our energy future?

a commentary on the PIU's energy review

by professor michael laughton
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Our Energy Future?

a commentary on the Performance and Innovation Unit's Energy Review

Summary

The Performance and Innovation Unit's Energy Review is an optimistic document. Security of supply, hitherto the fundamental concern of energy policy, is taken for granted. Its recommendations rest on three core assumptions covering the fifty year period studied: stable and relatively cheap long-term gas/oil prices; a substantial growth in energy efficiency and renewables; the easy adaptability of the electricity supply infrastructure to profound and large-scale technical changes. It appears reluctant to consider less comforting scenarios and disinclined to insure against policy failure. Yet the PIU's assumptions are challenged by a weight of evidence, including extensive domestic and international experience. There is a growing concern that the UK is taking an unprecedented gamble with its energy future.

The Performance and Innovation Unit's Report

The PIU Brief

The Government's brief for the PIU Review of energy policy was to set out relevant objectives for Great Britain to 2050 and to develop a strategy ensuring that current policy commitments are consistent with longer-term goals. It was expected that the proposed strategy had to be sufficiently flexible to cope with large economic, technological and scientific uncertainties in the transport, domestic, industrial and commercial sectors.

The Unit's own scoping note (published when the Review was announced) stated that current patterns and future projections of global and UK energy consumption raise three potentially conflicting challenges:

1. Meeting environmental objectives.
2. Ensuring continuing long-term security and diversity of energy supplies, including appropriate investment incentives to maintain sufficient spare capacity
3. Achieving affordable energy.

Key Messages from the PIU Report

1. Security of supply is not seen as a major problem for the foreseeable future. Rather, priority issues for the emerging energy system are ranked as those of the environment and of economics.
2. The United Kingdom will become a net importer of gas and oil at the same time as it may face increasingly demanding targets for reduction of gaseous emissions.
3. Gas-fired generation will grow, providing 70% of electrical energy by 2020. Gas will be available in large quantities, and at low cost, from producer countries.
4. Contributions from coal-fired and nuclear stations will diminish as their technical lifetimes expire, although both nuclear and clean coal options should be kept open.
5. The development of the electricity supply network is not seen as a major issue; the market will provide investment for new infrastructure.
6. Oil will retain a comparative cost advantage in road transport and remain essential for air transport.

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7. The energy industry operates on long time scales and requires suitable incentives if adequate investment is to be provided.
8. The reduction in carbon emissions over the last 10 years has occurred as a result of commercial decisions to switch fuels and has had little to do with government environmental policy.
9. Carbon valuation is essential if carbon emissions are to be constrained.
10. The UK must not 'go it alone' over carbon emissions reduction, since this could harm our international competitiveness.
11. Increases in energy efficiency and vehicle efficiency will both contribute to emissions reductions, with recommended targets of 20% improvement in energy efficiency in the domestic sector by 2010 and a further 20% by the next decade.
12. The existing 10% target of electricity generated from renewable sources, especially wind, should be increased to 20% by 2020.
13. A new Sustainable Energy Unit should be created which will co-ordinate all dimensions of energy policy in the UK

Commentary on the PIU Review

The commentary addresses a number of key issues, summarised in Figure 1, and discussed below.

The Review is strong on economic theory but weak on the realities of the energy industry

Basis of the Review

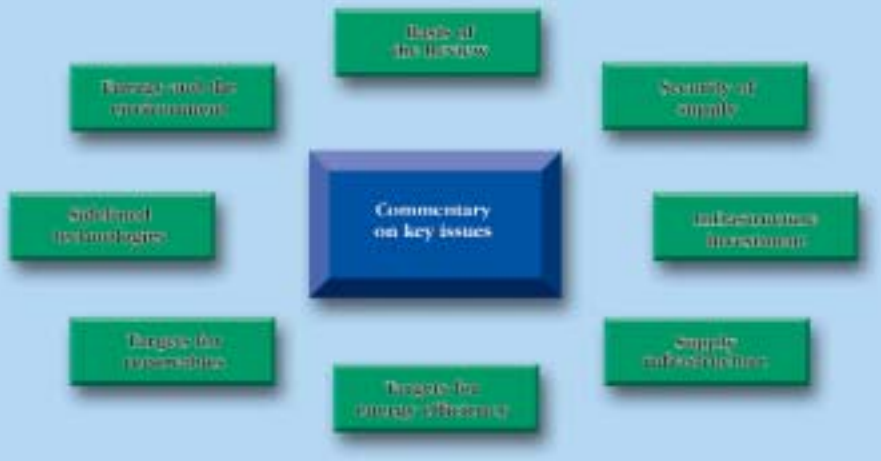
Was the PIU given the right brief?

The PIU's brief is too vague and omits vital matters such as a definition of clear objectives and constraints, the scope and prioritisation of public policy objectives, macro-economic impacts, and any detailed consideration of security of supply.

An appropriate Review team?

Understanding energy policy requires an assessment of the supply and demand of primary energy (which is turned into electricity) and the electricity supply infrastructure itself, a large, highly intricate system of power plants and interconnections. The PIU Review is strong on economic theory but weak on the constraints imposed by the existing electricity infrastructure. Given that the future of the electricity supply system was under consideration it is surprising that no experienced engineers were included in the Project Team to temper its somewhat optimistic views on the ease with which major changes can be made. For instance, the most significant weakness in the Review is probably the assumption of the speed with which expansion of renewable electrical generation could occur.

Figure 1. Overview chart showing issues covered in commentary



Confusing targets with aspirations

Policy aspirations should be bold, even visionary; actual policy targets must be

devised with some sense of practical constraints. The latter must be more realistic or disillusion and cynicism will follow. The PIU Review contains a number of unrealistic targets which appear to reflect aspirations rather than rigorous analysis. Such an approach can breed complacency about achieving current goals and may lead to inadequate consideration of alternative paths.

A lack of urgency

There is an apparent lack of urgency in the Review, especially given the need to make early decisions on major issues such as support for emerging technologies, carbon regulation, and energy imports post-2010. Ignoring the long-lead times required for meaningful action risks sleepwalking into an unnecessary energy crisis.

Security of Supply

Security of supply appears to be taken for granted

Security of supply, surely the most important objective of energy policy, appears to be taken for granted by the PIU. Yet, as it admits, Britain is on the verge of losing its self-sufficiency in oil and gas supplies as North Sea reserves decline. Global oil and gas prices may rise significantly between 2010 and 2020, a period during which the UK electricity supply industry becomes heavily dependent on imported gas. Yet the Government has no adequate alternatives in place and the PIU recommends none.

The UK currently enjoys a balanced electricity mix with a number of technologies playing significant roles. This diversity provides a high level of security of supply but it is likely to be compromised by increased penetration of gas-fired generation. In contrast with the House of Commons DTI Select Committee (HC 364-I), the PIU suggests that growing gas dependency will present few problems for security of supply.

Future oil and gas prices

The PIU have taken the view that oil and gas will remain relatively cheap and available over the next few decades. Gas, it is claimed, will remain a low-cost source of power generation and oil continue to be the best fuel for road transport until around mid-century (gas prices are also critical to attaining the government target of 10GW of CHP by 2010). These assumptions determine the course of the whole PIU analysis.

Any review of the databases for worldwide oil and gas exploration would cast doubt on the PIU's premise. Analysts believe that future oil supplies will increasingly depend on fewer producers, all in the Middle East, and that the rate of production will decline before reserves are fully exploited. Indeed, world oil production may peak before 2020 though this does not signify a lack of exploitable reserves, merely the end of an era of cheap oil.

Optimistic fuel price and availability must not become the basis of energy policy

Experience suggests that it is impossible to be certain about future oil and gas prices, but this long history of uncertainty underlines the need for extreme caution over the PIU's assumptions lest they become the basis of over-optimistic energy policies. As if to emphasise the unpredictability of such matters, post 11 September and contrary to expectations, the price of oil barely moved whereas the wholesale price of gas increased considerably. So great was the rise that it forced one UK generator to close a gas-fired power station in favour of a coal-burning one.

Gas imports and price prospects

UK currently meets nearly all of it's gas requirements from it's North Sea fields, the

Review argues that 'there appear to be no pressing problems connected with increased dependence on gas, including gas imported from overseas.' This is surprising in view of the DTI's own estimate that the UK will be importing 15% of its gas by 2006 and that gas import requirements will exceed existing pipeline capacity before 2010. Though major investment in gas interconnectors will be needed simply to satisfy the present level of demand, the Review makes no mention of the disincentives to invest in infrastructure created by current public policies.

The Review correctly identifies that some 80% of known world gas reserves lie within economically viable transportation distance from the EU, including those in North Africa, Russia and the Middle East. However, the anticipated increase in EU demand (with two thirds of the anticipated increase coming from electrical power generation) will make it necessary to find new supplies from Iran, Iraq, Qatar and Turkmenistan, where greater distances, and the need for new or enhanced supply infrastructure, may impose costs up to twice those of supplies from Algeria or Libya. Competing global demand for supplies will also yield upward pressure on prices.

A complacent model of energy security

The Review acknowledges the tendency of markets to under-provide security, but believes that government intervention will generally make matters worse. Indeed, non-interference in the markets is a defining characteristic of the Review. 'Risk management' will secure primary energy supplies from outside the EU. This involves trust in the calming influence of international diplomacy and hope that suppliers of oil and gas will prefer the benefits of normal trade to economic blackmail. The European Commission's faith in security of supply also rests largely on this so-called 'inter-dependency model of co-operation'.

This sanguine view, akin to the observation that on average the sea is flat, cannot provide protection against political crises such as occurred in 1973, 1979 and 1991, nor can it guard against price surges such as that for gas in late 2001. A complacent model of international co-operation, particularly in the context of relations with politically troubled regions of the world – for instance, North Africa and the Middle East - is likely to inhibit serious study of alternative energy strategies.

The review appears reluctant to insure against policy failure

The idea that economics will invariably trump political considerations is undermined further by the situation within the European Union. Despite the British government's efforts several key European countries continue to resist the opening of their energy markets; the benefits of a single energy market, notably downward pressure on electricity prices, is still not in sight.

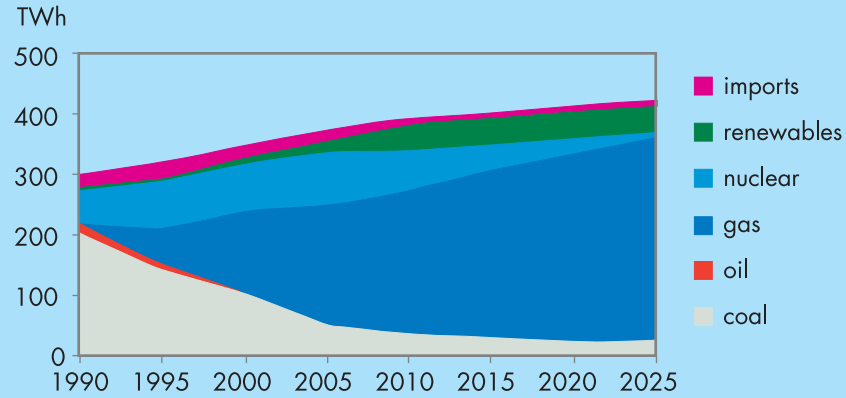
There exists an alternative approach to ensuring security of supply, based on contingency analysis and the identification of insurance measures – 'the spare tyre policy'. Yet the PIU refuses to entertain this, justified though it would be by the events of the last 30 years. A recommendation that the DTI should evaluate the cost-effectiveness of security of supply measures stands in stark contrast to the absence of any proposal to measure the consequences and cost of supply disruption.

Economic implications of rising gas imports

The Review has a tendency to minimise the macro-economic implications of energy policy. Yet the consequences of a growing reliance on gas for the balance of payments are worthy of serious examination. For example, the DTI estimates that gas will contribute 50-60% of UK primary energy supply and 61-76%

of electricity generation by 2020 (see Figure 2). Gas imports would impose significant additional costs on the UK. It would in any event be in high demand from industry and the domestic sectors as well as contributing increasingly to transport needs.

Figure 2. DTI projections for the UK power sector by technology



Source: Adapted from Energy Projections in the UK, CL Scenario, Energy Paper 68, DTI (2000)

Investment: Trusting the market

It is generally accepted that security of electricity supply requires the maintenance of total generating capacity capable of meeting about 125% of normal peak demand. The Review places its faith in market signals to remedy any prospective shortfall. But pure free market principles should not be placed above an absolute need to maintain reliable electricity supplies; in practice market signals can occur too late to correct generating deficiencies without industry and communities suffering painful and expensive transition periods. But three serious issues arise even if one shares the PIU's philosophy, and these are discussed below.

How over-regulation distorts price signals

Market signals in Britain are being distorted by a highly interventionist regulatory framework which has forced down electricity prices without regard for the need to fund new or replacement plant. As a result the market is signalling generating companies not to build new plant since the entry cost for all types of generating stations cannot at present be supported by the price of their product. New-build cannot be a viable proposition in such circumstances (except in the case of the highly-subsidised renewable sector).

California's extensive power blackouts have demonstrated how over-regulation can create an electricity supply crisis, tipping that State from over-capacity to crisis within five years. It is worth noting that, while the PIU believes that there is 'no reason for immediate concern' over investment, the Trade & Industry Select Committee was recently 'startled to learn that Ofgem has no target for maintaining a reserve of generating capacity'.

Markets and diversity of supply

Bringing new capacity on stream requires planning permission and several years of construction, termed 'lead time'. Different technologies have different lead times and this shapes the willingness of investors to fund new renewable or nuclear build. This means that the market alone may not yield diversity of electricity generation, a vital factor in security of supply. The PIU tacitly acknowledges this via its support for renewables.

When price signals are absent

The market can respond only to price signals and is powerless in their absence. Reducing carbon emissions is an obvious example of a public good where free markets can make no contribution unless government creates economic incentives

Only government can create price signals to reduce carbon energy emissions

to act in an environmentally-friendly fashion. Another, less widely considered problem arising from the absence of price signals is the lack of investment in good engineering practices by the many non-utility players in the electric power industry who have neither incentive nor obligation to invest in the security of the generation and transmission systems. The PIU's summary of submissions to the Energy Review puts it thus: 'Markets are most likely to achieve successful outcomes if they are designed to reflect all the costs and benefits judged important by Government and society…However, markets are unlikely to internalise these [and] Government sets the framework within which commercial choices are made, as with renewables. It is Ministers who should take responsibility for intervention in markets, if economic objectives conflict with environmental and social goals'.

The Importance of Supply Infrastructure

The electricity supply system infrastructure is a key national asset, the result of substantial financial and intellectual investment over many decades. Within this system the configuration of generating stations and the transmission network is based on geographic constraints imposed by supply and demand considerations. For very practical reasons the kind of radical transformations suggested in the PIU Review involving high penetration of distributed, embedded generation would involve large investment costs and higher prices. Such consequences are inherent in changing so large and long-established a system.

Embedded generation (including most renewable and combined heat and power) is usually connected to much older distribution networks that have not been designed to accommodate it. Embedded generation increases the potential for local damage to the network in the event of a fault (technically termed 'fault level') and hence, sooner or later leads to the need for network reinforcement as well as the restructuring of protective systems. The extra capital needed for reinforcement is not normally included in estimates of generation costs for such plant: in practice, however, the associated cost penalty is a common reason for failure to proceed with embedded generation projects.

The current electricity system provides a level of security unlikely to be matched by embedded generation

Irrespective of the development of renewable and CHP generation, large conventional stations under central operator control will remain essential to the electricity supply system. The combination of large power stations and a grid system provides a level of security unlikely to be matched by embedded generation; in the National Grid Company's view the transmission grid is always more reliable than small generating equipment. Large conventional stations, coal, gas and nuclear, provide the important ancillary services guaranteeing control of frequency and voltage, stability, cover for unexpected plant outages and also (via switching control) security of supply.

No matter how the system accommodates changes brought about by the development of smaller embedded stations these ancillary service functions will remain crucial for ensuring high quality of electricity supply. Large controllable stations will continue to be a feature of any future system and their needs must therefore feature prominently in any realistic energy policy. Yet the PIU Report largely ignores these issues.

Targets for Energy Efficiency

The Review rightly aims at major improvements in domestic energy efficiency. But a considerable body of experience from Britain and abroad suggests that the

achievement of its ambitious target of a 20% improvement in domestic energy efficiency by 2010, and a further 20% improvement by 2020 will be far from easy. Certainly a range of imaginative educational, fiscal and regulatory measures will be needed to reinforce cost incentives. Rewards have always proved more effective than penalties; even these can prove very limited in their effectiveness.

There are many technical opportunities to reduce energy used in existing and new buildings. But the cost of installation weighs more heavily on the decision to invest in energy efficiency than subsequent savings. This is particularly true of the domestic sector.

Similar factors apply – more surprisingly – in industry. Perhaps the principal reasons for the slow rate of diffusion of efficiency technology have been the shortage of skilled manpower and the adoption of relatively short payback periods: 3 years or less are common for energy related investment throughout the OECD area.

Ambitious targets for energy efficiency and renewables ignore too many practical difficulties

Targets for Renewables

Renewables have an important role to play in the future UK energy mix. But the Review's recommended target of 20% of electrical energy from renewable sources by 2020 ignores too many practical considerations. The PIU places considerable faith in the ability of the renewables industry to apply learning curves and overcome significant technological barriers whilst achieving major cost reductions. Yet many designs for offshore wave and tidal stream plants have still to be tested, the success of photovoltaic systems depend heavily on future scientific advances and tidal barrages are not presently under any detailed consideration. All emerging technologies will require public subsidy to progress.

Ambitious targets for wind power

The PIU regards wind power as having greater potential whilst accepting that wind turbines would have to be built in numbers and at rates never before seen in the UK if its proposed renewables target were to be achieved. Onshore and offshore wind is singled out for installation rates of 1-2 GW per year in the period 2010-2020 target (3 – 6 MW per day for ten years!). Taking into account the capacity proposed for construction by 2010 the implication is that 17-25 GW of wind power will be connected to the grid by 2020, supplied by between 10,000-15,000 wind turbines (the precise figure would depend on the size of turbines installed). There are about 12,000 transmission pylons in the UK. Although less complex to build than wind turbines, it still took five decades to build them.

Since 80-90% of all planning applications in England and Wales to date for onshore wind farms have been rejected because of popular protests, it cannot be assumed that local communities would welcome such massive industrialisation of the landscape. To remove this institutional barrier by 'placing local concerns within a wider framework of national and regional needs' i.e. overriding local objections as the PIU suggests, would encounter serious political obstacles. Mounting Danish protests over insensitive wind turbine sites have included direct action. Gaining rights of way to build new transmission circuits will also face determined and prolonged opposition from local communities and environmental groups; time spent in public inquiries is already a major factor in transmission planning.

Infrastructure issues

Geography makes the UK electricity system an essentially isolated one with little support or interchange of power with neighbouring countries. It must therefore

draw on its own renewable resources, the largest being the winds and waves of North-West Scotland which account for around 40% of Europe's potential. Unfortunately, large-scale development is seriously inhibited by inadequate transmission capabilities in the north-west and the limited spare capacity in the Anglo-Scottish interconnector (see Figure 3). The lack of effective means for collecting and transmitting Scotland's surplus renewable energy to the southern English markets frustrates the development of a UK resource as well as depriving Scotland of a significant revenue stream. Removing these barriers will require major investment in the reinforcement and expansion of the transmission grid from the northwest of Scotland to the English network. Once again the PIU has failed to consider the crucial factors of infrastructure, engineering and investment.

Weather patterns impact wind generation

No account is taken of the total annual cost of standby plant for days when there is little or no wind

The intermittent nature of wind energy prevents it from providing an electricity source which can be called upon when required (technically this is known as 'dispatchable generation'). It has been argued that, on average, wind will always be blowing somewhere in the UK, so widespread geographic deployment of wind turbines will effectively provide dispatchable wind-powered generation. But periods of no, or very light, wind occur over very large areas for periods in both summer and winter, particularly when anti-cyclones cover the country. NGC studies show that such periods affect wind farms up to several hundred kilometres apart. These unavoidable problems in turn require permanent reserve generating capacity provided by other energy sources if consumers are to be confident of reliable supply (a point made in the National Grid Company's evidence to the Review). The cost of very large standby plant capacity (beyond the current 125% margin) to cover the few days in a year when there is practically no wind power has not been appreciated by the PIU.

Under normal wind conditions fluctuations lead inevitably to variations in wind turbine output and the impact of such fluctuations will increase in step with the growth in wind power capacity. These small fluctuations can also be dealt with given sufficient stand-by plant and no transmission bottlenecks, but again involve additional costs.

The capital and operating costs of standby plant must be added to any estimates of wind generation costs, making higher electricity prices an inevitable feature of its extension. The mounting expense of the Danish programme, so often held up as an example to Britain, has led the new Danish government to pledge an end to subsidies.

The PIU refers to the development of energy storage via chemical or other means but this is a short-term measure, operating for a few hours at most and compensating for only minor fluctuations. Yet it makes no economic sense to build a compensating level of conventional plant capacity on stand by for even one day of the year. Without the considerable expense involved in large-scale storage, such as pumped hydro-electricity, it would prove impossible to fill even the smallest gaps created when most wind turbine capacity drops out of the system. Denmark is entirely dependent on Norwegian, Swedish and German support when an unexpected deficiency or oversupply arises. Only their help makes it practical to operate a system where wind contributes even 13% of electrical energy, a level well below the PIU recommendation for 2020.

The brutal reality is that 20GW of wind power cannot be accommodated in the UK electricity system. Neither private investors nor government are likely to fund the additional 20GW of conventional stand by generating capacity required

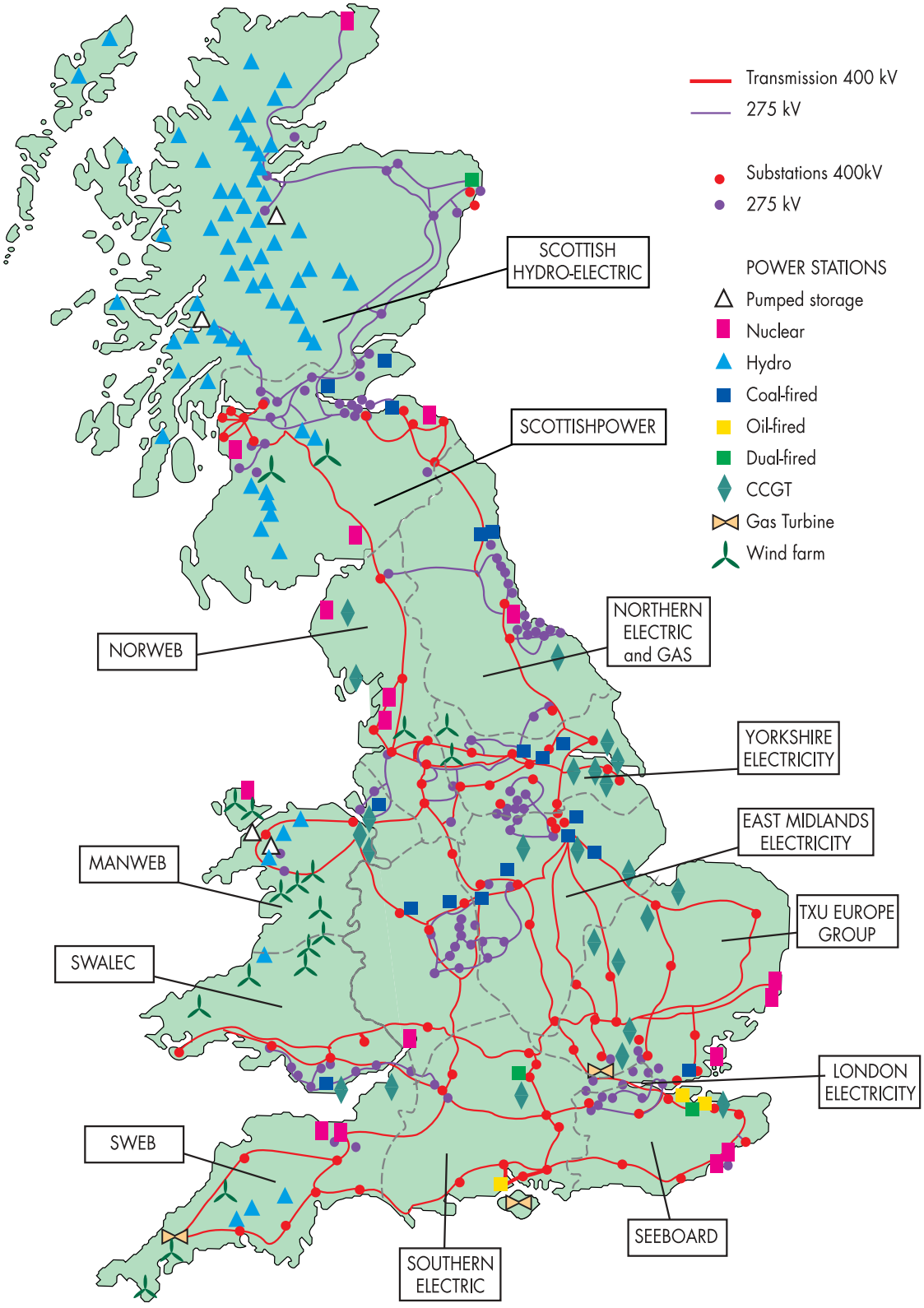


Figure 3. Electricity supply system as at April 1999

Source: UK Electricity Association, www.electricity.org.uk/inds fr.html

Large scale embedded generation means increased investment and higher electricity prices

to cope with wind turbines falling idle or under-performing because of weather fluctuations.

Sidelined Technologies

Undue pessimism over other emerging technologies?

The Review mentions alternative fuels such as liquid biofuels, hydrogen-based fuels and renewable electricity as a route to increase diversity but places little emphasis on the Government's role in supporting and encouraging their development, perhaps because of unduly pessimistic appraisals of the speed at which they could make a significant contribution to energy supply.

Hydrogen-based options are of particular interest for transport, a major subject somewhat neglected by the Review. The PIU considers that a transition from oil-based to hydrogen-based technology is unlikely to have been accomplished by 2050, but examination of fuel cell development offers a different perspective. Many observers predict that a volume market for reformer-based, gas-powered micro-CHP fuel cell systems will develop by 2010 and that fuel cells will have displaced the internal combustion engine for transport by 2050 (this is perhaps another of the many occasions when the PIU could have benefited from in-house engineering competence).

This timetable could be accelerated significantly if, as anticipated, international oil supplies tighten over the next decade. The development of hydrogen technology should be given greater prominence in UK energy policy – with the caveat that the electrical supply needed for hydrogen generation will need to come from carbon-free sources such as wind, solar or nuclear.

Keeping the Nuclear Option Open?

The future of nuclear energy does not figure in the main PIU recommendations, but is addressed in the body of the Review. Nuclear is seen as a last resort technology, highly attractive as a zero carbon emission source of electricity, but requiring a waste disposal solution. The Review recommends keeping the nuclear option open in order to meet possible energy security needs and to compensate for failures by other technologies (an indication, perhaps, that the PIU recognises the pitfalls in its advocacy of an increased renewables target).

Unfortunately for this approach, Britain's nuclear engineering expertise is running down; there is already a serious shortage of suitably experienced engineers to decommission existing nuclear installations. Further delays in building new plant will involve importing most equipment and engineering skills should the 'option' be translated into reality.

Keeping the nuclear option open demands positive action rather than rhetorical undertakings

Keeping the nuclear option open involves positive action rather than rhetorical undertakings. Nuclear generation currently supplies some 25% of UK electricity supply, a proportion that will fall from 2005 and rapidly after 2010. Even attainment of the Government's current renewables target will fail to provide a substitute for the loss of nuclear's carbon-free generation. It is often argued that wind power would remove the need for nuclear electricity. But unless overall electricity demand is reduced the replacement of nuclear by wind would actually increase carbon emissions because of the latter's need for fossil-fuelled back-up. Whatever the fate of the renewable sector, decisions on nuclear will need to be taken in the near future. The long lead times required for planning and building replacements for existing nuclear plants will otherwise make the 'nuclear insurance policy' unrealistic.

The level of activity being carried out elsewhere in the world, however, indicates that nuclear energy is seen as a viable solution by the UK's competitors. 438 reactors are in operation totalling 352,600 MW of installed capacity, supplying 2560 TWh in 2000, up 3% from 1999, and representing 16% of the world's electricity supply. A total of 24 reactors with a 12,000 MW capacity have been commissioned over the past five years and 36 are currently under construction.

British Energy's Torness Power Station

The Review states that, 'a decision whether to bring forward proposals for new nuclear build will lie with the commercial sector'. This, however, poses a false choice for supporters of the nuclear option: subsidy or decline. Real answers lie in the debate over economic instruments as a means of compelling the market to cost environmental externalities, particularly carbon emissions. Such measures would not involve an unfair advantage to a single type of generator. They would instead create a more level economic playing field for renewables, emerging technologies and 'cleaner coal' in relation to gas and open the way for commercial replacement of older nuclear plant over the coming decade.

Even without such measures rising gas prices would seriously undermine PIU claims that nuclear generation is unlikely to compete with fossil fuels before 2020, let alone 2050. And if, as the DTI forecasts, gas will supply up to 70% of UK electricity demand by 2020, the nation would suffer the consequences of 'a large and relatively inflexible programme of investment' in gas-fired stations, an outcome that the Review is anxious to avoid in the nuclear context.

Neglecting coal

The PIU only sees coal making a significant contribution if gas supplies become seriously constrained, and then only should large-scale carbon sequestration prove feasible. It also does not consider coal's contribution to security of supply, a fact underlined by the Trade & Industry Select Committee's enquiry into energy policy.

Energy and the Environment

The UK currently enjoys a balanced electricity mix. There is no doubt that country has benefited significantly, with respect to it's environmental objectives, from the 'dash-for-gas', increased productivity from the nuclear sector and the decline of coal fired-generation. These, however, are largely 'one-off' benefits to the environment, and, in the case of nuclear, will be almost entirely lost over the next two decades without the construction of replacement plant.

The PIU is to be praised for placing energy policy firmly in the context of sustainable development and emphasising the need for pricing carbon emissions. Accurate reflection of the environmental costs of fossil fuel use is central to the

A successful climate change policy means costing the environmental impact of fossil fuels

longer-term success of the UK's climate change programme. An economic level playing field in this area would help zero-carbon options compete with gas. But the Review fails to define carbon valuation as a matter of urgency, an unhelpful conclusion as early decisions are needed to prevent a rise in carbon emissions after 2010 that will reverse previous gains.

A new Sustainable Energy Unit

The next two decades are likely to see major changes in the energy scene, and it is important that energy is high on the Government's agenda. There needs to be an interdepartmental approach to policy making to ensure a balanced consideration of the UK's energy needs and a new Energy Unit, as recommended in the Review, may well be required to co-ordinate the various inter-connected aspects of public policy.

Key points

- Too many of the Review's recommendations are justified by debatable assumptions on the future roles of oil and gas, the stability of overseas primary energy supplies and of social behaviour of domestic consumers to effect ambitious efficiency improvement targets.
- The Review's free market rhetoric sits uneasily with its ignoring the Government/Ofgem manipulation of electricity prices and recommending an even more interventionist approach to renewables.
- The Report appears not to appreciate the engineering realities imposed by electrical power system design and operation and thus sets an overly ambitious target for renewables and for unrealistic targets for wind power in particular.
- There is an apparent lack of urgency in the Report, especially given the need to make early decisions in response to, for example, the predicted changes in energy technology, in carbon regulation, and in energy imports post-2010.
- The report contains much good economic theory, reflecting the skills of the Project Team, but appears to have missed the larger picture.

It is with the greatest regret that I have to record the tragic death of Professor Bert Whittington. Bert was an exceptionally fine source of calm, commonsense advice on electrical engineering and energy matters. He had an excellent understanding of the electricity supply industry, and contributed much in this important area in the UK and in developing countries. A man of enormous charm, he will be sorely missed by his many friends and colleagues.

Michael Laughton

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