ENERGY, ENVIRONMENT
AND DEVELOPMENT PROGRAMME

OPEC AND CLIMATE CHANGE
Challenges and Opportunities

Report

November 2005

CHATHAM HOUSE

OPEC and Climate Change:

Challenges and Opportunities

Report

November 2005

Published by
The Royal Institute of International Affairs
Chatham House
10 St James's Square
London SW1Y 4LE

www.chathamhouse.org.uk

(Charity Registration No. 208 223)

Contents

Boxes, figures and tables

Acknowledgments

The authors would like to acknowledge the financial support of DEFRA, the UK's Department for Environment, Food and Rural Affairs, and of the Energy, Environment and Development Programme's core supporters, without which this project would not have been possible.

This report benefits from the work of both the wider research community and inputs from climate, energy and regional experts. Many conversations were held on a non-attributable basis and often in a personal capacity and are thus difficult to credit. Even so, the authors would like to recognise Benito Müller's contribution, and the following for sharing their thoughts on this work as it developed: Amal-Lee Amin, John Ashton, Terry Barker, Suraje Dessai, Guy Gantley, Sarah Hendry, Saleemul Huq, Jürgen Lefevere, Valerie Marcel, Katrina McLeay, John Mitchell, Ricardo Moita, M.J. Mace, Chris Mottershead, Keith Myers, Alan Richmond, Jonathan Stern, and Paul Watkinson.

The authors also extend their appreciation to Chatham House staff who helped deliver a workshop and report within a very short timescale, including: Beverley Darkin, Gemma Green, Lorraine Howe, Matthew Link and Margaret May. We would further like to thank Tamar Bourne – an intern with Chatham House – for her production of relevant graphs. The final credit is to the partners of the authors: David Lye and Ash Ibrahim for their patience, ideas and support.

As ever responsibility for the content remains with the author and contributors.

Research by the Energy, Environment and Development Programme is supported by generous contributions of finance and technical advice from the following organizations:

- Amerada Hess
- Anglo American
- British Nuclear Fuels plc
- BG Group
- BP plc
- Department for Environment, Food and Rural Affairs (UK)
- Department for International Development (UK)
- Department of Trade & Industry (UK)
- ExxonMobil
- Foreign & Commonwealth Office (UK)
- General Direction for Energy and Mineral Resources, Ministry of Economy, Finance and Industry (France)
- Saudi Petroleum Overseas Ltd
- Shell International
- Tokyo Electric Power Co. Inc.

Authors and contributors

Jacqueline Karas is an Associate Fellow with the Energy, Environment and Development Programme at Chatham House and an independent consultant on climate change and sustainable development.

Tatiana Bosteels is a PhD student at Imperial College, specializing in climate change and Africa and the Middle East, and an independent consultant on climate change.

Benito Müller is an Associate Fellow with the Energy, Environment and Development Programme at Chatham House and Senior Research Fellow with the Oxford Institute for Energy Studies.

Glossary

Annex 1	Annex 1 to the UNFCCC lists industrialized country and economy in transition parties to the UNFCCC that assume specific commitments
Annex B	Annex B to the Kyoto Protocol defines emission allowances of Annex I countries for Kyoto's commitment period
AOSIS	Association of Small Island States
BaU	Business as Usual i.e. a future projection in the absence of the Kyoto Protocol
CCP	CSLF Carbon Capture Project
CCS	Carbon capture and storage
CDM	The Clean Development Mechanism, defined by Article 12 of the Kyoto Protocol. Refers to the emission reduction activities implemented in Non-Annex I, mainly developing, countries to create CERs, which can be used by Annex B countries to fulfil their commitments
CER	Certified Emission Reduction, a unit issued pursuant to Article 12 of the Kyoto Protocol (the CDM)
CICERO	Centre for International Climate and Environmental Research – Oslo.
CNG	Compressed natural gas
CO_2	Carbon dioxide
COP	Conference of the Parties to the UNFCCC
COP/MOP	Conference of the Parties to the UNFCCC and Meeting of the Parties to the Kyoto Protocol
CSLF	Carbon Sequestration Leadership Forum, an international climate change initiative that is focused on development of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage. The CSLF has endorsed 10 international CO_2 Capture and Storage projects.
EIA	US Energy Information Administration
EITs	Economies in Transition
ERU	Emission Reduction Unit, a unit issued pursuant to Article 6 of the Kyoto Protocol (JI)
EU ETS	European Union Emission Trading Scheme, a compulsory emissions trading scheme for EU member states
EU	European Union
FDI	Foreign direct investment
G77	The Group of 77, the largest developing-world coalition in the United Nations
G8	The Group of 8, an informal group of eight countries: Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
GDP	Gross domestic product
GEF	Global Environment Facility. The GEF, established in 1991, is an independent financial organization that provides grants to developing countries for projects that benefit the global environment and promote sustainable livelihoods in local communities
GGFR	World Bank's Global Gas Flaring Reduction partnership
GHG	Greenhouse gas. The principal anthropogenic greenhouse gases are identified as: carbon dioxide (CO_2); methane (CH_4); nitrous oxide

	(N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6)
GRULAC	Latin American and Caribbean countries
GTL	Gas-to-liquid
HDI	Human Development Index
IEA	International Energy Agency
IET	International emissions trading, as allowed under Article 17 of the Kyoto Protocol
IGO	Intergovernmental organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change, reviews scientific research and provides governments with summaries and advice on climate problems
IPCC TAR	IPCC Third Assessment Report, published in 2001
JI	Joint Implementation, defined by Article 6 of the Kyoto Protocol. Refers to the emission reduction activities implemented jointly between industrialized countries and EITs
kWh	Kilowatt hour
LDC	Least developed country, as officially defined by the UN
LNG	Liquid natural gas
MMSCF	Million standard cubic feet
MtCe	Million tonnes of carbon equivalent
MW	Megawatts
NC	National Communication to the UNFCCC
NGO	Non-governmental organization
NLNG	Nigeria Liquefied Natural Gas Corporation
NOC	National oil company
Non-Annex 1	Parties to the UNFCCC not listed in the Annex I of the Kyoto Protocol, mostly developing countries but also several countries of the Former Soviet Union. Non-Annex 1 countries do not have quantified emission reduction or limitation commitments
OAPEC	Organization of Arab Petroleum Exporting Countries
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
OWEM	OPEC's world energy model
ppm	Parts per million
PPP	Purchasing Power Parity
REEEP	Renewable Energy and Energy Efficiency Partnership
SCCF	Special Climate Change Fund
SNF	Foundation for Research in Economics and Business Administration
Tcf	trillion cubic feet
TSGP	Trans-Saharan Gas Pipeline
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WEO	World Energy Outlook
WTO	World Trade Organization

Executive Summary

OPEC countries tend to be highly reliant on revenues from the export of fossil fuels and they have consistently argued, throughout the climate negotiations, that measures taken by Annex 1 countries to reduce greenhouse gas emissions would have a major impact on their economies. They have advocated financial compensation to offset any adverse impacts.

If the climate change negotiations are to move forward, new approaches will be needed to engage constructively with energy exporters in moving towards a low carbon future. This in turn requires a better understanding of the position of OPEC countries, their national interests and the interaction with wider political and economic priorities and trends. This report seeks to facilitate this through an examination of OPEC countries in the climate negotiations; to identify the key challenges and drivers in relation to wider domestic and political concerns; and to examine the scope for more constructive dialogue on climate change.

OPEC and the climate change negotiations

OPEC does not itself participate in the climate negotiations, but its member states do. In these negotiations, Saudi Arabia, supported by a small number of other states, has consistently pushed the importance of addressing potential adverse effects of climate mitigation measures on their economies. In arguing their case, these countries point to the importance of oil in meeting global energy demand, as well as the need for advances in clean fuel technology and to minimize adverse social and economic effects on producer countries.

While OPEC's position in the negotiations has been remarkably stable over time, to understand its position, and that of its member states, and how this may change requires understanding of the wider dynamic within OPEC, changes in national circumstances of member states and the energy markets in which they deal, and emerging interests in new energy technologies. Moreover, some OPEC members are becoming more concerned about the potential impacts of climate change itself, and this could affect their position.

Wider economic and political factors may also influence OPEC country positions. For example, many Gulf countries, including Saudi Arabia, are liberalizing their economies and undertaking substantial internal economic reform, and this could increase the level of foreign investment. A key priority economic issue is the labour market. There is a crucial need to provide new jobs for the growing, young populations of these countries. It is possible that labour market pressures will push Gulf economies towards economic diversification more than climate change policies will ever do.

Understanding OPEC member states socio-economic circumstances is crucial to open constructive debate. For example, Iran, Nigeria and Algeria face very different conditions from the Gulf states. This suggests that interests in climate change will – or should – vary from country to country.

Impact of response measures

The report examines the impact of international action to curb greenhouse gas emissions on oil and gas markets, and the different level of exposure of OPEC countries, according to their dependence on energy exports and the nature and scale of their reserves. Consideration is also given to the potential interaction with wider energy markets and energy prices.

The research shows that while restrictions on emissions are expected to reduce the overall demand for fossil fuels, the impact will differ according to the fuel considered. While efforts to reduce greenhouse gas emissions are expected to reduce projected demand for coal and oil, projected demand for gas could increase. The impact on oil demand for transport energy will be limited, given the anticipated large growth of car use.

Overall, the impact of the Kyoto Protocol on oil markets is likely to be insignificant when seen in relation to the general volatility of the market and current high prices. Other drivers of the oil market will be more important in dictating oil prices. The impact of the Kyoto Protocol on OPEC countries may be limited still further by emission trading. That said, policies aimed at stabilizing climate would require deep cuts in emissions and thus could potentially have a much more significant effect on energy markets depending on how they are implemented.

A point also often sidelined in the negotiations is that the economic impact of climate mitigation measures will vary markedly between countries, depending on, among other things, the level of economic dependence on energy exports, the nature of these exports and the destination and size of reserves. This means that OPEC countries may respond differently to negotiations over future commitments beyond those of the first commitment period under the Kyoto Protocol, depending on how rapidly their resources are depleting and differences in fuel-supply mix.

It is important to view the potential impacts of response measures in the wider context of changes in the energy market and, in particular, the tripling of oil prices to $60 a barrel over recent years. Most analysts believe that oil prices are likely to remain high relative to the last decade or so, raising questions as to the likely market response to a sustained period of high oil prices. An enduring concern for producer countries is that high prices provide incentives for changes in consumer behaviour, enhanced competitiveness of non-conventional fossil fuels and alternatives and the risk of widespread recession. Thus there is a certain common interest between OPEC producers and consumers to keep demand and prices within reasonable bounds.

Vulnerability to climate change

An assessment of the vulnerability of selected OPEC countries to climate change demonstrates that while the impacts will vary, most will experience an exacerbation of already extreme climatic conditions. The prominent risks and vulnerabilities identified are mainly associated with water resources, such as increased water scarcity, desertification, drought, soil salinization, land degradation and threats to agricultural productivity. Sea level rise, flooding and salt-water intrusion in coastal areas are also identified as risks.

Existing analyses tend to be vague and focus on first-order (physical or direct) impacts. In practice the impacts will be far more diverse, aggravating existing socio-economic pressures. In addition, countries could face spillover effects from impacts in neighbouring countries, including mass immigration into OPEC countries from poorer vulnerable countries such as Yemen, Ethiopia, Eritrea and Somalia. The research highlights the need to develop techniques to explore the wider ramifications of climate change, to develop a more sophisticated understanding of the drivers of vulnerability to climate change and its impacts and hence the best ways to minimize adverse effects.

Emerging data on the vulnerability of OPEC countries to climate change might increase OPEC interest in on-going debates on adaptation to climate change and funding for adaptation. For most OPEC countries analysed, the principal vulnerabilities are associated not simply with climate change but with related socio-economic pressures. This raises questions about how these might affect the OPEC negotiating position.

Energy and mitigation activities

The report gives an overview of the role of energy in the economy in individual OPEC states and mitigation activities and identifies that the main mitigation actions undertaken are largely a by-product of wider developments in the energy field. For example, higher oil prices will encourage investments in new and more efficient technologies. There has also been reorganization of the energy markets, including market liberalization and a major change in fossil fuel markets which have resulted in large investments in gas markets. There have been technological developments made possible by the commercialization of new clean technologies, such as gas flaring reduction technologies and liquefied natural gas LNG production processes. The production costs of clean technologies such as solar cells and fuel cells have fallen and a large amount of research has been carried out on the feasibility of carbon capture and storage.

Mitigation actions in OPEC countries have largely consisted of increased natural gas production, both for fuel switching internally and increasing the share of gas for exports. The potential for mitigation through the reduction of gas flaring is increasingly recognized, and collaborative efforts are already under way to reduce gas flaring in OPEC countries and examine the application of carbon credits. Some OPEC countries, namely Nigeria, Algeria and Indonesia, are actively engaging in the Clean Development Mechanism for this purpose. The emergence of non-fossil fuel energy alternatives can be seen in some countries, such as UAE and Bahrain. However, technology transfer and financial investment are needed to improve the industrial and energy infrastructure and to develop new and renewable energy technologies.

Wider context

In considering the role of OPEC countries in the climate change negotiations it is important to view it in the context of wider developments and the various actors involved. In this report a preliminary assessment is given of the relevance of key issues such as the evolution of the energy markets, investment requirements, dynamics within OPEC, national interests and key actors and wider producer-consumer dialogues.

This suggests that while the impact of response measures was certainly a key issue when oil prices were low at the time the Kyoto Protocol was negotiated, their significance perhaps is likely to be less at a time of high demand and prices. Rather, given the

investment requirements to meet future demand, the key challenge is how to ensure these go into cleaner, more sustainable technologies.

A further key point is the changing dynamic within OPEC itself. Currently Saudi Arabia holds the sway within OPEC but in reality the priorities of individual countries differ and as energy resources in other members deplete and evidence of climate change mounts, then positions may change. More fundamentally, national priorities within OPEC vary and national interests are more complex than simply the highest possible revenues from oil. Indeed, in Saudi Arabia, a top priority is job opportunities for its growing populations.

In any case, many of the issues raised in the climate negotiations by OPEC countries resonate with long-standing concerns over, for example, subsidies and taxation in consumer countries. These are already subject to debate in other producer-consumer forums. This provides both a challenge and an opportunity in the sense it questions where is the most appropriate form to address many concerns.

1. Introduction

OPEC countries tend to be highly reliant on revenues from the export of fossil fuels and they have consistently argued, throughout the climate negotiations, that measures taken by Annex 1 countries to reduce greenhouse gas emissions would have a major impact on their economies. They have advocated financial compensation to offset any adverse impacts.

If the climate change negotiations are to move forward, new approaches will be needed to constructively engage with energy exporters in a transition towards a low carbon future. This in turn requires a better understanding of the position of the countries, their national interests and the interaction with wider political and economic priorities and trends.

This report seeks to facilitate this through an examination of OPEC countries in the climate negotiations; to identify the key challenges and drivers in relation to wider domestic and political concerns; and to examine the scope for more constructive discourse on climate change. It is primarily based on existing literature and discussions held on the topic at a Chatham House workshop in October 2005[1]. It further benefits from individual discussions with key participants and observers of the climate negotiations, and with energy and regional experts. The focus on Algeria, Iran, Nigeria, Saudi Arabia and some Gulf states serves to represent a range of interests in the climate negotiations but also is in part a reflection of the limited information available on other OPEC members.

This said, the report is a working document, intended to prompt thoughts and ideas on how to move forward on climate change in face of apparently conflicting interests. It deliberately raises wider issues such as the need to reconcile wider national interests with action on climate change, changes in the wider energy market and the coincidence (or otherwise) with longer-term strategic trends which influence positions on climate change, and touches on the relevance of dialogues beyond the 'climate bubble'.

As we move forward into further negotiations on climate change – one of the most intractable problems of our time – there has never been a greater need for developing a common understanding of the different dimensions of the challenges and opportunities associated with it. This takes time, yet – if the scientists are right – little time is available to affect the transformation to a low carbon world. Thus, the intention of this report is to open up debate, to recognize any legitimate concerns of those engaged, and above all, to look forward to the scope for cooperation and collaboration on a goal that all have agreed: to avert a dangerous climate change.

[1] The workshop included government negotiators and climate, energy and Middle East experts. It was held under the Chatham House rule of non-attribution to facilitate open discussion.

2. OPEC and the climate change negotiations

Introduction

Historically OPEC member states have exerted a strong influence in the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol negotiations. Throughout the negotiations, they have consistently argued that measures taken by Annex 1 countries to reduce greenhouse gas emissions would have a major impact on the economy of countries that are reliant on the export of fossil fuels. OPEC members' influence within the G77 has reinforced the negotiating power of the group as a whole. However, this influence has not always been to the benefit of other countries within the G77, in particular the Least Developed Countries (LDCs) and Association of Small Island States (AOSIS).

In preparation for future negotiations it is necessary to develop a better understanding of OPEC country positions in the UNFCCC and Kyoto Protocol negotiations. This section gives a brief history of the role of OPEC countries in the negotiations, in particular the role of Saudi Arabia, the reasons for its influence, the key arguments and strategies employed by relevant countries and recent developments.

What is OPEC?

OPEC is a permanent, intergovernmental organization composed of 11 heterogeneous members: Iran (1960), Iraq (1960), Kuwait (1960), Saudi Arabia (1960), Venezuela (1960), Qatar (1961); Indonesia (1962), the Socialist People's Libyan Arab Jamahiriya (1962), United Arab Emirates (1967), Algeria (1969) and Nigeria (1971).[2]

OPEC's objective is to coordinate and unify petroleum policies among member countries, in order to 'secure fair and stable prices for petroleum producers; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the industry' (OPEC 2005).

In 2003, OPEC countries accounted for 77% of proven oil reserves in the world and roughly 40% of its production. The largest reserves are situated in the Middle East comprising over 60% of the world's proven oil reserves. Saudi Arabia has by far the largest known reserves and production worldwide (twice as much as its closest OPEC competitor, Iran) (Dessai 2004).The OPEC population was over half a billion in 2003, most of whom live in Indonesia (the fourth most populous country in the world) and Nigeria. All countries have seen a large increase in their population in the last decade. GDP and GDP per capita vary considerably among OPEC members, from relatively low GDP per capita in Nigeria, Iraq and Indonesia, to the highest GDP per capita worldwide in the small Gulf States (see Appendix 1).

Key issues

The concern of developing countries and OPEC countries about the adverse effects of the impacts both of climate change and of response measures became apparent right at the start of the international climate change negotiations that led to the Climate Change

[2] Previous members of OPEC are Ecuador (1973–1992) and Gabon (1975–1994).

Convention. OPEC interests were secured by representatives of Saudi Arabia and Kuwait who, by taking a tough negotiating position, managed to secure the inclusion of their concerns in both the UNFCCC and later the Kyoto Protocol. The main relevant articles are Article 4.8 of the Convention and Articles 2.3 and 3.14 of the Kyoto Protocol (see Appendix 2).

OPEC secured the inclusion of Article 4.8 and its sub-paragraph (h) in the UNFCCC in exchange for its support for the Convention. This article calls for full consideration to be given to the specific needs and concerns of countries whose economies are highly dependent on income generated from fossil fuels. This highlights the power of OPEC as a negotiating group in the negotiations. Similarly OPEC member states exercised their influence to ensure the inclusion of Articles 2.3 and 3.14 in the Protocol.

The principal difference between Article 4.8 and Articles 2.3 and 3.14 is that the latter specifically call on Annex 1 countries to strive to implement their emission targets in such a way as to minimize adverse social, environmental and economic impacts on developing countries. Annex 1 countries are important for OPEC not only because of the impact of emission reduction commitments on their economies but also because they are the largest consumer of OPEC oil.

Dessai (2004) provides a good summary of OPEC history in the UNFCCC. At the inception of the negotiations, OPEC (led by Saudi Arabia and Kuwait) sought to avoid binding commitments to specific quantitative reductions in carbon emissions by a fixed date. Their approach was to emphasize the scientific uncertainty about climate change and to highlight the flaws in the economic analysis assessing the impacts of climate change measures. OPEC did not accept that binding targets were necessary, even when it became apparent that the commitments made under the UNFCCC were insufficient and that mandatory measures were needed to reduce greenhouse gas emissions. OPEC members also highlighted the uncertainties in the International Panel on Climate Change (IPCC) report to undermine the need for a Protocol with targets.

In the UNFCCC decisions have to be taken by consensus rather than by majority voting. The consensus rule gives power to countries who want to hold back the process by objecting to specific decisions, in effect giving them veto power. OPEC insisted that decisions under the Protocol were to be adopted by consensus as well in order to retain their veto power. This has prevented an agreement on the rules of procedure to this day. OPEC members have used their veto more than once to block the negotiations. In the run-up to the Geneva Ministerial Declaration, however, the overwhelming majority of the Parties agreed that such a small minority should not be allowed to block the decision-making process and a solution was proposed in the adoption of the Declaration by 'consensus minus x'.

After COP-2, OPEC members could be seen to adopt a new strategy to broaden the support of their position within the G77. They suggested that a compensation fund should be established as part of the negotiations to the Kyoto Protocol. The proposal was included in the G77 position in 1997 but never received widespread support. Instead Articles 2.3 and 3.14 of the Protocol were developed.

The main issue of interest to OPEC countries has always been the impact of response measures on the oil-dependent economies. As developed in the Section 3, it is important to account for these concerns and further research is necessary to find ways of

developing a constructive dialogue that takes them into account. Their main concerns are reflected in the OPEC 'narrative' in the UNFCCC negotiations which has been relatively constant over the last few years, as seen in OPEC official statements to the COP (see Table 2.1). The main points made by OPEC include the importance of rising energy demand, the role of oil in meeting these energy needs and the economic impact of the measures to mitigate the effects of climate change under the Kyoto Protocol. Another important recurrent theme for future negotiations is the call to re-structure energy fiscal systems in developed countries.

Box 2.1: Main OPEC narratives

- Commitments would affect developing countries' ability to achieve sustained economic growth, develop social infrastructure and eradicate poverty.
- Petroleum has a big role to play in meeting future energy demand before other forms of energy are fully developed.
- Reserves of oil and gas sufficient to meet rising world demand for decades to come.
- World energy demand will continue to rise for decades to come, access to advance forms of energy services is an essential element in sustainable development.
- OPEC as fossil fuel producers can make important contribution to the course of these [international climate] negotiations.
- Advances in technology are needed, to make oil and gas cleaner fuels.
- Carbon sequestration technology will ensure that fossil fuels, including oil, will continue to serve the needs of mankind for the foreseeable future.
- Reference to Art 4.8 and 4.9 of the UNFCCC, and Art 2.3 and 3.14 of Kyoto Protocol.
- Need to minimize adverse social and economic impacts of their response measures on nations, whose economies are highly dependent on production and export of fossil fuels.
- Need to restructure fiscal systems to address broader concerns than financial needs of governments [argument that benefit from oil goes as much to governments of consuming countries through taxation as to oil-producing countries].
- Impact of implementation of responses measures on economies of oil-producing countries counted in tens of billions of dollars per year.
- Equity issue.

Source: Tatiana Bosteels. Based on OPEC Statement to the Conference of the Parties to the UN Framework Convention on Climate Change (COP10, COP9, COP8).

An important debate in the negotiation relates to funding mechanisms to support developing countries. In addition to core GEF funding, a series of funding mechanisms was agreed at Marrakech in 2001, including the Special Climate Change Fund (SCCF), the Least Developed Countries Fund and the Adaptation Fund (see Appendix 3). The SCCF is of particular importance to OPEC countries. Established in Marrakech under the UNFCCC it aims to assist developing countries by financing activities, programmes and measures that are complementary to those funded by the Climate Change focal area of the GEF. As a result of OPEC influence the terms of reference for the SCCF included activities to assist developing-country Parties diversify their economies.

As part of the SCCF, OPEC countries have secured the inclusion of funding of activities to assist developing-country Parties referred to under Art. 4, para 8(h), in diversifying their economies. Agreement has been reached on the SCCF for i) adaptation and ii) technology transfer and these funds are now operational and contain funding. However, the remaining elements of the SCCF relating to iii) mitigation and iv) economic are outstanding issues.

At the negotiations in June 2004, Parties identified adaptation to adverse effects of climate change as a key priority, as well as technology transfer and capacity-building. At the ninth Conference of the Parties (COP-9) later that year, the inclusion of funding to help Parties diversify their economies was once again put on the table by the G77. They argued that the inclusion of funding for diversification was necessary, otherwise Parties would be backtracking from agreements reached at Marrakech. The EU argued that laws in individual EU countries prohibited them from agreeing to fund economic diversification in oil-exporting countries. This created a deadlock in the negotiations.

The issue of economic diversification has been discussed in subsequent negotiations but no agreement has been reached on this. However, guidance on the adaptation and technology transfer elements of the SCCF has been agreed and these parts of the fund are now operational. Unresolved issues will feature again at the next Conference of Parties in Montreal in November/December 2005.

Approach to the negotiations

Role of OPEC in Group of G77+China

OPEC member states have sought a leadership role within the G77, both through holding the chair of the G77 and by securing OPEC member representatives as chairs of working groups. Since 1998, OPEC member states have chaired the G77 group in five out of seven years: Indonesia in 1998, Nigeria in 2000, Iran in 2001, Venezuela in 2002, Qatar in 2004 (Yamin and Depledge 2004).

The G77 agrees to such leadership partly because of the resources available in OPEC countries. Their comparative considerable wealth means that OPEC countries can absorb the costs associated with chairing of the G77. Moreover, they are well placed to actively participate in the negotiations because they have developed good internal capacity on the issues at stake (Gupta 2001). According to one G77 delegate, large G77 countries have historically not taken the leadership because they are able to influence the debate in their own right and wish to avoid the perception that they are controlling the process (Dessai 2004). This said, China will take up the chairmanship of the G77 in 2006.

Despite the leadership role of OPEC in the G77, Dessai (2004) argues that its approach and positions have not always been in the main interests of the G77. In particular, OPEC member states' concerns have served to slow progress on assistance to developing countries for adaptation to climate change and it has been difficult to reach agreement on the implementation of decision 5/CP7 relating to articles 4.8 and 4.9.

Dessai (2004) provides a list of suggestions from G77 delegates on how to manage OPEC issues, including ensuring strong representation by other groups such as LDCs and AOSIS. Similarly the EU and Umbrella Group countries [3] need to make demonstrable progress on assistance to Article 4.8 (and 4.9) countries.

[3] The 'Umbrella Group' consisted of almost all the industrialized countries outside of the 'enlarged EU', the principal members being the US, Canada, Russia, Ukraine, Australia, Japan and Norway. Switzerland, New Zealand and Iceland joined with South Korea and Mexico to for the 'Environmental Integrity Group'. (See Yamin and Depledge 2004).

The prospect of genuine assistance may catalyze a firmer position from the G77+China on the adverse effects/impacts of response measures issue. An important question in the adaptation debate is funding. Annex 1 Parties to the Convention and the Kyoto Protocol have agreed to a series of funding mechanisms (see Appendix 3). The sums involved are small relative to overseas development assistance (ODA) but can help leverage funding for climate-related activities from bilateral and multilateral funding sources as well as the private sector.

OPEC's approach
As mentioned above, OPEC, as an intergovernmental organization, does not negotiate in the UNFCCC but its member states do. However, the OPEC secretariat does provide logistic support for its member states during the climate negotiations by organizing meetings and preparing documentation and reports prior to the sessions.

OPEC countries' approach to the negotiations has evolved over time and since COP2 they have intervened on an increasing range of subjects beyond those of direct interest to themselves, including policies and measures, adaptation and compliance debates. The effect of this has been to broaden support for their own position among G77 countries.

In analysing the position of OPEC it is important to recognize the strong heterogeneity of the group. One way forward in opening a constructive dialogue would be to focus attention on the issues of importance to key member states (such as Iran, Nigeria and Algeria) that are more likely to be adversely affected by the impacts of climate change than the impact of response measures.

Recent developments

- **Ratification of the Kyoto Protocol.** Since the entry into force of the Kyoto Protocol in February 2005, eight OPEC members have decided to ratify it (see Appendix 3). Such action allows OPEC member states to maintain their role in the negotiations around the Kyoto Protocol. It also allows those interested in the clean development mechanism (CDM) such as Algeria and Nigeria, to gain access to it.
- **Increasing concern over the impacts of adverse effects of climate change among OPEC members.** In the published National Communications, OPEC countries included a first approach to vulnerability assessment on the adverse effects of climate change. Countries such as Indonesia, Iran and Nigeria identified high risks and vulnerability to the impacts of climate change, especially how climate change would exacerbate existing extreme climatic conditions.
- **Growing interest in clean energy technologies** and particularly carbon sequestration and storage within states and national oil companies.
- **High oil prices over recent years relative to the late 1990s** represent a striking development that may influence future negotiation positions, particularly as such prices are expected to be maintained in the near- to medium- term. Higher oil prices affect the impact of climate change response measures in two main ways. On the one hand, higher oil prices will reduce potential negative impacts from reduced oil consumption due to climate change. On the other hand, higher oil prices will allow investments in new and more efficient technologies.
- **Re-organization of the oil and gas markets** is an important change happening in energy markets. This includes on-going market liberalization of energy sectors in

developed and developing countries and the slow opening up of national markets to foreign investors in OPEC countries.

Such changes were reflected in Saudi Arabia's statement for the Seminar of Governmental Experts organized in May 2005 in Bonn (Saudi Arabia 2005). Key points of note include:

- highlighting of issues related to current reviews of fiscal systems in developed countries, including the addition of further taxes and levies on petroleum products;
- widening of concerns about the adverse effects of climate change such as water stress, sea-level rise and loss of arable land, as well as impacts of response measures;
- interest in policies to improve and promote cleaner fossil fuel technology and carbon dioxide capture and storage (CCS). Studies published on the possibilities of carbon dioxide carbon capture and storage make this particular technology attractive in negotiating with OPEC members.

3. Impact of response measures

Introduction

Article 3.14 of the Kyoto Protocol deals with the adverse effects of emission reduction measures on vulnerable developing countries. In the past some OPEC country delegations have used this article to argue that agreement on 'compensation for lost oil revenues' should be a pre-condition for concluding negotiations on implementing the Kyoto Protocol. The Marrakech Accords permit ratification to proceed without agreement on this point. However, Article 3.14 remains and under 3.14 (h) Contracting Parties have an obligation to consider what actions are necessary under the Convention 'to meet the specific needs and concerns of fossil fuel exporting countries'. Box 3.1 gives an overview of these concerns and the responses of Annex 1 countries.

Box 3.1: Oil exporters concerns and Annex 1 responses

The concerns by oil exporting countries are varied:

- Annex 1 countries would reduce oil imports, not domestic production.
- The impact on oil could be stronger if subsidies on domestic fuels, such as renewables, nuclear, coal and peat, are continued.
- Oil exporting economies will suffer from both reduction in demand *and* reduction in price.

Annex 1 Parties have considered the adverse effects of the response measures, with some reluctance because:

- it is difficult to foresee a 'business as usual' oil price. Oil prices are very volatile. One year's worth of oil supplies at US$30 per barrel (rather than, say, US$20 per barrel) could bring the exporters more extra income than they risk losing by the global costs of fighting climate change,
- these articles are really meant for the most vulnerable countries, the least developed countries, those that suffer from drought, low-lying islands, etc,
- they find even reporting on some of these measures difficult. First they have to find effective policies to reduce emissions nationally, and then they have to adjust these policies to reduce their impacts selectively in favour of certain developing countries,
- oil demand will decline when emission reduction measures are taken. But the decline is likely to be much larger in coal and even in gas which are produced in Annex 1 countries,
- oil-producing countries are well positioned to receive CDM projects reducing emissions from oil wells, increase natural gas production, etc.

The section gives a brief overview of old and new projections of the impact and limitations of actions to reduce the threat of climate change on oil and gas markets. Differences in impact depending on the mitigation strategies adopted are also highlighted. This is complemented by discussion of the different level of exposure of different OPEC countries, given their varying levels of dependence on energy exports, and the nature and scale of their reserves. Consideration is also given to the potential interactions with the wider energy markets and energy prices.

Impacts on energy demand

Restrictions on carbon emissions and the trading of allowances and credits effectively put a price on carbon, which increases energy costs for users. While this will reduce the overall demand for fossil fuels, the impact will differ according to the fuel considered because of differences in their carbon content and cross-elasticities between fuels. For

example, electricity produced from gas releases less carbon per kWh produced than oil or coal. Coal has the highest carbon content in relation to useful energy (1.0), then followed by oil (0.8), and then gas (0.6). Thus carbon dioxide emissions trading in Annex 1 countries is anticipated to encourage a switch from coal to gas for power generation.

Examples of economic substitutions include switches:

- between fossil fuels (e.g. switching from coal to gas),
- between fossil fuels and non-fossil fuels (e.g. switching to solar for residential needs); between labour and other factors of production (e.g. increased use of labour instead of machines), and
- between energy-intensive and less energy-intensive products in consumption (e.g. the use of public rather than private transport).

There will also be a variety of spillover effects due to:

- effects of economic substitutions on, for example, price and terms of trade - a negative effect may be that of carbon leakage,
- diffusion of technological innovations induced by action in Annex 1 countries,
- policy and political influence of Annex 1 countries' mitigation efforts on carbon dioxide abatement activities.

Thus, while efforts to reduce greenhouse emissions are expected to reduce projected (but not necessarily absolute) demand for coal and oil, the projected impact on gas demand is less certain (see Section 3). In any case, it is expected that the impact on transport energy demand, mainly oil, will be limited owing to low elasticity.

Model analyses

Some of the early model analyses of the impact of international greenhouse gas reduction measures showed serious impacts on the world economy (especially in the absence of emissions trading) and dramatic drops in energy demand. This would have a very serious impact on the oil-exporting countries, through both reduced volume and repressed prices. For example, Rosendahl (1996) estimated that OPEC's oil wealth would be reduced by 33-42% and non-OPEC oil wealth by 40-54%. However, more recent analyses show much reduced impacts.

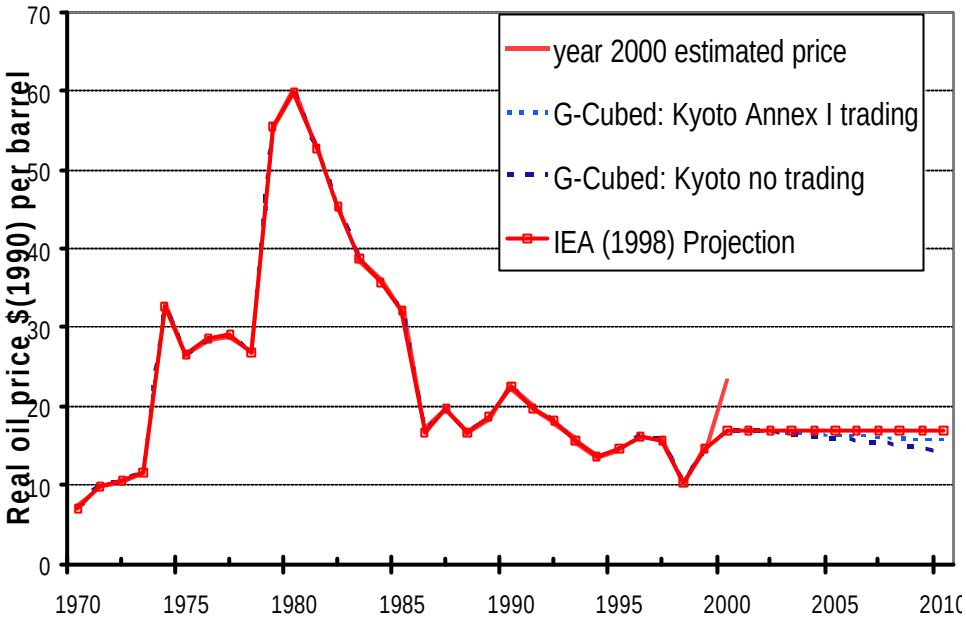
Barker et al. (2001) include a survey of numerous analyses of the potential impacts of measures to mitigate climate change. As with the estimates of the value of carbon prices, a wide range of types of model has been used to make these estimates, including macroeconomic models and specific energy-sector models. Detailed assumptions over, say, the treatment of greenhouse gases other than carbon dioxide, and use of the Kyoto mechanisms, also differ between models.

Oil price

The estimated impact of the Kyoto Protocol on world oil price compared with a 1998 IEA projection of future prices is shown in Figure 3.1. This suggests a modest decline in prices relative to a baseline of less than US$20 per barrel, with fewer losses being associated with emissions trading. The most notable feature is the small level of change relative to the IEA's projection. This is all the more significant since oil prices have risen

to over US$60. This said, although OPEC oil revenues are significantly higher than during the oil price hikes of the late 1970s/early 1980s when inflation adjusted, they remain significantly below their peaks of the 1970s (EIA 2005a).

Figure 3.1: Estimated impact of the Kyoto Protocol on the world oil price



Source: Barker et al. (2001).

The key point is that the impact of implementation of the Kyoto Protocol is likely to be insignificant when seen in relation to the general volatility in the market and current high prices. Other drivers of the oil market are simply much more important in dictating oil prices. To put this into perspective, the production costs of oil itself range from around US$3 to US$10 a barrel – the rest of the price is down to other factors (see Section 6).

Economic cost

The IPCC's Third Assessment Report suggests there may be spillover effects from Annex B actions on non-Annex B countries. Table 3.1 sets out a summary of estimated impacts on oil demand with and without emissions trading. Most studies suggest that the impacts on oil-exporting developing countries of initial commitments under the Kyoto Protocol would be slight - a reduction in GDP of 0.05-0.2% in 2010. However, worst-case assessments suggest as much as a 12% drop in projected revenues with emissions trading and 25% without.

Table 3.1: Economic impacts on oil exporters of implementation of the Kyoto Protocol (with the USA)

Model	No trading	With trading	Source
G-Cubed	-25% oil revenue	-13%	Mckibben et al. (1999)
Green	-3% real income	Much less	Pershing (2000)
GTEM	-0.2% GDP	-0.05%	Polidano et al. (2000)
MS-MRT	-1.4% welfare	-1.15%	Bernstein et al. (1999)
OWEM	-17% OPEC revenues	-10%	Ghanem et al. (1999)
CLIMOX	-10% OPEC revenues and N. Africa oil revenues	Not available	Bartsch and Müller (2000)

Source: Barker et al. (2001).

A key feature of these studies is that all show that emissions trading leads to a lower impact on oil production than if trading is not used. In any case, the modelled impacts are likely to be overstated. As Pershing (2000) notes in his review of other studies, none reflect cost mitigation measures that could be taken to lessen the impact, such as the use of sinks, reductions in other greenhouse gases (GHG) and use of CDM and JI.

Moreover, no account is taken of the fact that OPEC is able to maintain oil prices through control of output of supply and that actions related to technology development and transfer. Also, those OPEC countries that are gas exporters may benefit from fuel substitutions arising from the pricing of carbon - little assessment has been done on the overall impact of actions to mitigate climate change on the balance of trade.

A recent study for Statoil by CICERO assumes US participation, but is based on a more up-to-date assessment of the EU Emissions Trading Scheme (Hagem et al.2004). In this analysis, oil demand falls by 5-7% below projected levels, but oil prices fall by just 2–3%. Strategic behaviour by OPEC producers to minimize overall impact means that they bear the brunt of the falls in output. Other producers reduce output by 1.6–2.1%, and their revenues fall by 3.5–5%. Notably, all these figures represent reductions below projected increases in revenues as opposed to absolute reductions in income. (CEPA 2005).

More recent modelling exercises show the previous ones to be highly pessimistic. Considerable flexibility is allowed under the Kyoto Protocol and sinks and abatement through other greenhouse gases reduce the focus on carbon dioxide – and therefore energy. There is liberal provision for trading of emission allocations and for the use of the Clean Development Mechanism so that the cheapest reductions anywhere in the world will be accessible. In theory, sales of surplus emissions by Russia, Ukraine and other economies in transition (EITs) could account for many of the reductions required in the first commitment period, although it has yet to be seen whether there will be a market for surplus emissions.

Gas

The range of estimates for the impact of the Kyoto Protocol on gas markets is wider than those on oil. In Barker et al. (2001), the models surveyed indicated an impact on energy

demand ranging from –36.4% to +15% relative to BaU. A well-thought-through modelling study by Statoil and SNF projects a slight fall in gas demand of 2–3% with European gas prices falling by 3%, compared to a scenario without Kyoto[4].

The large range in impacts on gas markets reflects uncertainties associated with the extent of fuel switching, future demand and the extent of use of the Kyoto mechanisms. For example, Ferriter (1997) suggest that fuel switching in power generation is likely to increase gas demand while other studies suggest that emissions constraints could reduce gas demand as they may not only reduce electricity usage but also encourage replacement of older generation capacity with non-fossil, including nuclear energy sources (IEA 1998, IWG 1997 and EIA 1998).

Energy-intensive industries
As non-Annex 1 countries with no formal emission reduction commitments under the Kyoto Protocol, OPEC members could benefit from a significant carbon cost advantage over Annex B countries for their energy-intensive products.

Model comparison

Model results such as those described above are notoriously difficult to compare, chiefly because of difference in the inevitable underlying assumptions[5]. Barnett et al. (2004: 2081) gives a list of 13 such assumptions in energy economy models, including:

- the reference or Business as Usual (BaU) scenario of future developments from which the cost of deviations due to the Kyoto Protocol are estimated - the higher the baseline, the greater the estimated cost of reducing emissions,
- assumptions about substitution among fossil fuels, between fossil fuels and non-fossil fuels, between energy and other factors of production, and substitution among products of differing energy intensities,
- assumptions about the international policy regime to be pursued, including the amount of emissions trading, the use of flexibility mechanisms, and the use of sinks of carbon dioxide,
- assumptions about the extent to which energy-intensive industries may relocate. Some of this relocation may favour OPEC economies,
- whether the models account for OPEC's ability to act as a cartel to control the price of oil (few do, as equilibrium models assume perfectly competitive markets) – cartel action by OPEC may counteract possible impacts of response measures on oil revenue,
- whether the model accounts for reductions of other greenhouses gases besides carbon dioxide,
- assumptions about future availability of conventional (cheap to access) oil reserves.

OPEC bases its position in the UNFCCC negotiations on the OPEC World Energy Model (OWEM), as used in the 1999 paper by Ghanem et al. on 'The impact of emissions

[4] Globalization and energy is a joint project between STATOIL and the Foundation for Research in Economics and Business Administration (SNF). The purpose is to present key features of importance for the long-term development in the world economy, and to enable the user to retrieve information that can help in assessing the future market situation in vital markets. Further details at *http://www.snf.no/statoil/global/.*
[5] This sub-section is based on text provided by Benito Müller.

trading on OPEC'. Barnett et al. devote a special section to discussing the OWEM model, but probably the most thorough discussion is to be found in Bartsch and Müller's (2000a) comparison of OWEM with the Oxford Institute for Energy Studies' CLIMOX model. It is worth considering this comparison in some more detail, to appreciate not only the differences between (these two) models, but also the similarities in outcome.

Differences in model type
OWEM is a macro-econometric model and like other econometric models was designed as a short-term forecasting tool. It is therefore sparse in economic feed-back between demand and supply side. CLIMOX, like all other models listed in the table, is a Computable General Equilibrium (CGE) model and addresses supply and demand factors. Energy and non-energy sectors are distinguished in some detail, and international trade is accounted for. However, economic agents are treated as myopic, basing their decisions only on price signals in the current period.

ABARE-GTEM, G-Cubed, and the MS-MRT model, by contrast, all incorporate some form of foresight, where agents maximize discounted utility over the projection horizon. Economic agents are assumed to take the future course of the economy into account in decisions for the current period. The CGE models only consider the real side of the economy, not taking into account inflation and nominal exchange rate changes. G-Cubed is the only example with an adequate modelling of the financial sector. However, CLIMOX is different from most of the other models in that it has an internally determined oil price based on assumptions about future production capacities over the projection period.

Difference in elasticity of demand
Oil demand in OWEM is much more inelastic than in CLIMOX, which gives producers in OWEM much more scope to [assess the] influence on revenues, and the impact of Kyoto on revenues, than the more elastic demand in CLIMOX. Estimates of the price elasticity of demand for oil in the literature vary strongly with the time-frame of the analysis. It is clear that the elasticity is very low in the short term, and increases over time. The OWEM results for 2010 [–0.13] show an average for a period of ten years (2006–15), whereas CLIMOX results [–0.55] are for five years. Adelman discusses the changing price elasticity of demand, and estimates the long-term elasticity as –0.75. The OWEM structure therefore seems better suited to predict short-term behaviour. (Bartsch and Müller 2000).

Methane and consumer taxes
Another significant difference between the two models is that OWEM is focusing only on carbon dioxide emissions, while CLIMOX also includes methane. Indeed, the inclusion of methane, particularly in the energy sector, was partly responsible for some surprising results in Bartsch and Müller (2003a). Coal – in accordance with conventional expectation – is hardest hit under what the authors at the time considered to be the 'most likely Kyoto Scenario' (–4.4 million barrels of oil equivalent/day). It is contrary to expectation that this is followed by gas (–4.0mboe/d), and not by oil, which suffers least (–3.0 mboe/d).

The reason for this, according to the authors, is that economic agents base their decisions on final prices of energy, which are determined by producer prices, transport costs, taxation (consumption taxes and input taxes), and carbon permits. Uniform prices of carbon permits affect the three fuels differently, because (a) initial domestic prices

differ strongly whether we look at prices per unit of energy or prices per unit of carbon; and (b) because of different elasticities of substitution between different fuels in production, and between goods in consumption, and because of different elasticities of demand with respect to consumer incomes. (Bartsch and Müller 2000).

In other words, the difference in domestic prices (mainly due to different consumption tax levels) ensures that adding a uniform carbon levy/price will have very different relative effects on the three fossil fuels. The relative increase in the price of coal is much greater than that of gas which, in turn, is much greater than that of refined oil. Fuel switching will therefore take place not only away from coal, but also away from gas. Owing to the existing taxes on fuels we have a stronger impact of climate change measures on gas and coal than on oil.

Oil also mainly serves the transport sector, often described as a 'captive market' because substitution possibilities away from oil are severely limited. Electricity generation and energy-intensive industries, by contrast, are the major markets for gas and coal, and at least in the latter oil products are competitive. This is another reason, according to Bartsch and Müller, why they would expect a greater impact on gas and coal.

Finally there is the inclusion of methane in the CLIMOX calculations. Because methane emissions from gas production and distribution are large, a significant part of the adverse impact of climate change policies on gas is due to the methane leaks, especially in the EIT region. This again provides a partial explanation of Bartsch and Müller's projected relative impacts of response measures on the different fossil fuels.

Another interesting result from CLIMOX concerns the differentiated impacts of response measures on conventional and non-conventional oil. The authors consider in some detail the effects of a Kyoto-roll-over scenario (Kyoto targets continued beyond the end of the Kyoto commitment period in 2012) on the global and regional production of both conventional and non-conventional oil. CLIMOX projects increasing oil production for both the BaU and this Kyoto scenario, although at a lesser pace in the case of the latter (–3% in 2010), and conventional oil is projected to peak in both scenarios in 2015.

Most of the reduction under the Kyoto scenario comes from non-conventional sources. Indeed, the production of non-conventional oil is delayed by 10 years, only starting in 2015 and cut to half by the end of the projection horizon (2020). The global production of conventional oil reduces only by 1%, which is also the figure for the OPEC conventional production. In short, given the often carbon-intensive production methods of non-conventional oil, a price of carbon differentiates conventional from non-conventional production and increases the competitiveness of the former.

Main similarities

Despite these considerable differences, the OWEM and CLIMOX models do share interesting similarities in some of their results, apart from the projection of loss of revenue due to Kyoto-type Annex B trading scenarios (–9.8% and –10% respectively – see Table 1).

Ghanem et al. (1999) show that OPEC can maintain the projected BaU revenues by reducing production by around 26% below BaU levels, which – in the OWEM model – generated a price of US$22/barrel, as opposed to the OWEM BaU price of

US$19.4/barrel. In the words of Barnett et al., 'by exerting its cartel power OPEC need only influence the future price of oil by some US$3.3/barrel to prevent Kyoto-induced revenue losses' (Barnett et al.2004). This, Bartsch and Müller agree, supports their conclusion that flexibility in production in general, and careful planning of non-conventional oil capacity, are important to reduce the impact of Kyoto [response measures] on oil producers' (Bartsch and Müller 2000).

Differentiating energy interests

A point often sidelined in the negotiations is that the economic impact of climate mitigation measures will vary markedly between countries, depending on, among other things, the level of economic dependence on energy exports, the nature and destination of these exports and the size of reserves. A further important distinction is that in GHG emissions.

Model analysis
Country results from OWEM's Kyoto Annex B trading scenario are shown in Table 3.2. These suggest that:

- Qatar and UAE could potentially be the greatest losers, with losses greater than 3% of GDP per year,
- Saudi Arabia, Iraq (pre-current crisis), Kuwait and Libya would be next worst hit with losses of 2-3% of GDP per year,
- Iran and Nigeria could lose 1–2% of GDP per year,
- Algeria, Indonesia and Venezuela would suffer least, with losses of less than 1% of GDP per year.

These patterns of impact largely reflect levels of oil dependency, and precise figures – as with other model results – should be treated with extreme caution. However, in practice the potential impacts on countries of mitigation actions taken elsewhere vary markedly depending on one's viewpoint.

Table 3.2: Distribution of losses among OPEC countries on the basis of OWEM's Annex B trading scenario

	% of OPEC revenue 1999	Losses in 2000 (billion US$)	Losses in 2000 as % of 1999 GDP	Ranking in terms of losses as % of GDP
Saudi Arabia	28	4	2	5
Iran	11	1.5	0.4	9
Venezuela	10	1.4	0.7	7
Nigeria	9	1.3	1.2	6
Iraq	9	1.3	2.2	4
UAE	9	1.3	3.1	2
Kuwait	7	1	2.2	4
Libya	6	0.9	2.3	3
Algeria	5	0.7	0.5	8
Indonesia	3	0.4	0.07	10
Qatar	3	0.4	3.3	1

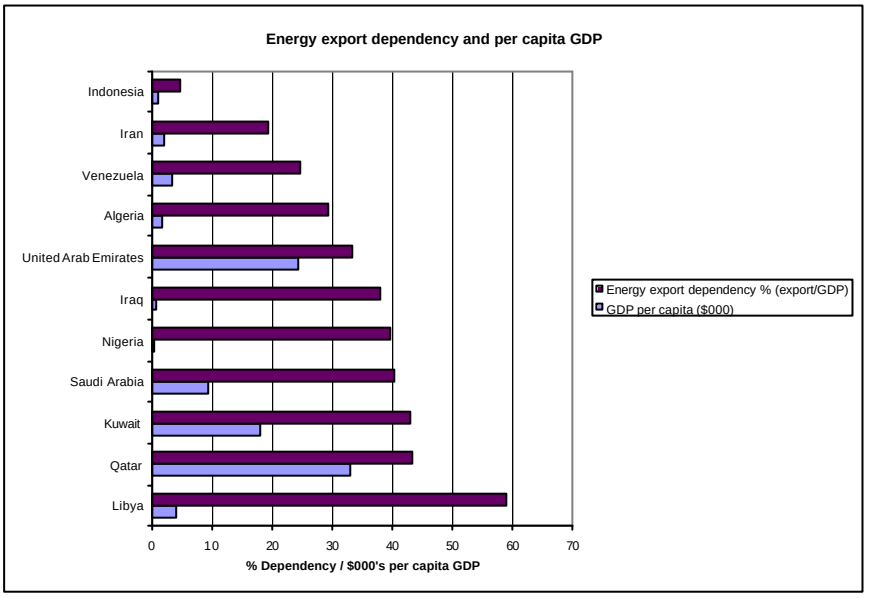
Source: Barnett et al. (2004).

Indicators of vulnerability

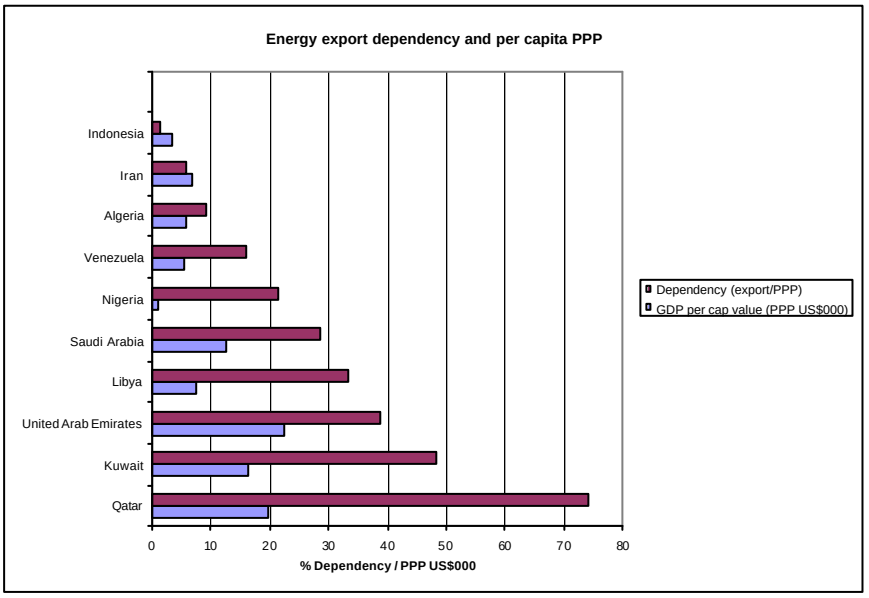
Crude indicators of relative potential impact between countries is given by level of economic dependence on energy exports and relative wealth of different countries. Figure 3.2(a) shows dependence on energy exports and GDP per person. On this basis Libya, Qatar and Kuwait have the highest dependency on energy exports and may be considered the most vulnerable. However both Qatar and Kuwait are relatively wealthy and therefore could be considered less vulnerable than others that are both dependent and less affluent, namely Libya, Nigeria, Iraq, Algeria, Iran and Venezuela.

Figure 3.2: Indicators of exposure to impacts of response measures

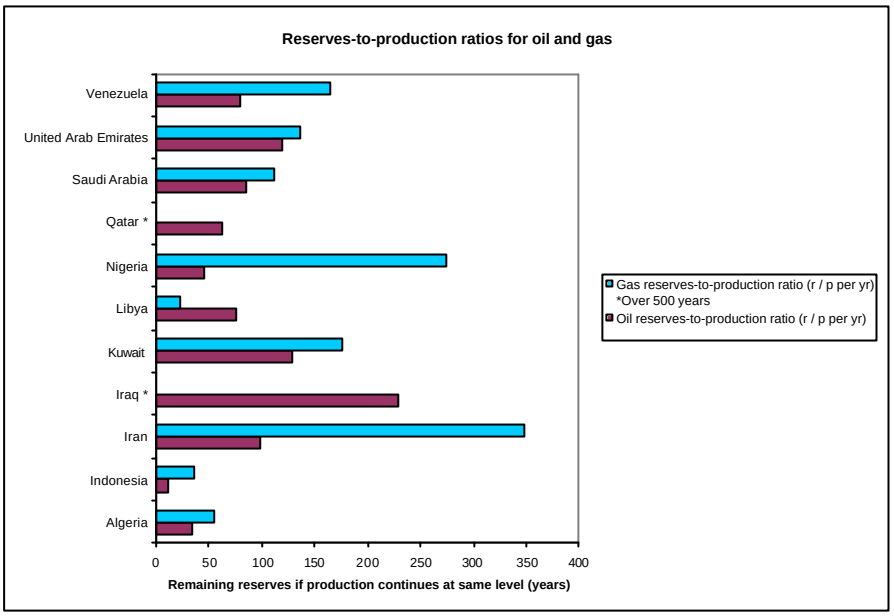
a)



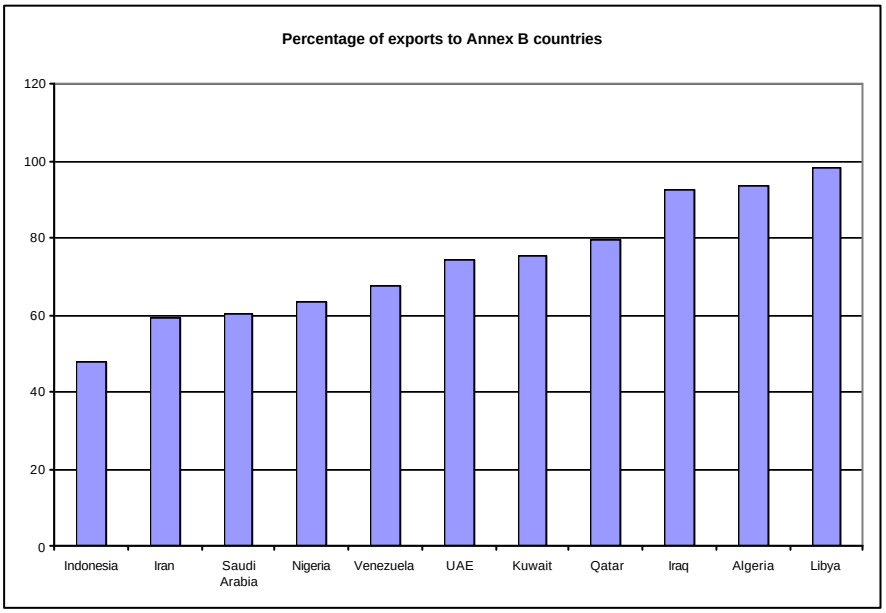
b)



c)



d)



Source: OPEC (2003).

The picture changes slightly if differences in purchasing power are allowed for (Figure 3.2(b)). Under these most countries (except UAE, Kuwait and Qatar) appear relatively more affluent and a number of countries seem less dependent, including Libya, Nigeria, Algeria and Iran.

An important consideration when looking at, in particular, longer-term commitments is the size of the reserves in each country. Figure 3.2(c) gives the reserves-to-production ratios for oil and gas. These show that:

- Algeria, Indonesia and Libya have considerably fewer reserves than other OPEC countries – indeed Indonesia is currently a net importer of oil. These countries arguably have less to gain from a focus on the Saudi/OPEC line on the impact of responses measures in the long-term as they simply will not have the resources to be affected.
- Overall, gas reserves are significantly larger than the remaining oil reserves, and all countries, with the exception of Libya, have larger gas than oil reserves and thus stand to benefit, rather than lose out from policies and measures which are more likely to increase demand for lower-carbon gas seems perverse.

More generally, given the limited nature of reserves and reliance on export incomes, it could be argued that it is in all countries' interests to take mitigation actions themselves in terms of energy efficiency and to develop alternative, renewable sources so as to release energy for export.

Nor are countries equally vulnerable to action from Annex B countries. As Figure 3.2(d) shows, Libya, Algeria and Iraq currently export the greatest percentage (>80%) of their crude oil to Annex B countries, and would therefore be hit the hardest if Annex B countries take action. Qatar, Kuwait and UAE also export a large proportion (>70%) to Annex B countries; however they are more affluent and less vulnerable. Further country detail on mitigation is given in Section 5.

Emissions

A further important differentiation is in GHG emissions. OPEC countries tend to be high emitters of CO_2, but here again there is a strong variation among members. Figure 3.3 shows emissions per capita for 1990 and 2002. This indicates that:

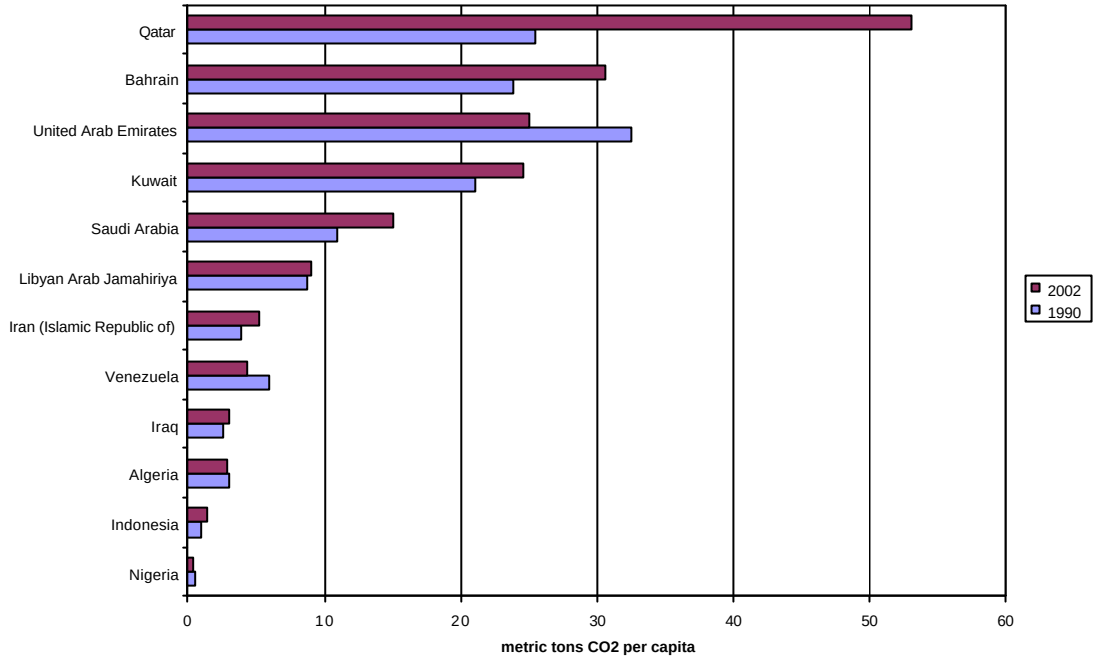
- The Gulf states (Qatar, Bahrain, UAE, Kuwait) and Saudi Arabia have the highest CO2 emissions per capita, emitting over 10 tonnes of CO2 per capita. This in large part owing to energy production and small populations. In all cases, with the exception of UAE, per capita emissions rose steeply from 1990 to 2002.
- Indonesia and Nigeria have very low per capita emissions, reflecting in part their high populations. In these and other countries emitting less below 10 tonnes CO2 per capita, per capita emissions fell or only slightly increased over the period 1990 to 2002.

Analysis of total CO_2 emissions for OPEC countries gives a slightly different picture. Total emissions from all countries rose from 1990 to 2000 (see Figure 3.4). However, again there are pronounced differences between countries.

- Iran, Indonesia, Saudi Arabia have by far the highest total emissions, with emissions of over 250 million tonnes in 2000. In all cases, this was significantly higher than a decade before.

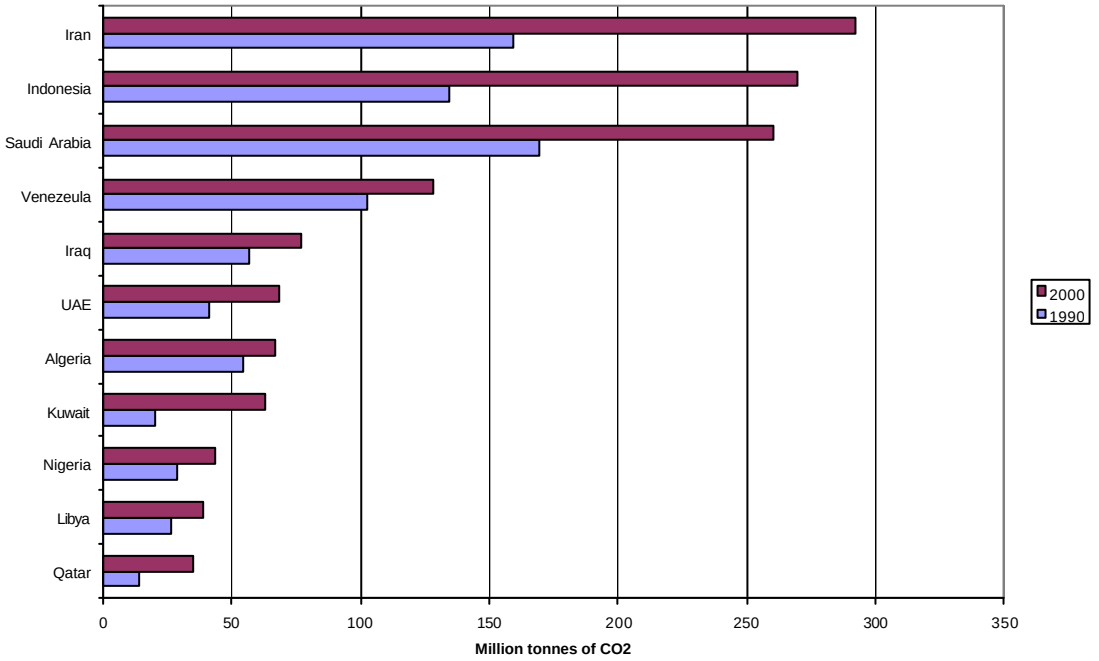
- The lowest emitters in terms of total emissions were Qatar, Libya, Nigeria and Kuwait. However, proportionally, emissions from Qatar and Kuwait rose by at least as much as those from high emitting countries.

Figure 3.3: OPEC per capita CO_2 emissions in 1990 and 2002



Source: UN Statistics Division (2005).

Figure 3.4: CO_2 emissions from fossil fuel combustion in 1990 and 2000



Source: IEA 2002.

Such distinctions are important in terms of negotiations over future commitments as higher emitting countries could come under pressure to contain their own emissions. This said, per capita emissions from even relatively high emitting countries such as Saudi Arabia are below those of the US. Thus it could well feel justified in resisting agreements which it perceives to be against its interests.

Policies and measures to reduce impacts

Under Article 2.3 of the Kyoto Protocol, Annex 1 Parties are urged 'to strive to implement policies and measures ... in such a way as to minimize adverse effects of climate change on ... economic impacts on other Parties' (see Appendix 2).

Current policies in Annex 1 countries are very varied. While economic instruments such as taxes and trading are widely used in the EU, in some other countries technology fixes dominate. Moreover, oil in particular is highly taxed for other reasons in the EU and Japan. This is a long-standing ongoing source of tension between producer and consumer countries as the G8 earns 72% more from these taxes than OPEC earns from its oil deposits. Annex 1 country actions to curb emissions may increase this share. From an OPEC perspective, this could be seen as other nations living off their backs. However, a counter-argument is that OPEC countries are benefiting from a 'free resource' while in the consuming countries the tax is just one way of raising revenue from people to recycle into other areas. A second source of tension is that in many Annex 1 countries, coal use is protected through subsidies. For OPEC countries, oil exports account for between 9% and 40% of their GDP, so price is a major issue.

As indicated in the model analyses above, the way in which Annex 1 countries choose to address their emissions commitments will depend on the approach adopted. In particular it is clear that emissions trading will reduce the economic impact on OPEC countries. Other ways of keeping the costs low are shown in Box 3.2.

Box 3.2: Minimizing adverse economic impacts

- Wide application of all the Kyoto mechanisms (emissions trading, joint implementation and the clean development mechanism).
- Use of other elements of flexibility, including mitigation of non-carbon dioxide gases and sink enhancement.
- Cost-effective policies to remove of subsidies in Annex 1 countries on coal and oil to encourage imports.
- Reductions in oil and gas prices in developing countries such as China to encourage use of these fuels instead of coal.
- Lower cost of conventional oil to discourage the development (largely non-OPEC) of non-conventional energy such as tar sands and shales.
- Green tax reform and technological progress could increase oil demand.
- Technological spillovers to reduce the costs of carbon capture and storage.

Source: Derived from Pershing (2000).

Discussion

This section shows that international action to curb emissions of greenhouse gas can have important effects on energy markets. Model analyses suggest that while the Kyoto Protocol's entry into force could reduce the overall value of energy exports, the effect is

likely to be small given the withdrawal of the US. Model findings also suggest that the impacts of Annex 1 action on developing-country energy exporters can be reduced through emissions trading. As emissions trading is becoming the policy instrument of choice for many Kyoto Annex 1 Parties, it could be argued that they are already meeting at least part of their obligations under the Kyoto Protocol to minimize adverse effects.

Model findings also suggest that how OPEC responds to changes in energy demand and prices will be important in determining the scale of impacts. Most current analyses underplay the role of OPEC countries and treat them as passive or as an unitary actor. In practice, however, their own strategic response will significantly influence the scale of impact on oil prices. Indeed a crucial lesson of recent high oil prices is that key drivers are not simply production costs or the market, but also available production and refining capacity and political security (see Section 4).

In the longer- term, stabilization policies could potentially have a much more significant effect. To date there is little research in this area, although an ongoing French study is addressing the potential effects of its Factor 4 policy on energy markets. Such modelling exercises will be useful in exploring potential impacts under varying scenarios and certainly efforts to represent the markets more realistically would be beneficial. However, as with all model results, findings will need to be treated with caution as they will depend critically on model design and basic assumptions.

In any case, as the above analysis suggests differences in resource base means that different OPEC countries should have diverse interests in the negotiations over future commitments, either because their resources are depleting rapidly, or on the grounds of differences in fuels.

As negotiations start on post-2012 commitments, a longer-term view is needed. Models of the impacts of climate mitigation measures on energy producers generally assume that reserves are not constrained. This is realistic for assessments to 2010 and maybe even to 2020. While the extent of reserves is uncertain and there will undoubtedly be new additions, nobody disputes that oil and gas are finite resources. Indeed, as the above analysis shows, some OPEC countries have very limited supplies – and growing domestic demands.

This raises a serious question over what might be the long-term economic impact of action. An indication of this can be gleaned if the amount of carbon required to reach a stabilization target of 550ppm is compared with the amount of carbon in oil and gas reserves. Reaching this target could require emissions of about five times all the carbon in proven oil and gas reserves – and three times more carbon than exists in all estimated conventional oil and gas resources.[6] Under such circumstances, it cannot be assumed that the interests of OPEC countries today will be the same in 2020 or 2030.

[6] Michael Grubb, internal document. Royal Institute of International Affairs, London.

4. Vulnerability to climate change

Introduction

The UNFCCC requires Parties to give full consideration to actions necessary under the convention to meet the specific needs and concerns of developing countries arising from adverse effects of climate change (UNFCCC, Article 4.8). Funds set up under the Marrakech Accords, the SCCF, LDCF and Adaptation Fund (see Appendix 3) are intended to begin to address this need. A further key issue relates to the transfer of technology (Article 4.9). However, progress in this area has been limited.

On the face of it, as developing countries, OPEC members should have a strong interest in such actions. Five OPEC countries (Algeria, Bahrain, Iran, Indonesia and Nigeria) have published National Communications, which gives a sense of the risks of climate change faced by these countries. These suggest that while the impacts of climate change will vary considerably from one country to another, most will experience an exacerbation of already extreme climatic conditions. This in turn could jeopardize other socio-economic priorities including economic diversification and poverty alleviation. In addition, countries could face spillover effects from impacts on neighbouring countries.

This section gives an overview of vulnerability of four of the largest OPEC countries – Algeria, Iran, Nigeria and Saudi Arabia – to climate change. In doing so, it draws on a range of sources, including National Communications to the UNFCCC, IPCC findings, reports to the Biodiversity Convention and country assessments by the US Energy Information Analysis (EIA).

The approach is necessarily broad-brush owing to limitations in the studies on which it draws. These arise from the high degrees of uncertainty associated with climate models, the complex set of parameters involved, limited data availability and understanding of local socio-economic conditions and poor information on local adaptive capacity. Further research is necessary to increase understanding of the potential impacts of climate change on OPEC countries. Even so, the evidence to date suggests that OPEC member states are vulnerable to climate change and would benefit from greater progress on adaptation issues.

Algeria

Algeria is the second largest African country with an area of about 2.4 million km^2. It has an arid climate: five-sixths of its area is classed as Sahara Desert. With a population of 27 million in 1994 and rapid population growth, the country is a net importer of food and faces chronic water scarcity. As it is, the country's water resource is insufficient to meet the needs of its population, agricultural and industrial sectors.

According to Algeria's Initial National Communication, *République Algérienne Démocratique et Populaire* 2001, and the IPCC (2001), the country's main vulnerability is through water scarcity. At less than $500m^3$ per capita per annum, existing water availability is below the absolute water scarcity level set by the UN (FAO 2003). Socio-economic factors exacerbating the problem include population growth (about 2.1% per year), urban migration and increasing living standards.

Climate change is likely to aggravate existing water problems. Recurring droughts

increase the pressure on water resources with negative impacts on all the country's economic sectors and agriculture in particular. They also bring the risk of increased desertification, soil salinization and concentration of water pollutants. In the Atlas region, rainfall varies considerably but it tends to be characterized by very high-intensity rains, often causing floods and mud slides. These existing patterns could be exacerbated by climate change.

Iran

Iran lies at the heart of western Asia. To the north of the country lie the Caspian Sea, Azerbaijan, Armenia and Turkmenistan, while to the west are Turkey and Iraq. To the south are the Persian Gulf and the Sea of Oman and to the east is Afghanistan. In the last decade, the population has grown rapidly from about 58 million in 1994 to around 72 million today.

Iran could experience a range of impacts from the adverse effects of climate change, from an increase in temperature, impacts on water resources, and a rise in sea level. According to Iran's Initial National Communication to the UNFCCC (Islamic Republic of Iran 2003), the country is particularly vulnerable to the impacts from droughts and water resources on agriculture and forestry.

Iran's vulnerability to climate change derives from its already extreme climate. More than 82% of Iran's territory is located in the arid or semi-arid zones and temperatures range from –20°C to +50°C. Severe drought is already a major problem. In the last three years the country has suffered severe desiccation and this lack of rainfall has resulted in extensive losses. It is estimated that damages amount to 55,873 billion rials (approximately US$7 billion) has been incurred in the water, agriculture and livestock sectors alone. A total of over 4,131 billion rials has been expended to combat the impact of this wide-ranging drought and partially offset its damages (Islamic Republic of Iran 2003).

Climate change is expected to affect existing patterns of drought, making agricultural areas highly vulnerable to climate change. Increases in temperature could lead to spikelet sterility in rice, loss of pollen viability in maize, reversal of vernalization in wheat and reduced bulking of potato tubers in some areas. Of particular significance is that drought and reductions in rainfall are expected to result in sharp reductions in wheat harvests, a staple food in Iran.

Climate change could also have a profound impact on the forestry sector. Low-tolerant species could become extinct, while others may have to move. As the natural regeneration regime of forest plants is upset, this could result in a reduction in both wood and non-wood forest products. Further problems could arise through pests and plant disease infestation and an intensification of land erosion, particularly in arid and semi-arid zones.

Human activities in Iran's coastal areas are also vulnerable to the effects of sea level rise. Data from three sites (Chabahar, Bandar Abbas and Bushehr) in the Persian Gulf and Sea of Oman show sea level to be rising at an average 4.5 mm per year. This is already degrading and destroying some mangrove forests in the area. The north is also home to agricultural production and the south to oil energy industries; both of these could be affected by coastal erosion. Low land such as the Miankaleh Peninsula and

Gorgan Bay could be inundated, Warmer ocean temperatures could cause mass bleaching of the coral reef.

The risk of increased salt-water intrusion into both surface water and groundwater is a particular concern. Sea level rise combined with low river flow are already causing intrusion problems in the Karun River system, which is the main source of drinking water for the population centres of more than one million people.

Nigeria

Nigeria, with a total area of 923,800 km^2, occupies about 14% of the land area in West Africa. The country is very densely populated (the total is estimated at about 120 million). In some parts of the eastern states, the population density exceeds 1,000 persons per km^2. Other areas with very high population densities include the western cocoa belt, the Lagos metropolitan area, and the Kano and Sokoto regions of the north. The main predicted climate change in Nigeria is one of warming, but no specific predictions have been made. In areas of higher rainfall, greater soil erosion and flooding are anticipated, while in northern regions drought and desertification risks could be heightened. Salt-water intrusion would be a problem along the coastal belt.

Nigeria's Initial National Communication (Federal Republic of Nigeria 2003) identifies the country's agriculture, livestock and fisheries sectors as particularly vulnerable to climate change. Boundaries of major ecological zones are expected to shift as the world warms, with alterations in the composition of flora and fauna and a consequent reduction in products from some zones. Agriculture is predominantly rain-fed and is, therefore, potentially vulnerable to climate change. Similarly, livestock production is heavily dependent on rainfall and thus also susceptible to climate change. Fisheries can be damaged by rising marine and freshwater temperatures and also, in the case of inland fisheries in rivers, lakes and aqua cultural installations, by salt-water intrusion.

As in the case of Algeria and Iran, the country's water resources are also viewed as vulnerable. With internal renewable water resources below 2,000 m^3 per capita per annum (FAO 2003), the country is not among the most water scarce: however, demand already outstrips supply.

Nigeria is at risk from sea level rise. The high proportion of population concentrated in coastal areas makes cities such as Lagos especially vulnerable (IPCC 2001). Similarly, the petrochemical industry is threatened by the expected sea level rise as it is concentrated in vulnerable coastal areas, as are the other numerous industries clustered around Nigeria's seaports. The energy sector is also vulnerable to the risks of reduced availability of hydroelectricity and fuel-wood as a result of climate change.

Certain health risks might increase with climate change. The country is located within the African 'meningitis belt'. This area experiences major epidemics of meningococcal infections every 5–10 years or so, usually starting in the middle of the dry season and ending a few months later with the onset of the rains (IPCC 2001). Between February and April 1996 the disease affected thousands of people in parts of northern Nigeria, many of whom died. While the IPCC has not found a clear link between climate and meningitis in the Gulf of Guinea, the fact that the disease is limited to semi-arid areas of Africa suggests that its transmission could be affected by warming and reduced precipitation.

Nigeria (Federal Republic of Nigeria 2003) has identified a series of potential adaptation measures, including:

- diversification and intensification of resource use in the agricultural sector,
- vigorous and extensive tree planting and greater development and use of solar energy to offset losses in other fuel sources,
- relocation of existing power generation, transmission facilities and industrial sites to safer sites and siting new developments in more secure locations.

Saudi Arabia

The Kingdom of Saudi Arabia occupies four-fifths of the Arabian Peninsula and is the tenth largest country in the world by area. It is bordered by Jordan in the north and Yemen in the south, while the Red Sea lies to the west and the Arabian Gulf to the east. The population is increasing at around 2.3% per year and is now around 26 million, of which over 20% are foreign nationals.

There is no detailed study on the vulnerability of Saudi Arabia to climate change. However, a report by the Saudi Environmental Protection Agency indicated that global warming would adversely affect Saudi Arabia's weather and that climate change is already having an effect on the country (EIA 2002a).[7] This report anticipates that over the next three decades climate change will cause more severe heat waves during the kingdom's summer, as well as more extreme weather conditions in the Persian Gulf and on the Red Sea coast.

An impression of Saudi Arabia's vulnerability to climate change can be gleaned from its existing climatic and geographical characteristics. It is generally an arid country with a few exceptional sub-humid regions on the south-western escarpments. Temperatures are subject to considerable diurnal and seasonal fluctuations. While winters are cool to warm, summer temperatures may approach 50º C. Humidity is generally low, except along the coasts. In most areas the precipitation is highly variable and unpredictable, but is augmented along the south-western escarpment by the high altitude and proximity to the Red Sea.

An IPCC regional study of the Middle East and Gulf Coast indicates that existing vulnerabilities, such as water scarcity, could be exacerbated by climate change (IPCC 1997). Water shortages in conjunction with land degradation problems already restrict agricultural productivity and threaten food security in the region. Desert rangeland, which includes dwarf-shrub steppes and arid grasslands, cover about 76% of Saudi Arabia's land area. The state of this land, together with agricultural practices, are particularly important to Saudi Arabia as not only does agriculture account for 7% of GDP but it is also a major importer (about US$3.1 billion) of agricultural products.[8] According to the first report of Saudi Arabia to the UN Biodiversity Convention (Abdulaziz H. Abuzinada,

[7] Meteorology and Environmental Protection Administration (MEPA) is the central agency for environment in the Kingdom of Saudi Arabia which is part of the Ministry of Defence and Aviation. MEPA was established in 1980 from the Directorate of Meteorology by adding environmental responsibilities to its functions. Reported in: EIA (2002): Saudi Arabia: Environmental Issues, November 2002.

[8] The government currently supports all kinds of agricultural activities and as a result, wheat production has increased from 142,000 tons in 1980 to 4 million tons in 1992 and vegetable and fruit production have also increased significantly.

no date), a key threat to Saudi Arabian agriculture is prolonged drought, and some have speculated that climate change may well increase the duration of drought conditions. Changes in cropping practices and improved irrigation practices could significantly improve the efficiency of water use.

Salt-water intrusion associated with sea level rise could aggravate existing problems resulting from the use of saline water for cultivation. Many boreholes already produce highly saline water and its application changes soil structure and chemistry. Other threats include uncontrolled grazing and the growth in herd sizes following the increased wealth in the country, excessive harvest of woody shrubs for firewood, and conversion of some rangelands to more intensive agriculture (Abdulaziz H. Abuzinada, no date).

Saudi Arabia's long coastal line and the location of its industrial development mean it is vulnerable to sea level rise. To the west the Gulf coast is relatively low-lying with extensive sandy beaches and flats. Not only are major oil fields located on the west coast but in recent years development activities have increased markedly. While most of this development is related to the petroleum industry, significant growth has occurred in basic industry and in commercial, residential and transport facilities. Desalination plants are also located close to coastal areas. Neighbouring Oman and the UAE are also reporting ground-water quality problems owing to salt-water intrusion into freshwater aquifers.

A climate impact study carried out by nearby Bahrain gives some indication of the scale of the threat facing Saudi Arabia (King of Bahrain 2005). This suggests that even with small changes in sea level Bahrain could face inundation of coastal areas with a variety of adverse impacts on population settlements, aquatic resources, crop productivity, coastal erosion and biological diversity. Similar threats could affect the Saudi Arabian Gulf coast. That said, the IPCC suggests that future pressures on the Gulf coast are likely to primarily derive from ongoing developments rather than specifically from climate change. Part of the north-western part of the Gulf of Oman currently under high potential threat from development (IPCC 1997). This development includes large cities (>100,000 people), major ports, roads, and pipelines - all of which contribute to pollution in coastal areas.

The Regional Organization for the Protection of the Marine Environment[9] warns that climate change could affect fisheries. Indeed, it suggests that a die-off of fish in September 1999 in the northern Gulf was due to high salt levels and water temperatures compounded by indiscriminate dumping of wastewater in the region by oil companies and unchecked oil seepage. Measures are being taken to reduce water industrial pollution but global warming could still affect fisheries in the gulf. As in the case of Iran, higher water temperatures could result in bleaching of the coral reefs in the area.

Discussion

In the past a focus on the impacts of response measures resulted in less progress being made on the issues of vulnerability and adaptation. However, emerging data on the vulnerability of some OPEC countries shows that these countries would benefit from greater attention to these issues. However, addressing these interests will require a more sophisticated approach to the issue, including the following.

[9] A leading Arab environmental organization.

Mainstreaming into development planning
It is widely accepted that adaptation should be mainstreamed into development plans both of the countries concerned and of international agencies. As the above analysis indicates, for most of the OPEC countries analysed the principal vulnerabilities are not associated with climate change but with rapid development, and with increasing population and related socio-economic pressures. Moreover, a general overview shows that most OPEC countries are characterized by an existing extreme climatic situation that could be exacerbated by climate change.

Thus there is a need for impacts to be viewed in the context of wider physical and economic development, and for climatic considerations to be mainstreamed into development plans and those of related international agencies.

More sophisticated analysis
Analyses to- date tends to be vague and to focus on 'first-order' (physical or direct) impacts. In practice the impacts will be far more diverse and profound as they cascade through the socio-economic system. In some cases, they will magnify adverse effects; in others, societal responses will work to reduce them. In particular there is a need to:

- develop techniques to explore the wider ramifications of climate change, perhaps through participatory methods or scenario-building,
- develop a more sophisticated understanding of the drivers of vulnerability to climate change and its impacts - and thus the best ways of minimizing adverse impacts, and
- improve communication of the implications in terms of more immediate social, economic and political priorities.

More attention on socio-economic impacts
A key limitation is that impacts are rarely described in terms of wider social-economic priorities, for example, the knock-on effects on people's livelihoods. Most governments prioritize economic growth. However:

- substantial energy, industry and transportation infrastructure is located in coastal zones and vulnerable to sea level rise,
- some OPEC countries are heavily dependent on non-energy sectors such as agriculture where significant impacts may be felt, e.g. agriculture accounted for more than 20% of GDP in Indonesia, Iran and Nigeria in 1999 (Barnett 2001),
- Gulf states (e.g. Kuwait and the UAE) are particularly vulnerable to risks to their substantial non-oil investments overseas from climate change impacts,
- climate change could also jeopardize attempts to diversify the economy of OPEC countries.10

[10] For example, climate change could indirectly affect the manufacturing industry could be affected indirectly through the availability of water, energy supply, and transportation systems throughout Asia. Similarly, erosion arising from mining could be aggravated by global warming and agro-industries such as food, beverages, tobacco, natural fibre textiles, leather, wood, and rubber could be affected. The heavy concentration of settlements along sea coast means increase risks of sea level rise are likely to exacerbate management problems relating to pollution, sanitation, waste disposal, water supply, public health, infrastructure, and technologies of production (IPCC 1996)., indirectly affecting economic growth.

Spill-over effects

While the most prominent risks and vulnerability are associated with water resources and impacts of water scarcity on the economy, important spillover effects from one country onto another also tend to be ignored. One example o(see Appendix 3f such effects is the potential implications for Saudi Arabia of climate change impacts in neighbouring countries such as Yemen, Ethiopia, Eritrea and Somalia. While Saudi Arabia currently accepts large numbers of workers from these countries, adverse impacts of climate change could present it with a major immigration challenge (see Box 4.1).

Box 4.1: Yemen and climate change - an immigration challenge for Saudi Arabia?

Yemen is one of the poorest countries in the Arab world and is heavily dependent on agriculture. It is also particularly vulnerable to climate change and, according to a 1999 study, climate change could exacerbate existing water problem in the region (Alderwish, Ahmad and Al-Eryani 1999).

This vulnerability is evident from over-exploitation of groundwater resources and the high variability of the surface water system, which is leading to grave problems of depletion and rising water cost. Add to this the mounting pressure of population growth, agricultural expansion, and industrial growth and desertification and the study concludes that not only could existing conflicts over water become worse, but others are expected to emerge.

As a result, it seems plausible that immigration pressures (legal and illegal) on Saudi Arabia could increase. Given Saudi Arabia's own problems in creating work for its indigenous labour force, this extra pressure could, in turn, lead to tensions within Saudi Arabia.

Currently, there is no way of readily analysing such effects quantifiably. Yet by not addressing them there is both a risk of understating the risks of climate change, and also in overstating them because the dynamic of adaptation is not allowed for. In any case, the superficiality of current analyses makes it hard for countries to derive significant benefit from discussions on adaptation.

Drivers of vulnerability

For people faced with flooding and other disasters, their prime concern is generally dealing with the problem, not what caused the problem. However, cause or responsibility is an important issue both in addressing adverse impacts. While it is widely acknowledged that impacts play on existing vulnerabilities ('the poor will suffer most'), the relative importance of the different drivers, such as climate, poor governance and trade restrictions, is poorly understood.

There are some cases where climate variations have clearly been identified as the primary driver, such as in the 1970s Sahel droughts. But people starved for other reasons too including the effect of underhand grain dealings between the US and the USSR which forced world grain prices out of their reach (Garcia 1982). Similarly, today it is acknowledged that trade barriers contribute to poverty in many developing countries – and thus implicitly to the vulnerability of people to climate change. Yet such wider issues are rarely given consideration within the climate change context.

Scale of assessment

OPEC member states differ fundamentally in terms of geographical location and characteristics. Thus it would be more relevant to assess vulnerability at a regional level rather than for OPEC countries as a group. Vulnerability assessment at a regional level could be triggered by regional partnerships. This was successfully achieved for the

Arctic area and there is no reason why a similar study could not be undertaken for Arab Peninsula states, North Africa or Latin America.

5. Energy and mitigation activities

Introduction

While the high level of dependency on energy exports presents an obstacle to progress in the climate negotiations, developments in some countries provide potential opportunities to further engage with countries on the climate change, energy and sustainable development agenda. This section gives an overview of the role of energy in the economy of individual OPEC states, and of mitigation activities and possible options. The assessment draws on a range of sources, including National Communications, EIA country studies (EIA 2005b, 2005c, 2005d, 2005e) and the World Bank's *Global Gas Flaring Initiative Status Report* (GGFR 2005).

Algeria

Energy and economy
Algeria is an important source of oil and has an estimated 11.8 billion barrels of proven oil reserves. Given recent oil discoveries and plans for more exploration drilling, proven oil reserve estimates could climb in coming years. Algeria is also a major natural gas exporter, mostly to Europe and the United States. It is rich in natural gas and as of 2005 had 160 trillion cubic feet (tcf) of proven natural gas reserves, the eighth largest in the world, but it is estimated that its recoverable natural gas potential could be as high as 282 tcf. Most of the country's natural gas reserves are occur alongside crude oil reserves.

Fossil fuel exports are critical to the Algerian economy, accounting for 90% of its exports and generating the majority of its foreign currency revenues. On the other hand, the country is food dependent and its main imports are food products, mainly cereals from the US, Canada, the EU and South America.

Mitigation
Algeria's gas production is expected to increase significantly. The aim is for natural gas to substitute for oil in domestic energy consumption. This substitution is likely to reduce domestic emissions relative to what they would otherwise have been and could lead to a sharp increase in crude oil exports over the next few years.

Algeria also owns two of the main gas pipelines to Europe: the GME (Gazoduc-Maghreb-Europe), with a capacity of 12 Gm^3 per year, to be increased to 25 Gm^3 per year, and the Trans-Med (Gazoduc Trans-Méditerranée), with a capacity of 25 Gm^3 per year. Algerian gas production is secured by four LNG plants together producing 25 Gm^3 per annum intended for the EU and US market. New pipelines are under construction. In July 2001, a consortium led by Spain's Cepsa (20%) and Algeria's Sonatrach (20%) agreed to build a new natural gas pipeline – Medgaz - linking Algeria and Europe.

In 2002, Sonatrach signed a deal with Italy's Enel and Germany's Wintershall to form Galsi, a consortium to build another natural gas pipeline from Algeria to Italy. Finally, Sonatrach and NNPC, the Nigerian state oil company, formed the Trans-Saharan Natural Gas Consortium (NIGEL) in 2002. The NIGEL consortium aims to construct a 4,550-mile natural gas pipeline from Warri, Nigeria to Hassi R'Mel, via Niger.

Gas flaring is a major contributor to GHG emissions in Algeria which has identified three gas flaring emission reduction projects in collaboration with the World Bank Global Gas Flaring Reduction Partnership (GGFR 2005). Options to reduce flaring include Ohanet, Tin Fouye Tabankort (TFT) and In Amenas, with a combined flared gas volume of 1.3 bcm.

The country is also positioning itself to develop CDM projects. A CDM Designated National Authority (DNA) was been established in 2003 and a number of potential projects are being developed. The Ohanet Project Idea Note (PIN) is likely to be included in the tender documentation, so that the prospective developer of the joint Tinhert/Ohanet fields may consider the CDM option. In addition, a CDM strategic framework for Sonatrach is being developed (GGFR 2005).

Algeria's National Communication identifies technology transfer as fundamental to improve industrial and energy infrastructure and to develop new and renewable energy technologies.

Iran

Energy and economy
Iran is OPEC's second largest oil producer and holds 10% of the worlds proven oil reserves. It also has the world's second largest natural gas reserves after Russia (EIA 2005ed). Iran's economy relies heavily on oil export revenues – around 80–90% of total export earnings and 40–50% of the government budget. Strong oil prices for the past few years have helped Iran's economic situation. Despite higher oil revenues, Iranian budget deficits remain a chronic problem, in part owing to large-scale state subsidies on foodstuffs, gasoline etc. Expenditure on fuels was estimated at US$4.7 billion in 2004, and the country's parliament (the Majlis) has rejected measures to raise consumer prices. Indeed, in January 2005 the Majlis decided to freeze domestic prices for gasoline and other fuels at 2003 levels. Currently, gasoline costs less than 40 cents per gallon in Iran, far below market cost. (EIA, 2005c).

Iran is attempting to diversify by investing some of its oil revenues in other areas, including petrochemicals. In 2004, non-oil exports rose by 9%. Iran also is hoping to attract billions of dollars' worth of foreign investment to the country by creating a more favourable investment climate (i.e., reduced restrictions and duties on imports, and the creation of free-trade zones). In May 2002, the country's Expediency Council approved the Law on the Attraction and Protection of Foreign Investment, which aims at encouraging foreign investment by streamlining procedures, guaranteeing profit repatriation and more. This law, which was sent to the government for implementation in January 2003, represents the first foreign investment act passed by Iran's legislature since the 1978/79 revolution. The legislation had been delayed for several years owing to disagreements between reformers and conservatives.

Mitigation
Mitigation measures have been identified in Iran's National Communication for both the energy and non-energy sectors (Islamic Republic of Iran 2003). They include options for enhancing energy efficiency such as increasing the share of the combined cycle power generation in power plants, defining better standards for energy consumption in domestic and commercial buildings, mandating the use of energy labels for domestic manufacturing of home appliances and improving vehicle technology. The study

estimates that by rational use of energy, accompanied with changes in the fuel mix, the average annual growth rate of carbon dioxide emission could be reduced from 4.2% to 2.4% in the period 1999–2021. However, no clear programme to implement these measures could be identified.

Iran holds the second largest gas reserves in the world and sees fuel switching to gas as an important mitigation measure which could lead to reduction of carbon dioxide emission from power plants by 7.2% within five years. Increasing the share of natural gas and LNG in the fuel mix consumed by petroleum refineries, in residential and commercial buildings and in the transportation sector through conversion of public vehicle fuels to compressed natural gas (CNG) are the most important policy recommendations.

Currently, natural gas accounts for nearly half of Iran's total energy consumption, and the government plans billions of dollars worth of further investment in coming years to increase this share. While this might be expected to reduce domestic emissions, the price of natural gas to consumers is state-controlled at extremely low prices and this encourages consumption (EIA 2005ed). Iran has also reached agreements to export natural gas to Turkey, China and India. In January 2002, Iran and Turkey officially inaugurated a much-delayed natural gas pipeline link between the two countries. Iran is developing LNG export facilities for export to the Chinese and Indian markets.

Flaring represents a large part of Iran's emissions, and thus gas recovery for oil well injection purposes and the development of gas-to-liquid (GTL) technologies are being considered (EIA 2005ed). The Iranian government is also taking positive steps towards the development of renewable energy sources including solar, wind, geothermal, wave and tidal energy and hydropower. Hydrogen and nuclear energy are also being considered. All categories have high potential for practical exploitation in Iran.

Nigeria

Energy and economy
Nigeria is well endowed with energy resources, the main ones being petroleum, natural gas, coal, tar sand, and biomass. It is the largest oil producer in Africa and the eleventh largest in the world, averaging 2.5 million barrels per day in 2004 (EIA 2005e). Petroleum dominates the economy and contributes over 80% of the foreign exchange. Nigeria also has large gas reserves. It has an estimated 176 tcf of proven natural gas reserves, giving it one of the top ten natural gas endowments in the world and the largest endowment in Africa.[11] However, despite its dependency on oil exports, agriculture is one of the principal sectors of the Nigerian economy, employing about 60% of the labour force. More than 90% of agricultural production comes from rural-based, small-scale farmers. While root crops dominate in the south, grains prevail in the north which also has the main livestock population (Nigeria National Communication 2003).

Mitigation
Nigeria consumes a considerable amount of LNG, motor spirits, kerosene, diesel oil, fuel oil and gas oil, all of which contribute significantly to environmental problems in general. The most significant energy consumption processes leading to GHG emissions are gas flaring (30% of CO_2 emissions), transportation and electricity generation. The country's

[11] *Oil and Gas Journal,* 1 January 2005.

National Communication recognizes that Nigeria's dense and increasing population makes it a comparatively high potential contributor to global warming.

Nigeria is expanding its gas production and suggested in October 2004 that reserves could be as high as 660 tcf. The government plans to raise earnings from natural gas exports to 50% of oil revenues by 2010 (EIA 2005e). Nigeria's most ambitious natural gas project, the US$3.8 billion LNG facility on Bonny Island, was completed in September 1999. The facility processes 397 billion cubic feet (bcf) of LNG annually and has three trains. Two further trains are under construction and expected to start up by mid-2005. Plans for a sixth train have been approved. This is expected to add 194.8 bcf to the plant's capacity, bringing the total to 1.1 tcf per year and could be operational by 2007. The facility is currently supplied from dedicated natural gas fields, but within a few years it is anticipated that half of the input will consist of (currently flared) natural gas from Akri/Oguta, Otumara, Utapate and offshore blocks (EIA 2005e).

Several distribution schemes are planned to help promote domestic consumption of natural gas. The proposed US$580 million Ajaokuta-Abuja-Kaduna pipeline will supply natural gas to central and northern Nigeria, while the proposed Aba-Enugu-Gboko pipeline will deliver natural gas to portions of eastern Nigeria. The Soku Gas Transmission pipeline, scheduled for completion in late 2005, will transport natural gas from Shell's Soku plant to the Bonny Island NLNG plant (EIA 2005e).

Gas distribution infrastructure is also being developed. For example, in November 2004, the World Bank approved a US$125 million investment guarantee for construction of the West African Gas Pipeline (WAGP), which will deliver 140 mmcff/d of natural gas to power stations in Ghana, beginning in December 2006. Nigeria and Algeria are also discussing the possibility of constructing a Trans-Saharan Gas Pipeline (TSGP). The 2,500-mile pipeline would carry natural gas from oil fields in Nigeria's Delta region via Niger to Algeria's Beni Saf export terminal on the Mediterranean (EIA 2005e).

Here to, the most significant contributor to carbon dioxide emissions is gas flaring, representing about 30% of carbon dioxide emissions. Nigeria has set an ambitious national target of zero flaring by 2008. It is supported in its effort by the WB GGFR. Collaboration is to focus on the areas of domestic gas sector policy; integration of operator plans; gas-to-power sector reform and implementation of the gas-to-power franchisee model; financing of common infrastructure projects; small-scale gas utilization and use of the CDM to obtain carbon credits for flare reduction projects. The World Bank has also approved a credit for the Nigerian government's National Energy Development Project which supports efforts to reform the energy sector and effect a smooth transition to the new market and institutional structure. It also facilitates preparatory work required to launch the main domestic transmission gas pipeline from the south of the country to the north and related gas- to- power. A pilot study for a gas flaring reduction has also been selected (GGFR 2005).

Nigeria's National Communication also identifies a massive potential for renewable energy: solar, hydropower, biomass and wind. However, no specific programmes are in place to develop these technologies.

Saudi Arabia

Energy and economy
Saudi Arabia is the largest oil producer in the world, and with a quarter of the world's proven oil reserves and some of the lowest production costs, it is likely to remain the world's largest net oil exporter for the foreseeable future. Oil export revenues make up around 90-95% of total Saudi export earnings, 70-80% of state revenues, and around 40% of the country's GDP (EIA 2005b). Despite all attempts at diversification, Saudi Arabia's economy remains heavily dependent on oil (although investments in petrochemicals have increased the relative importance of the downstream petroleum sector in recent years).

Saudi Arabia's proven natural gas reserves are estimated at 235.0 tcf, ranking fourth in the world (after Russia, Iran, and Qatar), and up about 5 tcf from 2002.[12] Most (around 60%) of Saudi Arabia's currently proven natural gas reserves consist of associated gas, mainly from the onshore Ghawar field and the offshore Safaniya and Zuluf fields. The Ghawar oil field alone accounts for a third of the country's proven natural gas reserves. However, it is important to note that only 15% of Saudi Arabia has been 'adequately explored for gas', according to Aramco.[13]

Mitigation
Some limited mitigation action can be identified in Saudi Arabia but it lacks a strong economic incentive to pursue the development of renewable energy sources. Consequently, it consumes almost no renewable energy (less than 0.1% of total energy consumption). However, one renewable energy source with abundant potential is solar power. Saudi Arabia has contributed to solar energy research and developed a number of solar-power projects, including desalination plants and green-house air-conditioning systems using solar energy. In addition, in May 1999 Saudi scientists and engineers completed the design of a solar-powered car, the first to be developed locally (EIA 2005b).

Saudi Arabia is also looking at expanding its gas developments and market, partly driven by increasing domestic demand. This is particularly important as prior to the extension of a key pipeline development, the MGS pipeline, Saudi Arabia used to flare 90% of its associated gas. Completed in June 2000, the project extended the MGS from the Eastern Province (which contains large potential gas and condensate reserves) to the capital, Riyadh, in the Central Province. This is part of a broader expansion of the existing gas transmission system in Saudi Arabia, reportedly to include the construction of around 1,200 miles of additional natural gas pipeline capacity by 2006 (on top of the 10,500 miles of oil, gas, condensate and LNG pipelines currently in operation). The MGS feeds gas to the industrial cities of Yanbu on the Red Sea and Jubail, which together account for 10% of the world's petrochemical production (EIA 2005b).

The largest Saudi natural gas project in more than ten years and the first to process only non-associated gas (from the deep Khuff and Jauf reservoirs), the non-associated gas processing plant at Hawiyah was completed in October 2002 ($4 billion 1.4 bcf/day). Located south of Dhahran and east of Riyadh, near the giant Ghawar oil field, Hawiyah

[12] *Oil and Gas Journal,* 1 January 2005.
[13] Oil firm Saudi Aramco is a State corporations which has a monopoly on Saudi upstream oil development, workforce of 54,000, and controls 98 % of the country's oil reserves.

was officially inaugurated in October 2002, and is reportedly producing enough natural gas to free up around 260,000 bbl/d of Arabian Light crude oil for export (EIA 2005b).

UAE and the Gulf states

Energy and economy
The UAE is important to world energy markets because it is estimated to contain 98 billion barrels, or nearly 10%, of the world's proven oil reserves. In addition, it also holds the world's fifth largest natural gas reserves, and exports significant amounts of LNG. The overall performance of the UAE's economy is heavily dependent on oil exports, which account for over 30% of total GDP. Growth in real GDP was 6.4% in 2004, partially owing to higher crude oil prices. Real GDP growth in 2005 is projected to reach 6.5%. The non-oil segment of the UAE's economy is also experiencing strong growth, particularly the petrochemicals and financial services sectors.

Mitigation
Mitigation options through gas switching and the development of renewable energy generation seem to be emerging in neighbouring Gulf states. Two examples are the UEA and Bahrain. In recent years, the UAE has undertaken several projects to diversify its economy and to reduce its dependence on oil and natural gas revenues. The non-oil sectors of the UAE's economy currently contribute around 70% of its total GDP, and about 30% of its total exports. The federal government has invested heavily in sectors such as aluminum production, tourism, aviation, re-export commerce and telecommunications. Dubai has become a key Middle East hub for trade and finance, accounting for about 85% of the Emirates' re-export trade.

The past few years have seen the UAE embark on a massive, multi-billion dollar programme of investment in its natural gas sector including a shift towards natural gas-fired power plants and the transformation of the Taweelah commercial district into a natural gas-based industrial zone. An ambitious plan, the Dolphin Project, to interconnect the natural gas grids of Qatar, the UAE, and Oman, is also under way. Most of the UAE's increased natural gas needs in the next decade are to be satisfied with imported natural gas from Qatar. Much of the natural gas development in the UAE itself involves the extraction of natural gas liquids (NGLs) and reinjection of the gas to maintain pressure in oil fields. (EIA 2005f).

The Gulf states have also already started to plan, develop and use alternatives to fossil fuels such as wind, solar and bio-energy. The UAE has started to look into a future where environmental conditions and oil availability are not so favourable, and as a result, a nascent renewable energy industry is slowly emerging. Recently the government set up its first renewable energy department. As an official in the Ministry for Electricity and Water explained, 'Even as an oil-producing country, we know that renewable energies are our future.'[14]

- In 2004, the United Arab Emirates opened the Arabian Peninsula's first wind power plant on the UAE's Sir Baniyas Island. (Sawahel 2005).
- In February 2006, Dubai will host the Middle East Electricity Exhibition and Conference, which has renewable energy as one of its main pillars.

[14] Oxford Business Group 2005. Available at *http://www.oxfordbusinessgroup.com/weekly01.asp?id=1535.*

Bahrain's Initial National Communication highlights the potential role of solar thermal combined cycle systems to both domestic electricity demand and to mitigation of climate change. One 150MW thermal station would reduce carbon dioxide emission by 1.4 million tones, at apparently negative cost (estimated as –5 US$ per tonne of CO_2 avoided). However, challenges in implementing such an option include the intermittent nature of the renewable energy technologies and the need for coordination among different institutional entities.

Other mitigation initiatives

WB Global Gas Flaring Reduction Partnership
The GGFR is exploring collaborative action that could help reduce flaring in OPEC member countries and to examine the application of carbon credits. In addition to the countries already involved in the GGFR (see above, Qatar and Iraq have expressed interest in joining. Other countries, including Kuwait and the UAE, have also have expressed an interest in sharing best practice experiences in reducing flaring (GGFR 2005). A workshop to discuss the details of potential partnerships was held in June 2005.[15]

Carbon capture and sequestration
Saudi Arabia recently became the 21st member of the Carbon Sequestration Leadership Forum (CSLF) and is participating in Phase 2 of the Carbon Capture Project (see Appendix 4). The CSLF is an international climate change initiative that is focused on development of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage. The CSLF has endorsed ten international CO_2 capture and storage (CCS) projects. Though not members, Algeria and the UAE are also involved in CSLF projects (see Appendix 4).

Discussion

The main mitigation actions in OPEC member states result, in the main, from wider developments in the energy field, in particular:

- **Oil prices.** Among the most striking changes over the last five years is sharp rise in oil prices relative to the late 1990s. Significantly projections show that such prices are expected to be maintained in the near- to medium- term. Higher oil prices will affect the impact of climate change responses measures in two main ways. On the one hand, they will reduce economic impacts from reduced oil consumption. On the other hand, they allow investments in new and more efficient technologies.
- **Reorganization of the energy markets**, including on-going market liberalization in developed and developing countries and the slow opening up of national markets to foreign investors in OPEC countries. One of the most significant developments in recent years has been the development of gas markets. Not only has there been large-scale investment in non-associated (not linked to oil fields) gas production but also in the recovery of associated gas. This is paralleled by investment in gas distribution infrastructure for local market and for export.
- **Technological developments.** The development and maturation of new clean technologies, including gas flaring recovery and LNG production processes have contributed to mitigation in many countries. Similarly, other technological

[15] The full contents of the workshop and presentations made by OPEC Member Countries can be viewed on the Partnership's webpage *www.worldbank.org/ggfr.*

developments have allowed decreases in the production cost of clean/er energy technologies such as solar cells, fuel cells, etc. Looking forward ongoing research by a range of multinational organizations on CCS could yield significant reductions in emissions.

To date, 'mitigation' has largely consisted of increasing natural gas production, both for switching national energy consumption from oil to gas and for increasing the share of gas for exports. This has been made possible by the emergence of new technologies and major investment in associated gas recovery and non-associated gas production, as well as the development of infrastructure for natural gas and LNG transportation. The market for export of natural gas is also developed in all the countries analysed.

The potential from gas flaring recovery is increasingly recognized, and OPEC members are assessing the possibilities to implement such projects. The WB Global Gas Flaring Reduction partnership is in the process of establishing a collaboration with OPEC to help reduce flaring in OPEC member countries and to examine the application of carbon credits. Some OPEC members are actively engaging in the CDM process (Nigeria, Algeria, Indonesia). No CDM project has yet being finalized but these three have established their Designated National Authorities.

The development of non-fossil fuel energy alternatives can be seen to emerge in some of the countries analysed. For example, in the Arabian Gulf, the UAE and Bahrain have programmes for development of solar energy. However, the need for technology transfer and financial mechanisms is fundamental to improve industrial and energy infrastructure and to develop new and renewable energy technologies.

6. The wider context

Introduction

In considering the role of fossil-fuel producers in the climate change debate, it is necessary to view it in the wider context. This section looks at the implications of the developments in the energy market in general, dynamics within OPEC, national interests, as illustrated by Saudi Arabia, and the role of other actors, notably the national oil companies (NOCs). In addition, it suggests some potential interactions with wider producer-consumer dialogues.

The world energy market

Energy trade
Only 10–14% of coal and gas production is traded on the world markets, compared with 50–60% for oil. Both the coal and gas trade are restricted by high infrastructure costs (ports, rails and pipelines) and have very low marginal costs up to the point of full capacity. OPEC has the highest proportion of world reserves of conventional oil and gas and acts as the residual supplier in the global oil market. Historically most gas trading has been on a regional scale with little cooperation between different producer countries on supplies and prices. However, international trade in gas is growing rapidly and this could change.

In the long term, there will be an increasingly uneven distribution of oil and gas, with proven oil and gas reserves being concentrated in the Middle East. Proven reserves of oil are much lower than those of coal and costs of extraction are likely to escalate. Meanwhile, access to gas supplies may become increasingly insecure depending on political developments. Such changes will have implications for the climate negotiations and in particular suggest that both oil and gas producers may have different interests, but also allegiances may shift or vary depending on the impact of policies and measures on demand for different fuels.

Drivers of energy demand and prices
Most analyses of the impact of response measures were conducted at a time when oil (and gas) prices were significantly lower than today, and thus assume future prices in the order of US$20–30. However, oil prices are historically very volatile and there is no clear trend in this oil price volatility. Over the last few years, oil prices have more than tripled to more than US$60 by August 2005, driven by rising consumer demand, security concerns, production and refining capacity constraints and, most recently, fall-out from Hurricane Katrina.

The primary driver of energy demand is, and will continue to be, economic growth. Asia is the main driver behind recent increases in energy demand. Between 1993 and 2003, it accounted for 60% of the world's population growth, 50% of the economic growth and 60% of the increase in world oil demand. Looking forward, the key markets for oil will be the US, China and developing Asia. The WEO estimated that China accounted for about half of the oil demand growth in 2004 while production has not kept up with supply (IEA 2004).

While Asia is a major driver of oil markets, their gas markets are relatively under-developed. Gas prices currently tend to be linked to those of oil, but this may change as

the market develops. Asia accounts for about 10–15% of world gas and most trade is currently intra-regional. In contrast, the Middle East accounts for about 40% of the gas resource. Currently, Europe and North America are the fastest growing markets for Middle East gas.

In a world of static demand, high oil prices benefit producer countries. While gains and losses arising from mitigation actions would be greater in absolute terms than indicated above, they are small in relation to the changes in revenues driven by wider changes in the markets. However, an enduring concern of producer countries is that high prices also provide incentives for changes in consumer behaviour, enhanced competitiveness of non-conventional fossil fuels and alternatives, and the risk of widespread recession in precisely the markets that producers need – all of which could reduce demand and prices in the medium to longer term. Already, there is some evidence of this. As a result of recent price hikes, US and European consumers are seeking out alternative fuels, or more efficient cars, and developing country importers seeking to curb imports. In some respects, the direction of impact is similar to that of carbon mitigation measures, but the scale is much greater. A key question is thus: what is likely to be the market response to a sustained period of high oil prices?

Investment requirements
New IEA projections suggest that world energy demand is set to rise by more than 50% over the next 25 years, giving rise to concern over the availability of the necessary finance energy security and climate change.[16] To meet this demand, the IEA estimates that governments and industry will need to invest US$17,000 billion over this period. Saudi Arabia alone could need to invest US$174 billion on oil and gas projects to achieve the levels of production envisaged by the IEA.

The availability of investment capital will depend in part on energy prices. At US$10 per barrel of oil, then very little capital would be available, while at even US$20 a considerable amount is likely to be available. In current circumstances, the availability of investment may be less a question of shortage of capital and more one of a shortage of developed projects. If investment is available, then the IEA anticipate that the cost of crude will rise from the present US$35 per barrel to US$39 by 2030. If investment is short, then they suggest that prices could rise to US$56 in real terms by 2030. The effect would be to knock one-quarter of a percent off world economic growth.

The IEA also highlight anxieties over the implications of rising energy demand for greenhouse gases and of rising Western dependency on Middle East oil and gas. From a climate perspective, the issue is how to ensure this investment goes into clean energy.

Dynamic within OPEC

OPEC countries face significant challenges and these give rise to tensions within the organization (van der Linden, 2004). However, while OPEC governments are trying to implement economic reforms, their dependence on oil is generally growing, this in turn can lead to policy development that is driven by a focus on shorter-term political and economic benefits.

Saudi Arabia continues to plays a central role within OPEC and in balancing the world oil market, in part because of the size of its production and in part because of its spare

[16] *The Times*, 8 November 2005. Warning as world faces $17,000 bn energy bill.

capacity. In 2004, it was the only country in the world with significant spare production capacity. Moreover, it continues to be the only country (besides Iraq) with significant spare capacity for the foreseeable future. While OPEC generally aims to negotiate production limits and thus price controls, in practice Saudi Arabia takes up the slack through accommodations in its own production limits when other countries exceed designated limits. The ability to do this gives Saudi Arabia a powerful position within OPEC.

In the face of the limitations in knowledge and capacity of poorer OPEC countries, Saudi Arabia provides a strong voice for the organization as a whole. This may, however, change as i) energy resources in other OPEC countries become depleted, or ii) they are able to increase their knowledge of their own vulnerability to climate change. In such circumstances, some countries may feel that their interests are not fully served by the current OPEC line.

National Interests: Saudi Arabia

Economic interests

Contrary to many Western perceptions, Saudi Arabia's economic interests are more complex than merely securing the highest possible oil revenues. The very high oil revenues since the 1970s have permitted huge investment in infrastructure and public services and have helped establish a broadly-based private sector; but they have not made possible a solution to all the country's economic challenges. They have generated insufficient economic growth for a rapidly growing population; until the recent escalation in oil price, the country was faced with the prospect of a declining per capita income. More seriously still, the economy has been generating few jobs for Saudi nationals, as opposed to foreign workers, and unemployment has been growing.

Over the last two or three years under Crown Prince, now King, Abdullah, Saudi Arabia has begun to recognize that the major challenge is to enable the private sector to deliver more than just economic growth but employment prospects for its population. In particular, there is a crucial need to provide new jobs for the growing young population: 40% of the population is below 18 years old, and unemployment among Saudi males may be as high as 30–35%. The pressure will be enhanced by increased female participation in the workforce.

Having used the oil windfall to reduce debt, to enhance public savings and push through some reforms aimed at economic liberalization,[17] the government is now intensifying labour market reforms – in particular beginning to restrict the private sector's freedom to employ foreign workers. The hope is that large numbers of private-sector jobs for Saudis can be created, initially perhaps mainly by replacing non-Saudis in existing jobs but eventually through the creation of new jobs.

A key issue for the country is where these jobs are to come from. Saudi Arabia's international comparative advantage will remain largely in hydrocarbons and related sectors: upstream oil and gas, associated services, refining, petrochemicals and some industries using petrochemical inputs – all of which is very capital-intensive. Because of the high exchange rate and relatively high local costs it will be more difficult for Saudi Arabia to create jobs in the sort of export-oriented manufacturing and services to which

[17] Although even here, while the Saudi government has opened up its gas fields and downstream (processing and distribution sector) to foreign companies, its oil fields remain in state hands.

most non-oil emerging economies aspire to, though there will be some scope in areas such as religious or other forms of tourism.

Climate change and broader Saudi interests
Climate change itself and mitigation measures both have a bearing on Saudi Arabia's ability to pursue its economic agenda. While it clearly recognizes the need to consider the impacts of climate change on the country, there is currently a lack of real information on how these impacts are likely to affect economic development and attempts at diversification. In an already arid country the effect is likely to be negative. Climate change could adversely affect prospects for tourism, while enhanced water scarcity and rising sea levels would both add an economic cost and challenge prospects for industrial development. Add to this the potential knock-on implications of changes in Yemen and the Horn of Africa, and the country could find itself with still greater pressures to create jobs.

Mitigation measures could damage Saudi Arabia's level of income to the extent that they reduce demand for oil. Although Saudi Arabia has more room for manœuvre than most producers, this may have some impact on oil revenues. However, on available estimates the scale of any possible reduction is much smaller than the swings in oil earnings which the Saudis experience anyway as a result of oil market fluctuations: in this sense it is a second-order effect. Furthermore, mitigation measures which rely on technical progress to reduce emissions or capture carbon are less of a threat and may even represent commercial opportunities.

The role of national oil companies

Saudi Aramco is one of the more sophisticated of the national oil companies (NOCs) operating in OPEC countries, in terms of both its approach to climate change and its general capacity and ability to take a long-term view of downstream threats to its business and potential responses. While its prime interest as a business is the 'bottom line', it also seeks to address more general weaknesses in the economy. In the past it has on occasion pre-empted government R&D efforts and policies on energy efficiency.

On climate change, the NOCs are looking at both reductions in gas flaring and carbon capture and storage (CCS). This they see to be in their commercial interest as a means of increasing recovery of fuels. These options are also attractive from a political standpoint as many governments espouse a form of 'resource nationalism' and thus wish to avoid waste of a strategic resource.

Saudi Aramco has expressed a strong interest in participating in technology developments around CCS and other clean energy technologies (Marcel and Mitchell 2006). Its interest stems from the fact that they perceive environmental concerns as a threat to both demand for oil and its public image. In the medium to longer term it sees that such issues could increase demand for alternative fuels at the expense of oil.

For this reason, the company is interested in research and development of fossil fuels to create hydrogen fuels and, according to Argus Petroleum, raised this as a possibility in the last OPEC meeting. It has also approached international oil companies such as Statoil in this regard. On CCS, Saudi Aramco is currently involved in Phase 2 of the CSLF-endorsed Carbon Capture Project (CCP) which is a pilot project aimed at developing new technologies to reduce the cost of capturing CO_2 from combustion

sources and store it safely underground (see Annex 4).[18]

Wider producer–consumer relations

Many of the issues raised by OPEC countries in the climate negotiations resonate with long-standing concerns over securing both income and markets for fossil fuels. Many OPEC countries perceive that they have carried the costs of oil market stabilization since 1982 in the form of lost output and lost revenues, while environmental taxes and levies imposed on final oil products have gone to consumer governments. A number of suggestions have been made over how to enhance co-operation between producers and consumers on climate change (see Box 6.1).

Box 6.1: Potential modes of cooperation between producer and consumer countries in tackling climate change

Van der Linden et al. (2000) identify a number of different potential modes of cooperation between producer and consumer countries in tackling climate change. (See also Van der Linde 2004).

- **Improved market access to the EU**. Helping oil-producing countries to diversify their economies by opening access to EU markets.
- **Non-oil investments in the oil producing countries** This depends on liberalization in the oil-producing countries. The current EU focus is on integration of actual and potential accession countries, so there is a question as to what scope really exists for this.
- **Strengthening of producer–consumer relations.** This depends on the effectiveness of OPEC as a joint body and on consumer countries pursuing consistent goals. Arguably, a wish to achieve stable markets might be a partial driver towards this.
- **Oil market organization.** Large international oil companies are potential instruments of OECD policy as funded by taxation and exploration franchises.
- **Imposition of carbon dioxide tax at source.** Producer countries could be allowed to levy taxes on oil, but this would be hard to monitor.

Mitchell (2005) suggests a number of other ways to enhance producer–consumer relations, and thus the prospects for progress on climate change and other sustainability issues, including:

- **The issue of excess subsidies in exporting companies** will be addressed partly by exporting governments' own need to improve their fiscal positions, and partly by the influence of the IMF in the same direction within negotiations with those countries involved in IMF programmes.
- **Border adjustments for environmental taxes (or lack of taxes)** remain a possibility, but at the present this is mainly theoretical. It may take some hard cases to bring up this agenda.

Price stability in particular is an area of common interest to both producers and consumers as short term falls and rises are damaging to each respectively. However, Mitchell (2005) observes there is currently no existing mechanism to address the inherent instability of the world oil market. In this respect the prospects for moderating the impact of climate change on oil revenues do not seem promising. However, Mitchell suggests 'Standby Arrangements', enhanced dialogue and informal cooperation could help in addressing price volatility.

[18] For further information see *http://www.co2captureandstorage.info/project_specific.php4?%20project_id=141.*

In theory at least, some the issues in Box 6.1 could be addressed through existing international frameworks, such as the multilateral trade institutions and Energy Charter Treaty or in other forums such as the International Energy Forum or even through other unrelated regional dialogues such as the Barcelona Process. And indeed while progress in these areas may facilitate progress in the climate change negotiations, a key question is which is the most appropriate forum for such discussions.

Appendix 1 - Key data on OPEC member states

Table A1.1: OPEC member states population and oil data

Country	Population 2003 (thousand)	Population growth (1983-2003) (%)	Proved reserves at end of 2003 (thousand million barrels)	Production 2003 (thousand barrels daily)	Reserve/production ratio (2003) (yrs.)
Algeria	31,849	2.12	11.3	1857	16.7
Indonesia	216,959	1.55	4.4	1179	10.3
Iran	67,050	1.96	130.7	3832	92.9
Iraq	25,159	2.53	115	1341	>100
Kuwait	2,449	2.10	96.5	2238	>100
Libya	5,660	2.44	36	1680	66.3
Nigeria	124,280	2.78	34.3	2135	43.1
Qatar	620	2.52	15.2	817	45.5
Saudi Arabia	22,579	3.30	262.7	9517	73.3
UAE	3,120	4.30	97.8	2528	>100
Venezuela	25,710	2.19	78	2987	71.9
OPEC	525,599	2.05	881.9	30084	79.9

Source: From Dessai 2004, based on BP 2004.

Table A1.2: Macroeconomic indicators for OPEC member countries in 2003 (including 1983-2003 average dependency and population growth).

Country	GDP at current market prices (m $)	GDP per capita ($)	Total external debt (m $)	Dependence (petroleum exports/GDP) (%)	Dependence (Average 1983-2003) (%)
Algeria	56,221	1,766	23,353	29.3	17.0
Indonesia	208,288	960	136,749	4.6	6.3
Iran	134,738	2,010	12,100	19.4	13.4
Iraq	19,854	789	93,893	37.9	23.7
Kuwait	43,598	17,942	14,077	43.1	39.3
Libya	23,001	4,064	4,194	59.0	33.8
Nigeria	55,769	448	30,033	39.8	36.4
Qatar	20,426	32,945	17,498	43.2	39.3
Saudi Arabia	211,440	9,327	32,536	40.2	30.2
UAE	75,640	24,244	21,464	33.3	35.3
Venezuela	89,030	3,463	33,048	24.5	20.3
OPEC	938,005	1,785	418,945	27.2	21.0

Source: From Dessai 2004, based on OPEC 2003.

Table A1.3: Human development in OPEC countries

	HDI rank 2002 (177 countries)	GDP per capita Rank 2002 (177 countries)	GDP per capita (PPP) rank minus HDI rank*	HDI Value 2002	GDP per capita value (PPP) 2002
Algeria	108	83	-25	0.70	5,760
Indonesia	111	113	2	0.70	3,230
Iran	101	70	-31	0.73	6,690
Iraq					
Kuwait	44	38	-6	0.84	16,240
Libya	58	64	6	0.79	7,570
Nigeria	151	166	15	0.47	860
Qatar	47	26	-21	0.83	19,844
Saudi Arabia	77	44	-33	0.77	12,650
UAE	49	23	-26	0.82	22,420
Venezuela	68	89	21	0.78	5,380

Source: UNDP 2004.
Note: * Higher means better on the HDI.

Appendix 2 - Key articles and decisions

Table A2.1: Key articles and decisions under UNFCCC and Kyoto Protocol

UN Framework Convention on Climate Change
Article 4.8: Calls on Parties to consider actions, including those related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing countries in this regard, listing categories of countries (e.g. small island countries and countries whose economies are highly dependent on fossil fuels) that may be particularly affected. "In the implementation of the commitments in this Article, 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 adverse effects of climate change and/or the impact of the implementation of responses measures, especially on:…. …. (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products;"
Article 4.9: Article 4.9 of the Convention refers specifically to the specific needs and special situations of the least developed countries (LDCs) concerning funding and transfer of technology. "The Parties shall take full account of specific needs and special situations of least developed countries in their actions with regard to funding and transfer of technology.
Article 4.10 The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situations of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or use of the fossils fuels for which such Parties have serious difficulties in switching to alternatives.
Kyoto protocol
Article 2.3 Urges Annex 1 Parties to strive to implement policies and measures set out under Article 2 in such a way as to minimize adverse effects of climate change, and effects on international trade, and social, environmental and economic impacts on other Parties, especially on those identified in Article 4.8 and 4.9 of the Convention, taking into account Article 3 of the Convention (principles). The COP serving as the meeting of the Parties (COP/MOP) may take further action to promote the implementation of this paragraph.
Article 3.14 Requires Annex 1 Parties to strive to implement their emission targets is such a way as to minimize adverse, social, environmental and economic impacts on developing countries, particularly those identified in Article 4.8 and 4.9. It also calls on the COP/MOP to consider, at its first session, what actions are necessary to minimize such adverse impacts.
Decision 3/CP.3 Adopted by Parties, requested the SBI to launch a process to identify actions needed to meet the needs of developing countries specified under Article 4.8 and 4.9 arising from the adverse effects of climate change and the impact of the implementation of response measures.
Decision 5/CP.7 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) FCCC/CP/2001/13/Add.1 - 21 January 2002 Report of the Conference of the Parties on its Seventh Session, held in Marrakesh, October-November 2001. Addendum: Part Two. Action taken by the Conference of Parties.

Appendix 3 - Financial support mechanisms

Table A3.1: Financial support mechanisms under the UNFCCC and the Kyoto Protocol

GEF

Funding mechanisms for number of multilateral environmental agreements including the UNFCCC. From 1991 to 2004, the GEF has spent over US$1.5 billion on climate change project activities, the majority supporting mitigation projects.

Special Climate Change Fund (SCCF)

The SCCF was established in Marrakech under the UNFCCC to assist developing countries by financing activities, programmes and measures that are complementary to those funded by the Climate Change focal area of the GEF in four broad areas:

- adaptation in accordance with paragraph 8 of decision 5/CP7,
- transfer of technologies,
- energy, transport, industry, agriculture, forestry and waste management, and
- activities to assist developing country Parties referred to under Art.4, paragraph 8(h), in diversifying their economies.

Activities to be supported:

- starting to implement adaptation activities [..] in the areas of water resource management, land management, agriculture, health, infrastructure,
- development, fragile ecosystems,
- health,
- supporting capacity building for preventive measures, planning, preparedness and management of disasters relating to climate change, and
- strengthening, establishing national and regional centres and information networks for rapid response to extreme weather events, using IT as much as possible.

Least Developed Countries Fund (LDCF)

The LDCF was established in the Marrakech accords (2002) under the UNFCCC to support LDC Work Programme. Among other it includes the preparation in and by LDCs of National Adaptation Programmes of Actions (NAPAs), a bottom up country driven process, intended to results in a list of each country most urgent and immediate priority adaptation needs.

The LDC fund is not funded by mandatory contributions but by a subset of countries has committed funding, and these will be insufficient to implement the adaptation activities identified in through the NAPA process. COP 9 asked GEF to support the implementation of NAPAs upon their completion, thus going on step backward by ceding authorities back to the GEF when the LDCs was born out of the frustration that LDCs experienced in accessing funding under the GEF.

Adaptation Fund

Third fund created in Marrakech (COP 7) under the Kyoto Protocol, it was established to support 'concrete adaptation projects and programmes in developing country Parties'.

This fund is to be financed from a levy to be placed on all CDM projects. In addition Annex 1 Parties that 'intend to ratify the Kyoto Protocol are invited to provide additional funding'. It is unlikely that this fund will receive large-scale funding before 2008. The size of the fund will largely depend on the size of the CDM market.

Insurance mechanisms

Insurance mechanism to be developed, such as: tiered national and regional insurance schemes, traditional insurance mechanisms, collective loss-sharing elements, global reinsurance mechanisms, etc.

Source: Tatiana Bosteels, based on GTZ (2004).

Appendix 4 - Carbon capture and sequestration

As indicated earlier, an area of potential common interest between OPEC countries and Annex B countries is in the development of CCS technology and their implementation. This developing technology is intended to prevent carbon dioxide from reaching the atmosphere through underground storage. Thus:

- From an environmental perspective, CCS technology could reduce the impact of continued fossil fuel use on atmospheric composition while cleaner energy sources are developed.
- From a producer perspective, it could potential help ensure a continued market for their product, while also enhance resource recovery.

Ultimately, these technologies could be applicable to a large fraction of carbon dioxide sources around the world – such as power plants and other industrial processes. This said, concerns remain both over financial viability and potential leakage and possible wider environmental impacts.

Thus, the current international focus is on research and development and demonstration. To date, three OPEC countries are participating in – or host to – projects under the Carbon Sequestration Leadership Forum. Brief details of the relevant projects are given below.

Saudi Arabia – CO_2 Capture Project (CCP)[19]

Saudi Arabia is participating in the second phase of the CSLF endorsed 'CO_2 Capture Project' (CCP). This seeks to develop new technologies to reduce the cost of capturing carbon dioxide from combustion sources and to demonstrate safe and effective geological storage of carbon dioxide. In doing so, it intends to address the issue of reducing emissions in a manner that will contribute to an environmentally acceptable and competitively priced continuous energy supply for the world.

The CCP is an international public private R&D partnership. Phase 2 is funded by eight of the world's leading energy companies and will cost US$24 million and run from 2005-2007.

- **Government partners.** Norway Klimatek, U.S. Department of Energy National Energy Technology Laboratory, European Union Directorate General – Energy and Transport, European Union Directorate General – Energy, Norges forskningsrad.
- **Industrial partners.** BP, ChevronTexaco, ENI, Hydro, Shell, Suncor, Statoil, ConocoPhillips, Saudi Aramco, Petrobras, ADNOC.

Algeria – CCS project

The BP and Statoil launched a CCS project at the In Salah gas field in the Algerian desert, as part of a joint venture with the Sonatrach, the Algerian NOC. BP and Sonatrach are developing this field as a 50:50 joint venture and it is ultimately aims to supply 9 billion m^3 per year of gas to the southern European market.

[19] http://www.co2captureandstorage.info/project_specific.php4?%20project_id=141.

Up to 10% of the gas field is made up of carbon dioxide and rather than venting this which is the normal practice, the project is compressing and injecting it into the lower layers of the gas reservoir. It is anticipated that around 1 million tonnes of carbon dioxide will be injected into the reservoir every year which reduces greenhouse gases by the equivalent of taking 200,000 cars off the road.[20]

UAE – CCS storage demonstration project

Japan Oil Development Corporation (JODCO), in collaboration with Mitsubishi Heavy Industries, has developed a new technique for carbon dioxide injection to boost oil production from those with diminishing output. It plans to try this for the first time as part of its operations on the Upper Zakum Field in the UAE. The new method is said to be able to increase oil recovery by as much as 50% by replacing natural gas, which is currently used to raise reluctant crude, with carbon dioxide. Oil recovery rates with natural gas are much lower, by 25–35%, as gas is much lighter and this makes it difficult to infuse into deeper layers.

[20] http://www.bp.com

References

Abdulaziz H. AbuZinada et al (eds), (no date) *First Saudi Arabian National Report on the Convention on Biological Diversity* (The National Commission for Wildlife Conservation and Development).

Ahmed, A. and A. Mohamed (1999). 'An approach for assessing the vulnerability of the water resources of Yemen to climate change', *Climate Research* Vol. 12, pp. 85-89.

Barker, T., L. Srivastava et al. (2001). 'Sector costs and ancillary benefits of mitigation' in B. Metz, O. Davidson, R. Swart and J. Pan (eds) *IPCC Third Assessment Report. Climate Change. Mitigation* (Cambridge: Cambridge University Press), Chapter 9.

Barnett, J., S. Dessai and M. Webber (2004). 'Will OPEC Lose From the Kyoto Protocol?', *Energy Policy* 32(18), pp. 2077-2088.

Barnett, J. (2001). *The Issue of 'Adverse Effects and the Impacts of Response Measures' in UNFCCC*. Working Paper 5 (Norwich: Tyndall Centre).

Bartsch, U. and B. Müller (2000). *Fossil Fuels in a Changing Climate: Impacts of the Kyoto Protocol and Developing Country Participation* (Oxford: Oxford University Press).

Bernstein, P., D. Montgomery, T. Rutherford and G. Yang (1999). ,Effects of restrictions on international permit trading: The MSMRT model', *The Energy Journal* (Special Issue edited by J. Weyant), pp. 221–256.

BP (2004). *BP Statistical Year Book*. Available at *http://www.bp.com*.

CEPA et al. (2005). 'Indirect effects of emissions trading' in A. Korppoo, J. Karas and M. Grubb (eds) *Russia and the Kyoto Protocol: Opportunities and Challenges* (London: Royal Institute of International Affairs), Forthcoming, December 2005.

Dessai, S. (2004). *An Analysis of the Role of OPEC as a G77 Member at the UNFCCC.* Report for WWF. A completed version to be distributed in selected audiences. (WWF).

EIA (1998). *Impacts of the Kyoto Protocol on US Energy Markets and Economic Activity*. Report SR/OIEF/98-03 (Washington DC: Energy Information Agency).

EIA (2002). *Saudi Arabia: Environmental Issues*, November 2002.

EIA (2005a). OPEC Revenues Fact Sheet, January 2005. Available at *www.eia.doe.gov*.

EIA (2005b). *Algeria Country Analysis Brief*, April 2005. Available at *http://www.eia.doe.gov/emeu/cabs/algeria.html.*

EIA (2005c). *Iran Country Analysis Brief*, April 2005. Available at *http://www.eia.doe.gov/emeu/cabs/iran.html.*

EIA (2005d): *Nigeria Country Brief Analysis Brief*, April 2005. Available at *http://www.eia.doe.gov/emeu/cabs/nigeria.html.*

EIA (2005f). *United Arab Emirates Country Analysis Brief*, April 2005.

FAO (2003). *Aquastat*. United Nations Statistics.

Federal Republic of Nigeria (2003). *Nigeria's First National Communication under the United Nations Framework Convention on Climate Change* (Abuja: Ministry of Environment of the Federal Republic of Nigeria), November 2003.

Ferriter, J. (1997). 'The effects of CO2 reduction policies on energy markets', in Y.Kaya and K. Yokobori (eds) *Energy, Environment and Economy* (New York: United Nations University Press).

Garcia R. (1981) *Drought and Man. The 1972 Case History. Nature Pleads Not Guilty*. (Oxford: Pergamon Press).

GGFR (2005). *Status Report.* April 2005 and July 2005 Updates. Available at *http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,*

contentMDK:20620350~menuPK:828276~pagePK:64168445~piPK:64168309~the SitePK:578069,00.html.

Ghanem, S., R. Lounnas and G. Brennand (1999). 'The impact of emissions trading on OPEC', *OPEC Review* June 23 (2), pp. 79–112.

Gupta, J. (2001). *Our Simmering Planet* (London: Zed books Ltd).

Hagem, C., S. Kallbekken, O. Mæstad and H. Westskog (2004). *Market Power with Interdependent Demand. Sale of Emission Permits and Natural Gas from the Former Soviet Union.* CICERO Working Paper 2004:01.

IEA (1998). *World Energy Outlook 1998* (Paris, IEA).

IEA (2002). *CO_2 Emissions from Fossil Fuel Production 1971/2000-2002.* (Paris: IEA).

IEA (2004). *World Energy Outlook 2004* (Paris, IEA).

IPCC (1997) 'Middle East and arid Asia' in R. Watson, R., M. Zinyowera and R. Moss (eds) *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. *A Special Report of IPCC Working group II.* (Cambridge: Cambridge University Press).

IPCC (2001). McCarthy, J., F. Osvaldo. N. Canzian et al. (eds).*Climate Change 2001: Impacts, Adaptation, and Vulnerability'. A Report of Working Group II of the Intergovernmental Panel on Climate Change*. (Cambridge: Cambridge University Press).

Islamic Republic of Iran (2003). *Initial National Communication to United Nations Framework Convention on Climate Change* (Department of Environment, National Climate Change Office with cooperation of the United Nations Development Programme), March 2003.

IWG: Interlaboratory Working Group (1997). *Scenarios of US Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond* (Washington DC: Office of Energy Efficiency and Renewable Technologies, US Department of Energy).

Kingdom of Bahrain (2005). *Bahrain's Initial Communications to the United Nations Framework Convention on Climate Change. Volume I: Main Summary Report*. (Kingdom of Bahrain, General Commission for the Protection of Marine Resources, Environment & Wildlife Resources), March 2005.

Kingdom of Saudi Arabia (2005). *Saudi Arabia's Statement's to UNFCCC Seminar on Informal Exchange of Information*. UNFCCC Seminar on Informal Exchange of Information, May 16-17 2005. Available at *http://unfccc.int/meetings/seminar/items/3410.php.*

Marcel, V, with J. Mitchell (2006). *Oil Titans: NOCs in the Middle East*. (London: Brookings Institution Press and the Royal Institute of Internal Affairs). Forthcoming, January 2006.

McKibbin, W., T. Ross, R. Shackleton and P. Wilcoxen (1999). 'Emissions trading, capital flows and the Kyoto Protocol', *The Energy Journal* (Special Issue edited by J. Weyant).

Mitchell, J. (2005). *North-South Producer-Consumer Dialogue. What Can Energy Ministers Say to Each Other?* Report. (London: Royal Institute of International Affairs).

Newell, P. (2000). *Climate for Change: Non-state Actors and the Global Politics of the Greenhouse* (Cambridge: Cambridge University Press).

OPEC (2005). *About Us.* Available at *http://www.opec.org/aboutus*. Reviewed Oct 2005.

OPEC (2003). *OPEC Annual Statistical Year Book 2*. Available at http://www.opec.org.

Oxford Business Group (2005). Harnessing Sun & Wind. *Emirates: Dubai*, Volume 95, 01.09.2005. Oxford business groups news on line. Available at *http://www.oxfordbusinessgroup.com/weekly01.asp?id=1535.*

Pershing, J. (2000). 'Fossil fuel implications of climate change mitigation responses', in Bernstein, L. and J. Pan (eds.), *Sectoral and Economic Costs and Benefits of GHG Mitigation* (Bilthoven: Intergovernmental Panel on Climate Change).

Polidano, C., F. Jotzo, E. Heyhoe, G. Jakeman, K. Woffenden and B. Fisher (2000). *The Kyoto Protocol and developing countries: impacts and implications for mechanism design.* ABARE Research Report (Canberra: Australian Bureau of Agricultural and Research Economics).

République Algérienne Démocratique et populaire (2001). *Elaboration de la stratégie et du plan d'action national des Changements climatiques : Communication nationale initiale*. (République Algérienne Démocratique et populaire, Ministère de l'aménagement du territoire et de l'environnement, Direction générale de l'environnement), Mars 2001.

Rosendahl, R. (1996) 'Carbon taxes and the impacts on oil wealth'. *Journal of Energy Finance and Development* 1(2), 223-234.

Sawahel, W. (2005). 'Middle East and North Africa "ideal for solar power"'. *News in SciDev.Net 2*5 August 2005. Available at *http://www.scidev.net/gateways/index.cfm?fuseaction=readitem&rgwid=2&item=News&itemid=2406&language=1*.

UNDP (2004). Human Development Report 2004. Available at: *www. http://hdr.undp.org*.

UN Statistics Division (2005). CO2 emissions per capita. Source CDIAC. available on line - *http://millenniumindicators.un.org/*. Accessed Nov 2005.

van der Linden, N., C. van der Linde and J. Hoogevan (2004). *The Impact of the Kyoto Protocol on the Export Revenues of OPEC Member States. An Update in Light of Recent Developments* (Bilthoven: Dutch National Research Programme on Global Air Pollution and Climate Change).

van der Linden, N., C. van der Linde, P. Lako and S. Rooijen (2000). *Analysis of the Impact of the Kyoto Protocol on the Export Revenues of OPEC Member States and on the Oil Import Requirements of Non-Annex 1 Countries*. Report no. 410 200 044 (Bilthoven: Dutch National Research Programme on Global Air Pollution and Climate Change).

van der Linde, C., P. van Ham, L. Homan, P. Meerts, K. Radtke, J. Roodand and R. de Wijk. (2004). *Study on Energy Supply Security and Geopolitics. Final Report* (The Hague: Institute for International Relations 'Cingendael', International Energy Programme).

Yamin, F. and J. Depledge (2004). *The International Climate Change Regime: A guide to Rules, Institutions and Procedures* (Cambridge: Cambridge University Press).

Energy, Environment and Development Programme

The Energy, Environment and Development Programme (EEDP) is the largest of the research programmes within Chatham House, one of the world's leading independent institutes for the analysis of international issues.

The Programme seeks to advance the international debate on energy, environment and development policy and to influence and enable decision-makers - governments, NGOs and business - to take well-informed decisions that contribute to achieving sustainable development. Independent of any actor or ideology, we do this by carrying out innovative research on major policy challenges, bringing together diverse perspectives and constituencies, and injecting new ideas into the international arena.

The Programme's work is divided into three key areas: International governance of environment and development; energy - security and development; and business and sustainable development. The Programme works with business, government, academic and NGO experts to carry out and publish research and stimulate debate on international issues in these three thematic areas.

The Programme regularly hosts workshops and meetings which provide a neutral and non-confrontational forum where experts from different perspectives are able to network and meet to freely exchange views and experiences. Meetings are often held under the Chatham House Rule of confidentiality to encourage a more open exchange of views. The impact of the Programme's work is recognised internationally and its research output is widely read throughout the 'policy community'.

If you would like further information on the Energy, Environment and Development Programme or to join the Programme's e-mailing list for notifications of publications and events, please email eedp@chathamhouse.org.uk or visit the Institute's website at www.chathamhouse.org.uk/eedp

Environment, Energy and Development Programme
The Royal Institute of International Affairs
Chatham House
10 St James's Square
London SW1Y 4LE

+ 44 (0) 20 7957 5711
eedp@chathamhouse.org.uk
www.chathamhouse.org.uk/eedp