

# **Security of International Oil and Gas**

## *Challenges and Research Priorities*

*A project for the Economic and Social Research Council*

**FINAL REPORT**  
(without annexes)

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**NOTE: THIS VERSION DOES NOT INCLUDE THE ANNEXES**

## *Executive Summary*

This is a *scoping* study, which has accumulated its material from two main sources: firstly, from the synthesis and analysis of information and ideas from the academic literature and available reports of governments and international agencies, and, secondly, from consultations with stakeholders.

The project aims to achieve *three* objectives:

- To provide an account of the main challenges facing the international community with respect to the security of international oil and gas supply in the short, medium and long term;
- To recommend substantive areas of further academic research that are required to enhance our understanding of how the vulnerability of international and oil and gas markets to disruption may be reduced, and
- To make recommendations on the nature and scope of research capacity required in order to carry out such research.

Our Final Report comprises four main Sections. The first of these (*Section 2* of the Report) examines the evolving context of international oil and gas security. Certain features of the international system play a central role in any discussion of international oil and gas security: balancing policy priorities; geo-political tensions; effects of liberalisation; wider system impacts; impact of perceptions of security; oil versus gas; increasingly complexity; weakening leverage; uncertainty about Europe; stabilisation potential of legal and regulatory mechanisms.

The Report then identifies the key risks and countermeasures, in terms of their probability and their impact, and from this it draws out and examines a number of recurring policy issues (*Section 3*). Security of energy supply is a risk-management challenge for government, the international community and for private parties. It is therefore necessary to systematically identify and evaluate the specific risks facing oil and gas users and the existing and possible countermeasures. For the purposes of this Report we have focused this risk analysis on the international dimensions of oil and gas security, and on security of supply, rather than of demand.

With respect to the UK, there appear to be *two* principal risks that affect energy security:

- (1) The dependence on imported oil and gas that results from a decline in domestic production from the North Sea, and
- (2) The need to ensure an adequate investment in infrastructure.

The first is a risk that will increase in significance over time as the UK becomes reliant on imports from areas that are increasingly remote. Imports will arrive by pipeline through continental Europe and in the form of LNG in tankers from countries outside Europe. The second of these affects electricity as well as gas, and is arguably a short to medium term problem.

In designing a scheme of risk mitigation, the UK suffers from an important constraint. In contrast to many other developed countries it has highly liberalised energy markets that circumscribe the potential for government intervention.

Building on the work reviewed in the previous Sections, we present twenty key questions for future research (*Section 4*). They have been arranged into *four distinct clusters* around the following 'lead' questions:

- How is the nature of international oil and gas security changing?
- What are the main concerns and how are they perceived?
- How may the different players respond to the challenges of international oil and gas security?
- How can international security of oil and gas be enhanced?

In order to assist with the planning of a research programme, we have ranked these research questions according to their urgency and to their relevance to government policy-making.

Finally, the Report provides a summary of current research capacity and fields of research that we have identified as existing in the UK at the present time (*Section 5*).

The development of a substantial programme of research projects in the security of international oil and gas will require collaboration between institutions, for no single institution has the size or the range of disciplines to address any one or more research questions identified by this report (*Section 4*) in the required depth. Further, a great deal of information, expertise and understanding lies with government research institutions, international organisations and commercial companies. As a result, research institutions will be required to collaborate both with each other and with a range of commercial and non-commercial organisations.

Even with such collaboration it will be necessary to address the issue of capacity building in UK social science from two perspectives:

1. *Short-term.* Social scientists who are currently active in fields relevant to international oil and gas and who wish to participate in the emerging research programme are likely to require short-term, intensive training in the fundamentals of international oil and gas. Such training can be provided by existing institutional capacity in the specialised oil and gas departments. In this way economists, lawyers, political scientists, area studies specialists, engineers and scientists can be encouraged and enabled to transfer their research activities to the field of international oil and gas.
2. *Long-term.* The UK's capacity of providing specialist or inter-disciplinary post-graduate education in the field of international oil and gas is very limited, and a large proportion of student places are taken up by overseas students. To a great extent this reflects a lack of funding available for UK students in this field, as well as the shortage of capacity to teach these subjects. If the UK is to develop long-term expertise in the field of international oil and gas it will be necessary for these deficiencies to be addressed

## *Preface*

In February 2006 CEPMLP was selected to advise the Economic and Social Research Council (ESRC) on future potential research priorities in the field of security of international oil and gas supply and on the capacity of UK research institutes to undertake such research.

An Interim Report was circulated in June 2006 in order to provide the basis for discussions with stakeholders from industry, the public sector and academia at two workshops:

- on 28<sup>th</sup> June 2006, at the Energy Institute, London
- on 4<sup>th</sup> July 2006, at the University of Dundee

These consultations were supplemented by responses to online questionnaires made available by the Energy Institute, the British Institute of Energy Economics and the Aberdeen branch of the Society of Petroleum Engineering.

The final compilation of this report was in progress just as the results of the UK Energy Review were published in July 2006. In this context, the Final Report of this ESRC project provides can be seen as providing a more detailed assessment of the concerns raised in the Energy Review, as well as a framework for establishing research priorities concerning security of international oil and gas .

The principal authors of this report are Philip Andrews-Speed and Peter Cameron. Other members of CEPMLP staff involved in the development of the ideas presented include: Paul Stevens, Jonathan Stern, Thomas Waelde, Subhes Bhattacharyya, Evelyn Dietsche, Stephen Dow, Janet Xuanli Liao, Melaku Desta, Sergei Vinogradov, James Gaitis. Research assistance was provided by Navin Seeterram and Colm Quinn.

We are grateful to the Energy Institute for hosting the consultation workshop in London, to those who attended the workshops in London and Dundee, and to those who responded to the online questionnaire.

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## ***1. Introduction***

Security of energy supply is once again high on the agenda of governments in the OECD countries, as well as for other governments of energy importing countries. It has played a significant role in the content and indeed the timing of a major energy review in the UK in 2005-2006, 'The Energy Challenge'. However, there are differences between the present situation and the 1970's when the focus of energy security was mainly on oil and particularly on the ability of OPEC to control its flow and price: the 'oil weapon'. When the International Institute for Strategic Studies published a book on 'Energy and Security' at the end of the 1970s, it comprised chapters on exactly these issues, supplemented by chapters on nuclear non-proliferation (Treverton, 1980).

Nowadays, the concept of security in energy has come to be understood in a wider and more complex sense. It includes the notion that our society needs to ensure: that long-term supplies of energy from producers are available in sufficient quantities and at reasonable prices to meet demand from consuming countries; that international or domestic flows of energy are not subject to interruption by political or terrorist actions, and that international or domestic flows of energy are not subject to short-term interruption by serious technical failures, supply failures, accidents or freak natural events.

This expanding range of concerns has arisen from a variety of developments in international economic and political life. These include: the greater volumes of internationally traded energy and, as a result the greater dependence of many nation states on imported energy;<sup>1</sup> the rapid expansion of trans-boundary energy networks; the widespread liberalisation of domestic energy markets; the rise of international terrorism and the continued market power of OPEC. A further dimension of energy security in the modern sense relates to scale: that is, the need to distinguish security of energy supply at regional, national, sub-national, and community levels. For the UK as a Member State of the European Union (EU), there is the additional consideration of ensuring that any measures proposed in this area are compatible with obligations arising from European law.

In this wide and dynamic international landscape, the project aims to achieve the following objectives:

- to provide an account of the main challenges facing the international community with respect to the security of international oil and gas supply in the short, medium and long term;
- to recommend substantive areas of further academic research that are required to enhance our understanding of how the vulnerability of international and oil and gas markets to disruption may be reduced;
- to make recommendations on the nature and scope of research capacity required in order to carry out such research.

It is not the purpose of this study to produce a theory of energy security or a definition that such a theory might generate or support. However, a working definition of energy security would seem appropriate. Within the framework of this study, we understand the term energy security when applied to energy *supply* to refer to a reliable supply of energy at an acceptable cost. This cost

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<sup>1</sup> More than 60% of all oil consumption in the world is traded internationally, up from 40% in 1985. Some 25% of gas is traded internationally, of which 75% is by pipeline and the balance as LNG (BP, 2006).

includes not only the price to the energy user but also external costs such as those relating to the environment and to society. Conversely the term security of energy *demand* may be used to refer to reliability of the demand for energy and the acceptability of the price which the consumers are prepared and able to pay.

This project is a scoping study and derives its evidence and conclusions from two main sources: the synthesis and analysis of information and ideas from the academic literature and from the reports of governments and international agencies; and consultation with stakeholders.

This Final Report comprises four sections after this introduction. In Section 2 we examine the evolving context of international oil and gas security. In the following Section we identify the key risks and countermeasures, and from these draw out a number of recurring policy issues. Section 4 builds on the previous two sections to present four Clusters of questions for future research and to prioritise these research questions. In the final Section we provide an account of research capacity in the field of international oil and gas and in related fields in the UK, and identify some of the challenges which will be involved in implementing a major research programme in the field of international oil and gas. The Annexes contain supporting information for the main text.

## ***2. Security in the Context of International Oil and Gas***

The literature on energy security<sup>2</sup> reveals a wide diversity of meanings, reflecting different priorities and perspectives on security and energy markets. As we have already noted, contemporary notions of energy security refer to a much wider range of phenomena than those that gave content to this notion in the 1970s. For this study we have been asked to limit our examination of security issues to those related to *oil and gas* and in particular those issues that have an *international* rather than purely national or sub-national dimensions. Such a focus sets certain parameters for our investigation. Within these parameters, it is clear that certain features of the international oil and gas system will play a central role. We summarise below the ten most important features in this respect:

**Balancing Policy Priorities.** The goal of energy security co-exists uneasily on a policy landscape with two other priorities: liberalisation and sustainability. The formulation of these priorities will surely differ but the arrival of each one on the public policy agenda predates energy security, at least in its modern form. Liberalisation of energy markets began in the 1980s in the UK, and more hesitantly in other parts of Europe. The legacy of privatisation, regulation, and related pro-competitive measures is that liberalisation and a relatively non-interventionist role for government has become the conventional wisdom. To the extent that energy security requires a ‘big government’ role, it challenges the assumptions of that new orthodoxy. Similarly, the policy commitments to sustainability date from the Rio Summit at least and carbon emissions reduction has become a mandatory part of government policy in all countries in Europe and many other countries. Measures of risk mitigation for vulnerability to disruption in energy supplies have to show a compatibility with sustainability objectives. Both of these features were entirely absent from the policy landscape of the 1970s and early 1980s.

An illustration of this feature of policy balancing may be made by reference to the two UK Energy Reviews in 2003 and 2006. The first was entitled: ‘Our Energy Future – Creating a Low Carbon Economy’. The second placed the chapter called ‘Valuing Carbon’ as the beginning as Chapter 1, and dealt with energy security as one of four sub-parts of Chapter 4 (although the Executive Summary rebalanced this somewhat).

**Geo-political Tensions and Growing Inter-dependence.** Lengthening supply chains and growing inter-dependence underlie the growing geo-political tensions relation to oil and gas. The geographical distribution of petroleum resources and the global pattern of industrialisation have created an increasing separation between consumers and producers of oil and gas. Issues of physical supply of oil and gas become important because of this separation and indeed because of the need to transport oil and gas across international spaces (land and water) to reach consumers.

The significant growth in international traded oil and gas in recent years has been accompanied by a rapid expansion of transportation and distribution networks, creating links of dependence along the supply chain that are both more complex and more extensive than anything before. The vulnerability of both importing and exporting states to disruption in parts of these networks is considerable, not least given the increased potential risk of infrastructure from terrorist attack. This has become most evident during a ‘tight’ market, when supply matches demand but leaves little surplus.

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<sup>2</sup> A selection of the recent literature is presented in the bibliography.

Related to this are key concepts such as transit, transportation and storage. These have a different significance between oil and gas. The transportation of gas by pipeline requires large fixed infrastructure generating a distinct set of questions about investment, and creating rigidities, and therefore vulnerabilities, that do not apply to large parts of the globally traded oil market. The substitutability of gas by other fuels creates another set of differences with oil, as does the narrowing of applications of oil to the transport sector.

For many countries that have a significant production of oil and gas the security issue is one of demand rather than supply. The security of their export markets is becoming an increasing concern for major oil and gas producers as demand remains difficult to predict. The governments of oil and gas exporting countries are becoming increasingly unwilling to invest in capacity which might be surplus to market needs.

**Effects of Liberalisation.** The patterns of liberalisation have been highly uneven in the oil and gas sector with some countries – like the UK and to a lesser extent the rest of the EU – using it to reorganise their energy markets, but with others – especially among the supplier countries – applying it reluctantly or not at all. For the former group, the provision of security is not necessarily seen as the task of governments (or inter-governmental organisations) or even a surrogate government in the form of an oil cartel (OPEC or a combination of large oil companies) or a state-controlled oil or gas company. Usually, the seeker of energy security will in practice be a state, but the providers may be a complex array of producers and intermediaries. Moreover, liberalisation has led to a stripping away of spare capacity created by state investment over the years, as non-state actors take over the costs of providing such capacity, leading to an increase in vulnerability among countries that have pursued a liberalisation agenda. This is particularly relevant to the UK as a world leader in energy market liberalisation.

**Wider System Impacts on Oil and Gas Security.** Rising oil and gas prices continue to have a significant negative impact on the economic growth of a nation, though the nature and magnitude of that impact changes with time and varies between countries. The central role of oil and gas in the economies of industrialised countries means that security risks have potential ripple effects on a wide range of other economic and non-economic variables: the role of energy-substitutes such as ethanol, refining capacity carbon reduction policies and various forms of demand management. There may well be impacts on other, non-energy security problems such as climate change and large-scale environmental problems, which have a systemic character.

**The Impact of Perceptions.** Because there are different ways of viewing or constructing the security issue, the principal actors will take or advocate quite different actions to address what they see as the ‘problem’. Some writers on energy security are open in admitting that their focus on security of supply expresses the concerns of the richer, resource-importing nations of the world. However, the nature of the concerns is likely to be quite different for developing and transition states which are importers of oil and gas. Just as important is the concerns of producing countries over the security of demand for their product in the light of the liberalising agendas pursued by many of the countries that host their customers. These very different priorities will support contrasting and possibly conflicting perceptions of the security problem and the responses that are deemed to be appropriate.

There is also an issue about ‘who’ perceives. Commentators agree that the changed role of the state as regulator and guarantor of supply security during the liberalisation period (in mostly OECD countries) has been accompanied by the rise of other actors, with diverse, sometimes short-term, often non-energy priorities, and as a result, constituting a new form of energy

governance. One consequence of this multiplication of actors is a risk that none of them (including government bodies in a liberalised era) will accept responsibility for the management of energy security risk.

**Oil versus Gas.** There are important differences between oil and gas in relation to security that will impact upon our study. Diversification into gas has played an important role for reduction in oil dependence for OECD countries. In spite of this success, oil continues to be the fuel of choice for transportation, and this is likely to remain so for a number of decades. The countries that produce the respective commodities are not always the same. However, the risks to gas security through extended pipeline networks and uncertain sources of supply and transit countries have become an increasingly important feature of security in the gas industry, as have concerns about the access to storage facilities and provision of the relevant infrastructure (especially in the UK and rest of EU). While LNG appears to offer greater security than pipeline gas, it also raises issues of maritime security (especially vis-à-vis terrorism) that have as yet received little attention.

**Increasing Complexity.** There is a sense that a period or phase of energy security has ended and that a new one is emerging (Helm, 2005; Clingendael Institute, 2006). Commentators differ in the features that they identify as significant for this new phase, and the weight that they ascribe to them. Most of them complain that at present there is a burden imposed on analytical work by the quantity of data available on ‘energy security’ issues, requiring the ‘management of noise’. However, there appears to be a consensus that (1) the phase of liberalisation beginning in the late 1980’s has had a seminal effect on the functioning of energy markets, especially with respect to the loss of surplus capacity (and other comfort mechanisms) built up a generation ago, and (2) this market-oriented tendency is under strain as a result of threats to ‘energy security’.

As a result, the interpretation of the liberalisation phenomenon in any medium to long-term policy designs is very much a matter of debate, although all parties seem to agree that the markets for oil and gas are characterised by a much higher degree of complexity but also of transparency. In addition, some writers are concerned that the multiplication of actors on oil and gas markets in recent years means that the conceptual tools fashioned in an earlier period (say, the 1970s oil shocks) are inadequate to analyse the current problems (Mitchell, 2005). Other indicators of complexity are a greater role for financial markets in the oil and gas business, and changes in the dynamics of consuming and producing nations, evident from the relative decline in the global influence of international oil companies, the entry of new players from China and India and the greater influence of transit countries on energy flows.

**Weakening Leverage.** Most commentators are concerned that the risk-mitigation strategies embodied in international relationships between the OECD countries and key producer countries and blocs are not proving sufficient to meet these challenges to security and therefore need enhancement; for example relations between the OECD/IEA and OPEC, and between Europe and Russia. For the UK a question mark arises over the value of the EU as a vehicle for the promotion of energy security with non-EU neighbours. This is worrying since there is awareness of the practicality of working through regional blocs and international organisations to achieve national goals.

**Uncertainty about Europe.** With respect to gas, there is a ‘Europe’ dimension that creates special difficulties for supply security, affecting not only the EU Member States but, as producers for this region, also Algeria, Norway and Russia, and, in the future, some Middle East States. The high degree of import dependence across the EU (and increasingly this includes the UK) coupled with the ongoing effects of liberalisation raise two principal concerns. Use of the regional bloc as

a lever with exporting countries such as Russia may appear sensible but has a very poor track record over the past 15 years (Energy Charter Treaty, various Dialogues, etc), suggesting that conventional bilateral approaches have not been superseded. The limited stage that energy market liberalisation has currently reached in the EU still allows member states to withhold gas supplies from each other in defence of national security interests (even limiting cross-border transactions within the same EU-based company). The geo-political factor plus inadequate liberalisation raise questions about supply security and underline the absence of a common energy policy (Paillard, 2005; Westminster Energy Forum, 2006).

**Stabilisation Potential of Legal and Regulatory Mechanisms.** It is generally accepted that international investment treaties, multilateral institutions and regulatory coordination can help to depoliticise international relationships and promote stability in cross-border energy transactions. Examples are the Energy Charter Treaty, the IEA crisis mechanism, the EU directives on security of gas and electricity supply and various forums for national energy regulators. However, there is a sense that the existing legal frameworks need reappraisal or a fresh injection of momentum (Energy Charter Treaty, development of an EU foreign relations policy that includes energy) if they are to meet expectations. Similarly, greater coordination between regulators and energy companies in liberalising markets may be necessary if stability is to be provided for investment to be made in the necessary infrastructure. A review of regulatory coordination and regulators' attitudes to their tasks is thought by some to be required. However, in this area there is no hard evidence that regulatory uncertainty or other effects of liberalisation have erected barriers to investment, not least because in many parts of the world market opening remains in its early stages.

### ***3. Identifying the key risks and countermeasures***

Despite the complex and changing nature of the context of energy security, it is necessary to develop a simplified framework for examining the challenges. In this report we consider security of energy supply as a risk-management challenge for government, the international community and for private parties. It is therefore necessary to systematically identify and evaluate the specific risks facing oil and gas users and the existing and possible countermeasures. For the purposes of this report we have focused this risk analysis on the international dimensions of oil and gas security, and on security of supply, rather than of demand.

In our assessment of risk, we have identified two components of vulnerability: probability and impact. The ‘probability’ of a particular occurrence or event is distinguished between high, medium and low. A ‘high’ probability means there is an expectation based on past experience. The event has occurred several times during the past ten years and is very likely to recur for documented reasons. A ‘medium’ probability means that the occurrence has been evident several times in the industry’s history, or is deemed to be likely for documented reasons. Finally, a ‘low’ probability means an occurrence that has never happened to date or is highly unusual.

The impact of a particular occurrence or event is distinguished according to a scale of three kinds of consequences: temporary impact (one year or less), and likely to be compensated by market adjustments, industry adaptation and draw-down on existing stocks; multi-year impact, with a duration of one to five years, presenting challenges to the short-term adjustment potential of the market and the industry, and causing a severe depletion of existing stocks, and finally, durable impact (more than five years), causing a generalised disruption and requiring a large-scale industry adaptation. Our assessment of the impacts has been from a global perspective, with either a short or a long-term classification of impacts. Individual countries, interest groups and economic entities will clearly face probabilities and impacts which differ from this ‘global’ assessment.

The approach taken and schemes presented in this section are intended solely as a pragmatic way of collating and synthesising a complex array of concerns and instruments in order to form the basis for an identification of fields of research in the subsequent section. They are not intended to form the basis for a novel and rigorous approach to the subject of risk assessment in oil and gas security.

For reasons discussed in section 2, oil and gas are considered separately, although considerable overlap exists. In very simple terms, the main risk concerning security of oil supply is price, whilst with gas physical interruption is a very real threat.

#### **3.1 Security of oil supply**

In the case of oil, the key risk events include short-term disruptions relating to freak natural events, accidents, industrial action and terrorism, and longer-term shortfalls in supply caused by under-investment, unexpected surges of demand growth, or by prolonged political or military action. Table 1a summarises in qualitative terms the relative probabilities of such events and their likely economic impacts in the short-term or long-term.

At one extreme lie the high probability incidents such as natural events, accidents and isolated terrorist and pirate attacks (including cyber-terrorism), which have a relatively modest, short-term impact, at least at a global scale. These result in a physical reduction of oil flow and in a consequent rise in oil price. At the other extreme lie the relatively low probability events which have a substantial impact. These might involve the reduction or cessation of supply from a number of oil exporters, a surge in demand, or inadequate investment in oil production and transportation. In the middle lie phenomena such as repeated incidents, the cessation of flow from a single major exporter, an unexpected surge in demand for oil. Whilst not all of these events result in a reduction of oil flows to the market, they do result in a reduction in the gap between supply and demand as well as a fear that such market tightness may be sustained or enhanced. Higher prices are the result.

These events may be categorised into those which are mainly out of the control of companies and governments, at least in the short-term, such as natural events and accidents, and those whose origins lie directly or indirectly in the political action or inaction of governments or groups of governments. The latter group include terrorism, piracy, insurgency, civil war, the deliberate withholding or reduction of supplies by producing governments or transit states, the blockading of exports, and the relative shortage of investment. A shortage of investment may arise from a number of sources including the behaviour of multi-national companies, of national energy companies and of producer governments.

Behind many of these risks lies the recent resurgence of 'resource nationalism'. Symptoms include the desire on the part of governments of maintain tighter control over their oil and gas resources, the increasing importance of national oil companies, both at home and abroad, and a deliberate policy to constrain the rate of investment in oil and gas production. Alongside this threat to supply security is that of failing states, states at war, and poorly governed states, whether these countries are either source of oil and gas, or are transit states.

The mitigation and response measures display the same sort of grouping as was shown by the risks (Table 1b). For the first group, the priority is for governments and companies to set suitably high technical and management standards in order to reduce the probability of such accidents and to reduce the impact of natural events, and to put in place suitable response measures to protect life and the environment and to minimise the economic damage.

Most of the other risks have a relatively low probability but a high impact. They require a much more sophisticated assessment of political and economic risks, the development of an array of economic and political strategies to reduce the probability and impact of such events, and a set of instruments to respond in the event that such risks materialise. Effective countermeasures will require action at the level of international organisations as well as by governments, societies and corporations to mitigate the risks and to develop better response mechanisms. These will require oil and gas-importing governments and other parties to work together more effectively to coordinate their domestic energy policies as well as to promote political stability and good government overseas.

A final consideration relates to the longstanding controversy which surrounds the estimates of the remaining proven oil reserves in the major oil producing countries. The OPEC quota system encouraged the systematic exaggeration of reserve statistics, and the estimates of proven oil reserves from major oil exporting countries are widely believed to be highly unreliable. Yet many national energy strategies are formulated on the apparent assumption that they are reliable.

### 3.2 Security of gas supply

For gas supply the security issues exhibit a number of key differences (Tables 2a and 2b). The parties responsible for risk mitigation are also slightly different from those in the oil markets, with the notable feature of national regulatory agencies taking a role in the gas markets. Since these gas markets are – at the present time – more regional than international, it is not surprising that the influence of regional blocs should be greater in the design of risk mitigation and response measures. This is particularly evident in the UK case where its response strategy has – with the decline of North Sea oil and gas production - become increasingly linked to that of the EU. For oil, the international and more open character of the market raises different concerns about security, and so does the relative independence of oil companies in the OECD countries from government, in contrast to the gas industry in many countries.

As Table 2b shows, the availability of storage facilities and cooperation by gas companies to mitigate shortfalls plays an important role. This points to the importance of continued investment in new infrastructure, whether it is in storage facilities or in transportation and distribution networks. It also underlines the importance of incentives for market players to develop cooperative measures as much as possible, with some coordination by national regulators. Another point of difference should be noted: the safety considerations involved in gas are more complex than with oil, leading to a lower degree of flexibility in response to unplanned interruptions.

Three of the features referred to in section 2 above play a significant role in the gas sector. The first is the discussion of appropriate mechanisms to address and mitigate geo-political tensions. These tensions have been prominent in the relations between EU Member States and Russia and to a lesser extent with other gas producers on which the EU is dependent. One response has been to propose an EU external relations strategy that incorporates energy (and especially gas) into it. The June 2006 Solana paper is the most recent example of this (European Commission, 2006). Specific regional initiatives are envisaged that will provide a more up-to-date and solid basis for EU relations with energy transit and producing countries. This includes bilateral legal agreements such as a new Partnership and Cooperation Agreement with Russia. However, the efficacy of such proposed measures that require a consensus to be adopted, in contrast to bilateral or focussed approaches (for example, the use of a regulators' association for specific issues) is open to debate. Elsewhere, there is a renewed interest in the potential of investment protection agreements in depoliticising such tensions and creating legal certainty for commercial transactions.

Secondly, there is the factor of growing interdependence. Again, the EU experience is illustrative. The high degree of dependence of EU countries on neighbouring states for energy imports is growing and it appears irreversible. As a result, mechanisms are being designed to create a kind of legal mirror to this energy network dependence (the Energy Community Treaty which involves Turkey and may also include Norway in the near future), and the Trans-European Networks and Energy Charter initiatives.

Finally, there is the impact of liberalisation. As the table suggests, liberalisation has raised questions about the role of price indexation in long-term contracts (the link of gas prices to oil) which have provided a major basis for security of gas supply in the past. With respect to liquefied natural gas, recent experience in the USA and in parts of the EU shows the speed with which governments will seek to adapt liberalisation programmes to the financing requirements and thereby secure the investment that is thought likely to contribute to long term security of gas supply.

**Table 1a. Security of supply for oil: summary of vulnerability over the long-term at a global scale**

	<b>LOW IMPACT</b>		<b>MEDIUM IMPACT</b>		<b>HIGH IMPACT</b>	
	<b>Short-term</b>	<b>Long-term</b>	<b>Short-term</b>	<b>Long-term</b>	<b>Short-term</b>	<b>Long-term</b>
<b>HIGH PROBABILITY</b>	Natural event  Accident  Terrorist event  Piracy  Industrial action		Repeated natural events Major accident  Reduction of exports from single major exporter			
<b>MEDIUM PROBABILITY</b>			Major terrorist event  Oil demand surge	Endemic terrorism or piracy  Prolonged cessation of exports from single major exporter  Prolonged oil demand surge	Reduction of exports from several major exporters	Prolonged reduction of exports from several major exporters. Inadequate investment.
<b>LOW PROBABILITY</b>					Cessation of exports from several major exporters	Prolonged cessation of exports from several major exporters

**Table 1b. Security of supply for oil: summary of main risk mitigation and response measures**

	<b>RISK MITIGATION</b>			<b>RESPONSE</b>		
	<b>Measures</b>	<b>Responsibility</b>	<b>Issues</b>	<b>Measures</b>	<b>Responsibility</b>	<b>Issues</b>
<b>Accident</b>	Construction standards, Maintenance procedures	Governments, Companies	Monitoring standards	Spare capacity Use local stocks Rapid repair & clean up Information to market	Governments, Companies	
<b>Natural event</b>	Construction, early warning systems, Maintenance procedures (international stocks)	Governments, Companies	Areas of endemic events	Spare capacity Use local stocks Rapid repair & clean up Information to market (Release of major stocks)	Governments, Companies IEA	
<b>Terrorism</b>	Security, early warning, local emergency stocks, (international stocks)	Governments, Companies IEA	Areas of endemic terrorism	Spare capacity Use local stocks Rapid repair & clean up Information to market (Release of major stocks)	Governments, Companies IEA	Access to site
<b>Inadequate investment</b>	Producer-consumer dialogue and other political approaches. Review refinery standards and approvals	Governments, International organisations	Outcome very uncertain	Energy conservation Fuel substitution Transport policy	Governments	How to achieve? Social psychology Economic instruments?

Table 1b. (cont)

	RISK MITIGATION			RESPONSE		
	Measures	Responsibility	Issues	Measures	Responsibility	Issues
<b>Reduction of exports from single/multiple major exporter(s)</b> <b>Cessation of exports from single/multiple major exporter(s)</b>	Diversify sources of import/investment, Political initiatives, Energy conservation, Fuel substitution, Transport policy. Build more stocks.	Governments, International organisations	Political initiatives require understanding and patience. Oil savings depend on social behaviour. Outcome very uncertain	Information to market. Release of major stocks. National emergency response measures	Governments, International organisations	Little proven effectiveness of emergency response.
<b>Oil demand surge</b>	Energy conservation Fuel substitution Political initiatives with major consumers, Reliable information, understanding of consumer policies	Governments, Companies, International organisations	Major demand centres such as China, India and USA	Energy conservation Fuel substitution Transport policy Reliable information	Governments, Companies, International organisations	How to achieve? Society responses? Economic instruments?

**Table 2a. Security of supply for gas: vulnerability over the long-term at a global or regional scale**

	<b>LOW IMPACT</b>		<b>MEDIUM IMPACT</b>		<b>HIGH IMPACT</b>	
	<b>Short-term</b>	<b>Long-term</b>	<b>Short-term</b>	<b>Long-term</b>	<b>Short-term</b>	<b>Long-term</b>
<b>HIGH PROBABILITY</b>	Natural event  Accident  Terrorist event  Industrial action  Technical fault on transport route or storage facility		Repeated natural events  Major accident at storage facility  Reduction of exports from single major exporter		Transit Interruptions	
<b>MEDIUM PROBABILITY</b>			Major terrorist event  Very cold winter	Endemic terrorism  Prolonged cessation of exports from single major exporter  Prolonged demand surge	Reduction of exports from several major exporters	Prolonged reduction of exports from several major exporters.  Shortage of investment in infrastructure
<b>LOW PROBABILITY</b>					Cessation of exports from several major exporters  Storage facility shortages	Prolonged cessation of exports from several major exporters

**Table 2b. Security of supply for gas: summary of main risk mitigation and response measures**

	<b>RISK MITIGATION</b>			<b>RESPONSE</b>		
	<b>Measures</b>	<b>Responsibility</b>	<b>Issues</b>	<b>Measures</b>	<b>Responsibility</b>	<b>Issues</b>
<b>Accident</b>	Construction + operational standards, Maintenance procedures	Regulator, Governments, Companies	Monitoring standards	Spare capacity Use local stocks Rapid repair & clean up Information to market	Governments, Companies	
<b>Natural event</b>	Design + construction, early warning systems, Maintenance procedures, availability of storage facilities	Governments, Companies	Areas of endemic events	Spare capacity Use local stocks Rapid repair & damage control Information to market (Release of stocks)	Governments, Companies Regulator	
<b>Terrorism</b>	Security, early warning, local emergency stocks, (regional stocks)	Regulator, Governments, Companies	Areas of endemic terrorism	Spare capacity Use local stocks Rapid repair & clean up Information to market (Release of stocks)	Governments, Companies Regulator	Access to site
<b>Inadequate investment</b>	Provision of incentives to investors Review environmental and planning obstacles	Regulator, EU Governments, investors	Adequacy of incentives uncertain	Review of and adaptation of competition measures such as TPA	Governments Regulator	How to achieve? Social psychology Economic instruments?

Table 2b. (cont)

	RISK MITIGATION			RESPONSE		
	Measures	Responsibility	Issues	Measures	Responsibility	Issues
<b>Reduction of exports from single/multiple major exporter(s) or Interruption created by transit state or dispute between the source and the transit states</b>	Long term contracts with take-or-pay clauses; diversification of supplier; diversification of supply route dependence; political dialogue between export and importing states; improvement of storage mechanisms	Regulators, EU, Governments, International organisations	Security of demand concerns among producers; reliability of transit routes; strains in political dialogue; Challenges to existing forms of long-term contracts	Improvement of dialogue between producers and consumers; assurances regarding contract forms to investors & producers; encouragement of new supply routes and new forms of gas (LNG); improvement of emergency response measures	Regulators; Governments, International organisations	Little proven effectiveness of emergency response.
<b>Gas demand surge</b>	Improved storage facilities (greater number and greater capacity) Political initiatives with transit countries and major producers. Reliable information, increase in joint ventures between producers and suppliers	Regulators, Governments, Companies, International organisations, including EU	Access to available supplies blocked by long term contracts – liquidity a major issue	Activation of crisis measures at national, EU and inter-company levels Spot markets and the introduction of more flexible contract formulas; reliable information	Regulators including regional regulatory groups, Governments, Companies, International organisations	How to achieve? Society responses? Economic instruments?

### 3.3 Further Considerations on Oil and Gas

**The importance of time.** Any assessment of the security risks and their mitigation will vary according to the timeline on which the risk is located. The simple timeline we have in this draft is short, medium and long-term for location of risk. The short-term risks (days, weeks) are likely to be ones over which the principal actors have little control and which offer only a limited range of mitigation possibilities. As the timeline moves forward into the medium term (months, 1-2 years), this capacity to influence events increases as the implementation of particular strategies begins to take effect (diversification of sources of supply, diversification into alternative sources of energy, for example). However, the lead times for investment in the energy sector (especially gas rather than oil) mean that the possibilities for risk mitigation are much more promising in the long term (years). Essentially, we would expect our assessments of the challenges facing the international community from oil and gas supply to vary significantly from one phase in this timeline to the next. Similarly, we would expect to produce different conclusions (and recommendations) with respect to risk mitigation strategies, according to the phase along this timeline on which they are located.

There is a further dimension to this. The actors involved in a risk analysis exercise may also be expected to differ according to the phase under consideration. Our initial impression is that currently there are many bodies in the public and private sector engaged in analysis of short or medium term risks to oil and gas security. However, it is much less clear which of these has an interest in carrying out such analysis in a long term perspective. This initial impression about the analytical limitations of many of the various actors can be expected to have research implications.

**National approaches.** Individual governments will develop mitigation and response measures which reflect their perceptions of the risks, the tools at their disposal and their domestic and international priorities. These may include various combinations of maximising the domestic production of oil and gas, efforts to enhance energy efficiency, deliberate steps to use other forms of energy where possible (such as renewables, coal or nuclear), and the development of new fuel technologies such as gas-to-liquids, coal-to-liquids, hydrogen fuel cells and bio-fuels. In the medium and long-term, the speed and efficacy with which such policies are pursued will depend on two inter-related factors: the effectiveness with which governments can manage the technology transition to a “new energy world” and the willingness of societies to adjust the way they use energy.

**Regional considerations.** The Middle East is clearly the major energy producing region of concern on account of its perceived political instability and the large and growing dependence of the world on its oil and, in the future, gas supplies. Other regions include North and West Africa, the Former Soviet Union and Latin America. Existing measures to address political and market instability in these regions include political moves for peace in the Middle East, political engagement with Russia, the European Union’s Mediterranean initiatives (the Barcelona process, also known as the Euro-Med partnership), the energy consumer-producer dialogue, the EU dialogue with the Gulf Cooperation Council, and a variety of initiatives to promote peace and good governance in Africa. Such approaches may have two aspects: the first seeks general stability of supplies from the region, whilst the second seeks to build bilateral relations in order to secure preferential treatment

**International measures for responding to major dislocations.** The International Energy Agency and the European Union both have specific preparatory measures which all of their member states are bound to implement. These include maintaining emergency oil stocks, drawing

up national emergency response procedures, and agreeing to a sharing of oil supplies in case of emergency. With respect to gas, in 2004 the EU's gas security of supply directive provided for the creation of a Gas Coordination Group to facilitate coordination in the event of a major supply disruption and assist the Member States. European law now provides some guidance as to the general roles and operational responsibilities of the different market players. Its declared objective is to set out a "minimum common approach to security of gas supply".

### **3.4 Challenges to Conventions about the State and Market**

The widespread unease about energy security is sometimes driven by concerns about the impacts of liberalisation and the market reforms of recent years. This has indeed removed the comfort zones or cushions of excess supply, storage, etc, built up by government investment a generation ago (or more). It is also a process that is still at an early stage in many EU countries and which has not proved attractive to many non-OECD countries, especially oil and gas producing countries. Russia is the most obvious example in Europe's 'near abroad' but outside of this area, much of Latin America provides other examples. A number of major energy consuming countries have also proved reluctant to follow the path of liberalisation in the energy sector, China for example.

The current concerns about oil and gas security frequently drift towards the idea that liberalisation and the retreat from state interventionism has weakened the government's ability to act to manage problems or to prevent them. In practice, there are many levers (the national regulatory authority, for example) that could be drawn upon, but there is an issue of coordination. It is certainly the case in some countries, especially the UK, that one effect of liberalisation has been to reduce the will of government to act in energy markets. However, the impact of liberalisation varies from one country to another, with Germany and France still possessing and wishing to use levers of government that permit action to address these issues more readily than in the UK. This sense of an uneven playing field is an important feature of the debate on energy security in some of the liberalising countries and also between these countries and the sellers of gas and oil. It may be assumed to limit the willingness of parties to engage in policy coordination. Yet, progress in risk mitigation will require that the public and private sector actors identify a common ground and work together in some way.

If one reverts to the timeline, and especially the long term perspective, two questions could be asked that would have a bearing upon energy security: how sustainable is the recent market-orientation in the OECD countries when many other countries and regions do not share its assumptions and in significant cases, do the opposite? How will energy security be understood if, in the medium to long term, a number of key international players such as the US and China engage in a 'war' to secure energy resources?

### **3.5 The risks from the UK perspective**

There appear to be two principal risks that affect UK energy security:

- (3) The dependence on imported oil and gas that results from a decline in domestic production from the North Sea, and
- (4) The need to ensure an adequate investment in infrastructure.

The former is a risk that will increase in significance over time as the UK becomes reliant on imports of both oil and gas from areas that are increasingly remote. Long an exporter of oil, the

UK could become a net importer by 2010 and these imports are likely to mainly by tanker. The UK is already a net importer of natural gas. The level of imports may rise to as much as 40% of demand by 2010 and to 80-90% by 2020 (DTI, 2006) . Imports of gas will arrive by pipeline through continental Europe and in the form of LNG in tankers from countries outside Europe. The latter risk relating to infrastructure affects electricity as well as gas, and is arguably a short to medium term problem.

In designing a scheme of risk mitigation, the UK suffers from an important constraint. In contrast to many other developed countries it has highly liberalised energy markets. The scope for government intervention to plan for high impact-low probability occurrences is therefore limited without the risk of creating market distortions. For example, the intervention to establish a strategic gas reserve and reduce the risks of such occurrences would have important impacts on existing commercial gas storage projects. In this domestic context, which also includes planning constraints, there are constraints on UK responses to some risks that other states might not face, and which are domestic in origin rather than international.

An international agenda for oil and gas is a *sine qua non* however, given the UK's increasing dependence on imports. This can be expected to proceed at three levels: bilateral, regional (i.e. EU) and multilateral/global. The Energy Review sees the first of these as likely to lead to stronger relationships with oil and gas producers; the second as being driven by a pro-competition agenda, and the third as involving dialogue between producers and consumers about investment, use of cleaner and more efficient technologies and more open trade in supplies.

#### ***4. Identification of research questions and different research fields***

In this section we summarise the clusters of key research questions, which arise from the previous sections and which we have identified during our discussions within the CEPMLP, with stakeholders and a review of relevant literature. They have been arranged into four clusters. In principle, a dependency exists between the clusters, so that the research identified in Cluster 2 would build on the results from Cluster 1, and likewise for Clusters 3 and 4.

*Cluster 1. How is the nature of international oil and gas security changing?*

- a) How are international oil & gas markets and industries changing and what will be the impacts on international oil and gas security?
- b) How is the “international world order” changing and what will be the impacts on international oil and gas security?
- c) How are the roles of governments and markets changing and what will be the impacts on international oil and gas security?
- d) What will be the impacts of evolving environmental and alternative energy strategies on international oil and gas security?
- e) How are societies changing and what will be the impacts of these changes in different regions on international oil and gas security?

*Cluster 2. What are the main concerns and how are they perceived?*

- a) How can the risks and the impacts relating to international oil and gas security be systematically identified and assessed?
- b) How is security of international oil and gas perceived by different players?
- c) How can more reliable estimates be made of present and future oil and gas reserves?
- d) How can more reliable estimates be made of future oil and gas demand in major energy consuming countries?
- e) To what extent are constrained investment levels in oil and gas a justifiable concern?

*Cluster 3. How may the different players respond to the challenges of international oil and gas security?*

- a) What are the likely policy responses of key producing/exporting countries?
- b) What are the likely policy responses of key consuming/importing countries?
- c) How do governments of different types formulate and implement energy policy?
- d) What are the likely responses of companies and financial markets?
- e) What are the range of possible outcomes of these behaviours on international oil and gas security and on world stability?

*Cluster 4. How can international security of oil and gas be enhanced?*

- a) What can global international organisations do to reconcile contrasting perceptions and to raise confidence?
- b) What can regional international initiatives do to address the security challenges?
- c) How should responsibilities for security of supply be divided between public and private sectors?
- d) How can domestic economic policy be adapted to enhance security of oil and gas supply?
- e) How effective are current and planned preparedness and response mechanisms?

#### **4.1 Cluster 1: How is the nature of international oil and gas security changing?**

*1A. How are international oil & gas markets and industries changing and what will be the impacts on international oil and gas security?*

There is wide agreement that the structures of international oil and gas markets and of the industries have undergone radical changes in the past couple of decades, under the impacts of globalisation (entry of new players from China and India, for example) and increasingly stringent requirements for sustainability in energy operations. There are important differences between gas and oil in this (and other) respects, with gas as a major beneficiary of these shifts. In this context, there is scope for research into the levers that are available to states and international organisations with respect to influencing market behaviour, not least in order to achieve their sustainability policies. The room for policy manoeuvre has become – in the view of many – significantly restricted. What are the implications of this in terms of energy security objectives, in the medium and long term? How can research cast light on the longer term adaptations that are required? In this context, the role of international and national oil companies in providing investment for the markets might also be considered

*1B. How is the ‘international world order’ changing and what will be the impacts on international oil and gas security?*

The collapse of the Soviet Union triggered a period of accelerated change in international relations, with the USA remaining as the sole super-power. Economic development has permitted a number of populous states, such as China, India and Brazil, to play a steadily more important role in world affairs. Over the same period it might be argued that two potentially important players, the EU and Japan, have failed to raise their profile on the international stage. During this time, the dominant policy priorities have shifted from the economic liberalisation characteristic of the so-called Washington Consensus (liberalisation, privatisation and free trade) to a complex mix of market, security and sustainability goals, in response to a rise in international terrorism and concerns about climate change. These changing dynamics in the ‘international order’ impact upon but are largely independent of the oil and gas industries. More recently, high energy prices and a perception of supply shortages have permitted governments in a number of oil and gas exporting countries to use energy as a political instrument both at home and abroad (e.g. Venezuela, Iran, Russia), as have certain energy importing states (e.g. China). One manifestation of this is the unilateral abrogation of agreements by certain producing states and verbal threats by government officials to take other actions in violation of obligations arising under contracts, bilateral treaties and multilateral agreements, and a corresponding rise in the use of international dispute settlement mechanisms.

These developments raise the broad questions of how oil and gas is affecting the changing international world order, and, conversely, how the changing world order is affecting the security of international oil and gas.

*1C. How are the roles of governments and markets changing and what will be the impacts on international oil and gas security?*

The impact of economic liberalisation among the OECD countries and attempts at exporting it to transitional and developing countries is a fertile area with respect to energy security research. Among the former, this process has stripped away the surplus capacity that had been built up by public monopolies over decades, leading to a new vulnerability. At the same time, the adoption of

value-based management systems in the international oil companies has had an important impact on investment patterns. Based on capital asset pricing model methodology, the idea is that if the company cannot earn a rate of return on its capital at least as great as the equities in the sector and the market generally, it should return funds to the shareholders rather than investing itself (Stevens, 2005). In contrast to previous 'oil shocks', the recent price increases have had little discernible impact on investment patterns. Research in this area could focus on changing patterns of industry decision-making, as well as the tensions between the market approach (however that is defined) and proponents of a focussed intervention by government in energy security issues.

Features of this include:

- National and international dimensions, plus a Europe-wide aspect for potential study of economic, legal and political aspects
- Many specific dimensions of this issue
  - Legal frameworks and strategies
  - Economic incentives and/or financial guarantees or subsidies (in the EU context, the role of these in a framework that is increasingly limited by state aid controls)
- Globalisation Impacts on corporate and government decision-making.

*1D. What will be the impacts of evolving environmental and alternative energy strategies on international oil and gas security?*

Environmental concerns, both global and local, have increasingly become a key consideration in the formulation of energy policy, and these have formed one set of drivers for the expanded use of natural gas. They have driven the already familiar trend towards local opposition (NIMBY) to new infrastructure schemes, from LNG terminals to wind energy farms. The considerable expansion in renewable energy and carbon reduction schemes (the EU Emissions Trading Scheme and regional schemes in California and NE United States, for example) has created a policy driven market that has already seen the establishment of support schemes and the creation of new financial instruments for energy trading. Developments such as these are likely to have long term significance on both perceptions of energy security and the acceptability of solutions proposed to address security concerns.

Under this heading could also be considered the impact of new alternative energy sources such as ethanol, based on corn, and related to this, the impacts on transport and agricultural sectors of such developments that are gaining momentum due to the impact of a high oil price. There may be trade and WTO aspects to this that could be incorporated into research projects, and opportunities for review of the potential for impacts of such 'new energies' on less developed countries. In particular, it seems appropriate to draw attention to the convergence of energy and agricultural markets, and to the medium to long term impacts of carbon reduction schemes on energy policy. Our understanding is that in these areas considerable research has already taken place.

Moreover, research initiatives in this area could also address the impact of environmental concerns and regulations on oil refiners and markets. Standards of fuel quality have been tightened (e.g. the spread of ultra-low sulphur diesel) and this has imposed strains on the refining industry's investment plans to upgrade plants and buy specific kinds of crude oil.

The reputational risk factor might also be considered. The fossil fuel industries have for many years had a poor image in the wider society. Evidence of efforts to counter this is seen in the adoption of the Equator Principles (and their recent expanded version) to guide lending practices

of financial institutions to natural resource projects in the developing countries. The steps being taken by the largest market players to promote legitimacy in their operations may generate research questions into actual and aspirational changes in the decision-making practices of international energy companies, the lending institutions and national oil and gas companies.

*1E. How are societies changing and what will be the impacts of these changes in different regions on international oil and gas security?*

The use of energy is an intrinsic part of daily life, in all societies, rich and poor. In general terms the use of oil and natural gas grows in line with economic development, depending on the availability of the appropriate appliances. The nature and success of government policies relating to the use of oil and gas, whether they are energy conservation fuel switching or environmental policies, will depend to a great extent on the willingness of the society to respond to economic and administrative signals and to exhortation. The nature of this response will vary between cultures, between countries and between regions, and will evolve over time. The inter-connectedness of the world energy markets means that the oil and gas security in one country may be partially dependent on the behaviour of society in another country.

These considerations should provide a foundation for comparative studies in social psychology.

#### **4.2 Cluster 2: What are the Concerns and How are they Perceived?**

*2A. How can the risks and the impacts relating to international oil and gas security be systematically identified and assessed?*

A need exists to develop and test new methodologies for assessing the risks and impacts relating to international oil and gas security. These methodologies would need to be applicable to the perceptions of the various major actors.

There are two main issues identified here: the benefits of analysing risk to oil and gas security in terms of probabilities and in terms of specific outcomes, with perhaps a greater emphasis on the latter. The second issue is the inter-linkage of 'events'. Some are inter-dependent and some are not. These considerations be used in future analysis of risk, which would also venture into areas such as:

- Identifying probabilities, vulnerabilities and impacts (costs) of oil and gas security threats, paying particular attention to low probability, high-impact events.
- Evaluating the economic impacts of high oil prices;
- Evaluating the costs and benefits of mitigation and response measures.

Of particular importance is the need to take a broad and long-term view of the likely economic and social impacts of high energy prices in oil and gas importing and exporting countries, both poor and rich.

*2B. How is security of international oil and gas perceived by different players?*

The identification and analysis of diverse and contrasting perspectives held by major actors on the problems of oil and gas security has been a recurring theme in our discussions and in the literature. It is important to examine how each of the major actors construct the problem and thereby frame their responses to it (and to each other). These actors include the governments of

oil and gas exporting and importing states and of transit states, major energy companies, certain international organisations and supranational groupings (such as the EU), as well as societies and communities

This suggests a methodology that is comparative and theoretical involving international relations specialists, but also one that could include specific empirical studies of perceptions with economic, social and political features of the actors concerned. The outcomes could be revealing in terms of potential for cooperation and for conflict in international relations. How governments and other actors influence the perceptions of people is also of relevance.

*2C. How can more reliable estimates be made of present and future oil and gas reserves?*

There are a number of research issues that could be identified as arising from concerns about the physical supply of oil and gas. These relate both to the unreliability of information from many producing countries and the uncertainty over the economics of unconventional sources of oil and gas. The research issues would develop from scientific or economic questions such as:

- What are the level of conventional oil and gas reserves (proven, probable and possible ) in major producing countries and in other countries?
- What are the likely future trends for the costs of developing unconventional oil and gas reserves, and what are the implications for the quantity of reserves?
- How can the environmental costs of developing these unconventional resources be assessed, and what are the implications of these costs for policy decisions on whether to and how to exploit these resources?

*2D. How can more reliable estimates be made of future oil and gas demand in major energy consuming countries?*

Despite the large number of forecasts for future oil and gas demand which are issued with great regularity by reputable institutions, most of these forecasts are invariably overtaken by events. This calls into question the value of the methodologies used and suggests that it is necessary to evaluate the commonly used approaches and either to develop new techniques or to explore new ways of interpreting the established methodologies.

In order to be of real value, demand forecasts need to be able to take into account possible future events or trends in key countries or regions relating to national politics, international relations, economic policy, energy policy and social behaviour.

*2E. To what extent are constrained investment levels in oil and gas a justifiable concern?*

Current high oil prices have been driven by high levels of demand meeting constrained supply. There is a commonly held view among observers of the oil industry that this constrained supply arises because of decades of underinvestment in the oil industry. For the international oil companies (IOCs), this has occurred because the financial strategies adopted by the companies since the early 1990s – value based management approaches – argue that if the company cannot outperform the market, it should return money to the shareholders. This return via dividends and share buy-backs represents a major leakage of investment funds from the industry. In 2005, the six largest IOCs invested \$54 billion but returned to the shareholders \$71 billion. As for the national oil companies (NOCs) of the producer governments, many have been starved of funds as other budget priorities take precedence and as there is growing concern that the NOCs are high cost and inefficient. Recently this underinvestment is reinforced by growing concerns in the producer countries over security of demand. More specifically, in the context of the UK gas

industry there is also concern that in the privatized environment post 1986 value based management approaches have also inhibited investment in infrastructure as the temptation is to maximize shareholder value by sweating assets.

In this context there are a number of important research questions:-

- The extent of the investment shortfall. For oil, this is a global question but for gas it is more a regional and national issue.
- What are the causes of the relatively poor returns in the industry which lead to potential investment funds being returned to shareholders?
- What incentive mechanisms might be required to try and fill identified investment gaps? In particular whether such mechanisms are feasible in the existing market driven environment.
- What measure might be taken to ensure that the producer countries' concerns over demand security can be met?

### **4.3 Cluster 3: How may the different players respond to the challenges of international oil and gas security?**

#### *3A. What are the likely policy responses of key producing/exporting countries?*

How governments respond to the challenges of international oil and gas security depend not only on how they perceive the challenge but also on their policy-making processes and priorities. The policy-making processes of the key actors among producers and exporters of oil and gas would benefit from analysis of an inter-disciplinary character. In particular, the notion of linkage might be explored in a multi-disciplinary context. Two aspects may be noted: linkages in terms of resource policy and economic policy coordination and linkages in terms of risk of interruption to energy security. Studies could either be of a comparative nature or could focus on particular issues such as resource nationalism. Case studies could be selected from the Middle East, Latin America, North Africa and the Former Soviet Union. Transit countries should also be included.

In addition to analysing the behaviour of national governments, it would be necessary to examine supranational bodies such as OPEC, and other players such as sub-national governments, national oil companies, communities and NGOs acting on behalf of these communities. This would include the examination of the role of domestic insurgent groups, terrorist groups and pirates.

#### *3B. What are the likely policy responses of key consuming/importing countries?*

For the largest consuming/importing countries the development of a 'policy' on energy may not be regarded as desirable even though the problem of energy security (however defined) may be widely acknowledged. The 'new orthodoxy' of liberalisation in energy markets may make development of an appropriate policy and institutional response difficult and provoke contradictory responses. Among these importing states, there can be expected to be widely divergent views about the role of government with respect to energy security. An example would be the different views between the USA and most EU countries with respect to energy efficiency and demand management . On the other hand, many developing or transition states which are major energy importers continue to maintain an approach in which government plays a central role.

Research could be carried out into economic, political determinants of the actions of the main consuming countries such as the USA, the EU states, India, China, South Africa, as well as comparative and theoretical studies of countries and also efforts at regional and global cooperation (NAFTA, NE Asia, EU, IEA)

*3C. How do governments of different types formulate and implement energy policy?*

The two previous research questions raise the wider issue of how governments make and implement energy policy. Policy analysis of how consuming countries and exporting states reach decisions and the processes through which they implement them should yield insights into energy security on the international scene. This could be carried out on a comparative basis drawing on political/administrative, economic and legal disciplines. The different notions of 'policy' and approaches to implementation at national and regional levels could be considered.

In this area, there would have to be consideration of how governments seek to reconcile the often competing demands of energy security, sustainable development and economic competitiveness. There would also have to be recognition of some countries that are reluctant to establish a policy as such on energy, but instead have 'priorities', and also that governments may choose to use oil and gas as tools of foreign policy..

*3D. What are the likely responses of companies and financial markets?*

The oil and gas companies, the major energy using companies and the financial institutions remain key players with respect to the international security of oil and gas, regardless of the role of government, international organisations and societies. These companies and institutions are not only at the front line of the security of supply issue, as investors, and as producers and consumers of energy, but they are the parties which are often first to identify the security challenges and to seek solutions which address, at the very least, their own concerns.

In addition to the development or improvement of specific preparedness and response mechanisms (see research question 4d, below) each set of parties are developing their own strategies to respond to the emerging set of challenges to their business. These will include new approaches to evaluation and management of projects and risks, and their impact on international oil and gas security may not necessarily be positive. In this context research should be directed at identifying the strategies of major oil and gas producing and consuming companies, both private sector and state-owned, of the financial institutions which back them, and of other players in the financial markets, and evaluating their likely impact on international oil and gas security

*3E. What are the range of possible outcomes of these patterns of behaviour on international oil and gas security and on world stability?*

The understanding which could be developed through the proposed research of the changing nature of world politics, of societies, and of the international oil and gas industries, the changing perceptions of oil and gas security, and the changing responses of parties to these challenges, should provide a framework for looking to the future of international security of oil and gas in a new way.

It would be useful to formulate a range of scenarios for the future developments in international oil and gas which identify key risks and vulnerabilities and which identifies key events or trends which are and will cause certain risks to increase or diminish. There is a particular need to

analyse low probability and high-impact events, such as major wars and the collapse of major oil or gas producing states.

#### **4.4 Cluster 4: How can international security of oil and gas be enhanced?**

*4A. What can global international organisations do to reconcile contrasting perceptions and to raise confidence?*

A number of international organisations have involved themselves in promoting energy cooperation and yet others have been established to articulate a common interest and promote it. Examples of the former would include the EU and the World Bank, while examples of the latter would include the OECD International Energy Agency, the Energy Charter Treaty, the International Atomic Energy Agency and the looser organisational structure of the International Energy Forum, based in Riyadh. Given the significant changes that have occurred since most of these organisations' efforts began, research into their efficacy in current and future circumstances could be beneficial. To the extent that security risks are redefined (perhaps in terms of the impact of high energy prices on international competitiveness, for example), questions may be raised about their capacity and structural limitations, that may impact negatively on their efficacy and future role. This international dimension gives rise to issues of externalities and issues of a legal character. Research could be encouraged into the workings of the existing international institutions, preferably of an interdisciplinary character. This may lead to questions about how the existing capacity could be supplemented or expanded or reorganised to respond better to the risks identified (what elements of institutional capacity are needed to make it work?).

Key features of this include:

- Historical, comparative and theoretical studies
- Implications for future international collaboration

*4B. What can regional international initiatives do to address the security challenges?*

A number of countries have attempted to resolve security issues on a regional basis although few have had much success (NAFTA, NE Asia, for example). Yet some of the security challenges such as international terrorism, and threats from non-state actors, leading to intra- and inter-state conflict, may require or benefit from a multilateral response. The International Energy Agency's crisis mechanism may appear to be an exception but it is a rather formal mechanism with little practical significance. The attempts by the EU to develop a security strategy, drawing on policy and legal instruments, would be an appropriate subject for research not least because of the potential for law and economics analysis, international relations approaches and a consideration of the tensions between security and environmental objectives.

Themes to consider here include:

- Development of cooperative frameworks for combating international terrorism and violence from non-state actors that can generate energy security occurrences
- The role of infrastructure access and other competitive mechanisms versus investment in interconnectors in a liberalising market
- The development of sub-regional units for promotion of security (e.g. within the EU)
- The balance between security concerns and sustainability ones; how can market players be encouraged to respond to security concerns without sacrificing environmental & sustainability objectives?

*4C. How should responsibilities for security of supply be divided between public and private sectors?*

One of the consequences of liberalisation has been a reduction in the role of governments and state companies in acting as the guarantors of energy security. As a result, coordination mechanisms have been developing to bring different players together that attempt to demarcate the responsibilities. A major new player in this will be the national regulatory authority for energy that is established in many countries around the world.

Among the key issues to consider here could be:

- Regulatory governance vis-à-vis cross-border infrastructure projects aimed at providing security of supply in the long term (interconnectors, LNG projects, for example)
- Planning and environmental regimes: what role do governments have balancing the demands of investors to facilitate projects but also to channel public opinion through planning laws, etc?

*4D. How can domestic economic policy be adapted to enhance security of oil and gas supply*

Energy consumption patterns and the nature of economic growth are inextricably linked. Different development strategies lead to different consequences for the energy sector in terms of both the level and structure of energy consumption. For example, an industrial policy based upon import substitution produces very different energy consequences from an export orientated strategy. Equally, periods of rapid bursts of economic growth produce different consequences from slow or steady growth. A classic example has been the recent economic history of China. Economic policy also affects the structure of the economy which also carries energy sector consequences. For example, an economy with a large heavy industry sector will have different energy consumption patterns from one where the service sector dominates. These issues give rise to a number of research questions:

- What are the side effects of economic policy on the energy sector, in particular the demand for energy?
- What are the implications of economic policy upon the oil and gas infrastructure in an economy?
- How far can economic policy affect the trade patterns associated with energy consumption?
- How far can economic policy affect the impact of energy trade flows on a country's balance of payments?
- How far will economic policy in producer countries inhibit investment in oil and gas producing capacity for fear of attracting an attack of "resource curse"? How far can assistance be given to these countries to manage the threat of "resource curse"?

*4E. How effective are current and planned preparedness and response mechanisms?*

The classification of risks we have adopted (of probabilities and impacts) is linked to responses to risks planned and actual. In this area, research could be done into response mechanisms established by government(s), by companies and by companies with governments such as the IEA emergency sharing system, and the design and operation of early warning mechanisms. In this context, two further aspects could be considered: firstly, the role of commercial contracts in securing long term supply security and the extent to which they may continue to provide this function in a liberalising market; secondly, the extent to which governments, either unilaterally or

acting in a cooperative manner, can reshape their economic policies so that their vulnerability to oil and gas ‘events’ is decreased. The ability of OECD countries to absorb the effects of a significantly higher oil price without inflationary consequences in 2004-2006 is an illustration of successful adaptation in the wider economy. In other words, ‘better economic policies’ (price adjustment, lower interest rates rather than the imposition of price controls and higher interest rates) can contribute to the management of ‘price shocks’.

Themes to consider here include:

- An examination of the specific measures and schemes that have been designed to respond to security risks, and their relevance (such as oil and gas storage mechanisms);
- A review of the wider macro-economic policies that can mitigate the vulnerability of consuming countries to oil and gas disruption, with a view to identifying the linkages between the dynamics of energy markets and economies in general
- How can available technology be more effectively used/applied to mitigate risks, and how can market players be encouraged to take up new technologies (carbon sequestration, for example)?

#### **4.5 Prioritising the research questions**

In principle the research programme should address all the research questions identified and should progress systematically from Cluster 1 through to Cluster 4. The reality of government policy requirements and of funding constraints demand that these research questions be prioritised.

We have thus ranked the research questions into four priority groups from two perspectives (see Figure 1):

- the direct relevance of the research to government policy-making in the UK; and
- the urgency of the need to address the question;

We have assigned a high degree of relevance to research questions either in cases where the UK government may have the opportunity to directly influence these events or phenomena, or where an understanding of these events or phenomena is critical for effective policy-making.

Research questions classified as having a relatively high degree of urgency are those which have immediate relevance to short-term policy making, and from which clear research outcomes should be achievable in the short-term

*Priority A: Research questions which are both directly relevant to government policy-making and urgent (Red in Figure 1):*

- 2a. How can the risks and the impacts relating to international oil and gas security be systematically identified and assessed?
- 2c. How can more reliable estimates be made of present and future oil and gas reserves?
- 2e. To what extent are constrained investment levels in oil and gas a justifiable concern?
- 4c. How should responsibilities for security of supply be divided between public and private sectors?
- 4e. How effective are current and planned preparedness and response mechanisms?

*Priority B: Research questions relating to issues over which government can have influence(Orange in Figure 1):*

- 4a. What can global international organisations do to reconcile contrasting perceptions and to raise confidence?
- 4b. What can regional international initiatives do to address the security challenges?
- 4d. How can domestic economic policy be adapted to enhance security of oil and gas supply?

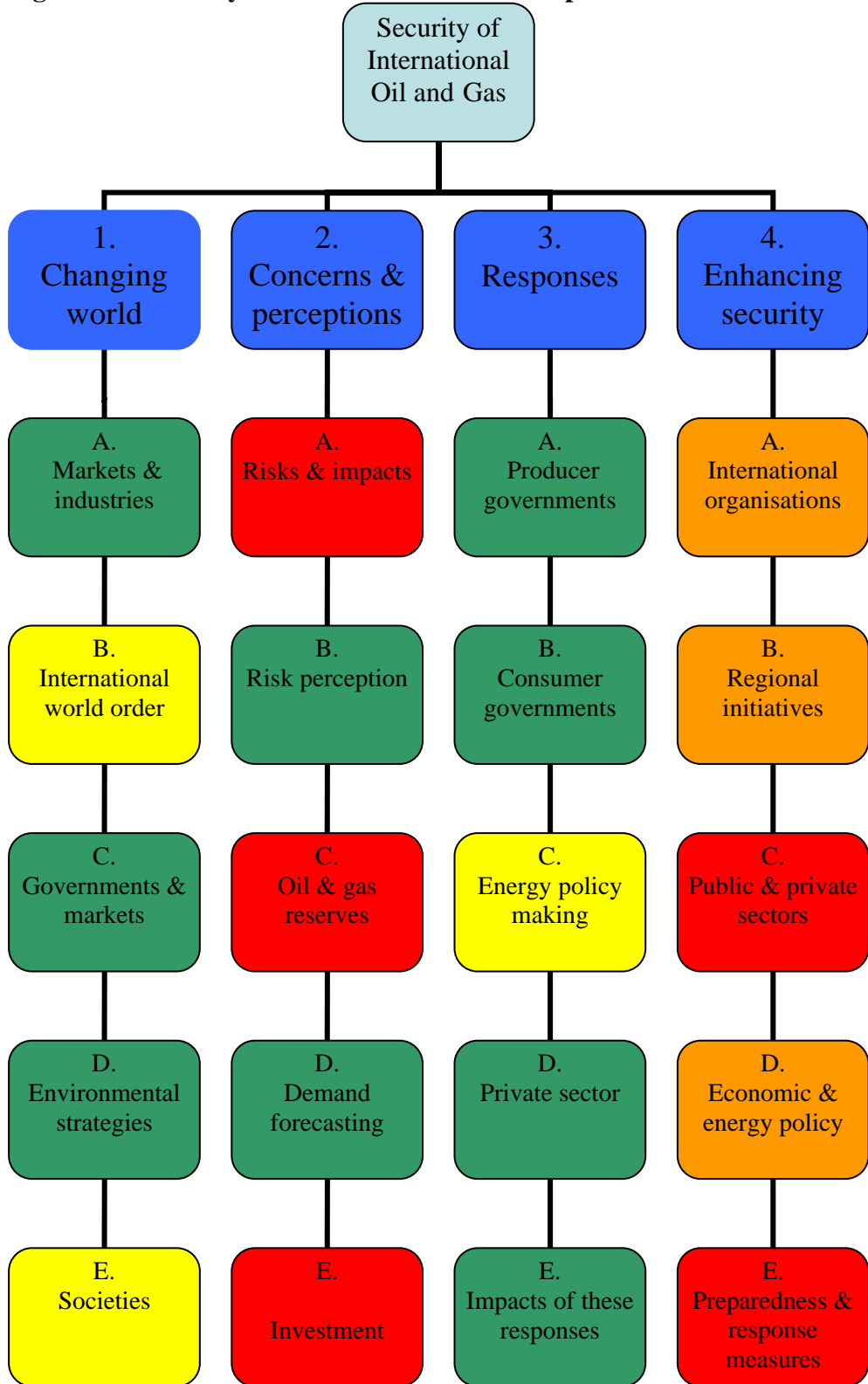
*Priority C: Research questions which provide direct support to government policy-making (Green in Figure 1):*

- 1a. How are international oil & gas markets and industries changing and what will be the impacts on international oil and gas security?
- 1c. How are the roles of governments and markets changing and what will be the impacts on international oil and gas security?
- 1d. What will be the impacts of evolving environmental and alternative energy strategies on international oil and gas security?
- 2b. How is security of international oil and gas perceived by different players?
- 2d. How can more reliable estimates be made of future oil and gas demand in major energy consuming countries?
- 3a. What are the likely policy responses of key producing/exporting countries?
- 3b. What are the likely policy responses of key consuming/importing countries?
- 3d. What are the likely responses of companies and financial markets?
- 3e. What are the range of possible outcomes of these behaviours on international oil and gas security and on world stability?

*Priority D: Research questions which provide less direct support to government policy-making but which add value to the research programme (Yellow in Figure 1):*

- 1b. How is the “international world order’ changing and what will be the impacts on international oil and gas security?
- 1e. How are societies changing and what will be the impacts of these changes in different regions on international oil and gas security?
- 3c. How do governments of different types formulate and implement energy policy?

**Figure 1: Summary of recommended research priorities**



## ***5. Current research capacity and fields of research***

Most of the research questions identified in the previous section are characterised by their inter-disciplinary nature. This provides two challenges for the UK research community if such a programme of research is to be carried out: an understanding of oil and gas must exist in participants from a wide range of disciplines; and these researchers must work in a collaborative and inter-disciplinary way.

This section provides a summary of the UK's social science research capacity in oil, gas and energy. This is followed by a brief review of capacity in area studies and in public opinion and social behaviour. The section concludes with proposals for making effective use of and enhancing the UK's research capacity in international oil and gas security.

This section includes tables which summarise the research capacity. More details are provided in Annex B.

### **5.1 Research in oil, gas and energy**

In 2003 the Science and Technology Policy Research Unit (SPRU) of Sussex University carried out a study of existing social science research capacity and activities in the field of energy in the United Kingdom (Berkhout et al., 2003). In this Report we focus on social science research relating to oil and gas (see Table 3 and Annex B, Table B1).

The current project identified three research institutions with substantial social science research capacity in oil and gas:

- Oxford Institute for Energy Studies
- Royal Institute for International Affairs, London
- University of Dundee: Centre for Energy, Petroleum and Mineral Law and Policy; and School of Accountancy and Business Finance

Between them they have as many more than 50 full and part-time researchers in the field of international oil and gas (excluding research students) in the disciplines of economics, law, accountancy and political science.

There are four further institutions with significant research capacity in international oil and gas, mainly relating to economics:

- University of Aberdeen: Business School and Law Department
- University of Cambridge, Department of Applied Economics; Judge Management School
- London Business School: Energy Markets Group
- University of Surrey: Energy Economics Centre

Two institutions have a substantial capacity in energy research, but oil and gas is currently only a marginal interest:

- Imperial College: Centre for Energy Policy and Technology
- University of Sussex, Science and Technology Policy Research Unit

The main expertise of this group of institutions lies variously in the fields of energy economics, energy markets and energy technology, with a varying emphasis on the environment. We have not included the UK Energy Research Centre in this survey as this is principally a virtual research centre.

In addition to these institutions which have oil, gas or energy as their core research activity, a number of other institutions have one or more researchers with a substantial or marginal interest in oil and gas economics, law, commerce, geography, and accountancy.

This survey shows that substantial actual and potential research capacity exists in UK research institutions in the field of international oil and gas. However, the ability of this capacity to address some of the research questions relating to security of international oil and gas is constrained by a number of factors, including:

- The relatively 'thin spread' of this capacity across at least nineteen institutions around the UK;
- The current application of a significant proportion of this capacity to energy and environmental issues other than oil and gas;
- The predominance of the disciplines of economics and business, with law, politics and international relations being relatively poorly represented;
- The lack of funding and of administrative frameworks to promote collaborative interdisciplinary research in the field of security of international oil and gas

## **5.2 Research in area studies**

With the exception of the Royal Institute for International Affairs there would appear to be no academic institution in the field of area studies and international relations which has oil and gas, energy and the environment as core interests. A detailed analysis of the UK's research capacity in regional studies and international relations is beyond the scope of this study, though the ESRC has commissioned such a survey, though the British International Studies Association, and their report is due before the end of 2006.

For this project we have carried out only a preliminary survey and the findings are summarised in Annex B. The information presented shows that the UK does indeed possess significant research capacity in area studies, particularly in the Middle East and North and North-East Asia. Two features are of interest in the context of this Report:

1. The capacity for research in certain regions of great importance to international oil and gas security appears to be less than might be desirable: for example the Former Soviet Union, Latin America, South and South-East Asia, and Africa; and
2. Few researchers in the identified research groups are active in the field of international oil and gas, even in those groups working on the Middle East.

## **5.3 Research in public opinion and social behaviour**

Given the importance of perceptions, public understanding, public opinion and the behaviour of societies, it will be necessary to incorporate research into these issues with some of the proposed research projects.

UK institutions with established records in public opinion research in different aspects of energy include:

- University of Cambridge, Cambridge Environmental Initiative
- University of Essex, Institute for Social and Economic Research
- Imperial College, Centre for Energy Policy and Technology
- University of Surrey, Institute of Social Research
- University of Sussex, Science and Technology Policy Research Unit

Of these, the Science and Technology Policy Research Unit has a long-standing reputation in this field (for example, McGowan and Sauter, 2005).

Research into social behaviour will draw on research capacity in the field of social psychology. Examples of institutions which have researchers active in the field of energy and the environment include the Departments of Psychology at the Universities of Surrey and Sussex.

#### **5.4 Recommendations: The way forward**

The development of a substantial programme of research projects in the security of international oil and gas will require collaboration between institutions, for no single institution has the size or the range of disciplines to address any one or more research questions identified by this report (Section 4) in the required depth.

Further, a great deal of information, expertise and understanding lies with government research institutions, international organisations and commercial companies.

For these reasons two types of collaboration may be identified.

1. Collaboration between research institutions:
  - amongst UK with social science expertise in international oil and gas
  - between these research institutions and:
    - UK research institutions in the field of international relations and area studies
    - UK research institutions in the field of engineering, technology and natural science
    - Academic and government research institutions in both OECD and non-OECD nations, both oil and gas importing and oil and gas exporting states
2. Collaboration between UK research institutions and non-academic institutions such as:
  - consultancy companies in the field of oil and gas;
  - law and accountancy firms, and financial institutions;
  - international oil and gas companies;
  - international organisations;
  - non-governmental organisations;
  - regional organisations and research institutions.

Even with such collaboration it will be necessary to address the issue of capacity building in UK social science from two perspectives:

3. *Short-term.* Social scientists who are currently active in fields relevant to international oil and gas and who wish to participate in the emerging research programme are likely to require short-term, intensive training in the fundamentals of international oil and gas. Such training can be provided by existing institutional capacity in the specialised oil and gas departments. In this way economists, lawyers, political scientists, area studies specialists, engineers and scientists can be encouraged and enabled to transfer their research activities to the field of international oil and gas.
4. *Long-term.* The UK's capacity of providing specialist or inter-disciplinary post-graduate education in the field of international oil and gas is very limited, and a large proportion of student places are taken up by overseas students. To a great extent this reflects a lack of funding available for UK students in this field, as well as the shortage of capacity to teach these subjects. If the UK is to develop long-term expertise in the field of international oil and gas it will be necessary for these deficiencies to be addressed

**Table 3. Summary of social science research capacity in the field of oil and gas in the United Kingdom**

	<b>Institution</b>	<b>Department</b>	<b>Main Fields</b>	<b>Main Disciplines</b>
<b>Important centres of expertise in international oil and gas</b>	University of Dundee	Centre for Energy, Petroleum & Mineral Law & Policy; School of Accountancy & Business Finance	Oil, gas, energy	Law, economics, politics, accountancy, finance
	Oxford Institute for Energy Studies		Oil, gas, power	Economics
	Royal Institute for International Affairs	Energy, Environment & Development	Oil gas, energy	Politics, economics
<b>Institutions with significant expertise in oil and gas</b>	University of Aberdeen	Business School; Law Department	Oil, gas	Economics, Law
	University of Cambridge	Department of Applied Economics, Judge Management School	Oil, gas, energy, environment	Economics, Commerce, Finance, Politics, Law
	London Business School	Energy Markets Group	Oil, gas, energy	Economics, Finance
	University of Surrey	Energy Economics Centre	Energy, oil, gas	Economics
<b>Other institutions with expertise in oil and gas</b>	University of Aberdeen	Business School; Law Department	Oil, gas	Economics, Law
	University of Cambridge	Department of Applied Economics, Judge Management School	Oil, gas, energy, environment	Economics, Commerce, Finance, Politics, Law
	London Business School	Energy Markets Group	Oil, gas, energy	Economics, Finance
	University of Surrey	Energy Economics Centre	Energy, oil, gas	Economics
	University of Edinburgh	Management School	Oil, gas	Finance
	Glasgow Caledonian University	Caledonian Business School	Oil, gas	Accountancy
	International Institute for Strategic Studies		Oil, gas	Political & military security
	University of Lancaster	Dept. of Geography	Oil, gas, environment	Geography, Development, Politics, Sociology.
	University of Leicester	Dept of Geography	Oil, gas, environment	Geography, environmental science
	University of Nottingham	School of the Built Environment; Business School	Energy, environment, oil, gas,	Environmental science, commerce, economics
	University of Oxford	Saïd Business School	Oil, gas, energy	Commerce, Finance, Economics.
	University of Plymouth	Centre for International Shipping and Logistics	Oil, gas, environment	Economics, shipping, commerce, environmental science

**Table 3. Summary of social science research capacity in the field of oil and gas in the United Kingdom (continued)**

	<b>Institution</b>	<b>Department</b>	<b>Main Fields</b>	<b>Main Disciplines</b>
<b>Other institutions with expertise in oil and gas (cont.)</b>	University of Sheffield	Management School	Oil, gas,	Economics
	Southampton Solent University	Law Research Centre; School of Technology	Oil, gas, environment	Law, management
	St Andrews University	School of Economics and Finance; Centre for the Study of Terrorism and Political Violence; Department of International Relations	Oil, gas	Economics, finance, international relations, security.
	University of Warwick	Business School; Politics & International Studies	Oil, gas	Economics, commerce, environment, politics, international relations.
<b>Institutions with substantial research capacity in energy, but with moderate or little focus on oil and gas</b>	Imperial College	Centre for Energy Policy & Technology	Energy, environment	Economics, technology
	University of Sussex	Science and Technology Policy Research Unit (Environment & Energy Programme; Tyndall Centre for Climate Change Research)	Energy, environment	Economics, technology
<b>Institutions with some research capacity in energy, but with little focus on oil and gas</b>	University College London	Faculty of Law	Energy, environment	Law
	University of East Anglia	Norwich Business School	Energy	Competition

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