Energy policy aims to fulfil a number of inter-linked, but not necessarily complementary goals. The importance of energy security derives from the critical role that energy plays in all aspects of every day and business life. Fossil fuels, particularly oil and gas, are the energy resources which underpin modern society. These serve both as fuels (to enable transport, light and heat) but also as the basic inputs, along with other resources, for manufacture and distribution of goods and services necessary for economic well-being and development. The economic and social implications of breakdown in energy security can be very severe.

The energy policy context has changed rapidly over the last twenty or so years, with major on-going impacts on Britain’s energy security. The increasing liberalisation and privatisation of energy industries globally means that they may be owned by companies whose interests are not necessarily the same as those of the Government. Natural gas has become the fuel of choice for electricity and heat within Britain, because of economic and environmental reasons, thereby fundamentally altering the trajectory of natural gas demand and energy security concerns. The recognition of the threat of climate change has led to the slow but inexorable inclusion of environmental concerns in mainstream energy policy. Finally, in the last few years Britain has moved from being a net exporter of energy to being a net importer, heralding greater concern about the sources of those imports.

Against this backdrop, the economic and political power of the globe has also rapidly altered. The increasing insecurity of the Middle East, for example related to the recent history of Iraq or concerns about Iran’s possible future nuclear capability, is precipitating alterations in the various dependencies between oil consuming and supplying countries. The fall of the Berlin Wall in 1990 has had major political ramifications, with the enlargement of the European Union (EU); the break-up of the Former Soviet Union (FSU); and the emergence of Russian nationalist capitalism. New economic and political world actors, such as Russia, India, China and Brazil, have led to a multipolar balance of power with complex structures of governance.

This already volatile mix of climate change worries, new global forces and liberalised energy markets is further shaken by increasing concerns about the long term availability and price of oil, gas and uranium. The developing economic powers have increasing energy resource needs. This in turn has led to the creation of new energy supply chain and strategic alliances, such as the majority of Angolan oil being sold to China. The increased global demand for resources has already led to increasing prices and is precipitating changes in the delicate balance of global relationships and strategic alliances. In addition, heightened concerns of ‘peak oil’ – that global supply of conventional oil has peaked – exacerbate these tensions.

In today’s uncertain and turbulent global markets, supply chain vulnerability is becoming an issue of increasing significance. As supply chains become more complex, as a result of global sourcing, supply chain risks increase, particularly in a multipolar world with increasing demand for resources of all kinds. If oil and gas supplies become increasingly expensive, and if they and other technologies are not available when needed, there could be severe energy security concerns with serious implications for social, environmental and economic well-being. The challenge to Britain is to manage and mitigate this risk in the short to long term, by reducing dependence on, and creating more resilient, supply chains in the short term.

**Summary of Proposal** – Energy security is, in one sense, a very practical and urgent issue. The lights have to be kept on; oil has to flow to meet demand. However, the economic and technical demands of keeping the lights on and the international relation and political aspects of keeping the oil flowing are generally dealt with separately because they have many different underlying energy security risks and solutions.

However, the hypothesis of this proposal is that Britain’s energy security would improve if they were dealt with in a more inter-linked manner. By bringing the different disciplines of energy policy, international relations and supply chain analysis together, this research cluster will analyse the various temporal and dimensional aspects of energy security. It analyses the extent to which energy secure policies within those disciplines exhibit resilience, stability, durability and robustness (after Stirling, 2008) and if so, in what situations and whether these characteristics add value, or not.
Focus of Proposed Research Cluster – Britain’s current energy policy is based on transforming its energy sector from a mainly fossil fuel based one to a more low carbon energy system, while at the same time ensuring energy security and reducing fuel poverty. To a large degree, the policy assumes that oil and gas (even if expensive) and low carbon technologies will be available when they are wanted, and that the necessary investment for new technologies and infrastructure needs will be met. It is not at all evident that these layers of optimism are well-founded. The purpose of the proposed research cluster is to strengthen the understanding of British energy security, in two main ways.

- First, to expand knowledge concerning how to make Britain more energy secure now, in the short term.
- Second, to analyse what has to be done in the short term, to ensure that energy security will be maintained in the medium to long term, with particular reference to the supply chains of oil and gas supply and sustainable energy technologies.

Aims and Objectives – The research cluster will be designed to bring together the ‘traditional’ energy policy approaches to energy security with new perspectives from the disciplines of international relations, security and supply chain studies. The research cluster will:

- Assess the fundamentals of oil and gas supply and demand, whether political, economic or physical, to Britain;
- Assess the necessary means to ensure short term energy security, both internal and external, to Britain and for both physical supply and infrastructure needs, and the constraints on that;
- Assess the necessary means to ensure medium to long term energy security by reducing dependence on fossil fuels while strengthening supply chains for those fossil fuels that are still necessary;
- Assess the extent to which the deployment of low carbon technologies to meet climate change goals will impact on overall levels of energy security (building on past work undertaken by project partners but concentrating on new or under-researched issues);
- Assess the supply chain needs of deployment of low carbon technologies, based on two case studies: marine energy and demand reduction technologies;
- Consider the relationship between different energy policy objectives including improving energy security and reducing energy poverty;
- Further the understanding of the value of individual and local actions for improving energy security;
- Highlight any research gaps within energy security, both within the focus of the research cluster but also tangential to it;
- Develop an agenda for further research, including specific proposals for new collaborative research projects;
- Stimulate networking and collaboration within the research cluster including both between institutions and disciplines within Britain, and centres of excellence abroad; and
- Bring a greater whole-system, inter-disciplinary approach to energy security analysis and policy.

Thematic Area to be Explored – The discourse about energy security is becoming ever more complex. Where once it was limited mainly to concerns about ensuring adequate supplies of energy within well-established frameworks of supply and demand options, this relatively simple construction has been broadened and deepened. In the energy policy world, debates about energy security now include the issue of climate change, since energy secure policies can be environmentally negative; the adequacy and resilience of energy systems and supply chains, including access to resources and the ability to overcome ‘shocks’; the stimulation of sufficient investment in infrastructure to ensure that the energy system is adequately operated, maintained, upgraded and expanded for secure functioning; encouraging innovation to enable the timely incorporation of new technologies (whether supply, demand or information technology) and design and operation initiatives to enable more efficient, and hence more secure, operation of the energy system; and implications of energy prices, on both domestic and overseas issues.

The 2002 PIU Energy Review considered energy security risks from two perspectives: those which derive internally or externally to Britain. It highlighted strategic risks which derive from outside the British borders, which often involve the risk of interruption to the supply of fuel from overseas and argued that the origin of the problem may be market power, political concerns or instability, or lack of investment in overseas infrastructure. And domestic risks, stemming from low or inappropriate investment within Britain in energy equipment (production, transportation or storage); from technical or human failure; from terrorism; or, from protests, such as the truckers strike in 2000 and the oil transporters strike in 2008. These internal and external issues have been highlighted in all subsequent Energy White Papers (2003, 2007 and 2008) and this proposal continues to use this basic distinction. However, what is becoming clear is that this distinction is blurred by supply chain issues which are relevant both to internal and external issues; and equally to technical and political aspects.
These supply chain issues fall into five areas. Firstly, oil and gas supply is a supply chain issue in itself, and a key focus of this proposal. Secondly, energy infrastructure, including electricity capacity and components, requires resources, including oil and/or gas to be made and transported to their place of use. Increased global economic activity has led to supply chain stresses, and these can be expected to continue. Thirdly, there are already supply chain concerns relating to long lead times for delivery or absolute availability of low carbon technologies or their system component, for example, pressure vessels for nuclear power reactors and onshore wind turbines. Fourthly, the development of new technologies, such as tidal and wave installations, requires the development of new supply chains and this is likely to pose particular challenges. Fifthly, many, if not most, conventional supply chains for products (including food) are very vulnerable to problems of energy security because (a) the focus on reducing stock means there is often very little in the ‘pipeline’ and (b) the ‘typical’ supply chain is designed around the idea of transport being a relatively low input cost and there is no real concept of it as a scarce resource.

The research cluster will examine all these issues. However, in addition it examines three other areas. Firstly, it analyses the institutional changes required to deliver major cuts in energy demand, thereby improving energy security – whether it be in buildings or in transport use. It also assesses the potential of individual and local actions to improve energy security. Individuals take decisions relating to their energy use in their homes, transport, personal consumption of goods, including food, and extent to which they recycle and reuse resources. Britain also has several positive examples of local authority and local non-local authority actions which improve energy security. The cluster will examine this, as well as how this can be improved by new technology. Finally, the cluster will analyse legal possibilities and problems.

Added Value to Existing Activities – The ‘new’ or ‘distinctive’ element of this proposal is to bring together three overlapping disciplinary research areas of expertise to address the problem of energy security: energy policy, international relations and research about supply chains. As discussed above, there has long been a distinction within the energy policy discourse between internal and external sources of energy security or insecurity.

The energy policy debate is, as yet, limited in its ability to incorporate new, or alternative, approaches to analysing and explaining evolving international contexts and their implications for domestic energy security. The research cluster will explore how Britain could develop strategic, flexible relationships with energy supply countries. In addition, it aims to develop a greater understanding and more secure approach to ensuring resilience in the strategic energy supply chains (a) for oil and gas (as it already attempts to) but (b) for resources and low carbon technologies (and their components) in the short through to long term to enable the move from the fossil fuel to low carbon economy.

Theoretical Approaches to Analysing Sustainable Energy and Energy Security - For the purpose of this proposal, we are not defining ‘sustainable energy’; rather we are analysing what properties a sustainably secure energy policy would have to satisfy. The research cluster commences with Stirling’s 2008 analysis identifying resilience, durability, stability and robustness as individually necessary and collectively sufficient sub-properties of sustainability (Figure 2).

This framework holds important practical consequences for policy making. It highlights the difference between system properties in the face of shocks as opposed to stress. Under shocks, the aim is to restore conditions of dynamic equilibrium for established trajectories (e.g. establishing appropriate incentives to get energy supply back as soon as possible). Under stress, the aim is more one of adapting the system to the shifting conditions (e.g. increasing demand reduction measures or transferring from fossil to non-fossil based energy). In an ideal world, a country would attempt to develop policies to suit conditions of both shock and stress. However, not all policies or situations are similarly flexible. This means that the choice of policies and actions put in place have different implications for change because of their attributes of robustness, durability, stability and resilience.

We will ask whether these four properties should also be the basis of a secure energy policy that both addresses the internal and external energy security concerns discussed above, but which also addresses the less definable, but
equally important, physical and political processes which are the backdrop of supply chain concerns. Stirling’s argument is used to kick off a debate about the theoretical principles underpinning energy security. His, and other work (e.g. UKERC, 2007[^13]) will be compared with analogous ideas emanating from the international relations and supply chains discipline to learn from and strengthen the theoretical principles of energy security policy[^14].

**Who will be Involved in the Research Cluster** - The PI is Professor Catherine Mitchell of the University of Exeter (UoE) and the Co-I is Professor Andy Stirling of the Science Policy Research Unit (SPRU), University of Sussex. Their CVs and competences are provided in Annex 3. The proposal is made up of five themes and the Theme Leaders are: UoE and University of Aberdeen for Theme 1 (Scene-Setting); Imperial College and UoE for Theme 2 (Technology and Absolute Constraints); University of Sussex and University College London for Theme 3 (Synergies and Conflicts); Cranfield University, the University of Westminster (UoW) and UoE for Theme 4 (International Relations and Supply Chain Analysis); and UoE and Sussex for Theme 5 (Bringing it all together: Consolidation and Outputs). The research cluster brings together three group: (1) traditional energy policy academics and practitioners, (2) transport and supply chain experts; and (3) international relations and foreign/security policy academics and practitioners. The research cluster has 20 partners and its disciplines of the partners span Geography, Engineering, Economics, International Relations, Politics, Arab and Islamic Studies, Supply Chain Theory; Science, Technology and Innovation Policy, Physics, Transport Studies and Law. While currently British based, the intention is to develop appropriate overseas members. It has been budgeted to invite experts to give key note talks and be involved in workshops and smaller meetings.

**Relevant Expertise for Sustainable Energy and Energy Security Issues** – All the different dimensions of energy security are strongly represented in the research cluster. Please see attached letters of support for details.

There are considerable levels of expertise within the group for the short term economic and technical energy security issues related to infrastructure. Prof. Strbac of Imperial College will co-lead this work with Phil Baker, who has recently joined UoE from BERR where he worked as the technical interface between Government, economic regulation and infrastructure issues. Prof. Jenkins of the University of Cardiff, Dr. Gross and Prof. Pearson of Imperial College; Prof. Mitchell, Dr. Woodman, Dr. Hor, Dr. Ahmed and Dr. Connor of UoE; Dr. Watson and Dr. Sauter of SPRU bring together an impressive depth of expertise on issues ranging from the energy security issues posed by increasing percentages of heat and electricity fuelled by natural gas, through to market and regulatory aspects for appropriate design and operation of the networks and sufficient investment. Similarly, with respect to delivery of oil to the pumps, Prof. Browne and colleagues at UoW have a particular expertise in freight transport and supply chains. Different supply chains (for the same product) require different amounts of transport energy. Sourcing strategies, choice of transport mode, urban freight initiatives are very important and relevant to energy security. These topics will be studied for their relevance here but also within the work on supply chains, described below. UCL also brings expertise on transport here and to the supply chain work below.

The expertise in the cluster in understanding the fundamentals of oil and gas supply and demand overlaps to a degree with the understanding of the broader, more complex set of interactions between religious groups, races, nation states and external influences and it implications for energy security. With respect to the former, Prof. Kemp and his team at Aberdeen University bring detailed knowledge of both domestic and global oil and gas supply and demand. This is powerfully complemented by Chatham House. Alongside them, MEC International and the Windsor Energy Group (WEG) has an unparalleled membership of practitioners and facilitate long standing groups such as the Arab Financial Forum and the Gulf Policy Forum. Sorrell (Sussex University) is currently undertaking a Technology Policy Assessment of Peak Oil for UKERC and will add another dimension to this area.

Both Chatham House and MEC International are also involved in the International Relations side of energy security. They are complemented by a strong group of international relations academics working on energy and security issues. This spans Arab and Islamic Studies experts (Middle East and Gulf political economy (Niblock, Stansfield, Githens-Mazer of UoE); the implications of rising energy and resource demand in newly developing manufacturing centres, such as China (Niblock, Exeter; Watson, Sussex); Russia and Gas (Hadfield, University of Kent; MEC International; Bellamy, Cranfield); and changing dependencies between oil suppliers and consumers (Niblock, Stansfield, UoE; Hadfield, Kent; MEC International, WEG; Chatham House; Bellamy, Cranfield).

The research into Supply Chain Issues will be led by the University of Cranfield and the University of Westminster, in conjunction with Prof Niblock and Phil Baker of UoE. The transport system and everything to do with supply and distribution of food, water and energy are viewed by government as parts of the Critical National Infrastructure. Current supply chain management relies on the combination of strong consumer demand at home satisfied by globe spanning supply chains, facilitated by cheap transport costs. Supply chain may fail for all sorts of
linked reasons, but the structural changes underway in the global economy, linked both to oil and the rise of a new geopolitical and economic multipolar world order will inevitably place more pressure on them. UoW, as discussed above, brings general expertise about transport and supply chains, including being Co-I in the EPSRC Green Logistics Consortium. Both Cranfield and UoW bring strong links with transport and logistics research groups.

Given the differing goals of energy policy, it is clear that there will be synergies and conflicts with the policies put in place to deliver energy security. As described above, the theoretical analysis of energy security is led by the Co-I, Prof. Stirling of Sussex University who is also Co-I of the STEPS research programme (please see attached CV). Prof Skea, Research Director of UKERC has also been working on energy system resilience issues, both personally and within UKERC, and co-supervises a PhD student with Dr. Gross of Imperial College. Their work is complemented by Prof Dunne (UoE) who has undertaken similar theoretical analyses of such terms as ‘security’ and the new strategic priorities for British foreign policy, from an international relations perspective. The Sustainable Development Commission, the Government’s advisor of sustainable development, and an institution with tremendous reach in terms of discussion and dissemination, takes the lead on greater understanding on what may be understood by climate security. SPRU, Imperial College, Chatham House and Manchester bring their technological, economic, financial, political and social expertise to the topic of cost of security; price, availability and affordability of fossil fuels; and the timely investment in new infrastructure.

In many ways, as described above, demand reduction is the key positive synergy between energy security and other energy policy goals. UCL brings broad strength in demand reduction, particularly within buildings and modelling energy (Profs Tadj Oreszczyn, Robert Lowe and Phillip Steadman, Dr. Barrett); University of Westminster brings expertise on alternative transport modes; Dr. Devine-Wright, Manchester brings expertise on personal consumption and behavioural choices along with Dr Barr of UoE and Dr West of Plymouth University. The Cornwall Energy partnership will build on its previous work on the resilience of local communities to climate change and energy use. All these partners as well as local Cornish groups, such as Transition Cornwall, will analyse the value of local institutions and communities for improving energy security.

Three themes running through the research cluster are case studies which relate to marine renewable energy technologies, demand reduction, and legal implications for energy security. The insights derived from the majority of cluster activities will be applied to these case studies. Demand reduction will be led by UCL and has been discussed above. The UKERC Marine Roadmap aspires to 2 GW of wave and tidal energy by 2020. If a wave installation is rounded up to 1 MW each (a current Pelamis is 750kW), then this is 200 marine installations a year required between 2010-2020. Developing the supply chains for any, or some, of these installations, including short and longer term access to energy and resources for manufacturing and transporting them, is essential for Britain’s energy security. Nuclear power and Carbon Capture and Sequestration for Coal plants have similar supply chain concerns. UoE has a very strong marine energy group, under Prof. Smith, which includes the PRIMaRE (or Wave Hub) research facility. UoE is joined by Peter Gledhill who has several decades of experience working in the marine oil and gas industry. A final area led by the University of Cambridge, again running through the cluster, is that of raising potential legal issues which may arise from various lines and paths suggested.

How the research cluster will operate

**Management** - The research cluster will have a steering group made up of the PI (Catherine Mitchell, UoE) and the Co-PI (Andrew Stirling, Sussex), Russell Seal (Chair of Council at UoE, and former MD of BP Plc), and Nick Hartley (an independent expert in energy policy and former head of the Energy Policy Analysis Unit at the DTI). The Research Councils have indicated that, if the proposal is successful, they are willing to sit on the Steering Committee. As detailed in the schematic the research cluster management group will act as a conduit for communication between the steering committee and the theme leaders. Likewise the theme leaders will communicate directly with cluster members and potential new members. UoE will appoint a 0.5fte administrator to deal with the day to day management of the cluster and organisation of events.
Development - The cluster will act as a developer to early stage researchers (ESR) or students. The budget allows each academic institution to bring an ESR to attend one workshop a year. In addition will use Access Grid to facilitate group-to-group interactions (http://www.accessgrid.org), and this will enable increased involvement of ESRs in network activities. Currently there are Access Grid nodes at the Universities of Exeter, Cardiff, Manchester, Aberdeen, Cardiff and UCL – representing a good geographical representation of network members. The energy security network will be developed by building on those networks already in place from the cluster members. It is envisaged that networks and research proposals will develop out of the research cluster. At the end of the four years, an assessment can be made whether it remained focussed enough to carry on or whether new, expanded collaborations should form in its place.

Proposed activities - The Work Plan providing activities, timing of those activities and their outputs is set out in Annex 1. The research cluster will take place in three broad phases with 5 themes, although overlaps inevitably occur. The first phase will undertake four scene-setting exercises in Theme 1 (Year 1) on the four central areas of the proposal: establishing what energy security is, and the synergies and conflicts which may be related to it; understanding the reach and value of international relations in a multipolar world; understanding the importance of supply chains to a secure energy future; and furthering the understanding of the value of local and individual initiatives in improving energy security. The next two phases (Phase 2, Year 2-3.5 Dimensions of Energy Security; and Phase 3, Year 3.5-4 Bringing it all Together) enables a deepening of understanding of these central areas. By the end of the research cluster, each issue will have been addressed in greater depth on three levels so that the inter-relationships between energy security, international relations and supply chains become clearer; and so that recommendations can be made to improve and coordinate policies to do with energy security across the British Government.

Activities will include a large Horizon Scanning Conference at the beginning of the cluster, and a ‘Bringing it all Together’ Conference at the end. In between, as described above there are a series of workshops and meetings. This will include a joint meeting on Equity and Energy Security (undertaken, if successful, with the Environmental Change Institute of Oxford University). In addition, throughout the cluster, there will be smaller, inter-disciplinary research projects, which will always lead to a deliverable. Currently, ideas include an analysis of marine technology and the issues raised about its development drawing on lessons learnt from the oil and gas industry’s skills and development history (UoE); analysing the particular reasons why it seems that the oil and gas industry does not seem to be investing in sustainable energy technologies (Chatham House); comparing different supply chain policies of different countries (U of Westminster); and implications of country energy trade flows for energy security (UCL); skills and capacity needs (UoE, UCL, UoW). In addition, overseas, and non-cluster member, experts will be invited to attend meetings or lectures. We will field members at conferences. There will be small, applied policy meetings with decision-makers, either in or outside of Government, arranged as a result of the cluster contacts. There will be background meetings to deliver the book and the special editions. Finally, there will be meetings to brainstorm about inter-disciplinary spin-offs.

Promotion of activities – In year one we have budgeted for the development of a dedicated website for the research cluster, and this will also involve developing a ‘brand identity’ that will enable the cluster and it’s activities to be widely and easily recognised. The large conferences at the start and end of the funding period will be widely advertised to attract delegates from outside of the core research cluster, and promotion of these events will be particularly aided by core members of the research cluster from outside academia, namely the Sustainable Development Commission, MEC International (through the Windsor Energy Group) and Chatham House. The website will host an on-line forum for cluster members to facilitate exchange of knowledge and ideas, and to promote the activities of sub-groups and individuals to the wider cluster. We will also endeavour to attract high profile sponsors for the larger conferences and workshops, both to augment the income stream to support these events but also to raise the profile of the cluster’s activities (this endeavour will be assisted by Research Knowledge Transfer team at Exeter University). We will also invite key journalists writing on energy issues from the UK media to attend the larger events, and via the communications department at Exeter University we will issue press releases highlighting specific achievements and findings emanating from of the cluster’s research activities.

Plans for extending collaboration beyond the award period - Within the consortium, there are plans for a number of smaller research activities, as discussed above. The cluster also aims to highlight gaps in the understanding of the best means to secure energy, and to develop further research projects by building on the research cluster outputs or on the smaller, individual inter-disciplinary network clusters which take place. It is hoped that this, in addition to the cluster meetings, will lead to permanent useful contacts and research relationships.

Expected outcomes and outputs - We believe that the proposed timetable is realistic for achieving the deliverables outlined in the attached work plan. These deliverables are Steering Group meetings; workshops and meetings with briefing notes; two Special editions (16 academic papers); a book. The main body of meetings finishes at the end of Q1.
in the 4th year, so that the book can be delivered to the publisher by the end of the four year funding period (Palgrave Macmillan has accepted in principle). The majority of 3rd year meetings aim to develop papers for the Special Editions of academic journals. Most crucially we expect new interdisciplinary partnerships to emerge and be sustained as a result of the unique mix of participants brought together in this cluster, and their meetings will lead to a deliverable whether a paper, a briefing notes, a research proposal and so on. The early stage researchers will have the opportunity of attending meetings. As a result of this, we aim to forge a new pathway in energy research that will open up new opportunities and lead to further successful funding applications for the cluster’s formal and informal members.

One of the main outcomes of the cluster will be to disseminate the clusters activities and outputs to a wide audience. The STEPS centre, which Prof. Stirling is Co-I of, has an excellent website and we will learn from their experience. The cluster members are very well placed to disseminate to the public arena (e.g. SDC). In addition many of the academic energy members are members of UKERC, and well networked within that community and able to take up the opportunities of the Meeting Place. MEC-International is well placed to disseminate between private and public practitioners. The quality of cluster members is exceptionally strong and the intention is to disseminate across a wide spectrum of society – from Governments, businesses, academics, practitioners, but also local authorities and local groups. But the cluster will also lead to bridge-building between disciplines, cross-fertilisation of ideas and improved understanding of the interactions between energy security and sustainable energy issues simply because of its interdisciplinarity.

1 Lawrence Freeman, 2008, A Choice of Enemies: America Confronts the Middle East, XXXX
5 A. Stirling, 2008, Strategies to Address Incertitude and Intractability in Governance for Sustainability, Poster for Stockholm Resilience Conference, available from a.c.stirling@sussex.ac.uk
6 Infrastructure is taken to include the facilities (such as ports), networks, energy capacity and information and control technology necessary to supply and transport energy from suppliers to consumers
12 IEA, 2008, Energy Technology Perspectives: Scenarios and Strategies to 2050, OECD.