Final Report

SCENARIO EXERCISE ON MOVING TOWARD A SUSTAINABLE ENERGY ECONOMY

A project to identify important areas of economic and social research to support the transition to a Sustainable Energy Economy

By

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Executive Summary

Project Background

Dramatic improvements are possible in how efficiently energy is used in the UK. More secure, diverse, and reliable energy supplies can be developed. The goal of reducing carbon emissions 60 percent by 2050 can probably be achieved. But moving toward this kind of *sustainable energy economy* is as much an economic and social challenge as it is a technological challenge.

The priority social science research needs for supporting the transition to a sustainable energy economy are exceptionally broad, touching on topics as diverse as the psychology of consumer energy choices, economic incentives for accelerating energy efficiency improvements, positive images of the future to motivate change, regulatory and policy changes to encourage innovation, governance changes to encourage better foresight and long-term action, and assessments of energy system vulnerabilities and contingency planning to deal with energy shortfalls. Pursuing this ambitious agenda will require significant changes in research methods and styles, including major initiatives to encourage interdisciplinary research projects that bring together participants from different social sciences, the natural sciences, and engineering disciplines.

These are among the key findings of a **Scenario Exercise on Moving Toward a Sustainable Energy Economy** carried out by the Institute for Alternative Futures (IAF) and the Institute of Innovation Research (IoIR) at the University of Manchester/UMIST. The project was sponsored by the Towards a Sustainable Energy Economy Programme (TSEC), a new joint effort of the UK's Economic and Social Research Council (ESRC), the Natural Environment Research Council (NERC) and the Engineering and Physical Sciences Research Council (EPSRC).

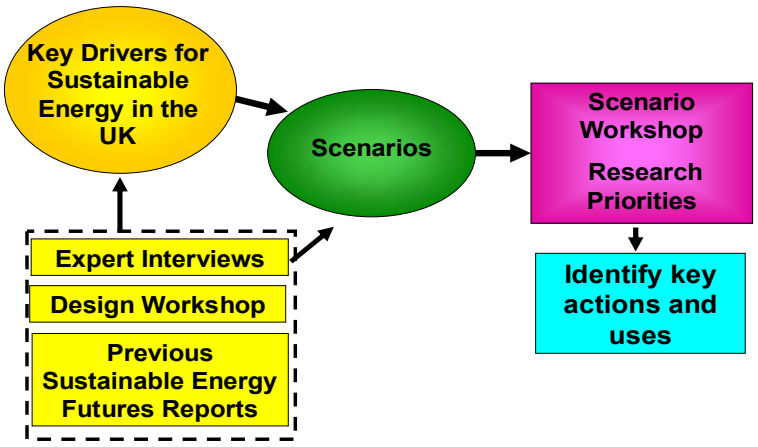
Project Objectives and Methodology

The project's central objective was to develop recommendations on economic and social research priorities. Another objective was to recommend improvements in how such research should be carried out and how the research can be communicated and utilized most effectively.

The project used an innovative methodology in which alternative scenarios of how a sustainable energy economy might emerge served as a framework for discussions of research priorities. The scenarios explored widely different ways in which the energy system might evolve between now and 2050. This approach was based on the assumption that looking at a wide "possibility space" of plausible future conditions provides a more creative perspective than thinking that is confined to current conditions, outlooks and assumptions.

Figure 1 presents an overview of the approach used in the project. The key steps in the methodology are to: 1) Identify key *driving forces* for the time frame 2004-2050 that will shape the evolution of the energy system; 2) Develop alternative forecasts for these driving forces and summarize the resulting pattern of forecasts in the form of *scenarios*; 3) Design a *Scenario Workshop* that uses the scenarios as a framework for discussion, and that employs computer-based groupware and visualization to encourage creative thinking; 4) At the Scenario Workshop, engage key stakeholders in identifying *priority areas for economic and social research*.

Figure 1. Overview of Approach



To identify driving forces of change, an Advisory Committee of experts was appointed and invited to attend a Design Workshop in November 2003 (participants are listed in *Appendix 3*). Developments in the areas listed below were selected by the Advisory Committee as the most important drivers likely to shape the energy future.

- *Supply System Technologies*
- *Energy Using Technologies*
- *Economy* – growth, competitiveness, fuel costs, investment role of financial markets
- *Society* – relevant aspects of demographics; location, consumption and lifestyle patterns; values and attitudes; perception of risks; worldviews
- *Climate Change/Environment*
- *Politics and Governance* – government energy policy, evolution of the UK's political institutions, disasters and game changing events

The general character of the scenarios was patterned around four general *scenario archetypes* designed to insure that a full range of plausible future conditions are examined: a positive "extrapolative" scenario, a problem-plagued "hard times" scenario, a structurally different scenario that portrays a "different kind of progress," and a scenario that imagines "best feasible" possibilities. The character of the scenarios was refined by drawing upon previous UK scenario studies, in particular the scenarios of the Royal Commission on Environmental Pollution (RCEP) and the foresight scenarios used in the Energy White Paper. The detailed content of the scenarios was then developed by preparing alternative forecasts for the driving forces in the context of the scenarios.

The Scenarios

The four scenarios created through this process are summarized below. Each scenario portrays an effort, not always successful, to achieve the Government's goal of a 60 percent reduction in carbon dioxide emissions by 2050.

More Is Better This scenario achieves decarbonisation through extensive development of large-scale, low-Carbon energy supply technologies, e.g. offshore wind, gas and coal with carbon capture & sequestration, biofuels, and nuclear energy. Two variants of the scenario explore contrasting sets of socioeconomic and political conditions which can accompany this change in energy system technologies. (Gov) features high levels of coordinated government policy, regulation and other forms of intervention in the marketplace. (Tech) achieves such a change through liberalization of the energy market and high levels of technological innovation in industry.

Making Do In Hard Times This scenario begins on a path similar to the *More is Better* scenario, but finds that path derailed by a global economic downturn triggered by failures in the US economy. Some decarbonisation is achieved by the reduction in energy use caused by reduced affluence. Increasing fossil fuel prices and concerns about energy availability drive a rapid uptake of low-cost energy efficiency technologies. Higher prices also create an incentive for a wide range of energy-saving behaviour changes and conservation practices. There is relatively little change in the character of supply technologies, because so little capital is available for investment.

Small Is Elegant This scenario achieves decarbonisation through dramatic improvements in energy efficiency and a shift toward renewable energy. Nearly all the activity on the supply-side is small-scale and distributed. The electrical grid is upgraded to a much "smarter" level to accommodate distributed generation, increase the effective capacity of existing power lines, and apply real time pricing to improve demand management. Neither nuclear power nor coal is utilized. These changes reflect both technical progress and underlying value shifts towards more locally-focused, community-based ways of living.

Leading the Next Industrial Revolution This scenario achieves decarbonisation through improvements in energy efficiency combined with breakthroughs in both large- and small-scale zero-Carbon renewable supply technologies. These breakthroughs result from developments that occur in areas like IT, biotechnology, and nanostructured materials. By 2050, a new kind of "Hydricity Economy" emerges based on progress in fuel cells and in interrelated systems for producing hydrogen and electricity. Technological progress along these lines makes it possible to move

rapidly toward a complete decarbonisation of the energy system and triggers the Next Industrial Revolution based on environmentally advanced technologies.

Scenario Workshop: Reactions to the Scenarios

The main element of the project was a *Scenario Workshop* held on the19th and 20th of February 2004 in London. Twenty-three participants attended, representing a wide range of organizations and disciplines (See *Appendix 3*). After working with the scenarios, Workshop participants voted on their comparative likelihood and desirability. This occasioned considerable debate and some resistance, but the results proved interesting.

- There is a striking gap between the future participants believe is most likely (Scenario 1, *Bigger Is Better*) and the future they believe is most socially desirable (Scenario 3, *Small is Elegant*).
- It is worth devoting significant effort to heading off the problems embodied in the second scenario, *Making Do in Hard Times*, and developing contingency plans for energy supply shortfalls. While this scenario was not judged highly likely, many participants viewed it as "somewhat" or "moderately" likely.
- The vote on scenario 4, *Leading the Next Industrial Revolution*, showed a sharp split. Forty percent of the participants thought the kind of breakthroughs illustrated in the scenario are highly plausible between now and 2050, but others were much more sceptical. The vote illustrates a dramatic change in perspective since the 1970s. Then, technological optimists often found themselves in conflict with environmentally-oriented techno-critics. By now, however, a new kind of technological optimism has emerged, whose proponents are enthusiastic about the potential for progress in energy efficiency, renewable energy systems, closed loop industrial processes, and other environmentally advanced technologies.

Priorities Emerging From the Scenario Workshop

Three different ranking exercises were held during the Workshop. In the first, participants were asked to vote individually on the most important short term areas for research where results can be achieved in 3-5 years. In the second, participants voted on the most important long term areas of research where work begun now will require more time to achieve its full results. The third exercise involved small groups working to build consensus on priority topics. The project's most striking result is that out of a large number of research topics proposed and considered, a relatively small number of broad topics or themes were rated as most important in all three of the ranking exercises. *These topics, listed below, are therefore areas which we strongly recommend to the ESRC for research funding.* The main body of the report fleshes out the kind of research efforts participants suggested around each of these themes.

Summary of Recommended Research Topics

Topics Rated High on All Three Lists
(Short Term, Long Term, Small Group Priority)

Psychology of Consumer Energy Choices
Government Foresight and Long Term Action
Accelerating Energy Efficiency Improvements
Positive Images of the Future to Motivate Change
Encouraging Innovation
Media and Public Opinion

Topics Rated High on Short Term Priorities List and also a Small Group Priority

Vulnerability
Liberalized Energy Markets
Distributed Generation
Joined Up Government

Topics Rated High on Long Term Priorities List and also a Small Group Priority

Improved Metrics for Decision Making and Investment
Aviation
Changing Values

Changes Needed in Research Methods and Uses

After discussing priority topics for research, workshop participants discussed changes needed in research methods and uses to more effectively pursue these topics. Discussion focused especially on the importance of interdisciplinary research. Participants believe that most of the top ranked topics they identified require interdisciplinary work involving more than one social science discipline, and many topics can only be dealt with by bringing social scientists together with natural scientists, engineers, and others. Several strategies were proposed for encouraging interdisciplinarity, such as:

- The ESRC should adopt a formal policy of putting half of its funding into interdisciplinary research.
- Create a new research council for interdisciplinary research – perhaps on the model of the old JRC.

- Totally restructure the Research Assessment Exercise in a way that insures that interdisciplinarity is not disadvantaged. Recent rule changes are not having enough affect.
- The ESRC should take on a greatly expanded role in interdisciplinary network building, pulling together best people from different fields. That kind of identification effort is difficult for individual academics to make. ESRC can work with all the Research Councils to put together lists of interests of researchers in various fields (e.g., anthropologists interested in energy).
- The ESRC can modify its assessment process for research bids to include a formal requirement to spell out interdisciplinary approaches and benefits.
- Create more research centres, like the Tyndall Centre, that are specifically designed to bring disciplines together focused on an aspect of the sustainable energy challenge.
- Change norms in the disciplines by creating an expectation that a certain percentage of the faculty in a discipline should be cross-trained in another discipline or have extensive experience in an unrelated area.
- Direct more research funding to non-academic institutions, using strategies such as making greater use of research by non-academic experts, opening more funding to non-academic institutions, dedicating some research funds specifically to non-academic institutions to allow them to hire academics to participate in research, and creating a research funding entity that funds non-academic institutions to hire retired academics no longer bound by disciplinary constraints.

Participants made recommendations on a wide range of other research-related topics such as developing and maintaining data sets, creating energy-economy-environment modelling tools that are transparent and easy to use, increasing funding for language translation to share research findings more widely across cultures, and encouraging team structures for problem-oriented research in academia more akin to those in commerce and industry.

Many recommendations dealt with research users and the way the research is used. For example, the ESRC and other Research Councils could:

- Say, "We expect user involvement."
- Develop a clear "protocol" for user involvement that is widely recognized as an appropriate way to involve users and avoid problems of undue user influence.
- Provide funding for user involvement as part of grants.
- Provide better guidance on accessing relevant research. Many potential users of social research simply have no idea of how they might locate and access results and expertise generated through ESRC and other social research.
- Produce or fund a Joseph Rowntree Foundation style quarterly journal that summarizes economic and social research findings on topics like energy efficiency and renewable energy.

- Provide funding to help bridge the institutional gap that exists now in terms of translating national research results into information useful for local action (e.g., national studies on the potential for energy efficiency improvements).

Project Team

The project was designed and carried out by a consortium of two organizations, the Institute for Alternative Futures (IAF) and the Institute of Innovation Research (IoIR) at the University of Manchester/UMIST. The IAF team included: *Clement Bezold*, IAF's President; *Robert Olson*, Senior Fellow; *Heather Warren*, Futurist; and Sandra Tinkham.

The IoIR team included: Professor *Ian Miles*, IoIR's Co-Director; *John Rigby*, PREST Research Associate at the University of Manchester; and *Heidi Pearson*.

The project's core group also included: *Simon Shackley*, Senior Lecturer in Environmental Management and Policy, Manchester School of Management, UMIST; *Kevin Anderson*, Associate Manager, Tyndall Centre for Climate Change Research; and *Joe Ravetz*, Manchester University.

Reactions to the Scenarios

The process of thinking about research priorities in light of alternative images of how the future might unfold appears to have had a significant influence on participants' sense of priorities. Of the top 15 statements of research priorities that emerged from a vote near the start of the workshop, none appeared in the top 15 of the final ranking after completing all the scenario based discussions. Some themes continued to be viewed as important throughout the process, including public attitudes and behaviour, benefits and costs of centralized vs. decentralized generation, and aviation. However, the final voting on research priorities emphasized many topics that had received little attention at the start. The final vote on short-term priorities put much greater emphasis on vulnerability, stimulating energy efficiency, and influencing public understanding. The final vote on long-term priorities put much greater emphasis on how to change the political system to encourage more long term thinking and goal-setting, how to foster innovation, and how to use the power of positive images to motivate change.