

Executive Summary

Key points:

- **There is a strong likelihood that the UK, with other developed countries, will need to make very large carbon reductions over the next century**
- **Addressing carbon emissions is likely to be the key task of energy policy**
- **Deep carbon cuts are possible at a cost which is bearable, but we should be creating new low carbon options now**
- **Government should create economic instruments which bring home the cost of carbon emissions**
- **A step change in energy efficiency is needed, with a new target for achievement**
- **Renewable energy targets should be expanded to 2020**
- **Institutional barriers to renewable investments should be addressed urgently**
- **Energy security should be addressed by a variety of means, including enhanced diplomatic activity and continued monitoring**
- **There are no pressing problems connected with increased dependence on gas**
- **Recent levels of investment in the energy industries have been healthy, but continued attention to the long-term incentives is needed**
- **The Government should create a Sustainable Energy Unit**
- **The representation of energy choices within the planning process must be improved**
- **Government should start a process of public debate about sustainable energy, including the issue of nuclear power**

What the Review is about

1. This Review had three tasks: to consider the implications for energy policy of the RCEP's view that the UK would have to make a substantial cuts in CO₂ emissions by the middle of the century if it were to join a world-wide coalition to stabilise CO₂ concentration in the atmosphere; to review energy security; and to consider whether the different objectives which energy systems meet can be better integrated, given that

the recent past has seen some conflicts, for instance between environmental and social objectives.

The process

2. The Review has been conducted on the basis of an open and inclusive process of investigation. Over 400 organisations and people helped by submitting evidence. There was also a series of workshops, seminars and meetings. The PIU thanks everybody who has contributed.

Recent trends have been benign

3. A review of trends in the use and production of energy and of its wider impacts on the economy, the environment and society, shows that whatever past successes, there are some very real challenges ahead. The UK has been in the fortunate position of being able to achieve carbon reductions with almost no government intervention. It is also one of just two G7 countries which is, at the moment, self sufficient in energy. Energy prices have been falling, partly as primary energy prices have fallen in the world as a whole, and partly as a result of the successful liberalisation of the UK gas and electricity markets. UK industry and UK consumers, including the fuel poor, have gained.

The future may be more difficult

4. The future for energy policy seems likely to be much less benign. A low carbon future, if it were to be adopted, could not be achieved on the basis of spontaneous changes within the energy system. Issues of energy security, which derive from a variety of different sources, are likely to become more insistent. And though good progress is being made in the elimination of Fuel Poverty, the UK still stands out as a county where, in contrast to the position in our Northern neighbours, many people spend a substantial proportion of their income on fuel, largely as a result of the age and energy inefficiency of the housing stock.

Conclusions about long-term possibilities

5. Possible future energy worlds in 2020 and 2050 were analysed by means of scenarios. Credible scenarios for 2050 can deliver a 60% cut in CO₂ emissions, but large changes would be needed both in the energy system and in society. One opportunity stands out: there is scope for a substantial improvement in energy efficiency, over and above the underlying trend, without there being any significant impact on the total spending needed to meet our energy needs. Yet even if this improvement can be achieved, and even if the electricity system was to produce no carbon whatsoever, a 60% cut could only be met if there were an associated shift away from oil as a means of powering future vehicles, probably towards hydrogen. This shows the scale of the challenge.

6. The analysis for 2020 shows that significant carbon reductions are possible even in this timescale, if energy efficiency is prioritised and the deployment of combined heat and power and low carbon technologies is accelerated.

A framework for policy-making

7. Energy policy needs to be approached within a consistent policy framework. In the past there has been a tendency to make energy policy decisions at times of crisis. A result has sometimes been a lack of clarity about objectives and priorities. It is inevitable that decisions will always reflect a mix of sometimes-conflicting objectives, but the more policy can be made within a coherent and consistent framework the better. This Review attempts to develop such a framework.

8. Energy policy needs to serve all of the three objectives of sustainable development—environmental, economic and social. Energy security is an intermediate objective which needs to be satisfied at all times if the other objectives are to be met. The central question for energy policy is the relative weight to be given to economic and environmental objectives. If a decision were made to aim for deep carbon cuts the environmental objectives would inevitably take precedence over economic ones within the energy system. This is not to say that energy should not continue to be produced in the most efficient way. But it does mean that the choices about the technologies used to produce energy, and about the levels of energy efficiency in the economy as a whole, may need to be very different from those which would be made if carbon emissions were not important. This is inevitable, given that the main way in which climate change can be countered is by carbon emission reductions, and carbon reductions can only be achieved by changes in the energy system—the source of 80% of UK greenhouse gases and 90% of CO₂. Even though it would be premature to adopt the RCEP target now, the strong likelihood of such a target being adopted in the future is sufficient to justify giving the environmental objective a strong priority within future energy policy.

9. Achieving the low carbon future will require action on many fronts, but an essential ingredient will be a more effective process of technological innovation in new low carbon directions.

What greenhouse gas targets?

10. The report has not considered the scientific case for carbon reductions—this was the task of the RCEP and of bodies such as the IPCC. Neither has it conducted a cost benefit analysis of the different ways of responding to the challenge—most obviously the choice between adaptation and mitigation. There is a lot of work on the possible overall costs to the economy of meeting a substantial carbon reduction target—most estimates are that the impact on GDP will be very small. The precise costs will, however, depend on the methods chosen to reduce carbon, technical progress, and the scope for trading reductions elsewhere in the world.

11. The Government will need to make decisions about its longer-term approach to carbon reducing policies in the light of a range of considerations. An obvious starting point is the likely course of the UK's international commitments. It would be unwise for the UK now to make a unilateral decision to meet the RCEP target, come what may. Greenhouse gases are global pollutants, and it would make no sense to

incur abatement costs in the UK and thereby harm our international competitiveness, if others were not contributing.

12. The UK is already committed to significant reductions in greenhouse gases by 2008-2012. A precautionary approach taking account of the period beyond the next decade suggests that the UK should be setting about creating a range of future options by which low carbon futures could be delivered, as, and when, the time comes. Action now may pay off later if we can avoid the need to make sharp and potentially costly changes of direction in later years. There is the potential for future commercial gains if we can put together the skills and expertise that can be used in international markets. The focus of this review is on ways of creating new options, and building upon the options we already have.

13. This approach justifies some positive steps to cut CO₂ emissions, beyond the 2008-2012 commitment. The Government has already adopted a 'leading' approach to climate change by setting demanding domestic targets and by its advocacy of the Kyoto proposals. This is a position where the UK decides to exercise some leadership and to demonstrate a way ahead. Clearly a choice of this kind is a political one.

14. The focus here has been on the best ways of achieving carbon reductions, given the strong chance that targets will become more stringent beyond 2012, and on ways of creating and preserving options.

The importance of market-based instruments

15. A conclusion of the Review is that a centrepiece of any carbon-reducing policy should be to use market-based instruments to put a price on carbon emissions and to determine the most cost-effective opportunities. This need not happen immediately, but decisions about long-term approaches are needed soon, since an early commitment will start to influence decisions in many markets.

16. The rest of the low carbon programme suggested in the Report focuses on two main areas: the scope for increasing the rate of improvement in energy efficiency, thereby reducing the overall demand for energy; and policies to create new low carbon energy supply options and preserve existing ones.

Energy efficiency must improve

17. Increased energy efficiency is obviously a good thing if it can be achieved without a cost. There is no point in wasting energy that can easily be saved. Evidence suggests that the scope for costless or low cost energy saving in nearly all parts of the economy—but most obviously the domestic sector and small businesses—is considerable. Major energy users already have sufficient incentive to save energy. But where energy is a small part of the budget the opportunities to make savings are often ignored. This may reflect pure ignorance, or it may be perfectly sensible behaviour on behalf of consumers, since there are risks and bother involved in making the necessary investments. The point for policy is that low cost intervention to remove the barriers to energy efficiency investments can be the means of unlocking these gains.

18. The Report puts forward a programme to produce a step change in the nation's energy efficiency, led by the Government itself. At the centre would be a new target—to ensure that domestic consumers' energy efficiency improves by 20% between now and 2010, and again by a further 20% between 2010 and 2020. This would approximately double the existing rate of improvement. It is therefore a challenging proposition. The gains in terms of energy savings could amount to some 0.3% of GDP in 2020, over and above the cost of the investment needed to unlock these savings.

19. A detailed programme of regulation and other incentives is proposed. In the long-run energy efficiency may also be supported by wider changes in society and in attitudes to energy use. When savings can be achieved by regulation, each new regulation should be subject to a cost benefit analysis. In other cases, financial incentives will be needed to unlock the savings. Their cost, and the distribution of the burden of support, would need to be reviewed over time. If the gains proved more difficult to come by than is anticipated, then the target could be adjusted later.

Renewable technologies are options for the future

20. The second main plank of a programme of action to put the UK in a position to react successfully to much tighter carbon targets is to develop new low carbon technologies. There are three main choices in the electricity sector: renewable technologies; nuclear power; and fossil fuels with carbon capture and sequestration. Elsewhere options are hydrogen and biofuels for transport and heat.

21. There is a wide range of renewable options and some will be developed under the Renewables Obligation. Unlike energy efficiency options, support for renewables nearly always costs money, since renewables remain more costly than using fossil fuels. The reasons for support are two-fold: to obtain carbon savings in the short term which help the UK to meet its international obligations; and in the longer-run to induce innovation and 'learning', bringing down the unit costs of the various technologies as volumes increase and experience is gained. In this way today's investment buys the option of a much cheaper technology tomorrow. Learning will, to a significant extent, be international, so that the UK can gain from investment elsewhere, but some of the new technologies—notably the marine technologies—may have particularly British application and require UK-based technology development.

22. The existing target that 10% of electricity should be supplied by renewable energy by 2010 is by no means in the bag. The industry faces three institutional barriers which must somehow be removed or countered if it is to succeed: these are what appears to be an excessive discount which, following the introduction of the New Electricity Trading Arrangements, is imposed on the sales value of small and intermittent generators; the urgent need to start to change the way in which local distribution networks are organised and financed; and the working of the planning system, which at present fails to place local concerns within a wider framework of national and regional need, and so tends to deter development. Recommendations are made to address all three.

A new renewables target

23. The Review recommends that an expanded renewables target for 2020 should be established. Any target expressed as a share of the market runs into the problem that it is difficult to know how much electricity will be produced and sold in 2020. If a significant improvement in energy efficiency can be achieved, then total demand should be significantly less than is currently envisaged on the basis of ‘business-as-usual’. The target proposed here for 2020 is a volume target of 80TWh. When this is applied to a level of 2020 demand broadly consistent with the policies suggested in this Review, it gives a 20% share of generation supply to renewables. The merit of this approach is that it tends to put a cap on the cost of the target (in terms of the total subsidy needed).

24. Why is it worth increasing the target? The new Renewables Obligation already has the potential to increase domestic electricity bills by up to 4.5%, and possibly double this in the case of industrial consumers. In fact, providing the new technologies can overcome their barriers, the cost to consumers should be less than this. The assumption behind the figure of 4.5% is that some companies meet their obligation by paying the ‘buy-out’ price rather than buying renewables, but if renewable supplies are cheaper they will not need to do this. Similarly, after 2010 if the scheme has been successful in stimulating the renewables industry the cost should come down. The Review estimates that the total cost of meeting a 20% target in 2020 could be an increase in domestic electricity bills of around 5-6%, still a significant increase.

25. What would this buy? The central proposition is that if renewables are ever to become a major feature of the UK energy balance—they at present constitute less than 1% of energy supply—the industry needs the assurance that demand will continue to grow. This will produce both substantial reductions in costs and, just as importantly, the infrastructure both of skills and capital equipment that is needed to make these investments. To put the proposition the other way round, if the Government fails to follow up the 2010 target and to make it obvious that there is continuing new demand for these technologies, enterprise will tend to lag. The existing investments will be supported until the end of the Obligation period, 2027, but without a new target there will be little incentive for continuing innovation or pressure to reduce costs further.

26. The investment also buys a very flexible set of options and not just a single technology. Each renewable investment is relatively small scale—though quite large wind farms are planned—and takes a relatively short time to build. One choice is the extent to which policy should aim for the maximum roll out of the cheapest technologies; or to develop a wide range of technologies, which would increase costs. In practice, policy should steer a course between the two. This carries implications for the means by which a given target is to be pursued. The Review has not come to a conclusion about means since this should wait upon the review of the workings of the Renewables Obligation in 2006/07. The range of possibilities includes further rounds of a Renewables Obligation and targeted public expenditure to help R&D, but new means may be devised. Deferring this decision also enables progress in cutting

renewables costs to be reviewed. If costs do not appear to be falling as expected, then policy can be refocused

Nuclear power—keeping the option open

27. Nuclear power offers a zero carbon source of electricity on a scale which, for each plant, is larger than that of any other option. Nuclear power seems likely to remain more expensive than fossil fuelled generation, though current development work could produce a new generation of reactors in 15-20 years that are more competitive than those available today. The decision whether to bring forward proposals for new nuclear build will lie with the commercial sector. Nowhere in the world have new nuclear stations yet been financed within a liberalised electricity market. But, given that the Government sets the framework within which commercial choices are made, it could, as with renewables, make it more likely that a private sector scheme would succeed.

28. Nuclear power based on fission is a mature technology, and there is a well-established global industry. In this it differs from renewables where support can be justified on the grounds that they are nascent industries, needing support if they are to fulfil their potential to help with the long-term carbon problem.

29. The general approach taken in this report is that, if there is to be public support, the aim should be to try to create options which are both flexible in their deployment, and which offer new prospects. The desire for flexibility points to a preference for supporting a range of possibilities, each of which could be abandoned, should it fail to meet its promise, rather than supporting a large and relatively inflexible programme. The nuclear option will still be open in later years since the nuclear industry is an international one, using designs that have been developed to meet circumstances in many countries. The need now is to ensure that, should there be a commitment to nuclear in the future, the lead-time to implementation of projects is reduced. The desire for new options also points to the need to develop new, low waste, modular designs of nuclear reactor, and the UK will continue to participate in international research aimed in this direction.

30. The nuclear skill base needs to be kept up-to-date. It is also suggested that, as the Government establishes a new framework for encouraging a low carbon economy, it should ensure that as methods to value carbon in the market are developed the nuclear industry is treated in the same way as other options.

31. The main focus of public concern about nuclear power is on the unsolved problem of long-term nuclear waste disposal, and perceptions about the vulnerability of nuclear power plants to accidents and attack. The problem of nuclear waste exists whether or not there is nuclear new build, and new nuclear stations would make only a small addition to the total (there would be a roughly 10% increase in the total stock of waste if all current reactors were replaced by new nuclear capacity). Nevertheless, these concerns overlay all the choices. Any move by government to advance the use of nuclear power as a means of providing a low carbon and indigenous source of

electricity would need to carry widespread public acceptance, which would be more likely if progress could be made in dealing with the problem of waste. Public acceptance would need to be built on an open and transparent public debate.

Combined Heat and Power: a low cost option

32. CHP is not zero carbon. But it is a low cost option for carbon abatement. In the long term it will benefit from policies that put a price on carbon. Industrial CHP is a mature technology. It therefore does not merit or need support through a premium price to encourage ‘learning by doing’ cost reduction, in this same way as new renewable technologies. It is important that CHP is given sufficient support to overcome current market and institutional barriers—many of these barriers are similar to the ones confronting renewable investments.

33. Micro-CHP is a new technology and faces some different obstacles. Its deployment will require changes to electricity distribution network and market operation to enable very small-scale generation to connect to the network.

Carbon sequestration may work

34. The potential benefits of CO₂ capture and sequestration—whereby carbon is taken out of fossil-fuels and buried—are that it could be a means to preserve diversity of fuel sources, including high carbon fuels such as coal, while meeting the need for deep cuts in CO₂ emissions. It also has a potential to be a source of zero carbon hydrogen for transport and other applications. It seems to be well suited to UK circumstances since the UK has potential repositories in the Continental Shelf, and the carbon could possibly be used to get more oil from existing wells.

35. At the moment uncertainties surrounding costs, safety, environmental impacts and public and investor acceptability are large. Steps should be taken to reduce these uncertainties. It appears impossible to do this unless the technology is demonstrated on a large scale in the UK context. At present it is not clear how best to do this. The next step should be to undertake more detailed analysis of the option and of the appropriate role for government.

Energy use for transport

36. The transport sector is likely to remain primarily oil-based until at least 2020. As a major oil producer access to oil supplies is not a current concern. Nevertheless, our economic dependence on transport, coupled with increased imports as our production declines, reinforces the need to improve the energy efficiency of oil-driven engines. For example, the next round of EU voluntary agreements need to reflect and bring about the technological potential for hybrids vehicles operating on both oil and hydrogen.

37. Longer-term possibilities that oil will become scarcer raise the need to develop alternative fuels. There is the long-term prospect that the technology for powering vehicles by fuel-cells fed on hydrogen will fulfil its current promise, and so ultimately provide the means of providing a substitute for oil. Other options, such as liquid biofuels, cannot yet be ruled out although they appear to be less cost-effective. International efforts are needed to develop all these technologies.

38. The way that the infrastructure to deliver hydrogen is developed and paid for will have a major impact. Investment in most new infrastructures has depended on Government intervention, mainly in nationalised industries. At this stage, when the future course of development is uncertain, it would be wrong to commit to one infrastructure so that we were 'locked-into' an inappropriate technology. This suggests an incremental approach: whereby small-scale projects are financed as demonstrations.

39. Handling the projected growth in aviation energy use and CO₂ emissions must become a priority for the transport community. Air transport issues need to be considered in wider transport planning. Taxation and other measures to manage aviation demand should be prioritised for discussion in EU and international forums.

Concerns about security

40. There are a number of reasons why security is on the agenda: the Californian electricity blackout experience; concerns resulting from the terrorist attacks in the USA of September 11; sensitivity to the need to import gas to the UK possibly across long pipelines and from trading partners who seem less secure than we are used to.

41. The basic approach taken is to view issues of security as ones of risk management. There are some risks which are essentially international and some that are domestic. Some obvious ways to improve security are to use the power of competitive markets to meet customers needs; to create a more resilient and flexible energy system; and to use international action to meet international problems. There is general agreement that a diverse energy system—both in terms of the range of different sorts of energy which are used and the sources of that energy—can benefit security. Some people argue that self-sufficiency is needed for security. There is no reason why this is necessarily so. As in other markets, imports can be a valuable means of increasing diversity and reducing risks—most of our major competitors already have substantial reliance on imported energy.

Is imported gas, risky gas?

42. But imports do carry risks that need to be managed. On just about any scenario the UK will become more dependent on imports both for its gas and for its oil. We still have a lot of our own oil and gas to exploit, but we must prudently now be looking to a future where imports start to provide a significant proportion of our needs. This will require the UK to face up to some new risks. One thing we can say is that there is little risk of their being insufficient gas available internationally: there is

plenty, and 70% of the world supplies can be accessed from Europe. But we cannot be so sanguine about the path that the gas will take from its source to the European market and the risks it will encounter *en route*. Particular concerns are: the level of investment in the exporting countries; investment in the transit countries; facility failure either overseas or domestically. All these risks need to be monitored. Most are outside the direct control of the UK purchasers or UK Government. Thus the Government should pursue a variety of diplomatic and trade related avenues to ensure that the UK and the EU continue to develop strong links with our trading partners, so that we can ensure that the benefits associated with trade are mutually recognised and delivered.

43. Similar work will be needed to ensure that the UK can protect itself in times of crisis. The report considers some of the obvious means of risk management—increased storage; use of liquid natural gas (LNG); greater use of coal than would otherwise be the case. In submissions to the Review proposals were made that the Government should decide the fuel mix for electricity generation. This proposal has been rejected on the grounds that it would be an excessive and major distortion in the market, although the proposals for renewables represent a small move in this direction. Since suppliers are likely to continue to meet new demands via increased gas-fired generation, it must be in the gas market itself that we mostly look to reduce risks, most obviously by increased use of LNG, storage and international interconnections

44. A strong conclusion of the Review is that the successful liberalisation of the gas and electricity markets in the EU will constitute a central pillar in the achievement of greater energy security. Relatively secure supplies can, of course, be obtained in non-liberalised markets. But liberalisation provides flexibility and depth, adding substantially to the resilience of the energy system. In liberalised markets, prices signal future availability to a wide range of participants, offering incentives for a range of different responses on the demand and the supply sides. Moreover innovation is encouraged in ways which would not be possible in a less competitive market.

Investment in a liberalised market

45. The other main area of risk which has been considered in this Review is the set of issues which arise as a result of the Californian experience. There supplies of electricity were threatened because insufficient investment had been made both the network and electricity generation. The Californian problems were very specific to that State and were due in considerable measure to failures in regulation, which have no parallels in the UK. The subsequent reactions to the crisis on both the demand and the supply sides have, however, been a partial demonstration of the power of markets.

46. In fact, present levels of capacity investment in the UK in both the network and in generation are healthy. The processes of privatisation and liberalisation seem to have succeeded well. Even so, the situation needs to be monitored since future investment might be constrained if the wrong signals and incentives come through the regulatory structures and the trading market. Some specific features of energy markets suggest that in principle markets might not deliver as much security as consumers want, though it is not always clear that Government, with its limitations, is well-paced

to improve matters. But there is no reason for immediate concern. Also very great care is needed to ensure that anticipation of significant possibilities for public intervention does not lead the private sector to hold back in its plans.

Some institutional changes are needed

47. The logic of the approach adopted here is that in the long-term the Government should be aiming to bring together the three inter-linked themes in this report—climate change policy, energy policy and transport policy—in one department of state. But this is clearly something for the long-term. In the shorter-term, the consideration should be given to locating responsibility for energy efficiency and CHP policy with other aspects of energy policy.

48. As an immediate response to the challenge established here, the Government should set up a new Sustainable Energy Unit. This would be a cross-cutting unit, staffed by civil servants from all the departments with an interest in sustainable energy and with outsiders as well. The Unit would focus on providing Ministers with cross-cutting analytical capability to ensure that the key developments in energy use and supply were monitored and assessed. It would lead on the development of strategic policy issues, adapting quickly to the changing priorities of energy policy.

49. The new Unit would sit alongside existing institutions and would be staffed by people representing all these interests. The different responsibilities of the DTI and the regulators, most notably Ofgem would continue. The DTI and DEFRA should do more to explain their priorities to Ofgem, so that Ofgem can further consider the impacts of its proposals for non-economic objectives.

Energy projects are finding it difficult to get planning approval

50. The other main institutional topic is the impact of the current planning system on investment in the energy industries. Throughout the energy industries, investors have found that their projects have difficulty in gaining planning permission. The attitude of local communities to proposals for new energy development is important and they must continue to have their say in the planning process. This is one reason why it is important to engage the public in the energy policy debate, discussing with them the range of future choices. But national planning guidance needs to make it clear where there is a national case for new investment in energy-related facilities by establishing the relevant national and regional context for each type of development.

The way ahead: the public debate

51. The report develops a radical agenda—to enable the UK to put itself on the path to a low carbon economy. Precautionary action is needed in advance of further international agreement. There are several important tasks that should be undertaken within the next five years. Government should move towards a clear rationale for the balance of policy instruments—taxes, permits and regulation—to create powerful incentives for long-term carbon reduction.

52. Governments have to accept the uncertainties surrounding energy policy interventions. It can set the framework within which markets operate, but it cannot determine precisely which technologies will work best or which opportunities will prove most commercial. The aim should be to create options for the future, and, so far as possible, to preserve some flexibility of response. This is not a recipe for inaction: quite the reverse. Action is needed to assist innovation and to create new options, and action is also needed to manage risk.

53. The implementation of an ambitious low carbon policy is a demanding task. The public must have no doubt about the political commitment to change. These are not changes which can be produced as a result of quick technical fixes: technology has a large part to play, but just as important are changes in institutions, attitudes and assumptions. Change of this kind takes a long time. It would be wrong to imagine that everything can be 'win-win': there will be some hard choices and there will be losers as well as winners. For this reason the government needs take the issues to the public soon. During the review proposals were made to the PIU for a process of public involvement. There was insufficient time for this, but it should constitute a central part of the implementation of the findings of the report.

54. A radical agenda implies substantial change, and widespread public acceptance of the need for change. The nation must not be lulled into inaction by the focus of much of the expert debate on long time-scales and on energy systems in a future, which will belong mainly to our grandchildren: the time for action is now. Given that there is considerable inertia in the system and that the low carbon technologies are not part of the conventional energy system, the change of direction is likely to be difficult to achieve. It will require considerable clarity of purpose in all parts of Government.