

REFERENCES

Energy: Definitions and Units

1. The international system of units (6th edition). HMSO, 1993.

Chapter 1

1. Annual rates of global energy use have been taken from Odell, P.R. (1999). *Fossil fuels in the 21st century*. Financial Times Energy. The Commission Secretariat has converted from tonnes coal equivalent to watts. To obtain estimates of global energy use in terms of tonnes coal equivalent, Odell expressed energy derived from hydro and nuclear power as the heat value of the electricity produced. Statistics of world population have been taken from Durand, J.D. (1974). *Historical estimates of world population: an evaluation*. University of Pennsylvania Population Studies Center, Philadelphia; United Nations (1966). *World population prospects as assessed in 1963*. United Nations, New York; United Nations (1998). *World population prospects: the 1998 revision*. ESA/P/WP.150. United Nations, New York.
2. International Energy Agency (IEA) (1998). *World Energy Outlook 1998 Edition*. IEA/Organization for Economic Co-operation and Development, Paris. The most recent year for which global data are available is 1995.
3. Tolba, M.K., El Kholy, O., El Hinnawi, E., Holdgate, M.W., McMichael, D.F. and Munn, R.E. (eds) (1992). *The world environment, 1972-1992: two decades of challenge*. Chapman and Hall.
4. Tolba *et al.* (1992).
5. IEA (1998). See page 413.
6. Department of Health, Committee on the Medical Effects of Air Pollutants (1998). *Quantification of the effects of air pollution on health in the United Kingdom*. The Stationery Office.
7. World Commission on Environment and Development (1987). *Our common future*. Oxford University Press, Oxford.

Chapter 2

1. Intergovernmental Panel on Climate Change (IPCC) (1996a). *The Science of Climate Change 1995*. Cambridge University Press, Cambridge.
2. Houghton, J.T. (1997). *Global Warming*. Cambridge University Press, Cambridge.
3. IPCC (1996b). *The Science of Climate Change 1995. Summary for Policymakers*. Cambridge University Press, Cambridge. See page 31.
4. Karl, T.R., Knight, R.W. and Baker, B. (2000). The record breaking global temperatures of 1997 and 1998: evidence for an increase in the rate of global warming? *Geophysical Research Letters*, **27**, 719-722.
5. The disparity between the rapid increase observed in surface temperature and the relatively minimal temperature increase observed during the last 20 years in the lower to mid-troposphere does not invalidate the conclusion that surface temperature has been rising: National Research Council, Panel on Reconciling Temperature Observations (2000). *Reconciling observations of global temperature change*. National Academy Press, Washington DC.
6. Barnola, J.M., Raynaud, D., Korotkevich, Y.S. and Lorius, C. (1987). Vostock ice core provides 160,000-year record of atmospheric CO₂. *Nature*, **329**, 408-414.

References

7. The average concentration of carbon dioxide in the atmosphere in 1997 was around 363 ppmv: Keeling, C.D. and Whorf, T.P. (1998). *Atmospheric CO₂ concentrations – Mauna Loa Observatory, Hawaii, 1958-1997*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee;
The average concentration reported from observations at the Mauna Loa Observatory throughout 1998 was 367 ppmv: <http://cdiac.esd.ornl.gov/ftp/maunaloa-co2/maunaloa.co2>
8. IPCC (1994). *Climate Change 1994: Radiative forcing of climate change and an evaluation of the IPCC IS92 emission scenarios*. Cambridge University Press, Cambridge. See page 34.
9. Rotty, R.M. and Marland, G. (1986). *Production of CO₂ from fossil fuel burning by fuel type*. Report NDP-006. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee.
10. Carbon dioxide is released into the atmosphere through the calcining of limestone during cement manufacture. For an assessment of the cement industry's contribution to carbon dioxide emissions, see *Greenhouse Issues* (newsletter of the IEA Greenhouse Gas R&D Programme), **46**, January 2000.
11. IPCC (1996b), page 8.
12. IPCC (1996a).
13. The flows shown in figure 2-III are averages of estimates for the years 1988-1997.
14. The figure of 260 GtC includes carbon dioxide emissions from cement manufacture.
15. Keshgi, H.S., Jain, A.K. and Wuebbles, D.J. (1996). Accounting for the missing carbon sink with the CO₂ fertilisation effect. *Climate Change*, **33**, 31-62.
16. Etheridge, D.M., Steele, L.P., Langenfelds, R.L., Francey, R.J., Barnola, J.M. and Morgan, V.I. (1996). Natural and anthropogenic changes in CO₂ over the last 1,000 years from Antarctic ice and firn. *Journal of Geophysical Research*, **101**, 4115-4128.
17. Petit, J.R., Jouzel, J., Raynaud, D., Barkov, N.I., Barnola, J.M., Basile, I., Bender, M., Chapellaz, J., Davis, M., Delaygue, G., Delmotte, M., Kotlyakov, V.M., Legrand, M., Lipenkov, V.Y., Lorius, C., Pepin, L., Ritz, C., Saltzman, E. and Stienhard, M. (1999). Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature*, **399**, 429-436.
18. See endnote 7.
19. Berner, R. A. (1994). Geocarb II: a revised model of atmospheric CO₂ over Phanerozoic time. *American Journal of Science*, **294**, 56-91.
20. IPCC (1996b), table 1.
21. IPCC (1994), page 245.
22. Hoffert, M.I., Caldeira, K., Jain, A.K., Haites, E.F., Harvey, L.D.D., Potter S.D., Schlesinger, M.E., Schneider, S.H., Watts, R.G., Wigley, T.M.L. and Wuebbles, D.J. (1998). Energy implications of future stabilization of atmospheric CO₂ content. *Nature*, **395**, 881-884. The power produced by 'carbon-emission-free' sources in 2050 would be 10TW (figure 2), equivalent to the power provided by all today's energy sources combined, and global energy intensity would have to be reduced by 1% a year over the next 50 years (notes to figure 3).
23. Meteorological Office (1999). *Climate change and its impacts: stabilization of CO₂ in the atmosphere*. The Meteorological Office, Bracknell. This projection assumed there would be no net addition to the greenhouse effect from other substances, and may therefore be an under-estimate.
24. Information supplied by The Hadley Centre, February 2000. In 1990 global emissions from burning of fossil fuels were 6.1 GtC (IPCC (1996a), page 78). The calculation assumes that carbon dioxide emissions resulting from land use changes also continue at the 1990 level.
25. Meteorological Office (1999).
26. United Nations Framework Convention on Climate Change (UNFCCC) (1992). Adopted 9 May 1992, New York.
27. Brown, B.E., Dunne, R.P. and Chansang, H. (1997). Coral bleaching relative to elevated sea surface temperature in the Andaman Sea (Indian Ocean) over the last 50 years. *Coral Reefs*, **15**, 151-152.
28. Meteorological Office (1999).
29. Oppenheimer, M. (1998). Global warming and the stability of the West Antarctic Ice Sheet. *Nature*, **393**, 325-332.

30. Meteorological Office (1999).
31. Turner, R.K., Adger, N. and Doktor, P. (1999) Assessing the economic costs of sea level rise. *Environment and Planning A*, 27, 1777-1796.
32. The most comprehensive assessment is that by the UK Climate Change Impact Review Group (CCIRG): Department of the Environment (1996). *Review of the potential effects of climate change in the United Kingdom*. HMSO.
33. UK Climate Impacts Programme (1998). *Climate change scenarios for the United Kingdom. Technical Report No. 1: Summary Report*. Climate Research Unit, University of East Anglia, Norwich.
34. Centre for the Study of Environmental Change and Sustainability (1999). *Climate Change: Scottish Implications Scoping Study*.
35. Meteorological Office (1999).
36. Evidence from Julian Morris (Director, Institute of Economic Affairs), December 1998.
37. A text published on the web-site of the Oregon Institute of Science and Medicine reviewing the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide during the 20th century concludes that this has had no deleterious effects on global weather, climate and temperature;
Robinson, A.B., Baliunas, S.L., Soon, W. and Robinson, Z.W. (1998). Environmental effects of increased atmospheric carbon dioxide. <http://www.oism.org/pproject/>
38. Twenty-first Report, paragraph 2.66.
39. In the four new scenarios increases in temperature and rises in sea level are measured from 1750, whereas in IPCC's 1995 scenarios they were measured from the 1860s; the difference in sea level between the two dates is negligible and the difference in temperature about 0.2°C.
40. Meteorological Office (1999).

Chapter 3

1. Twenty-first Report, paragraph 3.32.
2. In certain types of deep bituminous coal deposits it would be possible to combine injection of carbon dioxide with recovery of methane adsorbed in the coal seam, in an approach akin to enhanced recovery from oil fields (information supplied by Dr K. Thambimuthu, February 2000).
3. Croiset, E. and Thambimuthu, K.V. (1999). A novel strategy for greenhouse gas abatement in coal-fired power plants: enriched oxygen combustion. *Combustion Canada '99*. Calgary, Alberta, Canada, 26-28 May 1999.
4. Herzog, H., Golomb, D. and Zemba, S. (1991). Feasibility, modelling and economics of sequestering power plant CO₂ emissions in the deep ocean. *Environmental Progress*, 10, 64-74.
5. Thambimuthu, K. and Freund, P. (1998). CO₂ capture and sequestration from power generation: studies by the IEA Greenhouse Gas R&D Programme. *Proceedings of the 1998 Electric Power Research Institute and Gasification Technology Council Conference, San Francisco, California, October 1998*. For calculating the costs of avoiding carbon dioxide emissions the IEA Greenhouse Gas R&D Programme uses a discount rate of 10% and a standard set of assumptions and conditions: a power plant supplying 500 MW of electricity to a grid, at which 85% of carbon dioxide is removed, dried and pressurised to 90 bar, and kept in a temporary store. Costs have been converted from US \$ at the rate of \$1.6=£1.
6. Supercritical fluids are highly compressed gases which combine properties of gases and liquids. The definition of a supercritical fluid usually begins with a phase diagram, which defines the critical temperature and pressure of a substance. For example, carbon dioxide becomes supercritical above a temperature of 31.1°C and a pressure of 73.8 bar, known as the critical point.
7. International Energy Agency Greenhouse Gas R&D Programme (IEAGGP) (1994). *Carbon dioxide disposal from power stations*. Cheltenham.
8. Holloway, S. *et al.* (1996). The underground disposal of carbon dioxide. British Geological Survey, Keyworth, Nottingham.

References

9. Workshop organized by IEAGGP and Statoil on the geological storage of carbon dioxide in saline aquifers, 4-5 April 2000, Noorwijkerhout, Netherlands.
10. Schmidt, K. (1998). Coming to grips with the world's greenhouse gases. *Science*, **281**, 504-505.
11. Under existing circulation patterns the turnover of water between surface and deep layers of the ocean ranges from 250 years in the Atlantic to 550 years in the Pacific: Into the abyss, *New Scientist*, 15 May 1999, 14.
12. Greenpeace International (1999). *Ocean disposal/sequestration of carbon dioxide from fossil fuel production and use: an overview of rationale, techniques and implications*. Amsterdam, Netherlands.
13. Convention on the prevention of marine pollution by dumping of wastes and other matter (1972). A protocol updating and enhancing the environmental protection provided by the London Convention was agreed in 1996 but has yet to enter into force. A number of delegations at the twenty-first consultative meeting of the contracting parties supported the conclusion of the advisory scientific group that fossil fuel-derived carbon dioxide should be considered an industrial waste, the dumping of which is prohibited under the convention. Other delegations concluded that it was too early to reach a decision, that the convention should not be used to prevent research and that its terms could be changed if necessary. It was also pointed out that under article III(I)c of the convention (retained as article 1.4.3 of the 1996 protocol) the disposal or storage of wastes or other matter from offshore oil and gas activities is not currently covered by the provisions of the convention. The London Convention does not cover the disposal of carbon dioxide from land-based sources via pipelines. Delegations present at the twenty-first meeting agreed that the scientific group would maintain a watching brief on developments relating to carbon dioxide disposal.
14. UNEP (1999). *Global Environment Outlook 2000*. Earthscan.
15. Nilssen, A. (1992). *Greenhouse Earth*. John Wiley and Sons for Scientific Committee on Problems of the Environment.
16. Intergovernmental Panel on Climate Change (IPCC) (1996a). *Climate Change 1995: Impacts, adaptations and mitigation of climate change: scientific-technical analyses*. Cambridge University Press, Cambridge.
17. IPCC (1994). *Climate Change 1994: Radiative forcing of climate change and an evaluation of the IPCC IS92 emission scenarios*. Cambridge University Press, Cambridge.
18. IPCC (1996a).
19. Davison, J.E. and Freund, P. (1999). *A comparison of sequestration of CO₂ by forestry and capture from power stations*. IEAGGP, Cheltenham.
20. Dixon, R.K., Brown, S., Houghton, R.A., Solomon, A.M., Trexler, M.C. and Wisniewski, J. (1994). Carbon pools and flux of global forest ecosystems. *Science*, **263**, 185-190;
Schlesinger, W. H. (1997). *Biogeochemistry: An analysis of global change*. Academic Press.
21. Friend, A.D., Stevens, A.K., Knox, R.G. and Cannell, N.G.R. (1997). A process based terrestrial biosphere model of ecosystem dynamics (HYBRID v3.0). *Ecological Modelling*, **95**, 249-287.
22. Meteorological Office (1999). *Climate change and its impacts: stabilization of CO₂ in the atmosphere*. The Meteorological Office, Bracknell.
23. Nilssen (1992).
24. Cooper, D.J., Watson, A.J. and Nightingale, P.D. (1996). Large decrease in ocean surface CO₂ fugacity in response to *in-situ* iron fertilization. *Nature*, **383**, 511-513.
25. Denman, K., Hofmann, E. and Marchant, H. (1996). Marine biotic responses to environmental change and feedbacks to climate. Pages 487-516 in IPCC (1996b). *The Science of Climate Change 1995*. Cambridge University Press, Cambridge.
26. Ritschard, R.L. (1992). Marine algae as a CO₂ sink. *Water, Air and Soil Pollution*. **64**, 289-303;
IEAGGP (1998). *Ocean fertilisation as a CO₂ sequestration option*. Cheltenham.
27. Convention on the Conservation of Antarctic Marine Living Resources (1982). Hobart, Tasmania, Australia. <http://www.ccamlr.org/>
28. Sarmiento, J.L. and Orr, J.C. (1991). Three-dimensional simulations of the impact of Southern Ocean nutrient depletion on atmospheric CO₂ and ocean chemistry. *Limnology Oceanography*, **36**, 1928-1950.

29. IPCC (1996b).
30. International Energy Agency (IEA) (1999). *Energy balances of non-OECD countries 1996-1997*. Paris: IEA/Organization for Economic Co-operation and Development (OECD).
31. IEA (1998). *World Energy Outlook – 1998 Edition*. Paris: IEA/OECD.
32. Chadwick, M.J. (1997). Industrial ecocycles: rate adjustments and dematerialization. *Philosophical Transactions of the Royal Society of London A*, **355**, 1439-1447.
33. Energy intensity is the ratio between consumption of primary energy and output of goods and services. Between 1971 and 1997 global output of goods and services rose by 3.2% a year, whereas global energy use rose by 2.2% a year: IEA (1998).
34. Nakicenovic, N. (1996). Freeing energy from carbon. *Daedalus*, **125**(3), 95-112.
35. Patterson, W. (1999). *Transforming electricity*. Royal Institute of International Affairs/Earthscan.
36. Twentieth Report, paragraph 2.35.
37. Evidence from Dr L. Brookes, April 1999;
Herring, H. (1998). *Does energy efficiency save energy: the economists debate*. The Open University, Milton Keynes.
38. Watt Committee on Energy (1990). *Technological responses to the greenhouse effect*. G. Thurlow (Ed.). The Watt Committee on Energy, Rooster Books Limited.
39. Presentation by Professor Peter Odell, May 1999.
40. Reference efficiencies of power plant taken from IEAGGP (1994).
41. DTI (1998). *Conclusions of the review of energy sources for power generation and government response to fourth and fifth reports of the Trade and Industry Committee*. Cm 4071. See paragraph 9.57.
42. Carbon emissions from the ARBRE biomass plant are estimated as 44-109 g/kWh whilst the equivalent figures for coal and gas fired power plants are 410 and 1,050 gC/kWh, respectively. Bauen, A. (1999). *Gasification-based biomass fuel cycles: an economic and environmental analysis at the regional level*. Unpublished PhD thesis, King's College London, University of London. See page 146.
43. Energy Technology Support Unit (1995). *Full fuel cycle atmospheric emissions and global warming impacts from UK electricity generation*. ETSU Report No. R-88. HMSO.
44. IEA. Appendix B - Photovoltaics, in *Benign energy: the environmental implications of renewables*. <http://www.iea.org.tech/pubs>
45. Michaelis, P. (1998). *Life cycle assessment of energy systems*. A report prepared for the Royal Commission on Environmental Pollution. Centre for Environmental Strategy, University of Surrey, Guildford.
46. European Wind Energy Association/Forum for Energy and Development/Greenpeace International (1999). *Wind Force 10: a blueprint to achieve 10% of the world's electricity from wind power by 2020*. Birger Madsen BTM Consult, Ringkøbing (Denmark).
47. Thambimuthu, K. and Freund, P. (1998);
Davison, J.E. and Freund, P. (1999).

Chapter 4

1. Netherlands, Ministry of Housing, Spatial Planning and the Environment (1999). *Environmental News from the Netherlands*, **4**, 3. The Hague.
2. Wigley, T. (1998). The Kyoto Protocol: CO₂, CH₄ and climate implications. *Geophysical Research Letters* **25**(13), 2285-2288. The comparison was with IPCC's IS92a scenario (2.20).
3. United Nations (1998). *World Population Prospects: The 1998 Revision*. ESA/P/WP.150. United Nations, New York.
4. Nordhaus, W.D. (1999). *Roll the DICE again: the economics of global warming*. Yale University Press, New Haven. The quotation is from page 47.
5. Heal, G. (1997). Discounting and climate change, an editorial essay. *Climatic Change*, **37**(2), 335-343.
6. Dasgupta, P.S., Mäler, K. and Barrett, S. (1999). Intergenerational equity, social discount rates and global warming. In Portney, P.R. and Weyant, J.P. (Eds.). *Discounting and intergenerational equity*. Resources for the Future, Washington DC.
7. Nordhaus, W.D. and Boyer, J.G. (1999). Requiem for Kyoto: An economic analysis of the Kyoto Protocol. *Energy Journal*, May 1999, 93-130.
8. Global Commons Institute's website, <http://www.gci.org.uk>. The institute regards 450 ppmv as an upper limit.
9. Nordhaus, W.D. and Boyer, J.G. (1999).

References

10. The Council of Ministers first reached this conclusion in March 1998, on the basis that a 550 ppmv limit might prevent global temperatures from rising by more than 2°C. Community Strategy on Climate Change: Council Conclusions.
11. Wigley, T.M.L., Richels, R. and Edmonds, J.A. (1996). Economic and environmental choices in the stabilization of atmospheric CO₂ concentrations. *Nature*, **379**, 240-243.
12. International Energy Agency (1998). *World Energy Outlook 1998 Edition*. IEA/Organization for Economic Co-operation and Development, Paris.
13. Galeotti, M. and Lanza, B. (1999). Richer and cleaner? A study on carbon dioxide emissions in developing countries. *Energy Policy*, **27**, 565-573.
14. Wigley, T.M.L. (1997). Implications of recent CO₂ emission-limitation proposals for stabilization of atmospheric concentrations. *Nature*, **390**, 267-270.
15. Baumert, K.A., Bhandari, R. and Kete, N. (1999). What might a developing country climate commitment look like? *World Resources Institute Climate Notes*, May 1999. Washington DC. See also Sagoff, M. (1999). Controlling global climate: The debate over pollution trading. *Report from the Institute for Philosophy and Public Policy*, **19**, 1-6.
16. Wigley, T.M.L. (1997). But see also Ramakrishna, K., The Great Debate on CO₂ emissions. *Nature*, **390**, 227-228.
17. Table 4.1 has been calculated by the Commission Secretariat. The figures used for total allowable global emissions under different stabilisation scenarios are based on estimates in Intergovernmental Panel on Climate Change (1996). *The Science of Climate Change 1995. Summary for Policymakers*. Cambridge University Press, Cambridge.
18. The UK population in 2050 is assumed to be 57 million and the global population 8.9 billion: United Nations (1998).
19. Meyer, A. (1997). The Kyoto Protocol and the emergence of contraction and convergence as a framework for an international political solution to greenhouse gas emissions abatement. In Hohmeyer, O. and Rennings, K. (Eds.). *Man made climate change – economic aspects and policy options*. Proceedings of a ZEW conference. Mannheim; web-site of the Global Commons Institute. <http://www.gci.org.uk>
20. Auken, S. (*Minister for Environment and Energy, Denmark*) (1999). Kyoto and beyond. In: *The Sustainable Development Agenda 1999*. Campden. See page 18.
21. Grubb, M., Vrolijk, C. and Brack, D. (1999). *The Kyoto Protocol; a guide and an assessment*. Royal Institute of International Affairs/Earthscan. See page 270.
22. Emissions Trading Group (1999). *Outline proposals for a UK emissions trading scheme*. December 1999. The Group was set up in June 1999 by the Confederation of British Industry and the government's Advisory Committee on Business and the Environment. In the November 1999 pre-Budget report the Chancellor supported the group's work.

Chapter 5

1. Department of Trade and Industry (DTI) (1999). *Digest of United Kingdom Energy Statistics (DUKES) 1999*. Cited as DUKES 1999.
2. DUKES 1999, table 1.13.
3. DUKES 1999, table 1.12.
4. DTI (2000a). *Energy projections for the UK – working paper*. DTI EPTAC Directorate. This document, the first set of official energy projections since 1995, emphasised that it represented work in progress and had yet to be approved by Ministers. It was issued in this preliminary form to accompany the Draft UK Climate Change Programme, which took the DTI energy projections into account in projecting UK 'business as usual' carbon dioxide emissions. The energy projections cover six scenarios, based on different assumptions about future economic growth and energy prices. The projections quoted in the text, and used in constructing figures 5-I, 5-II, 5-III and 5-V, are for the central economic growth case (GDP increases at 2.5-2.75% a year between 2001 and 2020) and higher energy prices (oil traded at an average of \$20 a barrel, at 1995 prices, over the period 2000-2020).

5. DUKES 1999, table 1.9; 228.9 million tonnes of oil equivalent is equal to an average rate of 304 GW.
6. DUKES 1998, tables 1.1 and 1.9.
7. DUKES 1999, table 1.9, page 35.
8. DUKES 1999, table 1.9.
9. DUKES 1999, tables 6.1 and 1.1.
10. DUKES 1999, page 17, paragraph 1.40.
11. DUKES 1999, table 1.13; in total final users consumed 156.2 million tonnes of oil equivalent, equal to an average rate of 207 GW.
12. DUKES 1999, tables 1.9 and 1.13.
13. Calculated from DUKES 1999.
14. GDP at 1995 prices; watts represent the average rate of consumption of primary energy in the year in question.
15. Parliamentary Office of Science and Technology (POST). Appendix 1 in House of Commons, Environmental Audit Committee (1999). *Energy efficiency*. Minutes of Evidence, HC159-II 1998-99.
16. The policies set out in the 1969 Energy White Paper might have constituted an exception, had it not been followed quickly by a change of government.
17. DTI (1998). *Conclusions of the review of energy sources for power generation and government response to Fourth and Fifth Reports of the Trade and Industry Committee*. Cm 4071. October 1998. See paragraph 1.1. In paragraph 2 of the government's response to the House of Commons Environmental Audit Committee's report, *Energy efficiency* this is described as 'the Government's central policy objective'.
18. DTI (1998), paragraph 1.2.
19. Covered in chapter 9 of DTI (1998). See paragraph 3 of the government's response to the Environmental Audit Committee's report (end note 57).
20. The current Utilities Bill provides for the formal merger of the two offices, which have already been combined administratively. There is a separate regulator for the electricity industry in Northern Ireland; there is no public supply of gas in Northern Ireland.
21. DTI (1998).
22. Blair's energy cave-in to US. Revealed: how threats forced U-turn on mines. *The Guardian*, 13 August 1999.
23. A Directive on liberalisation of the electricity market was adopted in January 1997 and should make it easier for independent producers to sell electricity; by 2003 it will give anyone using electricity at an average rate of more than about 1 MW the right to choose a supplier. A programme for liberalisation of the gas market was agreed by Ministers in December 1997 and provides for 33% of the market to be opened to competition five years after a Directive comes into force. Owen, G. (1999). *Public purpose or private benefit? The policies of energy conservation*. Manchester University Press, Manchester. See page 54.
24. The source for the structure of the gas industry is DUKES 1999, chart 4.1 and paragraphs 4.8-4.10; figures for market share are for 1998 for the industrial and commercial market and end April 1999 for the domestic market, number of companies as at the end of 1998; sources for the structure of the electricity industry are DUKES 1999, chart 5.1, paragraphs 5.4 and 5.52-5.53, and table 5.4; Electricity Association (1999). *Electricity Industry Review 3*, pages 19-23 and table on page 39 (using data supplied by NGC Energy Settlements and Information Services Ltd). Figures for market share are for 1997/98; number of second tier suppliers as at 1 October 1998.
25. It has been suggested, on the basis of modelling studies, that the actual effect of moving from the Pool to bilateral agreements will be to increase the power of the large generators and raise prices: Cheap power plan to backfire. *The Observer*, 22 August 1999.
26. In March 1998 a government advisory committee recommended that the electricity and gas regulators should incentivise suppliers to develop in that direction in relation to housing: Advisory Committee on Business and the Environment. *Climate change: a strategic issue for business*. Report presented to the Prime Minister, 31 March 1998.
27. Department of the Environment Transport and the Regions (DETR) (2000a). *Energy Efficiency Standard of Performance – 2003-2005. Consultation Proposals*.
28. The Environment Agency in England and Wales and the Scottish Environment Protection Agency in Scotland; integrated pollution control does not yet operate in Northern Ireland.

References

29. Council Directive 96/61/EC concerning integrated pollution prevention and control. *Official Journal of the European Communities*, L257, 10.10.96.
30. Information supplied by DTI, February 2000.
31. In Northern Ireland appeals are made to the Planning Appeals Commission.
32. DETR (2000b). *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – working together for clean air*. The Stationery Office.
33. A decade of dramatic improvements in air quality predicted – Meacher launches new air quality strategy to start new century: DETR Press Notice 032, 19 January 2000.
34. DTI (1994). *New and renewable energy: future prospects in the UK*. Energy Paper 62. HMSO. See paragraph 3.1.1.
35. Department of the Environment (DOE) (1993). *Renewable energy*. Planning Policy Guidance Note 22; Scottish Development Department (1994). *Renewable energy*. National Planning Policy Guidance 6 (now under review); Scottish Executive (1999). *Renewable energy technologies*. Planning Advice Note 45; Welsh Office (1999). *Planning Guidance (Wales) Planning Policy First Revision* (now under review); DOE (1996). *Renewable energy. Planning Guidance (Wales)* Technical Advice Note 8; Planning Policy Statements being prepared by the Department of the Environment in Northern Ireland on ‘Protection of the environment’ and ‘Public services/utilities’ may address relevant issues.
36. DTI (1999). *New and renewable energy: prospects for the 21st century*. See page 22.
37. Energy Technology Support Unit (ETSU) (1999). *New and renewable energy: prospects for the 21st century – supporting analysis*. See page 257.
38. DUKES 1999, table 7.5.
39. Between 1994 and the end of 1998, of the 18 wind developments which went before planning inquiries, just two small schemes won approval: Questions but precious few answers in renewable energy review. *ENDS Report*, No. 291, April 1999.
40. DTI (2000b). *New and renewable energy – prospects for the 21st century. Conclusion in response to the public consultation*.
41. ETSU (1999). See page 17 and figure 4.
42. DUKES 1999, chapter 6.
43. DOE, (1994). *Climate Change – the UK Programme*, HMSO.
44. DETR/Scottish Executive/National Assembly for Wales/Department of the Environment (in Northern Ireland) (2000c). *Climate Change: Draft UK Programme*. DETR.
45. Based on estimates for carbon savings arising from various policies set out in DoE (1997), *Climate Change – the UK Programme: The United Kingdom’s Second Report under the Framework Convention on Climate Change*; DETR/Scottish Executive/National Assembly for Wales/Department of the Environment (for Northern Ireland) (2000). *Climate Change – Draft UK Programme*.
46. DETR (2000c).
47. DETR (1998). *A new deal for transport: better for everyone*. Cm 3950. The Stationery Office.
48. DETR (2000c).
49. International Energy Agency (IEA) (2000); *Energy Policies of IEA Countries – 1999 Review*, OECD/IEA: Paris. tables B2, B4, B11.
50. IEA (2000); *Energy Policies of IEA Countries – 1999 Review*, table B4.
51. Office of Science and Technology, 1999, *SET Statistics 1999 – a handbook of science, engineering and technology indicators*. OST.
52. A similar trend occurred in the USA, where a decline in industry funding of energy-related R&D has been attributed to utility industry restructuring: Yeager, K.E. (1998). Rebuilding the commitment to R&D investment and innovation. *World Energy Council Journal*, July 1998, 80-85.
53. From £174 million to £139 million. Information supplied by Energy Policy and Analysis Unit, DTI, April 1999.
54. *R and d scorecard*. See http://www.innovation.gov.uk/finance/rndscore_1999/intex.html
55. Evidence from the University of Greenwich Natural Resources Institute, November 1998; Local Government Association, December 1998; The Royal Institute of British Architects, December 1998; Eryl McNally MEP (Bedfordshire and Milton Keynes), December 1998; The Rocky Mountain Institute, December 1998; Dalkia plc, December 1998; Environmental Change Unit and the Department of Engineering Science, University of Oxford, January 1999; BIFFA Waste Services, February 1999.

56. House of Commons Trade and Industry Committee. *Energy policy*. Volume I, paragraph 21(a). Session 1997-98, Fifth Report, HC471-1.
57. House of Commons Environmental Audit Committee. *Energy efficiency*. Volume I, paragraph 6. Session 1998-99, Seventh Report, HC 159-1.
58. United Kingdom (1999). *A better quality of life: a strategy for sustainable development for the United Kingdom*. Cm 4345. See paragraph 8.12.

Chapter 6

1. Department of Trade and Industry (DTI) (1999). *Digest of United Kingdom Energy Statistics 1999*. The Stationery Office. Cited as DUKES 1999. Tables 1.12 and 1.13.
2. Department of the Environment, Transport and the Regions (DETR) (1999a). *Fuel poverty: The New Home Energy Efficiency Scheme*.
3. The Eurowinter Group (1997). Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all causes in warm and cold regions of Europe. *The Lancet*, **349**, 1341-1346.
4. DETR (1999a)
5. DUKES 1999, tables 1.12 and 1.13.
6. DTI (1997). *Energy consumption in the United Kingdom*. Energy Paper 66. The Stationery Office.
7. DUKES 1999, tables 1.11 and 1.13.
8. Energy Saving Trust (1997). *Energy efficiency and environmental benefits to 2010*.
9. Environmental Change Unit, Oxford University (1987). *DECADE 2 MtC* (Domestic Equipment and Carbon Dioxide Emissions Project – two megatonnes of carbon).
10. DUKES 1999, table 1.13.
11. DTI (1997).
12. DTI (1997).
13. HM Treasury (1998). *Economic instruments and the business use of energy*. A report by Lord Marshall. See paragraph 29.
14. Energy Technology Support Unit (ETSU) (1999). *Industrial sector carbon dioxide emissions: projections and indicators for the UK, 1990-2020*. Harwell.
15. ETSU (1999).
16. DUKES 1999, table 1B, page 21.
17. ETSU (1999).
18. Chancellor of the Exchequer's Budget Statement of 9 March, 1999; HM Customs and Excise (1999). *Consultation on a climate change levy*.
19. HM Treasury Press Release 7 on Pre-Budget Report, November 1999.
20. HM Treasury (1998), table c3.
21. DUKES 1999, page 238.
22. HM Customs and Excise (1999).
23. Chemical Industries Association (1997). *The energy efficiency agreement between the Chemical Industries Association and Government*.
24. House of Commons Environment, Transport and Regional Affairs Committee (2000). *UK Climate Change Programme*. The Stationery Office. See paragraph 71.
25. HM Treasury (1998), page 50.
26. Emissions Trading Group (1999). *Outline proposals for a UK emissions trading scheme*.
27. Information supplied by DETR, November 1999.
28. DUKES 1999, table 1.13.
29. DTI (1997).
30. DTI (1997).
31. DTI (1997).
32. DTI (1997).
33. DTI (1997).
34. Jonathan Fisher Environmental Economics (1998). *Prospects for energy saving and reducing demand for energy in the UK*. A report prepared for the Royal Commission on Environmental Pollution.

References

35. DETR Energy Efficiency Best Practice Programme. New Practice Final Report 106, Energy Consumption Guide 19. Building Research Establishment Conservation Support Unit (BRECSU) and University of East Anglia. Garston.
36. Information supplied by Chetwood Associates, architects, February 2000.
37. Scottish Executive (2000), *Scottish Climate Change Programme Consultation*. Edinburgh.
38. Evidence from the Royal Society for the Promotion of Health, January 1999.
39. BRECSU (1996). *Review of ultra-low-energy homes*. General Information Report 39. Garston.
40. HM Treasury (1998).
41. DUKES 1999, table 1.13.
42. DUKES 1999, table 1.13.
43. DTI (1997).
44. DETR (1999b). *Projections of households in England to 2021*.
45. DTI (1997).
46. Estimate supplied by ETSU, February 2000.
47. BRECSU (1998). *The government's Standard Assessment Procedure for energy rating of dwellings, 1998 Edition*. Garston.
48. Jonathan Fisher Environmental Economics (1998).
49. Energy Saving Trust (1998). *Small scale multi-residential CHP and environmental benefits to 2010*.
50. DUKES 1999, chart 9.4.
51. House of Commons Environmental Audit Committee (1999). *Energy efficiency*. Session 1998-99, Seventh Report, HC 159-1.
52. National Audit Office (1998). *The Office of Electricity Regulation: improving energy efficiency financed by a charge on customers*. The Stationery Office.
53. Office of Gas and Electricity Markets (OFGEM) (2000). *Energy Efficiency Standards of Performance 2000-2002. Final Decisions*.
54. DETR (2000a). *Energy Efficiency Standard of Performance 2002-2005. Consultation Proposals*.
55. The government's estimate of the annual reduction in emissions resulting from this measure is 0.75 million tonnes of carbon (MtC) or 2% of the sector total: DETR/Scottish Executive/National Assembly for Wales/Department of the Environment (in Northern Ireland) (2000). *Climate Change: Draft UK Programme*. Cited as DETR (2000b). See paragraph 17, page 98.
56. DETR (2000b), paragraph 18, page 99. The reduction in emissions is 2.7-3.8 (MtC) a year.
57. Broad estimate based on DETR (1998), *English House Condition Survey 1996*. The rate of demolition is higher in Scotland than in England.
58. See, for instance, chapter 7 of Northern Ireland Housing Executive (1998), *Northern Ireland House Condition Survey 1996*. Northern Ireland Housing Executive; Table A 9.13 of Scottish Homes (1997). *Scottish House Condition Survey Annex Tables 1996*.
59. For example, the Metropolitan Borough of Calderdale was granted £95,000 at the end of 1998 by Calderdale and Kirklees Health Authority in order to improve, free of charge, the insulation and heating of old, cold homes occupied by pensioners in receipt of means tested benefits. The project was part of a Department of Health initiative which aimed to reduce the number of elderly patients needing hospital beds during the winter months, when bed spaces were in shortest supply. The scheme was advertised in the local press and by the end of 1999 407 homes had been serviced, at an average cost of £206 each. The main measures were loft and cavity wall insulation, draughtproofing and installing, servicing and repairing heating appliances. Information supplied by Andrew Cooper, Calderdale MB home energy conservation officer, January 2000.
60. DETR (1999c). *Monitoring the implementation of the Home Energy Conservation Act*.
61. Lord Chancellor's Department/DTI/DETR (1998). *The key to easier home buying and selling – a consultation document*. DETR Press Release 940 announced the government's intention of introducing the seller's information pack, 11 October, 1999.
62. Information supplied by ETSU, February 2000.
63. Environmental Change Unit, Oxford University (1987).
64. Information from Market Transformation Programme website: <http://www.mtprog.com>
65. Information from Market Transformation Programme website.

66. DETR (1999b). The projection for the increase in the number of English households between 1996 and 2021 is 3.8 million. Increases in the rest of the UK take the total growth above 4 million.
67. BRECSU (1996).
68. Information supplied by Linden Homes, February 2000.
69. Percentages supplied by DETR in oral evidence to the Commission, July 1999. Average estate house construction costs for owner occupation were some £500/m² in the final quarter of 1999, according to Lindsey Pullen of the Royal Institute of Chartered Surveyors' Building Costs Information Service. The typical new house has a floor area of some 90 m². The Commission estimates the combined annual gas and electricity bills for the average home built to the standards of the 1991 building regulations at £520, with a SAP of 70, a National Home Energy Rating of 7 and a floor area of 90 m². The estimate was based on the NHER Cost Table 1999. Information supplied by the National Home Energy Rating Scheme, Knowlhill, Milton Keynes.
70. Information supplied by the Building Regulations Division, DETR, May 2000.
71. Smith, P.F. and Pitts, A.C. (1993). *Buildings and the environment: a study for the National Audit Office*. University of Sheffield. Submitted as part of evidence to the Commission by the Royal Institute of British Architects.
72. Domestic CHP on the horizon. *ENDS Report*, No. 301, February 2000, 27.
73. DETR (2000c). *Planning Policy Guidance Note 3. Housing*.
74. Eighteenth Report, paragraphs 9.17-9.36.
75. DUKES 1999, table 1.13.
76. DETR (1999d). *Transport Statistics Great Britain 1999 Edition*. The Stationery Office. Cited as TSGB 1999. See table 2.3, page 64.
77. TSGB 1999.
78. DUKES 1999, table 1.13.
79. DETR (2000d). *Information Bulletin: 1998 UK air emission estimates, 30 March 2000*. See Table 3.
80. Passenger kilometres on national railways increased by 22% between 1994/95 and 1998/99: TSGB 1999, table 5.11.
81. United Kingdom (1998). *A new deal for transport: better for everyone*. Cm 3950. The Stationery Office.
82. Jonathan Fisher Environmental Economics (1998).
83. DTI (2000). *Energy Projections for the UK – Working Paper*. DTI EPTAC Directorate. All the projections quoted in this report from this working paper are for the central economic growth and higher energy prices scenario.
84. DETR (2000e). *Tackling congestion and pollution: the government's first report under the Road Traffic Reduction (National Targets) Act 1998*.
85. United Kingdom (1998).
86. TSGB 1999, table 2.7.
87. Standing Advisory Committee on Trunk Road Assessment (1999). *Transport and the economy*. The Stationery Office. See paragraph 6.36.
88. DUKES 1999, pages 235-237.
89. TSGB 1999, figure 2.6.
90. Chancellor announces further progress on meeting the UK's environmental commitments. HM Treasury Press Release, 9 November 1999.
91. DETR (1998). *UK Climate Change Programme: Consultation Paper*. See paragraph 131. This percentage estimate, and others in the section on transport, are based on government estimates of the reduction in carbon emissions achieved by this measure, making the assumption that energy consumption is proportionate to carbon emissions.
92. DETR (2000e), Scenario D, pages 30-31.
93. DETR (2000e), Scenario A, page 30.
94. House of Commons Environment, Transport and Regional Affairs Committee (2000), paragraph 30.
95. DETR (2000b), page 85.
96. United Kingdom (1998).

References

97. Intergovernmental Panel on Climate Change (1999). *Aviation and the global atmosphere*. Cambridge University Press, Cambridge.
98. DTI (2000).
99. Jonathan Fisher Environmental Economics (1998);
DUKES 1999;
DTI (2000).
100. ETSU (1999);
DUKES 1999;
DTI (2000).
101. Jonathan Fisher Environmental Economics (1998);
DUKES 1999;
DTI (2000).
DTI's 'business as usual' projection for 2010 ignores the voluntary agreements between the European Commission and vehicle manufacturers to reduce the carbon dioxide emissions from new cars; DTI estimates this could lower the transport sector's emissions by a further 4 MtC a year, approximately equivalent to a reduction of 3 GW in the rate of energy consumption.
102. Jonathan Fisher Environmental Economics (1998);
DUKES 1999;
DTI (2000).
103. Romm, J., Levine, M., Brown, M. and Petersen, E. (1998). A road map for US carbon reductions. *Science*, **279**, 669-670.
104. Grubb, M. (1995). Asymmetrical price elasticities of energy demand. In Barker, T., Ekins, P. and Johnstone, N. (Eds). *Global warming and energy elasticities*. Routledge. See page 420.
105. Lovins, A., Lovins, H. and von Weizsacker, E. (1997). *Factor four – doubling wealth, halving resource use*. Earthscan.
106. Hawken, P., Lovins, A. and Lovins, H. (1999). *Natural capitalism – creating the next industrial revolution*. Earthscan.
107. DETR (1999a).
108. The latest projections for the number of households in England show a 3.8 million increase between 1996 and 2021; and a 4.1 million increase between 1991 and 2016, rather than the 4.4 million increase shown in the previous, 1992-based projections (DETR (1999b)).
109. At the time of finalising this report, the government was supporting a private member's bill, the Warm Homes and Energy Conservation Bill, that would require the Secretary of State for Environment, Transport and the Regions to prepare and publish strategy for 'ensuring, by means including the taking of measures to ensure the efficient use of energy, that as far as reasonably practicable the homes of all households on lower incomes can be kept warm at reasonable cost.'
110. The long-run price elasticities used by the DTI in its energy model and supplied to the Energy Advisory Panel in 1997 were -0.19 for the domestic sector, -0.09 for the service sector, -0.41 for the transport sector and in the range -0.07 (iron and steel) to -0.45 (textiles, leather and clothing) for the various manufacturing sectors. Thus a 10% increase in energy prices for households would bring about a 1.9% reduction in demand. DTI now estimates the long-run price elasticity for road fuel demand as -0.23, but also offers a projection based on an elasticity of -0.4 (DTI 2000).
111. Evidence from the Energy Advisory Panel, October 1998.
112. Motoring costs rose by 50% between 1989 and 1998 (before adjustment for inflation), rail fares by 66% and bus fares by 59%: TSGB 1999.
113. Oral evidence, DETR, July 1999; Oral evidence, DTI, July 1999.
114. Between 1970 and 1980 UK energy intensity declined at an average rate of 2.1% a year. Between 1980 and 1990 the decline averaged 2.0% a year. Between 1990 and 1998 the rate of decline fell to 1.2% a year. Rates calculated from DUKES 1999, table 1.12.
115. House of Commons Environmental Audit Committee (1999).
116. House of Commons Trade and Industry Committee (1998). *Energy Policy*. The Stationery Office. See paragraphs 144-148.
117. DTI (1999). *The Energy Report*. The Stationery Office.

Chapter 7

1. Energy Technology Support Unit (ETSU) (1999). *New and renewable energy: prospects in the UK for the 21st century – supporting analysis*. Energy Technology Support Unit, Harwell. The term ‘new and renewable’ is used because the assessment covers fuel cells as well as renewable energy sources.
2. The model used by ETSU is the International Energy Agency’s MARKAL, figured for the UK.
3. ETSU (1999), Figure 1 on page 178.
4. International Energy Agency (IEA)(1998). *World Energy Outlook 1998 edition*. Paris, IEA/OECD. These figures are for 1995 and are given as percentages in the tables on pages 412-413.
5. Figures for 1995 shown in Table 6.1 on page 64 in IEA (1998).
6. At La Rance in Brittany, with a capacity of 240 MW, built in the 1960s.
7. Department of Trade and Industry (DTI) (1999). *Digest of United Kingdom Energy Statistics 1999*. The Stationery Office. Cited as DUKES 1999. See table 5.4 (figures for 1998).
8. The EU average is 35%.
9. Royal Society and Royal Academy of Engineering (1999). *Nuclear energy: the future climate*. June 1999.
10. Between 70 and 135 years after closure of an AGR station, levels of radioactivity decline at a slower rate, reducing the advantages of extending decommissioning. The equivalent period for PWR stations is between 10 and 50 years beyond closure. Oral evidence from British energy plc, 7 May 1999.
11. Commission meeting with European Commission, Directorate-General XXI, Brussels, February 1999.
12. Sixth Report, 151-152.
13. Sixth Report, 367, 372, 389-90.
14. Sixth Report, 384-386.
15. Cummings, R. and Bush, R.P. *et al.* (1996). *An assessment of partition and transmutation against UK requirements for radioactive waste management*. Report DoE/RAS/96.007 for the UK Department of the Environment.
16. Sixth Report, 387-388.
17. House of Lords Select Committee on Science and Technology (1999). *Management of nuclear waste*. The Stationery Office, London.
18. DUKES 1999, tables 5.4 and 5.5 (figures for 1998).
19. Table A2.15 in Department of Trade and Industry. (1998). *The Energy Report: Transforming Markets Volume 1*. The Stationery Office.
20. European Commission (EC) (1997). *Energy for the Future: Renewable Sources of Energy*, COM(97)599. EC; ETSU (1999)
21. DUKES 1999, table 5.4.
22. Electricity Association (1999). *Electricity Industry Review 3*, pages 72-73.
23. ETSU (1999), pages 96 and 181.
24. ETSU (1996). Tidal Energy: UK Government Programme R&D Programme 1979-1994. ETSU-R-96. Harwell.
25. Department of Energy (1989). *The Severn Barrage Project: General Report: Energy Paper No. 57*; HMSO.
26. Evidence from the Severn Tidal Power Group, December 1998; information from DTI, February 2000.
27. Renewable Energy Advisory Group (1992). *Report to the President of the Board of Trade, November 1992*. Energy Paper 60. HMSO. See pages A36-A39.
28. ETSU (1994). *An Assessment of Renewable Energy for the UK*. ETSU, Harwell. See page 79.
29. REAG (1992).
30. Letter from Christopher Harding of the Severn Tidal Power Group to John Battle MP (Minister of State for Energy and Industry), 5 May 1999.
31. Information supplied by DTI, February 2000.
32. Oral evidence from British Energy plc, 7 May 1999.
33. REAG (1992), page A37.
34. DUKES (1999), table 5.4.
35. ETSU (1999), pages 184-185.
36. ETSU (1999), pages 186-187.
37. Electricity Association (2000). *Electricity Industry Review 4*. See page 56.

References

38. Capacity from wind turbines in Denmark was more than 1 GW at the end of 1997. IEA (1998). *Energy Policies of IEA countries: Denmark Review 1998*. OECD, Paris. See page 75; Wind power capacity in Germany was 1.5 GW in 1996. IEA (1998). *Energy Policies of IEA countries: Germany Review 1998*. OECD, Paris. See page 123; Onshore wind capacity in the UK in 1997 was 0.32 GW. ETSU (1999), page 166.
39. ETSU (1999).
40. A similar estimate is given by Brocklehurst, F. (1997). *A review of the UK Onshore Wind Energy Resource*. ETSU-R-99, ETSU, Harwell.
41. Commission visit to Denmark, June 1999.
42. Commission visit to Denmark, June 1999.
43. Information supplied by DTI, February 2000.
44. ETSU (1999).
45. Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment.
46. ETSU (1999), page 129.
47. Jackson, T. and Löfstedt, R. (1998). *Renewable Energy Sources*. A background paper for the Royal Commission on Environmental Pollution. Centre for Environmental Strategy, University of Surrey, Guildford.
48. Oral evidence from BP Solar, 4 December 1998.
49. Table 3 in Appendix B – Photovoltaics. In the report *Benign Energy: The Environmental Implications of Renewables*. <http://www.iea.org.tech/pubs>
50. The value reported was 1,700 kWh per square metre.
51. Alsema, E.A. and Nieuwlaar, E. (2000). Energy Viability of Photovoltaic Systems, *Energy Policy* (special issue), 28, in press.
52. Taylor, E.H. (1990). *Review of photovoltaic technology*. ETSU (ETSU-R-50).
53. Comprises an average pitch roof area of 70 square metres for 24.6 million domestic properties and roof and wall areas of non-domestic buildings. The total is reduced further by subtracting a proportion of surfaces which are likely to be shaded and those unsuitable for photovoltaics. ETSU (1999), page 133.
54. ETSU (1999) pages, 133-134
55. Presentation to the Commission by Dr Tim Jackson, May 1998.
56. ETSU (1999), page 119.
57. The average rate of electricity consumption in the public administration and domestic sectors in 1998 was 15 GW. DUKES 1999, table 5.1.
58. ETSU (1999), see page 29.
59. Estimates of accessible resources for domestic hot water, solar-aided district heating and water heating for non domestic building applications in 2025 are 1.4, 2.0 and 0.15 GW respectively. ETSU (1999), pages 32-33.
60. IEA Heat Pump Centre (1999). *International Heat Pump Status and Policy Review – National Position Paper United Kingdom*. Sittard, The Netherlands.
61. ETSU (1999), table 2 on page 83.
62. ETSU (1999), pages 96-97.
63. Evidence from South West Water plc, November 1998.
64. ETSU (1999), page 95.
65. Evidence from Thames Water plc, January 1999; Evidence from Institute of Energy and Sustainable Development, De Montfort University, February 1999; Evidence from Friends of the Earth, January 1999; Evidence from Southampton City Council, January 1999.
66. Forum for the Future (1999). *Power for the New Millennium: Benefitting from Tomorrow's Renewable Energy Markets*. Forum for the Future. See page 17.
67. ETSU (1999) estimate that the maximum practicable resource for the UK in 2025 is 30 GW (declared net capacity). This assumes that photovoltaic cells are applied to all available (see description above) domestic and non-domestic buildings. Therefore to generate an average rate of 10 GW (declared net capacity) would require about one third of this area.
68. In 1995 installed capacity using energy crops appears to have been only 30 MW worldwide, all within the European Union (ETSU (1999), table 3 on page 72).

69. ETSU R-82.
70. ETSU (1999), page 77.
71. Seventeenth Report, paragraph 5.29. For the evidence on which this conclusion was based, see box 5B and figures 5-II and 5-III.
72. Information obtained from Project ARBRE during Commission visit, July 1999.
73. ARBRE Technology, Yorkshire Water plc.
74. Commission visit to Eggborough, July 1999.
75. Annex 1, part 4 in EC Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.
76. Figure for end September 1999, supplied by DTI.
77. In March 1999 Commission Members visited a 38.5 MWe plant at Thetford designed to burn poultry litter, which is the bedding material from broiler houses.
78. ETSU (1999).
79. Information obtained from Project ARBRE during Commission visit, July 1999.
80. Visit by Commission Member, September 1999, as part of a Commission meeting held in Northern Ireland.
81. Visit by Commission Member, September 1999, as part of a Commission meeting held in Northern Ireland.
82. REAG (1992), pages A29-A30.
83. ETSU (1999), page 74.
84. Members of the Commission visited a coppiced plantation in Yorkshire in June 1999.
85. Information about Game Conservancy Trust research supplied by Project ARBRE, July 1999.
86. Jackson, T. and Löfstedt, R. (1998).
87. Press release from the Ministry of Agriculture, Fisheries and Food, Nick Brown announces a new direction for agriculture, 7 December 1999.
88. Total area of agricultural land in the UK in 1994 was 17.3 million hectares of which 3 million hectares was used for growing cereals. Ministry of Agriculture Fisheries and Food (1994). *The Digest of Agricultural Census Statistics: United Kingdom*. HMSO.
89. Berger, W.H. and Keir, R.S. 1984. Holocene changes in atmospheric CO₂ and the deep sea record. In: *Climate Processes and Climate Sensitivity. Geophysics Monograph Series*, volume 29. J.E. Hansen and T. Takahashi (Eds.), pages 337-351. American Geophysical Union, Washington D.C.
90. REAG (1992), pages A47-A49;
ETSU (1999), pages 187-188.
91. The 1982 Review of UK Energy Research, Development, Demonstration and Dissemination.
92. ETSU (1999), page 147.
93. ETSU (1999), page 147.
94. Information supplied by Wavegen Limited, 15 November 1999.
95. Ocean Power Delivery: <http://www.oceanpd.com/>
96. Information supplied by Dr. Richard Yemm, Ocean Power Delivery Limited, 16 November 1999.
97. ETSU (1999), page 161;
Evidence from Wavegen Ltd., March 1999.
98. Convention on Wetlands of International Importance, Ramsar, Iran, 1971 (Amended in 1982 and 1987).
99. REAG (1992), page A46;
ETSU (1999), page 162.
100. ETSU (1999).
101. ETSU (1999).
102. ETSU (1994). *An Assessment of Renewable Energy for the UK*. ETSU, Harwell. See table 5, page 99.
103. ETSU (1999), page 158.
104. DTI (1994). *Energy Paper 62*. HMSO.
105. Thorpe, T. (1999). An overview of Wave Energy Technologies: Status, Performance and Costs. *Proceedings of an International One Day seminar, Wave Power: Moving Towards Commercial Viability*. Engineering Employers Federation, 30 November 1999.
106. ETSU (1999).
107. ETSU (1999), page 149.
108. ETSU (1999), page 157.
109. Evidence from Wavegen Ltd., March 1999.

References

110. ETSU (1999), page 141.
111. ETSU (1999), page 140.
112. ETSU (1999), page 139.
113. Projection submitted in support of oral evidence from British Energy plc, June 1999.
114. DETR/Scottish Executive/National Assembly for Wales/Department of the Environment (for Northern Ireland) (2000). *Climate Change – Draft UK Programme*. Cited as Draft Climate Change Programme.
115. UK Government (1995). *The prospects for nuclear power in the UK: Conclusions of the Government's nuclear review*, HMSO.
116. House of Commons Trade and Industry Select Committee (1998). See paragraph 2.53.
117. Royal Society and Royal Academy of Engineering (1999), page 49.
118. Draft Climate Change Programme, page 62.
119. Draft Climate Change Programme, page 58.
120. DTI (2000). *New and renewable energy: prospects for the 21st century. Conclusions in response to the public consultation*. See the paragraphs 'Obligation profile' on page 9 and 'Further obligations' on page 12.
121. Draft Climate Change Programme, page 58.
122. DTI (1999). *New and renewable energy: prospects for the 21st century*. See page 22. This downward trend is all the more striking in that 34 of the 61 projects accepted under NFFO-1 which have been commissioned were already in existence before being offered contracts.
123. DTI (1999), paragraph 30. For NFFO and Scottish Renewables Obligation the potential size of this would rise to a plateau of £150 million in 2003/04, declines after 2009/10, and finally runs out in 2018; the actual extent of the subsidy will depend on the market price of electricity.
124. DUKES 1999, table 7.5.
125. 'Green electricity' accreditation launched into murky waters. *ENDS Report*, No. 294, July 1999.
126. Between 1994 and the end of 1998, of the 18 wind developments which went before planning inquiries, just two small schemes won approval. Questions but precious few answers in renewable energy review. *ENDS Report*, No. 291, April 1999.
127. Evidence from British Wind Energy Association, November 1998.
128. Evidence from Friends of the Earth, January 1999.
129. Evidence from the Council for the Protection of Rural England (September 1998), the Countryside Commission (December 1998), the Countryside Council for Wales (December 1998) and the National Trust (December 1998).
RSPB suggest that poorly sited wind farms (such as those on migration routes) can have adverse effects on the number of birds which strike rotor blades. This could be limited by avoiding development along these routes (November 1998).
130. Evidence from the Countryside Commission, December 1998.
131. Twenty-first Report, October 1998.
132. Oral evidence, March 1999. The functions of the Countryside Commission were taken over by the Countryside Agency on 1 April 1999.
133. Countryside Agency (1999). *Interim Landscape Character Assessment Guidance*. Land Use Consultants.
134. DTI (2000), page 20.
135. Draft Directive of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment, 5685/00.
136. The Northern Energy Initiative (1999). *Energy for a new century: an energy strategy for the North East of England*. Sunderland.

Chapter 8

1. Department of Trade and Industry (DTI) (1999). *Digest of United Kingdom Energy Statistics 1999*. The Stationery Office. Cited as DUKES 1999. See table 1.1. This calculation includes energy losses in the electricity system and the energy used in refining oil and transporting hydrocarbons to users, but not for example the energy used in extracting fossil fuels from underground, providing fuel for nuclear power stations or constructing energy installations of all types. Nor does it include losses for thermodynamic reasons at the stage of end use, in particular in internal combustion engines in vehicles.

2. DUKES 1999, table 1.13.
3. DUKES 1999, comparison of tables 1.1 and 5.8.
4. DTI (1997). *Energy consumption in the United Kingdom. Energy Paper 66*. The Stationery Office. See page 15.
5. DTI (1997), pages 84, 44 and 111.
6. Measured in terms of the amount of electricity generated.
7. Dann, R.G., Parsons, J.A. and Richardson, A.R. (1998). *Microgen – co-generation for the home*. Paper for the 1998 International Gas Research Conference. BG Technology, Loughborough.
8. Gummert, G. (Hamburg Gas Consult) (1999). Using PEFC for the total energy supply of buildings. Presentation to Sixth Grove Fuel Cell Symposium, London, 13-16 November 1999.
9. Patterson, W. (1999a). *Transforming electricity: the coming generation of change*. Royal Institute of International Affairs / Earthscan.
10. Visit by Commission to Denmark, June 1999.
11. Information supplied by Birka Energi, April 2000;
International Energy Agency (IEA) (1992). Heat pumps – an opportunity for reducing the greenhouse effect.
12. Seventeenth Report, paragraphs 5.24-5.29, box 5B and figures 5-II and 5-III.
13. This takes place at the Masnedø CHP plant, which consumes a 0.5 tonne bale of straw every 3 minutes.
14. Commission visit to Denmark, June 1999.
15. Information supplied by Energy Technology Support Unit, February 2000.
16. International Energy Agency (IEA) (1998). *World Energy Outlook 1998 Edition*. IEA/Organization for Economic Co-operation and Development. Page 412 shows that average annual growth rates for electricity (final demand) were higher than for mobility and other stationary uses between 1971 and 1995. Business as usual projections also suggest that electricity demand will have the highest growth rate between 1995 and 2020.
17. DUKES 1999, table 5.4.
18. DTI (1998). *Conclusions of the review of energy sources for power generation and government response to Fourth and Fifth Reports of the Trade and Industry Committee*. The Stationery Office.
19. Oral evidence from British Energy plc, May 1999.
20. Information provided by the Energy Technology Support Unit, February 2000.
21. Patterson, W. (1999a).
22. Maximum demand and capacity were 56 and 73 GW respectively. Electricity Association (2000). *Electricity Industry Review 4*.
23. Presentation by the National Grid Company plc, May 1999.
24. This figure was quoted by Dr Martin of Scottish and Southern plc during discussion at an international seminar on *Wave power – moving towards commercial viability*, Engineering Employers' Federation, Westminster, 30 November 1999.
25. Presentation by the National Grid Company plc, May 1999.
26. Patterson, W. (1999b). *Can public service survive the market? Issues for liberalized electricity*. Royal Institute of International Affairs Energy and Environmental Programme Briefing Paper (new series) 4, July 1999.
27. Meeting by the Secretariat with the Institution of Electrical Engineers, 21 January 1999.
28. Presentation by the National Grid Company plc, May 1999; visit to Edison Mission's Dinorwig pumped storage scheme. June 1999.
29. The Commission visited the Dinorwig pumped storage scheme in June 1999.
30. Electricity Association (2000), page 88;
Price, A., Bentley, S., Male, S. and Cooley, G. (1999). A novel approach to utility scale energy storage. *Power Engineering*, 13 (3), 122-129.

Chapter 9

1. Calculated from Department of Trade and Industry (DTI) (1999). *Digest of United Kingdom Energy Statistics 1999*. The Stationery Office.
2. DTI (2000). *Energy projections for the UK – Working Paper*.

References

3. DTI (1998). *Conclusions of The Review of Energy Sources for Power Generation and Government response to fourth and fifth Reports of the Trade and Industry Committee*. The Stationery Office. See paragraph 5.32.
4. Nuclear Utilities Chairmens Group (1994). *The Future Role of Nuclear Power in the UK: A background paper to the nuclear review*.

Chapter 10

1. House of Commons Environment, Transport and Regional Affairs Committee, 2000. *UK Climate Change Programme*, House of Commons. See paragraph 63.
2. The Advisory Committee on Business and the Environment has argued for a much greater proportion of the revenue from the levy to be devoted to such purposes.
3. A Finnish law of 1994 placed a tax on certain sources of energy at various different rates based on environmental considerations. A flat rate of tax was imposed on imported electricity, equivalent to the average rate of tax that domestically generated electricity attracted. In 1998 the European Court of Justice ruled that Member States could apply internal taxes on energy sources on environmental grounds. But in this particular case the way the tax had been applied to electricity imports into Finland breached EU Treaty principles which forbid Member States from imposing taxes on produces in excess of similar domestic products. The case is *Outokumpo Oy (C-231/96)*.
4. House of Commons Trade and Industry Committee. *Energy policy* (Fifth Report session 1997-98). HC471. See paragraph 21(a).
5. Department of Trade and Industry (DTI) (1999). *The future of gas and electricity regulation. The government's proposals for legislation*. October 1999. See section 2.1.
6. House of Commons Bill 49, session 1999-2000, clause 1.
7. DTI (1999), paragraph 15.
8. DTI (1999), section 5.2.
9. DTI (1999), section 5.4.
10. House of Commons Environmental Audit Committee (1999). *Energy efficiency*. Session 1998-1999, Seventh Report, HC 159-1.
11. House of Commons Environmental Audit Committee (1999). See paragraph 65.
12. DETR (1999). *Government response to the House of Commons Environmental Audit Committee report on Energy efficiency*. See paragraphs 25-26.
13. Oral evidence by DETR, July 1999; oral evidence by DTI, July 1999.
14. DETR (1999).
15. House of Commons Environmental Audit Committee (1999). See paragraph 64.
16. The case for a body on broadly the lines we envisage has been spelled out in a report by Green Alliance, published in 1999.
19. Commission visit to Japan, March 1999, including discussions with the Ministry of International Trade and Industry and, with particular reference to fuel cells, the New Energy and Industrial Technology Development Organisation.
20. We do not agree with DTI's view (DTI (2000), page 17) that the problems raised by embedded generation should be categorised solely as a non-technological barrier to extensive use of renewable energy sources.
21. DTI (2000). *New and renewable energy: prospects for the 21st century. Conclusions in response to the public consultation*. January 2000.
22. Meeting with Chair and Members of the Energy and Natural Environment Panel, October 1999.
23. Advisory Committee on Business and the Environment (1999). *Carbon trusts: exploiting the potential of low carbon technology*. October 1999.
24. Royal Society and Royal Academy of Engineering. *Nuclear energy: the future climate*. Report of a joint working group chaired by Sir Eric Ash. June 1999. See chapter 12.