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The 2001 Energy Review for UK.

1. Introduction

Over the next fifty or so years the world faces substantial challenges in the field of energy supply and demand. Demand could increase by two or even three times, while concerns about climate change may require a drastic reduction in emissions of greenhouse gases, by perhaps 60 to 70 per cent. That is likely to limit use of fossil fuels, which presently meet nearly 80 per cent of global energy demand. Furthermore, there is now greater realisation than in past decades that energy markets are global and that uncertainties both on the supply and demand side are such that reliable medium to long term forecasts of their future are impossible.

Since 1945 UK Governments have followed two distinct energy policies. Up to the mid-1980s they saw themselves as fully in charge of major decisions in the energy field. The adequacy of energy supplies was seen as essential to the wellbeing of the country and therefore a vital matter for Government. This changed in the mid 1980s, when, after the turbulences of the 1970s, the world and the UK appeared to have a surplus of energy and lower growth in demand than in previous decades. Under such circumstances it was felt that energy was just another commodity and that major decisions could safely be left to normal market forces. Wide-ranging liberalisation of the markets was therefore initiated and in UK this policy is broadly still in force.

More recently, perceptions about the continuation of energy surpluses and about the effect of energy on environmental issues have changed and questions have been raised whether today's policies can address longer-term issues. The Cabinet Office energy review is, therefore, highly welcome and in the hope of assisting it, this note discusses:

> The relationship between energy policy and strategy under conditions which can change rapidly, but where the high capital intensity of the industry makes rapid reaction difficult.
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> The question whether the present strong reliance on market forces can provide an adequate response to the long-term need to achieve severe cuts in greenhouse gas emissions as well as meeting increasing world energy demand.
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> The importance of developing and testing new technologies and how such activity might be funded. More specific issues regarding R. & D. for different energy sources are covered in four appendices.

2. Relationship between energy policy and strategy under conditions of uncertainty.

For the purpose of this paper it is assumed that energy ‘strategy’ addresses longer-term aims. ‘Policy’ refers to the decisions necessary to make achievement of these aims

possible. These decisions, in practice, will involve short-term actions (say with a five year horizon), but these short-term actions must be evaluated with reference to both short-term and long-term effects.

In a modern economy there are perhaps five requirements of energy systems:

- security of supply;
- competitiveness;
- social acceptability;
- environmental acceptability;
- safety.

The objectives of an energy strategy should be to keep these five demands in an acceptable balance in the long term. They are often in conflict with each other. As an example, protection of an indigenous coal industry, for reasons of security and/or social policy, can have negative implications for environmental emissions. Hydro-electric schemes and on-shore wind generators have provoked considerable local opposition in many locations.

In addition, the requirements can cause indirect tension with other interests of the State. For instance, the need to retain stocks of oil to improve supply security, for example, can damage the balance of payments for oil importing countries. Compromises are necessary in many such conflicts and there should be public understanding and acceptance of these.

Each of these requirements and their importance also changes with time. As an example, concerns about emissions of carbon dioxide are greater now than they were twenty years ago. They may increase or diminish in the future, depending on factors such as further scientific discoveries, or success in reducing emissions of the gases responsible. Concern about security of energy supply is a further example; it keeps changing with remarkable rapidity from high to low and back again.

Short-term decisions, then, should pay proper regard to long-term aims. However, owing in part to the impossibility of forecasting the future, there is a danger that long-term issues will not receive proper attention. Perhaps even more dangerous is to optimise policies for an estimate of the future, which (we know from experience) is unlikely to happen. In practice, therefore, there has to be flexibility to ensure that today's decisions do not cut off too many choices for the future.

Often it may look advantageous to delay decisions on policy until the situation becomes clearer, but in practice it hardly ever does. Instead, such an approach tends to lead only to procrastination, at times the worst policy of all. Far better is to recognise uncertainty and attempt to achieve an understanding by policy makers of the forces acting on the energy scene and refine that understanding as the situation evolves.

All this implies that there is need for a structure within Government which is able to assess, at regular intervals, whether the long term direction and aims require amendment, what effect that should have on policy and whether available policy instruments are adequate to respond to the various alternative futures. The input to such an exercise would include assessments of the present situation as well as information about alternative longer-term global energy scenarios, politics and technological potentials. Such analysis, which should naturally involve a range of stakeholders including the energy industry and pressure groups, could ensure better understanding of the energy

situation and thereby improve the quality of debate between government, industry and the public and thereby the quality of decisions.

3. Can a highly competitive market deliver the desired energy strategy?

The last ten years have been unusual in the history of post-war UK energy policy, in that supply has been largely market-led. The contrast with the early 1980s, with its series of state-owned monopolies (the CEGB, Area Electricity Boards, Gas Council, British Coal), and today's fragmented and competitive structure, is stark. Competition has proved a successful model during this time. Costs have fallen in the major energy industries and security of electricity supply has hardly been tested.

Nevertheless, it cannot be assumed that such a competitive model will be appropriate for all possible futures and especially one which requires perhaps a 60 per cent reduction in greenhouse gas emissions. It can be argued that the 1990s were anomalously easy with respect to at least two of the requirements of energy policy. The significant over-capacity of power generation capacity that resulted from the 'dash for gas', coupled with plentiful and cheap world gas supplies and of course the UK's own North Sea reserves, reduced the likelihood of major interruptions in supply. At the same time, the switch from coal to gas and substantial improvements in performance of the nuclear sector together with the completion of Sizewell B, delivered the unintended but welcome bonus of reducing carbon dioxide emissions, with the result that the UK was able comfortably to meet its commitments under the Rio Convention.

Ensuring that there will be at all times adequate capacity to meet peak demand may become especially challenging in the electricity market. In a competitive system no one company can be given the duty to keep the lights on, since no one company has a guaranteed market. Under such circumstances, new investments become far more risky compared to operating in a centralised system of controlled monopolies. Required commercial returns might then lie in the region of 12 to 15 per cent, compared to 5 to 7 per cent under the previous conditions. With capital cost/kW(e) for CCGTs around $700 or less, for new generation nuclear and 'clean' coal plants some $1000-1500 and for some renewables perhaps higher still, the need for increased commercial returns greatly enhances the advantage of natural gas for the production of electricity.

This raises the question as to who will wish to take the risk of building new expensive capacity in time to avoid shortages at peak demand times. Even if it were politically possible to charge very high prices at such times, there is no guarantee that the new investment would get the benefit of such prices. Indeed, one large plant may well tip the market from scarcity to surplus, so that new plant may well have to exist with low prices and a small off take. Perhaps a key challenge for a highly competitive market in energy (and electricity particularly) is how to attract capital for long-term capital intensive projects in an environment where there is little chance of a guaranteed offtake.

The recent Californian problems may be largely due to the specific arrangements for their competitive market, but there are voices here and in USA who believe that the issue of securing additional capacity in time to avoid power cuts may be far more general and unresolved.

The approach taken in the 1990s may, therefore, not be appropriate for say the second or third decades of this century. Government may well have to step in to ensure that peak

demand is fulfilled, and will almost certainly have to intervene to ensure reductions in emissions of greenhouse gases. The consequences, including economic consequences, of failing to meet environmental or security requirements, could be high.

The energy review, then, should include the development of a suite of instruments that would be available as a response by Government to the changing energy environment. These instruments might include measures and regulations , such as emission trading or energy taxes, which could steer the market in the direction of the strategy.

In order to develop this suite of possible responses and to know which to use and when, it is important to ensure that trends in world energy, including such issues as environmental effects and technological innovations, are being properly monitored.

4. A sustainable energy initiative.

Another factor to be taken into account in an energy review is to consider whether there is a balance between the need and availability (usually constrained more by lack of funds than by lack of facilities) of the necessary research facilities, both in the country and world-wide.

As already mentioned, the world faces growing challenges to meet a great increase of energy supply at the same time as having to help to contain climate change by the reduction of greenhouse gas emission. The task is enormous and implies the restructuring of the world's energy industry at the same time as expanding it two or three fold. The task has also to take into account that nearly one in three people in the world still do not have access to electricity, whilst others have inadequate and unreliable supplies. To enable the world to meet such a task will require a considerable effort in research, development and commercial demonstration (R. D. & D.).

There are four options to close the ensuing energy gap. These are:

- using energy more efficiently;
- use of renewable energy;
- expansion of nuclear energy;
- sequestration of carbon dioxide from the burning of fossil fuels

These four options are often viewed as being rivals, but the task is such that there must be a strong possibility that all four will be needed to meet this goal. However, a great deal of R.D. & D will be required before it becomes clear what role each can make. At present, we have quite inadequate information to get a feel for this.

So far, the lengthy efforts of the international community to develop agreements, which would be effective in achieving the needed reduction of greenhouse gas emissions and substantial increases in energy supply, have met with only modest success. Even if all the agreements reached at the recent meeting in Bonn be put into effect, global carbon dioxide emissions in 2008 to 2012 will still be much higher than they were in 1990. Although the diplomatic efforts to reduce greenhouse gas emission are bound to continue, there is a strong case for considering a technology-led approach as well. Thus, there is evidence from studies in several US National Laboratories that research could substantially reduce the costs of limiting the scale of climate change.

However, as part of the drive for liberalisation of the energy markets, OECD governments (with the exception of Japan) have drastically cut their research efforts in the area of energy, possibly in the expectation that private industry would increase its efforts. This, did not happen with the result, that total expenditure on world energy R. D &D has fallen drastically since the mid-80s. (The UK cut government expenditure by nearly 90% between 1985 and 1995.) Although there is already a great deal of collaboration between different countries and with industry in the field of energy R. & D., the effort needs rebuilding if a technology-led approach to the issue of limiting climate change is to succeed.

It is suggested, therefore, that Government should press for the establishment of a world fund, under professional and experienced management, to fund R. D.& D aimed at developing methods for the reduction of greenhouse gas emission which could be utilised to transform the energy economy well before mid-century. The emphasis would be on how far technological developments would make it possible to meet future energy needs without adversely affecting living standards. This approach could run in parallel with existing international efforts, as embodied in the Kyoto process, and could provide the necessary technological underpinning for that process. Wherever possible, the strategy would integrate government sponsorship with private sector initiatives and finance.

The strategy would aim at accelerated development and deployment of any or all of the four options available for transforming the energy economy. This would aid decisions to be taken, say in fifteen or twenty years, as to where and how to concentrate global efforts adequately to reduce green-house gas emissions in all the main energy-using sectors (heat, power and transport), whilst still providing the required energy for all.

If it is agreed that a policy initiative along the proposed lines should be launched, the first stage would be to put in place a multi-disciplinary team to carry out a pre-feasibility study with recommendations for action in time for the World Summit on Sustainable Development to be held in Johannesburg in 2002. The G8 Renewable Task Force, set up by the G8 at its Okinawa Summit last year to "prepare concrete recommendations ..... regarding sound ways to better encourage the use of renewables in developing countries" and which reported in July this year, could well be an example of what is needed for such a study.

The second stage would be to carry out detailed feasibility analyses, followed, where necessary, by pilot schemes before major investments were committed. Initial funding may well be within the same range for each of the options, but periodic reviews would begin to identify the most prospective routes forward and in the light of new information the allocation of effort would change accordingly.

The Appendix to this Paper sets out for each option in broad outline:

- Why they are seen as valid candidates for an international initiative.
- The chief barriers to their full deployment.
- The key technical and institutional opportunities for public policy action.

Appendix.

A SUSTAINABLE ENERGY INITIATIVE.

This Appendix has been prepared in the belief that meeting the energy challenges facing the world can be greatly assisted through a technology-led approach which would protect the environment and safeguard the quality of life. It is envisaged that all the four options outlined in this Appendix would have a part to play in achieving the desired transformation of the world energy economy.

1. RENEWABLE ENERGY

Reason for inclusion.

Renewable energy (hydro-electricity, biomass, solar, wind, wave etc.) are seen as relatively clean in environmental terms , but so far, the 'new' renewables (i.e excluding large hydro- and non-traded fuel such as dung) only contribute less than 1% of today's world energy supply. Their potential contribution is, however, immense. There are, however, possible limitations and there is the need for more information about these and how they might be overcome. Any study can build on the G8 investigation (already mentioned in the Paper), which largely concentrated on developing countries.

Barriers.

For the present, 'new' renewables are high-cost, but there is evidence that with greater use costs can fall substantially.

Another barrier is the intermittent nature of many renewables (e.g. solar, wind) and that compared to today's power stations, each project will have a very small capacity. There is, up to now, little experience how a power system including a few large scale and many small scale intermittent generators could operate, especially if the aggregate contribution of power from renewables were to be above 20- 30%.

Lastly, there is the question of financing. Although the capital cost of individual projects will be small compared to conventional power plants, the cost per kw is likely to be high. There may well have to be some guarantees about offtake before such projects become financable.

Action Areas.

Substantial research and development and especially demonstration in different areas of the world will be required before one could have an indication how to overcome the above-mentioned barriers.

2. ENERGY EFFICIENCY AND CONSERVATION.

Reasons for Inclusion

It is well known (and has been for a long time) that there is great potential for efficiency improvement throughout the energy supply and use chain. There are estimates that only about one third of primary energy is converted to useful energy. Even though improvement in energy efficiency is often highly cost-efficient and bankable, progress has been slow or non-existent, except in periods (such as the 1970s) when there were fears of long term energy shortages. It was then found that much could be achieved if governments, industry and the public would accept the importance of energy efficiency.

Barriers

In the recent years of low energy prices energy efficiency and conservation became a secondary issue with the result that some of the advances made during the 70s and early 80s have been lost.

Achieving greater energy efficiency can have a high up-front investment cost, which can deter buyers, even if there is a rapid return on the investment.

That issue is especially important for developing countries who may be developing their energy-using infrastructure without utilising the most efficient equipment.

In developed countries the slowness of capital-stock turnover implies that the introduction of more efficient technology can take a long time. The sale of redundant and inefficient equipment to third world countries can be another barrier to improving the energy efficiency of the developing world.

Increasing energy prices helps improvement of energy efficiency, but can be dangerous politically.

Action Areas

Increased consumer awareness of potential energy efficiency measures and their benefits is vital. This can be helped by setting high technical standards, but in some cases such standards appear to infringe WTO regulations.

Funding will be required to assist energy efficient investment in developing countries as well as in R. & D. for the development of more efficient equipment and of conversion technology. The potential of using fuel cells falls into this area. Here again, there will be the need to find ways for private organisations to share in this effort.

3. ADVANCED FOSSIL FUEL SYSTEMS AND SEQUESTRATION.

Reason for Inclusion

The availability of fossil fuel reserves - coal, conventional oil, tar sands, shale oil, heavy oils, natural gas, gas hydrides - is so large that, were it not for the pollutants caused by their use, they would continue to be the major sources of energy at least for this century and possibly for far longer. Although great strides have been made in using these resources more efficiently and in capturing SO_x, NO_x and particulates, there has been little progress in capturing and sequestering CO_2, the major greenhouse gas. If sequestration of this gas and more conversion efficiencies could be realised technically, economically and safely, fossil fuels could continue to offer a major supply option for a long time to come.

Barriers

Although improvements in conversion efficiency (say greater use of combined heat and power plants) is likely to continue, there has, at least until recently, been little appreciation about the potential for CO_2 sequestration. Based on today's technology, the practicability of the idea of removing this gas from flue gases and disposing of it, so it does not return to the biosphere, appears doubtful, but there appear to be a number of technical leads which might change this view.

Action Areas

In addition to efforts on conversion efficiency, there are a number of possibilities for CO_2 sequestration. These range from the production of carbonate solids from flue gas treatment to producing liquid CO_2 either for storage in aquifers or for use in enhanced recovery in oil and natural gas fields. To make extraction of CO_2 easier, use of combustion air with enhanced oxygen content is another possible lead.

This is an area which is likely to require considerable research, development and eventually demonstration plant of GW size, but, as the prizes for success are high, it should be easier than for other options to involve private companies.

4. NUCLEAR ENERGY.

Reason for inclusion.

Nuclear energy presently supplies some 17% of the world's electricity but its development has nearly stalled. Yet, along with large hydro-electric dams it is today the only large-scale power producer which does not emit significant quantities of greenhouse gases. If required, it could be expanded and it is therefore an available option, should the other three options be more difficult and slower than now assumed by their protagonists. Bearing in mind the uncertainty overhanging the future of energy supply, nuclear energy should provide some needed flexibility.

Barriers.

The perceived mistrust of nuclear energy by the public, especially owing to the risks from radioactive contamination, the risk of nuclear weapons proliferation and the lack of reliable arrangements for the management and disposal of nuclear waste, makes sponsorship of this option politically difficult in many countries.

In addition, the large scale and high capital cost of the present generation of nuclear reactors makes new nuclear projects (in distinction to already existing plant) an unattractive investment proposition in today's competitive electricity markets.

Action areas.

To meet today's competitive market conditions, a new generation of designs are becoming available which, it is said should make new nuclear generating plant competitive and even safer than the designs in present use. However, until demonstration plant of commercial size have shown that such plant meet the design specifications, it is unlikely that commercial companies will take the risk of utilising these designs. Means, therefore have to be found of funding demonstration units. Formation of consortia which would include design contractors, power companies and financial interests may be the answer, but they are unlikely to be formed, unless there were some tangible assistance for such a prototype from governments and/or international organisations, such as the World Bank.

Another area where action is required is in the management of nuclear waste. Inter alia research is required to consider the various methods of dealing with such waste, what role, if any, has partitioning and transmutation in reducing the quantity of highly radioactive waste and the time it has to be kept strictly segregated, how best to deal with Plutonium and highly enriched Uranium from the decommissioning of nuclear weapons.