SUSSEX ENERGY GROUP

SPRU, University of Sussex,
Falmer, Brighton BN1 9QE
www.sussex.ac.uk/spru

INITIAL RESPONSE TO THE STERN REVIEW

The Sussex Energy Group at SPRU, University of Sussex is a leading social science research group on energy issues. The Group receives core funding from the Economic and Social Research Council for an interdisciplinary programme of research on the transition to a sustainable, low-carbon economy.

The Group has collectively brought together a limited set of critical questions that we think the Stern review should address. These questions concentrate on the economic aspects of mitigation rather than adaptation and have been grouped under six generic headings. Most of these questions are the focus of previous and on-going research by members of the Group. We have highlighted several of our most relevant studies in these areas and have included related publications as evidence to the Review Team. We would be pleased to submit further evidence on these topics should that be helpful.

Energy efficiency

The UK Government in its 2003 Energy White Paper placed much emphasis on energy efficiency as a primary means to reduce carbon emissions. But there is scepticism over the cost effectiveness of energy efficiency policies and the ultimate contribution that they can make.

- Is it true that a large cost-effective potential exists to improve energy efficiency? If so, why has this not been taken up? What are the drivers and barriers to improved energy efficiency and how do these differ between different sectors of the economy?
- How useful are conventional economic models for understanding individual and organisational behaviour in relation to energy efficiency? Can other approaches (e.g. behavioural and new institutional economics) improve our understanding and contribute to practical policy design?
- On the basis of the above, what kinds of policy packages are most likely to be effective in encouraging energy efficiency within different sectors of the economy?
- If economic incentives are necessary to encourage energy efficiency, how can they best be combined with other approaches, given that large price increases in some areas (e.g. private transport) appear to be politically unfeasible?
- To what extent could energy efficiency be self-defeating as a route to a low-carbon economy? In other words how significant are the direct, indirect and economy-wide 'rebound effects' from efficiency improvements? How could such effects best be offset?

Both the so-called 'barriers' to energy efficiency and the magnitude of the 'rebound effect' are long-standing features of academic and policy debate. Successful climate policy must overcome the first and mitigate the second, but this requires greater understanding of the relevant issues and

mechanisms. Previous research by the Sussex Energy Group has focussed on organisational decision-making in relation to energy efficiency and the design and evaluation of energy efficiency policies[1]. We are currently undertaking a comprehensive review of evidence for the rebound effect[2].

Technology and innovation

Substituting low-carbon energy sources for high-carbon ones could radically reduce greenhouse gas emissions. Such substitution may be more or less cost-effective depending on the speed of innovation in low-carbon technologies, the timescale of deployment and the mechanisms by which innovation and diffusion are encouraged.

- What is the evidence about the relationship between technology diffusion and cost reductions, whether via 'learning' or in other ways?
- What are the essential components of 'learning', how far are they technology-specific and in what ways can public policy help accelerate learning processes?
- How can innovation in low-carbon technology most cost-effectively be pursued internationally, and with what mix of private and public funding and participation?
- What is the evidence about the effectiveness of alternative methods of public support for innovation?
- How can low-carbon technologies best be supported at each stage of the innovation process (e.g. R&D, demonstration, commercialisation) and how can any gaps in this process be overcome?
- Is 'not picking winners' a good description of current policy for low-carbon technology and – whatever the answer – is it a rational basis for future policy given the limited public resources available, the scale of the problem and the increasing internationalisation of technology development?
- What mechanisms contribute to the establishment and 'lock-in' of energy systems and what types of policy can facilitate a transition to a low-carbon energy system?
- Technologies are embedded in wider infrastructures, both social (e.g. a skills base, user practices) and technical (e.g. distribution systems), which change over the long term. To what extent is and should policy be promoting joined-up innovation that focuses upon the level of entire systems? Structural, system level change has strategic implications too (see Strategic Issues section).

Work at SEG has been considering the processes, dynamics and possibility for steering innovation at the systems level[3]. It has also been investigating the appropriate mechanisms for public R&D support with a particular emphasis on cleaner fossil fuel technologies[4]. Increasingly, analysts recognise not only that technological innovation is embedded and shaped within wider system-level changes, but also that the degree of resource efficiencies and emission reductions associated with sustainable development (e.g. a 60 per cent cut in carbon by 2050) will require structural changes at the system level.

Competitiveness

- What is the short-term distribution of the cost burden across UK economic and industrial sectors of low-carbon policies?
- Which economic sectors might be damaged, and to what extent, by low-carbon policies in the UK that may be more stringent than in trading partner countries?
- How far can Government develop cost-effective policy instruments to compensate low-carbon 'losers' without falling foul of State Aid or WTO rules?
- If UK low-carbon policies reduce exposure to international fossil-fuel price fluctuations, how far would this benefit the UK economy as a whole?

Developing country issues

It is a truism that the increases in carbon emissions in rapidly industrialising economies comfortably exceed current reductions in EU emissions. Effective climate change policy must, for this and other reasons, have a significant international dimension.

- What is the evidence about the capacity of economies such as those of China and India to derive 'win-win' (economy-environment) results from improvements in the operating efficiency of energy-intensive processes, especially coal-fired power plant? How can such benefits be unlocked?
- What is the evidence about international technology-transfer mechanisms for both large-scale (e.g. power plant) and small-scale (e.g. wind turbine) technologies?
- What are the economic returns to a UK policy to develop and transfer low-carbon technologies to developing countries?

Recent research at SPRU has focused on the scope for technology transfer from the UK and other OECD countries to developing countries, particularly China[5]. This shows that technology transfer that enhances industrial capacity in developing countries is difficult due to factors such as micro-management by governments, conflicts of interest between providers and recipients of technology and a lack of managerial skills within recipients. During 2006, a further phase of work will commence with the Tyndall Centre for Climate Change Research that will evaluate the effectiveness of State-led technology transfer programmes for low carbon technologies.

Low-Carbon Energy Sources

A growing range of low-carbon energy sources provide options in mitigating climate change. These have widely varying characteristics with respect to their state of development, current costs and likely changes in cost profiles in future, speed of development, flexibility, and relationships with existing energy infrastructures.

- What feasible contributions can the various low-carbon energy sources make to reducing carbon emissions over 20, 30 and 40 years?
- How do different low-carbon energy technologies compare in terms of the flexibility in planning and construction and their operational role within electricity systems?

- What is the evidence about the relative economics of different low-carbon technologies under different assumptions over the evolution of energy systems?

SPRU has worked on many of these issues over the years and has particularly focused on some of the issues to which nuclear power gives rise.[6]

Wider Strategic Issues: sustainability, precaution and diversity

In considering the relative merits of different low-carbon energy options, there arise a range of wider strategic issues, including environmental sustainability, diversity and security of supply. Conventionally, the favoured means for addressing these questions is cost-benefit analysis at micro level and econometric and simulation modelling at macro levels. A number of methodological questions arise in this connection:

- Cost-benefit analysis can be a powerful tool for addressing positive and negative effects at the margins of a technological or economic system, which have relatively direct causal relationships with market or shadow prices. The utility of cost-benefit analysis is less clear if the structure of the system itself is subject to change, or if significant effects have only remote, complex or indirect links with markets. These are exactly the conditions that apply under climate change, thus raising serious questions over the role of such methods. To what extent can evolutionary economic modelling and integrated appraisal tools address these concerns?
- A similar query arises for macro-economic approaches. Here, much of the debate about climate-change economics is couched in terms of the quantified costs of climate mitigation against quantitatively ill-defined benefits. Can national income accounting be robustly revised so as to give a reliable indication of the benefits of mitigation? How might this deal with the intrinsic uncertainties?
- A dominant feature of the climate-change debate is uncertainty. This applies both to the environmental imperatives as well as the policy responses and extends well beyond those issues that can be readily quantified in terms of risk. The increasingly well established policy response to these intractable forms of uncertainty, ambiguity and ignorance lies in new approaches to 'precautionary appraisal'. What are the best ways to articulate these new approaches with more conventional probabilistic approaches?
- Particular attention tends to be focused on the merits of energy diversity. This provides a hedge against uncertain global markets and geopolitical events, as well as a means to foster competition and innovation and accommodate divergent social values. But questions arise over how to characterise the relative diversity of contending energy portfolios and how to measure diversity in a system taken as a whole. How can we best deal with the trade-offs between different aspects of diversity, and with the costs of drawing on lower performing options? What insurance premium is it appropriate to spend on diversity, and how to spend it?

Research at SPRU over the years has directly addressed many of these questions. This includes detailed critical analyses of the results generated by studies of the environmental and wider external costs of energy technologies[7]. This has led to an interest in more robust appraisal techniques, including the development of the multi-criteria mapping approach[8]. Drawing on this work, SPRU has pioneered the development of new 'process-based' understandings of

precautionary appraisal, with and given direct attention to the practical policy implications[9]. Likewise in the analysis of diversity, research at SPRU resulted in the development of a novel form of diversity analysis, which has since been widely applied, including in the last UK Government Nuclear Review[10]. This is now further developed in such a way as to address the above questions even more directly[11].

References in order cited

[1] Sorrell, S. (2004), 'Understanding barriers to energy efficiency', in S. Sorrell, E. O'Malley, J. Scleich and S. Scott *The Economics of Energy Efficiency: Barriers to Cost Effective Investment*, Edward Elgar, Cheltenham.

[2] Sorrell, S. and J. Dimitropoulos (2005), *An assessment of evidence for the rebound effect from improvements in energy efficiency: Scoping Note*, SPRU, University of Sussex.

[3] A Smith, A Stirling, F Berkhout, (2005) 'The governance of sustainable socio-technical transitions' *Research Policy*, **34** (2005) 1491-1510.

[4] J. Watson (2005) Advanced Cleaner Coal Technologies for Power Generation: Can they deliver? Paper for BIEE/UKERC Academic Conference, Oxford, 22-23 September.

[5] J. Watson and Liu Xue (2002) 'Cleaner Coal Technology Transfer: Obstacles, Opportunities and Strategies for China' in D Runnalls et al (eds.) Trade and Sustainability: Challenges and Opportunities for China as a WTO Member Winnipeg: IISD.

[6] G. MacKerron 'Nuclear power and the characteristics of 'ordinariness' – the case of UK energy policy' *Energy Policy* 32:17, November 2004, 1957-1965.

[7] T. Sundqvist, P. Soderholm, A, Stirling, 'Electric Power Generation: Valuation of Environmental Costs,' in C.J. Cleveland (ed.), *Encyclopedia of Energy*, Academic Press, San Diego, 2004

[8] a) A. Stirling, S. Mayer, 'A Novel Approach to the Appraisal of Technological Risk' *Environment and Planning C*, **19**, 529-555, 2001;
b) Madlener, R., and S. Stagl. 2005. Sustainability-guided promotion of renewable electricity generation. *Ecological Economics* **53**:147-167.

[9] a) A. Stirling, O. Renn, P. van Zwanenberg, A Framework for the Precautionary Governance of Food Safety: integrating science and participation in the social appraisal of risk, chapter in E. Fisher, J.Jones, R. von Schomberg (eds), *Implementing the Precautionary Principle: Perspectives and prospects*, Edward Elgar, Cheltenham, forthcoming;
b) Stagl, S. forthcoming. Multi-criteria Evaluation and Public Participation: The Case of UK Energy Policy. *Land Use Policy.*

[10] A. Stirling, 'Diversity and Ignorance in Electricity Supply Investment: addressing the solution rather than the problem', *Energy Policy*, **22**, (3), pp. 195-216, March 1994

[11] S. Awerbuch, A. Stirling, J. Jansen, 'Portfolio and Diversity Analysis of Energy Technologies Using Full-Spectrum Uncertainty Measures,' in: David Bodde and Karyl Leggio (Eds.) *Understanding and Managing Business Risk in the Electric Sector*, Forthcoming, 2005