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Impacts of the Kyoto Protocol on

DEVELOPING COUNTRIES

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Impacts of the Kyoto Protocol on DEVELOPING COUNTRIES

ABARE report presented at the UN Framework Convention on Climate Change workshop on Articles 4.8 and 4.9 of the Convention and Article 3.14 of the Kyoto Protocol
'Impact of the Implementation of Response Measures'

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FOREWORD

The adoption of the Kyoto Protocol marked a significant step in the global policy response to the threat of human induced global warming. Since Kyoto, enormous international effort has gone into moving from the framework that the protocol represents toward policies that can be implemented. Implementation of the Kyoto Protocol would have far reaching economic consequences, including for those countries that do not have quantified emission targets as listed in Annex B of the protocol.

The purpose in this report is to examine the economic impacts of the protocol on these non-Annex B (developing) countries. The extent and nature of these impacts will be significantly influenced by the final form in which the protocol is implemented. Some of these issues of instrument design are also considered here.

The report is the forerunner of a more detailed ABARE research report, *Impacts of the Kyoto Protocol on Developing Countries*, scheduled to be published shortly. Copies of the report can be ordered from ABARE's website, (www.abareconomics.com). The analysis forms part of ABARE's continuing program of research in climate change policy, which aims to provide policy makers with a better understanding of the economic dimensions of the issues at stake.

BRIAN S. FISHER
Executive Director

March 2000

Impacts of the Kyoto Protocol on DEVELOPING COUNTRIES

Under the Kyoto Protocol, developed (Annex B) countries have agreed to reduce or limit their greenhouse gas emissions. Developing countries have no emission reduction commitments, but their economies may be affected by Annex B emission abatement through trade and investment linkages. The net economic impact of the protocol on any one developing country will depend on its particular production and trade structure.

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Kyoto mechanisms such as international emissions trading and the clean development mechanism could reduce the impacts on both developing countries and Annex B countries. An indicative analysis of the clean development mechanism in electricity generation highlights the potential for achieving sustainable development in developing countries while achieving environmental goals at least cost. Appropriate mechanism design that realises this potential is a crucial issue in the lead up to the sixth Conference of the Parties later this year.

The Kyoto Protocol

The world community adopted the Kyoto Protocol in December 1997 (see box 1). The main achievement was agreement by developed (Annex B) countries to reduce or limit their greenhouse gas emissions. The aggregate target is a reduction in their combined emissions of 5 per cent compared with 1990 levels for the commitment period, 2008–12.

To assist parties in meeting their emissions targets the protocol sanctions the use of economic instruments such as emissions trading, joint implementation and the clean development mechanism. The rules governing the use of these mechanisms are still to be negotiated. The challenge in these negotiations will be to design, agree and implement rules for the Kyoto mechanisms that allow emission targets to be achieved at least cost to the global economy.

Even though developing countries have no emission reduction commitments under the protocol, the potential remains for both climate change itself and the implementation of measures in industrialised countries to reduce emissions to affect the economies of developing countries. To date comprehensive assessments of these potential economic impacts of the protocol on developing countries have been limited.

However, there have been studies examining the impacts of the Kyoto Protocol on developing countries using global general equilibrium models of the world economy. These include the analysis by Bernstein, Montgomery and Rutherford (1999) using the MS-MRT model, and by Ellerman, Jacoby and Decaux (1998) and Babiker, Reilly and Jacoby (1999) using the EPPA model (Yang et al. 1996). The OPEC

Secretariat has also assessed the implications of the protocol for the OPEC economies, using its World Energy Model, OWEM (Ghanem, Lounnas and Brennand 1999).

The purpose in this paper is twofold: to add to the stock of knowledge about indirect economic impacts on developing countries, and to consider some of the implications for the design of the Kyoto mechanisms.

Two specific effects on developing countries are assessed:

- the indirect trade related impacts on developing countries of emission reductions in developed countries — with and without international emissions trading; and
- an indicative example of the impacts that may result from adopting the clean development mechanism — with a particular focus on electricity generation.

The Kyoto mechanisms

The Kyoto mechanisms convey flexibility to Annex B parties in how they meet their emission abatement commitments. All three mechanisms enable parties to access abatement options that are lower cost than

1 Key provisions of the Kyoto Protocol

Target commitments

Developed countries, as listed in Annex B of the Kyoto Protocol, have collectively agreed to reduce their greenhouse gas emissions to at least 5 per cent below 1990 levels for the commitment period, 2008–12.

To achieve this collective objective, individual countries were allocated differentiated targets. Japan, the United States and members of the European Union have commitments to reduce greenhouse gas emissions to 6 per cent, 7 per cent and 8 per cent below 1990 levels respectively in the first commitment period. Australia is required to constrain greenhouse gas emissions to 8 per cent above its 1990 level.

Whether a country meets its commitments will be assessed by comparing its target with its emission inventory averaged over the period 2008–12. An average is used to reduce the influence of annual fluctuations in emission levels that could be caused by factors such as unusual weather conditions or cyclical changes in economic activity.

Since the third Conference of the Parties in Kyoto, the European Union has agreed to a differentiated internal burden sharing arrangement for the purposes of collectively meeting its commitments. Under this arrangement, which is provided for under Article 4 of the protocol, Portugal and Greece, for example, can increase emissions by 27 per cent and 25 per cent respectively, while Germany and Denmark have each agreed to reduce emissions by 21 per cent. The European Union has the opportunity to further revise its individual targets. Final targets will be included in the European Union's ratification instrument as required by Article 4 of the protocol.

Anthropogenic (human) sources of six greenhouse gases are to be included in national greenhouse gas emission inventories, including emissions from land use change. However, for the purposes of calculating the base period inventory, emissions from land use change are not included when defining the emission targets unless land use changes were a net source of emissions in 1990. The six greenhouse gases covered by the protocol are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

Reductions in greenhouse gas emissions from sources and removals of carbon by sinks (such as forestry activities, subject to certain limitations and future agreement on rules and methodologies) can be used to meet target commitments.

Kyoto mechanisms

There are a number of flexibility provisions in the protocol that, if implemented, would reduce the costs of meeting abatement targets. Emissions trading, joint implementation and the clean development mechanism are the key

Continued ➪

domestic abatement, potentially reducing the overall cost of meeting their targets. To that extent, all the mechanisms are important in the context of examining the impact of climate change response policies on developing countries.

However, it is the clean development mechanism that provides a direct opportunity for developing country involvement in greenhouse gas emission abatement. Under this mechanism, an Annex B country (the investing country) may use a portion of the certified emission reduction credits generated from a project in a non-Annex B country (the host country) toward meeting its target commitment.

Article 12 of the Kyoto Protocol clearly states that one of the aims of the clean development mechanism is to assist non-Annex B parties achieve sustainable development. What is unclear at this stage is the way in which the economic benefits from clean development projects will be shared between the project participants from developed and developing country parties. This will be clarified to some extent once the negotiations on the modalities and procedures governing the clean development mechanism are finalised. However, even

1 Key provisions of the Kyoto Protocol *Continued*

Kyoto mechanisms. The rules, guidelines and procedures governing these mechanisms are subject to ongoing negotiations.

Abatement projects between Annex B parties that generate greenhouse gas emission reduction credits fall into the category of joint implementation, while credits generated from abatement projects between Annex B and non-Annex B parties are provided for under the clean development mechanism. These credits can be used by Annex B countries to meet their emission commitments.

Policies and measures

The protocol recognises that countries will implement greenhouse policies and measures in accordance with their national circumstances. The protocol lists a range of policies and measures; however, the list is illustrative rather than mandatory.

'Bubble' arrangements

Parties, such as those comprising the European Union, may fulfil their (aggregate) commitments jointly (as a 'bubble'). In the event of the European Union not meeting its aggregate Kyoto commitment, each member party will be responsible for meeting the target inscribed for it in its instrument of ratification.

The protocol provides in principle for the establishment of 'bubble' arrangements between any group of parties that choose to fulfil their commitments jointly. It also requires transparency in the way particular bubbles may operate.

The compliance system

The shape and nature of the protocol's compliance system was an issue left undetermined in Kyoto. A compliance system is needed to help parties comply with their protocol emission abatement targets and to sanction those parties that fail to meet their targets. Parties are currently working toward agreement on the operation of this compliance system at the sixth Conference of the Parties.

One of the most difficult issues for parties to agree on is likely to be the consequences that would be invoked if a party fails to meet its target. Current proposals range from facilitative means designed to help parties overcome their implementation problems to enforcement or 'hard' measures such as requiring additional emissions reductions in a subsequent commitment period. An outcome on this issue will be important to most Annex B countries' ratification decisions.

Entry into force

If the protocol is to come into effect, hold international legal status and be legally binding on those countries that have ratified it, then it must first enter into force. There are two conditions that must be met before it can enter into force. The first is that at least 55 parties to the UNFCCC ratify the protocol; and the second is that Annex I parties representing at least 55 per cent of total Annex I carbon dioxide emissions for 1990 must also have ratified the protocol.

then the final incidence of benefits will be the subject of commercial negotiation between the participants.

The fourth Conference of the Parties held in Buenos Aires in November 1998 set the target of resolving all the issues surrounding the implementation of the Kyoto mechanisms by the sixth Conference of the Parties, to be held in The Hague in November 2000. Details of various parties' submissions on the mechanisms both in the leadup to the fifth Conference of the Parties (held in Bonn in late 1999) and since that time are available at www.unfccc.de.

Developing country impacts

The impacts of climate change and climate change policy of most concern to developing countries can be broadly divided into two classes. The first class of impacts is the physical impact of climate change. These issues are covered primarily in Articles 4.8 and 4.9 of the UN Framework Convention on Climate Change (UNFCCC). There is substantial coverage in both the scientific and economic literature of the potential physical impacts of climate change (see, for example, McMichael et al. 1996; Watson et al. 1996; Mendelsohn and Neumann 1999) and this issue will not be dealt with further here.

The second class of impacts is the indirect impact on developing countries of the implementation of response measures in developed countries designed to meet the Kyoto targets. These issues (as they relate to measures taken under the convention) are dealt with in Article 4.8 of the convention and (as they relate to measures implemented to meet commitments under the protocol) Article 3.14 of the protocol. These articles require Annex B parties to consider the actions necessary to meet the needs and concerns of developing countries adversely affected by climate change and/or the impact of the implementation of climate change response measures and 'to strive to implement [their] commitments ... in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties...' (Article 3.14 of the protocol).

Estimates of the economic impacts on developing countries of implementing the protocol are provided here for a select set of countries and some conclusions are drawn about how mechanism design can determine the extent to which it will actually be possible to minimise the impacts on developing countries.

Analytical framework

Anthropogenic greenhouse gas emissions arise from many activities throughout the economy and therefore policies designed to constrain greenhouse gas emissions will influence almost every part of the economy. The analysis of the impacts of climate change policies in this paper is based on simulation results from ABARE's general equilibrium model of the world economy, GTEM. Models such as this are able to capture the impacts of policy changes on large numbers of economic variables such as prices, output and trade and investment flows between regions.

GTEM is a dynamic model developed at ABARE to address policy issues with long term, global dimensions, such as climate change. It is derived from the Megabare model (ABARE 1996) and the GTAP model (Hertel 1997). A detailed description of GTEM features can be found in Brown et al. (1999) and a full specification of the model can be viewed on ABARE's web page (www.abareconomics.com).

GTEM is an ideal tool for analysing international policies with wide ranging intersectoral ramifications, such as climate change policies, because of its detailed coverage of regions, sectors and greenhouse gases, and its detailed modeling of energy markets. At its most disaggregated level, GTEM includes 50 industries in 45 countries and regions. The greenhouse gas coverage in GTEM includes combustion and noncombustion carbon dioxide and methane and nitrous oxide, which account for around 99 per cent of global anthropogenic greenhouse gas emissions (IPCC 1996). Energy modeling features include fuel switching in electricity generation, and differentiated supply responses in fossil fuel markets.

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Modeling emission abatement policies

The policy simulations presented in this paper assume that countries reduce national emissions gradually until reaching their Kyoto target in 2010. The model specification requires that a particular year be defined as the time at which the Kyoto targets are met. In practice, countries must meet their emissions target over an average of the years 2008–12.

In GTEM, modeling independent emission abatement involves imposing a per unit tax or a 'carbon equivalent emission penalty' on greenhouse gas emissions in each period for which emission restrictions apply. The carbon equivalent penalty will be sufficiently large to achieve the assumed emission target, and will differ from country to country. The carbon equivalent penalty raises the costs of emission producing activities and encourages a shift of resources into less emission intensive industries, thereby reducing emissions. The magnitude of emission reduction required in each country depends on the abatement target and on the level of emissions growth that would have occurred in the absence of the protocol.

International emissions trading allows more abatement to be undertaken in countries where the marginal cost of abatement (at the given quota allocation) is lowest. Modeling an international emissions trading scheme requires the aggregate emissions of participating regions to be constrained to their emission reduction commitments under the Kyoto Protocol.

The model determines a uniform carbon equivalent penalty across participating regions that is sufficient to meet the aggregate emission target. The individual Kyoto commitments represent an initial allocation of emission quotas among the participating countries that can be traded between countries. The uniform carbon equivalent penalty can therefore be interpreted as the price of the international emission quota.

GTEM modeling does not generally take into account gains from technology transfer and economies of scale. Future model development will focus on representing these gains in a more realistic fashion. The modeling work undertaken to examine the impact of the clean development mechanism discussed later in this paper is one preliminary representation of technology transfer.

Reference case

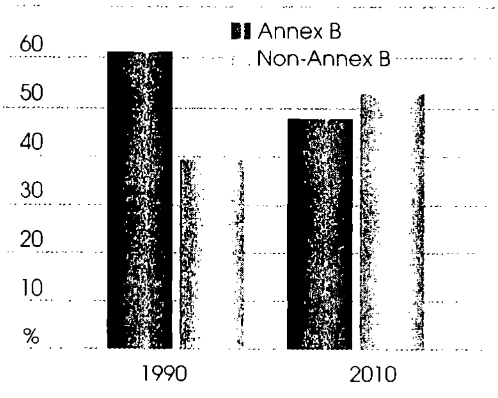
The GTEM reference case scenario provides a representation of the world economy over the period to 2010 in the absence of any policies to reduce greenhouse gas emissions. Comparing the projections from a policy simulation with results from the reference case allows the effects of implementing a policy change under the Kyoto Protocol to be isolated.

Global emissions growth

Global emissions of the three major greenhouse gases (carbon dioxide, methane and nitrous oxide) are projected to rise substantially in the absence of climate change policy, from 27 billion tonnes of carbon dioxide equivalent in 1990 to 37 billion tonnes by 2010. The growth in global emissions is driven largely by high projected emissions growth in non-Annex B countries, highlighting the importance of engaging developing countries in reducing emissions growth. In carbon dioxide equivalent terms the share of non-Annex B regions in global emissions is projected to increase from 39 per cent in 1990 to 52 per cent in 2010 (figure A).

The difference between projected reference case emissions and emission targets

A Annex B and non-Annex B contributions to global greenhouse gas emissions, reference case



represents the magnitude of the abatement task for Annex B countries, and therefore is a key determinant of the economic impact of the Kyoto Protocol on economies. The primary determinants of emissions growth are the growth in economic activity, measured in gross domestic product (GDP), and changes in the emission intensity of output, measured as greenhouse gas emissions per dollar of output.

The Russian Federation, the Ukraine, eastern Europe and some western European countries are projected to have low emissions growth compared with the Annex B average, and compared with their Kyoto targets. Emissions from the Russian Federation and the Ukraine, and eastern Europe are projected to stay below their Kyoto target levels without implementing policies to curb emissions.

Among developing countries, projected emission growth rates also vary substantially (table 1). China, for example, which is the largest emitter in the developing world, also has one of the highest projected emissions growth rates. China's share of global greenhouse gas emissions is projected to increase from 12 per cent in 1990 to 21 per cent in 2010.

GDP growth

Developing countries' economies are projected to grow faster than those of industrialised countries (table 1). This is because of faster increases in population, productivity and investment. The average annual rate of population growth is projected to be 1.4 per cent in non-Annex B regions, compared with 0.2 per cent in Annex B regions. Population growth tends to be inversely related to per person income.

Productivity growth is on average projected to be higher in developing countries, reflecting greater potential for technological catch up in low income economies. For the countries affected by the Asian downturn, projected productivity growth is low over the reference case. Investment growth is projected to be higher in non-Annex B countries, reflecting higher returns to investment because of lower levels of capital stock per person.

1 Projected annual average change in emissions, GDP, and emission intensity, 1990–2010: reference case

	Carbon dioxide equivalent emissions	Real GDP	Emission intensity of output
	%	%	%
South Korea	5.1	5.5	–0.4
India	2.7	6.0	–3.1
Brazil	1.8	3.4	–1.5
China	4.3	7.9	–3.3
Southern Africa	1.2	2.8	–1.5
Mexico	1.4	3.9	–2.4
Indonesia	4.0	4.7	–0.6
Middle East	1.8	4.2	–2.3
Colombia	2.0	3.8	–1.7
Venezuela	2.0	3.1	–1.0
Non–Annex B average	3.0	4.8	–1.8
Annex B average	0.2	2.3	–2.0

Emission intensity

The aggregate emission intensity of production, measured as emissions per dollar of output, is more than three times higher in non-Annex B regions than in Annex B regions. This is both because production efficiency is typically lower, and because the economic structure of developing countries tends to be more emission intensive. Agriculture and heavy industries on average contribute a larger share to total output in developing countries, while the share of services in the economy is smaller than in developed countries.

From its relatively high base, emission intensity in non-Annex B regions is projected to decline over time as productivity improvements are achieved and the structures of the economies change. The potential for improvements in aggregate emission intensity is generally greater in developing countries than in Annex B countries. However, changes in emissions intensity over time vary substantially from country to country, depending on economic structure and the stage of economic development.

In GTEM, economywide productivity growth is assumed to apply also to energy inputs. Consequently, countries with high projected rates of productivity growth, such as China and India, tend to exhibit a relatively fast projected decline in emission intensity.

The economic structure of developing countries is projected to change significantly over the reference case. For example, energy intensive industries are projected to grow at relatively high rates, and the contribution of industries such as iron and steel to total developing countries' emissions is projected to increase.

In contrast, the share of agriculture in total output is projected to contract relative to industrial output and services as industrialisation proceeds. Economies where the relatively slow growing agricultural sector accounts for a large share of total emissions tend to have lower projected emissions growth. In Brazil, for example, the livestock industry is estimated to account for over 40 per cent of total greenhouse gas emissions and is projected to grow at a rate below the average in the economy, contributing to relatively low projected emissions growth.

The projected relative contributions of carbon dioxide, methane and nitrous oxide to total emissions in selected non-Annex B countries is shown in table 2.

2 Contribution of greenhouse gases to total carbon dioxide equivalent emissions at 2010, reference case

	Carbon dioxide	Methane	Nitrous oxide
	%	%	%
South Korea	94	3	3
India	62	29	9
Brazil	55	34	11
China	84	13	3
Southern Africa	87	11	2
Mexico	84	11	5
Indonesia	74	22	4
Middle East	89	7	4
Venezuela	80	17	3
Colombia	63	30	7
Non-Annex B average	77	18	5
Annex B average	88	8	4

Economic impacts of the Kyoto Protocol

Adoption of Kyoto emissions targets and mechanisms will affect world trade, as well as investment flows and technology adoption. Such changes have the potential to profoundly affect the economic environment faced by developing countries despite the fact that they have no emission targets under the protocol. The source of change is that, to achieve emission reductions, Annex B countries would have to place explicit or implicit financial penalties on emitters.

For developing countries, the most important economic impacts would occur through changes in trade. Both positive and negative effects could be expected — the net impact would depend on the relative magnitude of the effects on individual sectors of the economy.

Emission abatement in Annex B countries has the following two main effects on trade flows and commodity prices.

- *Lower demand for fossil fuels*: Industrialised countries reduce their fossil fuel consumption to meet their emission reduction targets. They reduce their demand for fossil fuel imports from both Annex B and non-Annex B countries, leading to lower fossil fuel export prices and volumes than would otherwise be the case. Exporters of fossil fuels lose export earnings, while importers benefit from lower world prices.
- *Improved competitiveness of non-Annex B emission intensive industries*: The production of emission intensive goods becomes more expensive in Annex B countries as emissions are penalised. This leads to higher world prices and increased demand for emission intensive exports from developing countries, where emissions are not penalised. Emission intensive industries, such as iron and steel, in those countries benefit from higher export volumes and higher export prices.

Increased export demand causes increased production in developing countries, and increased emissions. As a result, emission reductions in abating countries are partially offset by increasing emissions in developing countries. This phenomenon is known as 'carbon equivalent leakage'.

Annex B emission abatement also affects import prices and investment. Increased world prices for emission intensive products are passed on to consumers, so developing countries that import emission intensive goods sustain losses relative to the reference case. The increased competitiveness of non-Annex B energy intensive production generally increases the rates of return on investment and the demand for capital in non-Annex B regions, relative to Annex B regions. As a result, investment tends to shift from developed to developing countries.

Emissions trading

The use of Kyoto mechanisms in implementing the Kyoto Protocol can reduce the economic impacts both on Annex B and non-Annex B economies. Under international emissions trading for example, abatement is undertaken where the cost of abatement is lowest, thus minimising and equalising the marginal costs of abatement across participating (Annex B) regions (Fisher et al. 1996).

Among Annex B regions, the Russian Federation, the Ukraine and eastern Europe have significant low cost opportunities to reduce emissions, given that production processes in these countries rely heavily on fossil fuel inputs and old technology.

As a result of reducing the total cost of abatement, the impacts on developing countries are generally reduced in magnitude relative to independent abatement. The competitive advantage gained by non-Annex B energy intensive exporters is reduced; at the same time, fossil fuel exporters are relatively better off under emissions trading because of smaller impacts on fossil fuel exports and prices.

Estimates of global economic impacts

To estimate the magnitude of economic impacts of the Kyoto Protocol, two policy scenarios are analysed here: independent abatement, where Annex B countries each meet their Kyoto emission abatement target through domestic policies only; and international emissions trading, where Annex B countries can trade emissions quota to assist in meeting their commitments.

Carbon equivalent penalties

In GTEM modeling, a carbon equivalent penalty required to meet the Kyoto emissions target is estimated. This penalty is equal to the marginal cost of abatement. Under independent abatement, the carbon equivalent penalty can be interpreted as the quota price in a domestic emissions trading scheme or a uniform tax applied in each particular region.

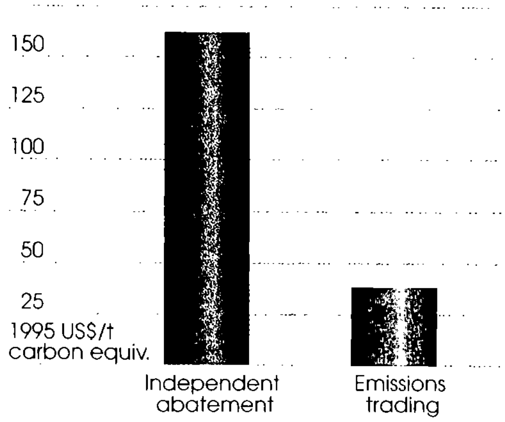
Under emissions trading, Kyoto emission targets represent an initial allocation of emission quota that can be traded among Annex B countries. In this case, the carbon equivalent penalty is uniform across participating countries and represents the global price of emissions quota.

Emissions trading is projected to greatly reduce the magnitude of the carbon equivalent penalty relative to independent abatement, particularly in Annex B countries with large abatement tasks. The average Annex B carbon equivalent penalty is projected to be reduced to US$38 (in 1995 terms) a tonne of carbon equivalent at 2010, or less than a quarter of that under independent abatement (figure B).

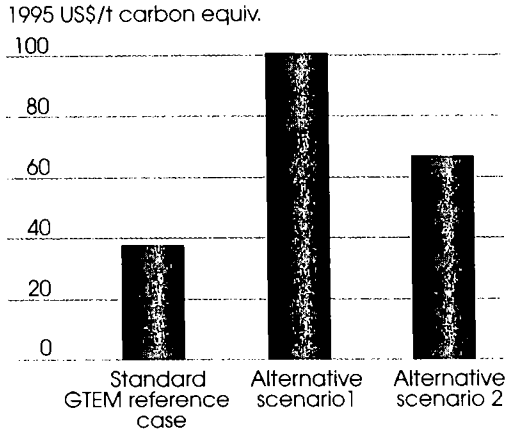
Emissions growth in the Russian Federation, the Ukraine and eastern Europe and the carbon equivalent penalty

The projected size of the carbon equivalent penalty in Annex B countries influences the

B Average Annex B carbon equivalent penalty at 2010



C **Average Annex B carbon equivalent penalty under emissions trading at 2010, under alternative assumptions on reference case emissions growth**



ence case emissions to be half way between the standard reference case and the Kyoto target.

impacts on developing countries. The size of this penalty under emissions trading depends to a large degree on reference case emissions in the Russian Federation, the Ukraine and eastern Europe, regions that are projected to sell quota. Given uncertainty about the medium term economic development in the region, particularly in the Russian Federation and the Ukraine, emission projections are also subject to a degree of uncertainty. Emissions in the Russian Federation and the Ukraine have fallen from 1990 to 1996, and slow emissions growth is projected after that in the GTEM reference case.

Higher projected reference case emissions growth increases the projected carbon equivalent penalty under emissions trading, as the Russian Federation, the Ukraine and eastern Europe would sell less emissions quota than in the standard GTEM reference case. The projected carbon equivalent penalties under emissions trading with two alternative assumptions about emissions growth in these regions are shown in figure C.

In the standard GTEM reference case, emissions in the Russian Federation and the Ukraine at 2010 are projected to be 59 per cent, and in eastern Europe 81 per cent, of 1990 emissions.

In alternative scenario 1, reference case emissions from these countries are assumed to equal their respective Kyoto target levels at 2010. Alternative scenario 2 assumes reference case emissions to be half way between the standard reference case and the Kyoto target.

Economic welfare

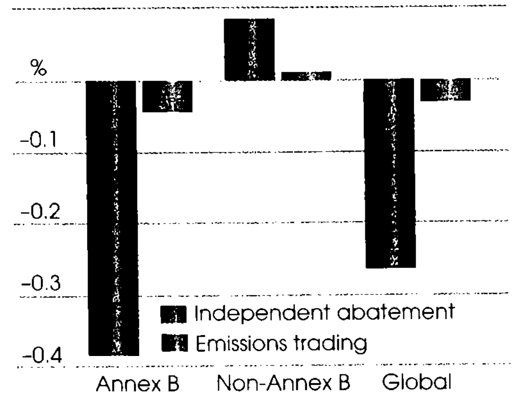
As noted earlier the impact on aggregate economic welfare, measured in terms of the change in real GNP relative to the reference case, is closely correlated with the size of the Annex B carbon equivalent penalty. Under emissions trading, the impact on global real GNP is projected to be reduced to one seventh of that under independent abatement. The impacts on both Annex B and non-Annex B regions in aggregate terms are projected to be reduced by a similar proportion (figure D).

The change for Annex B regions results from the access to emissions reductions in least cost countries under emissions trading. For non-Annex B regions, the GNP gain is reduced relative to independent abatement because of a reduction in competitive advantage relative to Annex B countries.

The net economic impact of implementation of the Kyoto Protocol on individual developing countries' economies is projected to vary significantly between countries (figure E). Generally, countries that rely heavily on fossil fuel exports to Annex B regions are projected to incur losses while exporters of emission intensive goods tend to gain.

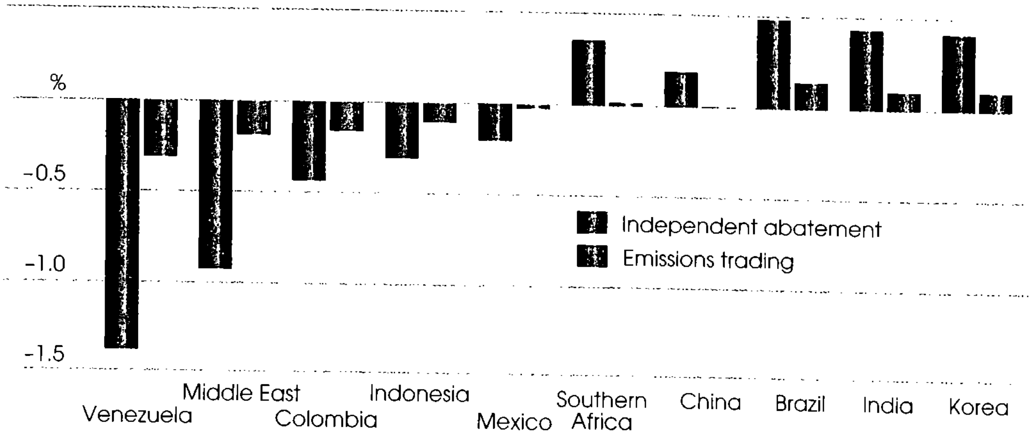
Changes in export volumes and prices, and changes in import prices are the driving

D **Change in real GNP at 2010**
relative to the reference case



E

Change in real GNP at 2010, in selected non-Annex B regions
relative to the reference case



forces behind impacts on developing countries. The particular trade structure of the economy determines the relative size of positive and negative impacts. The composition and destination of exports, along with the composition of imports, are the most important factors.

The magnitude of impacts on developing countries is correlated with the size of the carbon equivalent penalty in Annex B countries. Consequently, the projected impacts are significantly smaller under Annex B emissions trading than under independent abatement.

Impact on emission intensive industries

Production and exports of emission intensive goods in developing countries are projected to increase relative to the reference case as a result of increased export competitiveness against Annex B producers. Under emissions trading, the lower carbon equivalent penalty in Annex B regions diminishes the competitive advantage gained by non-Annex B emission intensive exporters, reducing the impacts relative to independent abatement.

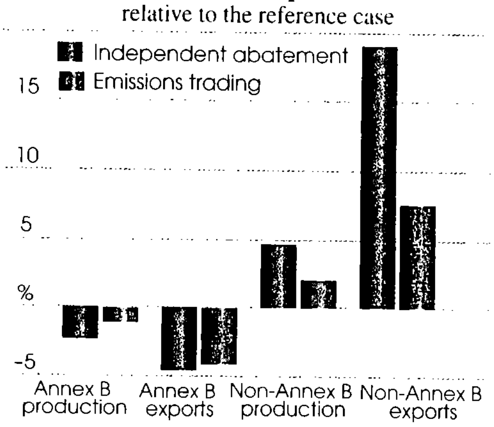
The increase in competitiveness is projected to be greatest in energy intensive commodities that are widely traded, such as iron and steel, and nonferrous metals. Total non-Annex B production and exports of these commodities are projected to increase substantially relative to the reference case, and Annex B production and exports to decline, as shown for iron and steel and nonferrous metals in figures F and G.

These projected changes illustrate the carbon equivalent leakage effect. The carbon equivalent leakage rate is estimated to be 9.2 per cent at 2010 under independent abatement. That is, carbon equivalent emissions from non-Annex B regions are projected to rise by 92 tonnes for every 1000 tonne reduction in carbon equivalent emissions in Annex B countries. Under emissions trading, the leakage rate is projected to be reduced to 6.7 per cent.

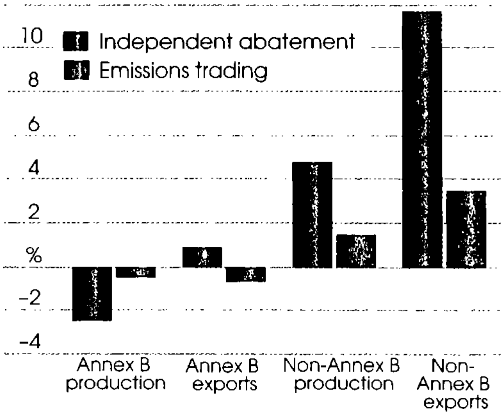
The production impacts in the South Korean iron and steel industry provide an example of changes in international competitiveness. Production of iron and steel is

F

Change in iron and steel production and exports at 2010
relative to the reference case



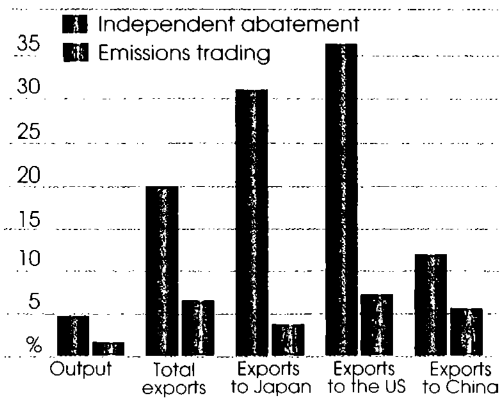
G Change in nonferrous metals production and exports at 2010
relative to the reference case



projected to increase relative to the reference case, driven by higher export demand (figure H). Japanese and US iron and steel imports from South Korea are projected to increase, substituting for domestic production, which would be subject to a carbon equivalent penalty under the Kyoto Protocol. The projected changes are smaller under emissions trading, as the carbon equivalent penalty in Annex B countries is projected to be lower than under independent abatement.

South Korean exports of emission intensive goods to non-Annex B countries are also projected to increase relative to the reference case. This is because South Korea is projected to gain a cost advantage over Annex B competitors in these markets.

H Change in South Korean iron and steel production and exports at 2010
relative to the reference case



Similar gains in export competitiveness are projected for developing countries such as China, India and Brazil (figures I, J and K), and in other emission intensive industries, such as chemicals and nonferrous metals. Aluminium producers in Annex B countries where electricity is generated mainly using fossil fuels are projected to be affected particularly strongly. Large aluminium exporters such as Brazil and southern Africa are projected to greatly increase their exports to the main Annex B markets. For southern Africa in particular, the increase in energy intensive exports more than offsets the reduction in coal exports, yielding a small projected increase in GNP relative to the reference case.

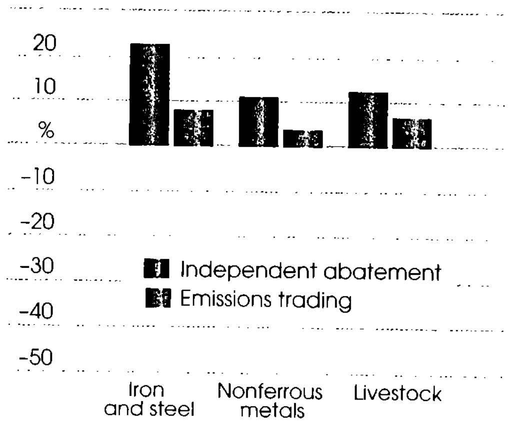
Emission intensive agricultural production in developing countries is also projected to benefit to some degree from carbon equivalent leakage. A case in point is rice cultivation, which is an important source of methane emissions and would thus be subject to the carbon equivalent penalty in cases where governments consistently apply abatement policies to all sectors. India, along with other Asian countries, exports rice to the Middle East, the largest market for imported rice, where it competes with the United States. Under independent abatement, the imposition of the carbon equivalent penalty is projected to lead to an increase in the production costs and export price of US rice. In response, the Middle East is projected to substitute away from US rice, and to increase imports from India and other Asian producers, such as Thailand.

As with rice, output from the livestock and meat and milk processing industries in developing countries is also projected to increase relative to the reference case. Livestock production is an important source of methane and nitrous oxide emissions. A carbon equivalent penalty applied in Annex B livestock industries would reduce the competitiveness of Annex B countries relative to livestock production in non-Annex B countries.

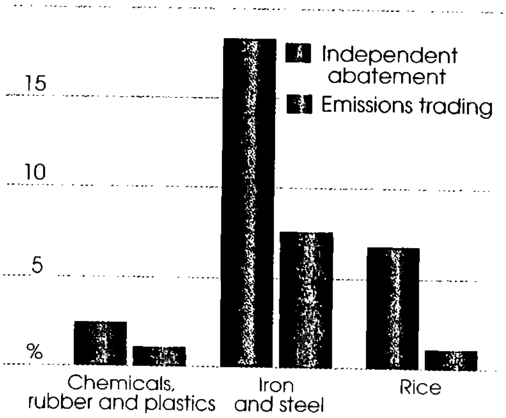
Impact on fossil fuel markets

Emission reduction in Annex B countries is projected to be achieved to a large degree by reduced fossil fuel consumption. Increases in developing countries' demand are

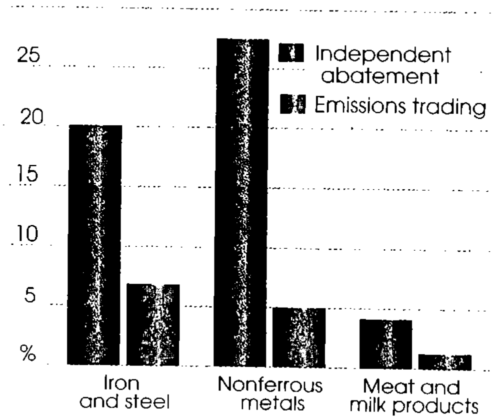
I **Change in Chinese exports at 2010**
relative to the reference case



J **Change in Indian exports at 2010**
relative to the reference case



K **Change in Brazilian exports at 2010**
relative to the reference case



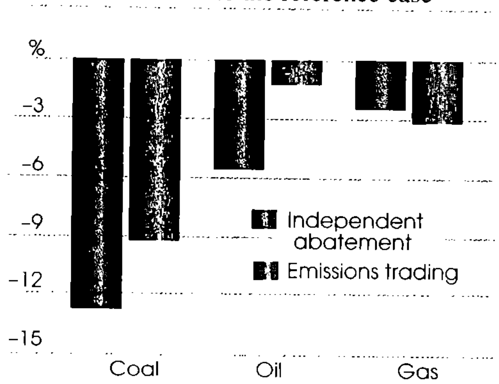
projected to be smaller than declines in Annex B demand. Lower fossil fuel demand is projected to result in reduced world fossil fuel prices relative to the reference case (figure L).

Different fossil fuels are projected to be affected to varying degrees. Consumption of coal, the most emission intensive fuel in terms of carbon content per energy unit, is projected to be cut back most strongly. The use of natural gas, the least emission intensive fossil fuel, is projected to be less affected than coal because the carbon equivalent penalty per energy unit would be lower. Some substitution away from coal and into gas is projected, particularly in electricity generation. World oil demand is projected to be least affected, because substitution possibilities are more limited, particularly in the transport sector.

The impacts on fossil fuel producers differ between Annex B and non-Annex B countries. Fossil fuel extraction in Annex B countries would be subject to a penalty on fugitive emissions, which tends to increase production costs and reduces competitiveness relative to non-Annex B producers.

Oil is more widely traded than gas and coal, and oil exports generally constitute a substantially larger share of developing countries' output than other fossil fuels. A large share of oil exports is destined for industrialised countries, making oil production more vulnerable to reduced Annex B demand. Approximately 50 per cent of oil produced in non-Annex B regions is

L **Change in world fossil fuel export prices at 2010**
relative to the reference case



destined for Annex B regions, compared with approximately 13 per cent for coal and for gas. Consequently, developing countries are projected to be most significantly affected by reduced oil demand in Annex B countries.

Under emissions trading, OECD countries in Annex B purchase emission quotas from low abatement cost regions, such as the Russian Federation, the Ukraine and eastern Europe. As a result, OECD countries are able to increase their emissions and fossil fuel use relative to the independent abatement scenario. This reduces the impact of abatement policies on OECD demand for fossil fuel input from non-Annex B countries.

On the other hand, emission abatement in the Russian Federation under emissions trading has the potential to free fossil fuel supplies from this region to enter world export markets. In the market for natural gas, projected increases in supply from the Russian Federation lead to a slightly larger projected fall in world prices under emissions trading than under independent abatement. However, the extent to which such supplies could enter world markets is constrained by infrastructure and factors such as perceptions about quality and reliability of supply, as well as established trading patterns. Also, the application of carbon equivalent penalties to fugitive emissions from fossil fuel production in the Russian Federation would reduce its competitiveness relative to non-Annex B fossil fuel exports.

On balance, emissions trading is projected to greatly reduce the impacts on fossil fuel exports from non-Annex B countries. Projected changes in export revenue from oil at 2010 are shown in table 3.

The impacts of Annex B emission reduction policies on fuel exporting developing countries are exemplified in the projected changes in Indonesia's fuel exports. Oil accounts for more than 10 per cent of Indonesia's export revenue, and exports of coal and gas are important as well. Japan is Indonesia's main export market, and accounts for just under half of Indonesia's total fuel exports. Japan is projected to reduce the use of fossil fuels in order to meet its Kyoto target, leading to reductions in

3 Loss in oil export revenue at 2010, relative to the reference case

	Independent abatement	Emissions trading
	(1995) US$m	(1995) US$m
Middle East	7 443	1 552
Mexico	1 122	223
Venezuela	855	189
Colombia	525	111
Indonesia	899	177

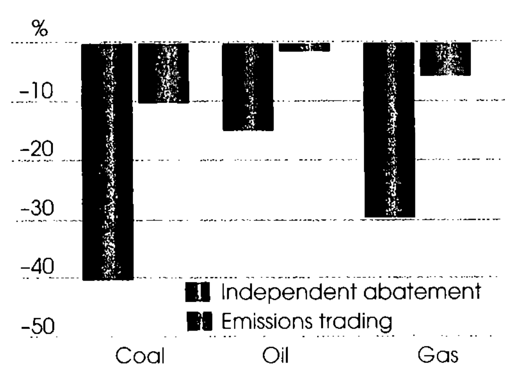
import demand. Indonesia's exports of all fossil fuels to Japan are projected to decline relative to the reference case, particularly under independent abatement (figure M).

Higher domestic fossil fuel demand in Indonesia as a result of carbon equivalent leakage and increased exports to China, Chinese Taipei, South Korea and ASEAN countries is projected to mitigate the negative impact of the fall in exports to Japan. Production of fossil fuels in Indonesia, however, is still projected to be reduced relative to the reference case.

Reduced global demand for fossil fuels is also projected to be the dominant effect for oil exporters such as the Middle East, Mexico, Venezuela and Colombia. In the Middle East, oil and petroleum products account for over 50 per cent of the total value of exports. More than 60 per cent of these exports are destined for Annex B countries.

The Mexican and Latin American oil industries rely heavily on exports to the

M Change in Indonesian fossil fuel exports to Japan at 2010
relative to the reference case



United States, where oil consumption is projected to decline by around 15 per cent relative to the reference case under independent abatement. Non-Annex B producers are in direct competition with US producers, which adds further downward pressure on their export prices and volume.

Coal export revenue for exporters such as southern Africa, Indonesia, China and Colombia is also projected to decrease relative to the reference case, as global coal demand and prices decline. The magnitude of the projected impact depends on the destination of exports from each country. Under independent abatement, exports to countries with high projected carbon equivalent penalties such as Japan are particularly affected. The largest impact is on southern Africa, where coal export revenue is projected to fall by US$529 million under independent abatement and US$329 million under emissions trading in 1995 dollar terms at 2010.

The clean development mechanism

The operational details surrounding the implementation of the clean development mechanism (CDM) have yet to be negotiated. To qualify as a CDM project, the project activity must result in reductions in emissions (removal of carbon dioxide by sinks) that are additional to any that would occur in the absence of the certified project activity (environmental additionality).

Ensuring environmental additionality and calculating certified emission reductions (CERs) attributable to each project will involve projecting baseline emissions (the emissions that would have occurred in the absence of the project). The CERs generated by the project are the difference between the projected baseline emissions and the actual emissions.

Under the CDM, CERs obtained from the year 2000 onward can be used toward meeting Annex B emission reduction targets in the first commitment period.

This section contains an illustrative analysis of the potential impacts of the CDM on non-Annex B countries, focusing on energy efficiency improvements in the thermal electricity sector (coal, oil and gas fired technologies). Transaction costs, monitoring and compliance costs are ignored in this analysis.

The protocol stipulates that a share of the proceeds from the CERs will be used to cover administrative expenses and to assist developing countries that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation (Article 12.8). The size of this so-called 'share of proceeds' is yet to be negotiated. No account is taken of the effects of the redistribution of the share of proceeds in this analysis. Distribution of the remaining CERs would be expected to be the subject of negotiation on a project by project basis between the project participants, perhaps with some involvement by governments.

It is further assumed here that, in line with the provisions of the protocol, CERs are perfectly substitutable with Annex B emissions quotas (assigned amount units) in an Annex B emissions trading scheme.

Implementation of the clean development mechanism in GTEM

Thermal electricity generation is an important source of power and emissions in non-Annex B countries. There is likely to be scope for efficiency improvements in the thermal electricity generation capacity currently employed in non-Annex B countries. For example, based on IEA data (IEA 1998) the average energy efficiency of non-OECD coal fired power stations, measured as the ratio of electricity output to coal inputs, is 27 per cent lower than the OECD average.

Technology transfer into the electricity sector may take the form of improving the energy efficiency of existing infrastructure through, for example, refurbishment. To undertake a comprehensive analysis of the economic effects of technology transfer under the CDM, large amounts of project specific data for each developing country would need to be collected and analysed. Here the simplifying assumption is made that CDM projects would result in a 10 per cent increase in the energy efficiency of thermal electricity generation across all non-Annex B countries over the period 2000–10 relative to the reference case.

The energy efficiency gains modeled relate to reduced consumption of fossil fuels in electricity generation and do not account for fuel switching and emission capture and disposal technologies. The reduction in emissions is therefore proportional to the energy efficiency improvement assumed.

The results should be viewed as indicative of the potential for CER generation from the thermal electricity sector and of the impacts of technology transfer on non-Annex B economies. For example, CERs generated in South Korea, Chinese Taipei and the Middle East are likely to have been overestimated, given the already high levels of thermal efficiency in those regions. On the other hand, there may be additional scope to generate CERs in China and India especially in older and highly inefficient power stations.

Obviously, this scenario provides no information on the potential impact of sink or other projects in the CDM.

Under the scenarios modeled here, the amount of CERs generated will vary across non-Annex B regions depending on the size of the thermal electricity sector, its composition in terms of fuel source and its projected growth over the reference case (table 4). For example, China and India dominate the emissions credits generated as a result of the relatively large size of their thermal electricity sectors and their heavy reliance on coal. Latin American countries have a low reliance on fossil fuel technologies in electricity generation, making technology transfer potential very low given the assumptions in this analysis.

The stream of revenue from CER projects will depend on the amount of CERs generated (table 4) and the size of the carbon equivalent penalty (figure N).

The trade in CERs from CDM projects in conjunction with an international emissions trading scheme is projected to lead to a decline in the carbon equivalent penalty from US$38 (in 1995 terms) a tonne of carbon equivalent to US$31 a tonne (figure N). CDM offers Annex B parties access to low cost abatement options, reducing their reliance on Annex B emissions trading to meet the objectives of the Kyoto Protocol while at the same time providing a means of accelerating technology transfer to developing countries.

4 CERs and revenue generated in non-Annex B regions assuming a 10 per cent increase in the energy efficiency of thermal electricity generation from 2000 to 2010

	CERs in 2010	Cumulative CERs 2000–10	Revenue from CERs in 2010 a	Revenue stream from CERs 2000–10 a
	Mt	Mt	(1995) US$m	(1995) US$m
Middle East	8.3	45.0	116	597
North Africa	0.9	5.0	13	66
Southern Africa	0.6	3.4	8	45
China	22.3	113.3	312	1 508
Chinese Taipei	1.8	10.0	26	133
South Korea	2.5	13.5	35	178
India	14.2	75.6	198	1 004
Indonesia	3.2	15.9	45	212
Rest of ASEAN	6.8	33.2	95	442
Mexico	3.4	17.7	48	236
Argentina	0.8	4.1	11	55
Brazil	0.7	3.3	9	44
Venezuela	1.0	5.0	13	66
Colombia	0.5	2.3	6	31
Rest of world	9.1	48.0	128	638
Total	76.0	395.3	1 063	5 255

a Figures discounted using a 5 per cent discount rate.

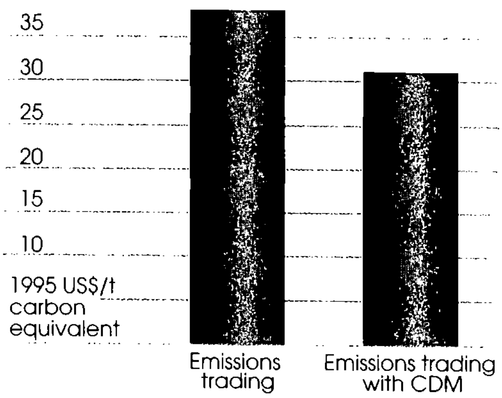
Over the period 2000–10 the total revenue generated in this analysis by selling CERs is projected to be around US$5.3 billion (in 1995 terms). At 2010, sales of CERs are projected to be worth around US$1.1 billion (in 1995 terms). Sales of CERs from China and India are projected to account for about half the total revenue generated, with China accounting for around 30 per cent and India 19 per cent.

Impacts on developing country welfare

The clean development mechanism will affect developing countries in several ways. The main effects on developing countries will be through:

- income transfers through the sale of CERs;

N Impact on the carbon equivalent penalty of the clean development mechanism in electricity generation at 2010



- indirect trade effects of any change in the carbon equivalent penalty applying in Annex B regions;
- impacts on the efficiency and prices of thermal electricity generation; and
- impacts on the availability of capital.

To examine these impacts in more detail, two simulations were undertaken using GTEM:

- *Optimistic*: Non-Annex B countries sell CERs into an Annex B emissions trading scheme, with a 10 per cent improvement in energy efficiency in thermal electricity generation in non-Annex B countries over the period 2000–10.
- *Pessimistic*: Non-Annex B countries sell CERs into an Annex B emissions trading scheme, with a 10 per cent improvement of energy efficiency in thermal electricity generation in non-Annex B countries over the period 2000–10 and an offsetting increase in capital costs sufficient to hold thermal electricity prices at the same level as projected in the optimistic scenario.

It is assumed in all simulations in this analysis that the revenue from the sale of CERs is shared equally between the host and investing countries.

There is a wide range of possibilities for technological advancement in the thermal electricity sector available at various costs in terms of capital investment (IPCC 1996). The technology chosen in a given CDM project is likely to have an impact on the cost of thermal electricity generation and the availability of capital in the remainder of the economy in developing countries.

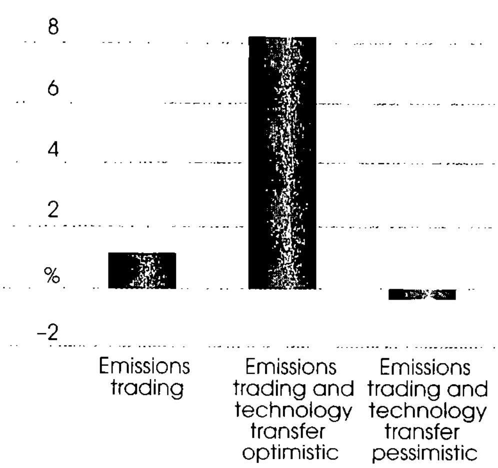
The optimistic assumption illustrates the effects of non-Annex B regions adopting technologies that achieve abatement through no-regrets energy efficiency gains. In this case, technologies are adopted that increase the energy efficiency of existing plants without any additional capital costs. Under these optimistic assumptions the price of electricity falls and the economic gain to non-Annex B countries in aggregate is projected to increase significantly relative to emissions trading alone (figure O).

Holding electricity prices constant leads to a projected loss in non-Annex B real GNP relative to the reference case (figure O). In this case, non-Annex B regions do not benefit from reduced electricity prices and the availability of capital is effectively reduced in non-Annex B regions. The reduction in the availability of capital results from capital being redirected into thermal electricity generation, away from other sectors in developing countries. The reduction in capital availability in the rest of the economy increases capital costs across non-Annex B regions, reducing output and income.

It is important to bear in mind that these simulations are illustrative only and that the aggregate impact of CDM on developing countries is likely to lie somewhere between the optimistic and pessimistic scenarios.

O Change in real GNP in non-Annex B regions, various scenarios, at 2010

relative to the reference case



Conclusions

Despite having no emission abatement commitments under the Kyoto Protocol, non-Annex B economies would be affected by emission abatement in Annex B regions undertaken as a result of entry into force of the Kyoto Protocol through their trade and investment linkages. Although the net impact for non-Annex B regions in aggregate is projected to be positive, there is a range of effects and the net impact for any one non-Annex B country will depend on its particular production and trade structure.

The analysis presented in this paper illustrates that as industrialised countries reduce their fossil fuel consumption to meet their emission reduction targets their demand for fossil fuel imports from non-Annex B countries declines, leading to lower fossil fuel export prices and volumes.

Regions that rely on exports of fossil fuels, face a reduction in export earnings and welfare. On the other hand, as the production of emission intensive goods becomes more expensive in Annex B countries as emissions are penalised, this leads to increased demand for emission intensive exports from developing countries.

Non-Annex B regions that export emission intensive products, such as iron and steel and nonferrous metals, benefit from higher export earnings.

International emissions trading — one of the mechanisms included in the protocol to help parties meet their targets — is shown to reduce the impacts both on developing countries and on Annex B countries of meeting the target commitments.

The preliminary analysis of the clean development mechanism presented highlights the scope for the generation of certified emission reductions in non-Annex B regions. Under the illustrative example chosen in the paper, developing countries generated certified emission reductions worth around US$5.3 billion (in 1995 terms), the majority of which accrued to China and India. This was because the analysis focused on the example of technology transfer in thermal electricity generation, giving results that were skewed toward a particular set of countries. Africa and Latin America, for example, are largely excluded from access to the mechanism and its benefits in this analysis.

This underscores the importance of ensuring that the clean development mechanism is implemented in a way that is all encompassing in its approach to projects, and includes removals by sinks as well as emission reductions by technology transfer.

In the lead up to the sixth Conference of the Parties later this year, it will be important that the opportunities afforded by the Kyoto mechanisms to achieve environmental outcomes at least cost and to maximise the benefits of technology transfer to all developing countries are not squandered by inappropriate mechanism design.

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Eleventh session
Bonn, 25 October - 5 November 1999
Item 3 of the provisional agenda

SUBSIDIARY BODY FOR IMPLEMENTATION
Eleventh session
Bonn, 25 October - 5 November 1999
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IMPLEMENTATION OF ARTICLE 4, PARAGRAPHS 8 AND 9, OF THE CONVENTION (DECISION 3/CP.3 AND ARTICLE 2, PARAGRAPH 3, AND ARTICLE 3, PARAGRAPH 14, OF THE KYOTO PROTOCOL)

Report on the workshop envisaged in the annex (Programme of work) to decision 5/CP.4

Note by the Chairman of the SBSTA

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Annex

Agenda for the workshop envisaged in the annex (Programme of work) to decision 5/CP.4: Implementation of Article 4, paragraphs 8 and 9, of the Convention (decision 3/CP.3 and Articles 2.3 and 3.14 of the Kyoto Protocol) 8

I. MANDATE

1. The Conference of the Parties, at its fourth session, agreed upon the programme of w set out in the annex to decision 5/CP.4, including the organization of an expert workshop. U the guidance of Mr. Kok Kee Chow, the Chairman of the Subsidiary Body for Scientific anc Technological Advice (SBSTA), assisted by Mr. Mohammad Reza Salamat, the Vice-Chair of the Subsidiary Body for Implementation (SBI), this workshop was held from Tuesday, 21 September 1999 to Friday, 24 September 1999 at Bonn, in accordance with the terms of reference adopted by the SBSTA, at its tenth session (FCCC/SBSTA/1999/6, para. 80).

II. SCOPE

2. This document is intended to respond to the requirements of the work programme se in decision 5/CP.4, in accordance with which the subsidiary bodies are to consider the outc of the workshop and prepare a report including conclusions and/or a draft decision for COP which would identify initial actions to address the implementation of Article 4.8 and 4.9 of Convention, as well as Articles 2.3 and 3.14 of the Kyoto Protocol.

3. The workshop included expert presentations followed by panel discussions in which policy-related implications of the information presented were addressed. The agenda for th workshop is included in the annex to this note.

III. WORKSHOP SUMMARY

A. Information

4. Information has been available and is being developed on the **adverse effects of clir change**. More information is needed on the nature and magnitude of the effects on countrie subject to the circumstances laid out in Article 4.8 and 4.9 of the Convention. Work relate vulnerability and adaptation is still at an early stage.

5. Information gaps centre around uncertainties related to national and regional impact to reducing the vulnerability of natural ecosystems and semi-managed resources, as well as potential consequences on livelihood security. There are differences in availability of data and in scientific understanding of, the various areas; for example, there is better understand small island countries and countries with low lying coastal areas than areas liable to drough desertification. Similarly, there is much more information on water resources and agricultu than there is on food security and health. Gaps have also been identified on the interaction among different impacts, as well as on the assessment of effective adaptive strategies. It is difficult to establish with certainty the proportion of the impacts directly attributable to anthropogenic climate change.

6. Some participants felt that sufficient information was available on the **impact of the implementation of response measures** by Parties included in Annex I to the Convention (Annex I Parties). Some other participants felt that further information needed to be developed with regard to the nature and magnitude of the impact on countries subject to the circumstances laid out in Article 4.8 and 4.9 of the Convention. Some gaps also remain in the assessment of the social, economic and environmental impacts of the implementation of response measures, particularly in relation to uncertainties in determining the baselines.

B. Specific needs, concerns and special situations

7. Developing countries would be affected by the **adverse effects of climate change** in different ways, depending on their national circumstances, their economic conditions and their capacity for adaptation. The adverse effects of climate change will have an impact on the livelihood security of developing countries by affecting water resources, agriculture and food security, economic activities and health, and in particular the least developed countries, where widespread poverty limits the capacity for adaptation. Countries with areas prone to natural disasters and other climate-related risks, including small island countries and countries with low-lying coastal areas, will be more affected by the adverse effects of climate change.

8. The adverse effects of climate change would also lead to secondary effects on developing countries, and in particular on the least developed countries, which could damage the life-supporting capacity of natural systems and/or the sustainability of human habitation. Such effects might include the use of poorer quality sources of fresh water, abandonment of the rural economy, displacement of settlements and infrastructure, and the occurrence of epidemics.

9. Capacity-building related to institutions and human resources at the local, national and regional levels will need to be further developed to reduce vulnerability. Some Parties pointed out that assistance would be needed in this context. Developing countries, and particularly the least developed countries, have limited capacities for conducting research on the adverse effects of climate change and for vulnerability assessment. There is a need to move towards implementing integrated approaches, such as integrated coastal zone management, and further developing integrated assessment models, as well as identifying effective adaptation strategies and assessing how to integrate these into national development programmes.

10. The **impact of the implementation of response measures** will affect developing country Parties through changes in the terms of trade, changes in income levels, and shifts in international capital flows. In this context, an especially important sector is the international energy sector. Some participants pointed out that the models presented in the workshop showed that the oil producing developing countries may be the most adversely affected and would have to bear a disproportionate or abnormal burden. Other participants pointed out that there were disparities in the timing and magnitude of this potential impact, and that the models did not cover the range of possible response measures.

C. Addressing information gaps to support actions

11. Cooperative research on the **adverse effects of climate change** on developing co
subject to the circumstances laid out in Article 4.8 and 4.9 of the Convention is needed.
regard, practical capacity-building measures are needed in developing countries. This re
should cover the adverse effects on social and economic conditions, in particular, on wat
resources, agriculture, food security, economic activities and health, including in the leas
developed countries. The research should focus on the regional and national levels, shou
monitor changes in both vulnerability of ecosystems and effects of climate change, and s
integrated with an analysis of the level of certainty on the adverse effects of climate chan
Research is also required to distinguish between effects due to climate change and those
other natural phenomena or economic and social changes, as well as the extent to which
change interacts with other natural phenomena and with socio-economic activities. More
research on the potential changes in risks associated with climatic hazards such as drougl
floods, and hurricanes is needed. This will also lead to information on what adaptation n
might be adopted in the most cost-effective manner and on what time-scale. Country-spc
information on adaptation could be provided through national communications.

12. In addressing the **impact of the implementation of response measures**, efforts a
needed to address the uncertainties in the information available on changes in patterns of
capital flows, availability and accessibility of new technologies, response measures unde
by all Parties, and any influence of the Kyoto mechanisms. Modelling activities could he
identify and refine our understanding of the key underlying assumptions. Country-specif
information on the impact of existing policies and measures could be provided through n
communications. Some participants felt that sufficient information was available to take
actions, including actions related to funding, insurance and the transfer of technology. O
participants felt that significant uncertainties in baseline assumptions and model paramet
remained, so approaches to addressing the impact of the implementation of response mea
developing country Parties would need to take into account these uncertainties.

13. More information is needed on actions related to funding, insurance and the trans
technology to meet the needs and concerns arising from the adverse effects of climate ch
and/or the impact of the implementation of response measures.

D. Views on preliminary actions

14. It is recalled that the Convention has called upon the Parties to give full considera
actions under the Convention to meet the specific needs and concerns of developing coun
Parties arising from the adverse effects of climate change, and the impact of the impleme
of response measures. The Convention has singled out the least developed countries as a
vulnerable group, and has requested the Parties to take full account of the specific needs a
special situations of the least developed countries in their actions with regard to funding a
transfer of technology.

(a) Initial actions addressing the adverse effects of climate change on water resources, agriculture and food security, economic activities and health, as well as on coastal zones, should focus on:

(i) Further developing methods for sensitivity, vulnerability and adaptation assessment, including through research and studies identified in section C above, and the information could be integrated in national communications;

(ii) Capacity-building in environmental management and conducting integrated assessment on areas identified in section C above;

(iii) Disseminating examples of useful strategies to reduce vulnerability;

(iv) Monitoring and systematic observation of climate change impacts in developing countries in order to facilitate timely adaptation; and

(v) Identifying adaptation measures and facilitating timely adaptation where near-term climate change impacts are well understood, and adaptation measures are feasible;

(b) Initial actions to address the impact of the implementation of response measures should focus on additional model development and assessment, including through studies identified in section C above. The information should be developed with experts from both developing and developed countries, as this will improve the models and lead to capacity-building, and the information could be integrated in national communications.

15. Some participants suggested that the policies and measures reported by Annex I Parties and the projected actions to implement the Kyoto Protocol should be examined in order to analyse potential impacts on the economies of oil producing countries and other developing countries under Article 4.8 and 4.9 of the Convention. In this context, it was also suggested that the subsidiary bodies should continue to examine information needed to minimize the adverse social, environmental and economic impacts of response measures by Annex I Parties on developing country Parties. This information should cover the following:

(a) Tax restructuring to reflect the carbon content of fuels, including measures to discourage the production of fossil fuels and nuclear energy;

(b) Compensation;

(c) Assistance to developing countries, including increasing investment, to help them diversify their economies.

Other participants stated that the uncertainties associated with the impact of the imple
of response measures are such that consideration of specific actions is at best prematu
noted that actions related to the impact of the implementation of response measures u
Kyoto Protocol would be considered at the Conference of the Parties serving as the m
the Parties to the Kyoto Protocol at its first session (COP/MOP 1). These participants
pointed out that any consideration of information relating to the impact of the implem
response measures should include examination of ways in which developing countrie
their economies. It should also include, *inter alia*, consideration of the potential posi
of the implementation of response measures within the scope of the Convention and t
Protocol. The same participants recalled that compensation was not provided for und
Convention or the Kyoto Protocol.

16. Some participants stressed the need for the identification and analysis of initia
meet the specific needs and concerns of developing country Parties arising from the a
effects of climate change and the impact of the implementation of response measures,
information on the possibility of using insurance and other appropriate mechanisms.

17. Some participants felt that the eleventh sessions of the subsidiary bodies shoul
initial priority actions to implement Article 4.9 of the Convention. Such actions, with
funding and the transfer of technology, should take full account of the specific needs a
circumstances of the least developed countries. Other participants felt that it was nece
first explore initial actions to implement Article 4.8 of the Convention.

18. Some participants suggested that workshops to address these issues could be o
by the secretariat as one option for taking the work forward. Some participants pointe
there was no provision in the budget for 2000-2001 for such a workshop, and that in v
possibility of other workshops being organized, a consolidated approach to the organi
timing of workshops needed to be taken.

Annex

Agenda for the workshop envisaged in the annex (Programme of work) to decision 5/CP.4 : Implementation of Article 4, paragraphs 8 and 9, of the Convention(decision 3/CP.3 and Articles 2.3 and 3.14 of the Kyoto Protocol)

21-24 September 1999
Beethovenhalle, Bonn, Germany

Day 1: Tuesday, 21 September 1999

Afternoon session

* Introduction and general overview.
  Chow Kok Kee, Chairman of the SBSTA
  Michael Zammit Cutajar, UNFCCC Executive Secretary

* Methodologies related to the adverse effects of climate change.
  Osvaldo Canziani, Co-Chairman, IPCC Working Group II
  Thomas Downing, Programme Leader, Environmental Change Unit, University of Oxford

* Impact of climate change on countries with arid and semi-arid areas, forested areas, and areas liable to forest decay; and countries with areas liable to drought and desertification.
  Dieudonné Goudou, National Environment Council, Niger
  Bubu Jallow, Department of Water Resources, Gambia
  Discussant: Massimo Candelori, UNCCD secretariat.

* Impact of climate change on countries with areas prone to natural disasters.
  Peter Walker, International Federation of Red Cross and Red Crescent Societies
  Max Campos, Comité Regional Recursos Hidraulicos, Costa Rica
  Atiq Rahman, Centre for Advanced Studies, Bangladesh

Day 2: Wednesday, 22 September 1999

Morning session

* Impact of climate change on countries with areas of high urban atmospheric pollution.
  Alexander Alusa, UNEP
  Discussant: Andrew Githeko, Kenya Medical Research Institute

* Impact of climate change on countries with low-lying coastal areas.
  Roger McLean, School of Geography and Oceanography, University of New South Wales, Australia
  Discussant: Manuel Dengo, SIDS

* Impact of climate change on small island countries.
  Graham Sem, Pacific Islands Climate Change Assistance Programme, Samoa
  Brian Challenger, Ministry of Public Utilities, Antigua and Barbuda
  Discussant: Clifford Mahlung, Meteorological Services, Jamaica

Afternoon session

* Impact of climate change on countries with areas with fragile ecosystems, including mountainous ecosystems.
  Martin Price, University of Oxford, UK
  Andrew Githeko, Kenya Medical Research Institute
  Discussant: Andreas Fischlin, Institute for Terrestial Ecology, Switzerland

* Consideration of the specific needs and special situations of the least developed coun and land-locked and transit countries.
  Mustafa Babiker, MIT Joint Program on the Science and Policy of Global Char
  Discussant: Bubu Jallow, Department of Water Resources, Gambia

* **Panel discussion**
  Discussants:
  Kiyotaka Akasaka, Deputy Director-General, Ministry of Foreign Affairs, Japa
  Mohamed Ould-el-Ghaouth, Counsellor, Ministry of Foreign Affairs, Mauritan
  Bernarditas Müller, Department of Foreign Affairs, Philippines
  Ole Ploughman, Deputy Permanent Undersecretary of State, Denmark

* Methodologies related to impacts of response measures.
  Bert Metz, Co-Chairman, IPCC Working Group III
  John Weyant, Stanford University, USA

Day 3: Thursday, 23 September 1999

Morning session

* Minimizing adverse effects of the implementation of response measures on internatic trade, and social, environmental and economic impacts on developing country Partie identified in Article 4.8 and 4.9 of the Convention.
  Warwick McKibbin, Australian National University
  Houshang Shojania, National Iranian Oil Company

Discussants:
Prodipto Ghosh, Asian Development Bank
John Weyant, Stanford University, USA

* Minimizing adverse effects of the implementation of response measures on countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products.
  Davoud Ghasemzadeh, OPEC
  Jonathan Pershing, IEA
  Thomas Rutherford, University of Colorado, USA
  Discussants:
  Mustafa Babiker, MIT Joint Program on the Science and Policy of Global Change, USA
  Brian Flannery, Exxon Corporation
  Prodipto Ghosh, Asian Development Bank

Afternoon session

* ***(continuation of morning session)***

* **Panel discussion**
  Discussants:
  Evelyn Bravo, Ministry of Energy and Mines, Venezuela
  Jos Delbeke, European Commission, European Community
  Brian Fisher, Bureau of Agricultural and Resource Economics, Australia
  Mohammad al-Sabban, Ministry of Petroleum and Mineral Resources, Saudi Arabia

Day 4: Friday, 24 September 1999

* Conclusions.

Joint SUBSTA/SUBIM Meeting
12 June 2000
Jack Schick

Nigeria launched a vigorous assault on unified Annex I opposition to the Co-chairs' so-called consolidated text on 4.8/4.9/3.14 that quickly took over the opening formal meeting of this session. Mohammed Barkindo, as G 77 Chair, laid out the Group's criteria for success at COP 6 that it is more important "to get it right than to get it done." Getting it right for him means bluntly that the G 77's "interests must be satisfied." "We will not step aside for the Mechanisms, compliance, and sinks without concrete actions on 4.8/4.9/3.14" and said "it is important for everybody to understand that at the outset." He rejected enhanced roles for developing countries beyond the 1995 Berlin Mandate that excluded them from emissions commitments. Instead, the G 77 is looking for financing of technology transfers. At COP 6, he said, the G 77 will insist on a commitment to "specific funding amounts" on a long term basis. Moreover, all decisions must be in balance and integrated together (a decision on 4.8/4.9/3.14 must achieve the same status as the decision on Mechanisms, compliance, and sinks.).

Saudi Arabia endorsed Nigeria's statement. The Saudis were joined by nearly the entire Arab world that lined up to speak in support of Nigeria's effort. Many African countries joined the chorus of endorsements mainly by reciting the ravages of climate change that were already affecting them and for which they needed assistance. AOSIS joined the list of supporters. China and India made relatively pro-forma supporting statements but did not go beyond that—in India's case, a one sentence nod. Interestingly enough, Colombia, Peru, and Venezuela were the only Latin American countries to support Nigeria. Brazil, Malaysia, Thailand, and South Africa remained silent.

The Co-chairs of the 4.8 Contact Group tried to reassure Annex I countries that their text of last weekend was without prejudice to developed countries' views and acknowledged that Annex I did not favor separate decisions on 4.8/4.9 of the FCCC and on 3.14 of the Kyoto Protocol (double jeopardy for Annex I). Moreover, they indicated they would have another paper--a negotiating text—by the end of the week.

Australia led the counter-attack, insisting that only one decision be taken at this session, combining the consideration of 4.8/4.9 together with 3.14. The current text was not an appropriate basis for discussion for Australia that urged going back to the compilation document where Australia's views were initially stated. Portugual immediately joined Australia with a similar statement, noting in particular that COP 4 and COP 5 decisions kept the two provisions together. The US would not agree to modify the Buenos Aires Plan of Action that associated the two, arguing that the way forward was a further discussion of the issues and conceptual draft elements of a decision to be pursued after this session. Switzerland and Japan also joined the Umbrella Group-EU effort to turn back the Nigerian bid. Japan recited the technical support programs it has already extended to developing countries to deal with climate change in an effort to reassure the G 77 that it sympathized especially with the plight of the least developed countries but clearly joined the US and EU. Canada linked itself to the US and EU while also saying that it has new ODA funding available.

New Zealand chimed in but with a mild-mannered statement (it was the least enthusiastic of the Umbrella Group to take on the Saudies over the 4.8 issue).

Compliance got off with the Co-chair's status report and an announcement that his newest draft elements text would be available at 6 PM tonight—no extended discussion ensued as the Joint Meeting was running out of time. However, Chairman Chow of the Mechanisms Contact Group, while congratulated all round for his efforts, drew a complaint from India that Chow's 94-pager had left out some of the nature and scope material. India also wanted to know what Chow's terms of reference are for the Lyon session in September. Both the EU and Umbrella Group endorsed Chow's latest text (without going into further detail where there is unhappiness with many sections). Canada warned that the 94-pager was still too long and complex: "We need simple rules for our work to produce satisfactory results at COP 6." Australia, the US, and Rumania (for EITs), and Chile generally supported Chow's text. (Comment: Saudi Arabia spoke to the Chow text but did not shred it as some in the Umbrella Group had feared it would if the EU and Umbrella Group opposed the status of the 4.8 text)..

Points of Leverage with the Saudi/Nigerian/African/AOSIS Coalition

Multiple points of leverage potentially exist because the coalition comprises markedly disparate elements.

AOSIS

- The island states' interests lie in adaptation to the impacts of climate change, not in dealing with the impact of response measures on oil revenues. Indeed, AOSIS was among the first in 1994 to point out the inadequacy of developed countries' commitments in the Convention and to urge more stringent response measures.
- These states have seen OPEC recently inflict higher oil prices on their economies without any special relief for the islanders.
- They should be alarmed that the adaptation fund in the CDM is at risk if OPEC blocks implementation of the Kyoto Mechanisms, but their reactions on this point are unknown.
- AOSIS is positioned to welcome developed countries' bilateral assistance in building disaster management infrastructures, including USAID/NOAA's early storm warning programs.

Africa

- African countries, excluding Nigeria, have a concern about dealing with the impacts of climate change from extreme weather events, including flooding and drought, but no economic interest in the impact of response measures on oil revenues.
- They, too, have seen OPEC recently inflict higher oil prices on their economies without any effort by OPEC to ease the impact on them. African governments are caught in a squeeze between paying higher oil prices and subsidizing extremely low retail gasoline prices of 20-30 cents per gallon for their populations.
- They should be concerned that the adaptation fund is at risk if OPEC blocks implementation of the Mechanisms, but their reactions are unknown.
- POTUS' August visit to Nigeria offers an opportunity to take up the issue of Nigeria's obstruction in the climate negotiations directly with President Obasanjo, who has respected authority in Nigeria to make things happen. He is probably unaware of Nigerian tactics as spokesman for the G 77 in the climate talks.
- Even so, Obasanjo would need to be reassured that Nigeria's oil revenues are not at stake in the negotiations as long as the Kyoto Mechanisms are implemented and that it is in Nigeria's interest to allow the Mechanisms to go forward as a least cost approach to limiting emissions. Implementing the

Protocol with full use of the Mechanisms would reduce any potential loss of oil revenue as much as ten-fold, according to Patrick Dunn of EB.

- Promoting CDM in Nigeria, however, may be a tougher sell because Nigeria's investment climate is not as hospitable as Latin America's or even Eastern Europe's due to Africa's lack of infrastructure especially in communications.
- It is worth noting that there is probably little leverage in attempting to urge South Africa to act as a counter-weight to Nigeria because Mbeki and the ANC remember the help Nigeria gave to them in their struggle against apartheid. Moreover, Nigeria has respect in Africa as a military heavy-weight that has helped Liberia and Sierra Leone maintain order.

Brazil, China, India

- The biggest countries in the G 77 have given only formal deference to Nigeria as current Chair of the Group. Each of the three gave a two or three sentence public endorsement to Saudi-Nigerian efforts in Bonn at SUBSTA 12 without elaboration
- Brazil stated publicly at the Pew Conference last April that the climate talks are about carbon removals from the atmosphere, not about funds. Moreover, Brazil claims parenthood for the CDM and continues to seek implementation even though it opposes inclusion of credits for forest management.
- China has a keen interest in the CDM as a vehicle for attracting investments in a range of clean energy sources.
- Similarly, India's willingness to sign a clean energy agreement during POTUS' visit to India last March puts it on the side of implementing the CDM. In the climate negotiations to date, it has focused primarily on the modalities of the CDM.

The OPEC Secretariat's "analysis" of the impaet of response measures on oil revenues remains a point of leverage because it does not hold together. The latest graphics displayed by the Saudis at the Warsaw Ministerial and at the Chatham House conference in June indicate that the driving assumption is that developed countries will impose higher energy taxes to drive up oil prices as their main tool to cap emissions (as some EU governments have done). All else follows from that assumption—a rise in the price of OECD exports due to higher energy costs, a fall in oil prices because of lower OECD demand, and an inability of OPEC oil exporters to import OECD manufactured goods due to lower export earnings.

- However if one takes away the assumption that higher energy taxes are the only policy option and replaces it with emissions trading and forest management to meet emissions targets (as the Umbrella Group proposes and as Patrick Dunn has illustrated), the dire consequences for oil export revenues fail to materialize.

Another point of leverage is that Nigeria's claim about Article 4.5 of the Convention requiring direct and concrete technology transfers to developing countries misreads the

Dr Mohammad Al-Sabban

Advisor to the Minister of Petroleum and Mineral Resources, Saudi Arabia

Embargoed until
16.00
19 June 2000

THE KYOTO PROTOCOL
The End of the Beginning?
19 & 20 June 2000

The Royal Institute of International Affairs
Chatham House
10 St James's Square
London SW1Y 4LE
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6 # Impacts upon OPEC of Achieving Kyoto Protocol Targets

OWEM Results for 2010

	Reference case	Kyoto (+ reference price)	Kyoto (+ lower price)	*Differences from Reference Case* Kyoto (+ reference price)	Kyoto (+ lower price)
Real Basket Price $(98)/b	19.4	18.8	11.2	*-0.6*	*-8.2*
Annualised OPEC revenue $ bill.(98)	144.2	120.9	81.2	*-23.3*	*-63.0*
World Oil Demand (mb/d)	87.9	80.6	84.2	*-7.3*	*-3.7*
Non-OPEC Production (mb/d)	48.3	48.0	44.4	*-0.3*	*-3.9*
OPEC Production (mb/d)	39.6	32.7	39.8	*-6.9*	*0.2*

It has been argued that OPEC can avoid revenue losses by sustaining a higher oil price, but this is not feasible

- Even maintaining "reference case" prices implies production that is 7 mb/d below business-as-usual and is therefore also an unlikely outcome
- Revenue losses are likely to be huge, probably between $20 and $60 billion pa

OPEC Secretariat, 1999

The Effects

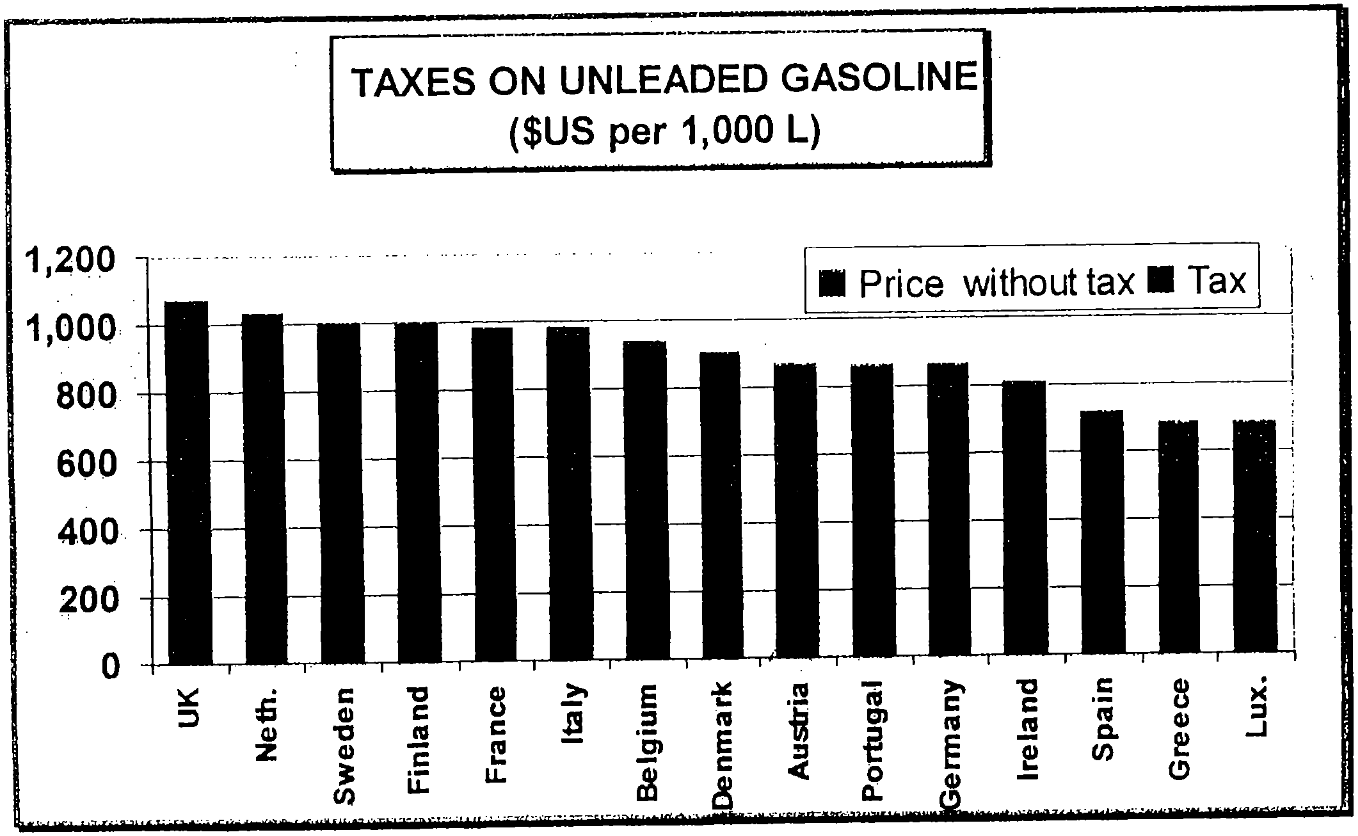
	GNP	T. of T.	Welfare
USA	- 1.18	+1.3	-0.64
EU	-3.68	+1.07	-1.45
India	+0.55	+1.12	+0.29
China	+0.06	-0.30	-0.01
RME	-3.12	-8.65	-3.81
MEX	-0.58	-1.98	-0.67
RSS	-0.92	-4.68	-1.00
ROW	+0.04	-0.37	-0.01

M. Babiker, J. Reilly & Jacopy "Mitigating the Effect of Response Measures on Developing Countries", MIT Joint Program on the science and Policy of Global Change, MIT, 1999

OECD Energy Taxes

Currently, OECD countries apply different rates of tax on fossil fuels. Petroleum transport fuels are heavily discriminated compared to other fuels.

Additional carbon/energy taxes could exacerbate this discrimination.



Fossil Fuel Consumption Taxes
(Percentage of End-Use Prices)

	EU	US	Japan
Gasoline	66% to 81%	30.6%	55.8%
Diesel	62% to 82%	42.3%	42.7%
HFO	0% to 31.2%	0.0%	4.8%
Coal	0%	0.0%	4.3%
Natural Gas	0%	0.0%	4.8%

* Finland is the exception with taxes of 48.6%

Petroleum Tax Revenues – 1998 estimate

	Consumption – 000 to 1998			Taxes - $ per tonne			Taxes $ million			
	Gasoline	Gasoil	HFO	Gasoline	Gasoil	HFO	Gasoline	Gasoil	HFO	TOTAL
Austria	2,129	5,438	1,544	824	523	40	$1,755	$2,841	$62	$4,658
Belgium	2,512	11,007	1,680	988	521	7	$2,482	$5,731	$11	$8,225
Denmark	2,031	3,972	610	932	575	307	$1,892	$2,282	$187	$4,362
Finland	1,857	4,144	1,377	1,092	552	53	$2,027	$2,288	$72	$4,385
France	14,577	43,313	4,288	1,119	635	20	$18,318	$27,507	$87	$43,910
Germany	30,352	61,907	4,938	918	525	17	$27,854	$32,504	$84	$60,443
Greece	847	6,225	2,558	649	399	45	$550	$2,486	$114	$3,150
Ireland	1,308	2,592	1,498	773	607	21	$1,010	$1,572	$31	$2,614
Italy	18,044	24,778	20,580	1,025	671	28	$18,490	$16,626	$533	$35,649
Lux.	545	1,090	6	623	423	7	$340	$461	$0	$800
Neth.	4,116	6,424	81	1,077	676	34	$4,432	$3,700	$3	$8,135
Portugal	2,016	3,963	3,431	888	473	14	$1,785	$1,874	$48	$3,708
Spain	9,234	21,496	5,413	688	448	15	$8,351	$9,830	$79	$16,061
Sweden	4,019	5,059	1,719	1,048	597	260	$4,212	$3,020	$447	$7,678
UK	21,884	23,149	3,304	1,223	1,101	37	$26,756	$25,497	$122	$52,375
EU Total	**115,469**	**224,553**	**52,994**				**$116,251**	**$138,018**	**$1,881**	**$256,151**

Coal Subsidies in 1997 US$ Million			
	Production	**Other**	**Total**
ermany	5,579	467	6,046
pain	798	413	1,211
rance	100	671	771
K	0	581	581
apan	528	0	528
TOTAL	**7,005**	**2,132**	**9,137**

Implicit Subsidy for Nuclear 1998		
	$ Million per year	**Consumption mtoes**
ıpan	$3,628	84
.S.A.	$7,903	183
'anada	$799	19
uropean Union	$9,428	218
Benelux	$505	12
Finland	$246	6
France	$4,319	100
Germany	$1,801	42
Spain	$656	15
Sweden	$786	18
UK	$1,114	26
Rest of World	$2,652	123
TOTAL	**$24,410**	**627**

Kyoto Protocol -Policies & Measures (Article 2.3)

"Each Party included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may [illegible], as appropriate, to promote the implementation of the provisions of this paragraph."

Kyoto Protocol – Targets & Time Frame

Each Party included in Annex I shall strive to

social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. In line with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what

of climate change and or the impact of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be

technology.

Kyoto Protocol -Policies & Measures

Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and apply market instruments;

REQUIARD ACTIONS

In order for Annex I countries to strive to minimize the adverse economic impact on developing countries, they should start with removing existing market distortions through:

- Restructuring of Annex I countries tax systems to reflect the GHGs content in all GHGs emitting sectors, and removal of subsidies.
- Discouraging the production of fossil fuels in Annex I countries.
- Discouraging the use of nuclear energy by reflecting its huge Externalities.
- Removing the existing barriers (political and regulatory) to the use of oil in the electricity sector.
- Encouraging a wider use of co2 sequestration technologies.

And they also should:

- Assist developing countries highly dependent on the Exportation of Fossil Fuels in diversifying their Economies.
- Provide Compensation to those proved impacted developing countries.

Minimising Impacts: Restructuring Energy Taxes According to Carbon Content

Calls for such a "greening" of taxes have been heard before (e.g. Norwegian Energy Minister)

OECD energy taxation has strong emphasis upon oil e.g. average tax on composite barrel in EU was $66/b in 1995, or 65% of retail price

Overt objective of raising revenue

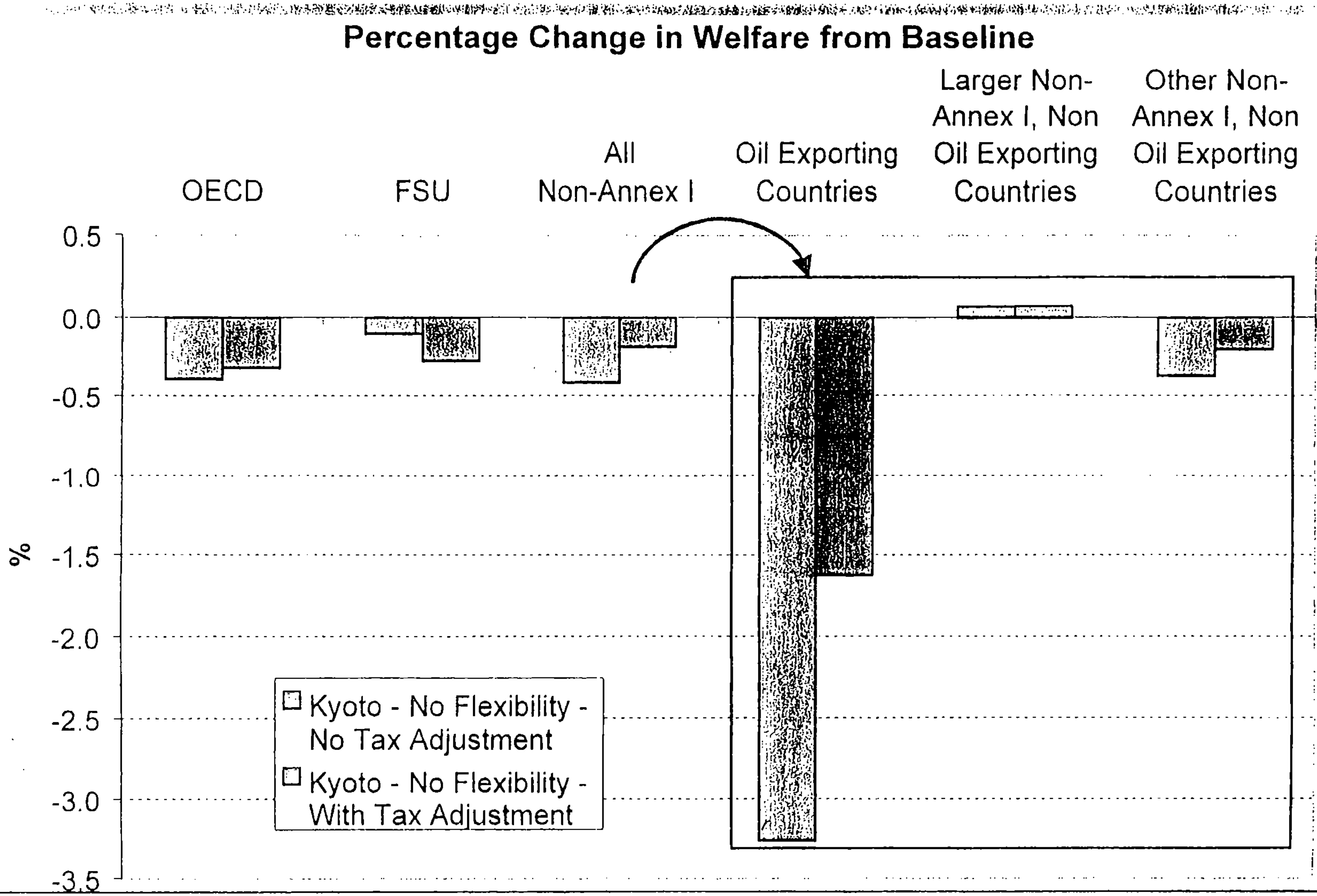
If OECD energy taxes are restructured according to carbon content, the most dramatic price increases would be for coal, with increases of between 108% and 270%

Key impact: lower coal use in electricity generation, falling by between 63% and 92% compared to reference case (replaced largely by gas)

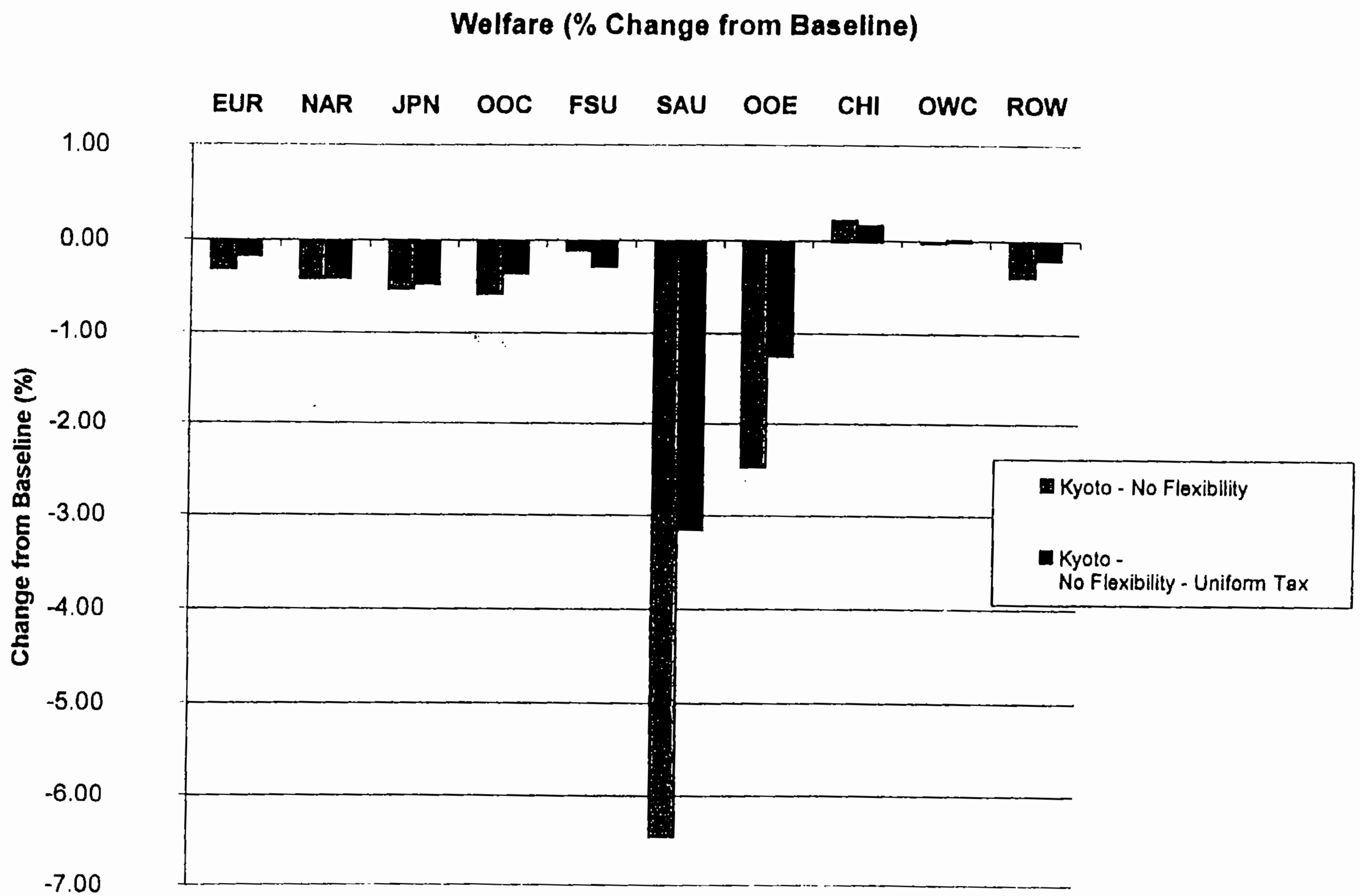
OECD CO_2 emissions reduced by at least 10%

OPEC Secretariat, 1999

Replacement of existing fuel taxes reduces disproportionate impacts on oil exporters



Lowering distorting fuel taxes and subsidies improves welfare for oil exporters and OECD



Lowering preexisting tax rates lowers burden on OECD and oil exporters

GDP under Kyoto with and without Tax Adjustments

	Baseline		Kyoto - No Flexibility - No Tax Adjustments		Kyoto - No Flexibility - with Tax Adjustments	
	2010 (Billions of US $s)	2030 (Billions of US $s)	2010 (%)	2030 (%)	2010 (%)	2030 (%)
EUR	11420	17218	-0.12	-1.21	0.65	-0.38
NAR	11827	17960	-1.01	-1.26	-1.03	-1.30
JPN	6777	10117	-0.67	-1.53	-0.26	-1.19
OOC	1203	1796	-0.65	-1.14	-0.01	-1.00
FSU	941	1809	0.46	0.01	0.43	-0.16
SAU	234	508	-7.14	-8.28	-3.16	-4.72
OEC	1247	2485	-3.25	-3.98	-1.38	-2.22
CHI	2268	6759	0.88	1.03	0.73	0.62
OWC	4922	11539	0.61	0.51	0.58	0.33
ROW	2329	5567	0.15	0.25	0.27	0.19

Replacement of existing fuel taxes and subsidies with uniform tax reduces adverse impacts

	Kyoto - No Flexibility- No Tax Adjustment	Kyoto - No Flexibility- With Tax Adjustment
Welfare Loss (Percentage)		
Europe	-0.3%	-0.2%
Saudi Arabia	-6.4%	-3.1%
Oil Exporting Countries	-3.3%	-1.6%
Compensation Required (Billions of 1995 U.S. Dollars)		
Saudi Arabia	$203.4	$99.4
Oil Exporting Countries	$503.8	$243.9

meetings that contributed an energy perspective to the climate change debate. Prior to that, he served three years as chef de cabinet for the Executive Director of the IEA.

Mr Solsbery has also been Deputy Land Commissioner of the State of Texas, where he managed policy, finance and legislation for the agency responsible for natural resources development and protection on 8 million hectares of onshore and offshore public lands. He represented the State of Texas in Washington, DC on natural resources and environment matters for four years, following service in the White House Office of Management and Budget. At OMB, he served as staff secretary to the White House Energy Coordinating Committee and conducted a series of projects for the federal government in the natural resources and energy field.

He has a Master's Degree in Public Policy from the Lyndon B Johnson School of Public Affairs at the University of Texas at Austin and a bachelor's degree in public policy analysis from Brown University in Providence, Rhode Island.

DR MOHAMMAD AL-SABBAN
Senior Economic Advisor to the Minister of Petroleum and Mineral Resources, Saudi Arabia

Mohammad Al-Sabban completed his undergraduate degree in economics in 1974 at King Abdulaziz University in Jeddah. He obtained his PhD in economics in 1983 from the University of Colorado and started his career as a professor of economics at King Abdulaziz University.

From 1984 to 1986 he was a part-time adviser to the Ministry of Industry and Electricity. In 1987 he was a part-time adviser to the Minister of Petroleum and Mineral Resources. This has been a full-time position since 1988.

Dr Al-Sabban has participated in many OPEC conferences and committees as a Saudi representative. He has participated in many IPCC meetings since 1990. He was the chief negotiator for Saudi Arabia to the UN Framework Convention on Climate Change. He headed the Saudi delegation to the AGBM process that led to the Kyoto Protocol. He has published many articles on energy and/or the environment. He is currently the head of the Saudi delegation to the COP meetings.

DR BENITO MÜLLER
Senior Research Fellow
Oxford Institute for Energy Studies

Dr Benito Müller jointed the Oxford Institute for Energy Studies in February 1996. He has a Dphil in philosophy from Oxford University, specializing in philosophy of science. He was formerly a research fellow at Wolfson College and a lecturer in logic at the Queen's College, Oxford. He has diploma in mathematics from the Eidgenössische Technische Hochschule (ETH) in Zürich, Switzerland.

His work in the field of climate change has focused on socio-economic and political issues, in particular issues of equity in allocating emission targets and in burden

In order for Annex (B) countries to strive to minimize the adverse economic impacts On developing countries, they should start with removing existing market distortions through: -

- **Restructuring of Annex (B)countries tax systems to reflect the GHG_s content in all GHG_s emitting sectors, and removal of subsidies.**

- **Discouraging the production of fossils in Annex B countries.**

- **Discouraging the use of nuclear energy by reflecting its huge Externalities.**

- **Removing the existing (political and regulatory) barriers to the use of more oil in ectricity sector.**

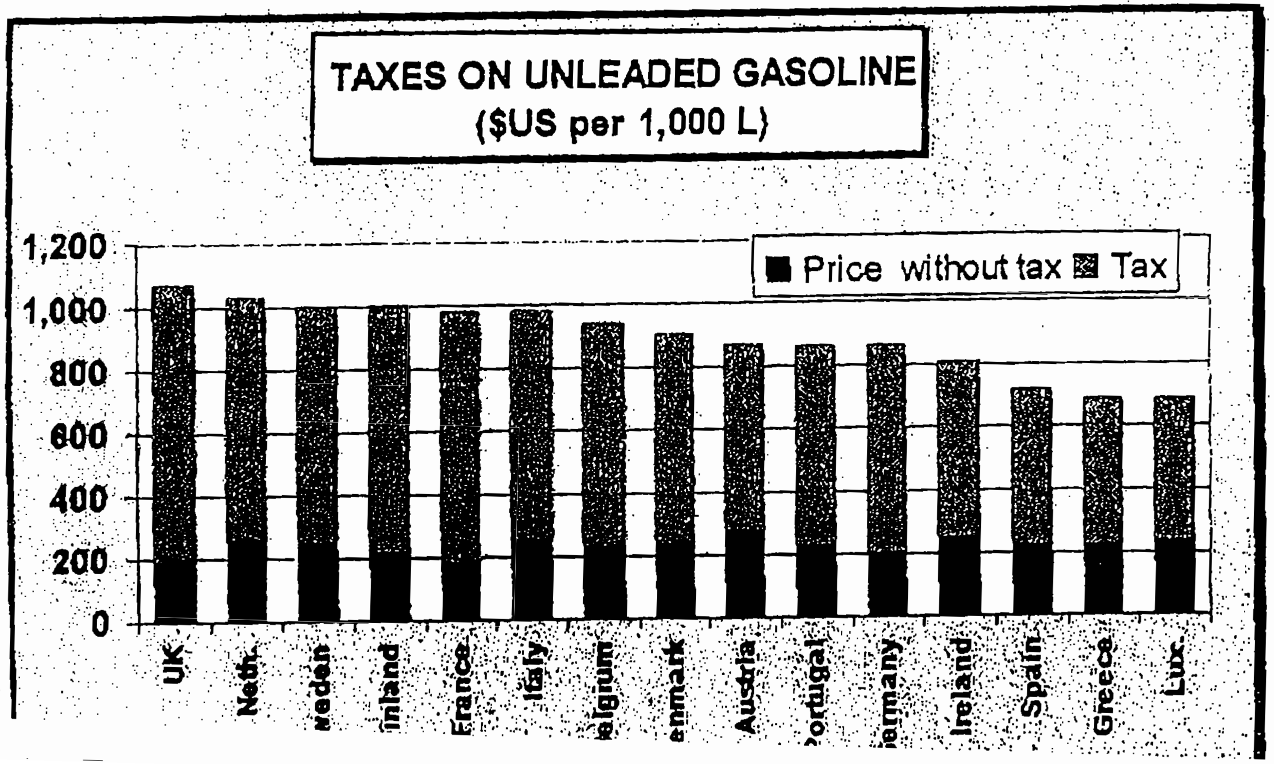
- **Encouraging a wider use of co_2 sequestration technologies.**

This List is not Complete, please refer to our Submition to SB12.

OECD Energy Taxes

Currently, OECD countries apply different rates of tax on fossil fuels. Petroleum transport fuels are heavily discriminated compared to other fuels.

Additional carbon/energy taxes could exacerbate this discrimination.



Fossil Fuel Consumption Taxes
(Percentage of End-Use Prices)

	EU	US	Japan
Gasoline	66% to 81%	30.6%	55.8%
Diesel	62% to 82%	42.3%	42.7%
HFO	0% to 31.2%	0.0%	4.8%
Coal	0%	0.0%	4.3%
Natural Gas	0%	0.0%	4.8%

* Finland is the exception with taxes of 48.6%

Coal Subsidies in 1997
US$ Million

	Production	**Other**	**Total**
Germany	5,579	467	6,046
Spain	798	413	1,211
France	100	671	771
UK	0	581	581
Japan	528	0	528
TOTAL	**7,005**	**2,132**	**9,137**

Implicit Subsidy for Nuclear 1998		
	$ Million per year	**Consumption mtoes**
Japan	$3,628	84
U.S.A.	$7,903	183
Canada	$799	19
European Union	$9,428	218
Benelux	$505	12
Finland	$246	6
France	$4,319	100
Germany	$1,801	42
Spain	$656	15
Sweden	$786	18
UK	$1,114	26
Rest of World	$2,652	123
TOTAL	**$24,410**	**627**

Lowering preexisting tax rates lowers burden on OECD and oil exporters

GDP under Kyoto with and without Tax Adjustments

	Baseline		Kyoto - No Flexibility - No Tax Adjustments		Kyoto - No Flexibility - with Tax Adjustments	
	2010 (Billions of US $s)	2030 (Billions of US $s)	2010 (%)	2030 (%)	2010 (%)	2030 (%)
EUR	11420	17218	-0.12	-1.21	0.65	-0.38
NAR	11827	17960	-1.01	-1.26	-1.03	-1.30
JPN	6777	10117	-0.67	-1.53	-0.26	-1.19
OOC	1203	1796	-0.65	-1.14	-0.01	-1.00
FSU	941	1809	0.46	0.01	0.43	-0.16
SAU	234	508	-7.14	-8.28	-3.16	-4.72
OEC	1247	2485	-3.25	-3.98	-1.38	-2.22
CHI	2268	6759	0.88	1.03	0.73	0.62
OWC	4922	11539	0.61	0.51	0.58	0.33
ROW	2329	5567	0.15	0.25	0.27	0.19

How Non-Annex I countries are affected

- Many non-Annex I countries will face adverse effects from actions taken by Annex I countries to limit their emissions
- Impacts on terms of trade create spillover effects
- Imports from Annex I countries will rise in price due to higher energy costs
- Exports of energy-intensive goods from non-Annex I countries will rise in price
- Energy exports will fall in price because of less demand
- Exports of less-energy intensive goods to Annex I countries will fall in price because of a drop in demand for all imports by Annex I countries

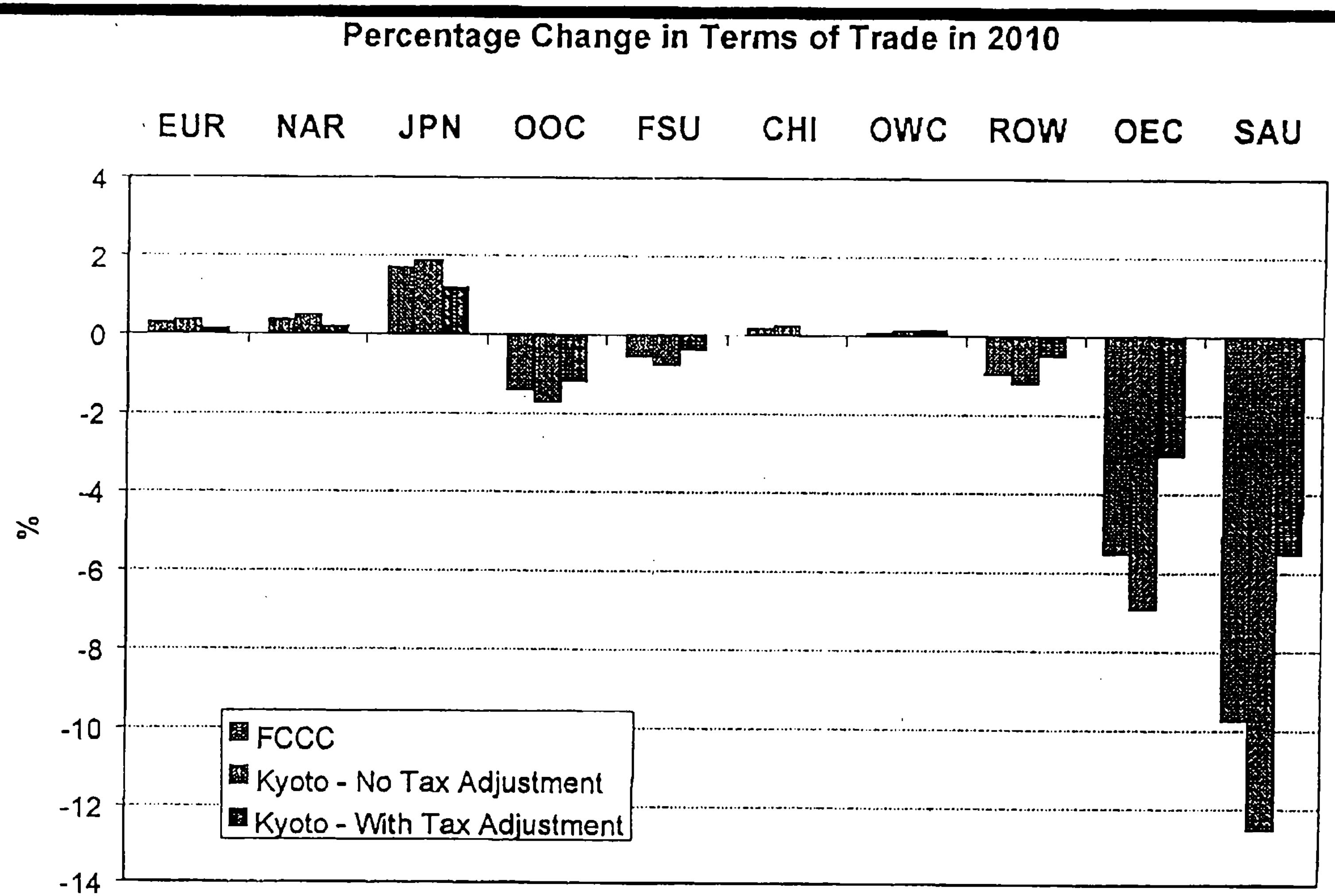
How oil exporting countries are affected

- Oil demand from Annex I countries will fall due to limits on carbon emissions and effectively a higher tax on oil use
- Export earnings of oil-exporting non-Annex I countries will fall
  - World oil prices will fall due to lower demand
  - Oil production and exports will be reduced in response to lower prices
- Other trade spillovers will also harm oil-exporting non-Annex I countries
  - General reduction in levels of economic activity reduces demand for other exports
  - Higher costs for imports from Annex I countries
- Oil exporting countries, such as Saudi Arabia, that are more heavily dependent on oil export revenues will be harmed the most

Trade Impacts of Annex I actions on economies of oil-exporting countries

- Terms of Trade
  - Oil exporting non-Annex I countries experience erosion in terms of trade as prices received for exports fall and prices paid for most imports rise
- Exports and Imports
  - Oil exports fall and to some extent oil exporting countries shift toward exporting other goods
  - Imports of manufactured and other goods must fall because of loss of export earnings
- Capital flows
  - Oil exporters must draw down foreign assets to pay for imports when oil prices fall

Terms of trade move against oil exporters as oil prices fall and import prices rise



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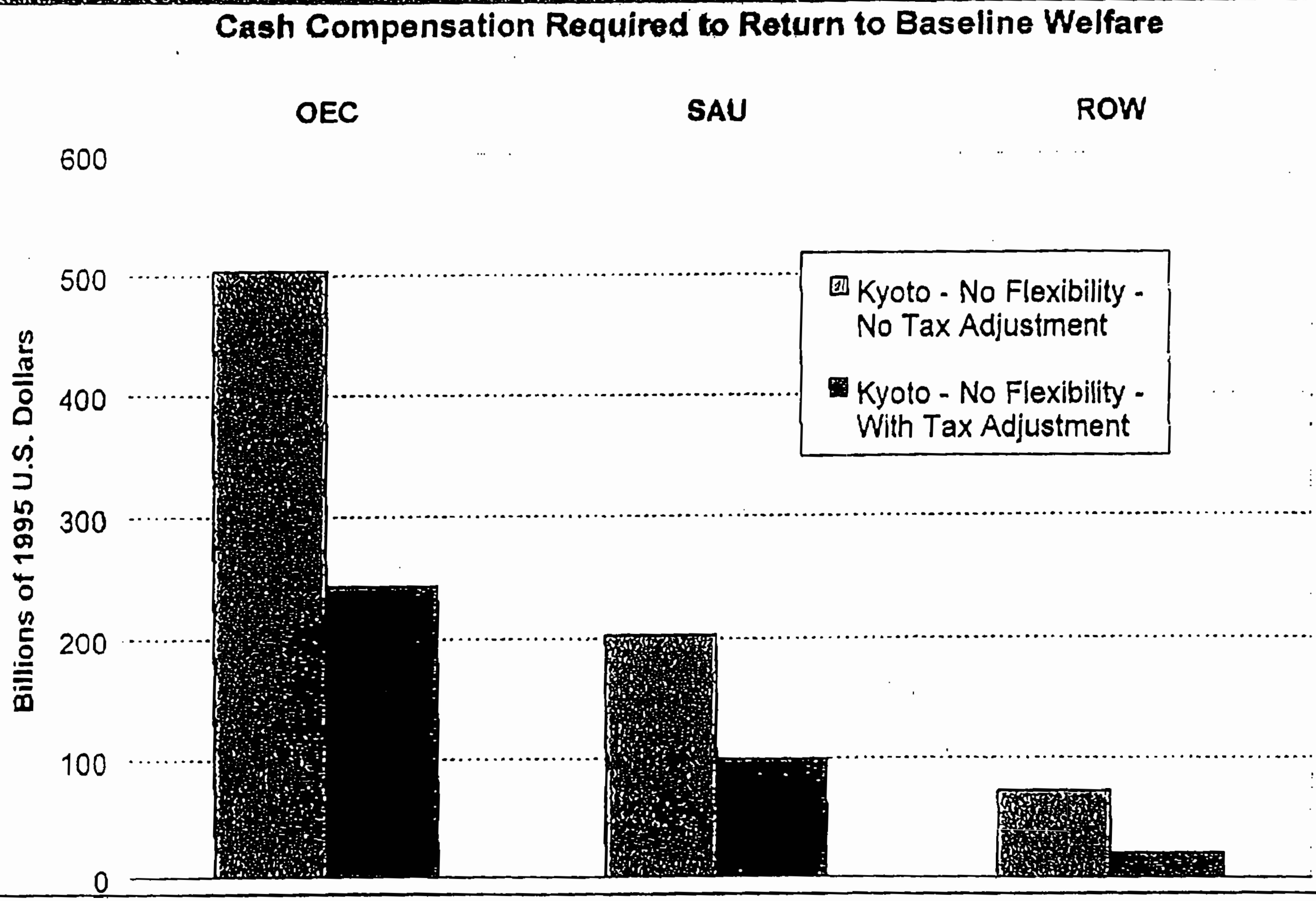
Required compensation is also reduced when pre-existing fuel taxes are removed



COP-5 4.8/4.9 decision

PRELIMINARY, UNEDITED VERSION

2. *Decides* that the process referred to in paragraph 1 above shall address information-gathering on initial actions needed to address the specific needs and concerns of developing country Parties referred to in Article 4.8 of the Convention and the specific needs and special situations of the least developed countries referred to in Article 4.9 of the Convention, arising from the adverse effects of climate change and/or the impact of the implementation of response measures;

3. *Decides* that the process shall also identify what actions are necessary under the Convention, including actions relating to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties referred to in Article 4.8 of the Convention, and the specific needs and special situations of the least developed countries;

4. *Requests* the subsidiary bodies to continue their consideration of the implementation of Article 4.8 and 4.9 at their twelfth and thirteenth sessions, and in particular of the following examples of initial actions, giving special attention to the situations of the least developed countries in accordance with Article 4.9, and reaffirming, in particular, the need for support for capacity-building and technical assistance:

(a) Information on the adverse effects of climate change, based on country-specific data, drawn from the national communications of non-Annex I Parties and other sources;

(b) Information on the impact of the implementation of response measures, drawn from the national communications of non-Annex I Parties and other sources;

(c) Information on policies and measures undertaken to respond to climate change, drawn from the national communications of Annex I countries;

(d) Consideration of the importance and extent of efforts to diversify the national economies of developing countries referred to in Article 4.8 and 4.9 of the Convention, and of how the international community could best support such efforts;

(e) Consideration of how adaptation measures can be integrated into national strategies for sustainable development and could help to form a basis for action in multilateral and bilateral development programmes;

and encourages Parties to respond positively where adaptation measures are identified by developing country Parties as priorities;

5. *Decides* to organize a workshop, under the guidance of the Chairmen of the subsidiary bodies, on the consideration of initial actions, including actions related to funding, insurance and the transfer of technology, needed to meet the specific needs and concerns of developing country Parties, and the specific needs and special situations of the least developed

countries, arising from the adverse effects of climate change on, *inter alia,* water resources, agriculture and food security, economic activities, coastal zones and health. The workshop shall consider, among other issues, the following:

(a) Enhancing capacity for monitoring, systematic observation and vulnerability assessment in developing countries;

(b) Capacity-building in environmental management and integrated assessment;

(c) Identifying adaptation options and facilitating adaptation where near-term climate change impacts are understood and adaptation measures are feasible;

6. *Decides* to organize a workshop, under the guidance of the Chairmen of the subsidiary bodies, on methodological approaches and what actions are necessary under the Convention relating to the impact of the implementation of response measures on, *inter alia,* terms of trade, international capital flows and developmental efforts, in accordance with Article 4.8 and 4.9 of the Convention and in the light of matters related to Article 3.14 of the Kyoto Protocol. The workshop shall consider, among other issues, the following:

(a) The nature and content of information needed;

(b) The sources of information;

(c) Procedures and modalities for the provision of information;

(d) What actions are necessary, including those relating to funding, insurance and the transfer of technology;

7. Decides that the workshops referred to in paragraphs 5 and 6 above shall be organized in two consecutive but equal time periods, before the end of March 2000, and requests the Chairmen of the subsidiary bodies to present a report in two parts thereon to the subsidiary bodies at their twelfth sessions;

8. *Invites* the subsidiary bodies to consider the report in two parts, referred to in paragraph 7 above, at their twelfth and thirteenth sessions and to make recommendations to the Conference of the Parties at its sixth session;

9. *Decides* to consider further, at its sixth session, matters related to Article 3.14 of the Kyoto Protocol, as an input to the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, taking into account the ongoing discussions in the Conference of the Parties on the implementation of Article 4.8 and 4.9 of the Convention.

9th plenary meeting
4 November 1999

UNITED NATIONS
NATIONS UNIES

→ Jeff Miotke
(202) (647 0191)

FRAMEWORK CONVENTION ON CLIMATE CHANGE - Secretariat
CONVENTION - CADRE SUR LES CHANGEMENTS CLIMATIQUES - Secrétariat

Executive Secretary
Secrétaire exécutif

Date: 21 December 1999
Ref: MZC/YN/mts
Direct line: 815-1100

INVITATION

Workshop on Article 4.8 and 4.9 of the Convention: Adverse effects of climate change
(Initial actions relating to the adverse effects of Climate Change
in accordance with Article 4.8 and 4.9 of the Convention)
9-11 March 2000

and

Workshop on Article 4.8 and 4.9 of the Convention: Impact of the implementation of response measures
(Methodological approaches and what actions are necessary under the Convention, relating to the impact of the implementation of response measures, in accordance with Article 4.8 and 4.9 of the Convention and in the light of matters related to Article 3.14 of the Kyoto Protocol)
13-15 March 2000

in

Internationales Kongresszentrum Bundeshaus Bonn, Görresstr. 15, 53113 Bonn, Germany

Dear Madam/Sir,

On behalf of the secretariat of the United Nations Framework Convention on Climate Change, I am pleased to extend an invitation to you to nominate an expert to participate in the two workshops mandated by decision 12/CP.5, which the UNFCCC secretariat is convening under the guidance of the Chairman of the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Bodies for Implementation (SBI).

The workshops will be held at the Internationales Kongresszentrum Bundeshaus Bonn (Former German Parliament), Görresstr. 15, 53113 Bonn, Germany from 9-11 March and from 13-15 March 1999.

.../.

The proposed agendas of the workshops are enclosed. The outcome of the workshops will be a report in two parts, which will serve as input to the twelfth and thirteenth sessions of the SBSTA and the SBI.

Included with this invitation are two registration forms and the provisional agendas of the workshops. We would appreciate receiving the forms by fax (+49 228 815 1999), by **31 January 1999**.

Please note that where applicable, and in order to facilitate travel, the secretariat strongly advises early contact with the appropriate consular authorities to allow sufficient time for the necessary visa and where required, transit visas, to be issued before departure. A copy of this notification should be attached to the visa request in order to facilitate issuance.

Should you require further information or wish to discuss matters relating to the workshops, please contact either Mukul Sanwal (Tel: +49 228 815 1429, email: msanwal@unfccc.de), or Youssef Nassef (Tel: +49 228 815 1416, email: ynassef@unfccc.de) at the UNFCCC secretariat.

We look forward to hearing from you.

Yours sincerely,

Michael Zammit Cutajar

Workshop on Article 4.8 and 4.9 of the Convention: Adverse effects of climate change
(Initial actions relating to the adverse effects of Climate Change
in accordance with Article 4.8 and 4.9 of the Convention)

9-11 March 2000
Internationales Kongresszentrum Bundeshaus Bonn (former Parliament building),
Bonn, Germany

Day 1: Thursday, 9 March 2000

09.00 - 10.30
Registration

Morning session

10.30 - 11.00
* Introduction and opening of the workshop

11.00 - 11.20
* Coffee break

11:20 - 12:30
* Overview

12.30 - 14.00
* Lunch break

Afternoon session

14.00 - 15.30
* Food security

15.30 - 17.00
* Water resources

17.00 - 17.20
* Tea break

17.20 - 18.50
* Economic activities

Day 2: Friday, 10 March 2000

Morning session

09.10 - 10.40
* Coastal zones

10.40 - 11.00
* Coffee break

11.00 - 12.30
* Human health

12.30 - 14.00
* Lunch break

Afternoon session

14.00 - 17.00
* Least developed countries

17.00 - 17.20
* Tea break

17.20 - 19.10
* Actions related to funding, insurance and the transfer of technology.

Day 3: Saturday, 11 March 2000

Morning session

09.00 - 10.10
* Actions. *(Cont.)*

10.10 - 10.30
* Coffee break

10.30 - 12.30

- **Panel discussion**
  Discussants;
  Bangladesh
  Jamaica
  Japan
  Netherlands
  Uganda
  UK

12.30 - 14.00

- Lunch break

Afternoon session

14.00 - 15.00

- **Panel discussion** *(cont.)*

15.00 -

- Conclusions.

Workshop on Article 4.8 and 4.9 of the Convention: Impact of the implementation of response measures
(Methodological approaches and what actions are necessary under the Convention, relating to the impact of the implementation of response measures, in accordance with Article 4.8 and 4.9 of the Convention and in the light of matters related to Article 3.14 of the Kyoto Protocol)

13 - 15 March 2000
Internationales Kongresszentrum Bundeshaus Bonn (former Parliament building), Bonn, Germany

Day 1: Monday, 13 March 2000

09.00 - 10.30
Registration

Morning session

10.30 - 11.00
* Introduction and opening of the workshop

11.00 - 11.20
* Coffee break

11.20 - 12.30
* Overview

12.30 - 14.00
* Lunch break

Afternoon Session

14.00 - 16.00
* Terms of Trade

16.00 - 16.20
* Tea break

16.20 - 18.20
* International Capital Flows

Day 2: Tuesday, 14 March 2000

Morning session

09.00 - 11.00
* Developmental efforts

11.00 - 11.20
* Coffee Break

11.20 - 12.30
* Least Developed Countries

12.30 - 14.00
* Lunch break

Afternoon Session

14.00 - 15.50
* Least developed countries (cont)

15.50 - 17.20
* Consideration of what actions are necessary, including those relating to funding, insurance and the transfer of technology.

17.20 - 17.40
* Tea break

17.40 - 19.10
* Consideration of what actions are necessary. (*Cont.)*

Day 3: Wednesday, 15 March 2000

Morning session

09.30 - 12.30
* **Panel discussion**
  Discussants:
    Australia
    Canada
    European Community
    Nigeria
    Saudi Arabia
    Venezuela

12.30 - 14.00
* Lunch break

Afternoon Session

14.00 - 17.00
* Conclusions.

3 January 2000

Secretariat Qs

2. Workshop related to the implementation of response measures

How can impacts on consumers of fossil fuels be assessed?

How can impacts on sectors other than fossil fuels be assessed – e.g. financial markets, agriculture?

How can assessments include non-oil fossil fuels?

How can the benefits for developing countries of the implementation of response measures be assessed?

Given doubts about models described at the last workshop, what other methods are available to assess impacts?

In looking at models and other assessment methods, how can the problem of defining baselines be tackled?

How can any impacts of implementation of response measures be disaggregated from other factors affecting fossil fuel markets?

What are the distinctions between Convention issues and Protocol issues under this heading, and how can actual evidence be identified in the case of Convention-related issues?

How to address the gathering of information on the impact of the implementation of response measures, drawn from the national communications of non-Annex I Parties and other sources?

What are the ways in which affected countries can adapt their economies?

How should we address the importance and extent of efforts to diversify national economies?

OFFICIAL USE ONLY

Decision 5/CP.4

Implementation of Article 4.8 and 4.9 of the Convention (decision 3/CP.3 and Articles 2.3 and 3.14 of the Kyoto Protocol)

The Conference of the Parties,

Recalling its decision 3/CP.3 on implementation of Article 4, paragraphs 8 and 9, of the United Nations Framework Convention on Climate Change,

Recalling also the provisions of Article 4.8 and 4.9 of the Convention,

Noting the provisions of Article 2.3 and Article 3.14 of the Kyoto Protocol to the Convention,

Recognizing that, in the implementation of the commitments in Article 4 of the Convention, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures,

Noting the provision under Article 12.8 of the Kyoto Protocol,

Recognizing the concern for sustainable development of the countries referred to in Article 4.8 and 4.9 of the Convention,

Welcoming the relevant work of the Intergovernmental Panel on Climate Change (IPCC), in particular its First and Second Assessment Reports, its recent Special Report on the Regional Impacts of Climate Change and its forthcoming Third Assessment Report, which will *inter alia* address issues relevant to Article 4.8 and 4.9 of the Convention,

Noting, however, that considerable uncertainties still persist with regard to the assessment of the adverse effects of climate change, particularly at the regional, sub-regional and national levels, and that in this context information gaps need to be filled, using in particular information contained in national communications from Parties included in Annex I to the Convention (Annex I Parties) and Parties not included in Annex I to the Convention (non-Annex I Parties),

Noting also that there is not enough information available on the adverse effects of climate change and the impact of the implementation of response measures, and that in this context also information gaps need to be filled, using in particular information contained in national communications from Annex I Parties and non-Annex I Parties,

1. *Decides* that the basic elements for further analysis should include the following:

(a) Identification of the adverse effects of climate change;

(b) Identification of the impacts of the implementation of response measures under the Convention;

(c) Identification of the specific needs and concerns of developing country Parties arising from such adverse effects and impacts defined through *inter alia* the national communications from non-Annex I Parties;

(d) Identification and consideration of actions, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns referred to in subparagraph (c) above;

2. *Requests* the Subsidiary Body for Scientific and Technological Advice (SBSTA) to initiate a process of compilation and analysis of available information, which is needed to elaborate any actions necessary to implement Article 4.8 and 4.9 of the Convention;

3. *Further requests* the SBSTA to take into account information needs arising from the basic elements mentioned in paragraph 1 above, as well as the programme of work set out in the annex to this decision, in revising the guidelines for the preparation of national communications by Annex I Parties and non-Annex I Parties;

4. *Requests* the Subsidiary Body for Implementation (SBI) and the SBSTA to continue consideration of the implementation of Article 4.8 and 4.9 of the Convention at their tenth and eleventh sessions and to report thereon to the Conference of the Parties at its fifth session;

5. *Invites* the IPCC to provide, in its Third Assessment Report, a further scientific and technical assessment on matters related to Article 4.8 and 4.9 of the Convention;

6. *Decides* to adopt and implement the programme of work set out in the annex to this decision.

8th plenary meeting
14 November 1998

Annex
PROGRAMME OF WORK

ITEM	ACTION	OBJECTIVE	RESPONSIBILITY	DEADLINE
1	Submission of views on the issues to be discussed in the expert workshop	Identify factors that will help determine the adverse effects of climate change and/or the impact of implementation of response measures, the information available, existing information gaps and further information needed as well as views on methodologies, taking into account *inter alia* submissions already made to the COP and the subsidiary bodies on the implementation of Article 4.8 and 4.9 of the Convention	All Parties	End of April 1999
2	Consideration of the secretariat's compilation of national submissions	Define the expert workshop terms of reference	SBI 10, SBSTA 10	June 1999
3	Organization of the expert workshop, including budgetary issues	Produce input for SBSTA 11 and SBI 11	Chairman of SBSTA, with the assistance of the secretariat	September 1999
4	Further discussion on the implementation of Article 4.8 and 4.9 of the Convention considering the outcome of the workshop	Prepare report including conclusions and/or draft decision for COP 5	SBI 11, SBSTA 11	October/ November 1999
5	Identification of initial actions to address the implementation of Article 4.8 and 4.9 of the Convention, as well as Articles 2.3 and 3.14 of the Kyoto Protocol	Identify initial actions, including initial input for COP/MOP 1, in accordance with Articles 2.3 and 3.14 of the Kyoto Protocol	COP 5	October/ November 1999
6	Identification of any additional actions needed to address the implementation of Article 4.8 and 4.9 of the Convention, as well as Articles 2.3 and 3.14 of the Kyoto Protocol	Take a decision on any further actions	COP 6	November/ December 2000

Decision 12/CP.5

Implementation of Article 4, paragraphs 8 and 9, of the Convention and matters relating to Article 3, paragraph 14, of the Kyoto Protocol

The Conference of the Parties,

Recalling its decision 5/CP.4 entitled Implementation of Article 4.8 and 4.9 of the Convention (decision 3/CP.3 and Articles 2.3 and 3.14 of the Kyoto Protocol),

Recalling also its decision 8/CP.4 on preparations for the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol,

Recognizing the specific needs and concerns of developing country Parties referred to in Article 4.8 of the Convention, and the specific needs and special situations of the least developed countries referred to in Article 4.9,

Recognizing also the concern for sustainable development of the countries referred to in Article 4.8 and 4.9 of the Convention,

Taking note of the report of the expert workshop referred to in the programme of work contained in the annex to decision 5/CP.4, which was held in Bonn from 21 to 24 September 1999,[1]

Recognizing that the identification of initial actions necessary to address the adverse effects of climate change and/or the impact of the implementation of response measures needs to be based on sufficient information and analysis within a clearly-defined process,

Acknowledging the efforts already made by Parties towards meeting the specific needs and concerns of developing country Parties, in particular the least developed countries, with regard to adaptation,

Having considered the report of the above-mentioned workshop regarding the specific needs and concerns of developing country Parties, and the specific needs and special situations of the least developed countries where widespread poverty limits adaptive capacity, particularly in relation to the impacts of the adverse effects of climate change on socio-economic conditions, including, *inter alia*, water resources, agriculture and food security, economic activities, coastal

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[1] See FCCC/SB/1999/9.

zones and health, and the impact of the implementation of response measures on, *inter alia,* terms of trade, international capital flows and developmental efforts,

1. *Decides* to continue the process of implementation of Article 4.8 and 4.9 of the Convention, as established by decisions 3/CP.3 and 5/CP.4, and to assess the process at its sixth session and, as appropriate, at subsequent sessions;

2. *Decides* that the process referred to in paragraph 1 above shall address information-gathering on initial actions needed to address the specific needs and concerns of developing country Parties referred to in Article 4.8 of the Convention, and the specific needs and special situations of the least developed countries referred to in Article 4.9 of the Convention, arising from the adverse effects of climate change and/or the impact of the implementation of response measures;

3. *Decides* that the process shall also identify what actions are necessary under the Convention, including actions relating to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties referred to in Article 4.8 of the Convention and the specific needs and special situations of the least developed countries;

4. *Requests* the subsidiary bodies, at their twelfth and thirteenth sessions, giving special attention to the situations of the least developed countries in accordance with Article 4.9 of the Convention, and reaffirming, in particular, the need for support for capacity-building and technical assistance, to continue their consideration of the implementation of Article 4.8 and 4.9 of the Convention, and in particular of the examples of initial actions listed in subparagraphs (a) to (e) below, and encourages Parties to respond positively where adaptation measures are identified by developing country Parties as priorities:

(a) Information on the adverse effects of climate change, based on country-specific data, drawn from the national communications of Parties not included in Annex I to the Convention and other sources;

(b) Information on the impact of the implementation of response measures, drawn from the national communications of Parties not included in Annex I to the Convention and other sources;

(c) Information on policies and measures undertaken to respond to climate change, drawn from the national communications of Parties included in Annex I to the Convention;

(d) Consideration of the importance and extent of efforts to diversify the national economies of developing countries referred to in Article 4.8 and 4.9 of the Convention, and of how the international community could best support such efforts;

(e) Consideration of how adaptation measures can be integrated into national strategies for sustainable development and could help to form a basis for action in multilateral and bilateral development programmes;

5. *Decides* that a workshop be organized, under the guidance of the Chairmen of the subsidiary bodies, on the consideration of initial actions, including actions related to funding, insurance and the transfer of technology, needed to meet the specific needs and concerns of developing country Parties, and the specific needs and special situations of the least developed countries, arising from the adverse effects of climate change on, *inter alia,* water resources, agriculture and food security, economic activities, coastal zones and health. The workshop shall consider, among other issues, the following:

(a) Enhancing capacity for monitoring, systematic observation and vulnerability assessment in developing countries;

(b) Capacity-building in environmental management and integrated assessment;

(c) Identifying adaptation options and facilitating adaptation where near-term climate change impacts are understood and adaptation measures are feasible;

6. *Decides* that a workshop be organized, under the guidance of the Chairmen of the subsidiary bodies, on methodological approaches and what actions are necessary under the Convention relating to the impact of the implementation of response measures on, *inter alia,* terms of trade, international capital flows and developmental efforts, in accordance with Article 4.8 and 4.9 of the Convention and in the light of matters related to Article 3.14 of the Kyoto Protocol. The workshop shall consider, among other issues, the following:

(a) The nature and content of information needed;

(b) The sources of information;

(c) Procedures and modalities for the provision of information;

(d) What actions are necessary, including those relating to funding, insurance and the transfer of technology;

7. *Decides* that the workshops referred to in paragraphs 5 and 6 above shall be organized in two consecutive, equal time periods before the end of March 2000, and requests the Chairmen of the subsidiary bodies to present a report in two parts thereon to the subsidiary bodies at their twelfth sessions;

8. *Invites* the subsidiary bodies, at their twelfth and thirteenth sessions, to consider the report in two parts referred to in paragraph 7 above, and to make recommendations to the Conference of the Parties at its sixth session;

9. *Decides* to consider further, at its sixth session, matters related to Article 3.14 of the Kyoto Protocol, as an input to the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, taking into account its ongoing discussions on the implementation of Article 4.8 and 4.9 of the Convention.

9th plenary meeting
4 November 1999

WORKSHOP ON ARTICLE 4.8 AND 4.9 OF THE CONVENTION: IMPACT OF THE IMPLEMENTATION OF RESPONSE MEASURES (METHODOLOGICAL APPROACHES AND WHAT ACTIONS ARE NECESSARY UNDER THE CONVENTION, RELATING TO THE IMPACT OF THE IMPLEMENTATION OF RESPONSE MEASURES, IN ACCORDANCE WITH ARTICLE 4.8 AND 4.9 OF THE CONVENTION AND IN THE LIGHT OF MATTERS RELATED TO ARTICLE 3.14 OF THE KYOTO PROTOCOL)

COMPILATION OF PRELIMINARY VIEWS OF PARTIES ON QUESTIONS TO BE ADDRESSED BY PRESENTERS

How can impacts on consumers of fossil fuels be assessed?

How can impacts on sectors other than fossil fuels be assessed – e.g. financial markets, agriculture?

How can assessments include non-oil fossil fuels?

How can the benefits for developing countries of the implementation of response measures be assessed?

Given doubts about models described at the last workshop, what other methods are available to assess impacts?

In looking at models and other assessment methods, how can the problem of defining baselines be tackled?

How to address the gathering of information on the impact of the implementation of response measures, drawn from the national communications of non-Annex I Parties and other sources?

What is the nature and content of information needed for the establishment of criteria triggering the necessary actions related to:

Compensation
Funding
Insurance and
Transfer of technology

to address the specific needs and concerns of pertinent/affected Parties?

What is the nature and content of information needed for evaluating the impacts on:

Terms of trade
International capital flows and
Developmental efforts

resulting from the implementation of response measures?

What is the nature and content of information needed to take **precautionary** actions to address the special needs and concerns of the parties that could be impacted?

What are the data sources that could be utilized as inputs to processes for identifying the impacts on terms of trade, international capital flows, developmental efforts, and actions for funding, insurance, the transfer of technology, and on precautionary measures?

How can any impacts of implementation of response measures be disaggregated from other factors affecting fossil fuel markets?

What are the distinctions between Convention issues and Protocol issues under this heading, and how can actual evidence be identified in the case of Convention-related issues?

What are the ways in which affected countries can adapt their economies?

How should we address the importance and extent of efforts to diversify national economies?

What are the procedures (*e.g.*, When? How? Prioritization, ...) and modalities for:
Compensation
Funding
Insurance and
Transfer of technology
to assist impacted parties?

What actions other than funding, insurance, and the transfer of technology can be considered under Article 4.8 of the Convention?

What are the ways to minimize the impacts of response measures? Do they include, but are not limited to, the removal of any exsisting market distortions in Annex-1 Parties? And if so, what actions should be taken to eliminate such distortions including, but not limited to, the removal of subsidies and tax restructuring?

Given the fact that Article 4.8 addresses actions required under the Convention to meet the specific needs and concerns of developing country parties, is there a need to assess the benefits - or positive impacts - of the implementation of response measures? And if so, are they relevant to the implementation of the Articles 4.8, 4.9, 2.3, 3.14?

What types of measures are needed to maintain continuous sustainable development in the most impacted countries?

What policies and studies are needed to further develop the "full consideration" principle referred to in Article 4.8 of the Convention?

What *precautionary* measures other than 'insurance" could be used to meet the specific needs and concerns of potentially impacted Parties?

Methodological Approaches and Necessary Actions under the Convention, Relating to the Impacts of Response Measures, in Accordance with Article 4.8 & 4.9 of the Convention and in Light of Matters Related to Article 3.14 of the Kyoto Protocol

Presented to the Workshop on Impacts of the Implementation of Response Measures March 13–15, 2000

Professor Thomas F. Rutherford
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SUMMARY

Actions by Annex I countries to reduce greenhouse gas emissions will have adverse impacts on a number of non-Annex I countries, with disproportionate impacts affecting countries that are highly dependent on revenues from oil exports. Based on analysis using the MS-MRT model, it would require a lump-sum payment of $300 to $600 billion US dollars to offset the economic damage to non-Annex I countries in the period 2000–2030.

Damages to non-Annex I countries could be significantly reduced if Annex I countries eliminated existing fuel taxes and subsidies and replaced them with carbon taxes sufficient to meet their obligations under the Kyoto Protocol. All spillover effects on developing countries would be reduced, and impacts on oil-exporting non-Annex I countries would be cut in half. Since existing taxes are so heavily weighted to penalize the use of a single fuel, and do not provide a consistent incentive to reduce carbon emissions across the board, Annex I countries could also gain by replacing existing taxes and subsidies with carbon taxes high enough to meet their obligations under the Kyoto Protocol in some regions. Such carbon taxes would also be sufficient to replace the net revenue from the existing tax and subsidy system.

The Framework Convention addresses adverse impacts of actions on non-Annex I countries taken by Annex I countries. Article 3.2 of the Convention refers to disproportionate impacts or abnormal burdens on specific groups of countries, and clearly oil-exporting non-Annex I countries would suffer disproportionate impacts. Articles 4.8 and 4.9 of the Framework Convention refer to actions related to Funding, Insurance, and the Transfer of Technology resulting from adverse effects on non-Annex I parties of actions taken by Annex I parties in the implementation of their commitments to reduce their emissions. Countries whose economies are dependent on exports of fossil fuels are mentioned explicitly.

EXPLANATION OF FINDINGS

Trade is a significant factor affecting the economic interactions of Annex I and non-Annex I countries. Many non-Annex I countries will face adverse effects from actions taken by Annex

I countries to limit their emissions. These adverse impacts are transmitted by changes in the terms of trade between Annex I and non-Annex I countries, and by changes in the volumes of imports and exports.

There are four important changes in the terms of trade that account for these spillover effects:

- Imports from Annex I countries will rise in price due to higher energy costs.

- Energy exports will fall in price because of decreasing demand.

- Exports of less-energy intensive goods to Annex I countries will fall in price because of a drop in demand for all imports by Annex I countries.

- Exports of energy-intensive goods from all countries will rise in price.

These changes in terms of trade lead to wealth transfers among countries, the largest of which are from oil-exporting non-Annex I countries to all others. Annex I countries benefit from the lower price of oil on world markets, and also receive higher prices for their exports to non-Annex I countries. On balance, terms of trade effects are:

- Beneficial for larger, oil-importing non-Annex I countries with infrastructure to expand production of energy-intensive goods for exports or domestic consumption;

- Very harmful for non-Annex I oil exporters;

- Mostly harmful for poorer non-Annex I countries, whose lower oil import costs are offset by higher prices of imports from Annex I and wealthier non-Annex I countries and lower prices for exports; and

- Ambiguous for Annex I countries, who benefit from lower prices for oil imports and higher prices for exports to non-Annex I countries, but suffer from higher prices for energy-intensive imports.

Oil-exporting countries are disproportionately affected by actions of Annex I countries to limit their carbon emissions. The mechanism by which these impacts occur is as follows:

- Oil demand from Annex I countries will fall due to limits on carbon emissions and (effectively) a higher tax on oil use.

- World oil prices will fall due to lower demand.

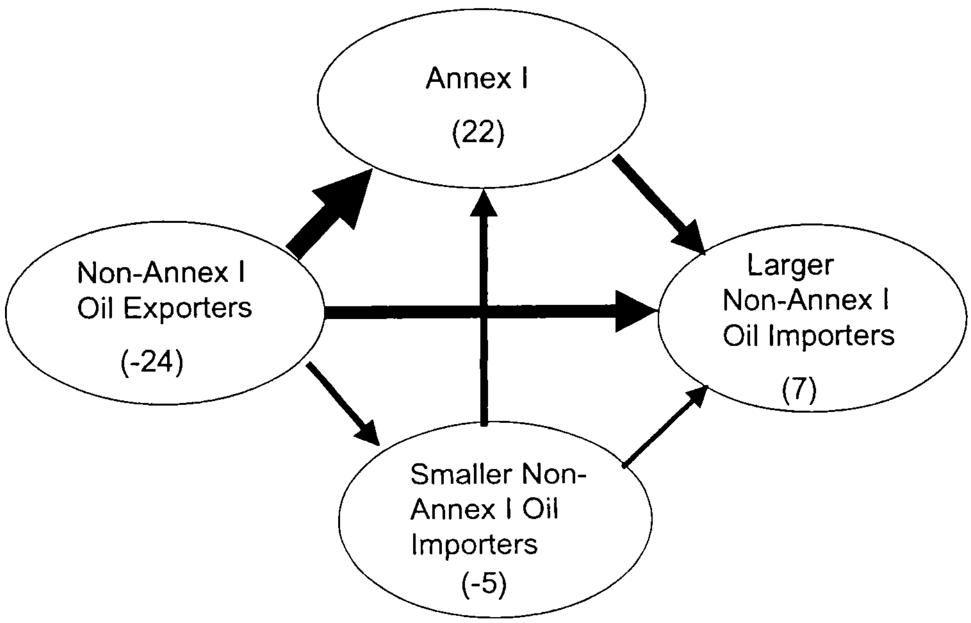
- Oil production and exports will be reduced in response to lower prices.

- Export earnings of oil-exporting non-Annex I countries will fall due to lower export volumes and prices.

Other trade spillovers will also harm oil-exporting non-Annex I countries. A general reduction in levels of economic activity in Annex I countries, compared to baseline levels, will reduce demand for other exports. Oil-exporting countries will also face higher costs for imports from Annex I countries, especially energy-intensive imports. Specialized oil-exporting countries, such as Saudi Arabia, that are more heavily dependent on oil export revenues will be harmed the most.

The figure below illustrates how wealth is transferred among regions through changes in oil prices.

Figure 1: Wealth Transfers



Note: Wealth transfer in billions of dollars under the Kyoto-No Flexibility scenario for 2010

The MS-MRT model was used to analyze impacts on non-Annex I countries. MS-MRT is a dynamic computable general equilibrium model of international trade. It includes several groups of non-Annex I countries, including oil-importing countries and oil-exporting countries. Saudi Arabia is highlighted as an example of a specialized oil-producing country. The regional breakdown of MS-MRT is as follows:

EUR	European Union
NAR	North America (Canada and United States)
JPN	Japan
OOC	Other OECD
FSU	Eastern Europe and Former Soviet Union
OEC	Oil-Exporting Non-Annex I Countries
CHI	China and India
OLC	Other Large Non-Annex I Countries (per capita GDP > \$3,300)
ROW	Rest of World (per capita GDP < \$3,300)

In order to deal with spillover effects in trade for non-energy-intensive goods, the industry breakdown in MS-MRT includes two non-energy industries: manufacturing and all other industries, and five energy sectors: crude oil, oil refining, natural gas, coal, and electricity.

For this study, an improved representation of world oil markets has been included in MS-MRT. For the first time, we assume that oil-exporting non-Annex I countries limit output and produce oil at a constant marginal cost of oil production equal to \$7.50/barrel in the Oil-Exporting Countries (OEC) region.

The approximate oil supply elasticity equals 0.1 outside OEC. OEC countries are assumed to limit crude oil production and refined product exports through quotas.

Estimates of adverse impacts and required compensation are based on results from four scenarios:

1. Business as usual
   Oil production and economic growth forecasts match those of the U.S. Energy Information Administration IEO 1998. No carbon emissions limits are imposed by any country.

2. FCCC Scenario
   Annex I countries are assumed to have started in 1995 to reduce emissions to 1990 levels by 2000 and apply these targets from 2000 onward.

3. Kyoto Protocol with no flexibility mechanisms
   Each Annex I country is assumed to reduce its carbon emissions to meet its Kyoto target through domestic action.

4. Kyoto Protocol with existing energy taxes and subsidies replaced by carbon taxes large enough to collect equal net revenues
   No flexibility mechanisms are adopted. Each region meets its Kyoto obligation with an internal carbon tax, cuts industry fuel oil taxes in half, and reduces gasoline taxes to U.S. levels. All coal subsidies are removed.

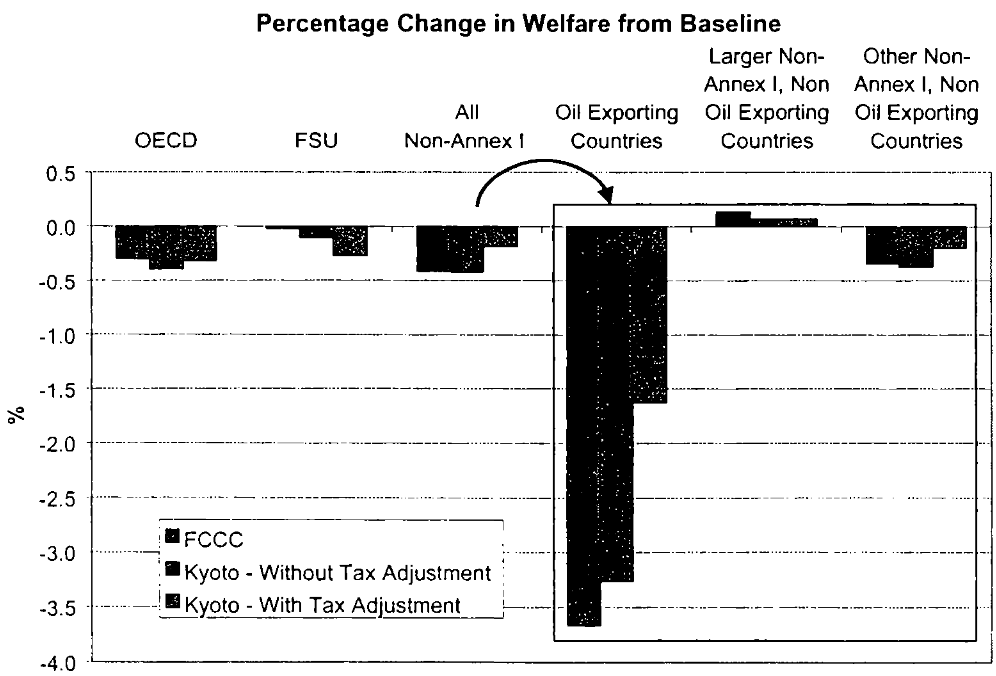
World oil demand and world oil prices fall relative to baseline levels in all the scenarios with limits on carbon emissions, as shown in Table 1.

Table 1: World Oil Market Impacts

	World Oil Consumption (% Change from Baseline)		World Oil Price (% Change from Baseline)	
	2010	2030	2010	2030
FCCC	-3	-4	-11	-13
Kyoto - No Tax Adjustment	-4	-5	-15	-16
Kyoto - With Tax Adjustment	-2	-3	-7	-9

Macro-economic impacts of Annex I actions on other economies are summarized in a net present value estimate of the change in economic welfare. MS-MRT reports a theoretically correct measure of the lump-sum cash payment required to restore the standard of living, which is used as the estimate of the change in welfare. Non-Annex I countries as a group are adversely affected by Annex I country actions to limit carbon emissions. Less well-off non-Annex I countries suffer adverse impacts, as well as oil-exporting countries, as seen in Figure 2.

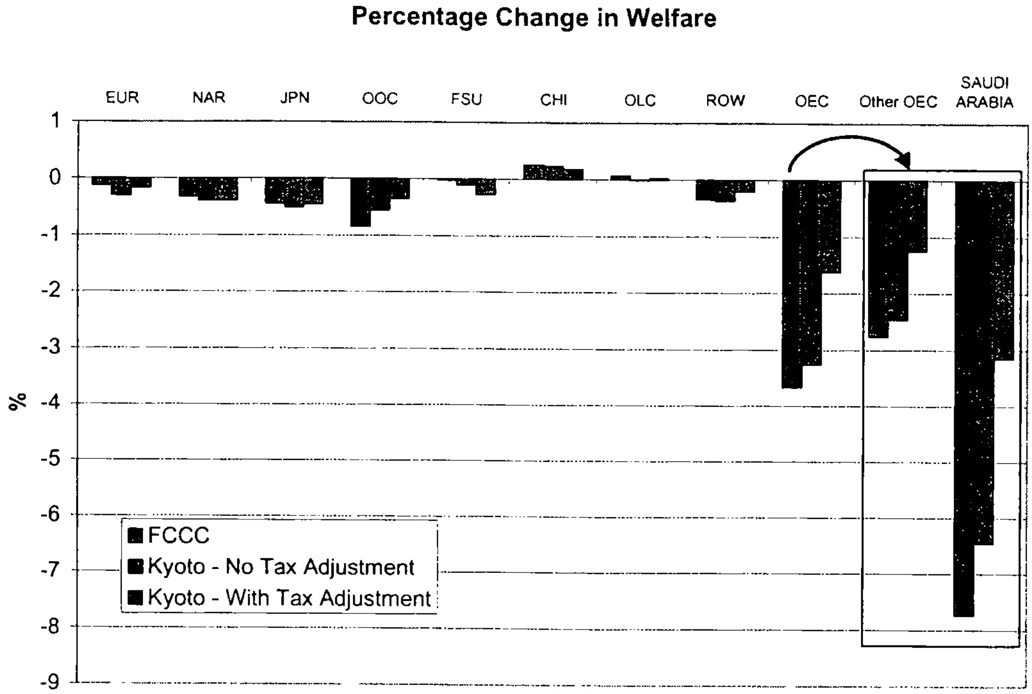
Figure 2: Non-Annex I Countries Suffer Adverse Impacts



China, India, and other wealthier non-Annex I countries can gain from being able to take advantage of lower world oil prices and sell energy-intensive goods at higher prices to Annex I countries.

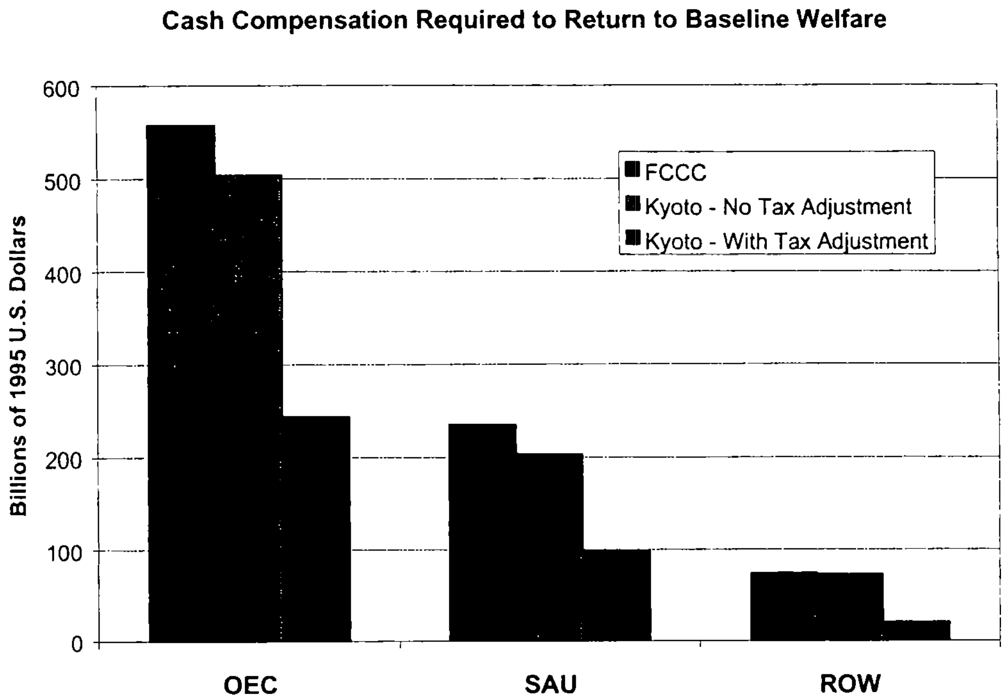
Specialized oil exporters experience even larger welfare losses, as seen in Figure 3. In general, oil-exporting countries bear larger costs than any Annex I countries, a result strongly suggesting "disproportionate" impacts are suffered by oil-exporting non-Annex I countries.

Figure 3: Oil-Exporting Non-Annex I Countries Suffer Disproportionate Impacts



Cash compensation is calculated as the lump-sum payment required to restore welfare loss from Annex I actions. Almost all of the compensation payments are to oil-exporting non-Annex I countries, with a significant payment to the less wealthy countries as well. Estimates of cash compensation in net present value covering damages in the period 2000–2030 are presented in Figure 4.

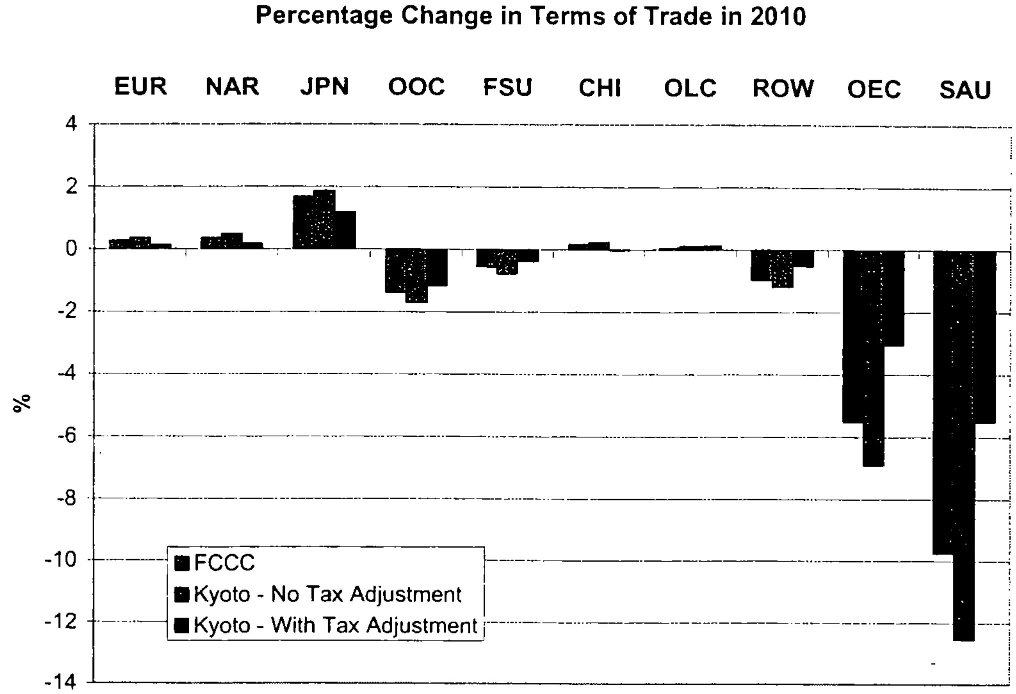
Figure 4: Net Present Value of Compensation Ranges from $300 to $600 Billion



Estimates of welfare impacts and cash compensations are sensitive to key assumptions. For example, varying the oil supply elasticity outside OEC from 0.1 to 0.5 provides a range of estimates of welfare loss from –3.3% to –2.4% and cash compensation from 500 billions of US dollars to 370 billions of dollars. However, major conclusions hold in either case: 1) some non-Annex I countries suffer disproportionate impacts; 2) significant compensation would be required to offset these impacts; and 3) a harmonized carbon tax replacing existing fuel taxes still provides significant benefits to all parties.

Terms of trade changes produce these spillover effects. Terms of trade move against oil exporters and other poorer non-Annex I countries as oil price fall and import prices rise. Oil-exporting non-Annex I countries experience erosion in terms of trade as prices received for exports fall and prices paid for most imports rise. Other poorer non-Annex I countries must pay more to Annex I countries for imports and earn less for their exports of goods and services. Terms of trade remain almost unchanged for OLC. China and India experience a small improvement in their terms of trade.

Figure 5: Terms of Trade Move Against Most Non-Annex I Countries



A great deal of attention has been paid to the question of whether it is possible to provide development assistance rather than compensation to offset adverse impacts. The viability of such assistance is unclear and definitely depends on what type of country is being considered. It is much less likely that specialized oil exporters can benefit from the types of traditional development assistance when compared to diversified oil exporters.

Faced with a loss of oil revenues, diversified oil exporters might be able to shift to greater production of non-energy goods. Their reduced imports could be replaced by domestic production of manufactured goods. Capital inflows and increased investment would be required to finance this transition.

The loss of oil revenues is much more difficult to replace for specialized oil exporters. In countries like Saudi Arabia, production and exports of goods other than oil are very small, so that the domestic industrial base for producing non-energy goods is lacking. There will be capital flight between 2000 and 2010, as investors realize that once policies to limit carbon emissions are implemented, oil production will be much less profitable. Without a domestic industrial base, consumption can be sustained only through imports and, in turn, imports can be sustained only by depleting net foreign assets. As a result, in the longer term, consumption must be reduced because imports cannot be replaced.

Additional studies are needed to establish requirements for a successfully transition for oil exporting countries from oil production to a different industrial base, to determine which kinds of industries could be viable in different countries, and to determine the cost of creating competitive global industries in all oil-exporting countries.

CONCLUSIONS

- Annex I country policies towards greenhouse gas emissions reduction should consider impacts of response measures on non-Annex I countries.

- Measures taken by Annex I countries will have a disproportionate economic impact on non-Annex I countries.

- Oil-producing as well as poorer non-Annex I countries are the most negatively affected by the implementation of the Convention.

- The Buenos Aires Plan of Action requires full consideration in COP-6 of Articles 4.8 and 4.9 of the Framework Convention in light of matters related to Article 3.14 of the Kyoto Protocol.

- Harmonization of carbon taxes in Annex I countries will result in reduced burdens on both non-Annex I and Annex I countries.

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The Kyoto Protocol and developing countries

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Abstract

Under the Kyoto Protocol, the world's wealthier countries assumed binding commitments to reduce greenhouse gas emissions. The agreement requires these countries to consider ways to minimize adverse effects on developing countries of these actions, transmitted through trade. Using a general equilibrium model of the world economy, we find that adverse effects fall mainly on energy-exporting countries, for some even greater than on countries that are assuming commitments. Removing existing fuel taxes and subsidies and using international permit trading would greatly reduce the adverse impacts and also reduce economic impacts on the countries taking on commitments. Another approach, preferential tariff reduction for developing countries, would benefit many developing countries, but would not target those most adversely affected. If instead, OECD countries directly compensated developing countries for losses, the required annual financial transfer would be on the order of $25 billion (1995 $US) in 2010.

Keywords: Climate change; Trade; Developing countries

1. The obligations of Annex B nations

Economic trade links among countries will transmit ; of greenhouse gas control measures adopted by ct of nations, in a ripple effect, to countries that may not have agreed to share the burdens of control. For example, emission restrictions under the Kyoto Protocol will increase the cost to Annex B regions of using carbon-emitting fuels, thereby raising manufacturing costs of their energy-intensive goods, some of which may be exported to developing countries. The restrictions also will lower global demand for carbon-emitting fuels, reducing their international prices. In addition, emission controls may depress economic activity in countries subject to emission restrictions, lowering these countries' demand for imports, some of which come from developing countries. In combination, these changes in trade volumes and prices can have complex consequences, harming some developing countries while benefiting others.

Beginning with the Framework Convention on Climate Change (United Nations, 1992), the Parties have agreed that implementation of any agreement should give special attention to the concerns of vulnerable economies. Article 4.8 of the Convention states:

> In the implementation of commitments… the Parties shall give full consideration to what actions are necessary… to meet the specific needs and concerns of developing country parties arising from adverse effects of climate change and/or the implementation of response measures….

Among a list of nine specific points of focus for this concern is the following:

(h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products.

Article 4.9 of the Convention calls for special attention to the least developed countries "with regard to funding and transfer of technology."

The Kyoto Protocol restates this obligation, using somewhat stronger language (United Nations, 1997). Its Article 2.3 holds that:

> The Parties in Annex I shall strive to implement policies and measures… in such a way as to minimize adverse effects, including… effects on international trade, and social, environmental and economic

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impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9 of the Convention, which consist mainly of energy exporting and small island countries.[1]

Article 3.14 goes on to call for early consideration by the Parties of "what actions are necessary to minimize the adverse effects," and expands the list of mechanisms to be considered to include "the establishment of funding, insurance and transfer of technology."

Building on an earlier analysis of these issues (Babiker and Jacoby, 1999), we here explore mechanisms by which implementation of Annex B commitments in the Kyoto Protocol may affect developing economies, and how these effects might be mediated. While we focus on possible adverse effects, we note positive effects, as well. Moreover, our analysis is designed to highlight effects on those countries that seem to be the special concern of the Convention's Article 4.8(h) above, i.e., those in the Non-Annex B group that are heavily dependent on exports of energy.

We do not consider all possible instruments that might be applied to mitigate these effects. For example, the mention of "insurance" in article 3.14 of the Protocol is a reference to means of alleviating the impacts of climate change itself; it is thus outside the scope of our analysis, which includes only the economic effects of proposed emission restrictions. In addition, the possible uses of technology transfers are not well defined and not easily subjected to economic analysis, so we do not consider them here. We do, however, consider two sets of actions that Annex B countries could take to limit negative impacts on Non-Annex B countries. The first is a set of policy measures, not specific to any particular disadvantaged country, that could accompany implementation of Annex B controls:

- revision of fuel taxation policies,
- removal of coal subsidies,
- trading of emission permits.

The second set of policy measures includes actions that Annex B countries might consider to meet the needs of particular developing countries. These actions include:

- special tariff concessions,
- direct financial compensation.

We explore these two sets of possible responses to the stated Annex B obligations in the context of the specific Kyoto emissions targets and timetable, i.e., a reduction in Annex B country emissions below 1990 levels (a reduction that averages around 5% for the 2008–12 commitment period (United Nations, 1997)). For the task, we apply a general equilibrium model of the world economy: briefly described in Section 2 of this paper.

In Section 3, we consider the distribution of burdens resulting from the Kyoto Protocol, and the mechanisms that could lead to such a distribution, taking the year 2010 as representative of the first commitment period. We assume in the first case that none of the possible measures listed above is adopted. For this case, our results are similar to those of previous analyses (Babiker and Jacoby, 1999; Babiker *et al.*, 1997; Montgomery *et al.*, 1998). We find that, in the absence of corrective measures, the welfare loss attributable to Kyoto for some Non-Annex B countries could exceed that for countries ~~accepting~~ emission restrictions. A key contributing factor is a shift in the terms of trade (i.e., the ratio of a country's export prices to its import prices, suitably weighted). As noted earlier, cost penalties on carbon emissions will increase the costs of energy-intensive goods (if manufactured in a country under restriction), even if the international prices of carbon-intensive fossil fuels fall. In this circumstance, for example, an oil-exporting Non-Annex B country will suffer economic losses because it (1) will have less revenue from oil exports and (2) will face higher prices for imports of energy-intensive goods from Annex B regions. Other Non-Annex B countries with a different mix of imports and exports may be better off under the same set of Annex B restrictions. The vulnerability of nations to this phenomenon is roughly related to the "weight" of fossil energy exports in their economies.

For our reference case, we establish a policy scenario that presumes no special effort is expended to mitigate developing-country effects of the Kyoto Protocol. In Section 4, we consider the extent to which these economic impacts might be mitigated using one or more of the first set of instruments mentioned above. We find that the latter "accompanying policies" could significantly reduce, though not completely offset, the adverse influence of Kyoto implementation on the most seriously affected developing countries.

Section 5 considers specific actions that may be invoked to compensate Non-Annex B countries that are adversely affected by response measures adopted by Annex B nations, beyond the mitigation options offered by emissions-reducing policies' implementation mechanisms. We first consider preferential tariff reductions granted to Non-Annex B countries, and find that beneficiaries of such a measure do not closely match those countries that suffer adverse consequences from Annex B carbon restrictions. Next, we estimate the direct level of financial transfers that would be needed to compensate adversely affected developing countries. We set up a mechanism for compensation within our model so that general equilibrium effects are considered in establishing the magnitude of transfer needed.

[1] The list of parties to the Convention in Annex I differs only slightly from the Annex B grouping developed in the Kyoto Protocol and used in this analysis. The composition of Annex B is shown in Table 1.

Section 6 draws conclusions from these sample calculations about (1) the nature and magnitude of spill- ·s from Annex B policies onto Non-Annex B econo- ·nd (2) the feasibility of the various policy measures might be considered to reduce adverse spillover effects.

Before we turn to the analysis methods and results, a cautionary note is in order. Our purposes in conducting these numerical exercises are to explore the mechanisms by which policies adopted by Annex B countries might influence Non-Annex B economies, and to develop a rough impression of how various attempts to limit these effects might work. The absolute magnitudes of these effects are, of course, subject to considerable uncertainty (Webster, 1997; Webster and Sokolov, 1998). For example, the cost of attaining any fixed emissions target is highly sensitive to growth rates in the forecast period. Experiences in Russia, the United States, Japan, and several Asian developing countries over the last decade indicate that one can expect large errors in growth forecasts over a period as short as a decade. Few foresaw the collapse of the Soviet Union or the economic problems that beset Asian economies in the 1990s. Nearly all forecasters have underestimated economic growth in the United States over the 1990s. By the same token, the precise effects of changes in tax and tariff regimes, or of real-world emissions permit-trading schemes are influenced by many details of implementation and market adjustment, and so are uncertain in themselves, as well. Still, it is worth pointing out that the *mechanisms* of burden transfer would remain the same (though the magnitude of effect might change) across the wide ·e of possible estimates of growth, ease of economic ·tment, and performance of any corrective measures ·en.

A further caveat regarding our results is the fact that they are computed assuming no economic, environmental, or political shocks other than those attributable to the Kyoto Protocol. In reality, other shocks are inevitable, and the magnitudes of policy effects studied here are such that, although it may be possible to identify and roughly quantify them ex ante, their influence would not likely be separable from general economic variability ex post. Finally, our economic model is based on the most highly disaggregated data set of its type, yet we are still only able to identify regional groupings of countries such as the Middle East or North Africa. These regions contain diverse countries in which the magnitude of impacts from Annex B actions will certainly vary (e.g., Egypt vs. Libya in North Africa); we cannot be sure even that the direction of impact would be the same for all countries in a region. If direct financial transfers to compensate for adverse consequences of Kyoto implementation were to be considered as a practical matter, these difficult problems would have to be dealt with.

2. The analysis method

For analysis of these burden-reducing measures, we apply the MIT Emissions Prediction and Policy Analysis (EPPA) Model (Babiker *et al.*, 2000; Yang *et al.*, 1996). EPPA is a recursive dynamic, multi-regional general equilibrium model of the world economy. The current version of EPPA is built on a comprehensive energy-economy dataset that extends the existing GTAP system (Hertel, 1997). Denoted GTAP-E, this dataset accommodates a consistent representation of energy markets in physical units as well as detailed accounts of regional production and bilateral trade flows. The base year for the model is 1995, and the model is solved recursively through 2100 in five-year intervals.

The GTAP-E database identifies 22 sectors and 45 nations or regions. Its underlying detail allows aggregation of the model to suit the specific analysis task. For the studies presented here, the model was aggregated to eight sectors, plus two future "backstop" energy sources, and 25 regions. As shown in Table 1, nonenergy goods are aggregated to three sectors, whereas the energy sector is

Table 1
Dimensions of the EPPA-GTAP model

Production sectors	Countries and regions
Non-Energy	*Annex B*
1. Agriculture	USA United States
2. Energy-intensive industries	JPN Japan
3. Other industries and services	EEC Europe[a]
Energy	OOE Other OECD[b]
4. Crude oil	FSU Former Soviet Union
5. Natural gas	EET Central European Associates
6. Refined oil	*Non-Annex B (Selected regions)*[c]
7. Coal	KOR Korea
8. Electricity	IDN Indonesia
Future energy supply	CHN China
10. Carbon liquids	IND India
11. Carbon-free electric	MEX Mexico
Primary factors	VEN Venezuela
1. Labor	BRA Brazil
2. Capital	RME Rest pf Middle East[d]
3. Fixed factors for fuel and agriculture	RNF Rest of North Africa[e]
	SAF South Africa

[a]The 15 nations of the European Union as of 1995.
[b]European Free Trade Area (EFT), Australia, New Zealand, Canada, Turkey.
[c]Other Non-Annex B regions included in the model but not in the reported results are: Malaysia (MYS), Philippines (PHL), Thailand (THA), Argentina (ARG), Chile (CHL), Colombia (COL), Morocco (MAR), Rest of Sub-Saharan Africa (RSS), and Rest of the World (ROW).
[d]Includes the Arabian Peninsula, Iran, and Iraq.
[e]Tunisia, Algeria, Libya, and Egypt.

represented in terms of fossil fuel type and electricity. Annex B is aggregated into six regions. Non-Annex B is modeled in greater detail, allowing the study of impacts of Kyoto-style restrictions on developing countries. Within the calculations, the Non-Annex B group is modeled as 19 separate countries or multicountry aggregates, but for ease of presentation, only the ten regions listed in Table 1 are shown in our tables and figures.

The model's equilibrium framework is based on final demands for goods and services in each region, arising from a representative agent. Final demands are subject to an income balance constraint with fixed marginal propensity to save. Investment is savings-driven, and capital is accumulated subject to vintaging and depreciation. Consumption within each region is financed from factor income and taxes. Taxes apply to energy demand, factor income, and international trade, and the proceeds are used to finance an exogenously grown level of public provision. International capital flows in base year accounts are phased out gradually, and the government budget is balanced each period through lump-sum taxes.

Along the baseline, fossil energy resources through 2010 are calibrated to an exogenous price path for fuels. Afterward, prices are driven by a long-run resource depletion model. Energy goods and other commodities are traded in world markets. Crude oil is imported and exported as a homogeneous product, subject to tariffs and export taxes. All other goods, including energy products such as coal and natural gas, are characterized by product differentiation, with an explicit representation of bilateral trade flows calibrated to the 1995 reference year of the GTAP database. Energy products (i.e., refined oil, coal, natural gas, and electricity) are sold at prices that differ between industrial customers and final consumers.

The analysis presented here focuses on CO_2 only, and the Kyoto targets are assumed to apply to a 1990 baseline of fossil carbon emissions, and to be achieved by a reduction in fossil fuel burning. In fact, implications of the Kyoto Protocol will depend also on the treatment of carbon sinks and the six non-CO_2 gases included in the agreement. Depending on the region, including sinks and all gases in the baseline and in the control regime yields an average OECD control cost that is 20% to 35% lower than the cost estimated from a carbon-only analysis (Reilly *et al.*, 1999a, b). Were this analysis extended to all gases and carbon sinks, therefore, the welfare effects would likely be reduced somewhat because fewer reductions in fossil fuel emissions would then be needed to meet the emissions targets under Kyoto.

3. The reference case, with and without the Kyoto Protocol

Carbon emissions (in megatons of carbon, MtC, by year) under the reference conditions are shown in

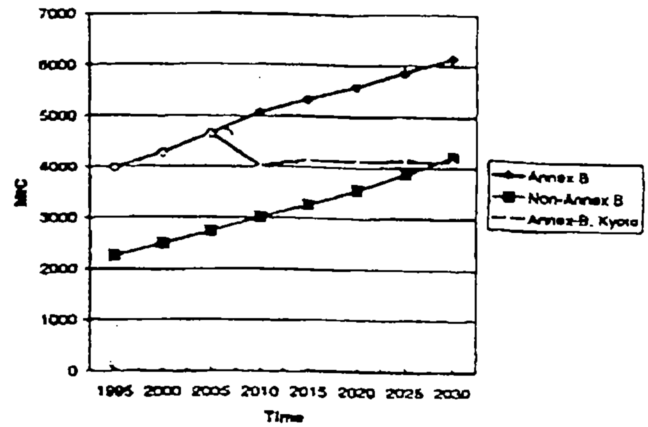

Fig. 1. Reference and Kyoto carbon emissions.

Fig. 1 for the Annex B and Non-Annex B aggregates. Also shown is the trajectory of Annex B emissions under the Kyoto emissions restraint, assuming the agreement stays in place at the 2008-12 level in succeeding decades. Under Kyoto-type constraints, the emissions of Non-Annex B countries may vary from their reference levels because of carbon leakage, but that difference is not shown here because it varies from case to case.

Under our reference conditions, with no climate policy, we assume the world oil price will fall somewhat by the year 2010 from its level in the 1995 GTAP base year. The scenario is a smoothed approximation of the realized price behavior over the period of price volatility experienced from 1995 to 1998, based on U.S. Department of Energy statistics (DOE/EIA, 1998). The oil price turns up after 2010 as the oil market comes under control of the EPPA Model's long-run resource depletion model. All the comparisons below are developed in relation to this reference case, with its underlying price model.

For a version of this reference case with the Kyoto Protocol in place, we chose a policy scenario with no trading in emissions permits and no attempt to correct distortions resulting from Annex B existing fuel taxes and tariffs. (Coal subsidies are removed by 2010 in the EPPA reference case, as discussed further in Section 5.2) This case is labeled NT-D, for No permit Trade with tax Distortions. As suggested earlier, the imposition of Kyoto emissions reductions would reduce the demand for the more carbon-intensive fuels, oil and coal, and thus lower their international prices below the levels under the reference with no climate policy. For example, in this case, the 2010 oil price is 15% below its level under no-climate-policy conditions. This oil price change is a key determinant of the burdens imposed on oil-exporting developing countries, and of the gains realized by others.

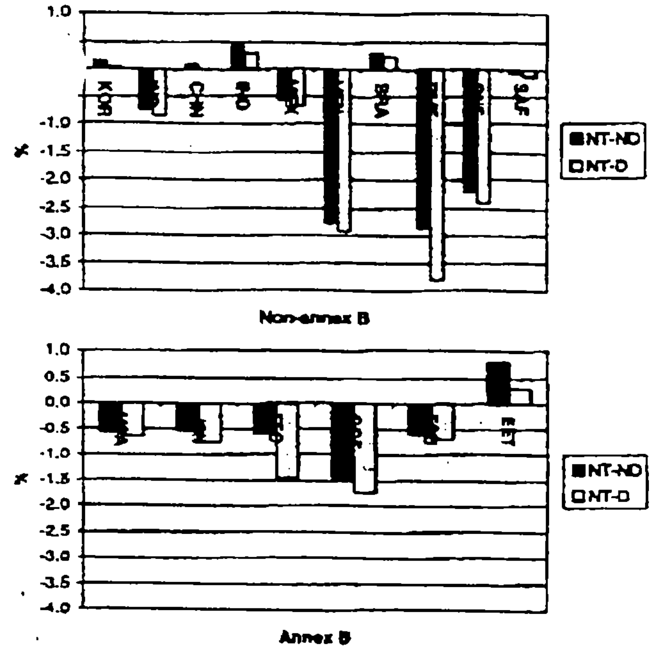

Fig. 3. Kyoto and welfare: The implication of pre-existing distortions in Annex B's energy markets (2010).

for the change is straightforward. The oil price declines by only 9% if tax distortions are removed (Case NT-ND), compared to the previously discussed 15% e if tax distortions are maintained. With a har- ed system, therefore, deterioration in terms of trade fo. oil-exporting regions is reduced, lowering their welfare losses.

For Annex B, shown in the lower part of the figure, a switch to a carbon-based increase in fuel prices is favorable for all regions. The gain is greatest in Europe because fuel tax distortions are greatest there. Interestingly, a choice of carbon-based rather than distorted fuel surcharges also benefits non-oil-exporting Non-Annex B countries such as Korea (KOR), India (IND), China (CHN), and Brazil (BRA).

4.2. Removal of subsidies for coal use

Another distortion in the energy system arises from subsidies provided to coal producers in several Annex B countries. These subsidies encourage use of Annex B coal at the expense of imported coal, and encourage coal usage at the expense of oil and natural gas. Removing coal subsidies from Annex B nations should therefore reduce effects on developing-country energy exporters. Such subsidies clearly distort economic activity in Annex B regions, and their removal might therefore increase welfare in Annex B regions, as well. Among the Annex B regions that will be under restraint in 2010, the main region where these subsidies are currently in place is Europe (EEC). Such subsidies also remain in effect in some countries of the Former Soviet Union (FSU) and Eastern Europe (EET), but these regions are not under restraint in 2010, so no change is considered there.

As noted earlier, our reference case (REF) assumes that these coal subsidies are removed from all countries by 2010. However, we can test the implications of this change by performing a calculation under the assumption that the subsidies will remain in place in OECD countries. This calculation reveals that the effects of removing all coal subsidies from the OECD are in the expected direction, but very small. The welfare effects of removal are neutral or positive everywhere, but not significant for any oil-exporting developing region. The coal sector is too small to make a difference to the OECD regions as defined in our model, and the effect on oil prices is also insignificant. Only in South Africa, where coal exports to the OECD are important, is the effect observable with rounding: the country's 2010 welfare loss is reduced from 0.15% to 0.13% when OECD coal subsidies are removed.

4.3. Emissions trading

The details of international emissions trading, covered under Article 17 of the Kyoto Protocol (United Nations, 1997), are the subject of continuing debate. Although the complexities of alternative implementation schemes may prevent attainment of the cost savings of an ideal trading regime (Hahn and Stavins, 1999), many studies have shown that the potential for cost reductions is great (e.g., Montgomery *et al.*, 1998; Jacoby *et al.*, 1997; OECD, 1992; Ellerman *et al.*, 1998). The analysis conducted here shows the same result. Gains from unrestricted emissions trading are substantial not only for those engaging in such trade, but often for others as well.

The results are displayed in Fig. 4, which shows a case with permit trade only among Annex B countries. Given our reference forecast, FSU and EET share a total of 165 MtC of "hot air" in 2010. They benefit from selling it, and the four OECD regions benefit from lower-cost carbon control when they buy it. In the United States, for example, the carbon price in 2010 drops from $205 per ton under autarchy to $92 per ton with Annex B trading (T-AB). In welfare terms, the cost is lowered most in Japan (by 58%) and in other OECD regions, as well (by 28% to 40%), compared to the case with no emissions trading.

The introduction of Annex B trading means that the 2010 oil price would fall from the reference by less than in the no-trading case (10% as compared to 15%). The reduced impact on energy prices would tend to mediate effects transmitted through the mechanisms of

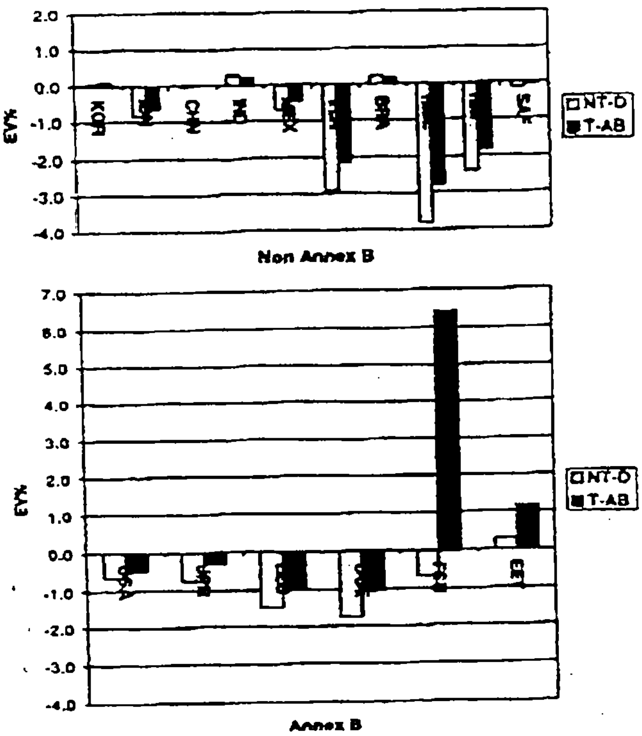

Fig. 4. Kyoto Protocol: The welfare implications of alternative emissions trading schemes, 2010.

international trade discussed earlier. So, for example, oil exporters (e.g., IDN, MEX, RME and RNF) would suffer lower welfare losses than they would in a world without trading. On the other hand, those regions that benefited under no-trade conditions (e.g., KOR and IND) would be somewhat less advantaged by Kyoto if trading is in effect. These effects are enhanced if a large developing country joins the trading regime, as explored in Babiker and Jacoby (1999).

4.4. *The combined effect of accompanying policy measures*

In this section, we combine all three of the above actions to evaluate the extent to which they reduce impacts on Non-Annex B regions. Table 4 shows the results for a subset of the developing countries that are of interest: Venezuela (VEN), the Persian Gulf (RME), and North Africa (RNF). The table shows the reference EV loss if the Kyoto Protocol is implemented, then presents the change in impact resulting from each associated policy, considered alone. Again, removal of coal subsidies is shown to be insignificant. Depending on the region, on the other hand, emissions trading and removal of distorting fuel taxes could soften the effect of Kyoto implementation.

Table 4
Reference welfare loss under Kyoto implementation, and the change in loss under various accompanying policies

	VEN (%)	RME (%)	RNF (%)
Reference EV loss	− 2.92	− 3.81	− 2.40
Change in EV loss with:			
Removal of distorting fuel taxes	+ 0.16	+ 0.96	+ 0.37
Removal of coal subsidies	0.0	+ 0.01	0.0
Addition of emissions trading	+ 0.81	+ 1.03	+ 0.59
Combined effect of the above	+ 2.47	+ 3.26	+ 1.80

The table also shows the effect if all measures were to be taken together. It is interesting to note that, contrary to what might be expected, the effects are not additive. Indeed, the combined effect is more than twice the sum of the separate effects for VEN, twice the sum of the separate effects for RNF, and about 50% higher than the sum of the separate effects for RME. This magnification of effect when combining the removal of existing energy distortions with emission-rights trading is explained by what happens to the international price of oil in the combined measure compared to the two separate measures. Whereas the oil price falls by 9.2% when only existing energy taxes are removed and by 10.1% when only emissions trading is considered, it falls by only 2.5% when all the measures are considered jointly (recall that dropping coal subsidies has no appreciable effect on oil prices). On the other hand, no Annex B region is adversely affected by the combined measure compared to the case NT-D. Thus, combining the two measures almost offsets the welfare costs inflicted on some developing countries by the Kyoto response measure without resulting in additional costs to Annex B regions.

Two main points can be drawn from the results in this section. First, the way emission restrictions are implemented substantially affects Non-Annex B countries. Second, the implementation options considered here, for the most part, both reduce the cost of the Kyoto emission restrictions for Annex B countries *and* limit the impacts on Non-Annex B countries. The implementation options we considered do not completely eliminate all negative consequences for all Non-Annex B countries, but they go a long way toward doing so. The other side of this coin is that the implementation options we considered also reduce the unintended beneficial consequences of Annex B actions on Non-Annex B countries, some of which are the poorest members of this group.

Basically, a more efficiently implemented policy has smaller costs and smaller unintended consequences. Furthermore, while we have not been able to consider the influence of non-CO_2 greenhouse gases and sinks, the work of Reilly *et al.* (1999a, b) cited earlier, indicates that efficient use of these control options would reduce bur- even further.

5. Direct measures to reduce effects on developing countries

The ways in which emissions constraints are implemented can substantially reduce impacts on Non-Annex B countries, but as long as policies lead to reductions in fossil fuel use, fuel exporters will experience consequences. In this section, we consider two options that go beyond the general policies that might accompany the imposition of Kyoto emission restrictions. These are preferential tariff reductions for Non-Annex B countries, and direct compensation of countries suffering losses from Annex B implementation of the Kyoto agreement.

5.1. Tariff concessions

Here we consider preferential removal of tariffs for Non-Annex B countries from goods imported into Annex B countries. When applying these preferential tariffs in our model, we exclude energy (oil, gas, and coal) and energy-intensive goods. Our reasoning is that reducing tariffs on energy-intensive goods would be inconsistent with the objectives of the Climate Convention, as this would encourage leakage of carbon emissions from Annex B to Non-Annex B regions. Tariff reductions extended to oil, and coal would effectively shift production of these ls from Annex B countries to Non-Annex B coun-. Such a shift in production of oil, gas, and coal would further concentrate Kyoto-related losses on the energy-producing sectors in Annex B. Tariff levels are included in the GTAP data set. The effect of tariff concessions can be computed by comparing the Kyoto case under current conditions (with Annex B tariffs in place) to a case assuming one-way reduction in tariffs by Annex B countries on goods from all Non-Annex B countries. We denote this case NT-TC, indicating No Emissions Trading and Tariff Concessions. All fuel-specific taxes (distortions) are in place.

The results of such tariff concessions are shown in Fig. 5. Not surprisingly, the one-way preferential removal of Annex B tariffs from Non-Annex B goods causes welfare losses in all Annex B regions except FSU, which seems to realize minor gains from the resulting trade diversion. In contrast, EET is most affected by such a concession policy, losing all the welfare gains it might have achieved from Kyoto. This is because the concession policy diverts Annex B imports away from EET toward Non-Annex B regions. This is not true for FSU because, as reflected in the GTAP base-year trade statistics, FSU has lower tariff rates and a smaller volume of trade with OECD than does EET.

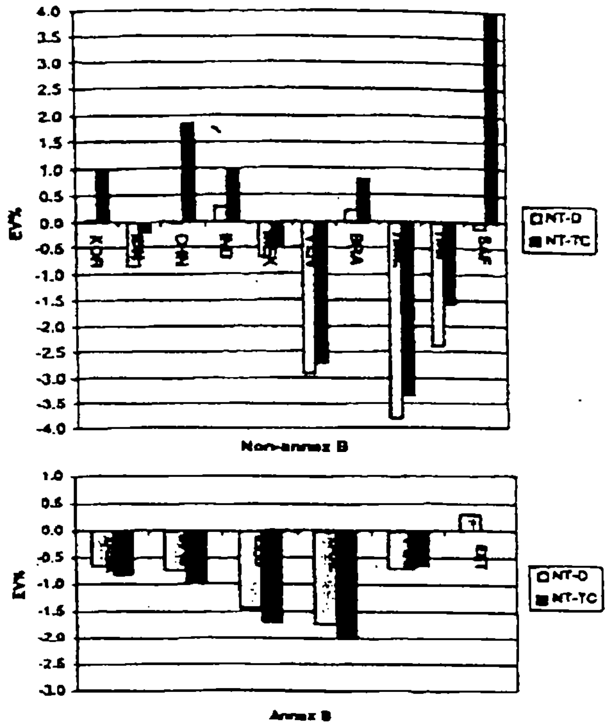

Fig. 5. Kyoto Protocol with and without tariff concessions on non-energy intensive products.

The effect of the concession on developing countries is highly variable. A number of countries benefit substantially, South Africa being the most prominent example. A number of regions that would suffer welfare losses from Kyoto implementation, on the other hand, are little affected by such tariff reductions. For example, benefits to the Persian Gulf countries (RME) and Venezuela (VEN) are quite small.

The basic conclusion is that a policy of country-specific preferential reductions in tariffs on Non-Annex B exports to Annex B nations would benefit many developing countries, but not target the benefits to those countries negatively affected by Annex B implementation of the Kyoto Protocol. Furthermore, even if, in principle, trade concessions could target countries that experience economic losses, predicting the dynamic effects of trade concessions targeted to closely compensate those adversely affected by Annex B climate policies would raise many difficult issues.

5.2. Direct compensation

We consider, finally, the level of financial transfer that would be required to compensate losses to Non-Annex

B regions. Even if such a direct transfer mechanism is not likely to be established, the calculations can offer some indication of the attention that should be given to other mitigation measures, both those discussed above and others we are unable to model, such as technology transfer. Naturally, the amount of compensation required to "minimize" Kyoto effects would depend on the stringency of the emissions control measures taken, how the measures are implemented, and other uncertain economic developments between now and 2010. We make the calculations on an ex ante basis, using our reference scenario as a representation of conditions in this future period. We do not attempt to resolve the institutional question of how the adverse effects would be calculated in the year in which they are to be paid.

Here we explore the potential magnitude of these financial transfers, focusing only on those regions that suffer welfare losses. We make no correction for Non-Annex B regions that may actually benefit from the imposition of Kyoto restrictions. Using the EPPA-GTAP Model, we analyze financial transfers by assuming an implicit allocation of emissions permits from selected Annex B countries to those Non-Annex B regions that are disadvantaged. Since the regions of the former Soviet Union (FSU) and Eastern Europe (EET) are not under restraint in 2010, the transfer of permits must come from the four OECD regions only (see Table 1 for their compositions). The obligation to transfer is allocated across the four OECD regions as a percentage of their individual post-reduction emissions targets.

The permit transfers are modeled such that each receiving region in Non-Annex B gets the same percentage of permits from each OECD region, with the objective of meeting the welfare criterion stated in the transfer scenario. For example, if RME requires 1% of the permits allocated to OECD to meet the prescribed welfare level in the scenario, then 1% of these permits allotted to each OECD region are transferred to RME. The recipient nation is then assumed to sell the permits back to the corresponding source at the marginal value in the source region. By this method, we can calculate the financial transfer that would be required, in the face of Kyoto implementation, to maintain all Non-Annex B regions at their reference levels of welfare, or with only some limited decrease in welfare. The calculation of the level of permits allocated was made endogenously in the model. Thus, the estimate takes into account the general equilibrium adjustment of the world economy to these transfers. To explore the magnitude of these general equilibrium adjustments, we also consider a case in which the effects of the financial transfers on goods flows and prices are ignored.

Table 5 presents the results. Considering first the general equilibrium adjustment, and assuming no trade in emissions permits, we can see that the "minimization" of adverse impacts to Non-Annex B regions (noted in the table as $\Delta EV = 0$) would require an overall annual financial transfer from OECD nations to Non-Annex B regions of \$27.6 billion in the year 2010. Somewhat over half this amount would comprise transfers to the Persian Gulf nations (RME). Other nations needing substantial transfers would include North Africa (RNF), Venezuela (VEN), Mexico (MEX), and Indonesia (IDN). If the objective were to mitigate these effects but not necessarily eliminate them, the overall transfer required would be substantially reduced. For example, the table includes a calculation for the 2010 loss in welfare within Non-Annex B nations limited to 1%. The overall transfer is cut to \$14.5 billion, and in this case, roughly 80% of the transfer is to the Persian Gulf region.

The allowance of permit trading among Annex B nations would lower the financial transfers required to hold EV at zero. Direct transfers would be reduced by about 25%, to a total of \$20 billion, as shown in the table.

The EPPA-GTAP Model computes a general equilibrium adjustment to these financial transfers. That is,

Table 5
Financial transfers from OECD countries required to reduce Non-Annex B welfare losses in 2010 to zero, or to a maximum of 1.0% (1995 \$US billions)

Region	General equilibrium			Partial equilibrium
	No permit trading		With trading	No permit trading
	$\Delta EV = 0$	$\Delta EV \leq 1.0\%$	$\Delta EV = 0$	$\Delta EV = 0$
IDN	1.59		1.16	1.52
CHN	0.13			0.09
MEX	1.75		1.16	1.60
VEN	1.97	1.29	1.44	1.84
RME	15.6	11.5	11.5	14.7
RNF	2.96	1.72	2.26	2.69
SAF	0.14		0.06	0.15
Total	27.6	14.5	20.0	25.7

compared to a solution without these transfers (NT-D), their addition increases the aggregate demand levels, cr--ting an upward pressure on prices in the recipient ...ies and decreasing the level of incomes in the ... countries. Thus, global adjustments occur in economic activity, international trade, and prices in response to the compensation plan. An alternative estimate would simply calculate the financial transfers needed to return Non-Annex B countries to the reference level of welfare (in effect, calculate the EV loss in monetary terms), ignoring the fact that these transfers influence economic activities in both recipient and donor regions. As can be seen from the table, this partial equilibrium approach differs only slightly from the EPPA-GTAP general equilibrium answer. The total transfer in 2010 is approximately $25.7 billion; thus, the partial equilibrium approach to estimating this figure underestimates the needed transfers by about 7%.

6. Discussion and conclusions

It is no surprise that emissions control actions by the large developed countries, which dominate world trade flows, will have ripple effects on the global economy, affecting countries that have not volunteered to share any burdens of the emissions control regime. The magnitudes of these impacts are highly uncertain, but the analysis above does give an idea of what these impacts might be. Clearly, the greatest loss is imposed on energy exporters, and the more dependent a country is on energy exports, the greater the effect will be on its economic ...re. A country like Mexico, therefore, with a large, ...sified economy, will be affected much less than will ...ions of the Persian Gulf (RME), for which oil revenues constitute a much larger fraction of GNP.

Our analysis leads to two broad conclusions. First, the way in which emissions targets are implemented can have a major effect on a policy's impact on Non-Annex B countries. In particular:

- Unrestricted emissions trading would reduce impacts substantially. With the accession of Non-Annex B regions to the agreement, the reduction could be even greater.
- Removing fuel price distortions in Annex B countries would also substantially reduce impacts.
- Removing coal subsidies would have a very small effect, though it would reduce negative consequences for South Africa measurably because of the importance of coal exports to the South African economy.
- We did not consider the effect on Non-Annex B of including other gases in the mitigation strategy of Annex B. Other work we have conducted leads us to believe that a "multi-gas" strategy would further reduce negative impacts on Non-Annex B countries.

Second, all of the above implementation options would also reduce the cost of restrictions for Annex B countries by increasing the cost-effectiveness of the emissions-reduction policies or by eliminating other economic distortions.

Third, as long as energy markets are affected, Non-Annex B countries that export energy are likely to experience some negative consequences. A broad policy of preferential tariff reduction on Non-Annex B exports to the OECD would benefit many developing countries but not target the benefits to those countries negatively affected by Annex B implementation of Kyoto. Therefore, the only remaining methods of mitigation may be a selective use of preferential tariffs or some form of direct compensation. If direct compensation is invoked, the required transfers could be substantial, concentrated on a few countries. We estimate the annual transfer for 2010 to be around $25 billion, the annual amount transferred would, of course, change over time.

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The Economic Impact of the Implementation of Response Measures: An Overview from A Modeler's Perspective

Thomas F. Rutherford
The University of Colorado

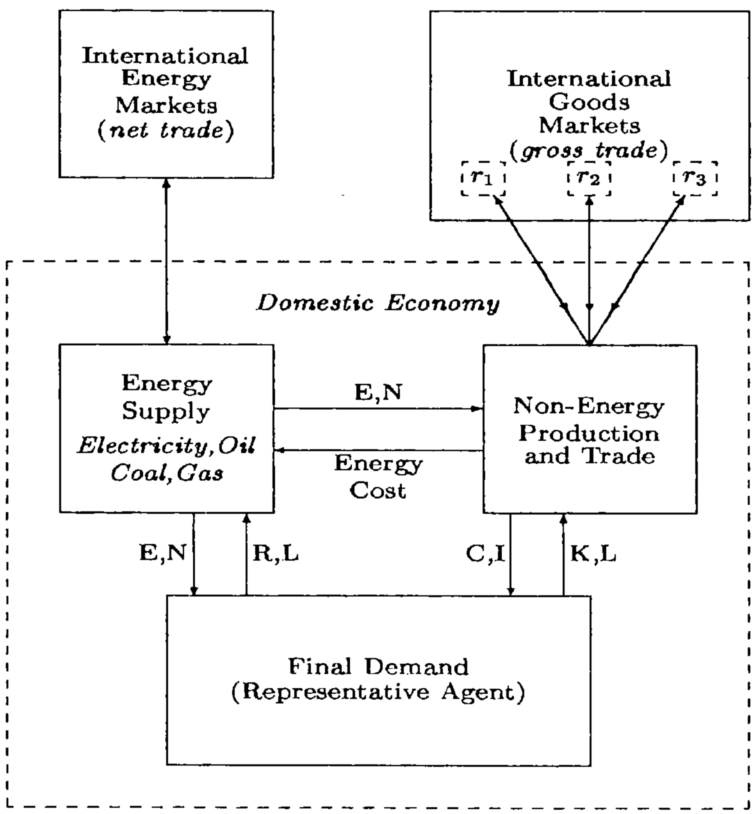
Talk Prepared for the UNFCC
Workshop on Articles 4.8 and 4.9
13 - 15 March 2000
Internationales Kongresszentrum Bundeshaus
Bonn, Germany

Outline

- Uses and limitations of economic equilibrium models
- EMF 18 – Models, Modeling Issues and Scenarios
- GTAP – Data Issues
- Implications of Kyoto for Energy-Exporting and Energy-Importing Developing Countries
- Methodological issues: quantifying uncertainty and decomposing spill-overs
- Outstanding Questions

Economic Models

- Can provide a useful reality check for policy proposals. Model-based justification for a policy proposal is a necessary but not a sufficient justification for the proposal's merit.
- Most dependable for policy issues which involve small changes from base year conditions
- Determinants of structural change, economic growth and development, international financial markets are all challenging issues for current models
- Model comparisons are essential in order to sort out a concensus opinion among the academic community.



Models Participating in EMF 18: "International Trade Dimensions of Climate Policies"

- Large collection of heterogeneous models
- Considerable variation in results presented at the first meeting
- At present time, we are unable to summarize findings, as a number of modeling groups are making changes which may change results substantially
- Focus on international spillovers, leakage and capital flows

ABARE-GTEM (Australian Bureau of Agriculture and Resources) Economics - Global Trade and Environment Model)	Brian Fisher/Vivek Tulpule/Darren Kennedy/ Steve Brown (ABARE)
AIM (Asian-Pacific Integrated Model)	T. Morita, M.Kainuma (NIES, Japan) Yuzuri Matsuoka (Kyoto University)
G-Cubed (Global General Equilibrium Growth Model)	Warwick McKibben (Australian National University) Peter Wilcoxen (University of Texas) Robert Shackleton (U.S. Congressional Budget Office)
GEMINI-E3/GEMWTrap Model (A General Equilibrium Model of International Interaction for Economy-Energy- Environment)	Alain Bernard – Ministry of Equipment, Housing and the Environment (France) Marc Vielle – CEA/IDIE (France)
MERGE 4.0 (Model for Evaluating Regional and Global Effects of GHG Reductions Policies)	Alan Manne (Stanford University) Richard Richels (EPRI)
MIT-EPPA (Emissions Projection and Policy Analysis Model)	Henry Jacoby/John Reilly (MIT) Mustafa Babiker/Ian Sue Wing (MIT)
MS-MRT (Multi-Sector - Multi-Region Trade Model)	David Montgomery/ Paul Bernstein (Charles River Assoc.) Thomas Rutherford (Univ. Of Colorado)
SGM (Second Generation Model)	Jae Edmonds (Pacific Northwest National Lab) Ron Sands (Pacific Northwest National Lab)
WAGE (World Applied General Equilibrium Model)	Claudia Kemfert (Institute for Energy Economic Investigations and the Rationale Use of Energy (IER), University of Stuttgart, Germnany)
WORLDSCAN	Tom Manders/Hans Timmer

Modeling Issues Addressed by EMF 18

- Determinants of aggregate leakage
- Spillovers for oil, coal and energy-intensive industries – determinants of winners and losers
- Sector-specific impacts (coal mining, oil refining, energy-intensive sectors - EIS)
- Role of EIS in the development process (higher GDP shares in developing countries)
- The Armington formulation
- Physical processes versus neoclassical production functions
- Treatment of exhaustible resources and the determinants of oil supply response

Data Issues Facing EMF Modelers

- Strengths and weakness of the GTAP/IEA database
- Updating to a 2000 base year
- Representation of EIS location decisions and technology choice (relatively little base year trade in EIS, and most of that is from the North to the South)
- Important to compare and quantify the differences implied by data versus model structure in order to identify important data issues
- Impacts on developing countries are particularly difficult to assess due to difficulties in reconciling energy and economic data

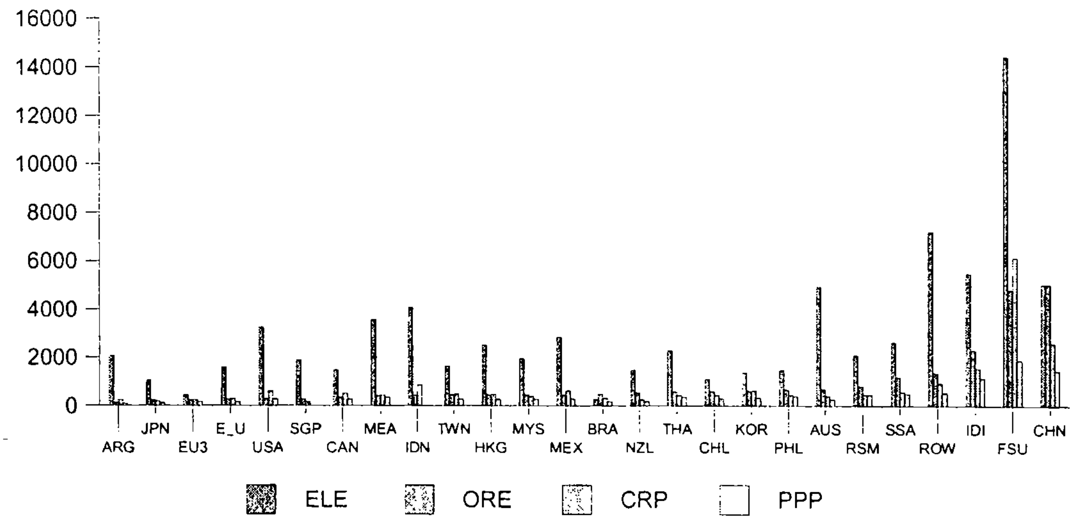
EMF 18 Scenario Focus

- Terms of trade effects and the transfer of impacts across countries
- Leakage rates and their determinants
- Impacts on developing countries
- Oil price responses
- Decomposition methodologies

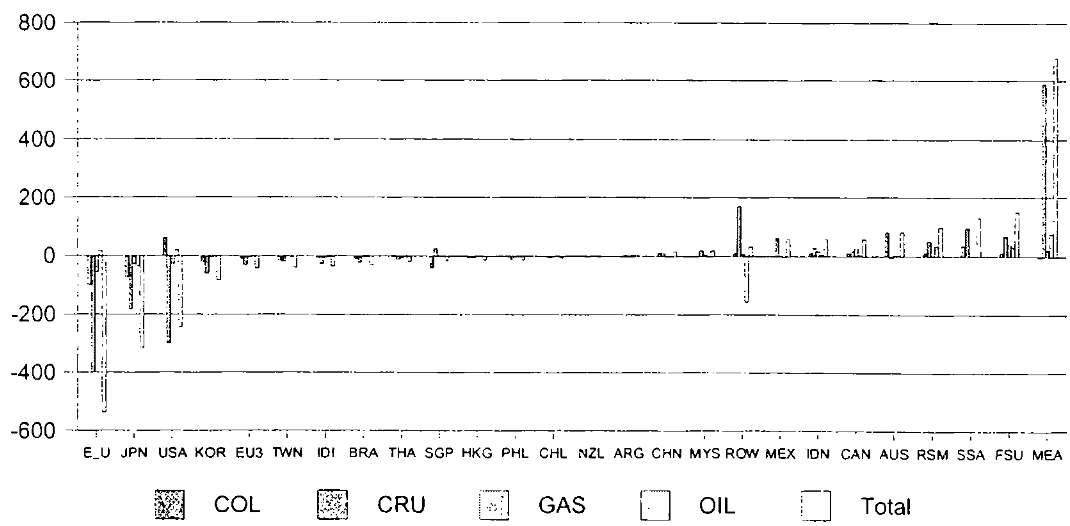
GTAP

- Mission of the project: assemble a consistent set of economic production and trade statistics for a recent year in order to facilitate policy analysis.
- Based on joint work with GTAP consortium members from Purdue and OECD
- Extended with sattellite tables for fossil-fuel production, demand and trade through a project funded by DOE.
- Energy dataset includes 45 regions, 23 goods and four primary factors, and a 1995 base year for energy and economic data
- Sattelite energy data based on 1995 energy balances from OECD/IEA; converted to exajoules and tkwh

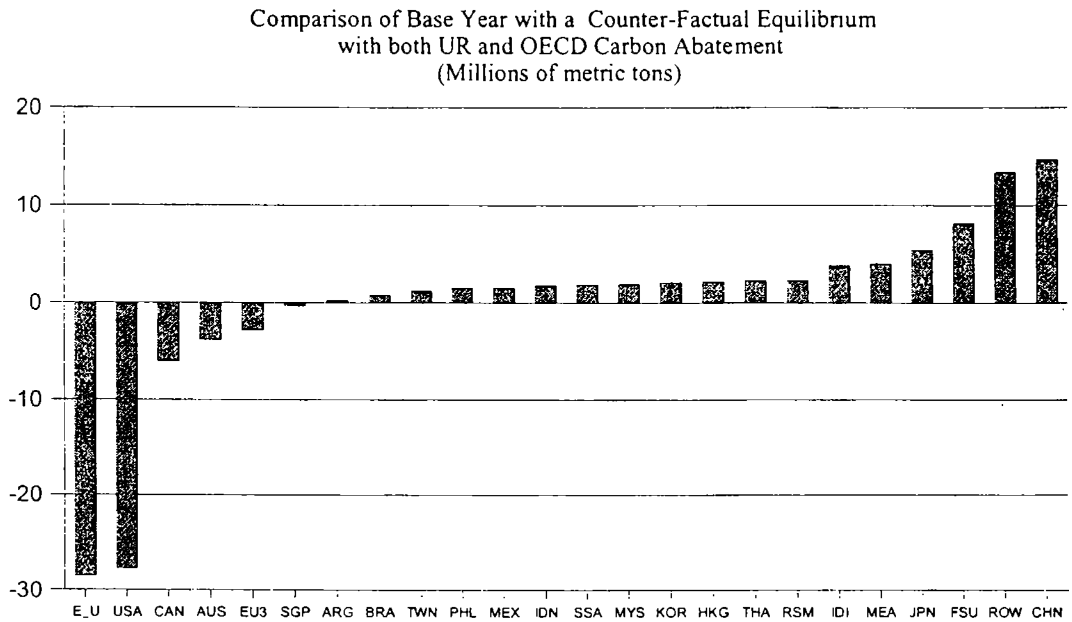
Carbon Content of Energy-Intensive Goods Produced in Different Regions Can Vary Widely



Base Year Net Fossil-Fuel Carbon Exports (millions of metric tons)



Change in Net Exports of Embodied Carbon Between OECD and Non-OECD Countries



CRA Models Based on GTAP

- International models currently in use or under development at CRA:
  - IIAM (integrated impact assessment)
    - 80 small open economies
    - 6 region trade framework
    - Ramsey determination of savings and investment
  - MS-MRT (multi-regional, multi-sectoral trade model)
    - 25 regions, 5 energy goods, 1-7 other goods
    - Special applications for auto stock, chemical industry
  - CETM (carbon emission and trade model)
    - 8 regions, several energy-intensive goods
    - Process representation of energy sectors (ETA)

Policy Questions

- What are the costs of Kyoto in 2010 under alternative assumptions regarding permit trading?
  - Kyoto Targets without trade
  - Annex 1 trade
  - Annex 1 trade + China or India or Brazil or CEA

- How do carbon taxes interact with international trade
  - Steam coal markets
  - Oil markets and welfare of non-Annex 1 countries
  - Aggregation bias: how many goods are needed?

Economic Impacts of Commitments by Annex 1 Countries

- OECD Countries – unambiguously negative
  - Reduction in GDP due to higher energy costs
  - Loss of competitiveness to non-participating countries
- Developing countries – offsetting effects
  - "Income effect" – loss in exports due to reduction in demand in OECD
  - "Substitution effect" – possible gain in competitivenss because of lower energy costs
  - "Terms of trade effects" – decreases in oil and coal prices, increases in prices of energy-intensive imports
- Oil producing countries – negative and potentially large

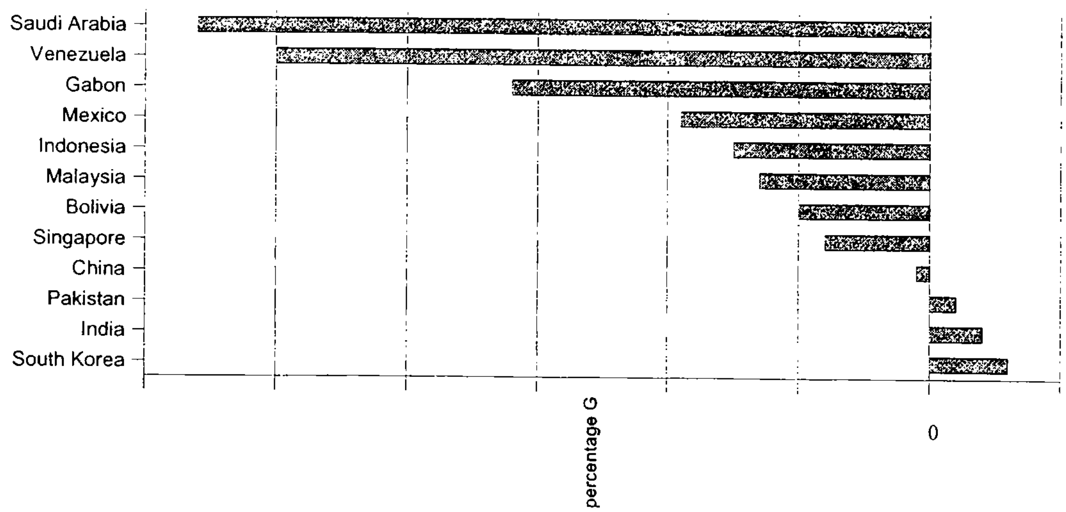
International Trade Effects

- Carbon emissions abatement in Annex-B can result in significant reductions in international oil and coal prices
- Carbon abatement in Annex-B provides an economic incentive for energy intensive industries to migrate from US, Canada, Australia and Japan to developing countries

Economic Implications for Developing Countries

- Most developing countries would be harmed by emission limits in the industialized countries, even if they do not take actions to reduce their own emissions.
- China is an exception, due to a favorable positions in trade and energy
- Oil-exporting developing countries face the largest costs often exceeding those of the industrial countries.
- CDM and Annex B trading provide limited welfare gains to developing countries

Impact of Uniform Targets on Non-Annex 1 Countries



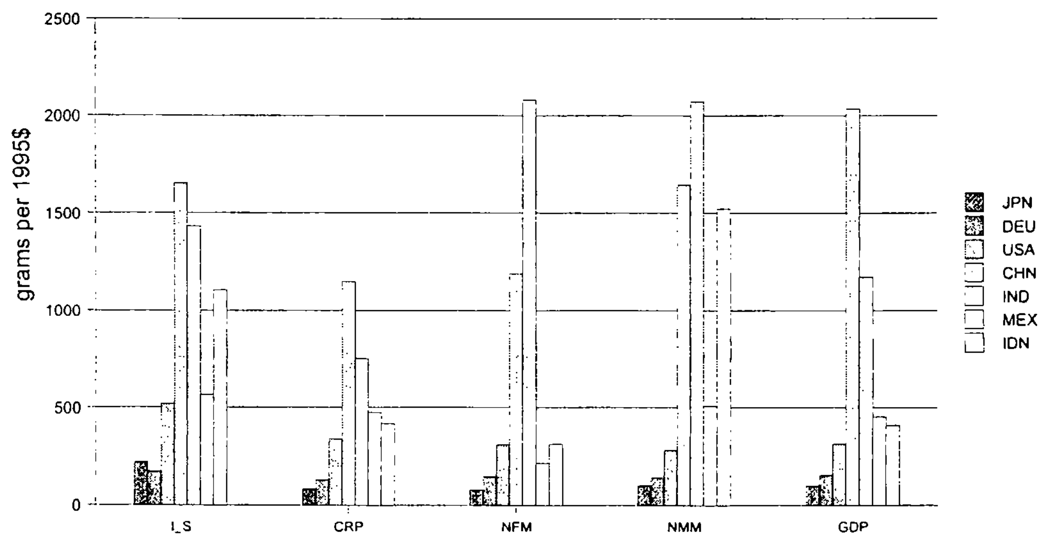
Participation of Developing Countries

- Kyoto with no permit trade produces an average leakage rate of roughly 20%. Annex B trading has virtually no impact on this value.
- Limited CDM (<2.5% of emission targets, 5% of obligation) does nothing to prevent GDP losses or migration of industries and other competitive effects.
- China+India are 27% of global emissions in 2010. Unless they participate, cost savings from other developing countries are limited.
- China and India gain from a large influx of energy intensive industries and improved GDP when they remain outside a global agreement.

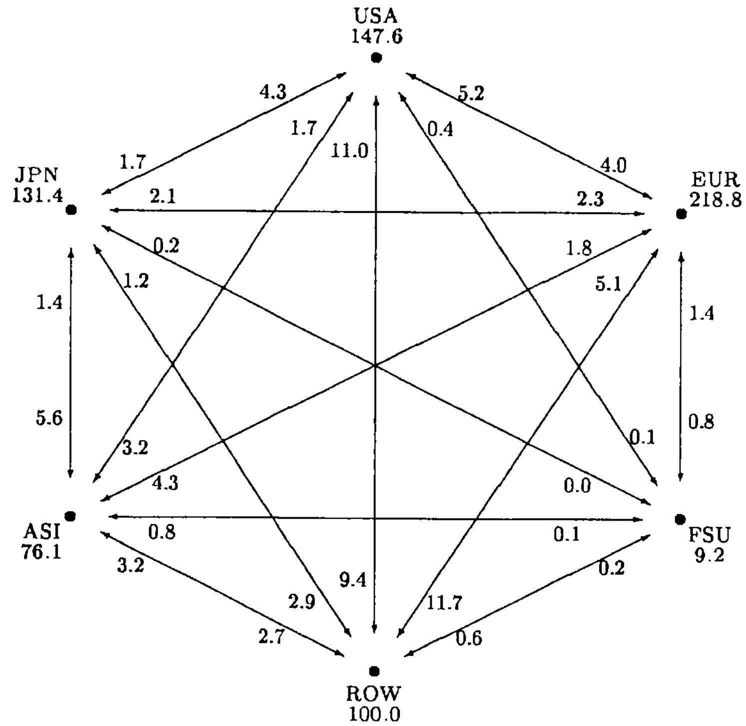
Reasons for Beneficial Effects of Annex B Emission Limitations for China and India

- Industries are carbon intensive relative to other non-Annex B regions, so that lower energy costs are a large advantage
- Higher ratio of exports to Annex B than other non-Annex B regions
- Lower share of imports from Annex B than other non-Annex B regions – higher costs of energy-intensive imports are less important
- Not a significant energy exporter – lower world oil prices provide significant benefits.

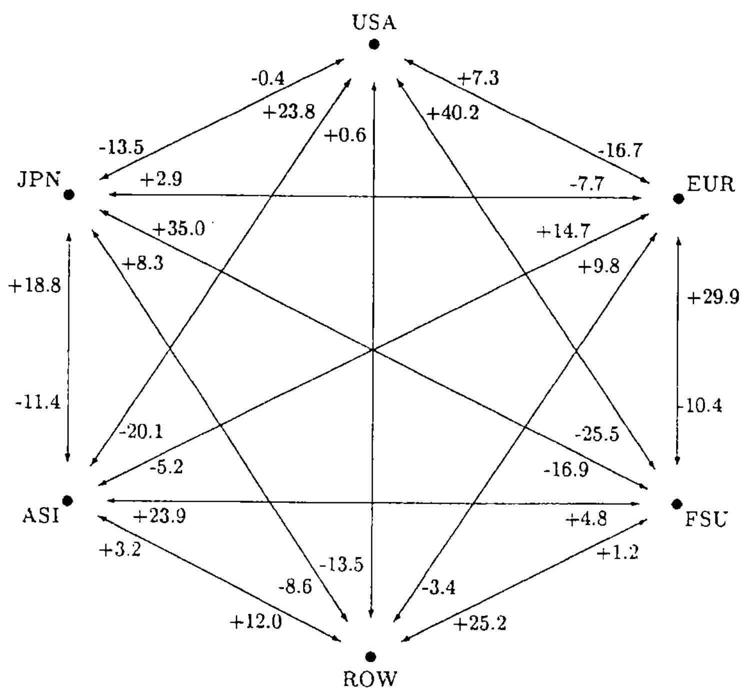
Carbon Content



Production and Trade in Energy-Intensive Goods



Kyoto-Induced Changes in EIS Trade (%)



WTO Provisions and Green Trade Restrictions

Bases for Wavers of MFN Obligations and Tariff Bindings in OECD

- Article XXV of GATT and Article IX of WTO
  - Required to support environmental policy and to deal with "exceptional circumstances"
- Article XX of GATT
  - Safeguard of public health, natural resources, national security and operation of domestic laws
- Agreement on Subsidies and Countervailing Measures
  - Broad interpretation of subsidy to include "government revenue that is otherwise due, is foregone or not collected" – absence of environmental taxes constitutes unfair and sector-specific subsidies

Coal Market Statistics

- Coal as a fraction of fossil fuel demand:
  - 73% in China
  - 53% in India
  - < 11% in Brazil and other developing countries
  - 36% in Central Europe
  - 32% in Other OECD (Austral-Asia)
  - 25% in the US
- 14% increase in China's coal consumption in 2010 contributes 21% to the global leakage rate.

Source Versus Destination Taxes On Fossil Fuels

- US welfare cost of Kyoto rises by an order of magnitude if tax revenues are remitted to the oil exporting countries
- Welfare cost of Kyoto for oil exporters is on the order of 5-10% of GDP under a destination tax. This changes to a 50% welfare *increase* when taxes are applied on a source basis.
- In most models the price elasticity of demand for oil is *inelastic*, so the gross payment for oil increases with the carbon tax

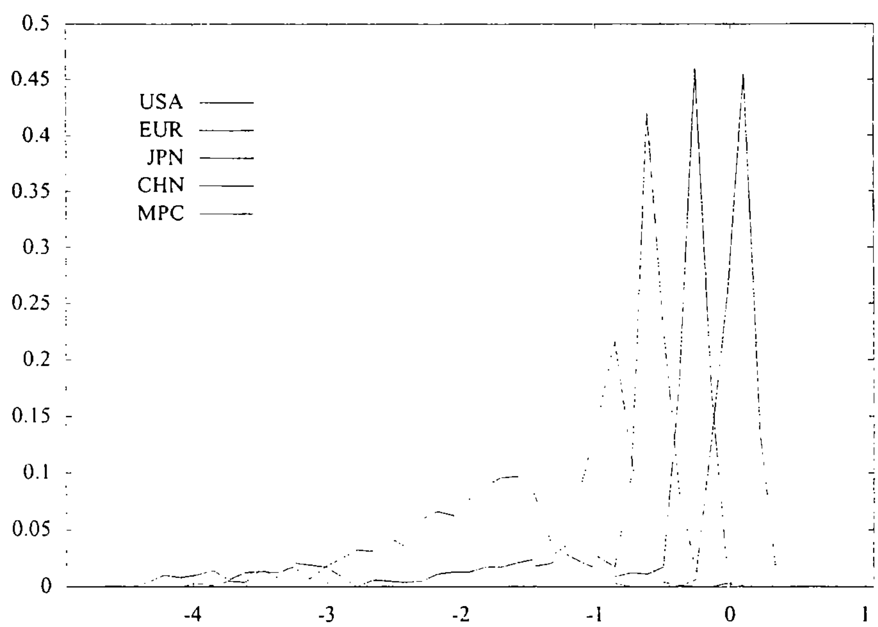
Outstanding Issues:

- Considerable *uncertainty* regarding the extent to which individual non-Annex-B are harmed by actions undertaken under the Climate Convention. Models are useful for understanding economic effects and orders of magnitude, but they are not ready to provide detailed estimates of damages.
- Technology transfer programs have obvious appeal, but they would be difficult to administer and suffer from a lack of clear individual incentives.
- Continued attention to the legality and likelihood of border measures is warranted

Quantifying Uncertainty

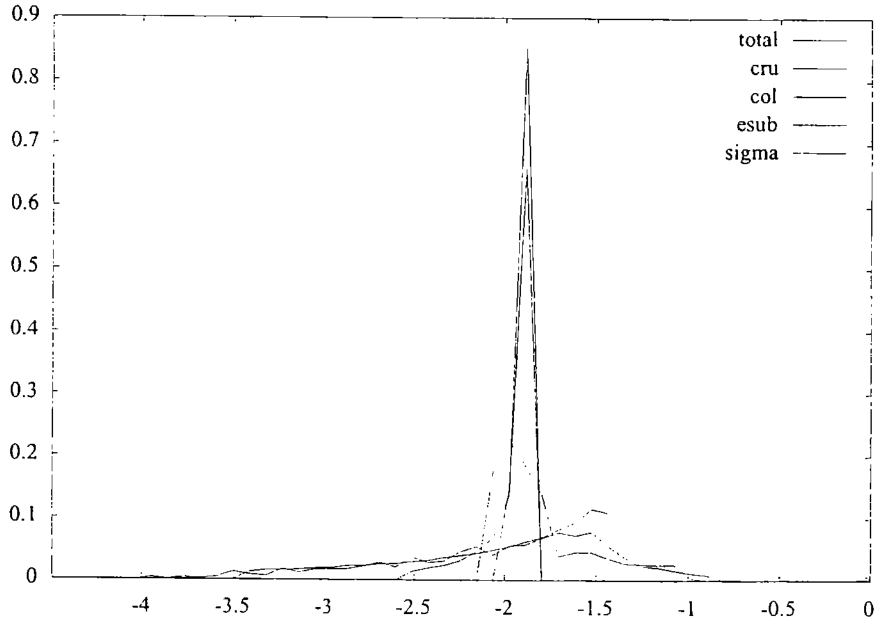
- Problems arise in the definition of input distributions – we typically do not have statistically meaningful samples, so a mathematically consistent approach, while appealing, is unlikely.
- There are important interactions between assumptions regarding correlations of parameters across markets.

Quantifying Uncertainty



Identifying the Source of Uncertainty

MPC Welfare



Decomposing Kyoto

- Need to assess magnitude of multilateral spillovers from Annex B policies on non-Annex B countries
- Existing analyses typically are based on partial equilibrium reasoning, e.g. calculating changes in terms of trade
- The problem with partial-equilibrium approach is that the decomposition is incomplete and does not "add up"

Key Findings:

- Emission constraints induce significant spillovers from Annex B to non-Annex B countries, both positive and negative
- In our analysis the greatest individual contribution to spillovers is due to actions of the United States
- There are significant *positive* spillover effects from US action for Japan and Europe
- Actions of other Annex B countries have negligible impact on the US
- The linear decomposition methodology provides a matrix of bilateral compensation payments, however specific values depend on instrument choice

Percentage of Welfare Variation Attributable to Actions of Individual Annex B Countries (*tax instrument decomposition*)

	USA	EUR	JPN	OOE	CAN	CEA
USA	107	-4	-3	-1	1	
EUR	-121	264	-23	-4	-15	
JPN	-47	-8	165	-4	-7	
OOE	16	7	18	58	1	
CAN	10	1	-3		92	
CEA	67	11	11	1	9	
FSU	55	18	30	4		-7
ASI	102	4	-25	9	10	
BRA	68	7	14	1	10	
CHN	82	1	-9	3	23	-1
IND	73	7	11	1	9	
MPC	70	11	11		8	
ROW	57	18	17	1	7	

How can impacts on consumers of fossil fuels be assessed?

Using a multi-sectoral general equilibrium model, we have a consistent framework for thinking about these effects. Key uncertainties relate to the response of international oil prices to changes in Annex-B imports.

How should we address the gathering of information on the impact of the implementation of response measures, drawn from the national communications of non-Annex I Parties and other sources?

The OECD/IEA data is a useful starting point, but there is a great lack of consistent economic data which corresponds to this information. The GTAP consortium and the EMF provide models of how collaborative work might be conducted.

What is the nature and content of information needed for evaluating the impacts on:
Terms of trade
International capital flows and
Developmental efforts
resulting from the implementation of response measures?

Any analysis of these issues must begin from a consistent base year dataset describing production and trade. Terms of trade impacts depend on capturing both the nature of new vintage production techniques and the transmission of prices through international trade.

Capital flows are a concern only in the effect of large-scale permit transfers to the FSU countries.

Non-Annex B Impacts of Annex B Policies

John Reilly
Joint Program on the Science and Policy of Global Change
Massachusetts Institute of Technology

I review the complex set of interactions among countries that lead to impacts on Non-Annex B countries. I identify 5 broad mechanisms or paths by which Annex B policy actions may affect Non-Annex B countries. Listed in approximate order of most to least studied these are: (1) Terms of trade effects, dominated by the effects on the prices of traded energy goods (e.g. oil, gas, and coal). (2) Overall impacts on the volume of trade—lower economic growth in Annex B means less demand for non-Annex B exports (3) change in comparative advantage of energy-intensive versus less energy intensive industry among regions (4) Economic effects of payments related to CDM (or carbon permits if a non-Annex B country elects to take on an overall reduction commitment) (5) The effects of carbon policy on earnings of capital invested outside a country or on labor earning remittances and the extent to which capital and labor can move internationally in response or in anticipation of Annex B policies. For the most part, these effects are the result of complex international trade and finance relationships. It can, therefore, be misleading to evaluate non-Annex B impacts using analytical techniques that do not represent these interactions.

For an example set of Non-Annex B countries, I provide estimates that suggest the relationship between carbon prices in Annex B and impacts on Non-Annex B countries. This provides a start at quantifying the relationship between Annex B policies and uncertainty in Non-Annex B effects. Much uncertainty in non-Annex B impacts is due to uncertainty in the carbon price in Annex B countries. This suggests that impacts can be more confidently assessed once we observe the effects of Annex B policies in terms of carbon price. An average carbon price can serve as an index of these impacts: to estimate the full effect of Annex B policies on non-Annex B countries would require formulas for converting the variety of policies Annex B may undertake to reduce emissions to a carbon-price equivalent basis. Such a process would be similar to estimates of producer and consumer subsidy equivalents in international trade work. I offer some concrete steps that are needed to improve estimates of non-Annex B impacts on the assumption that these impacts would be evaluated contemporaneously with the imposition of controls in Annex B. I conclude by identifying some of the tough issues that will need to be addressed.

Non-Annex B Impacts of Annex B Policies

Presented by John Reilly

MIT Joint Program on the Science and Policy of Global Change

Workshop on Article 4.8 and 4.9 of the Convention: Impact of the implementation of response measures
13 - 15 March 2000
Bonn, Germany

Presentation Outline

- Complex set of interactions among countries that lead to impacts on Non-Annex B countries.
- Quantifying the relationship between Annex B policies and uncertainty in Non-Annex B effects.
- A process for evaluating impacts on Non-Annex B countries.
- Concrete steps.

Issues: Most to Least Well-Studied

- Terms of Trade—Price of exports versus imports.
- Overall trade volume effects—Reduced demand for non-Annex B exports due to less income in Annex B.
- Relocation of industry due to energy price effects.
- Payment for CDM credits or other reductions.
- Financial Capital and Labor Mobility—investors and workers seeking highest return and better wages.

Terms of Trade Effects.

- Energy price changes dominate:
  - The direction of effect for most economies is clear
  - The magnitude of the effect for particular economies depends on:
    - Estimates of the cost to Annex B of the policies.
    - How important energy exports or imports are to the non-Annex B economy.
  - Lower cost of energy use outside of Annex B contributes to carbon leakage.

Poil under KP 15% below BAU in 2010

GLOBAL SCIENCE POLICY CHANGE MIT

Overall Trade Volume Effects

- Annex B countries are the major markets for goods from non-Annex B countries.
  - Lower economic growth in Annex B means less demand for non-Annex B exports.
- Inclusion of this effect in analyses is relatively more recent and not all models include this mechanism.

Relocation of Industry

- Annex B climate policies favor relocation of energy-intensive industries to countries without these policies.
  - The estimated magnitude of this effect varies widely and depends on key specifications of existing models.

- One aspect of this phenomenon is carbon leakage.
  - Carbon leakage rates range from 6% to 30% or more.

  - High end leakage rates are due to lots of relocation.

Carbon permit payments to Non-Annex B?

- CDM rules or how non-Annex B countries could take on commitments are not yet well-specified.
  - Aggregate models poorly represent the magnitude of CDM carbon reductions, real cost to the non-Annex B country, and payments to the country.
- The details of policy design and economic effects of them need more analysis.
  - Is participation beneficial for a particular non-Annex B country? Under what conditions? Relative merits of CDM versus other mechanisms?

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International capital and labor mobility.

- There is a web of cross-border investment and cross-border wage remittance. Compare:
  - Economic impacts that occurs within the border of a country.
  - Economic impacts to labor and capital that may be owned by residents of other countries.
- Capital and labor may also move due to climate policy, seeking higher returns or better jobs.
  - How much international capital and labor mobility is there? How fast can small economies absorb capital?

The Effects on Energy Exporters and Importers are Different.

- Fossil energy exporters experience large economic losses from Annex B policies.
- Non-Annex B energy importers often benefit.
- The size of these impacts are uncertain:
  - Much of the uncertainty is due to estimates of the carbon price in Annex B countries.

Fossil Energy Exporters

- Fossil energy exporters lose due to Annex B actions compared to a reference projection
  - Energy prices & volume of exports fall
  - These negative effects dominate, more so if the energy production sector is a big part of the economy.
- Partially offsetting gains
  - Energy intensive industrial production could move from Annex B to Energy Exporting Countries.
  - If much relocation, the negative economic effects might be much smaller than currently estimated:
    - But carbon leakage increases.

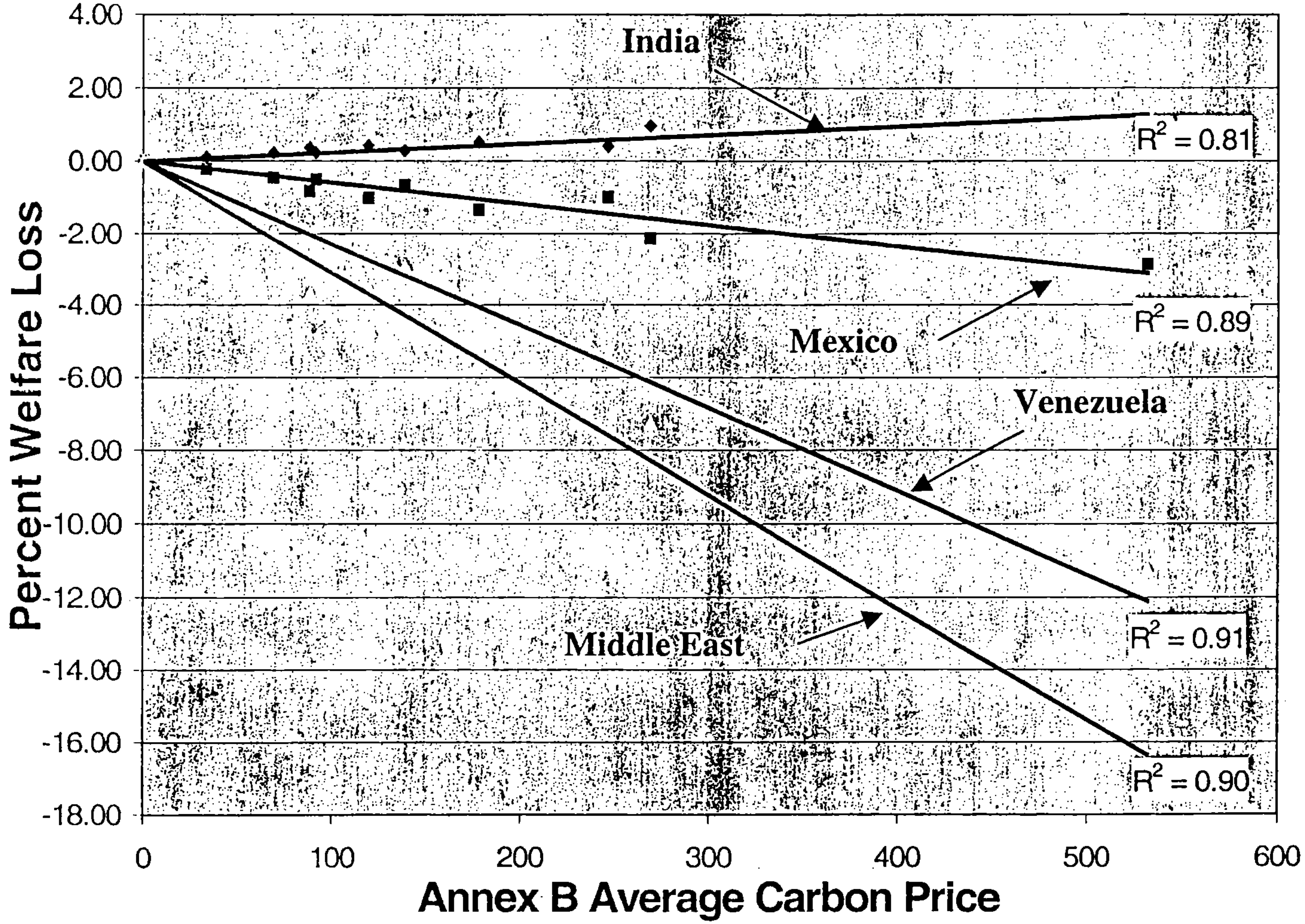
Non-Annex B Energy Importers

- Multiple effects
  - Lower energy prices in world markets are a benefit.
  - They may also gain from relocation of Energy Intensive Industries from Annex B countries
  - They may suffer losses from reduced exports of other goods to Annex B a a result of lower overall income in Annex B and reduced demand for imports.
  - Shift of financial investment to these countries could spur growth.
  - Potential CDM & carbon permit payments benefits
- Energy price effects are important but not as large as in energy-exporting countries.

Quantifying Carbon Prices & Non-Annex B Impacts

- Large uncertainty in economic growth, energy prices, other factors over the next few decades (e.g. 2000-2030).
  - ⑨ wide range of estimated Annex B carbon prices.
  - ⑨ uncertainty in non-Annex B impacts.
- High Annex B emission growth ⑨ high carbon price ⑨ big impacts on Non-Annex B countries.
- Low Annex B emissions growth ⑨ low carbon price ⑨ negligible impacts on Non-Annex B countries

Uncertainty in Carbon Prices & Impacts on Non-Annex B Countries, 2010-2030: Examples



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Implications

- Wide uncertainty in non-Annex B impacts exists.
  - E.g. Middle East range from 0 to –16 percent.
- Much of this can be reduced if we wait to observe the carbon price and focus on specific countries.
  - If in 2010 the carbon price in Annex B is $200 we are much more certain that the impact on Venezuela would be a loss of 5 percent and for India a gain of .5 percent.
- Model differences and limits discussed earlier would still be a source of additional uncertainty.

One Way to Proceed

1. Improve estimates of the relationships between carbon price and non-Annex B impact.
2. Panel of experts choose best estimate of the relationship for each non-Annex B country.
3. Used observed carbon prices (during the commitment period) in Annex B countries as basis for estimating impact on Non-Annex B.
4. Convert various Annex B carbon policies to a "carbon price equivalent."

Some Research & Follow-on Tasks

- Model Improvement
  - Disaggregated regions, other GHGs, better representation of all mechanisms through which Annex B policies affect non-Annex B.
- Improved Data and Reference Forecasts
  - Estimates of emissions growth, energy use, CDM potential, data for model improvement—particularly for non-Annex B & trade relationships.
- Carbon Permit Price Equivalency Calculations
  - Develop approach and develop data reporting system.

Tough Issues to Resolve

- Reference for non-Annex B impact scenarios.
  - Existing Annex B energy taxes
  - Energy exporter pricing & production restraints
- "Carbon price equivalence" of Annex B policies
  - Which policies are climate policies?
  - Anticipatory response, "early action," voluntary reductions, no-cost reductions.
  - Basis for estimating equivalency
- Process for agreeing on impact estimates.
  - Role of technical experts; arbiter of final decisions.

The Kyoto protocol and its impact on global oil markets up to 2020

Knut H. Alfsen

CICERO
Center for International Climate and Environmental Research – Oslo
Senter for klimaforskning

OXFORD INSTITUTE FOR ENERGY STUDIES

Based on a studiy carried out by Oxford Institute for Energy Studies and CICERO in 1999, and financed by the Ministry of Oil and Energy of Norway

To be published as an Oxford University Press book "Fossil fuel in a chanhing climate" in the spring of 2000

The question

- What are the impacts of climate protocols on oil production revenues

- The answer: It depends ...

A seemingly simple question

If time permits - also a brief look at the quota market and consequences for some developing countries.

Why one more model-based study?

- NEMS, EPPA, MERGE, SGM, GREEN, G-cubed, IIAM, GTEM, …

- … and now CLIMOX

CICERO Senter for klimaforskning — Center for International Climate and Environmental Research – Oslo — Oxford Institute for Energy Studies

Adds to the set of assumptios, samples the assumption space

Certain advantages in the construction and use of CLIMOX

Assumptions

- Resource and technology availability (backstop)
- Supply and demand elasticities
- Foresight?
- Industrial flexibility at the regional level
- Substitution possibilities among input factors
- Regional and sector aggregations
- International capital flow and financial effects

CLIMOX advantages

- Explicit consideration of oil supply, including non-conventional oil
- Includes fugitive methane emissions
- More realistic policy based considerations of mix of instruments

CLIMOX: OIES model for climate policy analysis

- Based on the GTAP data base and model, together with OECD's GREEN model
- Base year: 1995
- Production function structure as in GREEN
- Neo-classical foundation

… the model

- Fossil fuel supply modules based on transparent exogenous parameters determining e.g. capacity
- Solves for single periods (5 year averages)
- Capital stock distinguished by vintages
- Stock variables (capital, labour) updated
- Model is calibrated ⇒ scenarios, not forecasting

Sectors in CLIMOX

- **Non-energy sectors**
- Agriculture
- Forestry
- Paddy rice
- Livestock
- Energy intensive manufacture
- Transport
- Other goods and services

- **Energy sectors**
- Oil
- Refined oil
- Gas
- Coal
- Electricity
- Gas distribution

Regions in CLIMOX

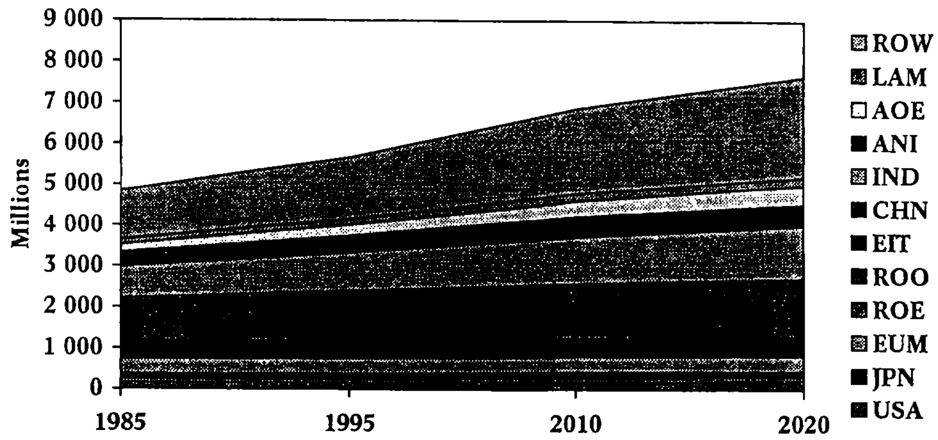
- **Annex I**
- USA
- EU
- Japan
- Rest of OECD/Europe (ROE)
- Rest of OECD (ROO)
- Economies in transistion (EIT)

- **Non-annex I**
- China
- India
- Asia Newly Industrialising (ANI)
- Middle East and N. Africa Oil Exporters (AOE)
- Latin America (LAM)
- Rest of World (ROW)

Three scenarios to 2020

- Business as usual **(BaU)**
- An extention of the Kyoto Protocol **(Kyoto)**
- A global, ambitious scenario **(Ambitious)**

Population



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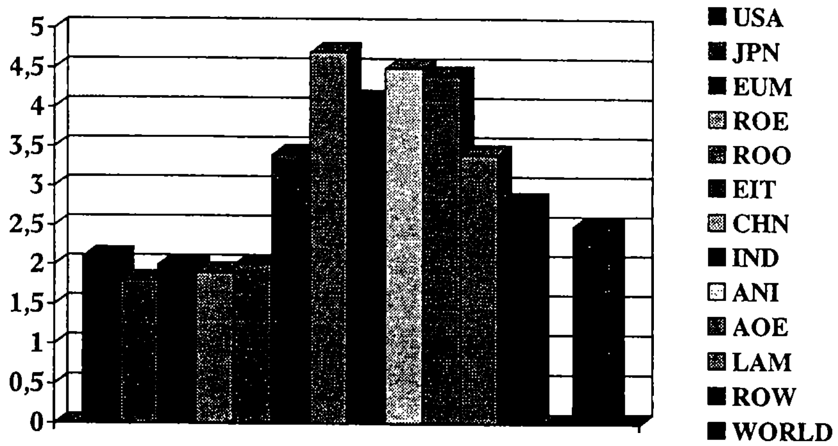
Average annual BaU economic growth 1995-2020



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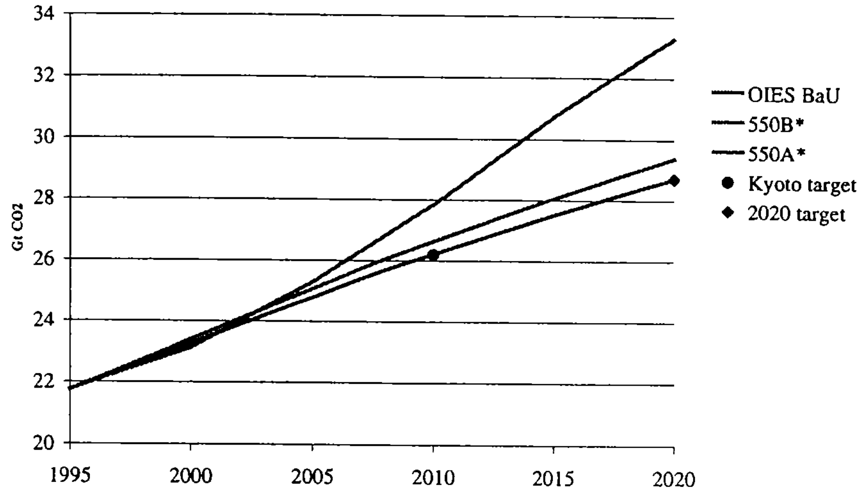
Kyoto scenario

- Kyoto protocol targets extended to 2020
- Japan and EU limits use of the Kyoto mechanisms
- Sales of 'hot air' from EIT limited
- 'Realistic' policy mix
  - Use of flexible mechanisms
  - Carbon tax/National quotas
  - Energy tax
  - Energy efficiency
  - Sinks

'Sizing the Cake' in the ambitious scenario: Global CO_2 energy emissions



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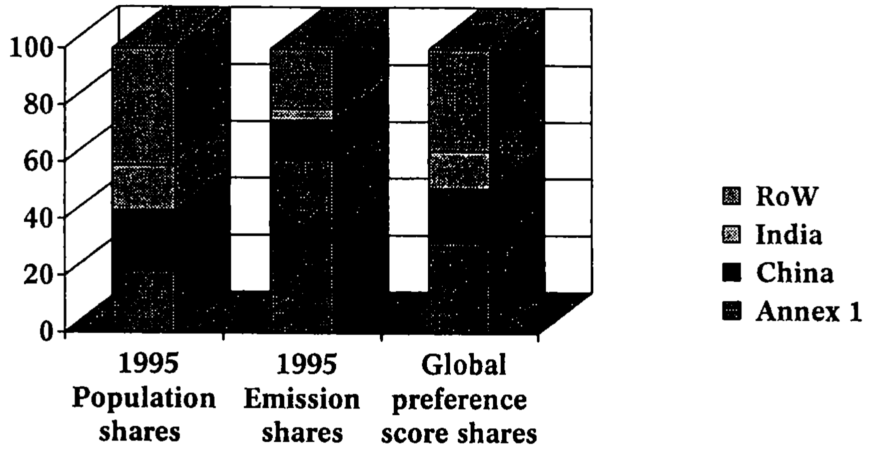
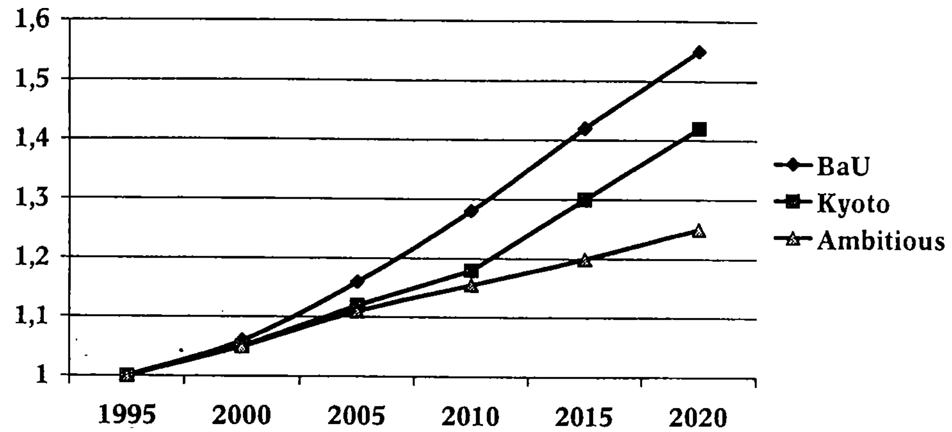
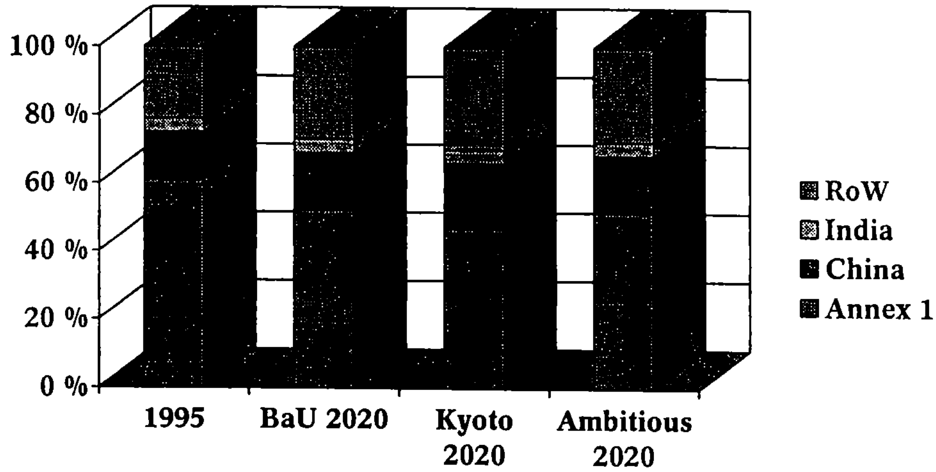
Ambitious scenario: "Distributing the cake"



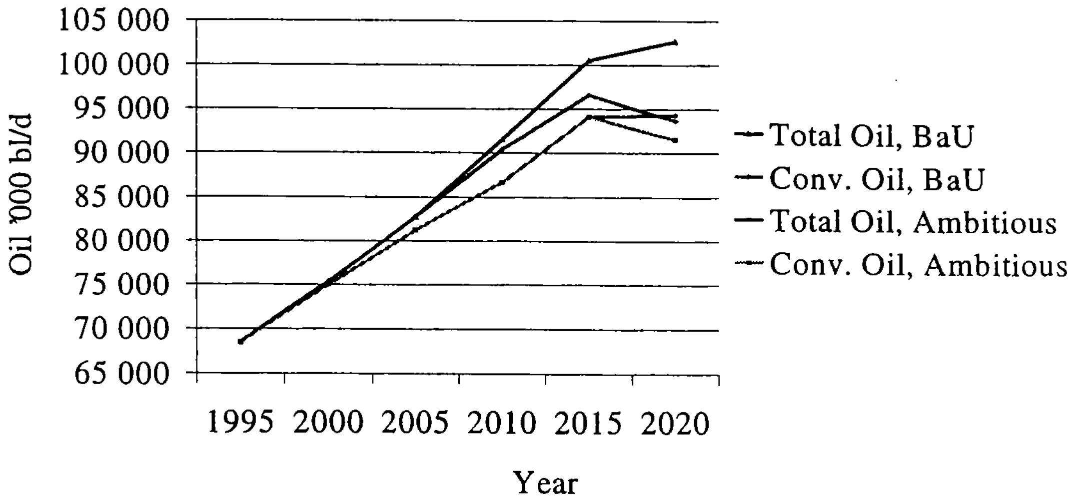
Energy CO_2 and Fugitive-Fuel CH_4 Emission Index



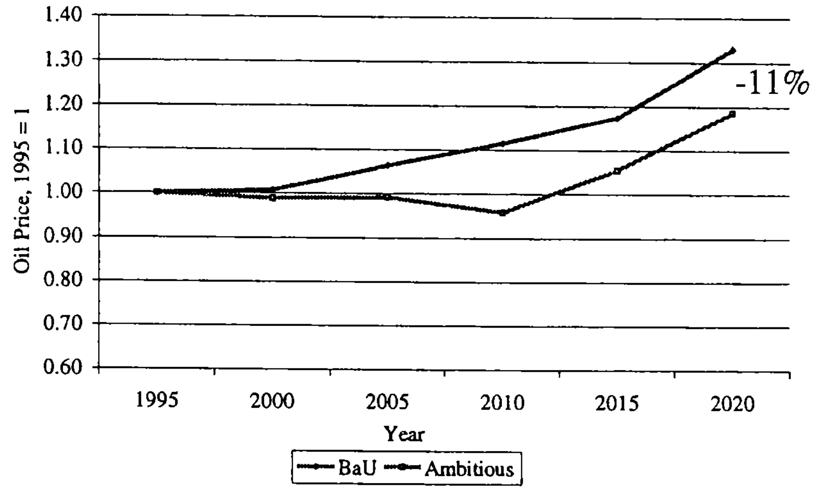
Emission shares



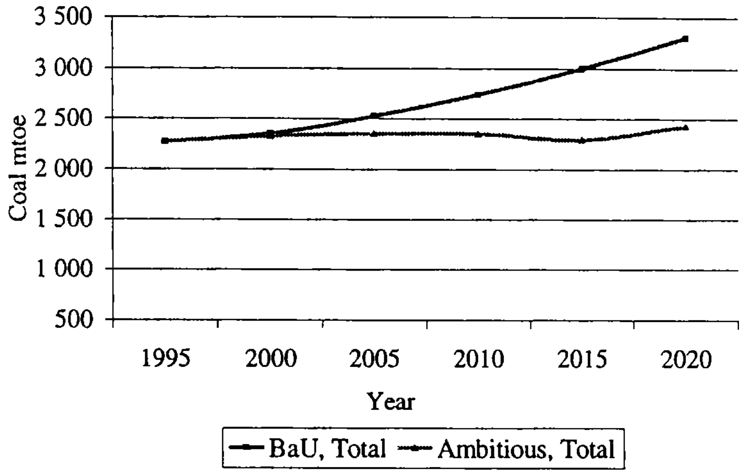
Oil supply - BaU and Ambitious



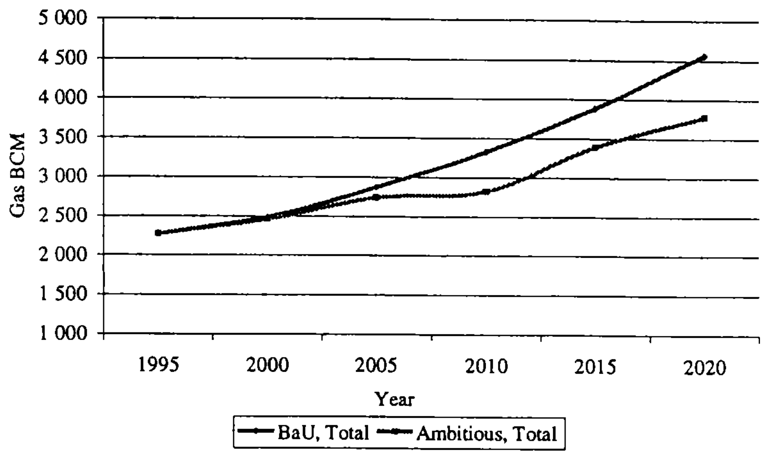
Oil price index - BaU and Ambitious



Coal consumption - BaU and Ambitious



Gas use - BaU and Ambitious



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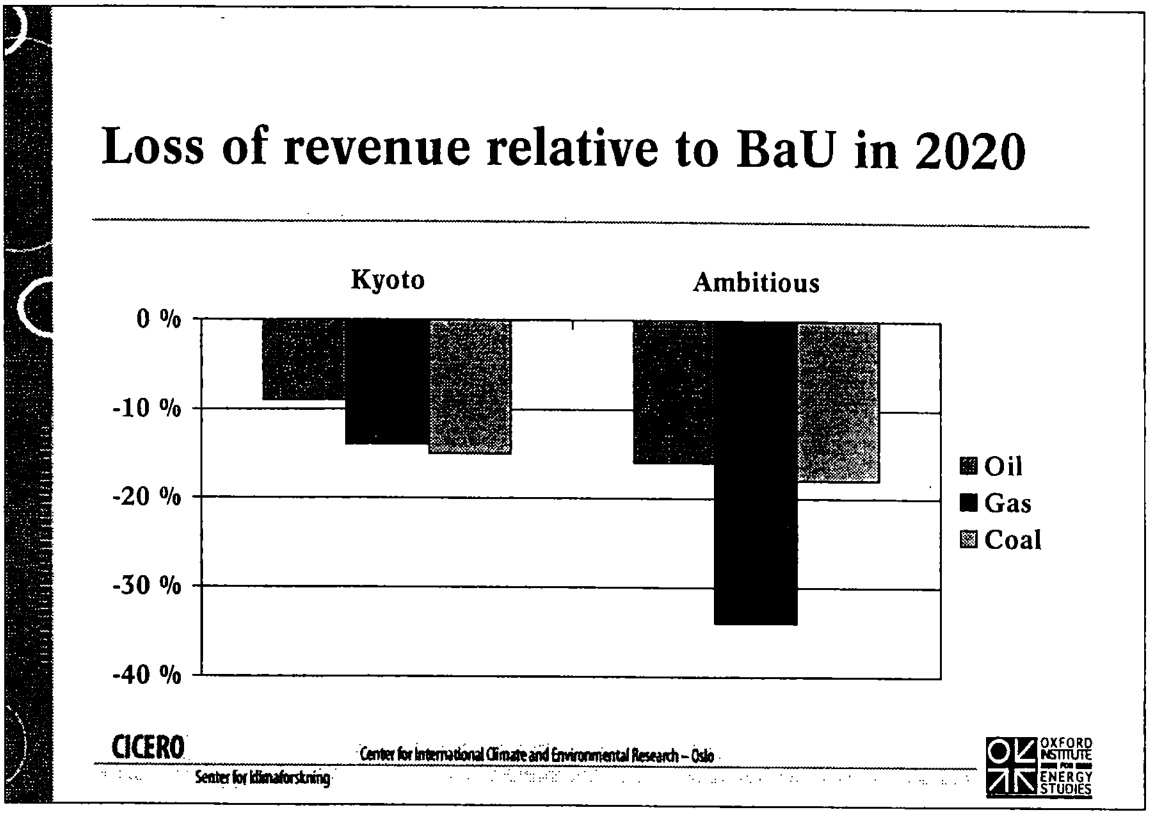
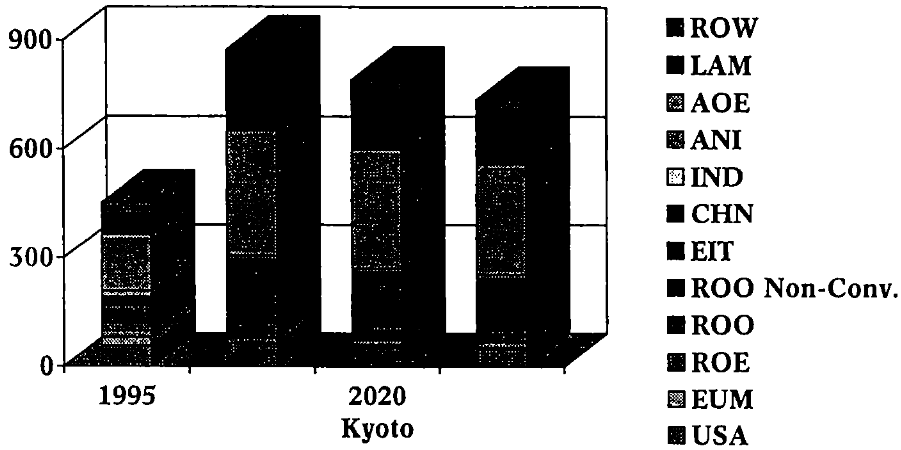
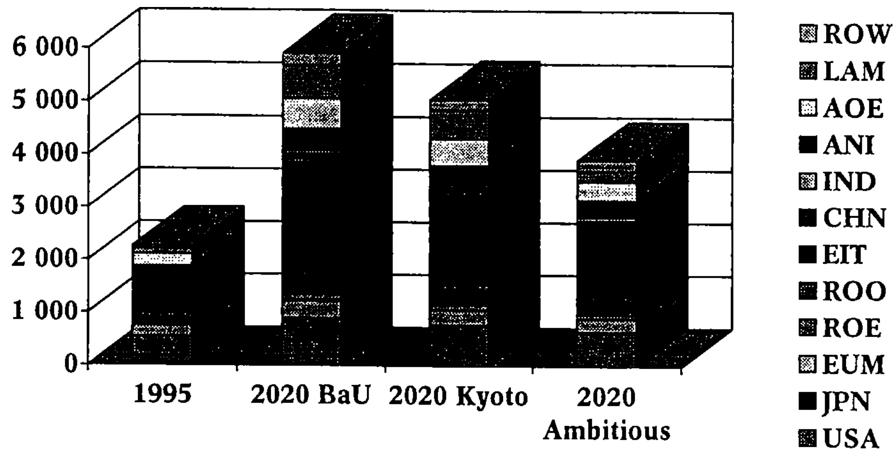


Countries exporting oil more dependent on oil revenue than coal and gas producing countries

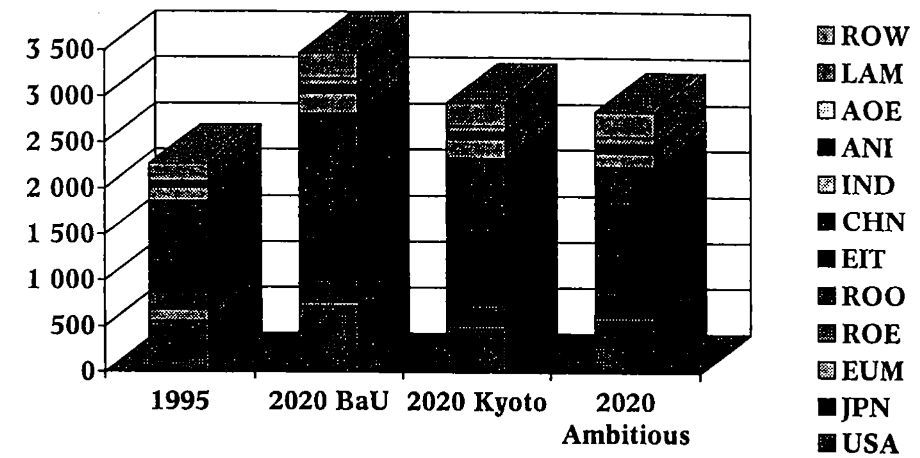
Oil revenue indices

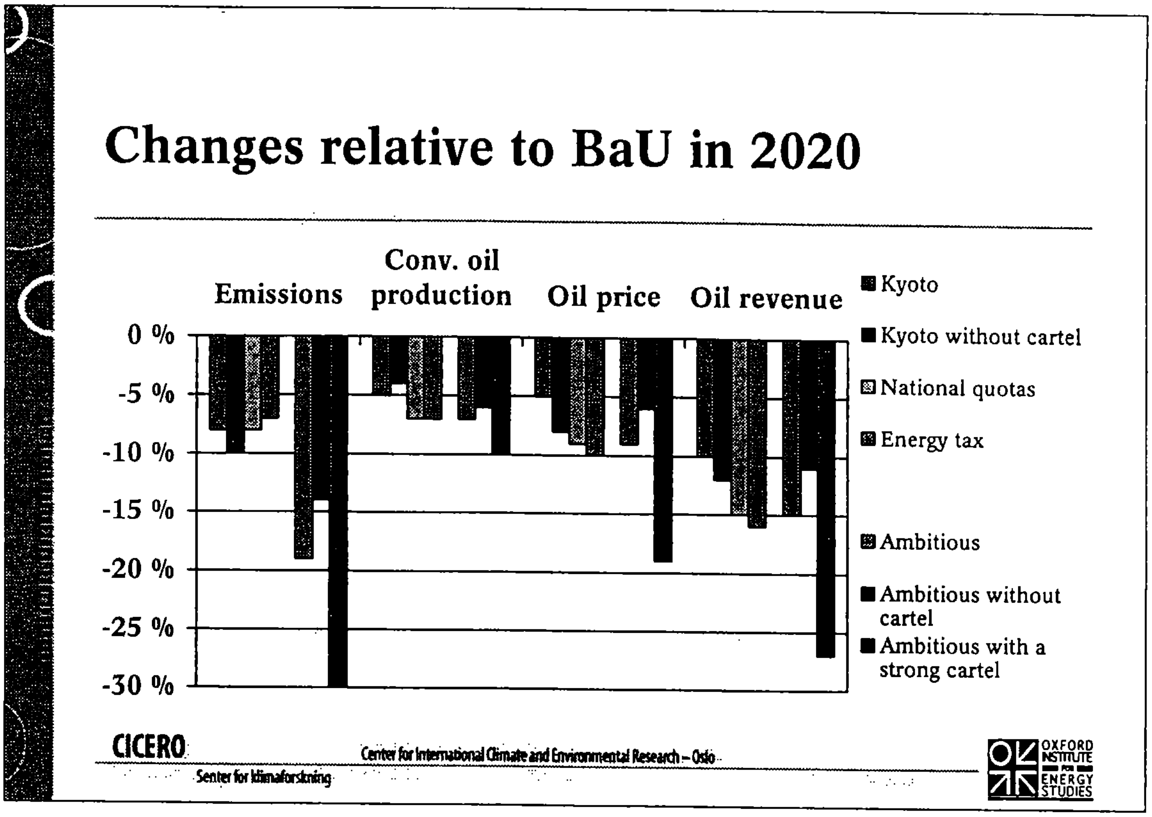


Gas revenue indices



Coal revenue indices





Oil exporting countries could be expected to argue strongly in favour of the flexible mechanisms

Some conclusions

- Climate policy affects all producers of fossil fuels
- The choice of policy intruments matters
- Oil producers should argue for the full use of the flexible mechanisms

The Kyoto Protocol and its impact on global oil markets up to 2020

Knut H. Alfsen
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The question

The question posed in the presentation is: What are the impacts of climate protocols on oil production revenues?

The answer

To help answer this question, I will use the CLIMOX[1] model, developed by the Oxford Institute for Energy Studies. This model is a general equilibrium model and covers 13 sectors in 12 world regions. Although a number of model-based climate policy studies have already been performed, this study has a number of advantages, including the following:

- It explicitly addresses the issue of oil supply, including non-conventional oil;
- It includes fugitive methane emissions;
- And it is has been able to take into account the likely variation in policy development from region to region, thus producing more realistic policy scenarios.

After I elaborate on these advantages, I will then describe some of the fundamental assumptions underlying the construction and use of the model. Thereafter, I will present the three scenarios developed by using the CLIMOX model:

1) A business as usual scenario up to the year 2020,
2) A scenario prolonging the Kyoto Protocol to 2020, and — assumes Rus/Ukr permit cartel, EU/Jap l… use of K… me…
3) An ambitious scenario where the greenhouse gas emissions of all countries are regulated.

The impacts of these policy scenarios on emissions and fossil fuel markets will be illustrated with special emphasis on effects on revenue from fossil fuel production.

Some conclusions

While income from oil, gas and coal production is expected to decline with the establishment of climate regimes compared to the business as usual scenario, the distribution of losses among regions varies according to the fuel under consideration. Also the distribution of revenue losses is strongly affected by the type of protocol (restricted to Annex I-countries in the case of the Kyoto scenario and global in the Ambitious scenario) and the type of policy instrument employed to reach the emission targets (that is, flexible instruments vs. command and control). Finally, the potential emergence of cartels in the market for emission permits will have an impact on future fossil fuel revenues.

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[1] A full presentation of the model and the studies carried out by the use of the model is forthcoming in a book titled "Fossil fuel in a changing climate" to be published by the Oxford University Press in April 2000.

Tariq Ban
Tellus Institute

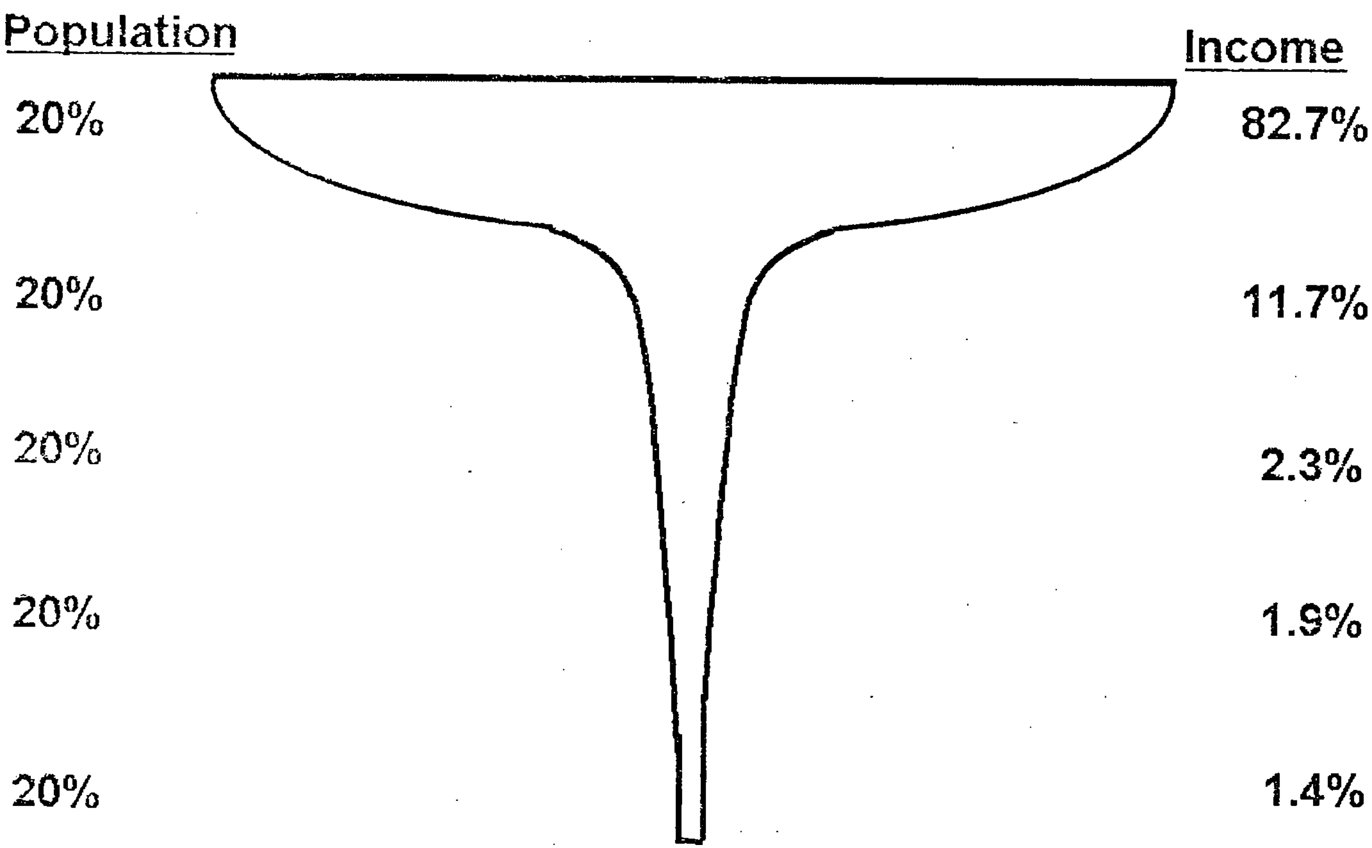
Sustainable Development

- Meeting the needs of the current generation without compromising the ***ability*** of the future generations to meet their own needs.

...The Brundtland Commission

- Ability = capacity for sustainable development = necessary but not sufficient condition

Global Income Inequity



The “2 billion” Poor

Alternative Approaches

- Static approach: finance, welfare increase
- Dynamic growth theory
  - Rent creation=> incentives for investment or rent seeking (transparency, governance)
  - Gradualism versus sudden changes
  - Dollar report: successful ODA as leveraging
  - Institutional structure (value chains, certification)

Sustainable Livelihoods

Coping Strategies

Asset Base of the Poor: physical capital, human capital, natural capital, technological capital, social capital

Vulnerability

Capacity

Capacity for Sustainable Development

- Climate Capital
- Conventional capacity
  - Financial Capital
  - Technological Capital
  - Ecological Capital
  - Social [equity] Capital
  - Institutional Capital
  - [Cultural Capital]

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Climate Capital

Correlation between emissions and PCI

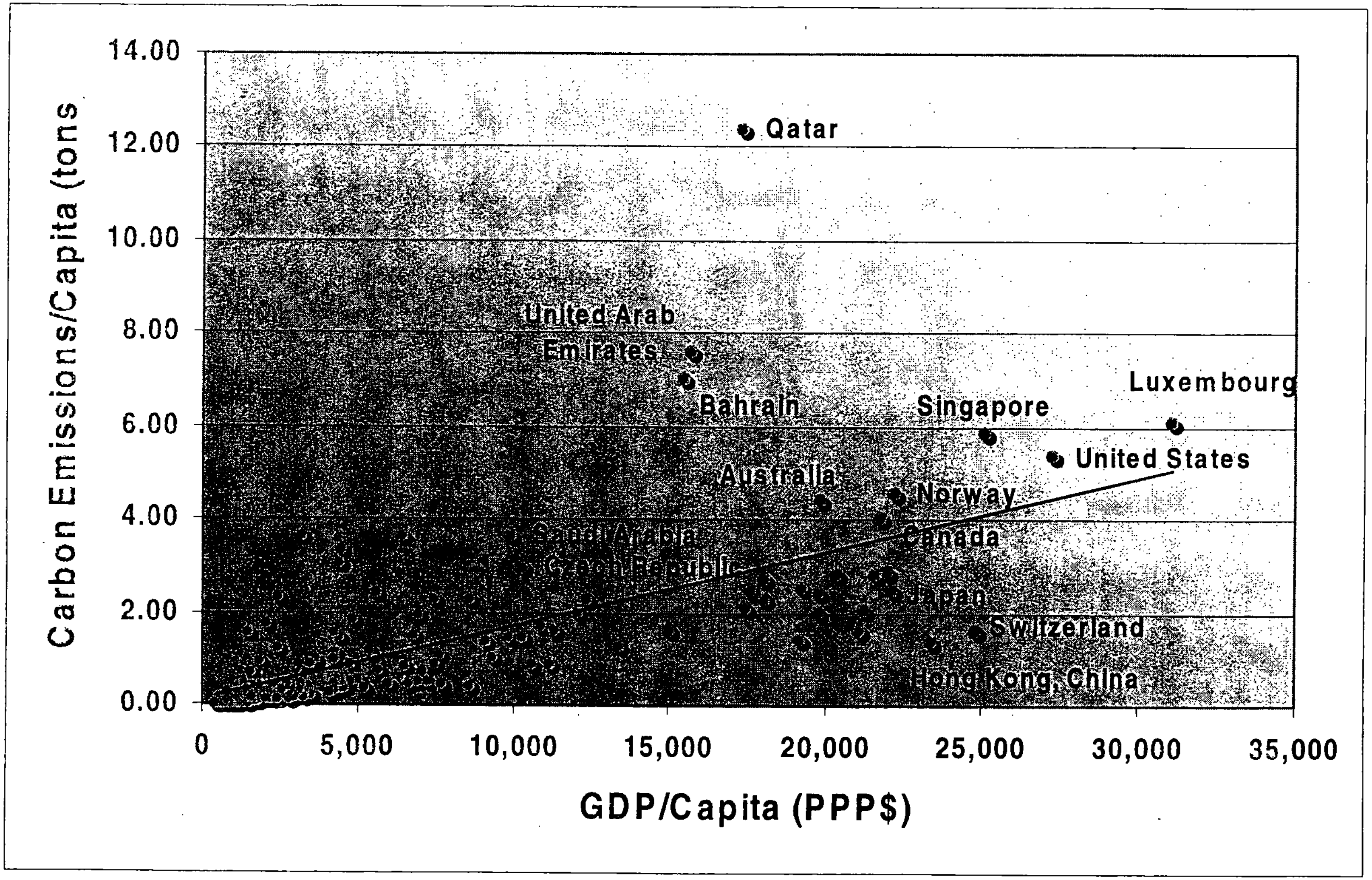
– Cross-section and time series

Carbon intensity indicator: possibility of sustainable development transition through increase in carbon intensity

In medium term, increase in emissions from 0.3-0.5 tC/cap to 1-2 tC/cap indicated

Long-term feasibility: 0.25-0.3 tC/cap

Relationship of Carbon Emissions to Income



Source: World Bank (1998); Marland, *et al.* (1998).

World Carbon Emissions by Region

Reference Case, 1990-2020 (Million Metric Tons)

Region/Country	History			Projections		Avg. Ann. % Change
	1990	1996	2000	2010	2020	1996-2020
North America	1550	1687	1833	2079	2314	1.3
United States	1346	1463	1585	1790	1975	1.3
Canada	126	140	151	162	182	1.1
Western Europe	936	904	947	1021	1114	0.9
Industrialized Asia	364	389	377	435	479	0.9
Japan	274	291	273	322	358	0.9
Australasia	90	99	103	113	122	0.9
Total Industrialized	**2850**	**2980**	**3157**	**3535**	**3907**	**1.1**
Former Soviet Union	991	613	583	666	746	0.8
Eastern Europe	299	228	243	270	277	0.8
Total EE/FSU	**1290**	**842**	**827**	**935**	**1024**	**0.8**
Developing Asia	1065	1474	1659	2426	3377	3.5
China	620	805	930	1391	2031	3.9
India	153	230	273	386	494	3.2
Middle East	229	283	323	434	555	2.8
Africa	178	198	214	270	325	2.1
Central and South America	174	206	251	418	629	4.8
Total Developing	**1646**	**2161**	**2447**	**3547**	**4886**	**3.5**
Total World	**5786**	**5983**	**6430**	**8018**	**9817**	**2.1**

Sources: History: EIA, *International Energy Annual* 1996; Projections: EIA, *Annual Energy Outlook* 1999

Equity and Climate Change

- Consistent principle in FCCC
  - But persistent doubts in South
- 4 different approaches
  - Silenced: tradable permits/ rights to commons
  - Ignored: Liability for damages
  - Muted: 2 billion excluded
  - Actual compromise: commitment, no payment, space for SD (but not Australian model)

The Compromise on Equity

No payment for South for any commitment (but persistent fears of it being overturned)

Not the same thing as a lack of willingness to act (i.e. to combat climate change)

Refusal to accept restrictions on the ***space*** for sustainable development

Commitment contingent on **explicit** demonstration of Northern commitment

Growing Southern Emissions

Pinguelli-Rosa, La Rovere, Ribeiro, Tolmasquim 1998

- 1990: Only 20 per cent emissions from non-Annex 1
- 2016: 50 per cent emissions from non-Annex 1
- 2056: 50 per cent of contribution to atmospheric carbon concentration
- 2118: 50 per cent contribution to global temperature increase

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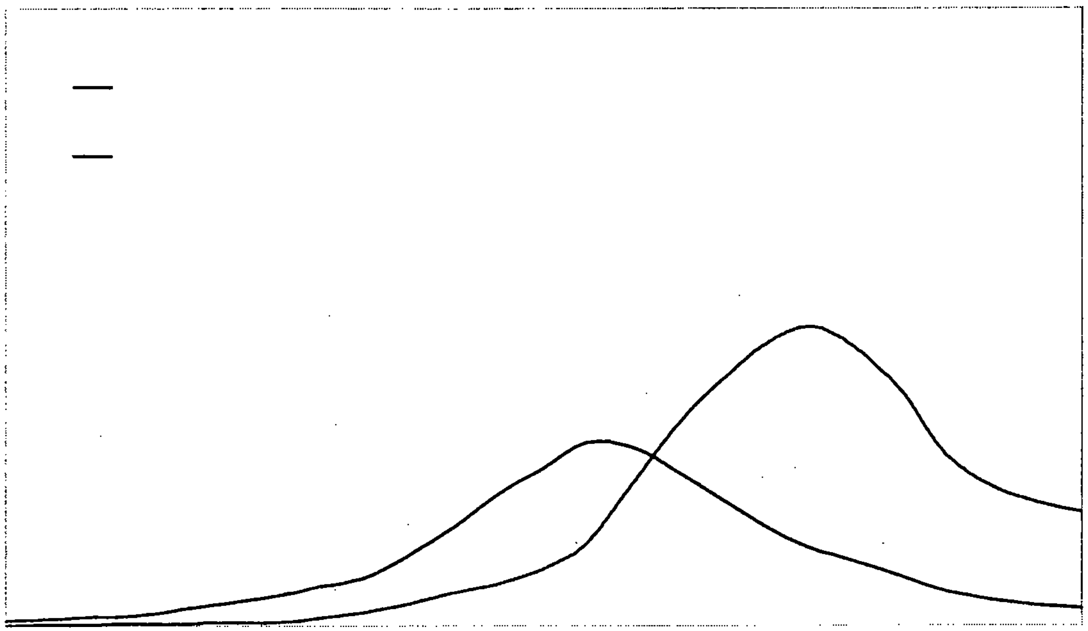
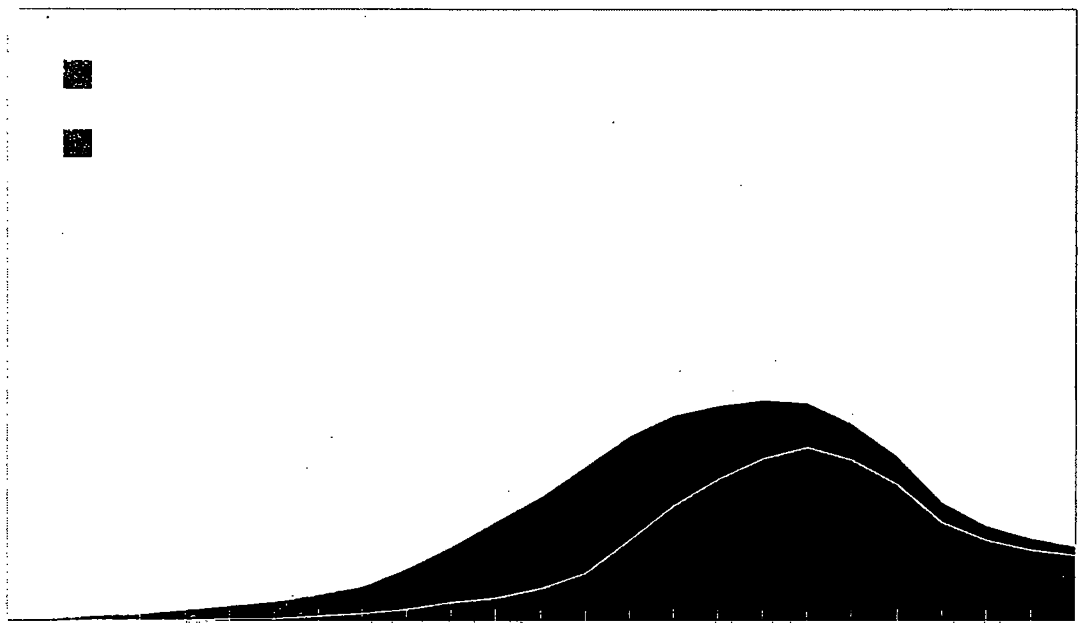
Carbon Trajectories for Stabilization at 450 ppm

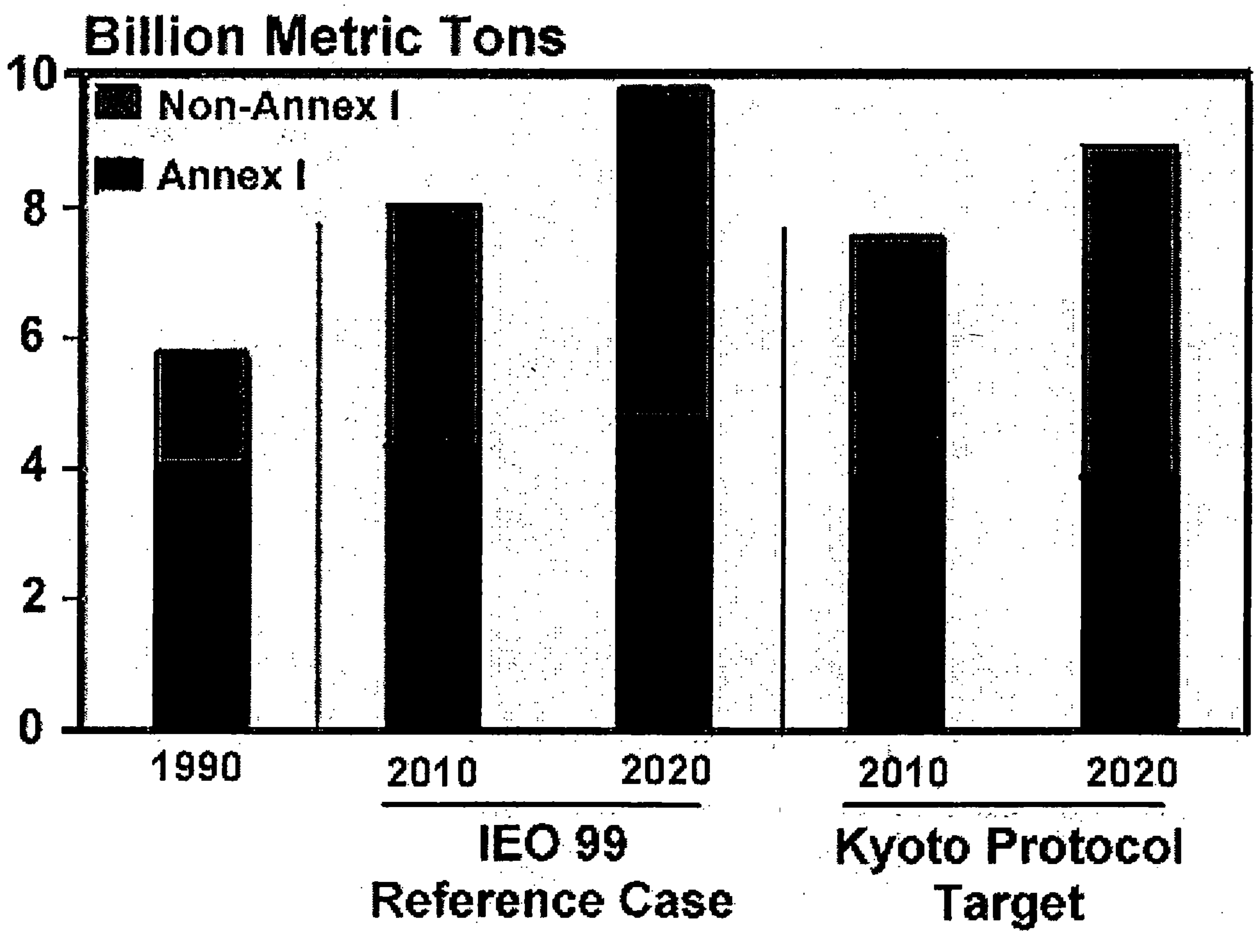


Carbon Trajectories for Stabilization at 450 ppm

Cumulative emissions	:	650 GtC
1990 emission rate	:	6 GtC/yr
2100 emission rate	:	3 GtC/yr



Growing Southern Emissions



Source: U.S. Department of Energy - *International Energy Outlook 1999*

Growth Caps: An Emissions "Guessing Game"

Source: World Resources Institute

Financial Capital and SD

ODA Future Trends and Baselines

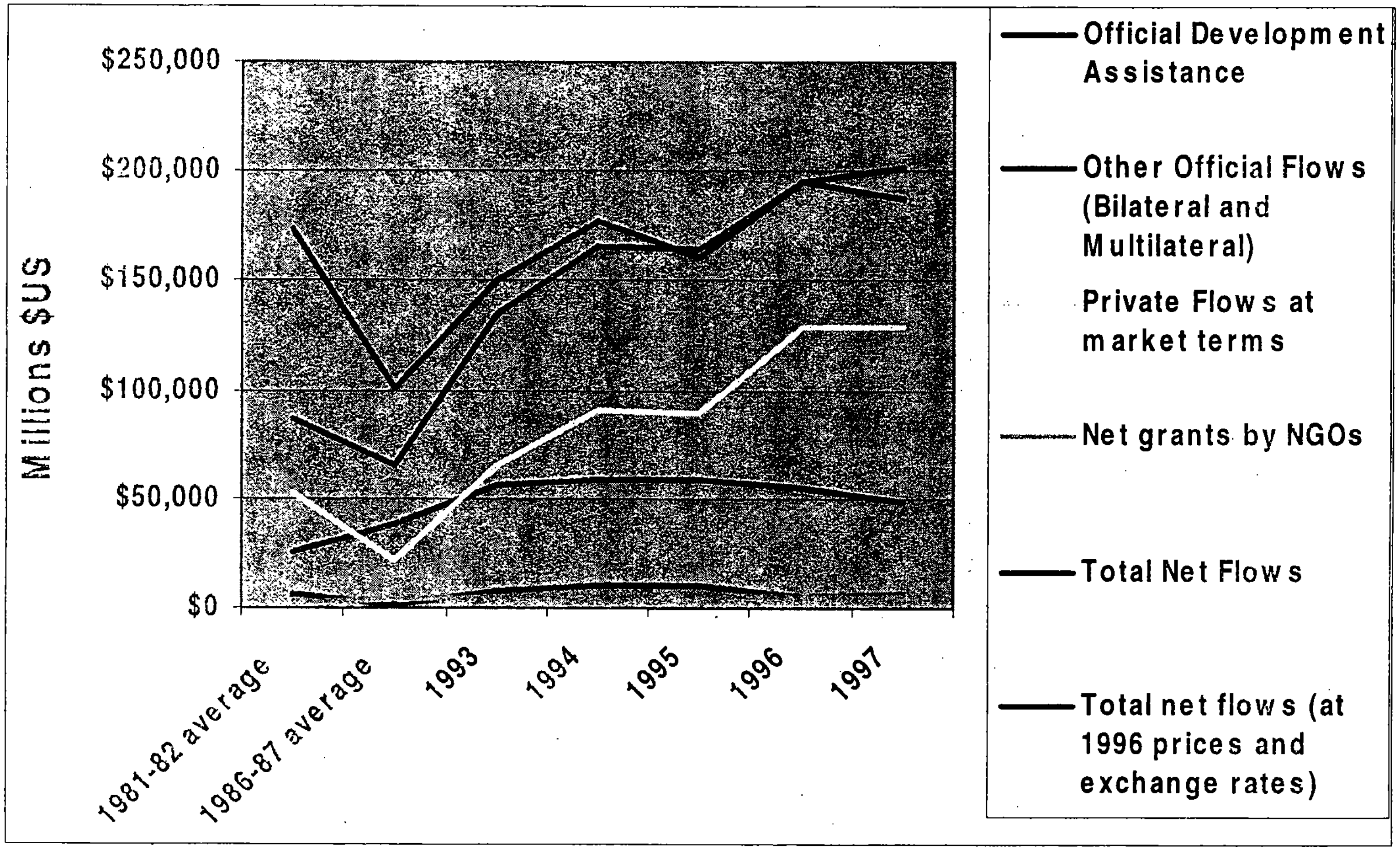
ODA-CDM Fungibility/Complementarity

Separate CER and FDI. What will happen to CER? Table

How to maximize CER earnings?

Human Security for the 2 billion poor.

Capital Flows to "Developing" Countries



Source: OECD, Development Assistance Committee (1998)

Estimates of the CDM Market in 2010

Sources: Edmonds *et al.* (1998); Ellerman and Decaux (1998); Haites (1998b); McKibbin *et al.* (1999); Van der Mensbrugghe (1998); Vrolijk (1999); Zhang (1999).

CO2 Permit Price Simulations

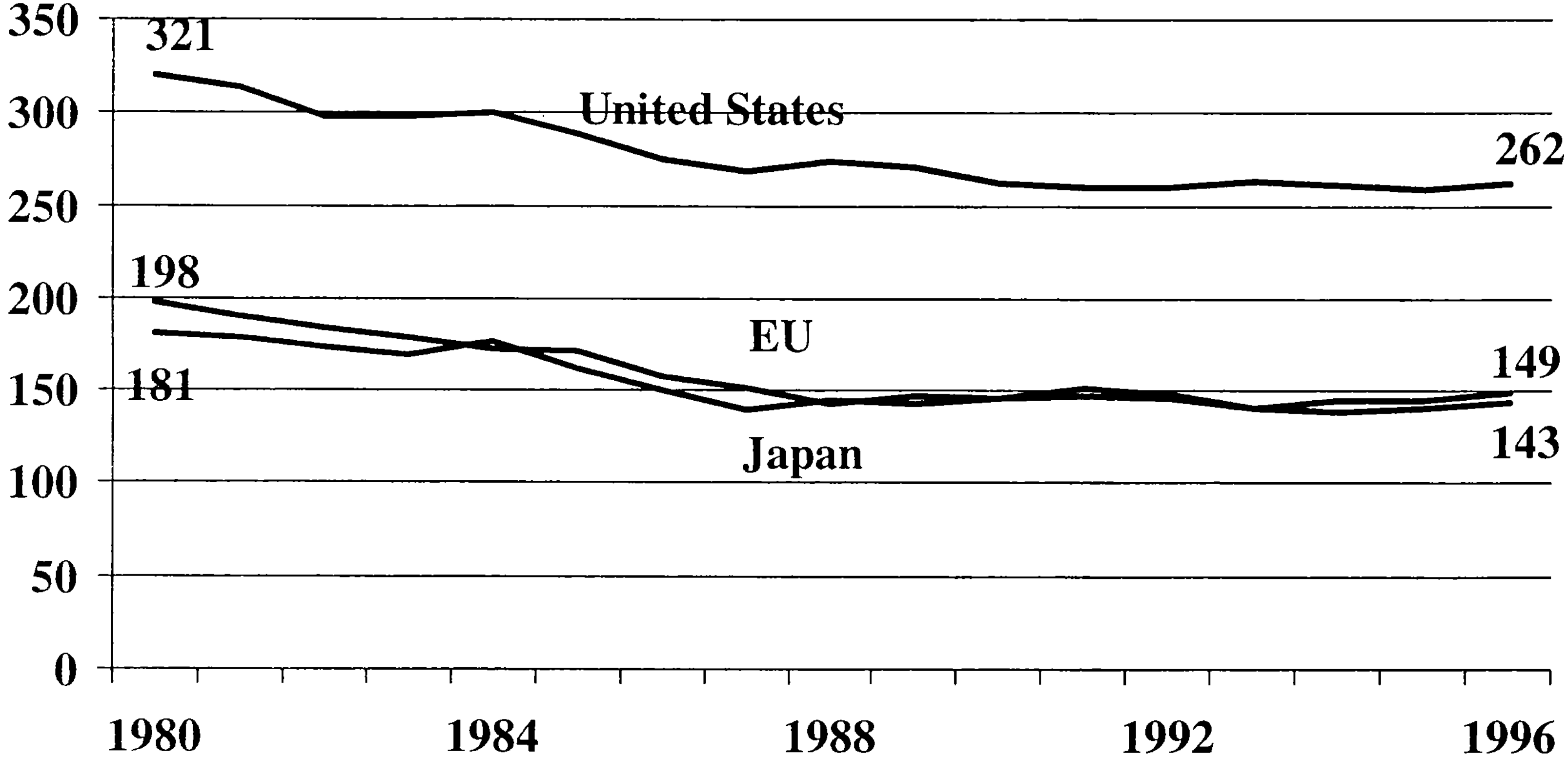
EU = European Union; CEE = Central and Eastern Europe; Annex I = OECD (US and EU) and CEE; World-wide = all nations (Annex I + developing countries).

Technological Capital

- Incentive for renewables transition
- Technology for Sustainable Livelihoods
- Experience with AIJ projects
- Experience with FDI. Code of conduct
- Value chains approach. “Certifier-driven” value chain

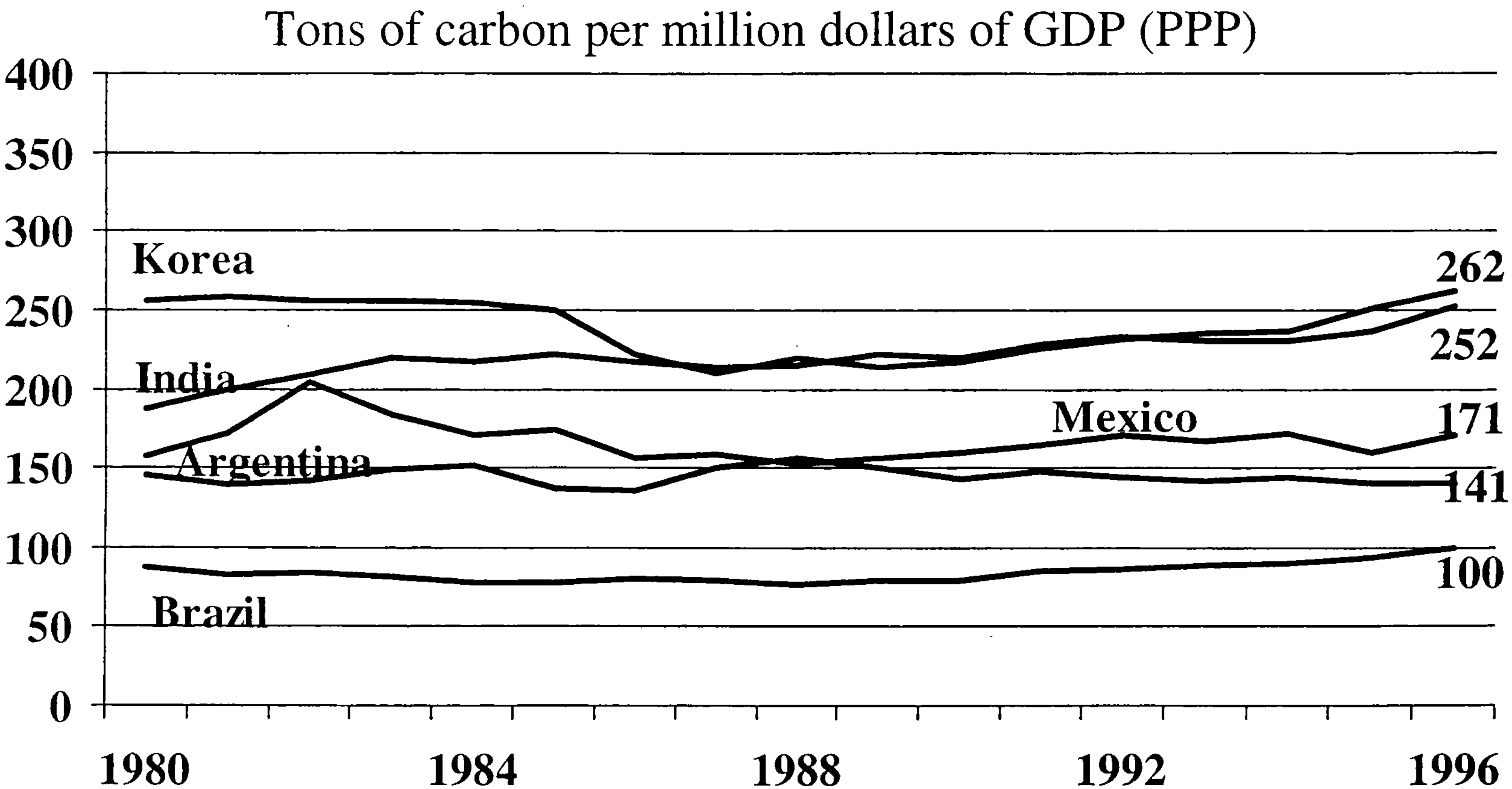
Industrialized Countries: Carbon Intensity

Tons of carbon per million dollars of GDP (PPP)



Source: World Resources Institute

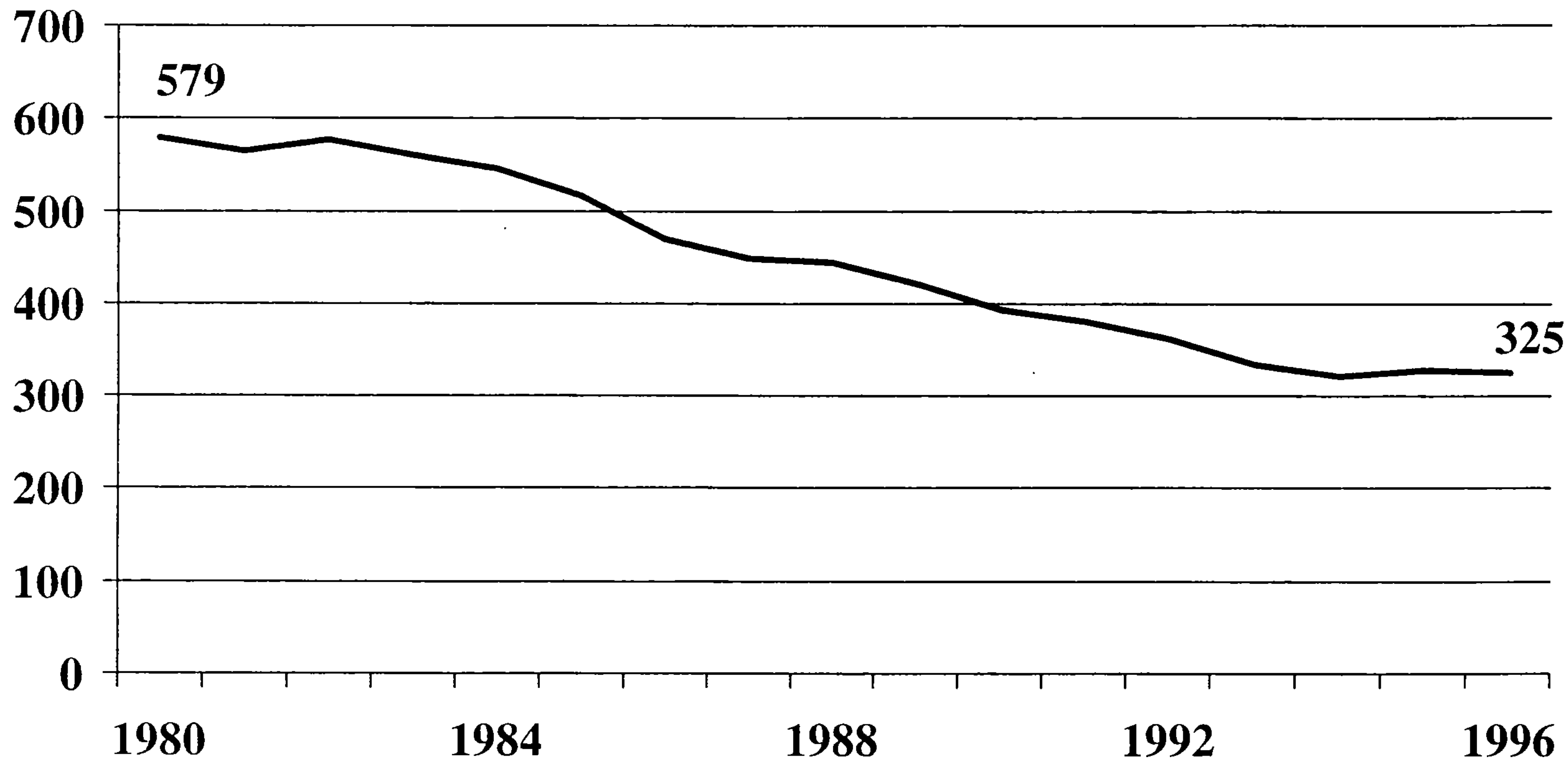
Developing Countries: Carbon Intensity



Source: World Resources Institute

China: Carbon Intensity

Tons of carbon per million dollars of GDP (PPP)

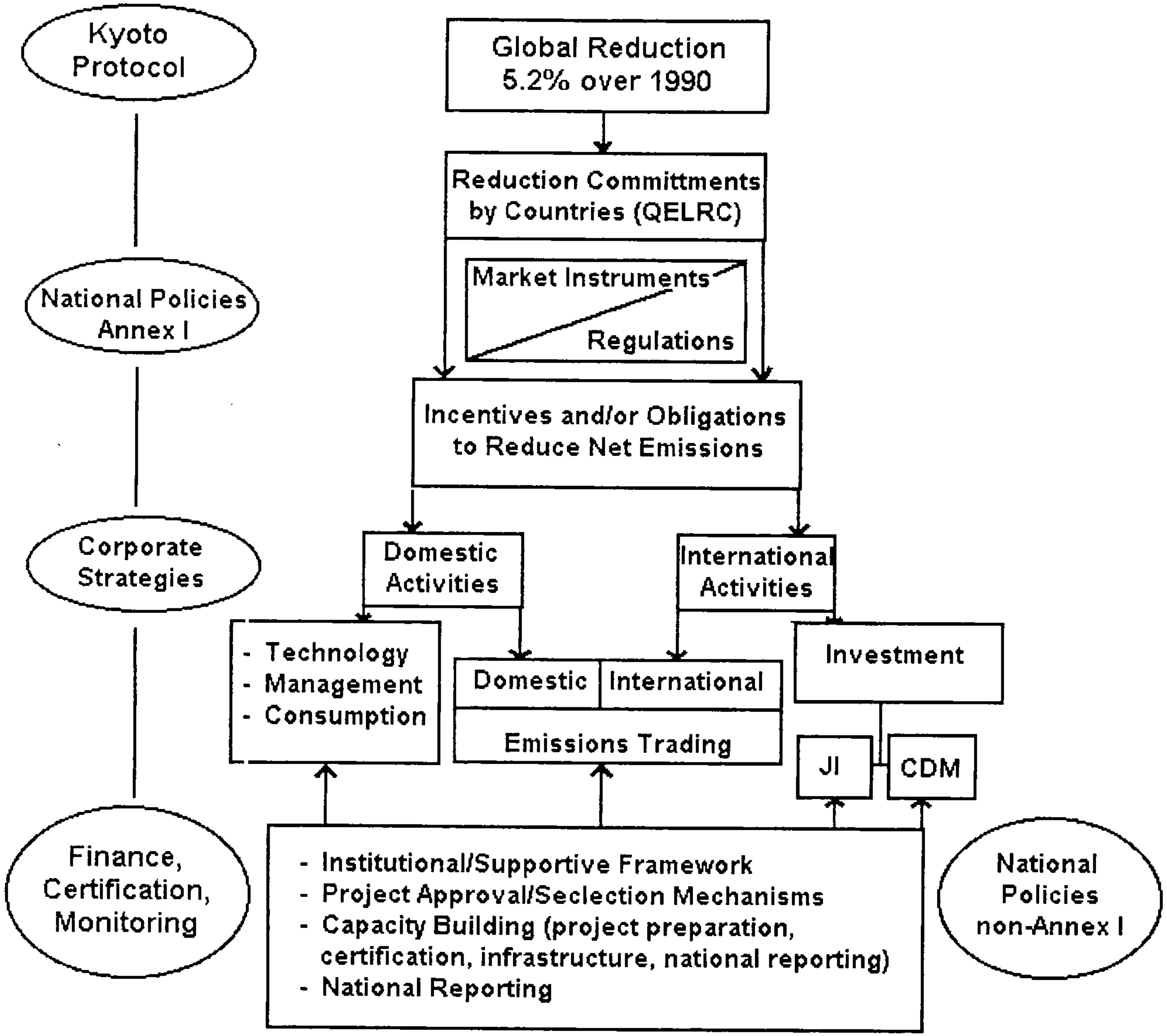


Source: World Resources Institute

Institutional Capital

- National: Planning, research, policy development, establishment of priorities, selection of projects
- Local: Community institutions, links between poverty, resource management, and protection against global impacts
- Global: research capacity, advocacy, policy agreements

Kyoto Mechanisms



Recommendations

Renewables transition

sustainable livelihoods

Capacity building for certification, monitoring, project preparation, self-protection, research and policy development

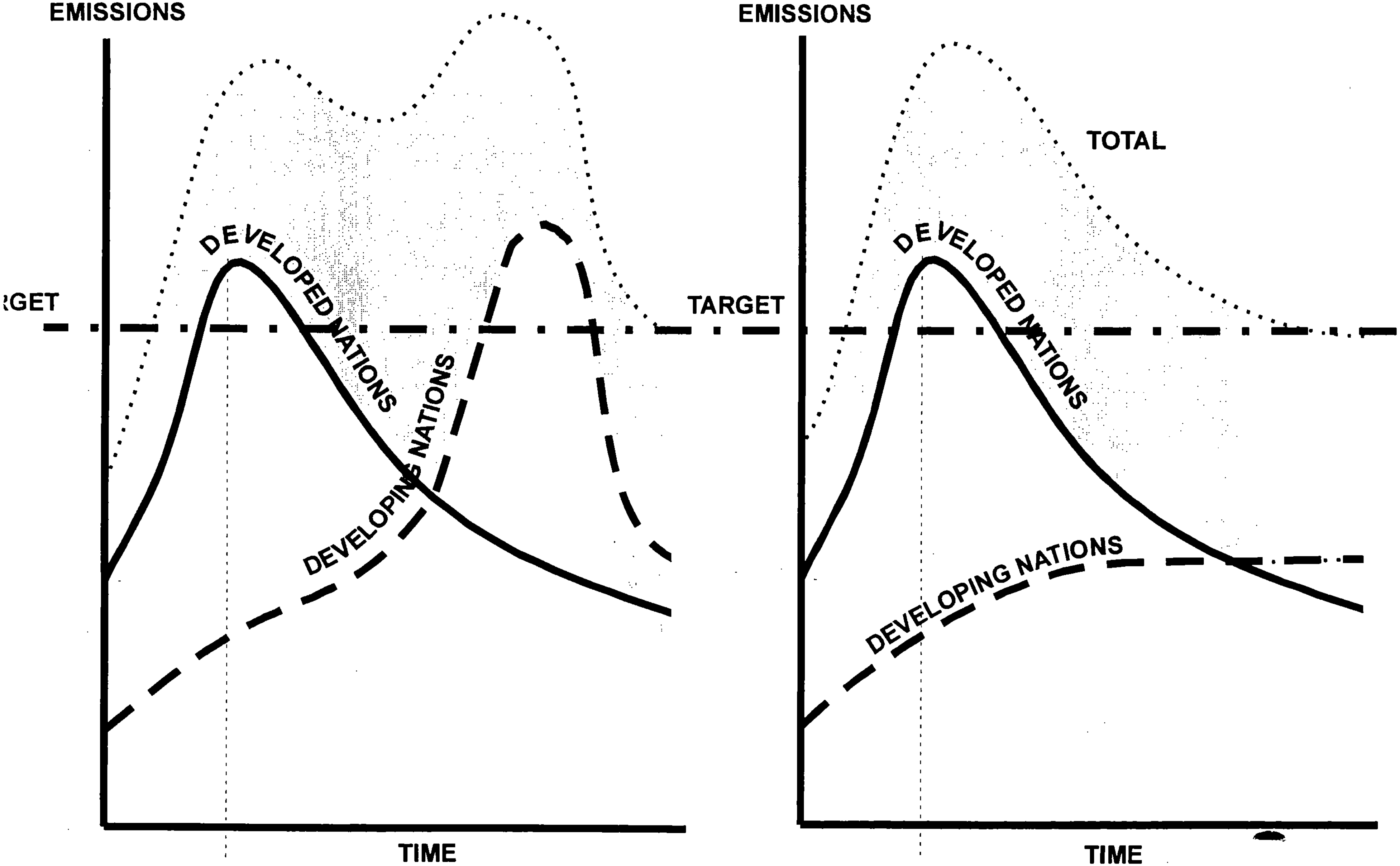
Baselines on ODA

National adaptation funds

Gradualist approach

Code of Conduct

GLOBAL EMISSION SCENARIOS



UNFCCC PRINCIPLES

- Article 3.2 and 3.3 emphsise the special needs of developing countries that would have to bear a disproportionate or abnormal burden, should be given full consideration, and account must be taken of different socio-economic contexts.

Proposed Strategies

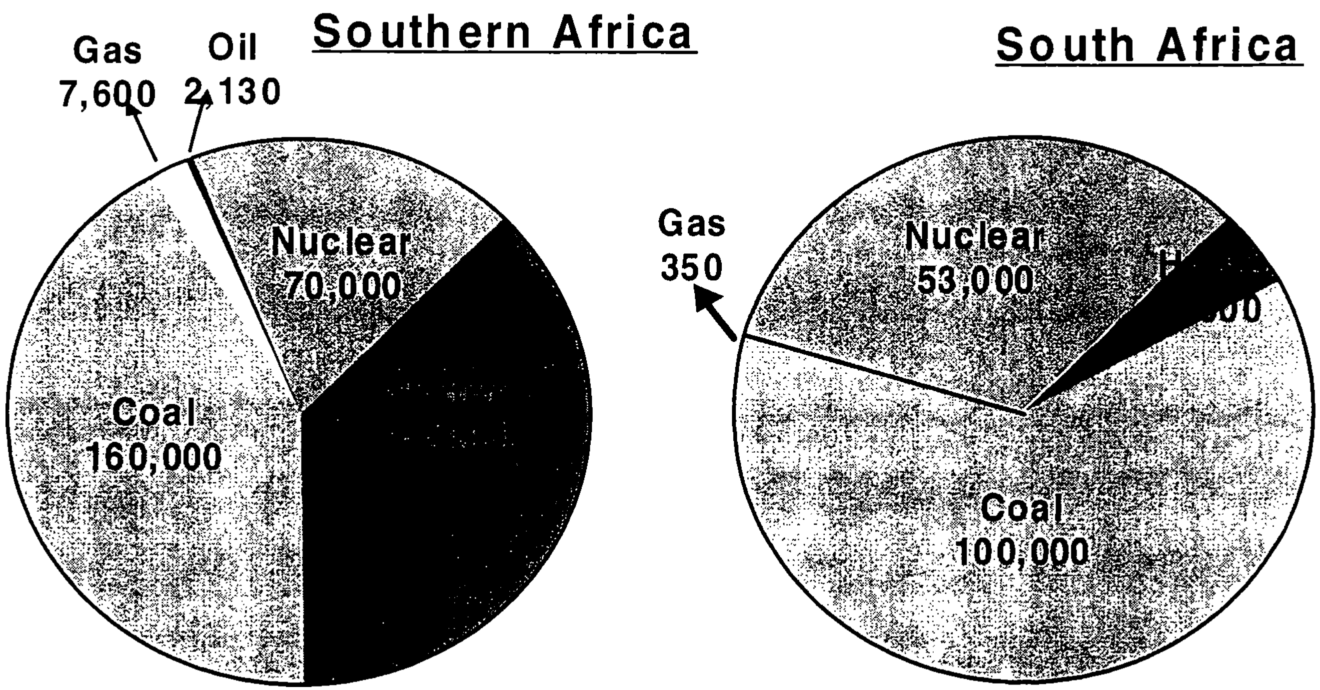
- **Long Term Policy Measures**
  - A1 look at domestic mitigation measures first such as reduction of local fossil usage.
  - Technology transfer linked to restructuring economies dependent on primary fuel income to service industries.
  - Technology transfer link to CDM and adaptation fund
  - Forced leakag

Proposed Strategies

- Actions not ‘wait & see’, nor ‘act now’, but rather sequential approach
- **<u>Short Term Policy Measures</u>**
  - **Modeling and scenario work on response measures impacts and actions, and development, equity and sustainability with explicit terns of reference from the Parties. Peer review by Party representatives**
  - **Technical review of mitigation measures as set out in the National Communications from A1.**
  - **R&D on macroeconomic impacts, N/A 1 asset base, social impacts and range of compensation measures**

Southern African Market Potential

ENERGY RESOURCES



Total : 380,000 MWe

Total : 161,000 MWe

DEVELOPMENTAL IMPACTS

- **Positive Externalities impacted:**
  - Job creation through FDI
  - Labour dependency of Zimbabwe, Uganda, Lesotho etc.
  - Electrification programme
  - Energy trading pool with SAPP
  - Black economic empowerment

- **All the above can be extrapolated for developing economies revenue dependent on oil, gas and energy-intensive products**
- **African export potential**

DEVELOPMENTAL IMPACTS

- Approximately 1.3 billion people have incomes of < 1USD per day and +2 billion without access to electricity and modern cooking fuels.
- More than 80 countries have lower incomes than a decade ago
- Any negative impacts on GNP of fossil dependent countries is significant
- Economic multiplier effect : increase in local price of fuel-stranded assets-investment decisions based on low fuel price eg Mozambique smelter based on cheap electricity from S.Africa/ Investment decisions of countries in Africa

Key Policy Issues

- The scale of regulation implemented and the "carbon value" that would be built into fossil fuel prices to meet the KP targets
- Cumulative impacts on "fossil countries" of both response measures and adverse impacts
- Above statements are equally applicable to oil and gas.

Key Policy Issues

- The business as usual (BAU) projections provides a likely outcome based on current policy environment.
- Variations from the BAU assumptions, especially policies adopted and measures taken by developed countries to reduce their GHGs, could produce marked deviations from the BAU projections.

Non-annex 1 Market Dynamics

- Indonesian coal production has been dominated by exports, over 75% in 1995. Exports continue to rise rapidly by 23% in 1995 and by 16% in 1996
- South Africa is the third largest coal exporter in the world. Further capacity is planned for expansion in the future.

Non-annex 1 Market Dynamics

- China and India will exert a large influence on the level of Asia's coal production and international coal trade. China could retain its position as a significant exporter of coal
- Columbia is already an established coal exporter with plans for significant expansion to US and European markets.
- Venezuela is similarly placed to Colombia with good quality coal and access to European and US markets. Infrastructure development from current export revenue.

Annex1 Market dynamics

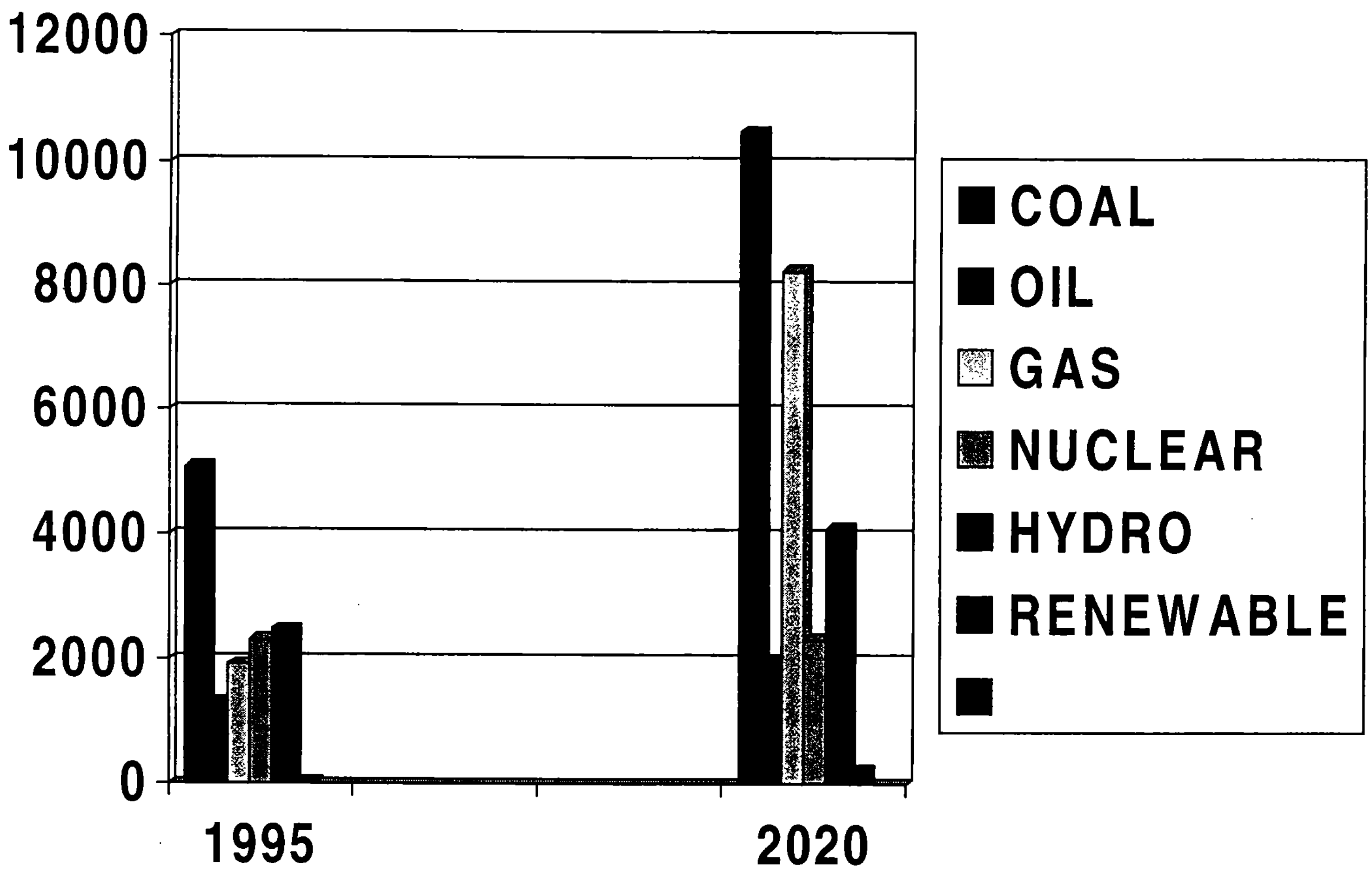
- USA major player in the international steam coal market, but high price a factor. In general, changes in the US domestic market are pushing for investment in low sulphur coal for domestic market, leaving surpluses of higher sulphur coal for export.
- Canada exports primarily to Japan, Korea, Chinese Taipei and Brazil.
- Australia's ability to increase its exports to Asia, dependent on ability to compete with Indones˙a, S. Afr˙ca and Ch˙na

Market Dynamics (BAU)

- 2035 total emissions estimated @ 11.71 billion tons CO2-(1995 6.46 billion) of which 50% is Annex1
- IEA BAU projections are that fossil fuels are expected to meet 95% of additional global energy demand from 1995-2020.
- Major exporters from non-A1 are South Africa, Indonesia, PR China, Columbia and Venezuela
- Percentage of internationally traded coal will increase with projected growth in emerging markets

BUSINESS AS USUAL PROJECTION-WORLD

ELECTRICITY GENERATION (TWh) IEA database



Coal Market

Coal -major fuel for generating electricity. Dependent Annex 1 countries include:

■ Poland	96%
■ Australia	86%
■ Czech Rep	73%
■ Greece	70%
■ Denmark	59%
■ USA	56%
■ Germany	51%
■ Netherlands	42%
■ Japan	37%

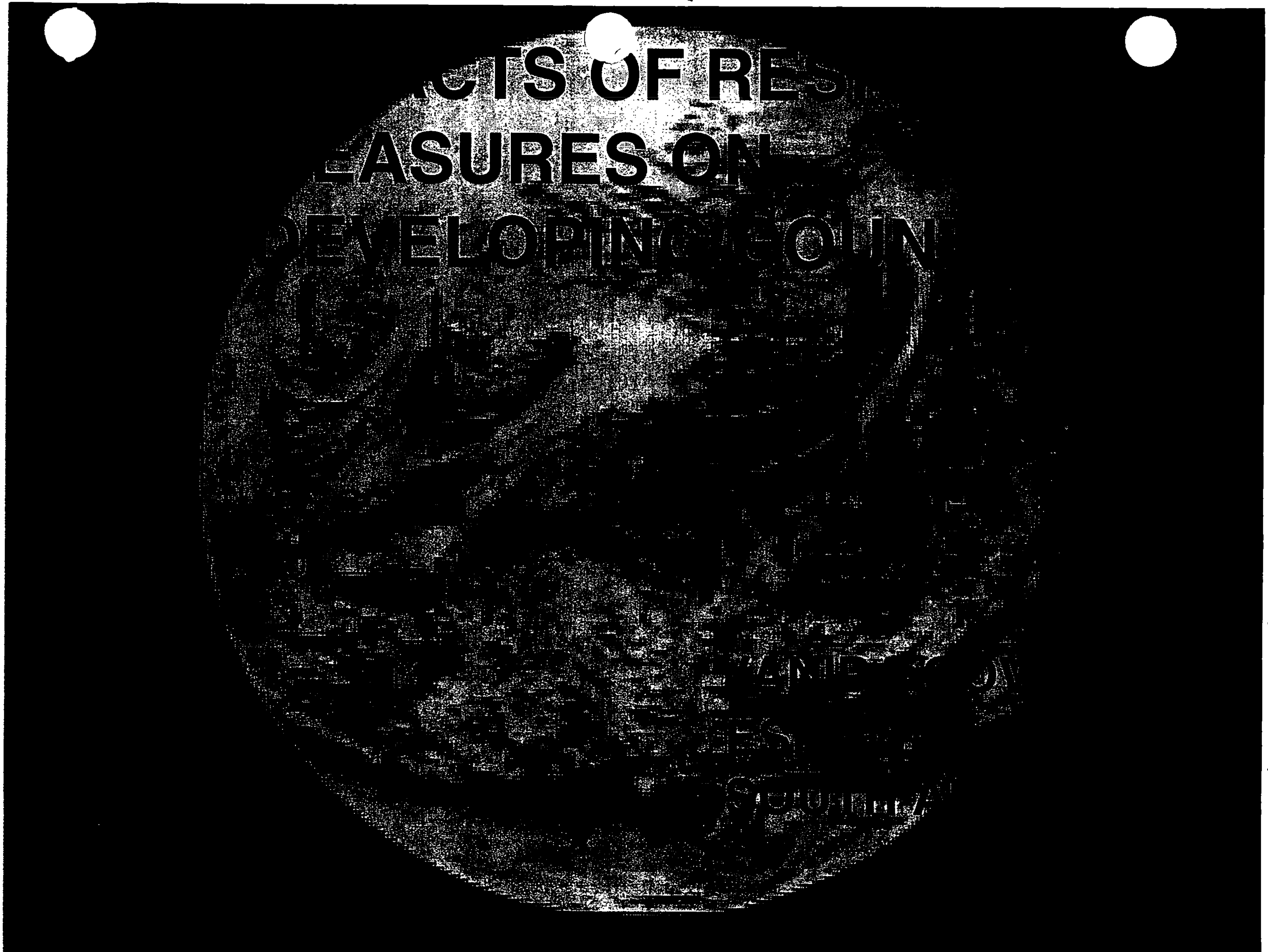
Major Coal producers Include (WCI 1998) :

- China 1,236 Mt
- India 303Mt
- S Africa 223Mt
- Kazakhstan 67Mt
- Indonesia 61Mt
- Columbia 34Mt
- Venezuela 7Mt
- USA 936Mt
- Germany 240Mt
- Australia 219Mt
- Russia 149Mt
- Poland 117Mt
- Ukraine 74Mt
- UK 50Mt

Total World Primary Energy Consumption-% by Fuel

(BP AMOCO1998 DATA)

- Oil 32%
- Coal 21%
- Renewables 20%
- Natural Gas 19.%
- Nuclear 6%
- Coal provides around 26% of global primary energy needs and generates about 37% of the world's electricity needs



Vanida Govender, ESKOM

IMPACTS OF RESPONSE MEASURES ON THE LEAST DEVELOPED COUNTRIES

Presented at the UNFCCC Workshop on Article 4.8 and 4.9, Bonn, Germany From 13th to 15th March, 2000

By

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IMPACTS OF RESPONSE MEASURES ON THE ON THE LEAST DEVELOPED COUNTRIES

1. Background

1.1 Characterization of LDCs

The least developed countries (LDCs) are countries recognized by the UN system. The LDCs are characterized by unbalanced balance of trade, their n
eeds exceed their production (higher imports than exports). Both gross national product (GNP) and gross domestic product (GDP) are low in these countries.

The LDCS also have high illiteracy rates, poor health services leading to high mortality rate, poor transport infrastructure making it difficult for peasants to market their produce and very low manufacturing capacity. Although the population in the LDCs is high their purchasing power is very low making it unattractive for big investors. In an attempt to improve living conditions for the people of the LDCS governments have borrowed large sums of money. The benefits of these borrowing is not being felt by the population instead the high repayment rates of this loans is adding more sufferings to the people of the LDCs.

1.2 Population Growth

The rate of population growth is high in the LDCS. This high rate of population growth is not matched with growth in production and provision of social services such as water, health and education. The high growth rate has tended to enhance the poverty in these countries. Although efforts are being made to control population growth these efforts will take long time to achieve results because of cultural practices and religious beliefs.

1.3 Economy Activities

The economic base in many of these countries has been very narrow for a very long time. The main economic activity has been agricultural production (both crop and animal). However, recent weather and climate events are posing a great threat to this sector. Ecotourism is an economic activity that is picking up in many LDCs. Processing of agricultural products has remained very low and therefore the value of the products has continued to remain low. Fishing is also gaining importance in some of these countries.

1.4 Transport Sector

The transport sector is key to development both for movement of people, goods and services. It is also a pre-requisite to attracting investment. The transport sector has remained undeveloped in many if not in all the LDCs. Many LDCs have depended on "small mass" transport systems such as motor bikes (*boda bodas*), minibuses, pickups and light lorries. Mass transport systems are literally absent. Increasingly second hand vehicles are being imported to ameliorate the transport problems. The consequence of the undeveloped transport systems has led to high oil bills thus impacting negatively on other sectors such as water, health, education and agriculture).

2. Highly Vulnerable Countries

The LDCS are the most vulnerable to adverse effects of climate change. The population suffers from direct impacts of weather and climate events and also from the after math such as outbreaks of diseases. The economies of these countries are also vulnerable to extreme weather events. The Mozambique situation is still fresh in our minds. The human and economic losses including loss of development are very high. The economies of these countries will also be impacted by response measures taken by Annex I Parties to mitigate greenhouse gases (GHGs).

3. Impacts of Response Measures

Article 4.2 (a) obligates Annex I Parties to adopt national policies and take corresponding measures on mitigation of GHGs. Article 4.8 also obligates the same Parties to give full consideration to negative impacts of the implementation of response measures on developing countries. The Convention demands that Annex I Parties reduce their GHG emissions to the 1990 level by the end of the year 2000. The energy sector provides the easiest option for achieving significant reduction in GHGs.

Some of the measures taken by the European Union to reduce GHG emissions include the following in the energy sector:-

- Agreements with automobile manufacturers to improve fuel efficiency in new vehicles.
- Taxation of aviation fuel.
- Energy efficiency of appliances, equipment and buildings.

Each member state of the European Union is expected to use these general guidelines to develop a more detailed strategy for achieving its reduction targets both under the Convention and the Kyoto Protocol. Other Annex I Parties are likely to take similar actions, although the approaches may differ. The overall objective is to use less fossil fuel and thereby reducing GHG emissions in such a way that the society feel very much the impact of the measures taken in their normal activities.

Measures taken by Annex I Parties are expected to directly impact on the following:-

a) Coal prices and

b) Oil prices.

a) **Coal Prices**

Coal is used in many Annex I Parties to generate power. Some of the coal used in these countries is imported from developing countries and countries in transition. As Annex I Parties reduce the use of coal for power generation the demand and hence the prices of coal will fall until new markets are found and developed. Some potential does exist in some developing countries. However, if such developing countries take the issues of the Convention seriously then coal may never regain its place in the market place. The economies of such developing countries would be negatively impacted. Bilateral assistance to LDCs from these countries would be negatively impacted. These countries would also import less than they would otherwise have done.

b) **Oil Prices**

It is not quite clear whether the consumption of oil will decrease in the immediate term (five to ten years). It is, however, clear that growth rate in oil consumption in Annex I Parties will decrease as a result of the measures taken by Annex I Parties. Economies of developing countries, including the least developed countries, will continue to grow. This growth will be reflected in the growth of oil consumption. However, it is not quite clear at the moment whether the two rates (decrease and increase growth rates) are comparable. Some analysis needs to be done to estimate these rates. This growth could offset the decrease growth rate of oil consumption in Annex I Parties.

Oil prices are not purely market driven as evidenced by the current high oil prices. Oil prices have been rising in the last many months. This fact cannot be disputed.

Oil Producers are likely to take some measures to ensure that there is minimum revenue loss. It is important to note that oil prices are not purely driven by the market forces as stated above and evidenced by the current high prices. This is a reflection and evidence of some control mechanism.

Oil is an essential and primary energy source for LDCs. Oil bills of the LDCs are expected to continue increasing to meet their development and social needs. However, the rate of increase is likely to be affected by the oil prices. High oil prices would have negative impact on economies of the LDCs thereby affecting other basic programme on sectors such as health, education, water and agriculture. The high current oil prices are having a serious impact on the economies of the LDCS. In Uganda, the fuel prices have been increasing since the last six or so months. This has led to increases in the prices of other basic commodities such as food prices and transport costs.

Encouraging efficiency in the energy sector and innovative technologies are very good moves. Automobile manufacturers are intensifying their efforts to respond to this demand. Manufacture of spare parts for the old technology will cease and therefore the transport sector will be negatively impacted. Old inefficient appliances would cease to be produced and LDCs would be expected to purchase new products. Fewer people in the LDCs can afford these new products and therefore pushing more people to *pot of poverty* thus enhancing poverty in these countries. While there will be global environmental benefits the less privileged members of the society will be punished for not fault of their own. The same argument goes for improvement in appliances. Access to new and better technology may not be affordable by the LDCs thus enhancing their poverty status.

In summary the response measures taken or envisaged to be taken with have the following impacts on the LDCs:-

- Decrease in imports;
- High prices of essential manufactured goods;
- Decrease in development assistance;
- Disincentive to higher productions;
- Very serious impact on the transport sector because of high fuel costs and cost of new technologies.
- Higher loans to pay due to low exports and high interest rates thus enhancing poverty. This will lead to many other social problems, which are closely associated with poverty.

4. Suggested Possible Actions

The following are suggested possible actions:-

- The LDCS seem not to have attracted the interest of the academic community. While there are studies being undertaken no single study seems to be focusing on the impact of climate change on the LDCs.
- Remove interventions and control of oil production so that market forces will drive this commodity. Developed countries have always used this argument.
- Remove market imperfections on other commodities so that commodities are driven by the market forces. In this way the LDCs will get some value for their products.
- Revenues, accruing from climate change tax/environment tax, should be used to assist the LDCs to cope up with these impacts. This can be apportioned inversely proportional to their pollution level.
- The LDCs should be given preferential treatment under technology transfer.

WORLD COAL INSTITUTE

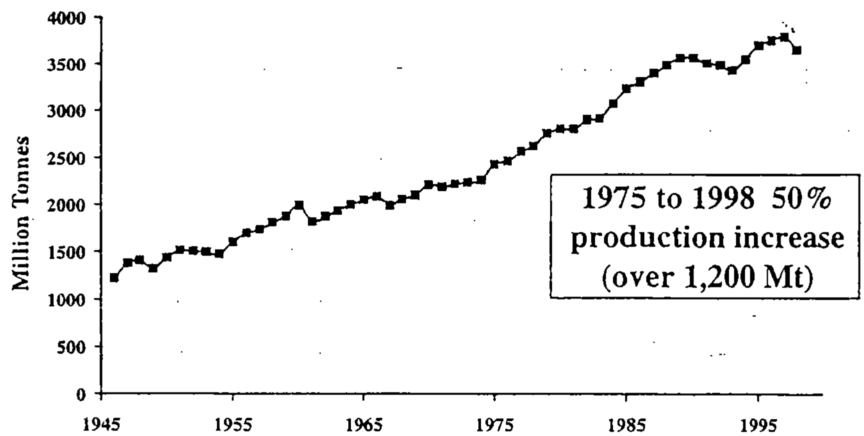
consumers & producers

UNFCCC WORKSHOP
Impact of response measures

Ron Knapp
Chief Executive - World Coal Institute

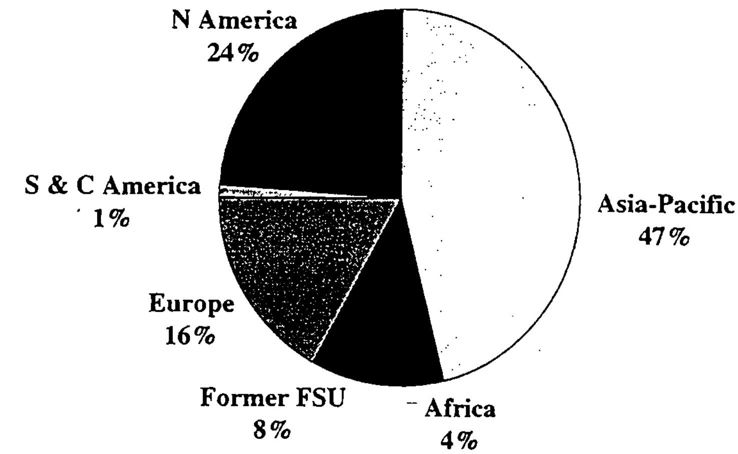
rknapp@wci-coal.com **13-15 March 2000**

World Hard Coal Production



Source: IEA 1998 Coal Information (1999)

World Coal Consumption - 1998



Source: BP Amoco Statistical Review 1999

http://www.wci-coal.com Ron Knapp - World Coal Institute

Kyoto ... impact on coal

- Kyoto Protocol will impose costs on coal
- Impact is not trade neutral
- Coal demand: dramatic variations across both producer and consumer countries
- Coal for steel maintains its market
  - different countries expand production
- Dependent on who ratifies...EU-15, Japan, USA
  ... and innovations over the next two decades

http://www.wci-coal.com Ron Knapp - World Coal Institute

1998 International Coal Trade

- Total 524 Mt (CIF value $US 22-23 billion)
- Annex B destinations about 65% of total
- Around 36% (189 Mt) used in steel industry
- Balance 334 Mt for electricity generation and other industrial/energy requirements
- Top seven countries covered 85% of 1998 coal exports ... Australia (32%), USA (13%), RSA (13%), Indonesia (9%), Canada, PR China, Colombia

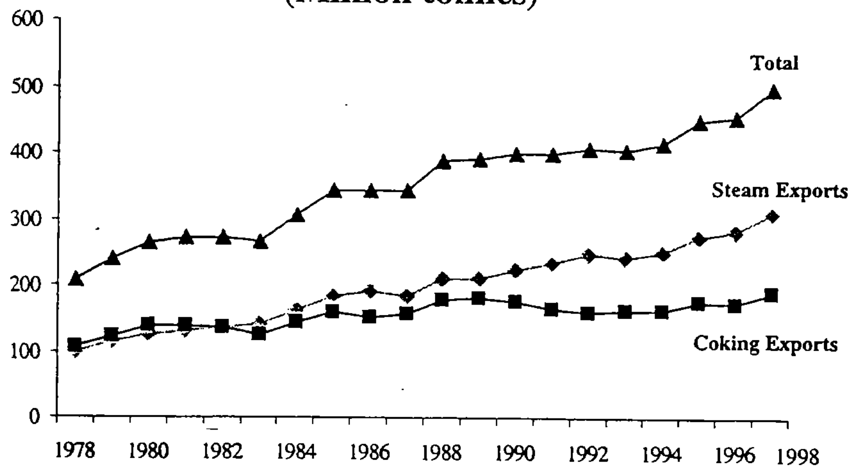
http://www.wci-coal.com Ron Knapp - World Coal Institute

Market Split Hard Coal Production

1998	Domestic	Export
PR China (1236 Mt)	97%	3%
USA (936 Mt)	92%	8%
India (303 Mt)	100%	–
RSA (223 Mt)	70%	30%
Australia (219 Mt)	24%	76%
Indonesia (61 Mt)	23%	77%
Canada (38 Mt)	10%	90%
Colombia (34 Mt)	12%	88%

http://www.wci-coal.com Ron Knapp - World Coal Institute

Internationally Traded Coal
(Million tonnes)

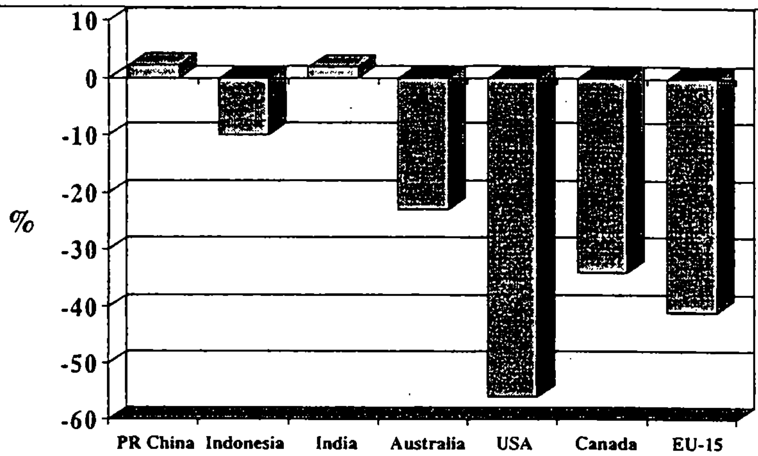


Source: IEA

Domestic Producers India	**Domestic/Export Producers** USA, China, Poland, Russia	**Export Producers** Aust, Canada, Colombia, Indonesia, RSA
High Sulphur China, UK, USA-part	**Thermal** China, Colombia, Indonesia, RSA	**Low Sulphur** Aust, Colombia, Indonesia, USA-part
Annex B Aust, Canada, USA	**The Market**	**Non-Annex B** China, Rusia, Poland, Colombia, RSA, India
Export Destination Annex B Dependency	**Coking** Aust, Canada, USA	**Export Destination** Non-Annex B Focus?

"Market Operators"	**Low Cost** Australia, Colombia, Indonesia, RSA	**High Cost** UK, Germany, Poland, Russia	"Market Adjusters"

ABARE Projections: Coal Production – Kyoto 2010
selected countries relative to reference case



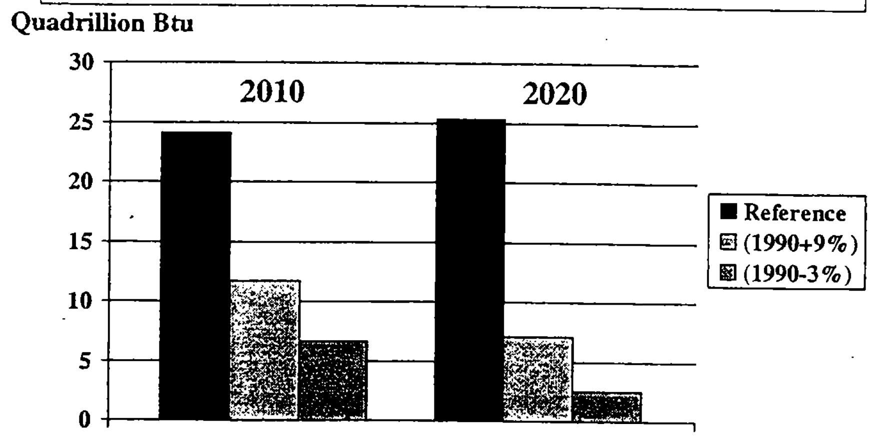
Source: ABARE Research Report 99.6

US Faces Significant Adjustment

- Over half (55%) of electricity from coal in 1999
- DOE EIA modelling shows collapse of domestic coal industry
- Western coalfield (mainly sub-bitumunous) carries majority share of burden - over 75% of reduction

... but this is key US low sulphur coal source.

EIA Coal Consumption – USA



Source: US DOE EIA (October 1998)

http://www.wci-coal.com Ron Knapp - World Coal Institute

Japan

- World's largest coal importer
- 130 Mt of coal imports in 1997
  - steel industry...65 Mt
  - power sector/other industry
- Will ratify Kyoto Protocol if....
- Limited domestic options to reduce emissions
- Impact will be dependent on access to off-shore solutions:
  - CDM, JI and ET

http://www.wci-coal.com Ron Knapp - World Coal Institute

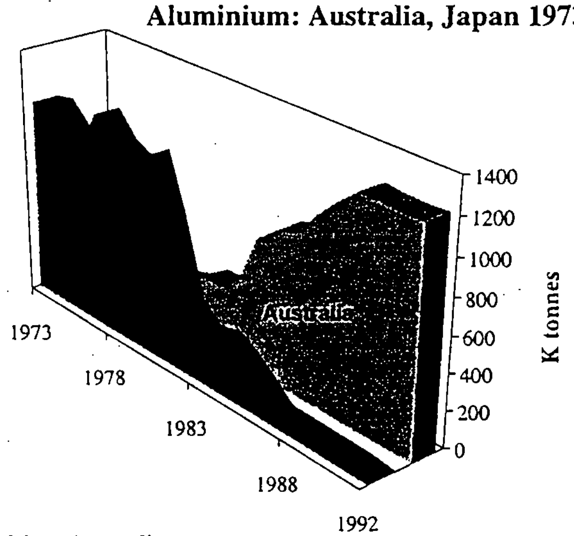
Coal for steel ...

- About 600 Mt (16%) of total hard coal production used by steel industry
- Around 36% (189 Mt) of total traded coal for steel sector used in steel industry
- Kyoto impact is relocation (from Annex B to non-Annex B) not decline over BAU

  ... unless global economic growth affected by Kyoto
- Australia, Canada and USA dominate coking coal trade supplying 80% of market

AN EARLIER EXPERIENCE...

Aluminium: Australia, Japan 1973-1992



Source: ACIL Consulting, Australia

EU-15 coal market ...continues decline

- Restructuring and competitive energy market
- Declining 'local' production
- EU-15 Hard Coal Consumption

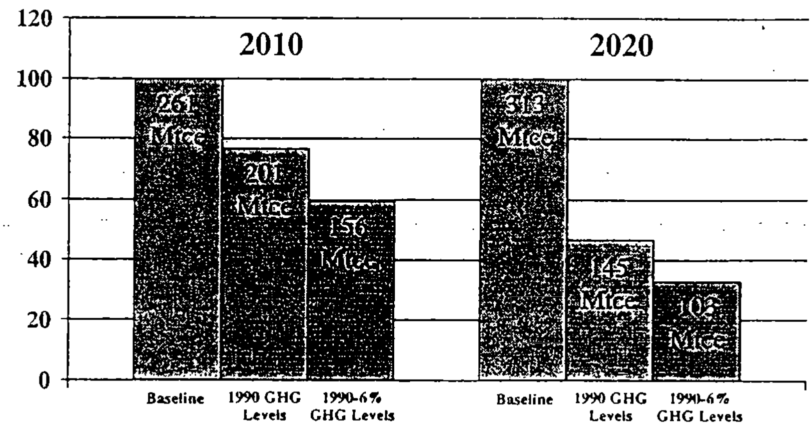
  1990 350 Mt 1998 250 Mt(e)

  ... down 100 million tonnes - over 28%

  ... no corresponding GHG reduction ... why?
- EU-15 coal demand 60 Mt for steel industry

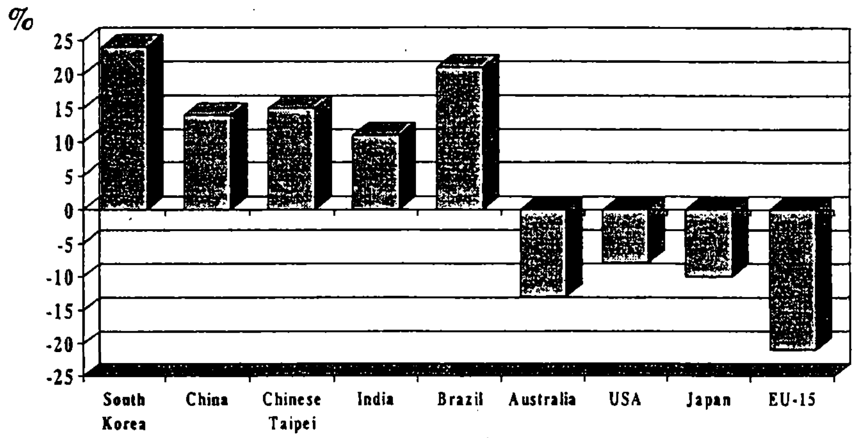
  ...could be exported to countries without Kyoto targets if EU-15 uncompetitive under Kyoto

EU-15 GHG Reduction Scenario Outcome for Solid Fuel Consumption



Source: European Commission Directorate-General for Energy 'European Union Energy Outlook to 2020', November 1999

Kyoto - Iron and Steel Production 2010
Selected countries relative to reference case



Source: ABARE Research Report 99.6

Thermal coal trade vulnerable ...

- About 334 Mt (84%) of total traded coal
- Annex B destinations 2/3rds of thermal coal trade
- Four leading developing country coal exporters have high exposure to thermal market:

  Colombia 95+% RSA 90%

  Indonesia 90% China 85%
- Colombia exports 70% to EU-15 with further 10% Annex B exposure in US market
- RSA exports over 60% to EU-15 destinations

Leading coal exporters ...

1998	1999
1. Australia	1. Australia
2. USA (69.1)	2. South Africa
3. South Africa	3. Indonesia
4. Indonesia	4. USA (52.6)

(Note: USA exports down 25% [16.5 Mt] in 1999 c.f. 1998, but less than 2% of USA production)

USA ...

- World's second largest coal producer (936 Mt 1998)
- Significant coal exporter - 70 Mt 1998
- 60% into the metallurgical sector
- Capacity to make tonnage available at short notice due to size of domestic industry (the swing supplier)
- Exports declining due to world price (52 Mt 1999)
  ... Australia and Canada taking more market share in Met. coal sector
  ... and emergence of new/dedicated thermal/steam coal export suppliers

http://www.wci-coal.com Ron Knapp - World Coal Institute

Australia ...

- World's fifth largest producer (219 Mt 1998)
- Largest coal exporter (166.7 Mt 1998)
- Exports dominate the Australian coal industry
- Equal split between exports of metallurgical and thermal coal
- Almost all met. coal exported
- Australia delivers just under 50% of total thermal coal exports to Japan.

Indonesia ...

- Two decades of coal growth
- Less than 1.0 million tonnes in early 1980s
- Today, a producer of about 70 Mt [check]
- ... and exports about 54 Mt (low ash/low sulphur)
- An impressive record of achievement
- (Like Australia) Indonesia exports are around 75% of total coal production.

Colombia ...

- 1983 5.2 Mt coal production
- 1998 33.8 Mt coal production (low sulphur)
- Exports of 29.6 Mt in 1998 (88% of production)
- Almost all exports into the thermal sector (29.1 Mt - over 98%)
- High exposure to EU-15 thermal market (70% to the EU-15

... and has further Annex B exposure in the US market (10%).

Republic of South Africa (RSA) ...

- World's fourth largest producer (223 Mt 1998)
- Now second largest coal exporter (67.1 Mt 1998)
- Thermal coal dominates RSA export tonnage ... over 90% of total exports
- RSA exports over 60% of its thermal coal to the vulnerable EU-15 destinations

... with additional tonnage into Japan.

Kyoto...identify the objective

- The goal is to reduce global increases in GHGs – not carbon intensity
- Reducing carbon will not be the most effective or appropriate response, or the least-cost option to achieving the goal for some countries (open markets are good for this type of decision-making...)
- Reducing carbon intensity is only one of range of solutions which include new technology, capture/sequestration, sink developments, etc

No discrimination between fuels

- We should not try to judge or pick winners
- No market quota or subsidy for renewables - this is a high cost policy for reducing GHGs
- Set the GHG emissions limit [the Kyoto target at country level] and allow markets to work
- Companies required to meet GHG targets will choose the least cost option to meet their goal
- Remove market impediments ... to allow the market to search out the best solutions

A Kyoto coal outcome...

- Can reduce the impact…the greater the use of voluntary measures, Kyoto mechanisms and effective market solutions …the more efficient the outcome
- Technology can deliver successful coal outcomes in response to market circumstances
- Promote clean coal technology for combustion efficiency and environmental solutions

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Impacts of Response Measures: Consideration of What Actions Are Necessary
Presentation at the UNFCCC Workshop on Article 4.8 and 4.9 of the Convention:
Impact of the Implementation of Response Measures
March, 2000

Jonathan Pershing, International Energy Agency, Paris

This presentation reviews some of the issues related to macro and micro analyses of the impacts of response measures, particularly on the energy sector. With respect to a "macro" analysis, the most commonly used assessment tool is the economic model. This form of assessment provides results which are constrained by several factors including the adequacy of data, as well as an inability (currently) to fully model all aspects of the response options open to countries. Thus, Parties may choose to substantially offset costs though such mechanisms as non-CO2 measures and sinks, and may choose, for political rather than economic reasons, to undertake policies that transfer a share of the burden between sectors (e.g., exempting transport from additional costs while adding additional costs to power generation). Furthermore, few models address the issues of market power, which may clearly change the price dynamics.

In spite of their shortcomings, such models offer insights on some specific policy options. For example, they clearly indicate the reduction in overall costs (and consequently of impacts) from the use of the Kyoto flexibility mechanisms and from the reduction of energy subsidies. Such models also suggest that, broadly speaking, the reductions in fossil fuel use are proportional to their carbon content: coal suffers most, oil next, and gas least (and in some models, gas gains).

Micro analyses may be more relevant given the requirements of the Convention and Protocol. The agreements require that individual policies be examined, and their impacts considered. A framework suggesting five steps for such an analysis is presented:

1. Select policy that may be relevant
2. Project effect of policy
3. Evaluate share of effect that might impact individual country
4. Evaluate alternatives (if any) to policy that would have similar emissions reductions with reduced impact
5. Consider whether alternative policy would have adverse impacts on others

In the measure considered (the voluntary agreement between the vehicle manufacturers and the European Commission), the net reduction in oil is less than 1%, and lower impact alternatives may not be readily available.

Finally, a brief review of some policy options is provided. It is suggested that with respect to the macro-effects, overarching efforts to reduce the overall costs of mitigation will also reduce the impacts on fossil fuel dependent countries. Thus, subsidy removal, the use of sinks, actions in non-CO2 greenhouse gases, and the use of the flexibility mechanisms are all key. With respect to the micro policies, it is necessary to establish and then implement an assessment framework to evaluate measures. Additionally, it appears that options such as funding and insurance are best accomplished by fossil fuel producers themselves, while technology transfer may be aided through other Convention and Protocol mechanisms.

Impacts of Response Measures: Consideration of What Actions Are Necessary

Jonathan Pershing
International Energy Agency

UNFCCC Workshop on
Articles 4.8, 4.9 and KP Article 3.14
March 2000

Overview

- Assessing impacts : macro vs. micro
- Macro issues in coal, oil and gas
  - Confounding factors in projections
  - Separating impacts of response measures from other factors
  - Some aggregate trends
- Micro issues : impacts from specific policies and measures
- Consideration of necessary action
  - Methodological recommendations
  - Possible actions to limit effects

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Macro Impacts : Modelled Results

- Conclusions of global economic models
  - "Top down" macro models (e.g., EMF) show global costs at several percent GDP
  - "Bottom up" models (e.g., ETSAP) show rapid technology improvements, lower costs
- Distribution of effect highly variable
  - Loss is function of national circumstances, including demographics, exports/imports, industrial structure, fuel mix, etc.
- Some Caveats
  - Most models do not include market power
  - Sinks/other GHGs not usually included
  - Conservative baseline assumptions

A Closer Look : COAL

- Most carbon intensive per unit of delivered energy; primary use power generation
- Majority consumed locally : less than 15% of production exported
- South Africa may be only significant non-Annex I "loser", although GDP losses less than 5% even with 30% decline in coal price
- Historic market fluctuations in coal price are much larger than those anticipated with Kyoto

OIL & GAS: More Complex

- 50% of oil produced is exported to a global market; gas market more local/regional
- Total reserves and costs of production are unevenly distributed
- Future price/volume affected by
  - Supply/demand and price fluctuations
  - Reserve depletion
  - Market power behaviour
  - Government policy (including for local pollution, congestion, energy security, tax revenue, and climate change)

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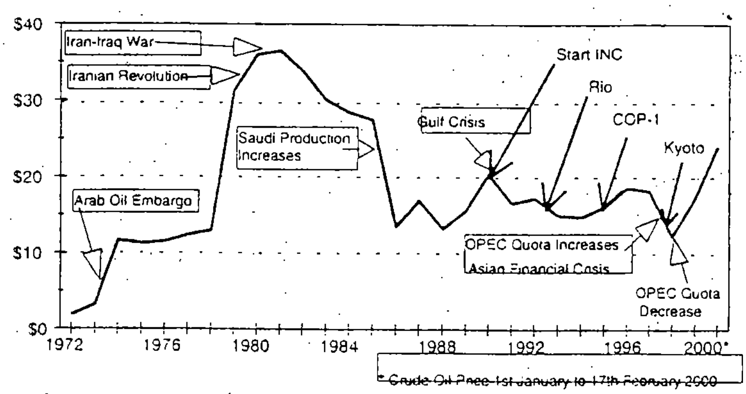
Political and Climate Events and Long Term Oil Prices

(Annual Average Price)



Note: from 1972-1986 price quoted is Arabian Light, from 1987 to 17th February 2000 price quoted is Dubai.

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Some solutions...

- Minimise overall costs for any specific target level
  - Use sinks, non-CO_2 GHGs
  - Remove subsidies that might distort playing field
  - Fully implement Kyoto mechanisms
- Exchange experiences
  - Diversify economic portfolios, long-term savings, (e.g., Kuwait Investment Authority, Norwegian Petroleum Fund)

...and their cost implications

- Including non-CO2 greenhouse gases: up to 60% reduction in cost (*Reilly et al, 1999*)
- Subsidy removal:
  - Annex I: subsidy removal could offset as much as a \$50 - \$90 ton carbon tax (*World Bank, 1992*)
  - Developing countries: energy subsidy removal in India and China could reduce emissions by 14% and 13% respectively (*IEA, 1999*)

Changes in Global GDP with and without Emissions Trading

Mechanism	Change in Global GDP	
	Marginal Cost (1995$ ton c)	% Change in Real Income
Base Case (without Kyoto)	0	~ 2.5%/yr; ~ 45% growth by 2010
Domestic implementation only	41 – 762	-0.2 to -2% in 2010; (growth of ~ 43-44%)
A-1 mechanisms only	18 – 160	>0.5% in 2010; (growth of ~ 45%)

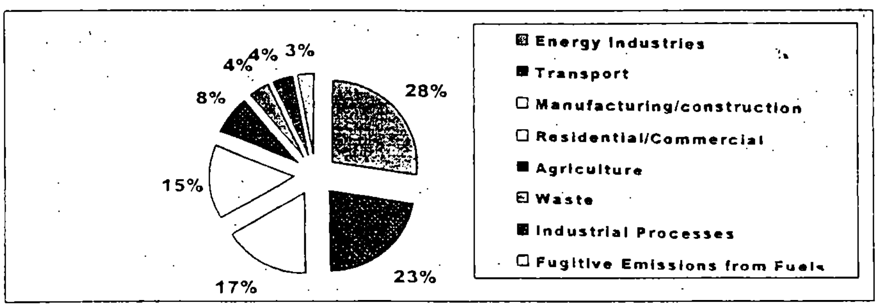
Micro Analysis : Focus on FCCC and KP Requirements

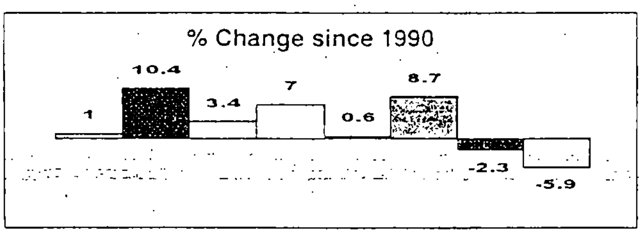
- Article 4.8 : "In the implementation of the commitments, Parties shall give full consideration to what actions are necessary ... related to ... specific needs and concerns arising from the ... impact of the implementation of response measures...."
- Article 3.14: "Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1 in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties...."

What *ARE* the Policies?

- Policies cover all sectors and all gases -- but neither policies (nor emissions) are evenly divided among these
  - Energy and CO2 are key
  - Disaggregating emissions useful for policy analysis
- Policy actions include:
  - Market approaches (taxes, subsidies, cap-and-trade)
  - Regulations
  - R&D
  - Processes/outreach

1996 OECD GHG Emissions by Sector





Shares of Greenhouse Gases in Total Emissions: Annex I Countries, 1995

Gas Type	CO_2	CH_4	N_2O	Others	Σ
Shares in Total GHGs	82%	12%	4%	2%	100%
Contribution of Energy Sector	96%	35%	26%	n.a.	85%
Main Source of Energy Sector	Fuel combustion	Fugitive fuel	Fuel combustion	n.a.	

Source: UNFCCC, "Second compilation and synthesis of second national communications:, FCCC/CP/1998/11/Add.1, September 1998

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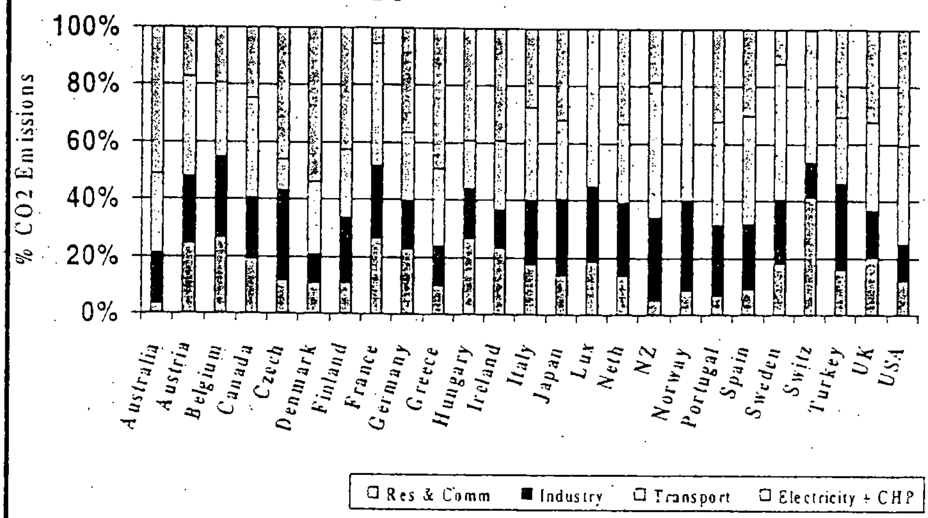
CO_2 Emissions from Energy and Energy-Related Sectors



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Policy Relevant Features of Emissions Sectors

	Capital Stock Turnover	Decisionmakers	Policies	% Oil Consumed
Residential/ Commercial - Buildings - Appliances, Office Equipment	 > 50 years < 10 years	Large numbers of individual consumers, contractors, financial institutions	Regulatory instruments; efficiency standards, fiscal incentives, labelling	23%
Energy Sector/Power Production	> 30 years	Small number of large players, sometimes government controlled	Market liberalisation/ deregulation, subsidy reform	2%
Industry	>10 - 15 years	Relatively small number, strongly profit driven	VA, energy intensity improvements, emissions regulations	10%
Transport - Infrastructure - Road Vehicles	 > 50 years > 10 - 15 years	Government and private sector actors, complex policy process	Limited policies; vehicle, efficiency standards, fuel taxes	56%

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OECD Total Final Consumption of Energy

(mtoe, % fuel in sector)

Fuel	Coal		Oil		Gas		TOTAL
Sector							
Industry	119	16%	345	46%	284	38%	748
Transport	0	0%	1,113	98%	24	2%	1,137
Comm/Res	24	5%	216	43%	261	52%	501
Electricty/heat	821	68%	133	11%	260	21%	1,215
TOTAL	964	27%	1,807	50%	829	23%	3,600

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Policies Affecting Transport

- Europe:
  - Voluntary agreement with auto manufacturers to cut CO2 from 180 g/km to 140 g/km by 2008 (EU)
  - Taxes (Denmark, France, Germany, Netherlands, Norway, Sweden, Switzerland, UK)
- Asia - Pacific:
  - Top-runner program (Japan)
  - Vehicle emissions standards (Australia)
- North America:
  - VA with auto industry, PNGV (US)
  - "Fleetwise" -- information program to help with fleet efficiency (Canada)
  - R&D in alternative fuels (Canada)

Hypothetical Steps in Considering Adverse Impacts

1. Select policy that may be relevant
2. Project effect of policy
3. Evaluate share of effect that might impact individual country
4. Evaluate alternatives (if any) to policy that would have similar emissions reductions with reduced impact
5. Consider whether alternative policy would have adverse impacts on others

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Example: EU VA with Automobile Industry

Environmental Impact: Reduce CO2 from 180g/l to 140g/l by 2009

- passenger vehicle fuel consumption down ~22% (7.7 l/100km to 6.0 l/100km)

Adverse impact:reduce oil imports from countries with economies highly dependent on income generated from the production of fossil fuels

Some Background EU Statistics

- Energy related CO_2 emissions : 94% of total CO_2
  - Energy related CO_2 emissions derived from oil : 51%
- Transport's share of energy emissions: 21%
  - Transport related emissions from oil : 99%

Detailing Adverse Impact

- Fleet fuel efficiency improvement in Europe (1985 - 1995): 12%
  - VA Effect : 10% greater than trend
- Total Oil imports (1998) : 554,171,000 metric tons
  - Import share from non-EU sources : 65%
  - Share of total consumption in transport: 47%
  - Share of motor gasoline in transport: 41%
- Proportional decline in imports from policy : ~1%

Caveats to Numbers

- Emissions growth projected in transport sector (1990 - 2010) : 39%
  - Proportional increase in imports from non-OECD countries as function of new demand : 25 %
- Consequence of policy: decrease in demand growth to approximately 24%

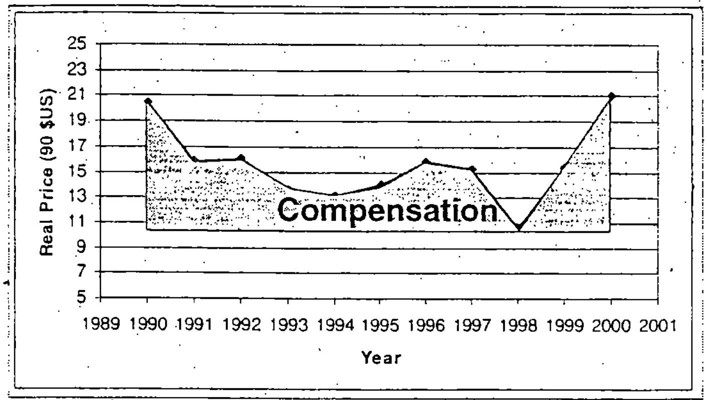
Ancillary Policy Benefits

- Reduced reliance on foreign supplies (energy security issue)
- Lower costs for vehicle operation (consumer benefits)
- Improved local/regional air quality
  - Equivalent percent reduction in emissions of SO_x, NO_x and particulates
- Share of fuel efficiency reduction driven by these benefits : ??

Next Steps

- Meeting the specific needs and concerns of developing country Parties
  - Funding
  - Insurance
  - Transfer of technology
  - Other
- Methodological actions

Compensation?



Compensation: (Annual Price - Minimum Price) * Annual Production

OPEC Share: ~ $350 billion/year

"Insurance"

- Long-term savings and national investments of revenues
  - Kuwait Investment Authority
  - Norwegian Petroleum Fund
- Diversification of economy, promotion of new technology
  - Financing, *inter alia*, through CDM

Methodological Actions

- Develop framework for assessing impacts
- Undertake impact studies for countries
  - Requires data input and analysis from both developed and developing country
  - Perhaps best undertaken through national communications
- Provide forum for exchange of experiences

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Conclusions

- Difficult to evaluate the impacts; separating climate policy consequences from other fluctuations will be difficult if not impossible
- Near-term impacts likely to be relatively minor (based on full use of all mitigation options discussed)
- In the longer term (post 2020), impacts may be felt

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Conclusions (2)

- Ultimately, FCCC and KP require assessment of individual policies
  - Requires framework for consideration
  - Best undertaken at national level
- Preliminary analysis suggests little impact from current Annex I policies
- Actions related to impacts are both macro and micro
  - Macro: KP mechanisms, sinks other gases, subsidy removal
  - Micro: national assessments, diversification, insurance

Workshop on Article 4.8 and 4.9 of the Convention: Impact of the implementation of response measures (Methodological approaches and what actions are necessary under the Convention, relating to the impact of the implementation of response measures, in accordance with Article 4.8 and 4.9 of the Convention and in the light of matters related to Article 3.14 of the Kyoto Protocol)

Faten Alawadhi

Abstract

This presentation argues for the importance of adoption of a framework for the discussion on actions necessary relating to the impact of the implementation of response measures, in which two issues advance in **parallel**:

- Exploring the details of the manner in which Annex B countries minimize the impacts of their mitigation policies on oil exporting developing countries.
- Information gathering and further detailed assessment of the impacts of mitigation measures on oil exporting developing countries.

The presentation then puts forward some suggestions regarding actions that may be taken by Annex B countries to fulfil their commitments as indicated in Article 3.14.

So: What Actions are Necessary? (cont.)

All of those projects are consistent with the objectives of diversification

- It is important that mechanisms, which explicitly encourage projects in oil exporting developing countries, be in place

Genuine effort to include all GHGs in abatement policies of Annex B countries

So: What Actions are Necessary? (cont.)

- The West Africa Pipeline Project: A pipeline that would feed Nigerian natural gas, which would have been flared otherwise, to three other West African countries: Benin, Togo and Ghana to be used in power generation and industries. The gas will also be used domestically to replace use of wood fuel thus slowing down deforestation and improving air quality in the region
- Energy efficiency improvement
- Enhancing the role of natural gas

So: What Actions are Necessary? (cont.)

Funding and transfer of state of the art technology for projects such as

- CO_2 storage: enhanced oil recovery and the use of exhausted oil and gas fields
- Reduction of gas flaring and venting
  - Natural gas electricity production for export
  - Developing local markets for natural gas
  - Separation and storage of associated CO_2
  - Utilization of natural gas as energy source for oil production process
  - Investing in transport systems such as long-distance pipelines or LNG systems

So: What Actions are Necessary? (cont.)

- There is a need to explore ways to overcome those problems. Encouraging developments that would bring about diversification, within the context of climate change mitigation, can be part of the fulfillment of commitments of Annex B countries

- Funding and transfer of technology are important. So is improving the terms of trade for oil exporting developing countries and providing more access for their exports in Annex B markets

So: What Actions are Necessary? (cont.)

Assistance in diversification of economies

- Efforts of oil exporting developing countries to diversify their economies have been frustrated by many problems

So: What Actions are Necessary?

Tax Reform

- Removing distortions in the Annex B energy markets and restructuring of existing energy taxes, some of which are designed mainly for revenue raising purposes, to reflect carbon content of fuels

- This, as some studies have shown, would reduce the negative economic effects on oil exporting developing countries. The deterioration in terms of trade of those countries would be reduced thus lowering their welfare losses. At the same time significant CO_2 emissions reduction would be achieved

Impact of Climate Change Measures on OPEC (cont.)

A more constructive discussion is needed, within which two issues can advance in parallel:

- Exploring details of the manner in which this commitment is to be fulfilled
- Reaching a consensus on the degree of losses through more modelling efforts and other methods

Impact of Climate Change Measures on OPEC (cont.)

- So far, the debate has been frozen within the circle of "the degree of losses that oil exporting countries may incur". There are for sure uncertainties regarding this issue, but there are tremendous uncertainties surrounding every aspect of climate change
- Annex B countries have the commitment to strive to minimize the impact of their mitigation policies on those countries, which would be negatively impacted. So far their efforts have not gone beyond emphasizing the efficiency of flexible mechanisms and global trading in reducing costs

Impact of Climate Change Measures on OPEC (cont.)

- More modelling efforts, which would provide detailed examination of the welfare, terms of trade and socioeconomic impacts on individual OPEC Member Countries, can be undertaken by Annex B countries in co-operation with OPEC

Impact of Climate Change Measures on OPEC (cont.)

- Doubts were expressed about model results. This, however, should not constitute a basis for inaction on consideration of specific ways to minimize the impacts

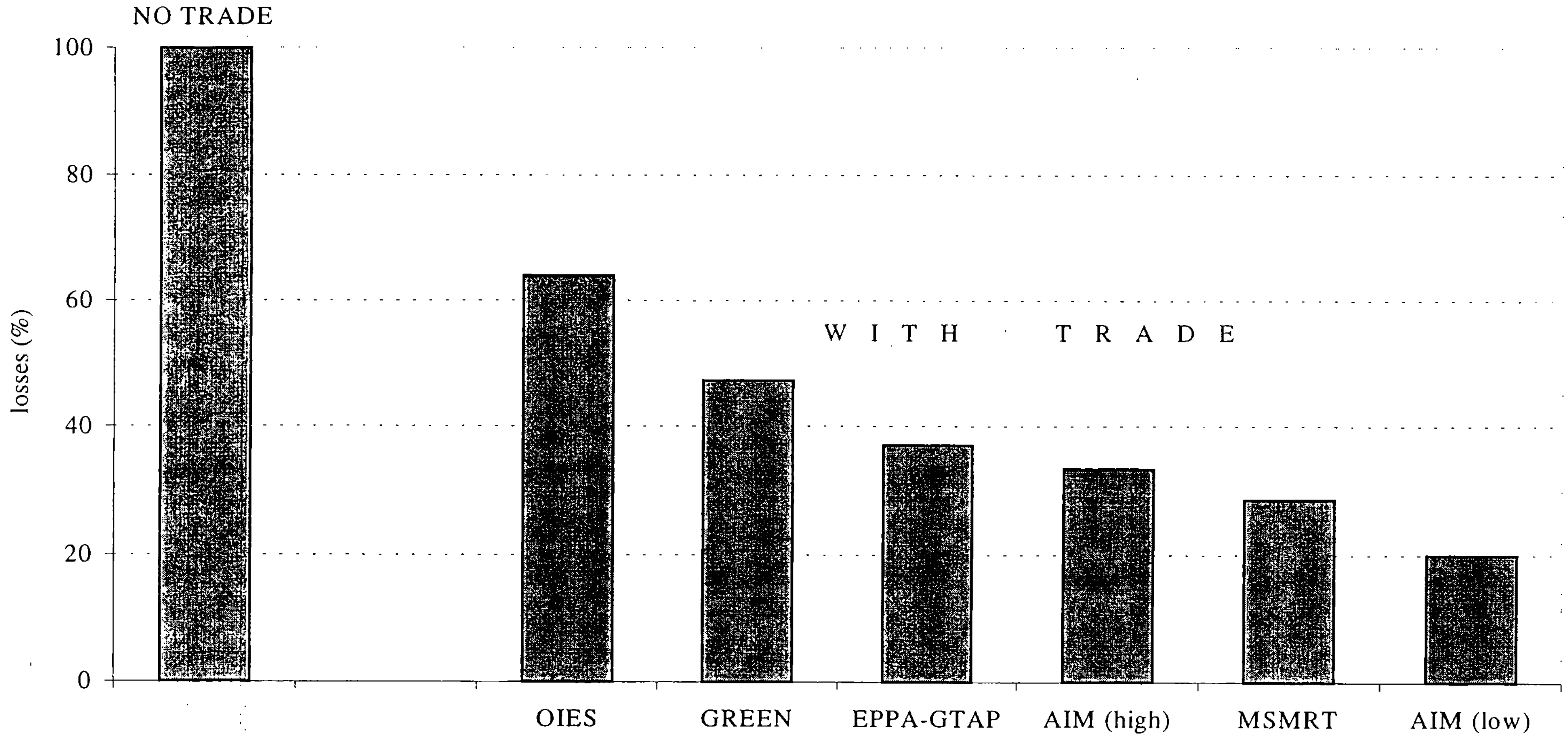
- We should be in a position, through careful examination of the structure of those models and assumptions made, to assess the robustness of the results and understand the reason for discrepancies among models' outputs

Impact of Climate Change Measures on OPEC (cont.)

- The combination of Kyoto mechanisms cannot be viewed as corresponding to full global trading. It is unlikely that they would result in the dramatic fall in marginal abatement costs implied by full global trading

- Anyway, global trading is not on the agenda of the negotiation and is not a realistic scenario, given the position of developing countries and the almost impossible task of agreement on how to allocate initial permits

Model Comparison of the Estimated OPEC Losses as a Result of Emissions Trading: Percentage of No Trade Case



- Model results typically suggest losses for oil exporting DCs (mainly OPEC countries) with full trade would be 35-50% of the losses with no trade
- Therefore general agreement that: - trading reduces losses, BUT, - they remain substantial
- The models assume global trading, which is almost impossible to be implemented

Impact of Climate Change Measures on OPEC (cont.)

- Given the high share of oil revenues in the GDP of those countries, negative welfare implications are even greater

- Declining oil revenues would have genuine and severe implications for socioeconomic developments, and there is a clear need to address this

- Those studies also showed that Kyoto mechanisms reduce losses. However, losses remain high

Changes in CO_2 Emissions and Gas Demand from Reference Case in Alternative Emission Abatement Studies

	Change in CO_2 Emissions (%)	*Change in Natural Gas Demand (%)*	*Ratio of Changes in Gas Demand to those of CO_2 Emissions*	*Year*	*Region*
DRI (1992)	-11.7	-7.2	0.62	2005	EC
Hoeller et al (1991)	-49.2	-27.4	0.56	2000	World
Bossier and De Rous (1992)	-8.2	3.0	-0.37	1999	Belgium
Proost and Van Regemorter (1992)	-28.0	15.3	-0.55	2005	Belgium
Burniaux et al (1991)	-53.6	0.0	0.0	2020	World
Barker (1995)	-12.8	-6.2	0.48	2005	UK
IEA (1993)	-8.8	23.0	-2.61	2010	OECD
Ghanem et al (1999)	-9.0	-8.2	0.91	2010	World
Baron (1996)(1)	-8.5(2)	-4.0	0.47	2000	USA
Birkelund et al (1994)	-10.7	-8.0	0.75	2010	EU
Bernow et al (1997)	-17.8	-5.4	0.30	2015	Minnesota
Gregory et al (1992)	-8.4	-5.2	0.62	2005	UK
WEC (1993) Case C	-24.3	-16.5	0.68	2020	World
Kratena and Schleicher (1998)	-29.0	-36.4	1.26	2005	Austria
Mitsubishi Research Institute (1998)	-11.3(3)	9.2	-0.81	2010	OECD
Fujime (1998)	-16.3(3)	-6.2	0.38	2010	Japan
Bernstein, Montgomery, Rutherford (1999)	-30.0	-25.0	0.83	2010	USA
Bernstein, Montgomery, Rutherford (1999)	-24.0	-49.0	2.04	2010	Japan
Bernstein, Montgomery, Rutherford (1999)	-18.0	-38.0	2.11	2010	EU
Bernstein, Montgomery, Rutherford (1999)	-25.0	-41.0	1.64	2010	Other OECD
Bacchilega et al (1999)	-2.3	-1.2	0.52	2010	Italy

(1) Citing a study by the US Congressional Budget Office (CBO).
(2) Estimated.
(3) Change in fossil fuel demand.
Median ratio (column 3): 0.56

Impact of Climate Change Measures on OPEC (cont.)

- The impact of climate change policies on natural gas demand, however, is uncertain. Some of the studies point to a net increase in gas demand while others suggest an opposite effect

- A decrease in gas demand would worsen the impacts on those oil exporters, which are also gas exporters

Impact upon OPEC of Achieving Kyoto Protocol Targets - OWEM Results for 2010

	Reference case	Kyoto (+ reference price)	Kyoto (+ lower price)	*Differences from Reference Case* Kyoto (+ reference price)	Kyoto (+ lower price)
Real Basket Price \$(98)/b	19.4	18.8	11.2	*-0.6*	*-8.2*
Annualised OPEC revenue \$ bill.(98)	144.2	120.9	81.2	*-23.3*	*-63.0*
World Oil Demand (mb/d)	87.9	80.6	84.2	*-7.3*	*-3.7*
Non-OPEC Production (mb/d)	48.3	48.0	44.4	*-0.3*	*-3.9*
OPEC Production (mb/d)	39.6	32.7	39.8	*-6.9*	*0.2*

C Tax - maybe \$100/ton - will have to check

It has been argued that OPEC can avoid revenue losses by sustaining a higher oil price, but this is not feasible

- **Even maintaining "reference case" prices implies production that is 7 mb/d below business-as-usual and is therefore also an unlikely outcome**
- **Revenue losses are likely to be huge, probably between \$20 and \$60 billion pa**

See journal article, OPEC Review, June 1999

Impact of Climate Change Measures on OPEC

- Studies that have examined the impacts of Kyoto protocol implementation have generally agreed on the fact that it would result in reduction in oil demand and price and showed substantial reduction in revenues of oil exporting countries (ranging from 10% to 45%)

Workshop on Article 4.8 and 4.9 of the Convention: Impact of the Implementation of Response Measures

Bonn, Germany, 13th – 15th March 2000

Consideration of What Actions are Necessary, Including those Relating to Funding, Insurance and the Transfer of Technology

Dr. Faten Alawadhi

OPEC Secretariat

Yearly Average Oil Prices (WTI Cushing)		
Year	**Nominal**	**Real ($1999)**
1970	3.35	14.38
1971	3.56	14.66
1972	3.56	14.19
1973	3.87	14.53
1974	10.37	35.06
1975	11.16	34.56
1976	12.65	37.02
1977	14.30	39.31
1978	14.85	37.94
1979	22.40	51.45
1980	37.38	75.62
1981	36.67	67.21
1982	33.64	58.08
1983	30.40	50.88
1984	29.28	46.95
1985	27.97	43.33
1986	15.04	22.85
1987	19.16	28.09
1988	15.96	22.48
1989	19.59	26.33
1990	24.49	31.22
1991	21.48	26.28
1992	20.56	24.41
1993	18.46	21.28
1994	17.19	19.31
1995	18.43	20.14
1996	22.15	23.53
1997	20.60	21.37
1998	14.39	14.70
1999	19.24	19.24

Table 12. World Crude Oil Prices
(Dollars per Barrel)

Country, Type of Crude/API Gravity(2)	In Effect: 3 Mar 2000	25 Feb 2000	7 Jan 2000	1 Jan 1999	1 Jan 1998	1 Jan 1997	1 Jan 1996	1 Jan 1978
OPEC								
Saudi Arabia, Arabian Light 34	25.30	25.30	23.45	10.03	15.50	22.98	18.20	12.70
Saudi Arabia, Arabian Medium 31	24.35	24.35	22.85	9.63	14.90	21.93	17.40	12.32
Saudi Arabia, Arabian Heavy 27	23.45	23.45	22.10	9.28	14.00	21.08	17.05	12.02
Abu Dhabi, Murban 39	26.01	26.01	23.94	10.50	16.27	24.06	18.81	13.26
Dubai, Fateh 32	24.20	24.20	22.20	10.20	15.25	21.90	17.40	12.64
Qatar, Dukhan 40	25.27	25.27	23.61	10.50	15.78	23.24	18.22	13.19
Iran, Iranian Light 34	25.15	25.15	23.55	9.83	14.93	22.63	17.73	13.45
Iran, Iranian Heavy 31	24.35	24.35	23.05	9.58	15.12	21.87	17.57	12.49
Iraq(3), Kirkuk 36	30.25	26.31	21.75	0.00	0.00	0.00	0.00	13.17
Kuwait, Kuwait 31	24.15	24.15	22.90	9.38	14.90	21.83	17.40	12.22
Neutral Zone, Khafji 28	25.30	25.30	23.45	10.03	15.50	22.98	18.20	12.03
Algeria, Saharan Blend 44	28.43	28.43	24.28	10.78	16.90	24.75	19.79	14.10
Nigeria, Bonny Light 37	28.10	28.10	23.85	10.60	16.50	24.65	19.70	15.12
Nigeria, Forcados 31	28.00	28.00	23.85	10.40	16.50	24.75	19.70	13.70
Libya, Es Sider 37	28.28	28.28	23.25	10.65	16.72	24.10	19.20	13.68
Indonesia, Minas 34	26.50	26.50	23.25	9.95	16.50	24.95	20.05	13.55
Venezuela, Tia Juana Light 31	28.50	28.50	23.42	9.45	15.93	26.62	18.81	13.54
Venezuela, Bachaquero 24	0.00	0.00	0.00	0.00	0.00	24.74	17.24	12.39
Venezuela, Bachaquero 17	0.00	0.00	0.00	0.00	0.00	20.45	15.60	11.38
Gabon(6), Mandji 30	0.00	0.00	0.00	0.00	0.00	0.00	17.80	12.59
Total OPEC(4), NA	26.31	25.94	23.19	9.96	14.97	23.07	18.12	13.03
Non-OPEC								
United Kingdom, Brent Blend 38	30.05	28.69	23.26	10.44	15.89	24.05	19.37	0.00
Norway, Ekofisk Blend 42	28.25	28.25	23.95	10.60	16.50	24.30	19.45	14.20
Canada, Sweet Mixed Bld 38	44.35	41.91	33.91	14.48	22.82	32.44	24.12	0.00
Canada, Lloyd Blend 22	37.08	31.63	27.80	7.90	13.36	23.17	17.89	0.00
Mexico,								

NA = Not applicable.

Sources:

- EIA, Office of Energy Markets and End Use, Energy Markets and Contingency Information Division.
- Platt's Oilgram Price Report.
- Petroleum Intelligence Weekly.
- Bloomberg Oil Buyers' Guide.
- Oil and Gas Journal.

Crude Oil Revenues (Bill $)

	71	72	73	74	75	76	77	78	79	80	81
Algeria	0.9	1.3	1.9	4.6	4.0	4.7	5.5	5.8	8.5	12.7	12.6
Indonesia	0.6	0.9	1.6	4.9	4.8	5.8	6.8	6.4	8.2	14.2	15.8
Iran	3.3	4.1	6.5	23.4	19.1	22.3	23.3	21.3	17.6	13.1	10.5
Iraq	1.5	-0.1	2.8	7.9	8.5	9.7	10.2	11.1	22.3	27.5	10.2
Kuwait	2.4	2.7	3.4	10.3	8.3	8.9	8.9	9.5	16.9	18.0	12.9
Libya	3.2	2.9	4.0	8.5	7.8	8.5	10.2	9.6	15.5	22.2	15.0
Nigeria	1.6	2.1	3.4	11.2	7.4	9.8	10.3	8.8	16.2	24.3	17.3
Qatar	0.4	0.5	0.7	2.3	1.8	2.1	2.1	0.9	3.6	5.3	5.2
Saudi Arab	3.4	4.7	8.4	34.3	28.3	36.5	41.7	38.1	58.5	102.5	114.3
United Arab	0.8	1.1	1.9	7.0	6.6	8.3	9.2	8.6	12.8	18.8	17.8
Venezuela	2.8	3.0	4.1	11.2	8.8	8.3	8.8	8.4	12.3	17.8	19.5
Total	20.9	23.3	38.7	125.5	105.4	124.8	137.1	128.5	192.3	276.6	251.2
Consumer	40.4	42.0	44.4	49.3	53.8	56.9	60.6	65.2	72.6	82.4	90.9

Crude Oil Revenues (Bill 90$)

	71	72	73	74	75	76	77	78	79	80	81
Algeria	3.0	4.2	5.7	12.1	9.7	10.7	11.9	11.6	15.3	20.2	18.2
Indonesia	1.8	2.8	4.8	13.1	11.8	13.3	14.6	12.7	14.7	22.6	22.8
Iran	10.7	12.9	19.2	62.1	46.5	51.3	50.3	42.8	31.7	20.9	15.2
Iraq	5.0	-0.3	8.1	20.9	20.6	22.2	22.0	22.2	40.1	43.6	14.7
Kuwait	7.6	8.5	9.9	27.3	20.1	20.4	19.2	19.1	30.4	28.5	18.6
Libya	10.5	9.1	11.9	22.5	19.0	19.6	22.1	19.3	27.9	35.3	21.6
Nigeria	5.2	6.6	10.0	29.7	18.1	22.6	22.2	17.7	29.2	38.6	24.8
Qatar	1.2	1.4	2.2	6.1	4.3	4.9	4.5	1.7	6.5	8.5	7.5
Saudi Arab	11.1	14.5	24.7	90.9	68.9	83.9	90.1	76.5	105.4	162.8	164.5
United Arab	2.7	3.3	5.5	18.6	16.0	19.0	19.8	17.3	23.1	29.9	25.6
Venezuela	9.0	9.4	12.1	29.6	21.4	19.0	19.1	16.8	22.2	28.3	28.1
Total	67.6	72.4	114.1	332.9	256.3	287.0	295.8	257.8	346.5	439.1	361.5
% Δ, year on year		0.071	0.576	1.92	0.230	0.120	0.031	0.128	0.344	0.211	0.177
					1			2			3

82	83	84	85	86	87	88	89	90	91	92	93
11.0	9.6	9.6	9.5	4.0	5.9	4.8	6.1	8.6	7.7	7.2	6.0
11.7	10.1	10.6	9.1	4.7	5.7	4.6	5.6	7.0	6.8	6.0	4.9
17.2	16.9	14.2	14.8	5.6	8.8	6.5	10.6	15.4	13.7	14.8	12.9
10.0	8.2	10.2	12.0	6.7	11.2	11.8	15.4	12.8	0.3	0.5	0.6
8.3	9.5	10.3	9.0	6.0	8.8	6.3	9.2	7.8	0.9	5.8	8.9
13.4	11.1	10.7	10.3	4.6	5.5	5.6	6.7	10.6	9.8	9.2	7.5
13.7	11.2	12.3	13.0	6.5	7.5	6.7	9.8	13.5	12.0	12.0	10.8
3.9	3.0	3.9	2.8	1.4	1.7	1.6	2.0	2.9	2.3	2.6	2.2
68.2	46.7	38.1	24.4	18.0	19.9	19.0	23.1	38.7	40.8	43.7	36.8
14.0	11.1	10.7	10.4	5.7	8.5	6.7	9.8	14.8	13.8	13.5	11.4
17.2	13.8	14.0	12.2	6.5	8.1	7.1	8.8	11.8	11.4	11.5	10.6
188.5	151.3	144.8	127.5	69.6	91.6	80.7	107.3	144.0	119.6	126.7	112.6
96.5	99.6	103.9	107.6	109.6	113.7	118.4	124	130.8	136.3	140.4	144.6

82	83	84	85	86	87	88	89	90	91	92	93
15.0	12.6	12.1	11.5	4.8	6.8	5.3	6.5	8.6	7.4	6.7	5.4
15.9	13.3	13.4	11.0	5.6	6.6	5.1	5.9	7.0	6.5	5.6	4.5
23.3	22.3	17.8	18.0	6.7	10.1	7.2	11.2	15.4	13.2	13.8	11.7
13.5	10.8	12.8	14.6	8.0	12.9	13.1	16.3	12.8	0.3	0.5	0.5
11.3	12.5	13.0	10.9	7.1	10.2	7.0	9.7	7.8	0.8	5.4	8.1
18.2	14.6	13.5	12.6	5.5	6.4	6.1	7.0	10.6	9.4	8.6	6.8
18.6	14.7	15.5	15.8	7.7	8.7	7.4	10.4	13.5	11.5	11.2	9.7
5.3	3.9	4.9	3.5	1.6	1.9	1.7	2.1	2.9	2.2	2.4	2.0
92.4	61.4	48.0	29.7	21.5	22.9	21.0	24.4	38.7	39.2	40.7	33.3
19.0	14.6	13.5	12.6	6.8	9.8	7.5	10.3	14.8	13.3	12.6	10.3
23.3	18.2	17.6	14.8	7.8	9.3	7.8	9.3	11.8	10.9	10.7	9.6
255.6	198.7	182.3	155.0	83.1	105.4	89.2	113.2	144.0	114.8	118.0	101.9
.293	0.223	0.090	0.150	0.464	0.268	0.154	0.269	0.272	0.203	0.028	0.136

4 5 6 7 8 9 10 11

94	95	96	97	98	99	00
5.6	6.2	8.0	7.5	4.8	6.5	10.1
4.4	4.5	5.2	4.1	2.7	3.7	5.6
13.4	14.8	17.6	16.1	10.3	13.9	21.9
0.5	0.5	0.8	4.8	6.4	11.4	20.4
9.7	11.1	12.9	12.5	7.9	10.0	16.2
7.0	7.7	9.4	8.9	5.5	7.4	11.7
9.9	10.8	14.7	14.0	8.6	12.0	18.5
2.2	2.4	3.3	4.2	2.9	4.1	6.6
36.9	41.5	48.7	48.2	29.6	38.3	59.6
11.1	12.0	14.6	14.2	9.3	11.9	19.1
11.2	13.4	18.6	18.0	11.1	13.6	21.8
111.9	124.8	153.8	152.6	99.1	132.8	211.5
					0.339709	
148.3	152.5	157	160.6	163.1	166.7	170.7

94	95	96	97	98	99	00
4.9	5.3	6.6	6.1	3.9	5.1	7.7
3.9	3.8	4.3	3.3	2.1	2.9	4.3
11.8	12.7	14.6	13.1	8.3	10.9	16.8
0.5	0.4	0.6	3.9	5.2	9.0	15.6
8.6	9.5	10.8	10.2	6.3	7.8	12.4
6.2	6.6	7.8	7.3	4.4	5.8	9.0
8.8	9.2	12.3	11.4	6.9	9.4	14.2
1.9	2.1	2.8	3.4	2.3	3.2	5.0
32.5	35.6	40.6	39.3	23.7	30.1	45.6
9.8	10.3	12.2	11.6	7.5	9.4	14.7
9.9	11.5	15.5	14.7	8.9	10.7	16.7
98.7	107.1	128.1	124.3	79.5	104.2	162.0
0.031	0.085	0.196	0.030	0.360	.311	0.555
12			13	14		

$\Sigma = 7.926$

$\bar{x} = 0.273$

14/29 - revenues ↓

12/14 - declines 9% or greater

$\bar{X}_{decl} = .19$

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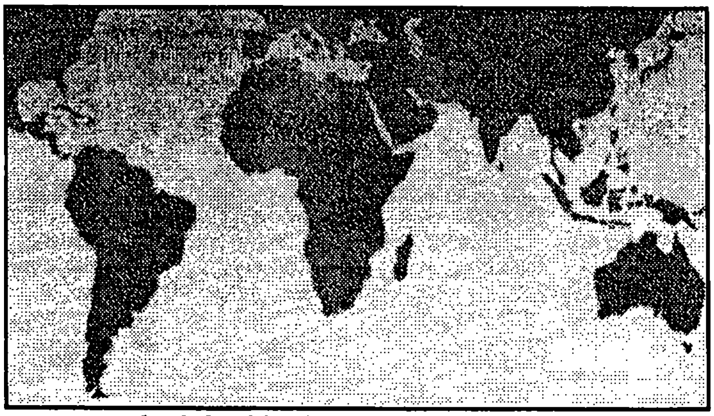
United States
Energy Information Administration

March 2000

OPEC Revenues Fact Sheet



The following provides information on OPEC oil revenues and the impact of sharply increased oil prices since their low point in early 1999. OPEC countries include: Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela. Most OPEC countries are overwhelmingly dependent on oil export revenues, and the surge in oil prices over the past year has translated into sharply higher oil export revenues, alleviating many of the pressures which had built up during the oil price slump of late 1997-early 1999. Please note that all the data and forecasts contained in this report are based on the best available information as of March 2000 and can change.

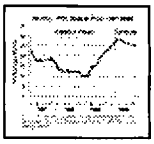
EXECUTIVE SUMMARY

The main conclusions of this study are the following:

- Assuming the U.S. Energy Information Administration's (EIA's) March 2000 "reference case" forecast for world oil prices and production, OPEC oil export revenues for 2000 are projected to be $211.5 billion (see table), or 59% higher than in 1999, which itself had seen a 34% increase from 1998 revenues (the lowest in "real," i.e., inflation-adjusted, terms since 1972). Thus, in only two years, OPEC oil export revenues have more than doubled, and are now the highest (in real terms) since 1984 (and in "nominal" terms since 1981).
- Increased OPEC oil export revenues since early 1999 have resulted in a dramatic improvement in OPEC finances and economic situations in general. Low OPEC oil revenues during 1998 and early 1999 had posed difficult social/economic/political challenges and tradeoffs for many OPEC countries
- Higher OPEC oil export revenues in 2000 are a result of sharply higher prices (52% higher) compared to 1999. OPEC oil production in 2000 is expected to be about 3.5% higher than in 1999.
- Saudi Arabia maintains the highest share of OPEC oil export revenues (at around 28% of the OPEC total). Other top OPEC oil exporters include Iran, Venezuela, Iraq, and Nigeria.
- Iraq is expected to earn around $20.4 billion in 2000, *nearly double* its former United Nations (U.N.) oil export ceiling (under the "food-for-oil" program) of $10.5 billion ($5.26 billion every 180 days). During the first half of 2000, Iraq is expected to earn $9.4 billion in oil export revenues, compared to $4.2 billion in the first half of 1999.
- In addition to the OPEC countries, dramatically increased oil export revenues during 1999 and early 2000 are significantly impacting non-OPEC countries, such as Russia and Mexico, as well. Russia's economic situation has rebounded somewhat (with positive economic growth in 1999 after

a sharp downturn in 1998), partly as a result of a rebound in the country's oil and gas export revenues from 1998. Mexico's economy is expected to grow by 4.8% in 2000.

- According to EIA's Monthly Energy Review, the price collapse of late 1997 and 1998 cut U.S. oil imports by over $20 billion. The sharp increase in oil prices of the past year increased U.S. oil imports in 1999 to $67 billion, up $17 billion from 1998. Given EIA oil price forecasts, U.S. oil imports could approach $90 billion in 2000.
- It is important to note that OPEC oil export revenue forecasts are dependent on both oil prices and production levels, each of which has a significant degree of uncertainty attached to it. Despite this uncertainty, EIA has a high degree of confidence in its general conclusion that OPEC oil export revenues in 2000 will be sharply higher than in 1999.



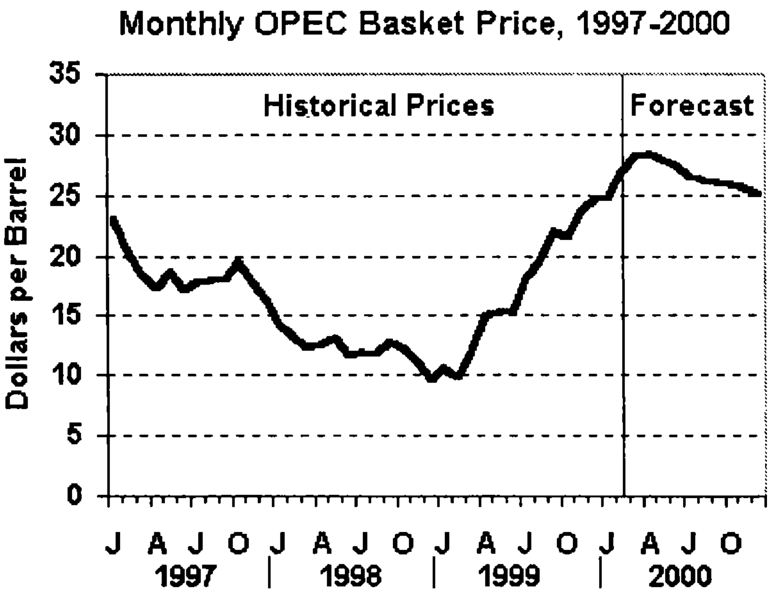
OVERVIEW

World oil prices declined sharply in late 1997, and continued to remain extremely low through 1998 and into early 1999. Over the past year, following OPEC's March 23, 1999 agreement to cut oil production by 1.7 million barrels per day (bbl/d), oil prices have rebounded sharply from their lowest levels in decades, with West Texas Intermediate and other major crude prices approximately tripling in less than a year. The latest U.S. Energy Information Administration's (EIA's) data and forecast information reflect this increase, with OPEC oil export revenues for 2000 up 59% from 1999, and an amazing 113% from 1998. For 2000 as a whole, it is expected that OPEC oil export revenues will be the highest (in real terms) since 1984, the year before the oil price collapse of 1985/1986. This massive inflow of oil revenues is helping OPEC countries' balance of payments, budgets, and overall economic conditions. (Note: EIA oil price forecasts include high, low, and reference cases. For the purposes of this report, the reference case was used. Use of low or high oil price cases would have resulted in, respectively, lower or higher OPEC oil export revenue forecasts -- possibly by about 10% in either direction.)

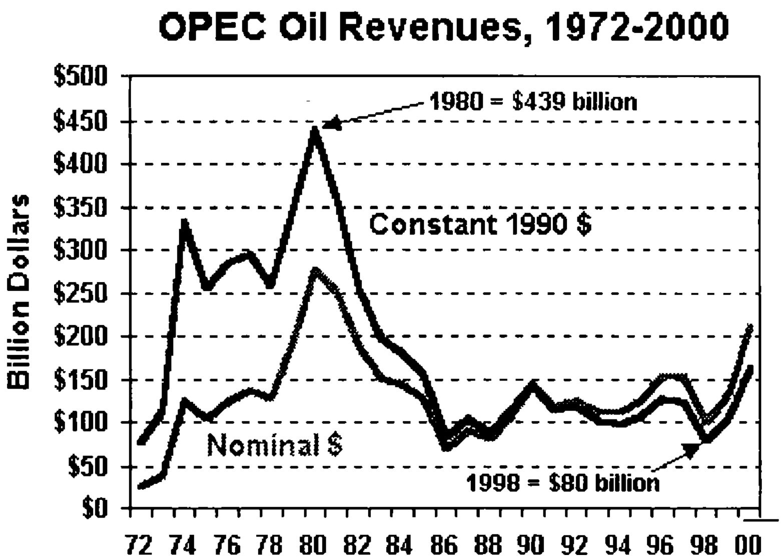
The sharp increase in oil prices of the past year is even more dramatic considering that the OPEC "basket" price (a weighted average of Algeria's Saharan Blend, Indonesia's Minas, Nigeria's Bonny Light, Saudi Arabia's Arabian Light, Dubai, Venezuela's Tia Juana, and Mexico's Isthmus) had fallen to under $10 per barrel in December 1998. Prior to the past year's oil price increases, real world oil prices during 1998 and early 1999 had been running at the lowest levels since 1973, prior to the Arab Oil Embargo late that year, and since 1986, following the oil price collapse of late 1985/early 1986. This had represented a reverse oil price "shock" (downward in this case), in contrast to the sharp upward oil price shocks of 1973/4, 1979, and 1990. In the most recent downward oil price "shock" from late 1997 through early 1999, low oil prices had a negative effect on oil exporting countries, while generally helping the major oil importing countries.

The sharp increase in oil prices has been caused by several main factors as well: 1) OPEC's March 1999, 1.7-million bbl/d quota cut agreement, in addition to over 2.5 million bbl/d in two output cutbacks agreed to earlier; 2) high levels of OPEC compliance to its quota agreement; and 3) strong world oil demand, including the rebounding Asian economies and the surging U.S. economy.

Among other effects, sharply increased oil prices during 1999 have resulted in a dramatic improvement in OPEC countries' economic situations, budgets, trade balances, etc. For 1999 as a whole, OPEC earned an estimated $133 billion in oil export revenues(see table), up 59% (in nominal terms) from 1999 and more than double 1998 levels (although still down around $20 billion from 1997). For 1999, prior to the upsurge in oil prices (and revenues), most OPEC countries had reduced their expectations for oil prices and revenues substantially. Given sharply increased OPEC oil prices and revenues, however, OPEC country budgetary assumptions for oil prices during 2000 now appear to have been far too low in many

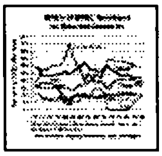


Source: Middle East Economic Survey for historical prices, and the Energy Information Administration's March 2000 Short-Term Energy Outlook.


OPEC Oil Revenues, 1972-2000
Billion Dollars
$500
$450
$400
$350
$300
$250
$200
$150
$100
$50
$0
1980 = $439 billion
Constant 1990 $
Nominal $
1998 = $80 billion
72 74 76 78 80 82 84 86 88 90 92 94 96 98 00

cases.

In real terms (constant $1990), OPEC revenue peaked in 1980, at $439 billion (see graph). OPEC's worst revenue year in constant dollar terms since the early 1970s ($77 billion in 1972) was 1998, when revenues reached only $80 billion (in constant $1990), slightly below the previous low revenue year of 1986 ($83 billion in earnings), following the oil price collapse of late 1985/early 1986. OPEC revenues for all of 2000 will most likely be around $162 billion (in constant $1990) given EIA's oil price and net oil export forecasts. Assuming EIA's current baseline forecast, OPEC revenues in real terms in 2000 would still be only 37% of 1980 revenues, but more than double 1998 revenues.



Individual OPEC members' shares of total oil export revenues have fluctuated over the past three decades, but several trends are apparent (see graph). First, Saudi Arabia consistently has earned more oil export revenues than any other single member of OPEC, with the Saudi share ranging from below 20% in 1972 to over 40% in the early 1980s, and 28% today. Second, Iran's revenue share fell after the 1978/79 Iranian Revolution (followed soon thereafter by the Iran-Iraq War for much of the 1980s), and has not recovered since. Today, Iran accounts for about 10% of total OPEC oil export revenues, down from 17%-18% in the 1970s. Third, Iraq's oil export revenue share has fluctuated sharply, from a high of around 15% in the late 1980s, to near 0% for several years following its August 1990 invasion of Kuwait (and the subsequent U.N. oil embargo, which continues to this day). Iraqi oil export revenues have increased over the past three years or so under the U.N. "food-for-oil" deal, which permits limited Iraqi oil exports to buy food and medicine, for war reparations, and for other U.N.-authorized purposes. Iraq's share of total OPEC oil revenues is now approaching 10%. Fourth, Venezuela has maintained a major -- and fairly consistent share of around 10%-12% of OPEC oil revenues. Finally, the rest of OPEC has earned between 40% and 50% of total OPEC oil export revenues between 1972 and 1998. Around half of this was earned by "other Persian Gulf" countries, which includes Kuwait, the United Arab Emirates, and Qatar.

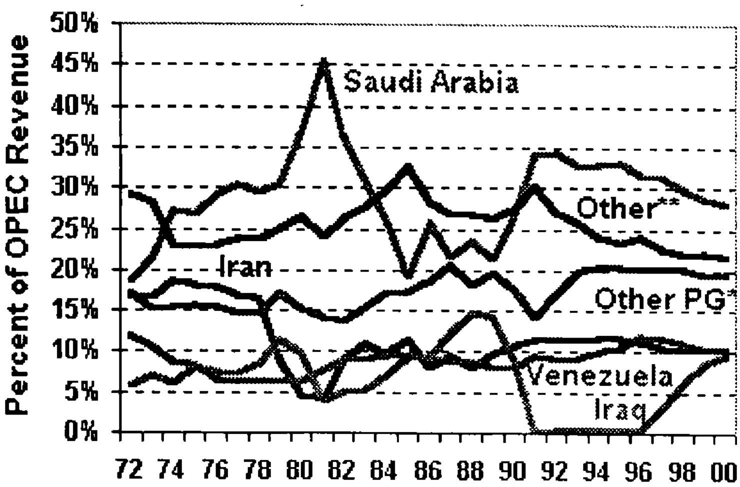
Algeria

In 1999, Algeria's oil and gas export revenues accounted for at least 90% of Algeria's total export revenues, and more than half of total fiscal revenues. The combination of sharply higher oil prices and moderately lower oil production since March 1999 has resulted in significantly higher oil export revenues for Algeria -- an estimated $6.5 billion in 1999, compared to $4.8 billion in 1998. This has helped to relieve pressures on government finances and has helped the country's overall economic growth. Prior to the oil price collapse of late 1997, Algeria's real GDP had grown strongly (5.5% in 1997, for instance). For 1998, a 6% growth rate had been projected prior to the oil price collapse, but in actuality ended up at 1%. In 1999 and 2000, higher oil prices have contributed to a sharp rebound in Algeria's GDP growth, to 5.2% and 6.1%, respectively. EIA is estimating that revenues from Algeria's oil exports will reach $10.1 billion in 2000 (up 55% from 1999), on exports of nearly 1 million bbl/d.

Indonesia

Indonesia's oil revenues are expected to rise 52%, to $5.6 billion, in 2000, compared to $3.7 billion in 1999 (and more than double the $2.7 billion earned in 1998). Increased Indonesian oil export revenues are helping the country's economy as it begins to recover from the devastating collapse of 1998. Indonesia is expected to export about 538,000 bbl/d of crude oil (on a net basis) in 2000, with oil and gas exports accounting for about one-third of Indonesia' total export revenues. For 2000, the Indonesian economy is expected to grow (in real terms) by 3.2%, following a sharp decline in 1998 and a smaller decline in 1999. Indonesia's oil price projection for the country's 2000/2001 budget is around $18 per barrel. This is around $10 per barrel lower than EIA's estimate for the average Indonesian oil price in 2000.

Share of OPEC Revenues for Selected Countries



* Other PG (Persian Gulf) includes: Kuwait, Qatar, and the United Arab Emirates

** Other includes: Algeria, Indonesia, Libya, and Nigeria

Iran

Iran's economy, which relies heavily on oil export revenues (around 80%-85% of total export earnings, for instance), was hit hard by record-low oil prices during 1998 and early 1999, but with the rebound in oil prices over the past year, has begun to recover somewhat. For 1999, Iran's real GDP grew by 2.5%; for 2000, it is expected to grow at a more rapid, 4.2% rate.

For 2000, Iran's oil export revenues are expected to reach $22 billion, up 58% from 1999 and more than double 1998 revenues. Despite higher oil prices, Iran continues to face budgetary pressures, a rapidly growing, young population with limited job prospects; heavy dependence on oil revenues (about half the state's budget and 80% of the country's hard currency earnings); $16 billion in external debt (including a high proportion of short-term debt); expensive state subsidies on many basic goods; a large, inefficient public sector and state monopolies (bonyads, which control at least a quarter of the economy and constitutionally are answerable only to supreme leader Ayatollah Ali Khamenei); and international isolation and sanctions. To cope with its economic problems, Iran's government has proposed a variety of privatization and other restructuring and diversification measures.

Iran's budget for FY 2000 is based on a forecast price of oil at $16 per barrel, compared to a price for Iranian crude oil of around $25 per barrel in February 2000. Low oil prices during 1998 exacerbated Iran's budget shortfall, which is a chronic problem in part due to large-scale state subsidies -- totaling some $11 billion per year -- including foodstuffs and especially gasoline (see below). Iran gains around $800 million in revenues for every $1 per barrel increase in the price of its oil. Iran is expected to export around 2.4 million bbl/d of crude oil in 2000, the same as in 1999.

Iraq

The effect of world oil price fluctuations on Iraq is more complicated than on other OPEC countries for one main reason: Iraq remains subject to U.N. sanctions stemming from its invasion of Kuwait in August 1990. Over the years, these sanctions have constrained both the dollar value that Iraq could export and also have controlled how Iraqi oil export revenues could be spent (in December 1999, the previous limit on Iraqi oil export revenues -- $5.26 billion per every 6 months -- was ended by the U.N. Security Council, although, for somewhat complex reasons, Iraq has informally, and somewhat vaguely, claimed continued adherence to the limit). Since late 1996, Iraqi oil production has increased by over 2 million bbl/d -- from 550,000 bbl/d in November 1996 to around 2.7 million bbl/d forecast for 2000. Iraqi oil exports reached an estimated 1.5 million bbl/d in April 1998 and around 2.2 million bbl/d in October 1999, before falling off sharply in November and December due to an impasse over U.N. weapons inspections. In 1997 and 1998, rapidly increasing Iraqi oil exports played a significant role in creating a world oil glut and causing a price collapse. Currently, Iraqi oil exports are increasing much more slowly, or have even leveled off, and are expected to average 2.2 million bbl/d for 2000 as a whole.

If Iraq were, for whatever reason, to adhere unilaterally to the old $5.26-billion, 6-month oil export revenue target, it would need to sustain oil exports of around 1.2 million bbl/d (assuming the $25 per barrel which EIA expects Iraq will average during 2000). Assuming oil exports of 2.2 million bbl/d for 2000 (EIA's current forecast), Iraq would earn around $20 billion in oil export revenues, up 79% from 1999 and more than triple 1998 levels. EIA's Iraqi oil production forecast assumes that the country receives sufficient spare parts for its oil industry (a frequent source of contention between Iraq and the United Nations), and also that Iraqi oil production is not capped by the United Nations or restricted by unilateral action by Iraq.

Kuwait

With oil revenues accounting for about 90% of Kuwait's government income (and nearly half the country's GDP), sharply increased oil prices since early 1999 obviously have had positive implications for

Kuwait's financial and economic situation. Following a serious recession in 1997 and 1998, Kuwait's economy is now expected to grow by 4.5% (real GDP) in 2000. For 2000, Kuwait oil export revenues are expected to increase sharply, to $16.2 billion, up 62% from 1999 revenues and more than double 1998 revenues. Kuwaiti net crude oil exports are expected to average around 1.8 million bbl/d, up slightly from 1.7 million bbl/d in 1999.

Libya

Libya is expected to earn $11.7 billion from oil exports in 2000, up 59% from 1999 revenues and more than double 1998 earnings of $5.5 billion. Oil export revenues account for about 98% of Libya's hard currency earnings and half of fiscal receipts. Over the past several years, Libyan oil export production and export earnings have been affected by U.N. (and U.S.) sanctions imposed in the years following the 1988 bombing of Pan Am flight 103 over Lockerbie, Scotland, in which 270 people were killed. On April 5 1999, Libya handed over the two suspects, prompting the United Nations (but not the United States) to suspend sanctions (see EIA's report on energy sanctions).

As a result of both sanctions and low oil prices, Libya's economy has barely grown in several years (0.6% growth in 1997, a decline of 1.5% in 1998, and 1.9% growth in 1999). For 2000, helped by higher oil export earnings and the end of international sanctions, Libya's real GDP is expected to grow by around 3.2%. Libya had been forced to adopt a more conservative fiscal policy and to limit public infrastructure spending to a few main projects, such as the Great Man Made River (GMR), a $25 billion project to bring water from underground aquifers beneath the Sahara to the Mediterranean coast. Given the rebound in oil prices (and the suspension of U.N. sanctions), Libya's macroeconomic picture has improved somewhat, as has its economic outlook. Libya continues its attempts at diversifying the country's economy away from oil and towards natural gas, and has kept government spending under tight control. Libya is expected to export around 1.2 million bbl/d of crude oil in 2000, up slightly from 1.1 million bbl/d in 1999.

Nigeria

Crude oil exports generate over 90% of Nigeria's foreign exchange earnings. Nigeria's crude oil export revenues are expected to increase by 54% in 2000, to $18.5 billion, compared to $12.0 billion in 1999 (and $8.6 billion in 1998). Low oil export revenues during 1998 came amidst a period of political and social turmoil for Nigeria, especially following the deaths of President Sani Abacha on June 8, 1998 and of Mashood Abiola -- presumed winner of 1993 presidential elections -- on July 7, 1998, and the election of a new president (General Olusegun Obasanjo) on March 1, 1999. Political turmoil, combined with low oil prices during late 1997 and into early 1999, had a serious effect on Nigeria's economic and fiscal situations. With higher oil prices and political stability, these situations now are improving. Real GDP, for instance, is expected to grow by 4.3% in 2000, compared to 2% in 1999. Nigeria is expected to export around 1.8 million bbl/d of crude oil in 2000, as it did in 1999.

Qatar

Oil continues as the dominant feature of Qatar's economy, although natural gas is becoming increasingly important and the government is pushing diversification efforts. Oil accounts for around 70% of Qatar's government revenues, and also has an impact on production of condensate and associated natural gas. Increased oil prices since early 1999 are helping Qatar in several ways, not the least of which is the increase in revenues which can be used to balance the country's budget and to pay for a huge liquefied natural gas (LNG) development program (Qatar has the third largest gas reserves in the world, after Russia and Iran). Qatar's oil export earnings for 2000 currently are forecast at $6.6 billion, up 61% from 1999 and more than double the $2.9 billion which Qatar earned from oil exports in 1998. Qatar continues to maintain relatively tight fiscal and monetary policies, keeping inflation under control. Qatar's real GDP is forecast to increase by 4.6% in 2000, up from 3.3% growth in 1999. Qatar is expected to export

685,000 bbl/d of crude oil in 2000, up from 649,000 bbl/d in 1999.

Saudi Arabia

Saudi Arabia is the largest world crude oil producer and is a leader in OPEC's production quota decisions. As such, Saudi Arabia was a critically important player behind the oil price collapse of late 1997 through early 1999, and also in actions taken by world oil producers which have led to a tripling in oil prices. Currently, Saudi Arabia produces about 8 million bbl/d of crude oil (28% of total OPEC crude production) and exports around 6.6-6.7 million bbl/d. This represents a significant cut from Saudi Arabia's production of 8.4 million bbl/d in 1998 (and 8.6 million bbl/d in 1997). The sharp decline in oil revenues which Saudi Arabia experienced during 1998 and early 1999 represented a major challenge for the country's government (since oil export revenues account for nearly 90% of total Saudi export earnings). The sharp increase in oil prices over the past year has significantly improved Saudi Arabia's economic situation, with 5.4% real GDP growth forecast for 2000.

Saudi Arabia is forecast to earn about $60 billion in 2000 from crude oil exports, up 55% from around $38 billion in 1999, and double 1998 oil export revenues. From January 1998 through March 1999, the price of Saudi oil averaged between $9 and $13 per barrel, down sharply from late 1997, and the lowest in inflation-adjusted terms for any sustained period of time since 1973. Saudi oil prices increased sharply following OPEC's March 23, 1999 cutback agreement, and now average $25-$30 per barrel.

Despite attempts to diversify its economy, Saudi Arabia remains heavily dependent on oil revenues (for around 90% of total export earnings, about 70% of state revenues, and 40% of GDP). The oil price decline of 1998 and early 1999 came just as the Saudi economy appeared to be recovering from the adverse impacts of the 1990/91Gulf War, and seriously hurt Saudi Arabia's short-term economic and financial situations. The dramatic turnaround in Saudi oil revenues over the past year has resulted in a significant higher GDP growth rate, as well as greatly improved external trade and internal budgetary situations. For 1999, Saudi Arabia had adopted an austerity budget which included spending cuts of almost 16% but without any new taxes or other measure to increase revenues. Low oil prices also had forced state oil and gas company Saudi Aramco, whose expenditures account for around 6% of Saudi GDP) to reassess its capital expenditure program, to delay a series of upstream and refining projects (at an estimated savings of $2 billion this in 1998), and to defer bidding on the $150-$200 million Haradh (phase 2) crude oil production increment project. In October 1998, a planned $800 million upgrade of the Rabigh oil refinery was cancelled, leaving Saudi Arabia with only one major energy project under bidding -- the $2 billion Hawiya natural gas processing plant (part of an ambitious expansion plan for the Saudi Master Gas System). Increased oil revenues now mean that Saudi Arabia will be more able to spend money on such projects.

UAE

The UAE is expected to earn $19.1 billion in oil export revenues in 2000, up 160% from 1999 and more than double 1998 revenues. As with other OPEC countries, the sharp increase in oil prices of the past year has significantly improved the UAE's economic and budgetary situation. Real GDP is forecast to grow by 5.2% in 2000, up from 5% growth in 1999 and a 5% decline in 1998. The UAE is expected to export around 1.9 million bbl/d in 2000, up slightly from 1999 oil export levels.

Venezuela

Venezuela is expected to earn $21.8 billion in oil export revenues during 2000, up 60% from $13.6 billion in 1999 (and nearly double 1998 oil export revenues). Due to this surge in oil revenues, Venezuela's real GDP is expected to grow by 3.5% in 2000, compared to a 5.7% *decline* in 1999. Despite this forecast increase, Venezuela is faced with a host of economic and political challenges, including the aftermath of devastating floods and mudslides that ravaged Venezuela in December 1999 and added yet another financial burden to the country, while also killing as many as 50,000 people, leaving over 100,000 homeless, and destroying businesses and public buildings.

Due to low oil prices during 1998, PdVSA's 1999 budget was the smallest in 10 years. Cuts in PdVSA's budget over the past few years have crimped the company's ambitious long-term expansion plans. PdVSA's production capacity target for 2007 already has been lowered from 6.4 million bbl/d, to 5.8 million bbl/d (up from 3.3 million bbl/d in 1997). Development of the Orinoco heavy oil field, a $2.6-billion project owned 51% by Conoco and 49% by PdVSA, has been threatened by Venezuela's economic crisis. Complicating this picture somewhat is the fact that PdVSA is a vertically integrated oil company, with extensive downstream (i.e., refining) operations in the United States, Caribbean, and elsewhere. In general, all else being equal (i.e., there is no abnormal oil stock overhang, as there was in 1998) downstream operations are helped by lower oil prices, while upstream operations are hurt. On balance, however, Venezuela still was hurt by the low oil prices of late 1997 through early 1999, and is being helped by sharply increased oil prices now.

OPEC Oil Export Revenues at a Glance

	Nominal Dollars (Billions)			Constant $1990 (Billions)			
	1999E	2000E	Change	1972E	1980E	1986E	2000E
Algeria	$6.5	$10.1	56%	$4.2	$20.2	$4.8	$7.7
Indonesia	$3.7	$5.6	52%	$2.8	$22.5	$5.6	$4.3
Iran	$13.9	$21.9	58%	$12.9	$20.9	$6.7	$16.8
Iraq	$11.4	$20.4	79%	$4.5	$43.6	$8.0	$15.6
Kuwait	$10.0	$16.2	62%	$8.5	$28.5	$7.1	$12.4
Libya	$7.4	$11.7	59%	$9.1	$35.3	$5.5	$9.0
Nigeria	$12.0	$18.5	54%	$6.6	$38.6	$7.7	$14.2
Qatar	$4.1	$6.6	61%	$1.4	$8.5	$1.6	$5.0
Saudi Arabia	$38.3	$59.6	55%	$14.5	$162.7	$21.4	$45.6
UAE	$11.9	$19.1	60%	$3.3	$29.9	$6.8	$14.7
Venezuela	$13.6	$21.8	60%	$9.4	$28.2	$7.8	$16.7
TOTAL	**$132.8**	**$211.6**	**59%**	**$77.2**	**$439.1**	**$83.1**	**$162.0**

Sources: U.S. Energy Information Administration;

Links
Economic Analysis and Methodology
Non-OPEC Countries Oil Revenues: Summary

Sources for this report include: Economist Intelligence Unit, International Energy Agency, Middle East Economic Digest, Middle East Economic Survey, New York Times, OPEC Annual Statistical Bulletin, and WEFA.

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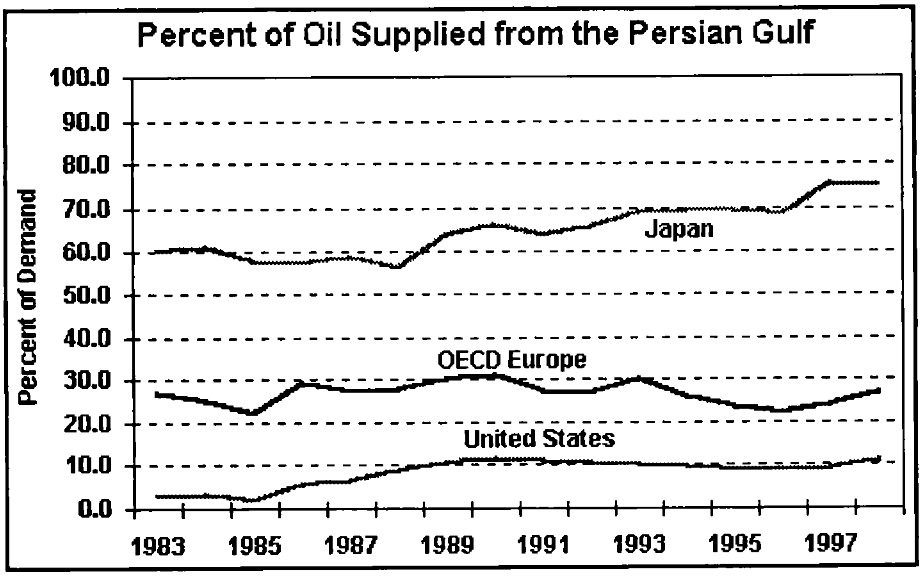
June 1999

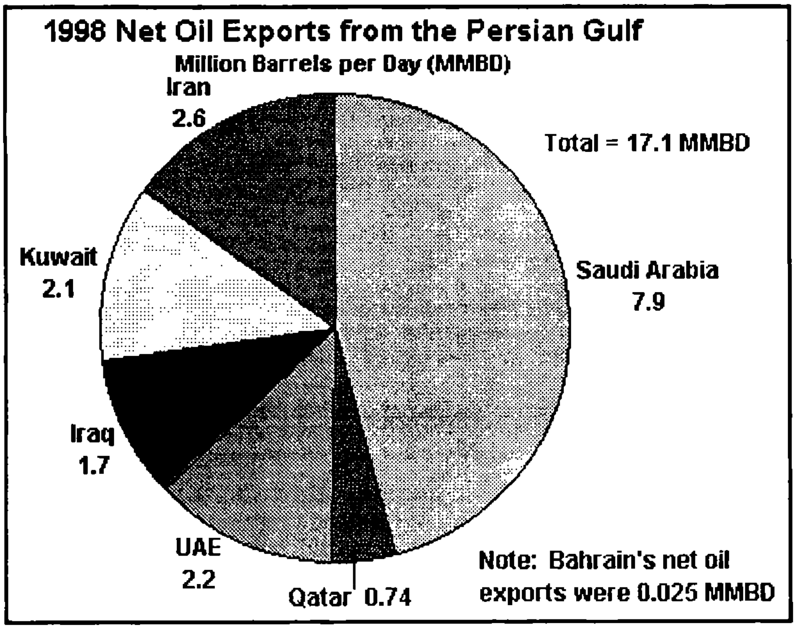
Persian Gulf Oil Export Fact Sheet

In 1998, the Persian Gulf countries (Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates produced over 27 percent of the world's oil, while holding 64 percent of the world's oil reserves. Persian Gulf net oil exports to OECD countries were up over 0.5 million barrels per day in 1998 from 1997 to more than 10.5 million barrels per day.



U.S. net oil imports from the Persian Gulf in 1998 rose to 2.14 million barrels per day from 1.76 million barrels per day in 1997. The vast majority of Persian Gulf exports to the United States came from Saudi Arabia (70 percent), with significant amounts also coming from Iraq (nearly 16 percent) and Kuwait (14 percent), with only very small amounts of oil coming from Qatar and the United Arab Emirates. Since rising from a 25-year low of 0.31 million barrels per day in 1985 to 1.97 million barrels per day in 1990, U.S. oil imports from the Persian Gulf as a percentage of oil demand declined gradually through 1996, until increasing in 1997 and 1998 (see graph). In 1998, more oil was imported to the United States from the Persian Gulf than in any year since 1977-1978. In these years, 2.45 million barrels per day and 2.22 million barrels per day of oil respectively was imported from the Persian Gulf to the United States.

Western Europe (defined as European countries belonging to the Organization for Economic Cooperation and Development, or OECD, but excluding new European OECD members Poland, Hungary, and the Czech Republic) imported nearly 4.0 million barrels per day from the Persian Gulf in 1998. This was an increase of nearly 0.5 million barrels per day from 1997. Nearly half of Persian Gulf oil exports to Western Europe came from Saudi Arabia (48 percent), with significant amounts also coming from Iran (over 25 percent) and Iraq (nearly 19 percent). After declining steadily between 1993 and 1996, Western Europe's oil imports from the Persian Gulf as a percentage of oil demand increased significantly in 1997 and 1998, rising from 22 percent in 1996 to 27 percent in 1998.



Japan imported over 4.1 million barrels per day from the Persian Gulf in 1998. Unlike the United States and Western Europe, this represented a decrease of nearly 0.2 million barrels per day from 1997. However, due to a significant decline in Japanese oil demand (0.2 million barrels per day) as a result of the Asian economic crisis, Japan's oil imports from the Persian Gulf as a percentage of demand stayed relatively flat from 1997 at 75 percent. Japan's dependence on the Persian Gulf for its oil supplies has been increasing steadily since 1988, when Persian Gulf oil imports represented only 57 percent of Japanese oil demand. In 1998, more than a third of Persian Gulf exports to Japan came from the United Arab Emirates (34 percent), with slightly less coming from Saudi Arabia (31 percent).

In 1998, Persian Gulf countries exported 17.1 million barrels per day of oil (see pie chart). This represented an increase of about 1 million barrels per day from 1997. Iraq's oil exports alone increased by 1 million barrels per day as increases in the United Nations' "oil-for-food" deal allowed Iraq to export more oil. Iran, the United Arab Emirates, Kuwait, Qatar, and even Bahrain all exported slightly more oil in 1998 than in 1997. The exception was Saudi Arabia, whose oil exports dropped from 8.1 million barrels per day to 7.9 million barrels per day. However, Saudi Arabia still accounted for about half of Persian Gulf oil exports (46 percent), with Iran, the United Arab Emirates, Kuwait, and Iraq each accounting for between 10 to 15 percent.

Imports from the Persian Gulf Region

	As Percent of Demand			As Percent of Net Oil Imports		
	US	W. Europe	Japan	US	W. Europe	Japan
1983	2.9	27	60	10.3	41	60
1984	3.2	25	61	10.7	39	61
1985	2.0	22	58	7.3	35	59
1986	5.6	29	58	16.8	45	58
1987	6.5	27	59	18.2	43	60
1988	8.9	28	57	23.4	44	58
1989	10.7	30	64	25.8	47	63
1990	11.6	31	66	27.5	48	65
1991	11.0	27	64	27.8	43	64
1992	10.4	27	66	25.6	43	66
1993	10.3	30	69	23.4	50	68
1994	9.8	26	70	21.5	48	68
1995	8.9	24	70	19.9	47	70
1996	8.8	22	69	18.9	43	70
1997	9.4	24	75	19.2	47	74
1998	11.3	27	75	21.9	50	76

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February 2000

OPEC FACT SHEET

The 11 countries which make up the Organization of Petroleum Exporting Countries (OPEC) produce about 40 percent of the world's oil and hold more than 77 percent of the world's proved oil reserves. OPEC also contains most of the world's excess oil production capacity.

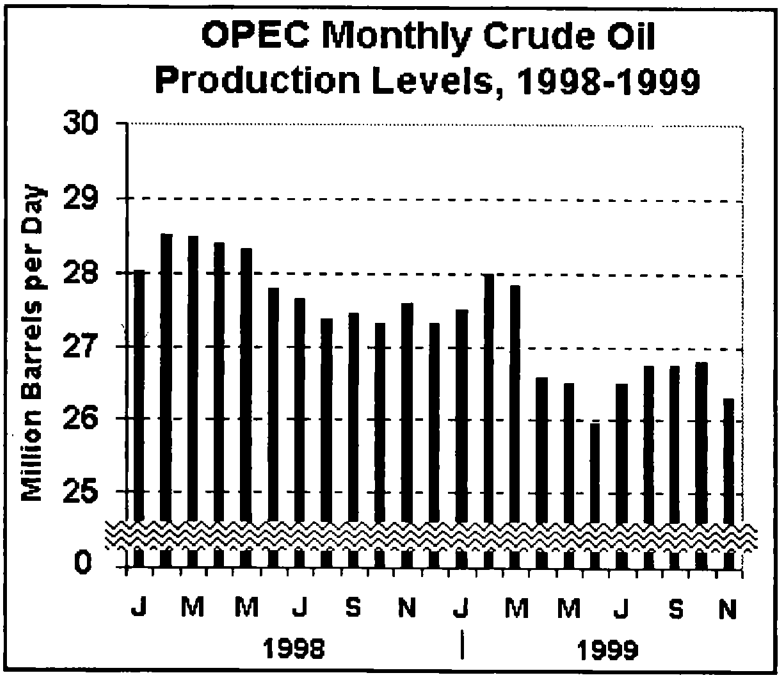
Country/Date Joined	April 1 1999 Quota* (thousand b/d)	Crude Oil** Production (thousand b/d) November '99	October '99	Oil/Energy Minister
Algeria (1969)	731	760	760	Youcef Yousfi
Indonesia (1962)	1,187	1,300	1,300	Susilo Bambang Yudhoyono
Iran (1960)	3,359	3,450	3,500	Bijan Namdar Zaganeh
Kuwait+ (1960)	1,836	1,905	1,925	Sheikh Saud Naser Al-Sabah
Libya (1962)	1,227	1,320	1,310	Abdullah Salim al-Badri
Nigeria (1971)	1,885	2,050	2,060	Rilwanu Lukman***
Qatar (1961)	593	650	650	Abdullah bin Hamad Al-Attiya
Saudi Arabia+ (1960)	7,438	7,865	7,845	Ali bin Ibrahim al-Naimi
United Arab Emirates++ (1967)	2,000	2,065	2,065	Obeid bin Saif Al-Nasiri
Venezuela (1960)	2,720	2,740	2,720	Ali Rodriguez
OPEC 10	**22,976**	**24,105**	**24,135**	
Iraq+++ (1960)	NA	2,200	2,665	Lt. Gen. Amir Muhammed Rashid
TOTAL OPEC	**NA**	**26,305**	**26,800**	***Secretary General Rilwanu Lukman***

NA: Not Applicable
**Quotas are based on crude oil production.*
***Crude oil does not include natural gas liquids or lease condensate.*
****Rilwanu Lukman is the oil advisor to President Olusegun Obasanjo.*
+Kuwaiti and Saudi Arabian figures each include half of production from the Neutral Zone between the two countries.

++Quota applies only to Abu Dhabi.
+++Iraqi oil production is constrained by the United Nations' limits on its exports and as such has not been a part of any OPEC agreements in 1998.

OPEC Overview

The Organization of Petroleum Exporting Countries (OPEC) was formed at a conference held in Baghdad on September 10-14, 1960. There were five original members: Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. Between 1960 and 1975, the organization expanded to 13 members with the addition of Qatar, Indonesia, Libya, United Arab Emirates, Algeria, Nigeria, Ecuador, and Gabon. Currently, OPEC consists of 11 member nations (Ecuador dropped out in December 1992 and Gabon withdrew effective January 1995).



OPEC was set up to help unify and coordinate members' petroleum policies and to safeguard their interests. Among other activities, OPEC holds regular meetings of national oil ministers to discuss prices and, since the early 1980s, to set production quotas. OPEC also provides financial assistance to developing countries through its OPEC Fund for International Development (founded in 1976), and conducts research on such topics as energy finance, technology, and relevant economic issues.

EIA estimates that combined, the 11 current OPEC members will account for 39.8 percent of total world oil supply (including crude oil, natural gas liquids, refinery gain, etc.) in 1999. OPEC's share of world oil supply had remained constant between 1993 and 1996 (at about 39.5 percent) as non-OPEC oil supply had increased dramatically, especially in the North Sea, Latin America, and West Africa. However, OPEC oil production increased by about 1.6 million barrels per day (b/d) in 1997 and another 0.5 million barrels per day in 1998, out of total global oil supply growth of nearly 3.2 million b/d between 1996 and 1998, thus increasing its share of the world's oil supply by more than 1 percentage point. However, following the most recent pledge to cut production, OPEC's share is expected to decline some in 1999, before increasing some over the latter half of 2000 as OPEC production is expected to gradually rise beginning in the first quarter of 2000.

OPEC Pricing

OPEC maintains a "basket" of seven crudes (Algeria's Saharan Blend, Indonesia's Minas, Nigeria's Bonny Light, Saudi Arabia's Arabian Light, Dubai, Venezuela's Tia Juana, and Mexico's Isthmus) which it uses for pricing purposes. In January 2000, the OPEC basket price averaged $24.58 per barrel, down $0.19 from the December 1999 average price, and $13.84 per barrel more than the price in January 1999 ($10.74 per barrel). The average OPEC basket price for the fourth quarter of 1999 averaged $23.42 per barrel, up $3.41 from the average third quarter price, while the average OPEC basket price for 1999 was $17.47 per barrel, up $5.19 per barrel above the average OPEC Basket price in 1998.

Recent Developments

On September 22, the Organization of Petroleum Exporting Countries (OPEC), at a meeting of its member states' oil ministers, decided to maintain current production cuts until March 2000. In another development, OPEC announced that its current Secretary General, Nigerian Rilwanu Lukman, will stay in office until March 2000. The announcement follows a vigorously contested race to succeed Lukman in the post, in which OPEC's three largest members, Saudi Arabia, Iran, and Iraq, had fielded candidates. The next OPEC Ministerial Meeting is scheduled to take place on March 27, 2000.

This meeting followed one on March 23, 1999, where OPEC (excluding Iraq) agreed to cut an additional 1.7 million barrels per day on top of cuts made in two agreements last year. At that meeting, four non-OPEC countries (Mexico, Norway, Russia, and Oman) pledged to cut nearly an additional 0.4 million barrels per day, bringing the total pledged cuts to just over 2.1 million barrels per day. These cuts are to be from the previous quotas, after making an adjustment for Iran. However, since the previous two agreements were only partially implemented (between 65% and 78% over the last 5 months of 1998), the levels in which these cuts are to be made from do not represent actual cuts for most countries. The table below shows what EIA is forecasting for OPEC crude oil production in each quarter of 1999 and the first quarter of 2000, as well as the new OPEC target crude oil production levels. Although our current estimates have fourth quarter 1999 OPEC (excluding Iraq) crude oil production about 1.1 million barrels per day above the new target level, it still represents over a 1.1 million barrel per day decrease from first quarter 1999 levels. Combining the pledged cuts in 1998 and the most recent agreement (a total of 4.3 million barrels per day), EIA is estimating that over 80% of the total supply cuts pledged occurred in the second and third quarters of 1999 before falling slightly to 74% in the fourth quarter of 1999.

OPEC Crude Oil Production in 1999 by Quarter

(thousand barrels per day)

					EIA Forecast	
Country	**1Q99**	**April 1, 1999 Production Target Levels**	**2Q99**	**3Q99**	**4Q99**	**1Q00**
Saudi Arabia	8,150	7,438	7,647	7,684	7,857	7,850
Iran	3,756	3,359	3,410	3,477	3,450	3,500
Venezuela	2,953	2,720	2,740	2,720	2,733	2,740
UAE	2,186	2,000	2,060	2,058	2,068	2,075
Nigeria	1,976	1,885	2,057	2,030	2,057	2,060
Kuwait	2,007	1,836	1,810	1,858	1,918	1,925
Libya	1,360	1,227	1,303	1,293	1,320	1,320
Indonesia	1,350	1,187	1,343	1,303	1,300	1,300
Algeria	810	731	763	757	760	760
Qatar	688	593	647	650	650	650
OPEC 10	**25,235**	**22,976**	**23,780**	**23,831**	**24,113**	**24,180**
Iraq	2,524	NA	2,568	2,833	2,087	2,900
Total OPEC	**27,759**	**NA**	**26,348**	**26,664**	**26,201**	**27,080**

NA: Not Applicable

Note: Effective April 1, 1999, four non-OPEC countries (Mexico, Norway, Russia, and Oman) have pledged to cut production by a total of 388,000 barrels per day as part of the March 23, 1999 OPEC *agreement to cut crude oil production.*

For more information on OPEC, see these other sources on the EIA web site:
EIA Information on OPEC
OPEC Oil Prices
Non-OPEC Fact Sheet
Persian Gulf Export Fact Sheet
International Petroleum Statistics Report - EIA's latest monthly international petroleum data
International Energy Annual 1998 - Annual international energy data through 1997
WORLD ENERGY Database for the International Energy Annual (requires Microsoft Access)
Detailed 1997 or 1998 Energy Data by country

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Crude Oil Exports- (Thousand Barrels per Day)

	Algeria	Indonesia	Iran	Iraq	Kuwait	Libya	Nigeria	Qatar	Saudi Arab	United Arab	Venezuela
1994	329.2	792.6	2650	60	1263.5	1125	1590	322.6	6233	1955	1696.4
1995	332.8	743.9	2621	63.5	1186.4	1120.3	1665	333	6290.8	1925	1819.9
1996	390.8	706.8	2630	88.1	1224.2	1099.4	1699	367	6109.3	1943.2	1976.4
1997	373.1	707.8	2587	713.9	1134.2	1091.4	1778.5	465	6184.5	1949	2210.8
1998	549.4	678	2512	1531.5	1190.2	1136.6	1544.6	572.4	6390.4	2039	2243.9

Annual Barrels (Millions)

	Algeria	Indonesia	Iran	Iraq	Kuwait	Libya	Nigeria	Qatar	Saudi Arab	United Arab	Venezuela
1994	120.158	289.299	967.25	21.9	461.1775	410.625	580.35	117.749	2275.045	713.575	619.186
1995	121.472	271.5235	956.665	23.1775	433.036	408.9095	607.725	121.545	2296.142	702.625	664.2635
1996	142.642	257.982	959.95	32.1565	446.833	401.281	620.135	133.955	2229.895	709.268	721.386
1997	136.1815	258.347	944.255	260.5735	413.983	398.361	649.1525	169.725	2257.343	711.385	806.942
1998	200.531	247.47	916.88	558.9975	434.423	414.859	563.779	208.926	2332.496	744.235	819.0235

Table 8. Worldwide Petroleum Trade in the Reference Case, 1995 and 2020
(Million Barrels per Day)

Exporting Region	Importing Region: Industrialized: North America	Western Europe	Asia	Total	Nonindustrialized: Pacific Rim	China	Rest of World	Total
1995								
OPEC								
Persian Gulf	1.8	3.4	4.2	**9.4**	4.1	0.4	1.5	**6.0**
North Africa	0.3	1.9	0.0	**2.2**	0.0	0.0	0.1	**0.1**
West Africa	1.0	0.6	0.1	**1.7**	0.3	0.0	0.1	**0.4**
South America	1.6	0.3	0.0	**1.9**	0.1	0.0	0.6	**0.7**
Asia	0.1	0.0	0.5	**0.6**	0.1	0.0	0.0	**0.1**
Total OPEC	**4.8**	**6.2**	**4.8**	**15.8**	**4.6**	**0.4**	**2.3**	**7.3**
Non-OPEC								
North Sea	0.7	3.4	0.1	**4.2**	0.0	0.0	0.4	**0.4**
Caribbean Basin	2.8	0.3	0.1	**3.2**	0.1	0.0	0.9	**1.0**
Former Soviet Union	0.0	1.6	0.0	**1.6**	0.3	0.0	0.7	**1.0**
Other Non-OPEC	0.6	0.2	1.1	**1.9**	0.1	0.2	0.4	**0.7**
Total Non-OPEC	**4.1**	**5.5**	**1.3**	**10.9**	**0.5**	**0.2**	**2.4**	**3.1**
Total Petroleum Imports	**8.9**	**11.7**	**6.1**	**26.7**	**5.1**	**0.6**	**4.7**	**10.4**
2020								
OPEC								
Persian Gulf	3.4	3.5	5.6	**12.5**	9.9	4.6	10.2	**24.7**
North Africa	0.3	1.9	0.1	**2.3**	0.1	0.0	0.2	**0.3**
West Africa	1.7	0.9	0.3	**2.9**	0.1	0.0	0.1	**0.2**
South America	2.8	0.7	0.1	**3.6**	0.1	0.0	0.6	**0.7**
Asia	0.0	0.0	0.2	**0.2**	0.1	0.0	0.0	**0.1**
Total OPEC	**8.2**	**7.0**	**6.3**	**21.5**	**10.3**	**4.6**	**11.1**	**26.0**
Non-OPEC								
North Sea	0.9	2.7	0.0	**3.6**	0.1	0.0	0.4	**0.5**
Caribbean Basin	3.3	0.2	0.1	**3.6**	0.1	0.0	1.5	**1.6**

Table 4.8 OECD Imports from OPEC, 1988-1998
(Million Barrels per Day)

	1988	1989	1990	1991	1992	1993	1
						Average	
Total..............	13.049	14.521	15.576	15.360	15.567	16.018	1
United States1/....	3.439	3.986	4.172	3.918	3.888	4.103	
Canada.............	.161	.205	.199	.210	.210	.268	
OECD Europe2/......	5.842	6.188	6.633	6.728	6.758	6.794	
Main European Importers							
France............	.737	.875	1.101	1.021	.932	1.006	
Germany3/.........	.761	.739	.771	.859	.957	.948	
Italy.............	1.191	1.260	1.375	1.393	1.343	1.222	
Netherlands.......	.850	.892	.850	.900	.914	.982	
Spain.............	.604	.686	.652	.700	.632	.582	
European Net Exporters							
Norway............	.002	.003	.007	.014	.004	.005	
United Kingdom....	.322	.342	.406	.377	.390	.439	
Smaller European Importers							
Austria...........	.082	.086	.097	.108	.115	.128	
Belgium...........	.302	.353	.313	.362	.359	.359	
Denmark...........	.067	.069	.044	.006	.001	.006	
Ireland...........	-	-	.000	.000	.000	.000	
Finland...........	.011	.013	.013	.029	.033	.007	
Greece............	.233	.244	.340	.298	.346	.303	
Portugal..........	.118	.156	.166	.139	.152	.166	
Sweden............	.074	.064	.073	.105	.116	.123	
Switzerland.......	.051	.021	.036	.052	.051	.063	
Turkey............	.439	.384	.388	.365	.412	.452	
Japan..............	3.309	3.788	4.062	4.026	4.198	4.245	
Other OECD.........	.298	.355	.510	.478	.512	.609	

1/ U.S. geographic coverage is the 50 States and District of Columbia.
2/ "OECD Europe" consists of Austria, Belgium, Denmark, Finland, France, Germany, G
the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United
3/ Data through 1990 are for the former West Germany.
Notes: Imports include crude oil, natural gas liquids, and refined products, and
for Economic Cooperation and Development. OPEC=Organization of Petroleum Exporting C
in these groups. Negative numbers represent net exports. A dash (-) indicates no t
less than 0.0005 million barrels per day. Data for 1997 are preliminary.
Sources: See end of Section 4.

Table D1. World Oil Production Capacity by Region and Country, Reference Case, 1990-2020
(Million Barrels per Day)

Region/Country	History (Estimates) 1990	1997	Projections 2000	2005	2010	2015	2020
OPEC							
Persian Gulf							
Iran	3.2	3.9	4.0	4.3	4.5	4.9	5.5
Iraq	2.2	1.6	2.8	3.2	3.8	4.7	5.9
Kuwait	1.7	2.6	2.7	3.1	3.2	4.3	5.2
Qatar	0.5	0.6	0.5	0.6	0.6	0.6	0.7
Saudi Arabia	8.6	11.4	11.1	13.7	14.1	16.2	20.0
United Arab Emirates	2.5	2.7	2.8	3.2	3.4	4.2	4.9
Total Persian Gulf	**18.7**	**22.8**	**23.9**	**28.1**	**29.6**	**34.9**	**42.2**
Other OPEC							
Algeria	1.3	1.4	1.6	2.0	2.2	2.1	2.0
Indonesia	1.5	1.7	1.5	1.5	1.5	1.4	1.3
Libya	1.5	1.5	1.5	1.6	1.7	1.6	1.5
Nigeria	1.8	2.2	2.5	2.9	3.2	3.3	3.1
Venezuela	2.4	3.4	3.8	4.6	5.1	5.4	5.8
Total Other OPEC	**8.5**	**10.2**	**10.9**	**12.6**	**13.7**	**13.8**	**13.7**
Total OPEC	**27.2**	**33.0**	**34.8**	**40.7**	**43.3**	**48.7**	**55.9**
Non-OPEC							
Industrialized							
United States	9.7	9.5	9.1	9.0	9.0	8.9	8.7
Canada	2.0	2.6	2.8	3.0	3.2	3.4	3.4
Mexico	3.0	3.4	3.7	3.7	4.0	3.9	3.9
Australia	0.7	0.8	0.8	0.8	0.8	0.8	0.7
North Sea	4.2	6.3	6.9	7.2	7.0	6.4	5.9
Other	0.5	0.8	0.8	0.8	0.8	0.7	0.7
Total Industrialized	**20.1**	**23.4**	**24.1**	**24.5**	**24.8**	**24.1**	**23.3**
Eurasia							
China	2.8	3.2	3.2	3.3	3.5	3.6	3.6
Former Soviet Union	11.4	7.1	7.3	7.6	10.1	12.1	13.1
Eastern Europe	0.3	0.3	0.3	0.3	0.4	0.4	0.5
Total Eurasia	**14.5**	**10.6**	**10.8**	**11.2**	**14.0**	**16.1**	**17.2**
Other Non-OPEC							
Central and South America	2.4	3.4	3.8	4.0	4.4	4.8	5.0
Middle East	1.4	1.9	2.0	2.1	2.2	2.1	2.0
Africa	2.2	2.6	2.6	2.7	3.3	4.5	5.5

Asia	1.7	2.2	2.3	2.4	3.0	3.2	3.3
Total Other Non-OPEC	**7.7**	**10.1**	**10.7**	**11.2**	**12.9**	**14.6**	**15.8**
Total Non-OPEC	**42.3**	**44.1**	**45.6**	**46.9**	**51.7**	**54.8**	**56.3**
Total World	**69.5**	**77.1**	**80.4**	**87.6**	**95.0**	**103.5**	**112.2**

Note: OPEC = Organization of Petroleum Exporting Countries.
Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, Office of Integrated Analysis and Forecasting, World Energy Projection System and "DESTINY" International Energy Forecast Software (Dallas, TX: Petroconsultants, Fourth Quarter 1998).

Table D2. World Oil Production Capacity by Region and Country, High Oil Price Case, 1990-2020
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	1997	2000	2005	2010	2015	2020
OPEC							
Persian Gulf							
Iran	3.2	3.9	3.9	4.1	4.2	4.3	4.5
Iraq	2.2	1.6	2.3	2.8	3.2	3.7	4.7
Kuwait	1.7	2.6	2.6	2.9	3.1	3.4	3.9
Qatar	0.5	0.6	0.5	0.6	0.6	0.6	0.7
Saudi Arabia	8.6	11.4	11.5	12.4	12.9	13.3	17.8
United Arab Emirates	2.5	2.7	2.7	3.0	3.1	3.3	3.7
Total Persian Gulf	**18.7**	**22.8**	**23.5**	**25.8**	**27.1**	**28.6**	**35.3**
Other OPEC							
Algeria	1.3	1.4	1.6	2.0	2.0	2.1	2.0
Indonesia	1.5	1.7	1.5	1.5	1.5	1.4	1.3
Libya	1.5	1.5	1.5	1.6	1.6	1.6	1.5
Nigeria	1.8	2.2	2.5	2.7	2.8	3.3	3.2
Venezuela	2.4	3.4	3.8	4.5	4.9	5.5	5.8
Total Other OPEC	**8.5**	**10.2**	**10.9**	**12.3**	**12.8**	**13.9**	**13.8**
Total OPEC	**27.2**	**33.0**	**34.4**	**38.1**	**39.9**	**42.5**	**49.1**
Non-OPEC							
Industrialized							
United States	9.7	9.5	9.3	9.3	9.5	9.6	9.3
Canada	2.0	2.6	2.9	3.0	3.3	3.4	3.5
Mexico	3.0	3.4	3.7	3.8	4.1	4.0	3.9
Australia	0.7	0.8	0.8	0.8	0.8	0.8	0.7
North Sea	4.2	6.3	6.9	7.3	7.1	6.6	6.1
Other	0.5	0.8	0.8	0.8	0.8	0.7	0.7
Total Industrialized	**20.1**	**23.4**	**24.4**	**25.0**	**25.6**	**25.1**	**24.2**

Eurasia							
China	2.8	3.2	3.2	3.4	3.6	3.7	3.7
Former Soviet Union	11.4	7.1	7.3	7.7	10.3	12.4	13.4
Eastern Europe	0.3	0.3	0.3	0.3	0.4	0.4	0.5
Total Eurasia	**14.5**	**10.6**	**10.8**	**11.4**	**14.3**	**16.5**	**17.6**
Other Non-OPEC							
Central and South America	2.4	3.4	3.9	4.1	4.5	4.9	5.1
Middle East	1.4	1.9	2.0	2.1	2.2	2.1	2.1
Africa	2.2	2.6	2.8	2.8	3.3	4.7	5.7
Asia	1.7	2.2	2.3	2.5	3.2	3.3	3.4
Total Other Non-OPEC	**7.7**	**10.1**	**11.0**	**11.5**	**13.2**	**15.0**	**16.3**
Total Non-OPEC	**42.3**	**44.1**	**46.2**	**47.9**	**53.1**	**56.6**	**58.1**
Total World	**69.5**	**77.1**	**80.6**	**86.0**	**93.0**	**99.1**	**107.2**

Note: OPEC = Organization of Petroleum Exporting Countries.
Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, Office of Integrated Analysis and Forecasting, World Energy Projection System and "DESTINY" International Energy Forecast Software (Dallas, TX: Petroconsultants, Fourth Quarter 1998).

Table D3. World Oil Production Capacity by Region and Country, Low Oil Price Case, 1990-2020
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	1997	2000	2005	2010	2015	2020
OPEC							
Persian Gulf							
Iran	3.2	3.9	4.1	4.7	5.3	5.8	6.4
Iraq	2.2	1.6	2.9	3.5	4.4	5.4	7.2
Kuwait	1.7	2.6	2.7	3.3	3.7	4.2	4.9
Qatar	0.5	0.6	0.5	0.6	0.7	0.8	0.7
Saudi Arabia	8.6	11.4	11.2	14.8	17.3	21.9	27.4
United Arab Emirates	2.5	2.7	2.8	3.3	4.0	4.7	5.7
Total Persian Gulf	**18.7**	**22.8**	**24.2**	**30.2**	**35.4**	**42.8**	**52.3**
Other OPEC							
Algeria	1.3	1.4	1.8	2.3	2.3	2.2	2.1
Indonesia	1.5	1.7	1.7	1.7	1.6	1.5	1.4
Libya	1.5	1.5	1.5	1.8	1.9	1.8	1.6
Nigeria	1.8	2.2	2.6	3.0	3.5	3.6	3.8
Venezuela	2.4	3.4	4.2	5.4	6.3	6.8	6.7
Total Other OPEC	**8.5**	**10.2**	**11.8**	**14.2**	**15.6**	**15.9**	**15.6**
Total OPEC	**27.2**	**33.0**	**36.0**	**44.4**	**51.0**	**58.7**	**67.9**

Non-OPEC							
Industrialized							
United States	9.7	9.5	9.0	8.4	8.1	7.8	7.6
Canada	2.0	2.6	2.8	3.0	3.2	3.3	3.3
Mexico	3.0	3.4	3.6	3.7	3.9	3.8	3.7
Australia	0.7	0.8	0.8	0.8	0.8	0.8	0.7
North Sea	4.2	6.3	6.8	7.1	6.8	6.3	5.8
Other	0.5	0.8	0.8	0.8	0.8	0.7	0.7
Total Industrialized	**20.1**	**23.4**	**23.8**	**23.8**	**23.6**	**22.7**	**21.8**
Eurasia							
China	2.8	3.2	3.2	3.2	3.4	3.5	3.5
Former Soviet Union	11.4	7.1	7.2	7.4	9.8	11.7	12.6
Eastern Europe	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Total Eurasia	**14.5**	**10.6**	**10.7**	**10.9**	**13.6**	**15.6**	**16.5**
Other Non-OPEC							
Central and South America	2.4	3.4	3.8	3.9	4.3	4.6	4.8
Middle East	1.4	1.9	2.0	2.1	2.1	2.0	2.0
Africa	2.2	2.6	2.6	2.6	3.2	4.3	5.3
Asia	1.7	2.2	2.3	2.4	2.8	3.1	3.1
Total Other Non-OPEC	**7.7**	**10.1**	**10.7**	**11.0**	**12.4**	**14.0**	**15.2**
Total Non-OPEC	**42.3**	**44.1**	**45.2**	**45.7**	**49.6**	**52.3**	**53.5**
Total World	**69.5**	**77.1**	**81.2**	**90.1**	**100.6**	**111.0**	**121.4**

Note: OPEC = Organization of Petroleum Exporting Countries.
Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, Office of Integrated Analysis and Forecasting, World Energy Projection System and "DESTINY" International Energy Forecast Software (Dallas, TX: Petroconsultants, Fourth Quarter 1998).

Table D4. World Oil Production Capacity by Region and Country, High Non-OPEC Supply Case, 1990-2020
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	1997	2000	2005	2010	2015	2020
OPEC							
Persian Gulf							
Iran	3.2	3.9	3.9	4.0	4.1	4.4	5.1
Iraq	2.2	1.6	2.3	2.6	3.0	3.9	5.5
Kuwait	1.7	2.6	2.6	2.8	2.9	3.3	4.4
Qatar	0.5	0.6	0.5	0.6	0.6	0.6	0.7
Saudi Arabia	8.6	11.4	11.6	12.1	12.6	13.9	17.5
United Arab Emirates	2.5	2.7	2.7	2.8	2.9	3.3	3.9
Total Persian Gulf	**18.7**	**22.8**	**23.6**	**24.9**	**26.1**	**29.4**	**37.1**

Other OPEC							
Algeria	1.3	1.4	1.6	1.8	1.9	2.0	1.9
Indonesia	1.5	1.7	1.5	1.5	1.4	1.4	1.3
Libya	1.5	1.5	1.5	1.6	1.5	1.5	1.4
Nigeria	1.8	2.2	2.4	2.5	2.6	2.8	3.0
Venezuela	2.4	3.4	3.7	4.2	4.4	5.1	5.5
Total Other OPEC	**8.5**	**10.2**	**10.7**	**11.6**	**11.8**	**12.8**	**13.1**
Total OPEC	**27.2**	**33.0**	**34.3**	**36.5**	**37.9**	**42.2**	**50.2**
Non-OPEC							
Industrialized							
United States	9.7	9.5	9.2	9.1	9.4	9.3	9.1
Canada	2.0	2.6	2.9	3.2	3.4	3.7	3.8
Mexico	3.0	3.4	3.8	4.0	4.3	4.5	4.5
Australia	0.7	0.8	0.8	0.8	0.8	0.8	0.8
North Sea	4.2	6.3	7.2	7.6	7.5	6.9	6.3
Other	0.5	0.8	0.8	0.8	0.8	0.8	0.8
Total Industrialized	**20.1**	**23.4**	**24.7**	**25.5**	**26.2**	**26.0**	**25.3**
Eurasia							
China	2.8	3.2	3.3	3.6	3.9	4.0	3.9
Former Soviet Union	11.4	7.1	7.5	8.9	11.8	13.5	14.6
Eastern Europe	0.3	0.3	0.3	0.4	0.5	0.5	0.5
Total Eurasia	**14.5**	**10.6**	**11.1**	**12.9**	**16.2**	**18.0**	**19.0**
Other Non-OPEC							
Central and South America	2.4	3.4	4.1	4.6	5.1	5.5	5.7
Middle East	1.4	1.9	2.0	2.3	2.3	2.2	2.2
Africa	2.2	2.6	2.8	3.6	4.7	5.6	5.9
Asia	1.7	2.2	2.5	3.0	3.6	3.8	3.7
Total Other Non-OPEC	**7.7**	**10.1**	**11.4**	**13.5**	**15.7**	**17.1**	**17.5**
Total Non-OPEC	**42.3**	**44.1**	**47.2**	**51.9**	**58.1**	**61.1**	**61.8**
Total World	**69.5**	**77.1**	**81.5**	**88.4**	**96.0**	**103.3**	**112.0**

Note: OPEC = Organization of Petroleum Exporting Countries.
Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, Office of Integrated Analysis and Forecasting, World Energy Projection System and "DESTINY" International Energy Forecast Software (Dallas, TX: Petroconsultants, Fourth Quarter 1998).

Table D5. World Oil Production Capacity by Region and Country, Low Non-OPEC Supply Case, 1990-2020
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	1997	2000	2005	2010	2015	2020

OPEC							
Persian Gulf							
Iran	3.2	3.9	4.0	4.7	5.2	5.6	6.3
Iraq	2.2	1.6	2.5	3.6	4.2	5.2	7.1
Kuwait	1.7	2.6	2.7	3.2	3.5	4.1	4.7
Qatar	0.5	0.6	0.6	0.7	0.7	0.8	0.7
Saudi Arabia	8.6	11.4	11.6	14.7	16.7	21.5	27.0
United Arab Emirates	2.5	2.7	2.8	3.3	3.7	4.5	5.5
Total Persian Gulf	**18.7**	**22.8**	**24.2**	**30.2**	**34.0**	**41.7**	**51.3**
Other OPEC							
Algeria	1.3	1.4	1.6	2.0	2.2	2.1	2.0
Indonesia	1.5	1.7	1.5	1.5	1.6	1.4	1.3
Libya	1.5	1.5	1.5	1.6	1.8	1.7	1.6
Nigeria	1.8	2.2	2.5	3.0	3.5	3.6	3.7
Venezuela	2.4	3.4	3.9	4.8	6.0	6.7	6.9
Total Other OPEC	**8.5**	**10.2**	**11.0**	**12.9**	**15.1**	**15.5**	**15.5**
Total OPEC	**27.2**	**33.0**	**35.2**	**43.1**	**49.1**	**57.2**	**66.8**
Non-OPEC							
Industrialized							
United States	9.7	9.5	9.1	8.8	8.6	8.4	8.1
Canada	2.0	2.6	2.7	2.8	2.9	3.0	2.8
Mexico	3.0	3.4	3.5	3.6	3.7	3.6	3.4
Australia	0.7	0.8	0.8	0.8	0.8	0.7	0.6
North Sea	4.2	6.3	6.8	6.4	5.8	5.1	4.2
Other	0.5	0.8	0.8	0.8	0.8	0.7	0.7
Total Industrialized	**20.1**	**23.4**	**23.7**	**23.2**	**22.6**	**21.5**	**19.8**
Eurasia							
China	2.8	3.2	3.2	3.2	3.3	3.3	3.2
Former Soviet Union	11.4	7.1	7.2	7.3	8.2	9.0	9.6
Eastern Europe	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Eurasia	**14.5**	**10.6**	**10.7**	**10.8**	**11.8**	**12.6**	**13.1**
Other Non-OPEC							
Central and South America	2.4	3.4	3.8	3.9	4.2	4.3	4.3
Middle East	1.4	1.9	2.0	2.1	2.1	2.0	1.9
Africa	2.2	2.6	2.6	2.5	2.8	3.5	4.0
Asia	1.7	2.2	2.3	2.4	2.6	2.8	2.7
Total Other Non-OPEC	**7.7**	**10.1**	**10.7**	**10.9**	**11.7**	**12.6**	**12.9**
Total Non-OPEC	**42.3**	**44.1**	**45.1**	**44.9**	**46.1**	**46.7**	**45.8**
Total World	69.5	77.1	80.3	88.0	95.2	103.9	112.6

Note: OPEC = Organization of Petroleum Exporting Countries.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, Office of Integrated Analysis and Forecasting, World Energy Projection System and "DESTINY" International Energy Forecast Software (Dallas, TX: Petroconsultants, Fourth Quarter 1998).

Table 10.1a World Crude Oil Production, 1973-1992: Algeria Through Venezuela

(Thousand Barrels per Day)

	Algeria	Iraq	Kuwait a	Libya
1973				
January	1,142	1,527	3,768	2,293
February	1,142	1,687	3,340	2,250
March	1,142	2,044	2,753	2,287
April	1,142	2,152	2,699	2,318
May	1,153	2,117	2,827	2,251
June	1,153	2,051	2,857	2,276
July	1,142	2,099	3,283	2,176
August	1,142	2,091	3,012	2,096
September	1,142	2,166	3,483	2,273
October	1,059	1,846	3,060	2,370
November	914	2,203	2,617	1,756
December	893	2,215	2,558	1,759
Average	1,097	2,018	3,020	2,175
1974				
January	1,046	1,994	2,839	2,007
February	1,067	1,975	2,850	1,921
March	1,067	1,986	2,842	1,859
April	1,089	2,164	2,837	1,713
May	1,089	1,753	2,846	1,926
June	1,035	1,851	2,870	1,753
July	980	1,905	2,287	1,564
August	1,035	1,938	2,069	1,258
September	980	1,871	2,226	1,309
October	980	1,991	2,061	1,056
November	871	1,921	2,547	949
December	871	2,301	2,321	963
Average	1,009	1,971	2,546	1,521
1975				
January	786	2,066	2,030	956
February	786	1,941	2,155	894
March	1,010	2,093	2,321	928
April	1,010	2,414	2,143	1,071
May	898	2,364	1,924	1,271
June	1,010	2,261	2,222	1,494
July	1,010	2,377	2,106	2,067
August	1,010	2,390	1,956	2,061
September	1,010	2,541	2,708	1,763
October	1,010	2,485	1,579	1,625
November	1,122	2,120	1,785	1,760
December	1,122	2,070	2,099	1,818
Average	983	2,262	2,084	1,480
1976				
January	1,071	2,044	1,806	1,748
February	1,071	2,245	2,004	1,829
March	1,071	2,413	1,758	1,853
April	1,071	1,609	1,888	1,921
May	1,071	1,385	1,642	1,958
June	1,071	2,011	1,848	1,981
July	1,017	2,402	1,851	1,989
August	1,017	2,681	1,897	2,013

September........	1,017	2,681	2,378	2,008
October..........	1,071	2,904	2,652	1,987
November.........	1,178	3,239	2,691	1,885
December.........	1,178	3,351	3,325	2,020
Average..........	1,075	2,415	2,145	1,933
1977				
January..........	1,230	2,000	1,480	2,038
February.........	1,230	2,631	2,015	2,072
March............	1,195	2,421	1,981	2,068
April............	1,230	2,210	2,046	2,129
May..............	1,118	2,316	1,488	2,138
June.............	1,118	2,316	1,660	2,093
July.............	1,006	2,105	1,603	1,896
August...........	1,006	2,105	1,846	2,120
September........	1,006	2,526	2,397	2,044
October..........	1,230	2,526	1,921	2,115
November.........	1,230	2,526	2,466	2,075
December.........	1,230	2,526	2,751	1,972
Average..........	1,152	2,348	1,969	2,063
1978				
January..........	1,125	2,047	1,757	1,761
February.........	1,125	2,437	1,774	1,802
March............	1,125	2,437	2,181	1,884
April............	1,125	2,437	2,033	1,877
May..............	1,125	2,340	1,890	1,924
June.............	1,125	2,340	1,984	1,991
July.............	1,125	2,340	1,978	2,094
August...........	1,378	2,583	2,394	2,024
September........	1,378	2,827	2,637	2,014
October..........	1,378	2,924	2,091	2,046
November.........	1,378	3,022	2,682	2,171
December.........	1,378	3,022	2,163	2,194
Average..........	1,231	2,563	2,131	1,983
1979				
January..........	1,223	3,325	2,616	2,125
February.........	1,362	3,325	2,616	2,165
March............	1,362	3,325	2,275	2,174
April............	1,362	3,325	2,559	2,090
May..............	1,362	3,325	2,616	2,056
June.............	1,362	3,527	2,616	2,049
July.............	1,112	3,527	2,587	2,053
August...........	1,112	3,527	2,559	2,021
September........	1,112	3,527	2,502	2,061
October..........	1,112	3,527	2,445	2,063
November.........	1,112	3,728	2,388	2,130
December.........	1,112	3,728	2,235	2,124
Average..........	1,224	3,477	2,500	2,092
1980				
January..........	1,306	3,336	2,216	2,103
February.........	1,306	3,336	2,440	2,103
March............	1,306	3,336	2,122	2,003
April............	1,088	3,336	1,541	1,752
May..............	1,088	3,336	1,480	1,702
June.............	1,088	3,336	1,579	1,702
July.............	980	3,240	1,335	1,682
August...........	980	3,240	1,374	1,692
September........	980	2,764	1,258	1,682
October..........	1,088	143	1,318	1,667
November.........	1,088	286	1,438	1,682
December.........	980	524	1,797	1,682
Average..........	1,106	2,514	1,656	1,787

1981				
January..........	1,111	436	1,837	1,652
February.........	1,111	763	1,550	1,704
March............	1,111	1,046	1,515	1,642
April............	1,049	872	959	1,652
May..............	1,049	1,019	1,019	1,446
June.............	987	1,090	1,079	1,136
July.............	987	981	1,234	723
August...........	987	1,090	755	620
September........	925	1,090	809	620
October..........	925	1,090	959	723
November.........	925	1,199	929	774
December.........	864	1,308	875	1,033
Average..........	1,002	1,000	1,125	1,140
1982				
January..........	916	1,439	864	860
February.........	916	1,550	864	669
March............	844	1,218	741	669
April............	903	886	679	765
May..............	942	886	741	860
June.............	982	886	803	1,147
July.............	982	886	864	1,243
August...........	903	886	988	1,243
September........	1,047	886	864	1,434
October..........	1,178	886	864	1,625
November.........	1,178	886	864	1,625
December.........	1,047	886	741	1,625
Average..........	987	1,012	823	1,150
1983				
January..........	1,005	850	780	1,130
February.........	855	850	895	925
March............	855	900	965	925
April............	1,005	950	880	1,030
May..............	855	1,000	1,030	1,130
June.............	1,005	1,000	920	1,130
July.............	1,005	1,050	1,086	1,130
August...........	1,005	1,100	1,181	1,130
September........	1,005	1,050	1,376	1,180
October..........	1,005	1,100	1,305	1,180
November.........	1,005	1,150	1,265	1,180
December.........	1,005	1,050	1,075	1,180
Average..........	968	1,005	1,064	1,105
1984				
January..........	1,033	1,100	1,080	1,100
February.........	954	1,000	1,240	1,100
March............	954	1,200	1,293	1,100
April............	954	1,200	1,250	1,200
May..............	1,033	1,200	1,200	1,200
June.............	1,113	1,200	1,200	1,250
July.............	1,033	1,200	1,110	1,100
August...........	1,033	1,300	1,220	1,000
September........	1,033	1,300	1,183	1,000
October..........	1,033	1,200	1,129	1,000
November.........	1,033	1,300	990	1,000
December.........	954	1,300	990	1,000
Average..........	1,014	1,209	1,157	1,087
1985				
January..........	1,032	1,250	1,118	1,000
February.........	1,064	1,250	1,133	1,000
March............	1,112	1,200	1,092	1,000
April............	1,048	1,370	977	1,000
May..............	1,048	1,300	946	1,100

June............	967	1,370	926	980
July............	967	1,450	946	910
August..........	967	1,400	946	910
September........	1,048	1,600	987	1,100
October..........	1,048	1,650	1,062	1,200
November.........	1,096	1,700	1,057	1,200
December.........	1,048	1,650	1,087	1,300
Average..........	1,037	1,433	1,023	1,059
1986				
January..........	1,023	1,650	1,115	1,100
February.........	866	1,650	1,315	900
March............	944	1,650	1,516	900
April............	944	1,500	1,521	900
May..............	944	1,710	1,511	1,100
June.............	944	1,800	1,651	1,200
July.............	944	1,800	1,806	1,150
August...........	944	1,800	1,734	1,150
September........	944	1,800	1,118	990
October..........	944	1,800	1,130	1,000
November.........	944	1,605	1,350	1,000
December.........	944	1,510	1,250	1,000
Average..........	945	1,690	1,419	1,034
1987				
January..........	1,010	1,650	1,456	950
February.........	1,010	1,670	1,357	950
March............	1,010	1,700	1,287	850
April............	1,010	1,900	1,310	925
May..............	1,010	1,900	1,269	930
June.............	1,010	2,000	1,374	950
July.............	1,085	1,950	2,063	1,100
August...........	1,085	2,200	2,063	1,200
September........	1,085	2,300	2,026	900
October..........	1,085	2,500	1,601	1,000
November.........	1,085	2,550	1,619	950
December.........	1,085	2,600	1,572	950
Average..........	1,048	2,079	1,585	972
1988				
January..........	990	2,588	1,373	1,147
February.........	1,030	2,639	1,239	1,147
March............	1,050	2,689	1,244	1,147
April............	1,010	2,689	1,342	1,086
May..............	1,040	2,639	1,249	1,147
June.............	1,040	2,740	1,456	1,147
July.............	1,040	2,639	1,420	1,147
August...........	1,040	2,639	1,621	1,147
September........	1,040	2,740	1,714	1,203
October..........	1,040	2,740	1,704	1,259
November.........	1,080	2,740	1,807	1,259
December.........	1,080	2,740	1,725	1,259
Average..........	1,040	2,685	1,492	1,175
1989				
January..........	1,085	2,720	1,237	1,102
February.........	1,085	2,720	1,336	1,102
March............	1,085	2,720	1,375	1,102
April............	1,085	2,823	1,677	1,154
May..............	1,085	2,823	1,984	1,154
June.............	1,085	2,772	2,083	1,154
July.............	1,105	2,926	1,885	1,154
August...........	1,105	3,080	1,885	1,154
September........	1,105	2,977	1,885	1,154
October..........	1,105	3,080	1,885	1,154
November.........	1,105	3,028	2,073	1,207

December.........	1,105	3,080	2,068	1,207
Average..........	1,095	2,897	1,783	1,150
1990				
January..........	1,160	2,946	2,003	1,222
February.........	1,160	2,946	2,003	1,375
March............	1,160	2,946	2,184	1,324
April............	1,160	2,997	1,958	1,273
May..............	1,160	3,150	1,958	1,273
June.............	1,160	3,251	1,762	1,273
July.............	1,160	3,454	1,858	1,273
August...........	1,160	1,016	100	1,426
September........	1,190	508	100	1,426
October..........	1,210	457	75	1,579
November.........	1,210	432	75	1,528
December.........	1,210	432	75	1,528
Average..........	1,175	2,040	1,175	1,375
1991				
January..........	1,230	256	51	1,500
February.........	1,230	0	0	1,500
March............	1,230	0	0	1,450
April............	1,230	205	0	1,450
May..............	1,230	358	0	1,450
June.............	1,230	358	76	1,450
July.............	1,230	410	167	1,450
August...........	1,230	410	198	1,450
September........	1,230	410	304	1,500
October..........	1,230	410	436	1,500
November.........	1,230	410	507	1,550
December.........	1,230	410	527	1,550
Average..........	1,230	305	190	1,483
1992				
January..........	1,230	450	565	1,550
February.........	1,230	450	630	1,550
March............	1,230	450	735	1,450
April............	1,230	450	863	1,500
May..............	1,210	450	915	1,450
June.............	1,210	450	1,015	1,450
July.............	1,210	450	1,080	1,450
August...........	1,210	450	1,130	1,425
September........	1,210	450	1,200	1,475
October..........	1,210	450	1,280	1,500
November.........	1,210	450	1,375	1,500
December.........	1,210	450	1,550	1,500
Average..........	1,217	450	1,029	1,483

See footnotes at end of table.

Table 10.1a World Crude Oil Production, 1973-1992: Algeria Through Venezuela (Continued)

(Thousand Barrels per Day)

	Qatar	Saudi Arabia a	United Arab Emirates	Arab OPEC b
1973				
January..........	581	6,876	1,416	17,603

February.........	613	7,194	1,597	17,823
March............	604	7,481	1,548	17,859
April............	591	7,359	1,602	17,863
May..............	586	8,316	1,613	18,863
June.............	560	7,553	1,537	17,987
July.............	606	8,682	1,613	19,601
August...........	568	8,423	1,674	19,006
September........	609	8,532	1,660	19,865
October..........	600	7,796	1,669	18,400
November.........	474	6,267	1,297	15,528
December.........	456	6,614	1,171	15,666
Average..........	570	7,596	1,533	18,009
1974				
January..........	517	7,513	1,388	17,304
February.........	516	7,796	1,511	17,636
March............	517	8,131	1,736	18,138
April............	518	8,654	1,854	18,829
May..............	518	9,014	1,856	19,002
June.............	519	8,885	1,821	18,734
July.............	519	8,783	1,933	17,971
August...........	515	8,275	1,779	16,869
September........	514	8,763	1,704	17,367
October..........	524	9,052	1,489	17,153
November.........	518	8,812	1,530	17,148
December.........	518	8,053	1,536	16,563
Average..........	518	8,480	1,679	17,724
1975				
January..........	512	7,839	1,088	15,277
February.........	500	6,754	1,007	14,037
March............	428	6,550	1,424	14,754
April............	515	5,917	1,660	14,730
May..............	469	6,989	1,678	15,593
June.............	329	6,818	1,897	16,031
July.............	261	6,980	2,023	16,825
August...........	411	8,208	1,829	17,866
September........	279	8,407	1,834	18,543
October..........	393	5,869	1,632	14,593
November.........	554	6,947	2,010	16,299
December.........	608	7,585	1,845	17,148
Average..........	438	7,075	1,664	15,985
1976				
January..........	496	7,464	1,902	16,530
February.........	482	7,969	1,902	17,501
March............	508	8,365	1,872	17,839
April............	496	8,270	1,873	17,127
May..............	507	8,450	1,874	16,886
June.............	505	8,526	1,944	17,885
July.............	502	8,971	1,947	18,678
August...........	528	8,738	1,962	18,835
September........	466	8,323	1,979	18,851
October..........	474	9,236	2,024	20,347
November.........	489	9,394	1,954	20,829
December.........	510	9,185	1,998	21,566
Average..........	497	8,577	1,936	18,579
1977				
January..........	460	8,609	1,924	17,741
February.........	407	9,634	2,038	20,027
March............	496	9,890	2,003	20,054
April............	431	10,198	2,058	20,302
May..............	390	8,507	2,044	18,001
June.............	415	9,634	2,034	19,270

July............	398	9,839	2,040	18,887
August...........	512	8,711	1,927	18,227
September........	332	8,711	1,994	19,010
October..........	530	8,711	2,016	19,049
November.........	486	8,968	1,928	19,679
December.........	476	9,583	1,987	20,525
Average..........	445	9,245	1,999	19,221
1978				
January..........	456	7,828	1,733	16,707
February.........	483	8,446	1,878	17,945
March............	428	7,725	1,854	17,634
April............	515	8,034	1,761	17,782
May..............	381	7,313	1,876	16,849
June.............	456	7,519	1,848	17,263
July.............	486	7,416	1,834	17,273
August...........	547	7,107	1,839	17,872
September........	517	8,343	1,834	19,550
October..........	510	9,270	1,840	20,059
November.........	477	10,249	1,832	21,811
December.........	588	10,403	1,844	21,592
Average..........	487	8,301	1,831	18,525
1979				
January..........	556	9,789	1,832	21,465
February.........	556	9,789	1,830	21,642
March............	369	9,789	1,819	21,112
April............	544	8,758	1,748	20,385
May..............	544	8,758	1,859	20,519
June.............	458	8,758	1,860	20,629
July.............	521	9,789	1,836	21,424
August...........	535	9,789	1,831	21,373
September........	455	9,789	1,838	21,283
October..........	490	9,789	1,784	21,209
November.........	528	9,789	1,866	21,540
December.........	544	9,789	1,874	21,405
Average..........	508	9,532	1,831	21,163
1980				
January..........	502	9,767	1,740	20,970
February.........	457	9,767	1,737	21,146
March............	498	9,767	1,697	20,729
April............	498	9,767	1,706	19,688
May..............	477	9,767	1,762	19,612
June.............	441	9,767	1,746	19,659
July.............	460	9,767	1,710	19,174
August...........	468	9,767	1,665	19,186
September........	461	9,767	1,671	18,583
October..........	440	10,199	1,671	16,526
November.........	475	10,414	1,695	17,078
December.........	483	10,281	1,706	17,453
Average..........	472	9,900	1,709	19,144
1981				
January..........	507	10,180	1,579	17,301
February.........	482	10,180	1,564	17,353
March............	507	9,976	1,568	17,364
April............	513	10,180	1,619	16,843
May..............	436	10,180	1,486	16,634
June.............	342	10,180	1,397	16,210
July.............	378	10,282	1,377	15,961
August...........	295	10,384	1,443	15,573
September........	363	9,264	1,426	14,497
October..........	363	9,671	1,440	15,170
November.........	340	8,653	1,331	14,151
December.........	342	8,653	1,463	14,538

Average..........	405	9,815	1,474	15,961
1982				
January..........	402	8,659	1,407	14,547
February.........	374	8,353	1,399	14,125
March............	309	7,335	1,378	12,494
April............	231	6,621	1,246	11,331
May..............	321	6,010	1,197	10,957
June.............	407	6,621	1,228	12,074
July.............	274	6,316	1,228	11,793
August...........	340	6,010	1,228	11,598
September........	286	5,603	1,228	11,348
October..........	380	5,603	1,228	11,764
November.........	309	5,603	1,228	11,693
December.........	327	5,195	1,017	10,838
Average..........	330	6,483	1,250	12,035
1983				
January..........	255	4,950	1,062	10,032
February.........	200	3,510	1,062	8,297
March............	170	3,910	1,037	8,762
April............	260	3,930	1,147	9,202
May..............	275	4,725	1,177	10,192
June.............	300	4,620	1,182	10,157
July.............	300	5,536	1,177	11,284
August...........	265	5,931	1,187	11,799
September........	310	6,026	1,187	12,134
October..........	320	6,005	1,167	12,082
November.........	460	5,915	1,197	12,172
December.........	420	5,825	1,197	11,752
Average..........	295	5,086	1,149	10,672
1984				
January..........	445	5,130	1,200	11,088
February.........	315	5,040	1,200	10,849
March............	440	4,843	1,205	11,035
April............	400	5,150	1,205	11,359
May..............	400	5,000	1,200	11,233
June.............	500	5,450	1,225	11,938
July.............	430	5,010	1,090	10,973
August...........	400	4,520	990	10,463
September........	480	4,133	1,110	10,239
October..........	380	4,129	1,060	9,931
November.........	280	3,990	1,060	9,653
December.........	260	3,590	1,210	9,304
Average..........	394	4,663	1,146	10,670
1985				
January..........	270	3,510	1,100	9,280
February.........	290	4,025	1,160	9,922
March............	315	3,835	1,215	9,770
April............	260	3,470	1,215	9,340
May..............	290	2,590	1,160	8,435
June.............	300	2,420	1,100	8,064
July.............	320	2,740	1,155	8,489
August...........	320	2,340	1,200	8,084
September........	295	2,980	1,285	9,295
October..........	320	3,910	1,255	10,446
November.........	300	4,200	1,250	10,803
December.........	335	4,680	1,225	11,326
Average..........	301	3,388	1,193	9,434
1986				
January..........	333	4,310	1,179	10,711
February.........	301	4,551	1,369	10,952
March............	324	3,972	1,321	10,627

April............	167	4,556	1,274	10,862
May..............	333	4,208	1,416	11,223
June.............	398	5,068	1,511	12,572
July.............	371	5,700	1,511	13,281
August...........	371	6,209	1,539	13,747
September........	259	4,651	1,274	11,037
October..........	278	4,855	1,283	11,291
November.........	278	5,164	1,132	11,474
December.........	278	5,164	1,151	11,298
Average..........	308	4,870	1,330	11,596
1987				
January..........	275	4,004	1,235	10,581
February.........	241	3,868	1,215	10,312
March............	193	3,300	1,195	9,536
April............	145	4,030	1,235	10,556
May..............	270	4,197	1,265	10,842
June.............	338	4,238	1,435	11,346
July.............	434	4,602	1,605	12,841
August...........	405	4,755	1,855	13,565
September........	319	4,653	1,995	13,279
October..........	309	4,638	1,895	13,029
November.........	290	4,248	1,895	12,637
December.........	290	4,612	1,645	12,755
Average..........	293	4,265	1,541	11,783
1988				
January..........	363	4,155	1,174	11,791
February.........	427	4,322	1,028	11,833
March............	318	4,332	1,223	12,005
April............	318	4,470	1,389	12,305
May..............	318	4,484	1,369	12,247
June.............	323	4,582	1,369	12,659
July.............	323	4,641	1,394	12,604
August...........	323	5,177	1,857	13,804
September........	323	5,314	1,915	14,250
October..........	373	6,336	1,949	15,401
November.........	373	6,532	2,047	15,838
December.........	373	6,655	2,047	15,879
Average..........	346	5,086	1,565	13,389
1989				
January..........	389	4,918	1,647	13,098
February.........	408	4,673	1,566	12,889
March............	330	4,515	1,590	12,718
April............	321	4,914	1,618	13,592
May..............	398	5,022	1,618	14,084
June.............	408	4,825	1,875	14,201
July.............	389	4,923	1,823	14,204
August...........	389	5,022	1,861	14,494
September........	389	5,219	2,046	14,774
October..........	389	5,317	2,141	15,070
November.........	369	5,701	2,236	15,718
December.........	384	5,696	2,283	15,821
Average..........	380	5,064	1,860	14,229
1990				
January..........	390	5,537	2,052	15,312
February.........	401	5,636	2,027	15,549
March............	422	5,765	2,052	15,853
April............	422	5,888	2,097	15,796
May..............	385	5,394	2,107	15,427
June.............	385	5,398	2,047	15,277
July.............	390	5,394	2,047	15,576
August...........	422	5,789	1,648	11,561
September........	422	7,660	2,197	13,503

October..........	422	7,729	2,307	13,779
November.........	422	8,224	2,372	14,263
December.........	390	8,481	2,447	14,563
Average..........	406	6,410	2,117	14,698
1991				
January..........	366	8,075	2,448	13,925
February.........	407	8,134	2,472	13,743
March............	407	7,936	2,496	13,519
April............	407	7,341	2,496	13,129
May..............	407	7,341	2,301	13,088
June.............	407	8,085	2,301	13,908
July.............	407	8,407	2,301	14,373
August...........	407	8,397	2,301	14,393
September........	407	8,332	2,292	14,475
October..........	407	8,382	2,379	14,744
November.........	386	8,372	2,443	14,898
December.........	324	8,571	2,409	15,020
Average..........	395	8,115	2,386	14,104
1992				
January..........	350	8,790	2,435	15,370
February.........	325	8,640	2,425	15,250
March............	375	8,260	2,300	14,800
April............	375	8,213	2,300	14,930
May..............	375	8,265	2,300	14,965
June.............	375	8,315	2,275	15,090
July.............	400	8,350	2,300	15,240
August...........	425	8,400	2,330	15,370
September........	425	8,450	2,320	15,530
October..........	440	8,505	2,310	15,695
November.........	440	8,500	2,305	15,780
December.........	440	8,575	2,305	16,030
Average..........	396	8,438	2,325	15,338

See footnotes at end of table.

Table 10.1a World Crude Oil Production, 1973-1992: Algeria Through Venezuela (Continued)

(Thousand Barrels per Day)

	Indonesia	Iran	Nigeria	Venezuela
1973				
January..........	1,157	5,808	1,936	3,272
February.........	1,197	5,835	1,944	3,309
March............	1,216	5,832	1,933	3,330
April............	1,258	5,769	1,963	3,360
May..............	1,364	5,842	1,957	3,426
June.............	1,390	5,826	2,007	3,383
July.............	1,373	5,873	2,000	3,391
August...........	1,395	5,701	2,110	3,396
September........	1,390	5,792	2,112	3,406
October..........	1,447	5,977	2,200	3,381
November.........	1,432	6,008	2,210	3,395
December.........	1,441	6,070	2,266	3,340
Average..........	1,339	5,861	2,054	3,366

1974				
January..........	1,431	6,100	2,194	3,284
February.........	1,416	6,154	2,194	3,230
March............	1,421	6,122	2,299	3,189
April............	1,480	6,172	2,284	3,053
May..............	1,510	6,179	2,259	2,939
June.............	1,469	6,060	2,345	2,953
July.............	1,431	6,061	2,205	2,949
August...........	1,332	5,953	2,308	2,868
September........	1,332	5,833	2,321	2,778
October..........	1,234	5,717	2,334	2,818
November.........	1,234	6,012	2,247	2,826
December.........	1,214	5,912	2,071	2,841
Average..........	1,375	6,022	2,255	2,976
1975				
January..........	1,333	5,544	1,991	2,747
February.........	1,338	5,900	1,807	2,565
March............	1,193	5,513	1,718	2,535
April............	1,219	5,456	1,535	2,490
May..............	1,100	5,094	1,551	2,394
June.............	1,258	5,126	1,621	2,439
July.............	1,326	5,437	1,631	2,336
August...........	1,372	5,508	1,760	2,285
September........	1,376	6,104	1,926	2,316
October..........	1,356	4,730	1,914	2,244
November.........	1,410	4,995	1,956	2,045
December.........	1,408	4,854	1,986	1,771
Average..........	1,307	5,350	1,783	2,346
1976				
January..........	1,425	4,940	1,996	1,675
February.........	1,456	5,018	2,067	2,002
March............	1,521	5,744	2,015	2,289
April............	1,528	5,502	2,061	2,401
May..............	1,513	5,600	2,079	2,410
June.............	1,478	6,102	2,092	2,371
July.............	1,498	5,576	2,046	2,481
August...........	1,511	5,823	1,934	2,447
September........	1,496	6,461	2,044	2,429
October..........	1,539	6,507	2,110	2,364
November.........	1,501	6,677	2,177	2,264
December.........	1,581	6,630	2,187	2,388
Average..........	1,504	5,883	2,067	2,294
1977				
January..........	1,629	5,059	2,193	2,380
February.........	1,701	6,052	2,192	2,332
March............	1,701	6,275	2,254	2,367
April............	1,701	5,412	2,254	2,180
May..............	1,696	5,741	2,206	2,125
June.............	1,699	5,104	2,096	2,230
July.............	1,698	4,713	2,061	2,209
August...........	1,677	5,660	2,016	2,284
September........	1,670	5,972	2,023	2,366
October..........	1,639	5,531	1,946	2,350
November.........	1,708	6,086	1,915	2,074
December.........	1,720	6,385	1,872	1,965
Average..........	1,686	5,663	2,085	2,238
1978				
January..........	1,693	5,327	1,620	1,802
February.........	1,698	5,567	1,549	1,640
March............	1,698	5,639	1,505	2,085
April............	1,677	5,648	1,862	2,251
May..............	1,691	5,742	1,702	2,038

June.............	1,642	5,801	1,975	2,372
July.............	1,570	5,842	1,893	2,309
August...........	1,608	5,846	2,038	2,206
September........	1,579	6,093	2,086	2,275
October..........	1,603	5,528	2,091	2,328
November.........	1,583	3,517	2,252	2,272
December.........	1,582	2,387	2,176	2,367
Average..........	1,635	5,242	1,897	2,165
1979				
January..........	1,593	729	2,423	2,342
February.........	1,611	729	2,423	2,342
March............	1,622	2,448	2,430	2,422
April............	1,605	4,167	2,411	2,380
May..............	1,593	4,063	2,445	2,377
June.............	1,607	4,063	2,395	2,246
July.............	1,601	3,958	2,346	2,326
August...........	1,592	3,646	2,326	2,324
September........	1,571	3,646	2,112	2,358
October..........	1,568	3,958	2,026	2,354
November.........	1,568	3,438	2,146	2,389
December.........	1,563	3,021	2,147	2,407
Average..........	1,591	3,168	2,302	2,356
1980				
January..........	1,564	2,605	2,147	2,281
February.........	1,553	2,832	2,147	2,206
March............	1,575	2,265	2,153	1,989
April............	1,553	2,039	2,186	2,052
May..............	1,551	1,472	2,138	2,047
June.............	1,575	1,699	2,192	2,060
July.............	1,560	1,699	2,098	2,171
August...........	1,569	1,472	2,047	2,211
September........	1,579	1,246	1,598	2,191
October..........	1,586	510	1,877	2,228
November.........	1,622	793	2,059	2,231
December.........	1,636	1,359	2,016	2,351
Average..........	1,577	1,662	2,055	2,168
1981				
January..........	1,632	1,243	2,092	2,214
February.........	1,622	1,554	1,943	2,189
March............	1,634	1,864	1,868	2,229
April............	1,616	1,657	1,623	2,194
May..............	1,614	1,657	1,293	2,169
June.............	1,608	1,450	1,350	1,985
July.............	1,604	1,450	773	1,755
August...........	1,593	1,243	707	1,955
September........	1,589	1,243	1,061	2,092
October..........	1,589	932	1,250	1,975
November.........	1,574	1,036	1,460	2,224
December.........	1,582	1,243	1,820	2,254
Average..........	1,605	1,380	1,433	2,102
1982				
January..........	1,469	1,219	1,745	1,989
February.........	1,444	1,108	1,406	1,734
March............	1,484	1,330	937	1,834
April............	1,239	1,663	884	1,533
May..............	1,235	2,217	1,314	1,503
June.............	1,301	2,438	1,656	1,513
July.............	1,295	2,438	1,265	1,844
August...........	1,235	2,549	1,111	1,964
September........	1,295	2,549	1,170	1,994
October..........	1,367	2,771	1,489	2,165

November.........	1,395	3,103	1,361	2,305
December.........	1,315	3,103	1,209	2,338
Average..........	1,339	2,214	1,295	1,895
1983				
January..........	1,188	2,716	880	2,098
February.........	984	2,414	675	1,791
March............	1,144	2,213	905	2,093
April............	1,358	2,012	1,150	1,726
May..............	1,358	2,313	1,625	1,695
June.............	1,358	2,514	1,535	1,700
July.............	1,445	2,816	1,710	1,705
August...........	1,445	2,514	1,300	1,741
September........	1,425	2,716	1,220	1,736
October..........	1,474	2,414	1,290	1,750
November.........	1,513	2,313	1,245	1,781
December.........	1,396	2,313	1,310	1,786
Average..........	1,343	2,440	1,241	1,801
1984				
January..........	1,415	2,200	1,335	1,825
February.........	1,515	2,300	1,530	1,800
March............	1,505	2,400	1,525	1,800
April............	1,512	2,200	1,270	1,800
May..............	1,415	1,700	1,270	1,825
June.............	1,465	2,200	1,370	1,790
July.............	1,340	2,400	1,175	1,845
August...........	1,360	1,800	1,125	1,805
September........	1,350	1,900	1,370	1,835
October..........	1,375	2,100	1,565	1,785
November.........	1,300	2,400	1,565	1,710
December.........	1,395	2,500	1,565	1,755
Average..........	1,412	2,174	1,388	1,798
1985				
January..........	1,380	1,942	1,423	1,673
February.........	1,401	2,147	1,718	1,678
March............	1,369	2,249	1,728	1,683
April............	1,369	2,351	1,626	1,678
May..............	1,264	2,045	1,474	1,688
June.............	1,106	2,249	1,118	1,673
July.............	1,369	2,249	1,016	1,673
August...........	1,369	2,453	1,220	1,673
September........	1,264	2,249	1,474	1,673
October..........	1,327	2,351	1,728	1,673
November.........	1,369	2,249	1,789	1,678
December.........	1,317	2,453	1,646	1,683
Average..........	1,325	2,250	1,495	1,677
1986				
January..........	1,458	2,275	1,197	1,730
February.........	1,335	2,166	1,397	1,730
March............	1,335	1,950	1,597	1,730
April............	1,376	2,166	1,697	1,730
May..............	1,463	2,275	1,597	1,730
June.............	1,386	2,275	1,536	1,755
July.............	1,381	2,220	1,552	1,770
August...........	1,461	1,841	1,761	2,115
September........	1,345	1,625	1,297	1,760
October..........	1,360	1,625	1,322	1,750
November.........	1,406	1,841	1,322	1,780
December.........	1,365	2,166	1,322	1,855
Average..........	1,390	2,035	1,467	1,787
1987				
January..........	1,311	2,463	1,291	1,671

February.........	1,281	2,368	1,191	1,671
March............	1,296	2,368	1,281	1,807
April............	1,311	2,179	1,183	1,701
May..............	1,332	2,463	1,348	1,726
June.............	1,332	2,368	1,413	1,766
July.............	1,362	2,368	1,413	1,887
August...........	1,485	2,558	1,401	1,796
September........	1,342	1,989	1,351	1,746
October..........	1,352	2,273	1,401	1,751
November.........	1,352	2,084	1,451	1,746
December.........	1,352	2,084	1,351	1,746
Average..........	1,343	2,298	1,341	1,752
1988				
January..........	1,278	2,082	1,360	1,853
February.........	1,278	1,983	1,410	1,853
March............	1,329	2,082	1,360	1,853
April............	1,379	2,181	1,415	1,853
May..............	1,379	2,181	1,465	1,853
June.............	1,379	2,082	1,465	1,853
July.............	1,379	2,280	1,410	1,853
August...........	1,379	2,280	1,460	1,853
September........	1,278	2,380	1,515	1,928
October..........	1,379	2,380	1,515	1,928
November.........	1,278	2,479	1,465	2,078
December.........	1,379	2,479	1,560	2,078
Average..........	1,342	2,240	1,450	1,903
1989				
January..........	1,401	2,748	1,474	1,862
February.........	1,401	2,797	1,474	1,862
March............	1,401	3,141	1,626	1,862
April............	1,401	2,846	1,677	1,862
May..............	1,401	2,454	1,677	1,862
June.............	1,401	2,748	1,778	1,913
July.............	1,384	2,748	1,879	1,875
August...........	1,434	2,945	1,778	1,926
September........	1,384	2,797	1,778	1,926
October..........	1,434	2,896	1,677	1,977
November.........	1,434	2,748	1,879	1,977
December.........	1,434	2,846	1,879	1,977
Average..........	1,409	2,810	1,716	1,907
1990				
January..........	1,306	2,700	1,731	1,990
February.........	1,306	3,000	1,731	2,140
March............	1,411	3,000	1,731	2,040
April............	1,463	2,900	1,830	2,040
May..............	1,411	3,200	1,731	2,040
June.............	1,411	3,100	1,731	2,040
July.............	1,442	3,050	1,731	2,040
August...........	1,516	3,300	1,830	2,090
September........	1,536	3,300	1,880	2,290
October..........	1,542	3,000	1,929	2,275
November.........	1,568	3,200	1,929	2,320
December.........	1,620	3,300	1,929	2,340
Average..........	1,462	3,088	1,810	2,137
1991				
January..........	1,608	3,179	1,906	2,396
February.........	1,608	3,278	1,906	2,396
March............	1,608	3,378	1,906	2,396
April............	1,608	3,278	1,906	2,346
May..............	1,608	3,278	1,906	2,346
June.............	1,608	3,278	1,858	2,346
July.............	1,658	3,378	1,858	2,346

August..........	1,608	3,378	1,906	2,346
September........	1,559	3,278	1,906	2,346
October..........	1,510	3,278	1,809	2,396
November.........	1,559	3,278	1,906	2,396
December.........	1,559	3,477	1,930	2,446
Average..........	1,592	3,312	1,892	2,375
1992				
January..........	1,580	3,500	1,975	2,390
February.........	1,605	3,500	1,925	2,340
March............	1,630	3,350	1,900	2,190
April............	1,605	3,250	1,925	2,190
May..............	1,530	3,250	1,925	2,290
June.............	1,560	3,250	1,925	2,290
July.............	1,550	3,300	1,975	2,290
August...........	1,540	3,450	2,000	2,340
September........	1,550	3,450	2,025	2,390
October..........	1,550	3,650	2,050	2,440
November.........	1,550	3,650	2,050	2,440
December.........	1,550	3,550	2,100	2,415
Average..........	1,566	3,429	1,982	2,334

a Includes about one-half of the production in the Kuwait-Saudi Arabia Neutral Zone from 1973-July 1990 and from June 1991 on. Kuwaiti Neutral Zone output was discontinued following Iraq's invasion of Kuwait on August 2, 1990, but was resumed in June 1991. In 1992, Neutral Zone production by both Kuwait and Saudi Arabia totaled about 336 thousand barrels per day.

b The Arab members of the Organization of Petroleum Exporting Countries (OPEC) are Algeria, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, and the United Arab Emirates. Production in the Neutral Zone between Kuwait and Saudi Arabia is included in "Arab OPEC."

Notes: • Crude oil includes lease condensate but excludes natural gas plant liquids. • Annual averages may not equal average of months due to independent rounding. • Data for countries may not sum to totals due to independent rounding.

Sources: See end of section.

Table 1.2 OPEC Crude Oil Production (Excluding Condensate), 1990-Present
(Thousand Barrels per Day)

	Algeria	Indo-nesia	Iran	Iraq	Kuwait1/	Libya	Nigeria
1990 Average...	765	1,281	3,088	2,040	1,175	1,375	1,755
1991 Average...	800	1,410	3,312	305	190	1,483	1,832
1992 Average...	772	1,326	3,429	425	1,058	1,433	1,820
1993 Average...	747	1,327	3,540	512	1,852	1,361	1,835
1994 Average...	750	1,334	3,583	548	2,025	1,378	1,821
1995 Average...	767	1,343	3,608	555	2,057	1,390	1,878
1996 Average...	812	1,367	3,651	574	2,062	1,401	1,885
1997 Average...	847	1,355	3,629	1,150	2,083	1,446	2,217
1998 January...	860	1,340	3,600	1,256	2,215	1,450	2,108
February..	860	1,340	3,600	1,698	2,210	1,450	2,153
March.....	860	1,340	3,600	1,820	2,210	1,450	2,270
April.....	840	1,340	3,800	1,980	2,115	1,400	2,128
May.......	820	1,340	3,600	2,240	2,105	1,360	2,120
June......	810	1,310	3,800	1,915	2,105	1,360	2,100
July......	800	1,310	3,550	2,350	2,075	1,360	2,050
August....	790	1,330	3,400	2,550	2,025	1,340	1,900
September.	790	1,330	3,650	2,550	1,972	1,335	1,900
October...	790	1,360	3,450	2,550	1,970	1,335	1,850
November..	790	1,360	3,600	2,500	2,020	1,350	1,950
December..	790	1,360	3,550	2,300	2,020	1,350	2,000
1998 Average...	816	1,338	3,599	2,145	2,085	1,378	2,043
1999 January...	800	1,360	3,630	2,510	1,995	1,360	1,970
February..	810	1,340	3,890	2,650	2,005	1,360	1,900
March.....	820	1,350	3,760	2,425	2,020	1,360	2,050
April.....	780	1,350	3,450	2,650	1,785	1,320	2,050
May.......	760	1,350	3,400	2,700	1,815	1,300	2,080
June.......	750	1,330	3,380	2,350	1,830	1,290	2,040
July.......	750	1,310	3,480	2,800	1,830	1,290	2,020
August.....	760	1,300	3,500	2,850	1,860	1,290	2,030
September..	760	1,300	3,450	2,850	1,885	1,300	2,040
October..	760	1,300	3,500	2,665	1,925	1,310	2,060
November.	760	1,300	3,450	2,200	1,905	1,320	2,050
December.	760	1,300	3,400	1,400	1,922	1,330	1,940
1999 Average...	772	1,324	3,522	2,503	1,898	1,319	2,020

1/ Includes about one-half of the production in the Kuwait-Saudi Arabia Neutral Zone
in June 1991. Kuwaiti Neutral Zone output was discontinued following Iraq's invasion
resumed in June 1991. From August 1990 through May 1991, all production in the Neutra
Saudi Arabia. In December 1999, Neutral Zone production by both Kuwait and Saudi Ara
Data for Saudi Arabia include approximately 150,000 barrels per day from the Abu Safa
Notes: OPEC=Organization of Petroleum Exporting Countries. See Appendix A for co
Monthly data are often preliminary and also may not average to the annual totals due
Sources: See end of Section 1.

April, 1996

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Impact of greenhouse gas mitigation on oil-exporting countries: Preliminary Analysis

EXECUTIVE SUMMARY

This paper analyzes the oil market impacts of greenhouse gas mitigation commitments now under discussion within the Framework Convention on Climate Change. As requested, it focuses on the effects of mitigation on the projected revenues of oil-exporting countries in the Middle East.

The analysis considers a greenhouse gas mitigation commitment under which OECD countries are required to reduce their emissions 5 percent below their 1990 level by 2010. This target falls between proposals tabled by Germany and the Alliance of Small Island States requiring emissions reductions of 15 to 20 percent by 2010 and the widely-discussed alternative of stabilizing emissions at their 1990 level. Starting from a "conventional wisdom" baseline oil market scenario -- which is itself subject to great uncertainty -- a range of impact estimates are then developed.

Summary of Analysis Results

	1993	2010 Baseline	2010 w/ Mitigation
Price of Oil ($1994/barrel)*	$16.48	$23.71	$17.15-$23.71
World Petroleum Production** (million barrels/day)	65.8	87.7	81.5-82.7
Middle East Production** (million barrels/day)	18.7	36.0	31.2-32.8
Middle East Revenues*** (billions of $1994/year)	$87	$259	$164-$220

* U.S. Refiner Acquisition Cost for imports

** including natural gas liquids but excluding refinery gains.

*** gross revenues based on assumed export price $1.50 per barrel below U.S. Refiner Acquisition Cost and Middle East production level less consumption of 2.8 mbd in 1993 and 4.1 mbd(est.) in 2010.

Global Oil Demand and Production Impacts

- The current conventional wisdom, as captured in four widely cited forecasts, projects a rise in global oil demand from a 1996 level of roughly 70 million barrels per day (mbd) to between 86 and 96 mbd by 2010. Nearly all of additional demand is expected to be met by increased Middle East production.

- Starting from the Energy Information Administration's reference case scenario (88 mbd of global oil production in 2010), we expect that mitigation efforts necessary to reach the greenhouse gas emission goal would reduce world oil demand by 5 to 6 mbd in 2010 below otherwise projected levels, assuming a least-cost policy.

    * Mitigation would not significantly affect projected non-OPEC production. Middle East producers are expected to absorb 75 to 80 percent of the global reduction in baseline oil output.

    * A 5 million barrel per day reduction in global demand is expected to reduce projected Middle East output in 2010 by about 10 percent, but Middle East production would still exceed present levels by a wide margin.

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Middle East Oil Revenue Impacts

- In the EIA baseline scenario, gross oil revenues for Middle East producers are projected to reach nearly $260 billion (1994 dollars) in 2010, tripling their 1993 level.

- Under a least-cost mitigation strategy that reduced global oil demand by between 5 and 6 mbd, revenues to Middle East oil producers in 2010 would be lowered by between 15 and 37 percent ($39 to $95 billion). The decrease in revenues reflects the combined effect of price and quantity changes.

  * Even at the high end of the impact range, projected revenues for Middle East producers would remain far above current levels.

  * The impact of demand reduction on prices realized by producers, a key driver of revenue impacts, depends largely on the capacity decisions of OPEC members.

Implications for Policy Design and Negotiation Positions

- The Berlin Mandate, the agreed basis for the current negotiations, suggests that new mitigation commitments could involve two distinct types of elements: common "policies and measures" pursued by all parties; and "targets and timetables" that leave the choice of reductions in the hands of the individual parties.

- Assuming an unwavering resolution among developed countries to negotiate and implement tough new emissions reduction commitments, a "targets and timetables" approach could have certain advantages for oil-exporting countries:

  * Since many of the most cost-effective opportunities for mitigation involve reduction in coal use, targets and timetables should have lower oil market impacts than the oil-oriented measures (e.g. common vehicle fuel efficiency standards) typically featured under a policies and measures approach.

  * Common policies and measures could spread outside the OECD approach and thus have additional oil market impacts. For example, vehicle manufacturers subject to policies and measures within the OECD may choose to standardize their products to the required levels on a global basis. This could lead to an even greater reduction in oil demand.

- While still likely to oppose new commitments, the Middle Eastern producers would probably favor flexible policies to attain targets and timetables as a secondary negotiation strategy to protect oil markets from common policies aimed directly at reducing oil use.

- The projected lifetime of existing oil reserves and the relative abundance of reserves of oil and natural gas (which could gain a market advantage due to its lower carbon content per unit of energy if mitigation is required) are two key factors affecting the interests of individual energy exporting countries. Differences in the circumstances of individual Middle East producers may cause their interests, concerns, and responses to diverge.

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Impact of greenhouse gas mitigation on oil-exporting countries
Preliminary Analysis

This paper responds to a request for analysis of the oil market impacts of greenhouse gas mitigation commitments now under discussion within the Framework Convention on Climate Change. Per the request, the analysis focuses on the impact of greenhouse gas mitigation on projected revenues of oil-exporting countries in the Middle East.

This paper, which provides the detail supporting the findings presented in the Executive Summary, is organized into the following five main sections:

- review of alternative baseline oil market projections for 2010.
- analysis of mitigation scenarios using the Energy Information Administration world oil market model.
- outline of oil exporter options to ameliorate the revenue effects of greenhouse mitigation.
- discussion of differences among oil producers.
- background information on world oil market trends over the past 15 years.

1. Baseline Oil Market Projections

Our review considered a variety of world oil market scenarios from the U.S. Energy Information Administration, Cambridge Energy Research Associates, Data Resources Incorporated, and the International Energy Agency. These projections are summarized (in abbreviated form) in Table 1.

- Total world oil consumption is projected to rise from the present level of approximately 70 million barrels per day (mbd) to between 86 and 96 mbd.
  - Non-OECD consumption is projected to increase by between 14 and 24 mbd. OECD consumption is projected to increase by between 1 to 8 mbd. In most scenarios, non-OECD demand, now only 2/3 of the OECD demand level, exceeds OECD demand by 2010.
  - Growing transportation demand underlies demand growth. The International Energy Agency projects that by 2010, transportation could account for 60 percent of global oil use.
- All scenarios project that OPEC will supply all, or nearly all, of the growth in oil demand.
  - OPEC production is projected to reach a level of between 46 and 50 mbd, up from a current level of approximately 27 mbd.

All scenarios considered project some increase in the real price of oil, with most forecasts clustered in the range of $21 to $24 (1994 dollars). With higher prices and higher volumes, OPEC revenues in 2010 are projected to increase substantially from their current levels.

2. Production and Revenue Impacts of Greenhouse Gas Mitigation

A significant greenhouse gas mitigation effort would reduce world oil demand. The size of the reduction depends directly on the mitigation approach taken.

- Modeling analysis suggests that an unrestricted cap-and -trading scheme or an emissions tax would focus emission reduction efforts on energy use in the industrial and electricity generation sectors rather than in the transportation sector, where oil is the dominant fuel.
  - * Even significant carbon permit values (or taxes) translate into relatively small effects on petroleum product prices. For example, a tax or emissions permit value of $100 per metric ton of carbon would raise the price of gasoline by only 25 cents per gallon. An adder of this size would have only a modest effect on U.S. fuel demand and would represent only a small percentage of the consumer price in countries where vehicle fuel is already heavily taxed.
- Most of the projected increase in world oil demand between now and 2010 is projected to occur outside of countries that will be undertaking new mitigation commitments under the Berlin Mandate.
- Energy modeling analyses suggest that a phased-in tradable permit scheme sufficient to reduce emissions 5 percent below the 1990 level by 2010 in the OECD would require an implicit price of carbon of $150 to $200 per metric ton.
  - * Starting from oil consumption levels projected by EIA, OECD oil consumption might be reduced by almost 6 million barrels per day (approximately 12 percent). Even with this reduction, OECD oil consumption in 2010 would be approximately 7 percent above its 1990 level.
  - * In the U.S., a carbon premium in this range could encourage significant early reductions in the utilization of existing coal-fired power generation capacity.

The tradable carbon permits or taxes considered in most modeling exercises are only one possible approach to reducing greenhouse emissions. Other available approaches would also affect oil demand. For example, if half of the transportation sector's 60 percent share in total year 2010 oil demand projected by the International Energy Agency is used by passenger automobiles, a 20 percent improvement in the projected average fuel efficiency of the <u>global</u> car fleet in 2010 would also reduce world oil demand by about 5 mbd (88mbd*60%*50%*20%) if higher fuel efficiency does not increase miles traveled.

- Greater reliance on "policies and measures" in new mitigation commitments could increase oil market impacts.
  - * Policies and measures are likely to be targeted on a limited number of activities, requiring deeper cuts in the targeted areas than would be necessary if the entire emissions-reduction potential of each nation were engaged by using economic instruments to meet an overall goal.

* The demand-reducing effects of a policies and measures approach are likely to spread beyond the industrialized countries. For example, vehicle manufacturers and others subject to policies and measures within the OECD may choose to standardize their products to the required levels on a global basis.

The implications of OECD mitigation for world oil demand depend in part on the extent of changes in producer prices. If producer prices fall, consumption in regions that are not subject to new mitigation commitments is likely to increase, partially offsetting the reduction in world demand from lower OECD consumption. To explore the potential effects of greenhouse mitigation on world oil markets, the EIA World Oil Model was used to estimate the effects of a 5 million barrel per day reduction in world oil demand in 2010. The results (see Table 2) are summarized below.

- A 5 mbd reduction in 2010 oil use would leave consumption substantially above the present level of approximately 70 mbd.
- The change in projected revenues of oil exporting countries reflects two factors: changes in producer prices and changes in production levels.
- The price impact of demand reduction depends critically on how exporters adjust their production capacity.
  * In the Energy Information Administration World Oil Model, a 5 mbd demand reduction would lower the world oil price in 2010 by approximately $6.50 per barrel (28 percent) from a base case level of $23.71 ($1994) if OPEC maintains its baseline production capacity.
  * A 3 mbd reduction in projected OPEC production capacity would cut the projected price impact by 50 percent.
- Changes in oil export quantities are directly linked to changes in prices
  * If oil prices fall by $6 in response to weaker demand, one-fifth of the projected supply reduction is projected to occur outside of OPEC. The great bulk of non-OPEC production would still be profitable at the new prices, and would be unaffected.
  * If oil prices are unaffected, non-OPEC production would be unchanged. In this case, demand in countries that are not required to limit their greenhouse emissions would remain at baseline levels. Together, these two effects would lower OPEC output by 2 mbd beyond the 4 mbd loss in the $6 price reduction case.
- The implications for the estimated gross revenues of Persian Gulf oil exporters are straightforward:
  * With no reduction in the world market price and a pro-rata division of production cuts within OPEC, Persian Gulf production and producers' gross revenues in 2010 would be reduced by approximately 15 percent.
  * With no adjustment in OPEC capacity, the EIA model projects a combination of price and quantity cuts that would reduce the gross revenues of Persian Gulf producers in 2010 by 37 percent.

Note: The above calculations assume an average export price for Middle East producers $1.50 per barrel below the projected average U.S. refiner acquisition cost for imported oil and a projected Middle East consumption level of 4.1 mbd in 2010.

Appendix A provides a further discussion of the key relationship between demand reduction and price.

3. Possible Actions to Ameliorate Impacts on Oil Exporter Revenues

If OPEC producers see GHG mitigation efforts as unavoidable, they may seek to ameliorate its effect on their oil export revenues. Steps they might propose include the following:

- Consumer support of oil export tax or cartel pricing. Producers may seek an arrangement in which importing countries subject to new commitments allow oil exporters to collect all or part of an explicit or implicit carbon tax. In effect, oil importing countries would become enforcement agents for a minimum price agreement. Such a consumer-sanctioned transfer from importing to exporting countries would represent a reversal of existing U.S. oil policy, which has sought to maximize price competition among exporters.
- Restraint on non-OPEC supply. Limitations on oil supply investments within the OECD area, or by OECD companies in non-OPEC regions, could fully or partially offset price and volume reductions that would otherwise result from oil demand reductions. Again, such an arrangement would run counter to existing U.S. policy, which has sought to maximize production outside the OPEC area.
- Guaranteed access to OECD markets for energy-intensive products. Oil exporters, with the support of developing countries, may seek assurances that no trade barriers will be erected to forestall the migration of energy-intensive industries away from regions that are reducing emissions. Such assurances, while not in conflict with current policy, might make it harder to win support for mitigation within the U.S. and other OECD countries, where local producers subject to higher energy costs as a result of mitigation are likely to seek protection against import competition.

4. Differences Among Exporters and the Long-run Perspective

While a broad analysis necessarily addresses the group of major oil exporters as a single unit, there are important differences among them.

- Nations with large reserves of oil (e.g. Saudi Arabia, Kuwait) may have greater interest in assuring oil's long-term role in meeting global energy needs than nations (e.g. Indonesia, Oman) whose limited resources dictate a transition to other types of economic activity whether or not greenhouse mitigation commitments are adopted.

- Proved reserves of oil and natural gas, the latter of which might be relatively advantaged in a world where significant mitigation of greenhouse gas emissions is required, are distributed in very different patterns.
    * For example, while Saudi Arabia's proved oil reserves are approximately three times larger than Iran's, its proved gas reserves are only about 1/3 as large as Iran's. Moreover, while the Middle East accounts for approximately 65 percent of the world's proved oil reserves, it accounts for less than 40 percent of proved gas reserves.
    * Proved gas reserves in the former Soviet Union (FSU) are larger than those of the entire Middle East region. Proved oil reserves in the FSU are less than 10 percent of those in the Middle East region.

Resource depletion alone cannot be relied upon to drive a shift away from oil in the foreseeable future.

- While oil and natural gas are non-renewable resources, the effects of depletion in the market have been offset by advances in exploration and production technology that have lowered costs and increased recovery rates for oil and gas.
- With today's oil prices in real terms only slightly above levels prior to the 1973 oil shock, the global reserves to production ratio for oil estimated to be recoverable at current market prices with current technology is approximately 41 years. This value has increased by more 20 percent since early 1970s, despite more than 20 years of resource use and an increased level of production.
- The global reserve-to production ratio for natural gas, now over 65 years, has risen by 50 percent since the early 1970s despite a nearly 100 percent increase in production levels.

5. World Oil Markets: Recent Experience

Table 3 summarizes data on world oil markets for four years: 1980, 1985, 1990, and 1993.

- World oil consumption has been increasing in recent years, with the IEA projecting a 1996 consumption level of more than 70 million barrels per day. However, total oil use has been relatively flat over the last 15 years.
- Increases in vehicle fuel economy and other energy efficiency indicators, together with increased reliance on natural gas and coal in industrial, residential, and power generation applications, have largely offset the demand-increasing effects of economic growth and reductions in real oil prices.

- OPEC members, whose production was sharply depressed from peak levels by the middle of the 1980s, have only recently returned to their 1980 level of production.
    - Taking account of price declines and inflation, OPEC's 1993 revenues in terms of real dollars remain substantially below earlier peaks, reaching less than half their 1974 level or one-third of their 1980 level.
- The slow decline in U.S. production since 1980 has been more than offset by increases elsewhere in the OECD -- most notably in OECD Europe.
- . OECD oil demand has been stagnant since 1980. Demand has grown at a rapid rate from a small base in China and other developing countries. Demand in the former Soviet Union has fallen sharply in recent years, reflecting sharp declines in economic activity.

Appendix A: The effect of demand reduction on the world market price of oil.

Our analysis shows that the sensitivity of world oil prices to demand reduction is the most important determinant of revenue impacts on oil-exporting countries.

The EIA model implicitly reflects the role of continually advancing technology in raising recovery rates for existing fields, lowering exploration and production costs, and providing access to additional reserves as well as the difficulties posed by demand reduction for oil exporting nations seeking to coordinate production decisions.

The actual relationship between demand and price levels depends on market dynamics that are very imperfectly understood. Capacity decisions by OPEC members, one of the most critical factors, may be related to policy on foreign investment, estimates of uncertain future world demand for oil, and the role of capacity additions in determining output shares of individual OPEC members. .

An intermediate case to the "frozen capacity" and "frozen price" extremes presented in this paper might posit that oil markets in 2010 would maintain today's real prices were 2010 demand to remain at today's demand level. Based on recent experience, this is a quite optimistic scenario from the producer perspective -- real prices have been generally falling even with modest global demand growth over the past decade. Under this scenario, prices in the 5 mbd demand reduction scenario would be lower than the baseline price projections, but would remain above current levels given anticipated growth in demand from today's level.

A final point worth noting is that price estimates from the EIA model without capacity adjustments cannot be extrapolated linearly. As increasing demand reductions put downward pressure on price, exploration, development activities, and even production in high cost areas, would eventually be affected on a significant scale. Once a such a price level is reached, cutbacks in non-OPEC oil output would greatly reduce the incremental price sensitivity to further demand reductions.

Table 1
Comparison of Oil Market Projections for 2010
(million barrels per day)

	AEO96[1]	CERA[2]	DRI[3]	IEA-CC[4]	IEA-ES[5]
Price (1994 $/Barrel)	**$23.71**	**$21.14**	**$23.12**	**$28.53**	**$18.34**
Total Consumption	**87.98**	**86.60**	**96.43**	**95.20**	**92.00**
OECD	**48.23**	**41.30**	**46.25**	**48.30**	**47.50**
OECD North America	25.48	19.20	23.12	25.40	24.70
U.S.	21.03		21.18		
OECD Asia/Pacific	8.00	8.20		7.80	7.60
OECD Europe	14.75	13.90		15.10	15.10
Non-OECD Total	**39.75**	**45.30**	**50.18**	**46.90**	**44.50**
Developing Countries	26.51				
Pacific Rim	9.69				
OPEC	6.78		9.04	5.10	5.10
Eurasia	13.24				
Former Soviet Union	6.60	5.90	4.97	7.90	7.10
China	5.11	6.10	7.12	6.50	6.60
Total Production	**87.68**	**86.70**	**96.43**	**95.20**	**92.00**
OECD	**20.16**	**15.00**	**20.43**	**21.00**	**17.50**
U.S.	8.79		6.95		
Canada	2.37		2.46		
OECD Europe	5.24	4.80			
Non-OECD Total	**67.52**	**71.70**	**76.00**	**74.20**	**74.50**
OPEC	46.57		45.88	46.70	49.40
Eurasia	12.81				
Former Soviet Union	9.55	10.00	10.04	10.70	10.00
China	3.04		3.81		

1. U.S. Energy Information Administration, 1996 Annual Energy Outlook, January 1996
2. Data Resources Incorporated, Oil Market Outlook, Special Issue, July 1995
3. Cambridge Energy Research Associates, model output, 1996
4. International Energy Agency, World Energy Outlook 1995, April 1995 (Capacity Constrained Case)
5. International Energy Agency, World Energy Outlook 1995, April 1995 (Energy Savings Case)

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Table 2
Impact of Demand Reduction on World Oil Markets
Sensitivity Analysis for 5 mbd Global Demand Reduction in 2010

	AEO96	-5 MBD	no price change	1993 Actual
Price (1994 $/Barrel)	$23.71	$17.15	$23.71	$16.48
(U.S. Refiner Acquisition Cost for Imports)				
Total Consumption (million barrels/day)	87.98	82.98	81.75	66.72
OECD	48.23	42.00	42.00	40.85
U.S.	21.03	17.59	17.59	17.48
Japan	6.86	5.75	5.75	5.38
OECD Europe	14.75	13.67	13.67	13.60
Non-OECD Total	39.75	40.98	39.75	25.87
OPEC	6.78	6.78	6.78	4.58
Developing Countries	19.73	20.41	19.73	11.37
Eurasia	13.24	13.79	13.24	9.92
Former Soviet Union	6.60	6.83	6.60	5.77
China	5.11	5.41	5.11	3.11
Total Production (million barrels/day)	87.68	82.68	81.45	65.80
OECD	20.16	19.80	20.16	19.56
U.S.	8.79	8.60	8.79	8.58
OECD Europe	5.24	5.18	5.24	5.04
Non-OECD Total	67.52	62.88	62.52	46.24
OPEC	46.57	42.38	40.34	27.20
Developing Countries	8.14	7.96	8.14	7.83
Eurasia	12.81	12.53	12.81	11.22
Persian Gulf Production (mbd)	36.04	32.80	31.21	18.66
Persian Gulf Oil Revenues* (billions of $1994)	$259	$164	$220	$87

* Revenue calculation based on assumed average export price $1.50 below U.S. Refiner Acquisition Cost, and reported/projected Persian Gulf production levels, with an adjustment for consumption of 2.8 mbd in 1993 and 4.1 mbd in 2010.

Table 3
World Consumption and Production of Petroleum
(million barrels per day)

	1980	1985	1990	1993
CONSUMPTION				
TOTAL	**63.07**	**60.10**	**66.16**	**66.72**
OECD	**40.20**	**36.07**	**39.29**	**40.85**
United States	17.40	15.97	16.99	17.48
Japan	4.96	4.38	5.14	5.38
OECD Europe	14.01	12.04	12.93	13.60
OPEC	**2.82**	**3.69**	**4.51**	**4.58**
Developing (non-OPEC)	**7.59**	**7.99**	**10.33**	**11.37**
Eurasia	**12.48**	**12.35**	**12.02**	**9.92**
Former Soviet Union	9.00	8.95	8.39	5.77
Eastern Europe	1.71	1.51	1.33	1.04
China	1.77	1.89	2.30	3.11
PRODUCTION (excludes refinery gains)				
TOTAL	**63.04**	**57.92**	**65.20**	**65.80**
OECD	**17.09**	**20.06**	**18.85**	**19.56**
United States	10.17	10.58	8.91	8.58
Canada	1.77	1.81	1.98	2.18
Mexico	2.13	3.02	2.98	3.13
OECD Europe	2.56	3.98	4.29	5.04
OPEC	**27.51**	**17.25**	**24.75**	**27.20**
Developing (non-OPEC)	**3.97**	**5.81**	**4.06**	**7.82**
Eurasia	**14.47**	**14.80**	**14.44**	**11.22**
Former Soviet Union	11.99	11.94	11.40	8.10
Eastern Europe	0.37	0.37	0.27	0.21
China	2.11	2.51	2.77	2.91