. As a special issue related to the consideration of carbon and energy taxes, this paper considers carbon charges on maritime transport fuels, aiming to reduce greenhouse gas emissions from international maritime transport. The main rationale for such carbon charges would be to internalise the social costs of climate change resulting from CO_2 emissions from maritime transport. However, a carbon charge on bunker fuel would only be feasible, fair and economically efficient in a context where such a charge is globally imposed, and where other transport modes pay their full social costs.

46. There are many ways in which a bunker charge could be implemented. The **level** of a charge might fall anywhere in a wide range. Charge levels of $5, $25 and $125 per tonne of carbon have been investigated. These represent about 5%, 25% and 125% of the price for residual fuel oil (at $90/tonne), and 3%, 15% and 75% of marine diesel fuel prices (at $150/tonne). Various **methods of collection** are possible — based on sales of fuel from bunkers to ships, sales from oil companies to bunker dealers, fuel out of the refinery gate, etc. — which might influence the ease of implementation, potential for avoidance, and hence GHG impacts of the measure.

47. Alternative Measures for GHG Mitigation: The study briefly mentions a number of alternative measures which might be more feasible means of GHG mitigation in international maritime transport. These measures include the use of alternative charges and fees (such as port fees related to ship energy efficiency); regulations on ship technology; voluntary agreements with ship-builders and operators; best practice programmes; technology prizes; and supports for research, development and demonstration of energy-efficient ship technology.

Approach and Methodology

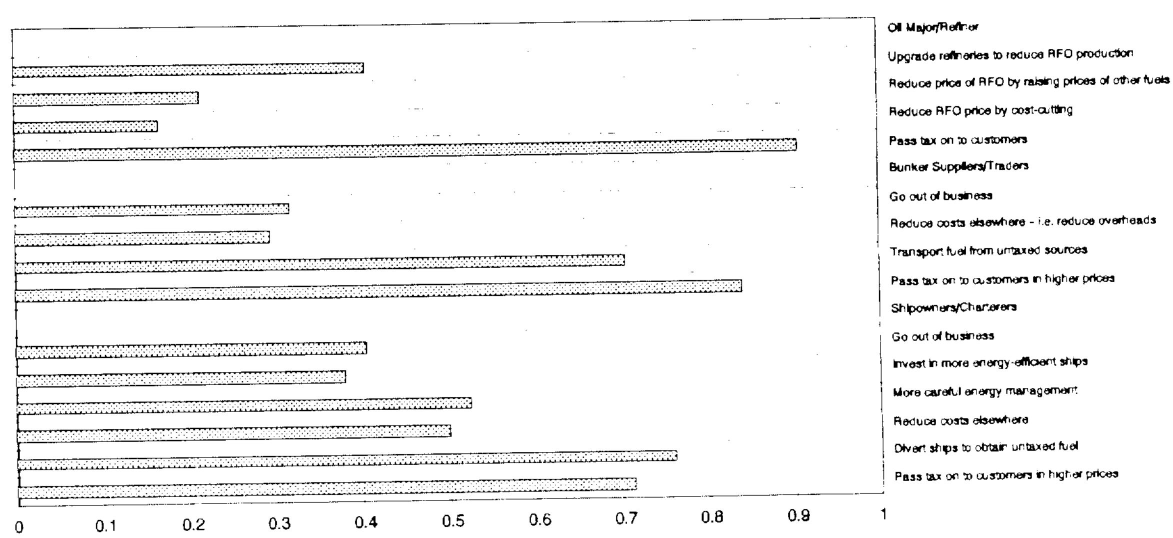
48. The study considers: the potential impact of a marine bunker charge on maritime CO_2 emissions; the direct and wider economic costs that might be associated with the charge; the other policy issues associated with bunker charges, including trade, employment and competition; issues that need to be considered in the implementation of any charge; the rationale for common action to implement a charge; and the possible approaches that Annex I countries might take to implement a bunker charge in common.

49. Background information on the characteristics of maritime transport is based on a review of the literature, discussions with maritime industry experts and comments from reviewers of the study. No existing quantitative analysis has been identified on the impact of bunker prices on maritime transport GHG emissions. It is extremely difficult to discern the effects of bunker prices on maritime traffic using historical data: bunker prices are closely correlated with crude oil prices, which affect countries' terms of trade. Additional qualitative insights were sought through a questionnaire sent to a large number of firms including ship owners and operators, bunker traders and suppliers, and oil companies. The extended outline of the study was also widely circulated in the industry with the aim of obtaining additional comments, although few were submitted.

GHG Reduction Potential, Costs and Timing, Rationale for Common Action

50. The OECD Secretariat distributed a questionnaire through an industry newsletter to survey their contacts in the three industry areas identified in Figure 2. This questionnaire asks how likely they consider each of the effects to be for each of three levels of charge ($5, $25 and $125 per tonne of carbon). While the results have no statistical significance, they provide some perspective on possible industry attitudes to a bunker charge. It is perhaps most interesting to note that, whereas respondents from all three industry areas anticipated that the most likely action of oil companies and bunker suppliers would be to pass the charge on to their customers, ship owners and charterers generally did not think that they would be able to pass the charge on by increasing their shipping rates. If this were true, ship owners would bear most of the cost of any charge.

Figure 2. Expected Responses to a $25/tC Charge on Bunker Fuel Based on a Questionnaire Survey
(Mean of 22 respondents to date of which 13 bunker suppliers, 6 ship owners and 3 oil companies)
1=very likely to occur; 0=not very likely



51. It is not possible to separate the historical effect of bunker prices on maritime freight traffic from the broader effects of crude oil prices on international trade. Thus, the effects of a bunker fuel charge on traffic cannot be estimated, although they would be expected to be small unless the bunker charge formed part of a wider carbon tax. Bulk freight traffic, apart from crude oil and coal, has not been affected by oil price changes except in the short term following sudden, large price rises. This may be due to a lack of alternatives for the buyers and sellers of bulk commodities. Non-bulk freight traffic has been reduced by oil price increases and this may reflect more flexibility in markets for manufactured and agricultural goods, although it may be an effect of changes in international terms of trade rather than a response to bunker prices. Crude oil traffic is strongly affected by the oil price: high oil prices in the 1970s and 1980s both reduced the demand for oil and resulted in its being produced closer to the main markets, resulting in a halving of traffic in ton-miles.

52. For the majority of international trade, there is no real alternative to maritime transport. However, high-value and time-sensitive consignments are increasingly shipped by air, and road and rail are serious alternatives for some international freight currently moved by sea. It is possible that a bunker charge, if not matched by fuel price increases for other transport modes, could reduce the price advantage of maritime transport relative to those modes. If a bunker charge were to lead to a decrease in the share of freight carried by sea and an increase in road and air transport, this might result in increased CO_2 emissions.

53. Energy intensity in shipping has been affected by the oil price, along with other factors including the rate of new-building and the level of over-capacity in the industry. A large number of orders placed in the 1960s as well as high prices in the 1970s and 1980s accelerated efficiency improvements in engines. Subsequent overcapacity in the 1980s led to changes in operational practices including reduced ship speeds. Over the last ten years, with lower oil prices and the elimination of overcapacity, energy intensity reductions have been small. However, opportunities do remain for reducing the energy intensity of maritime transport. Some, such as improved propeller maintenance and the use of antifouling hull paint may be cost-effective in their own right and offer a few percent (< 10%) energy savings. Technological developments in new ships, such as improved hull forms, engine technologies and propeller designs, may also offer small energy savings compared to the existing fleet but the current maritime freight market does not favour early fleet replacement. Greater energy savings might be achieved by designing ships for lower speeds, but again, this would run counter to current market pressures. In the very long term, GHG mitigation may be achieved through changes in the source of energy for maritime transport. Nuclear power and a variety of alternative fuels have been used in ships in the past although they are not economic for new ships at current fuel prices.

54. A bunker charge might cause significant economic costs in many countries, especially a) those competing in markets for agricultural and manufactured goods, and relying on maritime transport for a large share of their exports and b) those exporting raw materials. A bunker charge might also be economically damaging for countries heavily dependent on imports for manufactured and agricultural goods. The United States, Netherlands and Japan account for most of Annex I country bunker sales but would not be likely to feel most of the negative impacts of a charge, which would be mostly passed on to customers in higher bunker prices. It is possible that revenue recycling could offset some of the negative economic impacts of the charge but an evaluation has not been possible for the current study.

55. A bunker charge could be evaded easily by bunker suppliers and ship operators, unless it were globally implemented as part of a general carbon tax. Offshore refuelling is already normal practice, making it a simple matter to bring fuel from any untaxed source. Bunker charges in excess of $10-20 per tonne of fuel would provide an incentive for widespread evasion, provided sufficient untaxed fuel existed, and would possibly result in a net increase in GHG emissions. Alternative measures focused on technical improvements (best practice programmes, R&D funding, etc.) could reduce GHG emissions without risk of evasion. Such measures would be much less dependent on common action, although technology effects are likely to depend on incentives being applied in several countries.

Implementation Issues

56. There are clearly major political barriers to implementing a bunker fuel charge. These mostly relate to the potential effects of a charge on international trade. Because of these effects, many implementation details would need to be carefully discussed and agreed. Even if a charge only involved a small number of countries, it would be important for them to negotiate a range of issues with non-participating states. Any Annex I country initiative would need to be negotiated in a wider international framework including developing countries. Discussion would need to address issues such as the point of application of the charge, the question of which governments would be responsible for collecting and disbursing the proceeds of the charge, and the question of transfers of charge revenues among countries.

57. The International Maritime Organisation (IMO) has pre-eminent competence in the fields of maritime safety and protection of the marine environment. IMO Member states are currently discussing Annex VI of the MARPOL convention, providing a regulatory framework for the prevention of air pollution from ships. The new Annex would address a variety of pollutants including ozone depleting substances, VOCs, NO_x and SO_x. Negotiation to implement any bunker charge would need to be carried out with the co-operation or under the auspices of the IMO.

58. The World Trade Organisation would also need to play an important role, given the trade implications of a bunker charge, including the likely different impacts on bulk and non-bulk traffic and other effects on trade competitiveness. The complex economic and political issues involved in the implementation of a bunker charge, and the large number of countries that would need to be involved, would be likely to make the negotiation process very lengthy, perhaps taking several years.

Conclusions

59. A carbon charge on bunker fuel could internalise social costs resulting from CO2 emissions from maritime transport, but would only be feasible, fair and economically efficient if globally imposed and if all other transport modes also paid their full social costs. However, a bunker fuel charge would not necessarily lead to significant net GHG emission reductions, mainly due to the likelihood of avoidance strategies and modal shifts. Such a charge could also have significant negative impacts on international trade, and would therefore need to be carefully negotiated on a multi-lateral basis.

Several types of common action are possible:

- **Replication of Successful Measures.** This approach is not likely to be relevant for a bunker fuel charge, although it might be for other measures briefly mentioned in the study such as technology prizes, best practice programmes for ship operators, voluntary agreements with shipbuilders, and port fees or other measures related to the environmental performance of ships.

- **Agreement to Take Action in the Transport Sector Toward an Aim or Target.** Countries might agree explicitly to take effective action with the objective of reducing bunker emissions. Countries might further agree on a method for allocating national responsibility for bunker emissions, bringing them into the scope of existing commitments under the FCCC to introduce and report on measures to mitigate national GHG emissions.

- **Co-ordination to Implement the Same or Similar Measures.** This type of common action, with all countries applying charges at similar levels but without full harmonisation, might avoid some of the distorting effects and enforcement difficulties identified for non-uniform charges. However, the approach is more appropriate for some of the alternative measures mentioned in the study, such as the application of port fees linked to ship energy efficiency, charges on "embedded carbon" in imports, etc.

- **Specific Policies and Measures Implemented Together.** All countries or some group of countries might agree to introduce a measure, such as a bunker fuel charge, at a harmonised level at the same time.

60. Any approach to reducing GHG emissions from marine bunker use might be influenced by the decision taken by SBSTA and the FCCC Conference of the Parties on bunker allocation. Allocation to individual countries is not a prerequisite for GHG mitigation in this sector. However, if bunker emissions remain unallocated, or are allocated to an international category, mitigation is more likely to depend on common action.

5. Carbon Charges on Aviation Fuels: Executive Summary Context

61. World consumption of aviation fuel in 1990 was approximately 168 million tonnes, of which 138 million tonnes was consumed by civil aviation, and 133 million tonnes by commercial airlines. This study concentrates on air transport by commercial airlines. Commercial aviation in 1990 was responsible for approximately 420 million tonnes of CO_2 emissions (114 million tonnes of carbon), of which about half was due to international traffic. NO_x emissions from aircraft resulted in increased tropospheric ozone concentrations whose radiative impact may be as large as that of their CO_2 emissions. Annex I countries accounted for about 80% of air traffic[9] and 75% of aviation fuel sales.

62. Commercial air traffic grew at an average of 6.5% per year during 1990-1995 while energy intensity[10] reductions, which had averaged 4% per year during the period 1974 to 1988, slowed to 0.3% per year during 1990-1995. This led to CO_2 emissions in 1995 of about 550 million tonnes (150 million tonnes of carbon). Air traffic growth trends are expected to continue well into the next century, as a result of rapid income growth in non-Annex I countries and airline deregulation in Annex I countries.

63. Figures 1a and 1b compare CO_2 emissions from the main transport modes. They show that aviation has the highest CO_2 intensity for many types of transport function. Care must be taken to compare like with like: for example, short haul air travel might be substituted by high speed rail travel, while long haul air travel has no real substitute.

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[9] Air traffic is considered throughout this report includes freight, mail and passengers, all measured on a "tonne-kilometres performed" (TKP) basis.

[10] Energy intensity is defined as energy use per tonne-kilometre performed.

Meanwhile, air freight is a factor of two to 20 times more carbon intensive than road freight. For intercontinental freight, the fastest alternative to air transport is containerised maritime freight, whose carbon intensity is nearly two orders of magnitude lower.

Figure 1a. CO_2 Intensity of Passenger Transport
g carbon per passenger-km

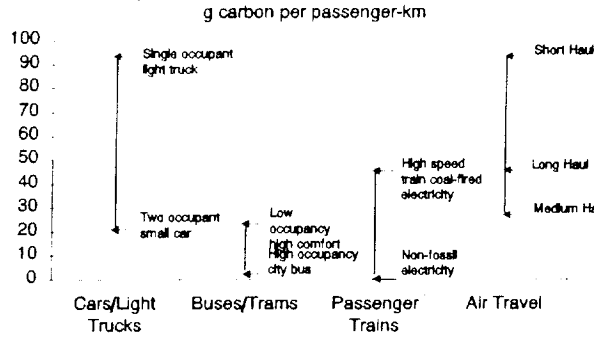
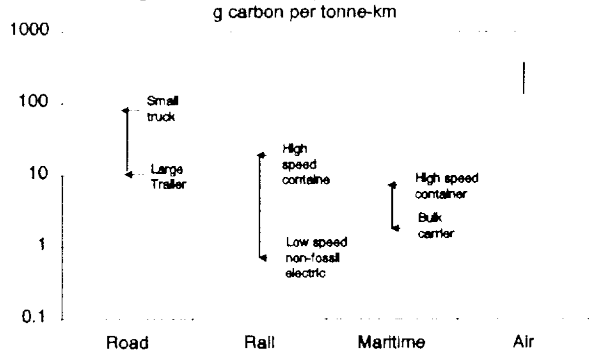


Figure 1b. CO_2 Intensity of Freight Transport
g carbon per tonne-km



64. Most countries follow the recommendation by the Council of the UN International Civil Aviation Organization (ICAO), that fuel used for international aviation should be tax-exempt. The recommendation does not preclude "charges" for environmental purposes. Some airports have landing fees related to aircraft noise levels, and various countries have considered or introduced more general environmental charges which could extend to cover aircraft GHG emissions. Aviation fuel taxation is also precluded in most countries by provisions in the bilateral Air Transport Agreements which are the main legal framework for the operation of international civil aviation.

65. ICAO is currently reviewing its approach to aviation charges and in particular is considering the response the aviation industry should make to global environmental challenges. In response to a request from ICAO, the Intergovernmental Panel on Climate Change plans to produce a Special Report in 1998, examining aviation and the global atmosphere. The report will consider scientific aspects of the role of aviation in climate change and stratospheric ozone depletion, and explore the options for reducing these impacts.

Description of Measures and their Policy Objectives

66. The focus of this study is a carbon charge on fuels used for international aviation. The primary aim of the charge would be to reduce the consumption of aviation fuel, and hence reduce the emission of greenhouse gases by aircraft, through internalisation of the social costs of CO_2 emissions.

67. There are several ways such a charge could be implemented. The **level** might fall anywhere in a wide range. This study considers charge levels of \$5, \$25 and \$125 per tonne of carbon on an illustrative basis. These equate to roughly 2%, 10% and 50% of current prices of aviation fuel (at 20c/litre), respectively. The study also considers the possibility of a charge that gradually increases the price of aviation fuel by 1-5% per year. Various **methods of collection** and **uses of the revenue** are possible.

68. **Alternative Measures for GHG Mitigation and Possible Common Action** are also considered. These include various types of charge on aviation emissions, voluntary agreements by airlines to reduce energy intensity, best practice programmes, and government support for research, development and demonstration. Aviation emissions could also in principle be included in an international emission trading scheme.

Approach

69. The study considers: the potential impact of fuel charges on aviation CO_2 emissions; the direct and wider economic costs that might be associated with aviation fuel charges; the other policy issues associated with fuel charges, including trade, employment and competition; issues that need to be considered in the implementation of charges; the rationale for common action to implement charges; and the possible approaches that Annex I countries might take to implement aviation fuel charges in common.

70. Two reference scenarios are used as the basis for estimating the GHG effects of fuel charges. These scenarios are derived from the transport sector scenarios designed by the World Energy Council in 1995, but are somewhat modified. The lower growth scenario is characterised as "Muddling Through", and represents a situation where barriers to trade and regional differences in development are maintained or strengthened. This scenario has air traffic increasing at 4.9% per year, with a fairly low rate of energy intensity reduction at 1.1% per year. The higher scenario, "Markets Rule", sees the removal of trade barriers and particularly rapid economic growth in developing countries and countries with economies in transition. This scenario has air traffic increasing at 7.5% per year, with energy intensity falling at 2.2% per year. World energy use for civil aviation increases by a factor of 2.8 to 3.2 between 1995 and 2020. These two scenarios are not intended to represent the full range of possible futures.

71. The quantitative effects of different charge rates on air traffic are estimated using results from existing analysis in the literature. For the purposes of calculation this study has considered the effect of a charge on fuel used for both international and domestic aviation. The energy intensity response to increased fuel prices is addressed on a more qualitative basis, based on a review of the historical relationship between fuel cost and the rate of energy intensity reduction in aviation. Historical data are also used to consider, on a qualitative basis only, the impacts of fuel prices on air traffic, airline profits and employment in the industry. Switching from aviation to other transport modes is discussed briefly in the study, also on a qualitative basis.

GHG Reduction Potential, Costs and Timing, Rationale for Common Action

Effects of a Fuel Charge

72. Any increase in aviation fuel prices would be likely to have effects on greenhouse gas emissions through several mechanisms:

73. Cost increases would be partly passed through to airline customers, resulting in lower demand for air transport, and reducing energy use and GHG emissions. A carbon charge on fuel would be likely to reduce air passenger traffic more than freight traffic. It is possible that some air travel would be substituted by other transport modes, resulting in higher GHG emissions from those modes.

74. Airlines might aim to reduce non-fuel costs to offset increased fuel costs. Analysis in this study shows that airlines have made continual progress in cutting labour and other costs over the last 35 years, but there is no evidence that these cost reductions accelerated during the period of high fuel prices from 1974 to 1985.

75. Airlines would reduce their fuel consumption through more efficient operation of aircraft. To the extent that these short to medium term measures reduced overall costs, their success would mean that the fuel price increase was not fully passed through to customers but energy use and GHG emissions would fall. Literature sources anticipate that operational changes will save 10-20% of aircraft energy use per passenger-km over the period to 2015.

76. Airlines would re-engine or retire some of their existing aircraft and seek to purchase more energy-efficient aircraft, while manufacturers would intensify their efforts to develop and supply them. While these aircraft might be more expensive than previous versions, they would reduce fuel costs. To the extent that they succeeded in reducing overall airline fuel, financing and other costs, the fuel price increase would not be fully passed through to customers, but energy use and GHG emissions would fall. Current pre-commercial technology could reduce aircraft energy use by 30-50%.

Effects on traffic

77. The first-order effect of a global CO_2 charge on international air travel has been estimated in Table 1, assuming airlines pass the whole of the charge through to customers. As the table shows, the effect of a CO_2 charge on air passenger traffic is very uncertain: price elasticity estimates for air travel demand vary by a factor of more than three. Only for

the highest level of charge do the reductions in traffic shown in Table 1 become comparable even with a single year's growth.

Table 1. Effect of a Globally Applied Fuel Charge on International Air Passenger Traffic

Charge on carbon	5	25	125
Change in traffic	-0.2 to	-0.9 to	-4.4 to

78. The effect of a carbon charge on air freight transport would probably be about two-thirds of the effect on passenger transport. Increased travel by other modes would slightly offset the reduction in GHG emissions due to reduced air travel.

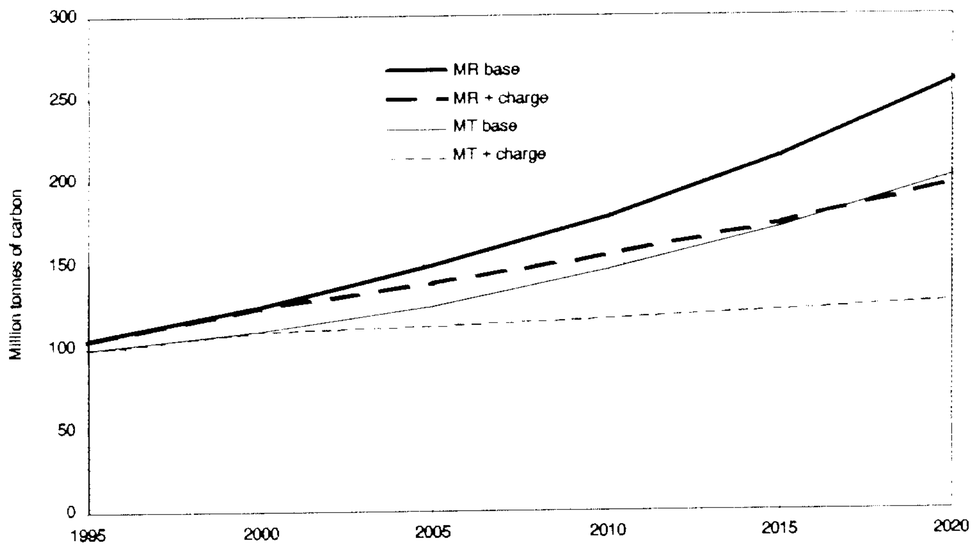
Effects on Energy Intensity

79. This study finds that the rate of energy intensity reduction in civil aviation (points 3 and 4 above) has been very responsive to fuel price in the past, following a "threshold" effect. Energy intensity reductions accelerated to a ceiling of 3-4% per year when fuel costs exceeded about 15¢ per TKP or about 14% of airline costs. These rapid energy efficiency improvements resulted from a combination of operational improvements and fleet replacement. The source of the apparent threshold effect has not been investigated and is a possible area for future work, but the recent slowing of energy intensity reduction has coincided with an industry recession and low rates of fleet replacement.

80. As total aviation costs continue to fall faster than fuel costs, so that the energy share of airline costs increases, energy efficiency improvements are likely to receive renewed attention in future. This may be accentuated by the sharp increase in fuel prices in 1996. Operating restrictions on older, noisier aircraft are also likely to contribute to more rapid fleet replacement.

81. An international commitment to raise fuel prices at a moderate rate each year could increase the rate of energy intensity reduction. The study does not attempt to identify the direct relationship between fuel price and energy intensity over the scenario period. However it does suggest that energy intensity reductions of 3.5% per year would probably be technically possible over the 20 years from 2000, resulting in about 30% reduction in aviation carbon emissions in 2020 relative to the reference scenarios (see Figure 2).

Figure 2. Effect of Accelerated Energy Intensity Reductions on Global Carbon Emissions from Civil Aviation, Two Scenarios, 1995-2020.



82. It is not possible to predict at this stage what rate of fuel price increase would be needed to achieve the potential emission reductions shown in Figure 0, but it would probably lie between 1% and 5% per year. A charge that increased the fuel price by 2% per year from 2000[11] would reach a level of $125 per tonne of carbon after 20 years, assuming no change in the underlying fuel price.

Effects of non-Global Implementation of a Charge

83. If a fuel charge were applied at a non-uniform level, it would be less effective than a uniform, globally applied charge and could cause costly distortions in airline competition. Non-uniform application of a charge would mean that not all airlines would have an incentive to adopt energy-efficient technology. This would reduce the incentive for manufacturers to develop energy-efficient aircraft, or result in higher costs for those airlines that did wish to adopt such technology, relative to the case of a uniform charge. "Tankering", where aircraft take on more fuel than is needed for a flight to avoid taking on more expensive or lower quality fuel at the next port of call, already occurs to some extent. More tankering would occur as a result of an unevenly applied fuel charge, and this might lead to an increase in CO_2 emissions due to the additional weight carried by aircraft.

The charge would start at 2% of the fuel price in 2000, amounting to roughly $5 tonne of carbon.

84. Another effect of non-uniform charges might be to change patterns of air traffic, in particular by affecting international competition between airlines for long-haul flights. This effect would be most likely to occur in regions that include a mixture of participating and non-participating countries. Such changes in air traffic patterns could lead to increased CO emissions. This distortion would be much smaller if the charge proceeds were used by governments to reduce other aviation industry costs, such as airport taxes, landing fees and routing charges.

Employment and Competitiveness Effects

85. Given the rapid rate of air traffic increase and cost reduction, the effect of a gradual fuel price increase on air traffic, employment in the aviation industry, and airline profits, would probably not be noticeable. However, for less than global application of a charge, the effects described above on competition among airlines might damage the aviation industry in countries imposing the charge. Meanwhile, airlines in non-participating countries would not pay the charge but would receive the benefits of energy-efficient technology. Countries that are particularly dependent on aviation for international trade, tourism and business would also be adversely affected by any new aviation charges. Charges that applied for fuel used for domestic as well as international flights would adversely affect large countries that depend heavily on aviation for internal travel.

Other Measures

86. Given that most of the effects of a charge would be on energy intensity rather than on traffic, it might not be necessary to increase the cost of air transport to reduce GHG emissions. Thus, the proceeds of the charge might be used to reduce other airline costs. Other measures to encourage energy intensity reductions might also be effective. Such measures range from best practice programmes, through incentive schemes such as airport emission fees that are revenue-neutral for the industry, to energy efficiency standards, or an industry-wide emission cap with trading among airlines. It was beyond the scope of this study to evaluate such measures in any detail.

Implementation Issues

87. Airlines, not surprisingly, have expressed strong opposition to the idea of a fuel tax, and this position has in the past been shared by the Council of ICAO, which has issued a recommendation that Member states of ICAO should not impose revenue-raising taxes on fuel for international aviation. ICAO does, however, acknowledge the need for governments to impose charges to cover the costs of providing infrastructure and services for airlines, and also to remedy environmental problems caused by aircraft. The ICAO Council is currently reconsidering its guidance on the issue of fuel taxes and charges, and the outcome may affect the feasibility of an international aviation fuel tax or charge. Nevertheless, implementation of a charge would also depend on the renegotiation of existing bilateral air transport agreements between most countries, which exclude the taxation of fuel used by each other's airlines.

88. It might be possible to implement an aviation fuel charge with less airline opposition if the proceeds were used within the aviation industry, to improve air traffic control, to fund R&D into energy-efficient aircraft technology, or even to subsidise the purchase of energy efficient aircraft. Such uses of the revenue might be opposed by governments which adhere to the principle, grounded in economic efficiency, that tax revenues should not be earmarked.

89. Discussion on the implementation of any aviation fuel charge would need to be carried out with the co-operation, or under the auspices, of ICAO. Additional assessment would be needed to consider the effect of the fuel charge on international trade, airline competitiveness and technology development. Alternative measures would also need to be assessed.

Conclusions

There are several possible types of possible common action:

- **Replication by Parties of successful measures implemented elsewhere.** This approach would probably not be relevant for an aviation fuel charge, but it might be appropriate for several other types of measure which are briefly mentioned in the study, such as airport emission fees and best practice programmes.

- **Agreement to take action in the aviation sector toward an aim or target.** Countries might agree explicitly to take effective action with the objective of reducing international aviation emissions. Countries might further agree on a method for allocating national responsibility for GHG emissions from international aviation, bringing them into the scope of existing commitments under the FCCC to introduce and report on measures to mitigate national GHG emissions.

- **Co-ordination to implement the same or similar measures.** Countries might agree to the legitimacy or even desirability of aviation fuel charges in principle, opening the way for those countries that wish to take unilateral action without contravening existing international agreements. A next step might be for groups of countries to introduce a charge, whether at the same level or at different levels.

- **Specific policies and measures implemented together.** Countries might agree in the FCCC process and subsequently in ICAO to introduce a measure, such as an aviation fuel charge, at a harmonised level. In this case, countries might agree that national governments have responsibility for charge collection and revenue disbursement. Alternatively, countries might agree to some international body (e.g. the GEF or UN Commission for Sustainable Development) collecting the charge and disbursing it for climate change mitigation and adaptation purposes.

90. Common action to reduce GHG emissions from civil aviation might address international aviation alone, or both domestic and international aviation. Any approach to reducing GHG emissions from international aviation might be influenced by the decision taken by SBSTA and the FCCC Conference of the Parties on bunker allocation. Allocation to individual countries is not a prerequisite for GHG mitigation in this sector. However, if international aviation emissions remain unallocated, or are allocated to an international category, mitigation is more likely to depend on common action.

6. Policies and Measures to Encourage Innovation in Transport Behaviour and Technology: Executive Summary

Context

91. The transport sector is responsible for 25% of global CO_2 emissions from fossil fuel use, and this share is growing. Of all energy-using activities, transport is generally the area where governments find it hardest to find politically feasible policies that can mitigate GHG emissions. Projections for Annex I countries indicate that, without new CO_2 mitigation measures, road transport CO_2 emissions might grow from 2500 million tonnes in 1990 to 3500 to 5100 million tonnes in 2020. Annex I countries already have in place a wide range of measures that affect vehicle energy use and CO_2 emissions. National and local governments are also working hard to develop strategies to address the environmental and social problems associated with urban transport, and these strategies can contribute to mitigating CO_2 from vehicles. Many countries have announced new initiatives to reduce vehicle CO_2 emissions since 1990.

92. The Tranche 1 study, "CO_2 Emissions from Road Vehicles"[12], provides an in-depth analysis of several types of measures:

(a) Measures whose primary objective is to reduce the energy intensity of cars and "light trucks[13]:

- feebates", where purchasers of the most efficient vehicles receive a tax rebate while purchasers of less efficient vehicles pay a tax;
- "corporate average fuel economy standards" (CAFE);
- voluntary agreements between governments and car manufacturers to achieve fuel efficiency improvements.

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12 Working Paper 1 in the Tranche 1 series of studies. The Tranche 1 studies are available on the internet at www.oecd.org/env/online.htm, or from the OECD Secretariat.

13 Light trucks" are mentioned here, but the coverage might include a variety of vehicle types, including "vans" or "minibuses", "sports utility vehicles" and four-wheel drive vehicles.

(b) Taxes on fuels purchased for use in road vehicles. Three options are considered:

- "vehicle tax reform", where existing charges on cars and light trucks are reduced, and fuel taxes are increased to keep total tax revenue constant;
- "full budgetary cost pricing", where fuel taxes are modified to improve the extent to which car and truck drivers pay the full costs to the public budget of their driving;
- externality adders", where fuel taxes are modified to include externality adders, so that the full social costs of driving are reflected to car and truck drivers.

93. These measures were found to offer substantial GHG mitigation opportunities in the road transport sector, if implemented at levels that might be justified on economic efficiency grounds.

Description of Measures and their Policy Objectives

94. This Tranche 2 study complements the Tranche 1 analysis by considering an additional range of measures that can encourage innovation in transport behaviour, institutions and technology to achieve

(i) large reductions in traffic relative to projected levels,

(ii) large reductions in the energy intensity of vehicles,

(iii) a switch to fuels with a very low fossil carbon content, or

(iv) a shift to transport modes with lower GHG emissions.

95. Measures addressed in the Tranche 1 study can help to provide the market context and the direction for innovation. Some measures discussed in Tranche 1, such as "full cost pricing" to internalise externalities, might be encouraged as aspects of innovation in local government policy. The Tranche 2 study emphasises innovation strategies rather than individual measures. The study uses a framework for considering government policies which applies to all types of innovation, in behaviour, institutions and technology. The first step in an innovation strategy is for government to establish a "vision" or set of goals for sustainable development including climate change mitigation. The elements of an innovation strategy are summarised below in Box 1.

Box 1. Possible Elements in an Innovation Strategy

1. Encouraging the development and discovery of new ideas, technology, concepts and behaviours. Part of central government's role may be to absorb the local financial risks of technological and other R&D which, in aggregate, is likely to result in long term benefits. Relevant measures might include: monitoring range of ongoing R&D. Funding and incentives for basic science as well as GHG-related R&D, partnership programmes for collaborative research, social sciences research into travel behaviour etc., research into methods for assessing technology, transport system changes etc.

2. Facilitating the exchange of ideas among firms, communities, local governments, departments of national government, etc. New ideas and discoveries often occur in places where they cannot be used. The chance of an idea leading to a successful innovation is greatly increased by a continual exchange of information. Relevant measures might include: information, partnership programmes (firms, universities, government research etc.) to encourage exchange of ideas and research results; ensuring patent laws provide incentives for creativity and application of good ideas.

3. Supporting experimentation with new ideas, possibly selecting for those that could contribute to GHG mitigation and other policy objectives. Again, government can play a role by increasing the potential benefits of success. Those carrying out the experiment bear the political risk associated with possible failure — but local actors are likely to be less sensitive to this risk than central governments. Meanwhile, central government encourages a broad portfolio of experiments which, as a whole, minimises this political risk.. Relevant measures might include: Monitoring and support for demonstration projects, community experimentation etc.; financial incentives, technology prizes or other rewards for successful projects, provision of methodological and other support

4. Facilitating replication of successful innovations. Innovations often occur in special situations where they are particularly appropriate, but after some replication and development to "move up the learning curve" and achieve economies of scale, they may be more broadly applicable. Relevant measures might include:limited term financial support; information and best practice programmes to encourage replication of successful projects; modification of national legislation where necessary to permit use of new approaches (e.g. road pricing).

5. Providing a market framework that encourages GHG mitigation along with other policy objectives. This includes the measures considered in the Tranche 1 study to internalise externalities, provide targets for energy efficiency improvement, etc. Co-ordination of different policy areas to develop compatible strategies for addressing multiple goals is also an important step. This may mean, for example, that policy on land-use takes account of implications for transport and the environment. Specific measures might include: monitoring, consultation with firms, local government etc. to understand needs and capabilities; applying market instruments — fiscal and regulatory incentives, information, education, etc., emphasising objectives of sustainability; market regulation to minimise barriers to entry and encourage competition.

Approach

96. The study considers: the potential impact of transport sector innovation on CO_2 emissions; the possible economic effects of innovation; the other environmental and social policy issues associated with policies to encourage innovation in transport; issues that need to be considered by central governments aiming to encourage innovation; the potential advantages and disadvantages of common action to encourage innovation; and the possible approaches that Annex I countries might take to implement a transport innovation

strategy[14]. This study is based on a review of recent literature, including a large amount of material submitted by reviewers, in several areas including: innovation processes and policies; local transport policies and their effects; and alternative fuel and alternative technology vehicles. Some of the specific measures are summarised in Table 1 below. A large number of examples are used based mainly on published literature to illustrate and develop the policy messages in the study and in particular to identify implementation approaches that are likely to succeed. The examples cover technologies, local government policies and strategies, and national government policies and strategies. They include instructive failures as well as success stories.

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[14] These are the elements identified for consideration in the Framework for Analysis of the Common Actions project.

Table 1. Examples of Policies and Measures

Note: many of the initiatives listed in this table were not designed for GHG mitigation

Local Govt and Business and Community Strategies	National Government Strategies
Modelling studies UK: Impact of transport policies in several cities: cordon charges, parking fees, reduced public transport fares, reduced parking space, fuel price increases. Netherlands: Impact of transport policies in the Randstad: parking fees and constraints, fuel price increase, road pricing, cordon charges, reduced road-building, improved public transport, park and ride facilities, high-occupancy vehicle lanes, traffic management. US: LUTRAQ approach in Portland, Oregon: land use changes, parking fees, improved public transport, improved pedestrian and cyclist access. **Implementation studies** UK: "All Change" in Central Region, Scotland: community consultation process to develop a new transport plan. Norway: Trondheim toll ring: a cordon charge for entering the city, varying according to the time of day. Sweden: Greening freight transport: freight companies responding to customers' demands for cleaner freight services. Singapore: Area Licensing Scheme: cordon charges, a range of fiscal measures, a vehicle quota system, settlement planning, and other measures. Global Action Plan: a non-governmental organisation promoting the "Ecoteam" approach; where neighbours, colleagues, etc., work in small groups to meet environmental goals.	**Strategies to encourage local government policy innovation** US: Intermodal Surface Transportation Efficiency Act. Requires metropolitan planning organisations to alter their planning processes to improve co-ordination among authorities, develop procedures for community involvement, and address environmental objectives. US: Travel Model Improvement Program. Aiming to develop a new generation of transport models. EU: The Citizen's Network. A wide range of mostly information-based measures to help improve provision for environmentally friendly forms of transport. Norway: TP10: A government scheme for ten cities, aiming to make environmental goals a premise of transport planning, to co-ordinate land-use and transport policies, increase the use of public transport and reduce car use. **Strategies to encourage technological innovation** US: Clean cities: a government-sponsored network of cities promoting alternative fuel and alternative technology vehicle use. PNGV (partnership for a new generation of vehicles): a collaborative R&D programme between government, industry and independent research organisations. British Columbia, Canada: demonstration of fuel cell buses. EU: the DRIVE programme, developing information technology for use in transport ; and the COST programme, supporting studies on propulsion systems, alternative fuels, alternative forms of public transport. Brazil: government strategy to encourage the use of ethanol from sugar cane as a gasoline substitute.

GHG Reduction Potential, Costs and Timing

GHG Effects

97. The nature of innovation is such that it is not possible to forecast its effects on GHG emissions or on the economy. An innovation strategy aims to increase both the economic and the technical potential for GHG mitigation. It also aims to encourage attainment of the economic potential. The potential for behavioural changes is particularly uncertain. Several case studies of local government transport policies, and of policy evaluation exercises, indicate that GHG emission reductions in the range of 10-20% are achievable with strategies currently considered reasonable. However, this probably understates the potential for GHG mitigation if Annex I country governments were to co-operate to build up a consensus on the need for innovation to achieve deeper reductions. The technical potential for reductions in vehicle energy intensity by 2020 is in the region of 20-50%, while switching to alternative fuels could reduce GHG emissions per unit of energy by 80% or more. The economic potential is much smaller: only 10-40% emission reductions are achievable through energy efficiency improvements and fuel switching without increasing the overall cost of transport.

98. While the GHG mitigation potential is considerable, many of the technological and behavioural options considered in the study have disadvantages: alternative technologies may be more expensive or have poorer performance than current technology, and they may increase some environmental problems. Alternative behaviour patterns may not meet current lifestyle expectations. Some of the local transport strategies considered may reduce individuals' freedom to drive, or may benefit one group to the disadvantage of another group. By providing a framework for innovation as described in Box 1, governments encourage local actors to find ways around these disadvantages, rather than attempting to determine the best solution centrally.

Economic and Other Policy Effects

99. Innovation is increasingly seen as a key factor in economic success. Policies to encourage innovation are in general likely to reduce the economic and social costs of meeting GHG emission constraints. Governments can reduce the risk of future economic and social disruption due to climate change by ensuring that innovators are aware of the magnitude of that risk, and by encouraging innovations that reduce it. Most of the policies and measures considered in this study as part of an innovation framework have the potential to contribute to a wide variety of policy objectives. Within the transport sector these might include reducing air pollution, accidents and traffic congestion. The strategies discussed may also be able to contribute to a wide range of policies including those aiming at social objectives, urban regeneration, and regional industrial development. Co-ordination among government ministries is an important element in providing clear signals about the direction for sustainable development. Co-operation between policy-makers may lead to more cost-effective approaches to achieve the full range of government policy objectives.

Timing

100. New ideas, discoveries and behaviour patterns can spread in a few months, or take many decades to achieve widespread acceptance and use. Innovation policies implemented before 2000 might take at least 10 years, and perhaps much longer, to achieve noticeable effects.

Implementation Issues

101. Relationships between local, regional and national government agencies, and between planning and environmental agencies, are important for policy implementation to change travel behaviour. Involving communities in local transport policy can be hard work but be the key to introducing environmentally sustainable strategies. The preferences of communities can change once they fully understand the alternatives available to them

102. With regard to vehicle technology innovations, the study identifies a number of key barriers that national programmes need to overcome:

- **cost and risk barriers to market entry for vehicle manufacturers** such as the costs of retooling production lines, the investment required to achieve economies of scale in vehicle production, and the risk attached to that investment
- **absence or inadequacy of refuelling networks** has been mentioned as one of the main disadvantages of alternative fuels for consumers
- **concern about safety can be an important barrier** — fears about the toxicity of methanol or the explosiveness of hydrogen may prevent their use for private vehicles
- **lack of standards and norms** for alternative fuel vehicle (AFV) equipment make the market more uncertain and expensive for component manufacturers
- **the position on the learning curve** for manufacturers, technicians and consumers is far more advanced for gasoline than for other vehicles. This means that manufacturers are able to optimise gasoline vehicles for consumer needs much more effectively than AFVs.

Conclusions

103. Policies and measures addressed in this Tranche 2 studies could be considered for common action alongside the measures considered in the Tranche 1 study. Each of the five elements of the framework for innovation described in Box 1 might form part of a common action, which could contribute to cost-effective GHG mitigation in various ways.

- by sharing the costs and benefits, and hence the risks of research, development and demonstration programmes
- by allowing cross-fertilisation of ideas and approaches to occur among countries, improving the chances of finding successful and cost-effective solutions

- by enlarging the potential market for any new technology, allowing economies of scale to be achieved more easily
- by giving clearer market signals to manufacturers and fuel suppliers operating in an international market

104. Many of these advantages of common action are likely to be greatest for states in the same region, especially those sharing a common border.

105. Common action may also face a variety of barriers, and may have disadvantages. Some types of common action — for example those that involve sharing information on industry practices or research results — may be opposed by national industries on the grounds that their competitiveness would be compromised by sharing proprietary information. Premature convergence on a technical standard can prevent competition that would otherwise have led to the emergence of a better technology. Additional costs could also arise if incentives were made too rigid, and could not be adapted to national circumstances, in which case inappropriate solutions might be forced on some countries.

Replication of Successful Measures

106. Many initiatives already exist to help replicate successful initiatives internationally. These include outreach by individual countries and co-operative efforts among groups of countries (such as IEA Implementing Agreements, European Conference of Ministers of Transport and the European Union). The IEA/OECD Climate Technology Initiative (CTI) is one such initiative. A common action might build on existing approaches to create an international network of firms, local governments and communities interested in innovation. The network might share information on research findings, technologies, demonstration projects, and the implementation of technologies and practices. It could also provide access to technical support and guidelines. One approach would be to make more systematic use of the national communication process under the FCCC to share information on innovations in technology, behaviour and institutions. The communication guidelines could be extended to include recommendations to this effect.

Agreement to Take Action in the Transport Sector Toward an Aim or Target

107. Common actions in this area might take the form of agreements to achieve some target such as reversing the upward trend in GHG emissions from urban transport or achieving a certain level of GHG mitigation through alternative fuel and vehicle introduction. Alternatively the agreement might be to aim for a principle such as "fair and efficient pricing in urban transport" or "full community consultation in local transport planning". Advantages of such a common action would include the creation of common aims in local transport policy or vehicle manufacturers' innovative efforts, extending beyond national borders. International agreement on aims and targets would give added contextual stability, which can contribute to a "climate for innovation". A transport sector GHG mitigation target could be negotiated through the FCCC, building on initiatives such as ECMT Ministers' declaration aiming to reduce vehicle CO_2 emissions.

Co-ordination to Implement the Same or Similar Measures

108. Measures that might benefit from co-ordination include the experimentation with road pricing, intermodal freight technologies or intelligent vehicle and highway systems, where there would be advantages in the long run from the adoption of standardised technology.

109. Co-operation in the form of information exchange, joint funding of demonstration programmes, and collaboration on research and development, would allow countries to learn from each other's experiments and move towards consensus on the best technology for later standardisation. Governments might also co-operate in the development of information networks, R&D and training schemes. Agreements to co-operate on R&D could include co-funding for major research programmes, collaboration among researchers from universities, firms and government agencies in different countries. International co-ordination in these areas could add value and reduce the costs of national programmes. Governments could also co-ordinate the incentives they provide for new technology to ensure that manufacturers are receiving the same signals from several markets. The levels of incentives would not need to be harmonised to provide a clear signal.

Specific Policies and Measures Implemented Together

110. The main areas where harmonisation might be appropriate are those relating to vehicle technology, because vehicles can move among countries. Important areas for harmonisation include safety and technical standards for AFV components, refuelling technologies, and fuel specifications. Common standards would also permit manufacturers to produce technologies for niche markets such as urban bus fleets, airport and marine port fleets in a number of countries. It may also be important that road pricing, intelligent vehicle and highway systems, intermodal technologies, etc., are "inter-operable" — i.e. that vehicles designed for one system can operate within another. In addition to allowing interoperability, harmonised standards might lead to reduced costs by reducing the need for one-of-a-kind systems and facilitating competition between companies from different countries.

111. Much of the impetus for the development of alternative fuels and vehicles derives from concern about employment, the survival of specific industries, local environmental issues and energy security. As the relative importance of these issues varies widely among countries, harmonised policies beyond the more easily agreed basic technology specifications are unlikely to be cost-effective or politically feasible, and different types of incentives may be appropriate for different countries. Meanwhile, standardisation of the approach to technology development might result in a loss in diversity of new approaches, which is an essential ingredient for innovation.

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