

REVISED NUFFIELD ADVANCED SCIENCE
PHYSICS

ENERGY SOURCES: DATA, REFERENCES, AND READINGS

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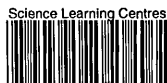
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ENERGY SOURCES: DATA, REFERENCES, AND READINGS

REVISED NUFFIELD ADVANCED SCIENCE

Published for the Nuffield–Chelsea Curriculum Trust
by Longman Group Limited



N12336

Longman Group Limited

Longman House, Burnt Mill, Harlow, Essex CM20 2JE, England
and Associated Companies throughout the World

First published 1986

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Design and art direction by Ivan Dodd Designers

Illustration by Oxford Illustrators Limited

Filmset in Times Roman and Univers

Printed in Great Britain by Scotprint Limited, Musselburgh, Scotland

ISBN 0 582 35425 0

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Introduction

This book is intended for students and for teachers. It has several aims.

a The data about fuel supply and demand, reserves, population, and so on, printed in Unit G, 'Energy Sources', of the Revised Nuffield A-level Physics course (Longman, 1985), will inevitably become out of date. This book gives the latest data obtainable at the time of preparation (1985), (Part 1, pages 1 and 2), and lists sources of up-to-date information, (Part 2, pages 3 to 7).

b The subject matter of Unit G is outside the scope of many A-level courses and is therefore likely to be unfamiliar. This book suggests references dealing with the topics covered in the Unit (pages 10 to 28).

c The Unit places great emphasis on learning from reading. Part 3, 'Where to look' (pages 8 and 9) gives advice on where to find and how to use suitable material. Much of the book (Part 4, pages 12 to 28), is devoted to an annotated list of references to such material.

d The references for some of the 'Energy options' may be relatively sparse or rather inaccessible. In order to help schools in the early stages of teaching the Unit, 'starter' articles for those options have been provided in a companion to this book, the Reader *Energy options*. It is hoped that schools and colleges will steadily be able to make a collection of suitable articles and books, eventually reducing the need for dependence on the Reader.

PART ONE

Data and information

Year	Fuel consumption/ 10^{18} J	Year	Fuel consumption/ 10^{18} J
1925	47	1971	226
1929	55	1972	236
1937	59	1973	248
1949	73	1974	250
1950	81	1975	250
1953	92	1976	264
1955	105	1977	272
1958	118	1978	282
1960	131	1979	292
1963	146	1980	290
1965	165	1981	288
1968	192	1982	288
1969	206	1983	292
1970	217	1984	302

Table 1

Total World fuel consumption since 1925.

Source of data: Based on BP Statistical Review of World Energy 1985 for recent figures (since 1965), and various sources before that.

Year	Population/ 10^6	Year	Population/ 10^6
1925	1 890	1970	3 609
1950	2 505	1971	3 678
1955	2 726	1972	3 747
1960	2 990	1975	4 258
1965	3 281	1981	4 528
1968	3 484	1984	4 763

Table 2

World population 1925–1984.

Region	Consumption/Mtoe per annum					Total 1984	Total 1974	% Change	(1984)	(1984)
	Oil	Natural gas	Coal	Hydro	Nuclear				Population / 10^6	Consumption per capita /toe
N. America	791.4	505.8	466.2	154.6	101.3	2 019.3	1 953.0	3.4	261	7.7
Latin America	217.7	61.6	17.8	62.0	1.7	360.8	249.4	44.7	397	0.91
America – Total	1 009.1	567.4	484.0	216.6	103.0	2 380.1	2 202.4	8.1	658	3.6
United Kingdom	88.7	45.2	45.3	1.2	11.5	191.9	214.5	–10.5	56	3.4
West Germany	110.9	41.1	83.3	4.7	20.9	260.9	256.0	1.9	61	4.3
W. Europe – Total	591.0	190.1	256.7	107.0	104.6	1 249.4	1 204.2	3.8	342	3.7
USSR	447.8	439.4	357.0	53.0	25.0	1 322.2	924.1	43.1	276	4.8
China	85.8	10.8	466.5	23.5		586.6	388.1	51.1	1 052	0.56
Japan	214.6	33.1	64.0	19.8	30.6	362.1	346.5	4.5	119	3.0
Africa	82.4	17.8	76.9	17.4	1.0	195.5	101.7	92.2	537	0.36
Rest of World – Total	1 835.4	842.5	1 695.6	268.8	179.2	4 821.5	3 743.3	28.8	4 105	1.2
World Total 1984	2 844.5	1 409.9	2 179.6	485.4	282.2	7 201.6			4 763	1.5
World Total 1974	2 760.3	1 088.1	1 691.2	343.7	62.4		5 945.7			
% Change	3.1	29.6	28.9	41.2	352			21.1		

Table 3

World primary energy consumption.

Note: In this table America (total) is equivalent to North America and Latin America, but West Europe (total) is more than just UK and West Germany, and Rest of World (total) is more than just the total of the nations listed.

Source of fuel data: Based on BP Statistical Review of World Energy 1985.

Source of population data: The World Population Situation in 1983. *Population Studies (United Nations) No. 85, 1984.*

Region	Production/Mtoe					Total
	Oil	Natural gas	Coal	Hydro	Nuclear	
N. America	567.7	504.6	533.0	154.6	101.3	1 861.2
Latin America	338.0	71.1	12.5	62.0	1.2	484.8
America – Total	905.7	575.7	545.5	216.6	103.0	2 346.0
United Kingdom	125.9	31.5	30.0	1.2	11.5	200.1
West Germany	4.0	13.1	81.6	4.7	20.9	124.3
W. Europe – Total	186.5	152.3	179.5	107.0	104.6	729.9
USSR	613.0	526.5	356.2	53.0	25.0	1 573.7
China	114.5	11.5	472.1	23.5		621.6
Japan	0.4	1.4	11.0	19.8	30.6	63.2
Africa	248.8	26.6	91.4	17.4	1.0	385.2
Rest of World – Total	1 920.4	868.7	1 621.8	268.8	179.2	4 858.9
World Total	3 012.6	1 596.7	2 346.8	592.4	386.8	7 935.3

Table 4

Production of fuels by area 1984.

Source of fuel data: Based on BP Statistical Review of World Energy 1985.

This part is divided into three: section A is a list of magazines and journals which frequently contain information or articles on energy sources; section B is a list of particular sources of information; and section C is devoted to some of the teaching aids which may be of use.

A REGULAR SOURCES OF INFORMATION

Atom is a free monthly magazine published by the UKAEA (see page 5) and usually has at least one article in each issue which is relevant to this Unit. Although most of the articles are on nuclear power a substantial number are on alternative sources of energy. Only teachers may apply to be put on the mailing list.

Energy Manager is a restricted circulation monthly magazine covering industrial and domestic fuel conservation. A-level science teachers may apply to be placed on the circulation list by writing to:
Energy Manager, Nelson House,
265 Rotherhide Street, London SE16.

Mechanical Engineering is an American journal which frequently contains suitable articles. It is likely to be most easily consulted in university libraries.

New Scientist contains readable and up-to-date articles. It has a favourable group subscription scheme for schools (applications for the scheme must be from teachers, tel: 01-261 5542) and a similar one for individual teachers who are members of the Association for Science Education (send for details to ASE – see this page).

Physics in Technology is published by the Institute of Physics, 47 Belgrave Square, London SW1X 8QX. Tel: 01-235 6111. It is likely to be most easily consulted in university libraries (see page 9). Teachers may join the Institute's Schools Affiliation Scheme and obtain this journal and many other materials at a reduced rate.

Scientific American is well known for its authoritative but readable articles on many aspects of science and technology. Collections of

PART TWO

Sources of data and information

particular articles which have been reprinted as books can be bought from:
W. H. Freeman, 20 Beaumont Street, Oxford
OX1 2NQ. Tel: (0865) 726975.

B PARTICULAR SOURCES OF INFORMATION

Some of the information presented here overlaps that given elsewhere in this book. This is done deliberately in order to make particular pieces of information easier to find.

Association for Science Education

College Lane, Hatfield, Hertfordshire
AL10 9AA. Tel: (07072) 674111.

A directory of physics resource materials. ASE, 1985. A useful and inexpensive general source of information.

British Gas Education Service

Room 707A, 326 High Holborn, London
WC1V 7PT. Tel: 01-723 7030.

R & D Digest.

British Gas facts and figures.

Single copies of both of these are free. British Gas also publishes a wide range of other information, much of which is free and available to teachers.

CEGB

Technology Planning and Research Division,
Courtenay House, Room 405, 18 Warwick Lane,
London EC4P 4EB. Tel: 01-634 5111.

CEGB Research. This is free to teachers.

Centre for Alternative Technology

Llwyngwern Quarry, Machynlleth, Powys, Wales. Tel: (0654) 2400.

Exhibition of alternatives at Machynlleth. Please send a stamped addressed envelope to the education officer for a list of publications.

CFL Vision

Marketing Headquarters, Central Office of Information, Hercules Road, London SE1 7DU. Tel: 01-928 2345.

Free catalogue which includes details of many suitable films and videos, both free and for hire or purchase. To borrow the free ones write to: CFL Vision, Chalfont Grove, Gerrards Cross, Buckinghamshire SL9 8TN. Tel: (02407) 4433.

Department of Energy

Distribution Unit, Thames House South, Millbank, London SW1P 4QJ. Tel: 01-211 3000. Many free items, such as those listed below, are available. *Energy Papers*, which are not free, are listed in the bibliographies for particular options (pages 13 to 28).

Energy Flow Chart for the U.K. This is Figure G4 in Revised Nuffield Advanced Physics *Students' guide 1* (Longman, 1985).

United Kingdom Energy Statistics. Handy folded card summary.

Reading lists. Various topics including oil, gas, nuclear energy, alternative energy, energy conservation, energy policy, energy in the Third World.

Periodicals list. Contains the titles of periodicals in the Department of Energy library.

Publications in print is a list of all Department of Energy publications.

Fuel efficiency booklets.

Energy Management is a monthly news sheet aimed at industry and commerce.

RE News is an excellent newsletter on renewable energy research and development.

Energy Management and *RE News* are free.

The Department of Energy also issues a *Schools Project Pack* which contains some of the above. It is available free on request.

There are also local offices of the Department (Energy Efficiency Offices), which may be useful sources of data and information.

Energy Technology Support Unit (ETSU)

Building 156, AERE Harwell, Oxfordshire OX11 0RA. Tel: (0235) 834621.

Students should write stating what subject they are interested in, and ETSU will provide information where possible.

Institution of Electrical Engineers

Station House, Nightingale Road, Hitchin, Hertfordshire SG5 1RJ. Tel: (0462) 53331.

'The power station game' is a longer version of the simulation used in the ASE's *Science in Society* course.

For the rationale of simulations see:

ELLINGTON, H. I. and LANGTON, N. H. 'The power station game'. *Physics Education*, **10**, 1975, pp. 445-447.

Longman Group Ltd

Burnt Mill, Harlow, Essex CM20 2JE.

'The nuclear reactor'. Computer simulation of the AGR. This is obtained from the Resources Unit:

62 Hallfield Road, Layerthorpe, York YO3 7DQ. Tel: (0904) 425444.

The oil companies produce a large amount of material, much of which is free. Listed below are examples of what is available. Full details and catalogues are available from the addresses given.

BP Educational Service

Britannic House, Moor Lane, London EC2Y 9BU. Tel: 01-920 8000.

BP Statistical review of World energy is published annually.

'BP Energy file' is a reasonably priced database and interrogation program, intended for use with popular educational computers. It is expected that the 'Energy file' will be updated regularly. (Do not forget to state the format required when ordering.)

These are both available from:

Distribution Centre, BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 6YY.

Esso Petroleum Company PLC

Corporate Affairs Department, Esso House, Victoria Street, London SW1E 5JW.

Tel: 01-834 6677.

Esso Magazine (particularly its *Annual supplement*). Both are available on request.

Shell Education Service

Shell UK, Shell-Mex House, Strand, London WC2R 0DX. Tel: 01-257 3976.

Alternative energy leaflets. Free to individuals, but they will send a larger range to schools.

Shell Briefing Service booklets.

Science in Society

Materials associated with this ASE project can be obtained through the ASE. (Prices from the addresses given, or Tel: (07072) 674111.)

Science in Society Data Project based at: Gloucestershire College of Arts and Technology, The Park Campus, The Park, Cheltenham, Gloucestershire GL50 2RR.

Updated data covering areas of interest to

Science in Society including energy.

Science in Society Audio, 218 Sussex Gardens, London W2 3UD.

'Energy today and in the future' is an audio cassette which can either be ordered from the address given, or directly from the ASE, College Lane, Hatfield, Hertfordshire AL10 9AA.

'The power station project' and 'The alternative energy project' are decision making exercises in the *Science in Society* course.

UKAEA

Information Services Branch, 11 Charles II Street, London SW1Y 4QP. Tel: 01-930 5454.

Atom, a monthly bulletin. (See page 3.)

Numerous leaflets on aspects of nuclear power are free from the UKAEA Library.

Films (see list in part C, pages 5 to 7) free from VISCOM, Park Hall Road Trading Estate, London SE21 8EL. Tel: 01-761 3035.

This organization also handles CEGB films and videos.

Understanding Electricity Educational Service

30 Millbank, London SW1P 4RD.

This service is sponsored by the CEGB, the area electricity boards, and the UKAEA.

Understanding Electricity is a catalogue which is published annually, and contains details of the leaflets, posters, films, and filmstrips that are available from the sponsors. It is free to teachers.

C TEACHING AIDS

Some of the information presented here overlaps that given elsewhere in this book. This is done deliberately in order to make particular pieces of information easier to find.

If an item is thought to have particular relevance to a Section of the Unit it is labelled, for example, **G2**.

CHARTS AND POSTERS

'Global Energy Resources'. BP Educational Service (see page 4). Not free; available from the Distribution Centre.

G2, G4 'Life With Nuclear Energy'. Understanding Electricity Educational Service (see page 5).

G2, G4 'Looking at Nuclear Energy', set of 12 posters. UKAEA Education Department (see this page).

FILMS AND VIDEOS

Free loan films are available from:

BP Film Library, 15 Beaconsfield Road, London NW10 2LE. Tel: 01-451 1129.

CFL Vision, Chalfont Grove, Gerrards Cross, Buckinghamshire SL9 8TN. Tel: (02407) 4433.

Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT. Tel: 01-202 7803.

VISCOM, Park Hall Road Trading Estate, London SE21 8EL. Tel: 01-761 3035.

G1 'The energy problem: the nuclear solution'. (Film/video, free loan, CFL Vision.) General survey with emphasis on nuclear power.

G1 'Fate of the forests'. (Film/video, free loan, Shell Film Library.)

A general background film showing the ecological problems ensuing from the continuing destruction of rain forests and the consequent need for fuel sources alternative to wood.

G1 'Eye on the future'. (Film/video, free loan, Shell Film Library.)

The consequences of the move away from an oil-based economy to a more energy efficient one.

G1 'Time for energy'. (Film/video, free loan, Shell Film Library.)

A consideration of alternative fuel sources.

G1 'Energy within reason'. (Film/video, free loan, BP Educational Service, BP Film Library.)
Useful background material.

G1 'Energy in perspective'. (Film/video, free loan, BP Educational Service, BP Film Library.)
Introductory material.

G1 'The need for more power'. (Video, free loan or purchase, CEGB/VISCOM.)
How the CEGB hope to meet demand over the next twenty years.

G1 'Power to the people'. (Film/video, free loan, video purchase, CEGB/VISCOM.)
The development of the National Grid and its role in economic development.

G2, G4A, G4B 'Power from the atom'. (Film, free loan, CFL Vision.)
General introduction.

G2, G4 'The nuclear fuel cycle'. (Film/video, free loan, CFL Vision.)
The production, processing, and reprocessing of nuclear fuel.

G2 'Principles of fission'. (Film/video, free loan, CFL Vision.)
Introductory material.

G3, G4 'Old house, new house'. (Film/video, hire, CFL Vision.)
Ways of modifying a house to conserve fuel.
Hire this from:
CFL Vision, Marketing Headquarters, C.O.I., Hercules Road, London SE1 7DU.
Tel: 01-928 2345.

G4 'Search for a site'. (Video, free loan or purchase, CEGB/VISCOM.)
The technical and environmental aspects of choosing a power station site.

G4A 'The case for Sizewell'. (Video, free loan or purchase, CEGB/VISCOM.)
Includes economic, safety, and environmental factors; the need for nuclear power and for the PWR in particular.

G4A 'Fast reactor '84'. (Film, free loan, CFL Vision.)

Mainly about the prototype fast reactor.

G4B 'Nuclear fusion – energy for the 21st century'. (Film/video, free loan, CFL Vision.)
Joint European Torus described.

G4C 'Operation smash hit'. (Video, free loan or purchase, CEGB/VISCOM.)
Testing the strength of transportation flasks.

G4C 'Another safe journey'. (Film/video, free loan, video purchase, CEGB/VISCOM.)
Transport of nuclear fuel.

G4C 'Safety first'. (Video, free loan or purchase, CEGB/VISCOM.)
Safety in the design, construction, and operation of nuclear power stations.

G4C 'All around us: radiation'. (Film/video, free loan, CFL Vision.)
Sources of radiation; advantages and disadvantages.

G4C 'Return journey'. (Film/video, free loan, CFL Vision.)
Transport of nuclear fuel.

G4C 'The management of nuclear waste'. (Film/video, free loan, CFL Vision.)
The nature and disposal of nuclear wastes.

G4I 'Acid rain'. (Film/video, free loan, video purchase, CEGB/VISCOM.)
Research into the problem and proposals for reducing it.

G4I 'Managing energy: using coal'. (Film/video, free loan, CFL Vision.)

This is one of a number of films under the general title 'Managing Energy', which are intended for managers and therefore tend to focus on the economics of fuel conservation. They do contain much useful scientific material however, and are excellent sources of information, though rather densely packed sometimes. Such films can usefully be viewed more than once.

Supporting notes are provided free with some of these films.

Other films in this series are labelled * below.

G4K 'Heat below'. (Film/video, free loan, CFL Vision.)

Geothermal energy projects in Britain.

G4M 'Managing energy: waste as fuel'.* (Film/video, free loan, CFL Vision.)

G4R 'Under glass'. (Film/video, free loan, Shell Film Library.)

How fuel can be conserved in greenhouses.

G4R 'Managing energy: factory heating and ventilation'.* (Film/video, free loan, CFL Vision.)

G4R 'Managing energy: controls for buildings'.* (Film/video, free loan, CFL Vision.)

G4R 'Managing energy: heat recovery'.* (Film/video, free loan, CFL Vision.)

G4R 'Managing energy: insulation of industrial buildings'.* (Film/video, free loan, CFL Vision.)

SLIDES AND FILMSTRIPS

G2, G4 'Nuclear energy'. BP Educational Service. Only available on loan from local BP Preview Centres. Wide-ranging and relatively simple introductory material.

G4 'Alternative energy'. BP Educational Service (as above).

G2, G4 'Nuclear energy pack'. UKAEA (free loan from VISCOM).

G4 'Energy: alternative sources'. Mary Glasgow Publications Ltd, Brookhampton Lane, Kineton, Warwick CV35 0JB.
Tel: (0926) 640606.

AUDIOTAPES AND CASSETTES

G4 'Nuclear power'.

Sussex Publications Ltd, Townsend, Poulshot, Devizes, Wiltshire SN10 1SD. Tel: (038082) 337.
Available for hire or purchase. This is a tape on the debate about nuclear energy.

'Energy today and in the future'. *Science in Society* series, ASE.

COMPUTER PROGRAMS

G1 'The energy file'. BP Educational Service. Database and display program allowing a variety of patterns of fuel use to be displayed. Reasonably priced and intended to be updated frequently.

G4 'The nuclear reactor'. Longman. Simulation of the operation of the core of an AGR, the heat exchanger, and the turbine, separately and together.
Longman Resources Unit, 62 Hallfield Road, Layerthorpe, York YO3 7DQ.
Tel: (0904) 425444.

PART THREE

Where to look

Although it may sometimes be hard to find material on a particular specialized aspect of energy, in general the difficulty with energy sources is likely to be an excess of material rather than a shortage. A physics department should certainly have some basic books on energy sources, although it is unlikely to be able to cover all aspects. The school or college library may also have some useful books.

Many public libraries have a surprising number of suitable books on the shelves. A major problem in locating useful material is that you need to look in several places: first for relevant parts or chapters in general books about energy or physics, and then for more specialized books which will be found in different sections of the library.

Learning to seek out suitable material is one of the skills you should learn to develop in this part of the course. However, it would not be helpful merely to send you out with the instruction 'Go and look'!

We have tried to help in three ways:

1 By providing annotated bibliographies (pages 10 to 28)

We hope that you will be able to find some of the material we have listed in the school or local public library. We have tried to list only those books and articles which we think are at about the right level. It is as well to remember, however, that all these references are to technical material. You are not likely to find any of them a relaxed, easy read! Among the references there are some which, because they cover the field well, are more suitable as an introduction.

Others are more specialized or perhaps more difficult. We have tried to indicate this in the notes, but our comments should only be taken as the most rough and ready guidance. So, if you find that you can cope easily with a source which we have labelled as suitable for 'later work' (*i.e.* we think it is more difficult), ignore our comments!

2 By giving ideas of the subject headings in a library where you may find sources of information

Even if you cannot find the exact references in our lists they should give you an idea of what to look for in the library's subject index. In addition the following list may act as a reminder of suitable 'targets'. (These are condensed from a particular library's list and will not generally match exactly the categories used by other libraries.)

Biomass
Coal
Conservation
Development of natural resources
Energy and the environment; pollution
Energy and fuels by geographical area
Geothermal energy
General production of electrical power
Health physics, effects of radiation
Heat pumps
Natural gas
Nuclear energy
Petroleum
Philosophy of technology, alternative technology, appropriate technology, technology
Power plants of various kinds
Production of electricity by direct conversion, for example photovoltaics, fuel cells
Solar heating for water, buildings
Technological innovation
Technology and civilization
Water-power engineering, including tidal power, hydroelectricity, wave energy
Wind energy, windmills

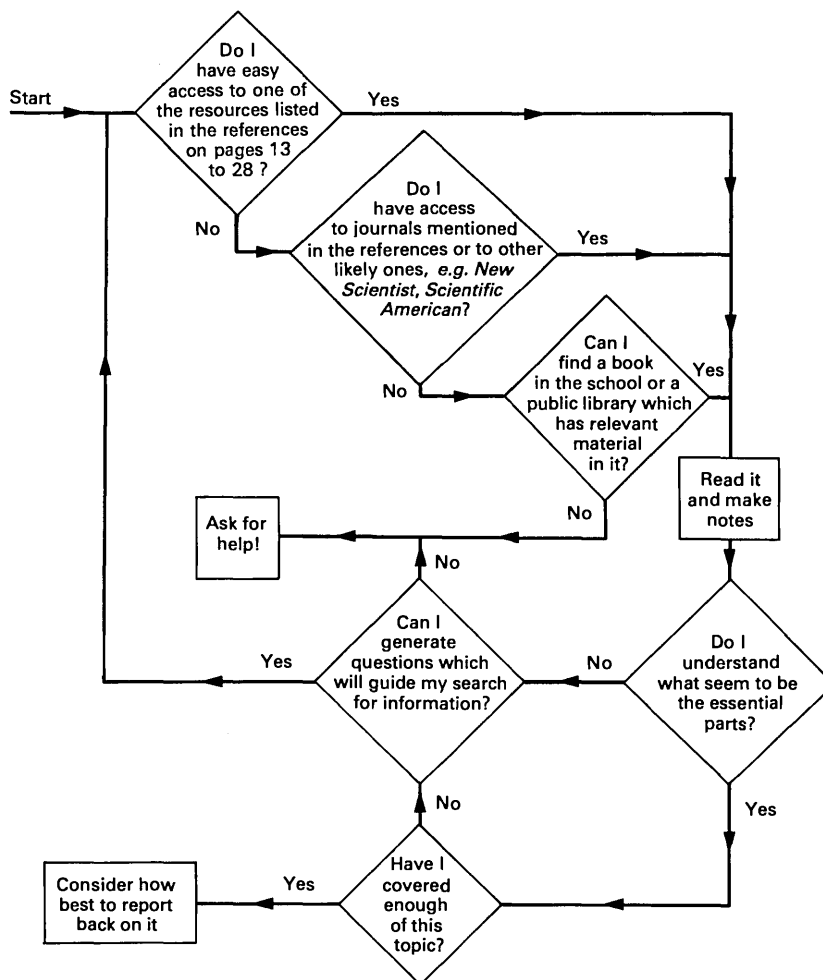
Some useful resources may be found in the library's reference section.

Public libraries are often happy to receive recommendations for books to be obtained for lending or reference. They can sometimes arrange to borrow from other libraries. But it may take time to obtain the books, so it would be sensible to plan well ahead. The bibliographies (pages 10 to 28) may help here.

Public libraries also subscribe to appropriate journals, such as *New Scientist* and *Scientific American*. Since these are so readily available they are not generally referred to in the lists

below. Many other journals which contain relevant articles are, however, taken by other libraries such as those in universities, polytechnics, and H.E. Colleges. Although such libraries are not public they are often prepared to allow occasional access to their book and journal collections, and this might be a useful avenue of exploration for schools which are not too far away. This would have to be negotiated with the particular library, and access might be limited to teachers. Contact should probably be made by a teacher, at least in the first instance.

3 By suggesting a strategy for finding information



PART FOUR

Bibliographies

GENERAL BIBLIOGRAPHY FOR UNIT G

Some of the following books and articles concentrate on the background to the supply and use of fuels, the subject of Section G1 'The background to energy supply and demand'. Some concentrate on the more specialized topics introduced in Sections G2 'Power from nuclear fission' and G3 'Conserving fuel in the home'. Others cover a range of the 'Energy options' which are the subject of Section G4. Some of these are also listed under the appropriate headings in the specialized bibliographies on pages 13 to 28. They are listed here too because, like the other books in this general bibliography, they can be considered as candidates for a 'library'. In general, books have only been listed if they have been quite recently published. Even so it cannot be guaranteed that these, and especially the older ones which are listed because of their special value, will be readily available. It is hoped that the references will be valuable, nevertheless, in indicating the sort of material to look out for.

REFERENCES FOR SECTION G1 'THE BACKGROUND TO ENERGY SUPPLY AND DEMAND'

ADLER, C. G. 'The pro-solar, anti-nuclear movement: A philosophical perspective'. *American Journal of Physics*. 51(6), 1983, pp. 503–509.
The article argues that the energy/fuel debate is as much political as scientific.

CHAPMAN, P. *Fuel's paradise*. 2nd edn. Penguin, 1980.
A very readable source which is particularly useful for its clear exposition of possible 'futures'.

CURRAN, S. 'Energy resources available to Man'. *Physics in Technology*. 8, 1977, pp. 138–143.
A short overview of some of the material in this section.

CURRAN, S. C. and CURRAN, J. S. *Energy and human needs*. Scottish Academic Press, 1979.
A hardback book which is therefore rather more expensive than the paperback books in this list. Nevertheless a strong contender for an energy library, because it deals briefly, but clearly and authoritatively, with most aspects of the Unit, and other areas.

EIJKELHOF, H. M. C., BOEKER, E., RAAT, J. H., and WIJNBEEK, N. J. *Physics in society*. Uitgeverij, Vu Boekhandel, 1981.

A readable book (translated from the original Dutch) covering many aspects of life, including energy.

ELKINGTON, J. *Sun traps*. Penguin, 1984.
Large sections on passive and active solar energy, photovoltaics, biomass, wind power, and tidal energy all in the context of nuclear power, fossil fuels, and geothermal energy.

FOLEY, G. *The energy question*. 2nd edn. Penguin, 1981.

Contains a good background to the first part of the Unit, and also some useful introductory sections on nuclear power, and non-depleting sources such as geothermal, passive solar, and hydro power.

FREMLIN, J. *Power production: what are the risks?* Hilger, 1985.

Detailed treatment of the risks from all sources of energy.

GRIFFITHS, R. F. (Ed.) *Dealing with risk*. Manchester University Press, 1982.

Interesting background reading to later work on risks.

HAFEMEISTER, D. 'Science and society test for scientists: the energy crisis'. *American Journal of Physics*. 42(8), 1974, pp. 625–641.

A delightful article containing 33 'Fermi' questions with suggestions for the answers. These questions are intended to be soluble using back-of-the-envelope calculations and would be an excellent resource for those who find the questions in the Unit rather easy. The same

author has published similar articles in the same journal on a variety of energy-related topics. See Volumes 41, 44, 47, 48, and 50 (two articles).

HAWTHORNE, W. 'Energy and environment: conflict or compromise'. *Journal of the Royal Society of Arts*, 126(5264), 1978, pp. 481-495. Mainly on the effects of power stations.

HUBBERT, M. KING 'The world's evolving energy system'. *American Journal of Physics*. 49(11), 1981, pp. 1007-1029.
An excellent treatment and extension of ideas in Section G1 by a prominent analyst of fuel supply and demand.

IRWIN, A., SMITH, D., and GRIFFITHS, R. 'Risk analysis and public policy for major hazards'. *Physics in Technology*. 13, 1982, pp. 258-265. Takes further the material on risks in Section G1.

LEACH, G. *A low energy strategy for the United Kingdom*. Science Reviews Ltd (3/4 St. Andrew's Hill, London EC4V 5BY), 1979.
A much-quoted source relating particularly to this country.

LOGAN, P. F. 'A role for the physicist in the Third World'. *Physics in Technology*. 10, 1979, pp. 4-10.

LOGAN, P. F. 'Physics in appropriate technology'. *Physics in Technology*. 11, 1980, pp. 187-192. Mainly concerned with energy in the Third World.
and

LOGAN, P. F. 'Energy from village to nation'. *Physics Education*. 18, 1983, pp. 71-77.
A readable article which provides additional material on energy in agricultural systems, and also on the advantages and disadvantages of various energy sources.

LOVINS, A. B. *Soft energy paths*. Penguin, 1977. Passionate exposition of renewable, low-technology solutions to the energy 'problem'.

McMULLAN, J. T., MORGAN, R., and MURRAY, R. B. *Energy resources*. 2nd rev. edn. Arnold, 1984. Readable, wide-ranging source, suitable for much of the Unit.

McVEIGH, J. C. *Energy around the World*. Pergamon, 1984.
Excellent, wide-ranging reader for the whole Unit.

MARCHETTI, C. 'On strategies and fate'. *Physics in Technology*. 8, 1977, pp. 157-162.
Examination of the limitations on freedom of decisions about energy strategies.

MEGAW, W. J. 'The role of physics in solving environmental problems'. *Physics in Technology*. 7, 1976, pp. 154-159.
A brief survey of environmental problems, often energy-related.

ODELL, P. R. *Oil and World power*. 7th edn. Penguin, 1983.
Detailed extension of some parts of the first section of the Unit.

PAUSTENBACH, D. J. Risk assessment and engineering in the 80s, *Mechanical Engineering*. 106(11), 1984, pp. 54-59.
A readable article discussing the meaning of risk assessment and the responsibilities of the engineer.

PIMENTEL, D. and PIMENTEL, M. *Food, energy, and society*. Arnold, 1979.
Interesting extension of the sections on personal energy and agriculture.

POOLEY, D. 'Energy options for the long-term future'. *Energy World*. Dec. 1982, pp. 12-15. Short, clear appraisal.

RAMAGE, J. *Energy: a guidebook*. Oxford University Press, 1983.
Substantial sections on fossil fuels, nuclear power, power from wind and water, and solar energy; all sandwiched between a survey of energy today, and various futures. A very readable resource for much of the Unit.

RYLE, M. 'Economics of alternative energy sources'. *Nature*, 267, 1977, pp. 111-117.
Excellent article arguing that availability of 150-hour storage would reduce demand for nuclear power and make renewable energy sources viable.

STERN, P. C. and AARONSON, E. (Eds.) *Energy use: the human dimension*. Freeman, 1984.

Behavioural aspects of fuel consumption: why people do not react as expected.

WENHAM, E. J. (Ed.) *New trends in physics teaching Volume IV*. UNESCO, 1984.

Collection of short essays, some of which are appropriate to this course.

WILD, M. (Ed.) *Energy in the 80s*. Longman, 1980.

A compilation of 10 booklets containing much useful information on the social and environmental, as well as the scientific, aspects of fuel use. Five chapters examine aspects of fuel supply and demand in fairly general terms, three consider nuclear power, one examines developments in coal mining and one deals with buildings and energy. Its style, together with the fact that the chapters are available as separate booklets, makes this material a good contender for library use and for use with individual options.

WOLFE, B. 'Is the energy debate really about energy?' *IAEA Bulletin*. **24**(4), 1982, pp. 28–32.

A clear exposition of the problems of energy supply set in the political arena.

REFERENCES FOR SECTIONS G2 'POWER FROM NUCLEAR FISSION' AND G3 'CONSERVING FUEL IN THE HOME'

BASSETT, C. R. and PRITCHARD, M. D. W. *Heating*. Longman, 1969.

A useful candidate for a library. Shows how the simple ideas introduced in Section G3 can be extended and applied in a variety of ways including electrical analogues.

BENNETT, D. J. *Elements of nuclear power*. 2nd edn. Longman, 1981.

Provides more detail for example on nuclear cross-sections. Readable of its kind but not a school level book.

MURRAY, R. L. *Nuclear energy*. 2nd rev. edn. Pergamon, 1980.

Provides more detail on the content of Section G2 (for example, cross-sections and moderation), but also has useful information on different kinds of reactor and their operation.

STUCKES, A. D. 'The thermal resistance of a cavity filled wall'. *Physics in Technology*. **15**(6), 1984, pp. 315–320.

Using the ideas developed in Section G3 and extending them.

WILD, M. (Ed.) *Energy in the 80s*. Longman, 1980.

See this page.

GENERAL BIBLIOGRAPHY FOR SECTION G4 'ENERGY OPTIONS'

CURRAN, S. C. and CURRAN, J. S. *Energy and human needs*. Scottish Academic Press, 1979.

See page 10.

DEPARTMENT OF ENERGY *The environmental impact of the renewable energy sources*. Energy Technology Support Unit, 1979 (Available from the Department of Energy Library).

Good overview, but short, so little detail possible.

DEPARTMENT OF ENERGY *Strategic review of the renewable energy technologies: an economic assessment: Volume II*. Energy Technology Support Unit, 1982 (Available from HMSO).

Initially daunting because of its size and economic focus, but has a wealth of useful material on the applicability of renewable energy technologies to the UK. These include biomass, geothermal (aquifers and hot dry rock), solar, wind, wave, and tidal. Since it is also loosely bound it might be divided up as a resource for groups working on all these areas.

ELKINGTON, J. *Sun traps*. Penguin, 1984.

See page 10.

FOLEY, G. *The energy question*. 2nd edn. Penguin, 1981.

See page 10.

LEACH, G. *A low energy strategy for the United Kingdom*. Science Reviews Ltd 1979.

See page 11.

LEACH, G. 'Energy futures'. *Atom*. April 1981, pp. 95–100.

Interesting, readable overview.

LEBER, R. E. 'Unconventional energy for a public power utility'. *Mechanical Engineering*. **104**(1), Jan. 1982, pp. 36–44.

Useful introduction; ranges widely but does not give much detail.

LOGAN, P. F. 'Energy from village to nation'. *Physics Education*. **18**, 1983, pp. 71–77.

See page 11.

LOVINS, A. B. *Soft energy paths*. Penguin, 1977.

See page 11.

McMULLAN, J. T., MORGAN, R., and MURRAY, R. B. *Energy resources*. Arnold, 1984.

See page 11.

POOLEY, D. 'Energy options for the long-term future'. *Energy World*. Dec. 1982, pp. 12–15.

See page 11.

RAMAGE, J. *Energy: a guidebook*. Oxford University Press, 1983.

See page 11.

ROSS, M. 'Efficient use of energy revisited'. *Physics Today*. Feb. 1980, pp. 24–31.

Wide-ranging introductory article.

RYLE, M. 'Economics of alternative energy sources'. *Nature*. **267**, 1977, pp. 111–117.

See page 11.

TAYLOR, R. H. *Alternative energy sources*. Hilger, 1983.

Substantial sections on wind, wave, tidal, geothermal, and solar energies.

VALE, B. and VALE, R. *The autonomous house*. Thames and Hudson, 1975.

Interesting book which contains chapters on solar, wind, heat pumps, and storage, all in the context of the home.

WILD, M. (Ed.) *Energy in the 80s*. Longman, 1980.

See page 12.

WRIGHT, J. K. and TAYLOR, R. H. 'Electricity generation options from alternative sources'. *Atom*. Jan. 1985, pp. 3–7.

Assesses the feasibility of various alternatives from the CEGB's point of view.

SPECIALIZED BIBLIOGRAPHY FOR SECTION G4

(Note: The introductory paragraph is similar for each of these sections. This may seem unduly repetitive but it has been done deliberately because students will generally only be looking in detail at about two options, and will therefore need the same basic words of guidance, regardless of the particular option they happen to be looking at.)

A Nuclear power stations and nuclear power generally

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources, but the list may give an idea of what is available and where it may be found. The monthly magazine *Atom* is a particularly useful source for this option, see page 3. Many of the articles from *Atom* listed below are also available as offprints from UKAEA. (See page 5 for details.)

BETHE, H. A. 'The necessity of fission power'. *Scientific American*. **234**(1), Jan. 1976, pp. 21–31. General introductory article.

BLAIR, I. *Taming the atom*. Hilger, 1983. Wide-ranging book at an appropriate level.

CENTRAL OFFICE OF INFORMATION. Reference pamphlet No. 28. *Nuclear energy in Britain*. 7th edn. HMSO, 1981.

Useful for introductory descriptions.

CHERMANNE, J. 'Gas-cooled fast breeder reactors'. *Physics in Technology*. **8**, 1977, pp. 89–93.

Using established cooling technology with new reactor technology.

COHEN, B. L. 'Breeder reactors: a renewable energy source'. *American Journal of Physics*. **51**(1), 1983, pp. 75–76.

Fairly simple calculations support this statement.

CROALL, S. and SEMPLER, K. *Nuclear power*. Writers and Readers, 1980.

In an unusual cartoon style, arguing against nuclear power.

DARMAYAN, P. 'The economics of uranium supply and demand'. *IAEA Bulletin*. **23**(2), 1981, pp. 3–7.

Readable and useful article, giving information on resources.

GRENON, M. *The nuclear apple and the solar orange*. Pergamon, 1980.

A readable attempt to explain the complexities of energy supply.

HANSEN, M. V. 'World uranium resources'. *IAEA Bulletin*. **23**(2), 1981, pp. 10–14.

Contains much useful data.

HERMAN, S. W. and CANNON, J. S. *Energy futures*. Ballinger, 1977.

Chapter on nuclear breeder reactors.

HILL, J. 'Nuclear power generation'. *Physics in Technology*. **8**, 1977, pp. 152–156.

A general overview.

HIRSCH, P. 'The fast reactor: perspective and prospects'. *Atom*. Nov. 1983, pp. 242–251.

Detailed article on economic and resource arguments.

HOYLE, F. *Energy or extinction?* 2nd edn.

Heinemann Educational Books, 1979.

Lively and partisan (pro-nuclear) treatment of the energy 'problem'.

McINTYRE, H. C. 'Natural-uranium heavy-water reactors'. *Scientific American*. **233**(4), Oct. 1975, pp. 17–28.

The Candu (Canadian Deuterium Uranium) reactor.

MARSHALL, W. 'Fast reactors'. *Atom*. Sept. 1980.

Detail on the operation of fast reactors.

NATIONAL RESEARCH COUNCIL *Energy in transition 1985–2010*. Freeman, 1980.

A large section on nuclear power as well as other energy sources.

PATTERSON, W. C. *Nuclear power*. 2nd edn. Penguin, 1983.

Readable descriptions of various types of reactor, and nuclear power placed in a historical and current context.

PENTREATH, R. J. *Nuclear power, Man, and the environment*. Taylor and Francis, 1980.

One chapter on reactors and much useful material on safety and fuels.

PRICE, M. S. T. and SHEPHERD, L. R. 'Prospects for the high-temperature reactor'. *Physics in Technology*. **10**, 1979, pp. 110–117.

Considerably detailed, but readable.

SCHWALLER, A. E. *Energy technology*. Davis, 1980.

A chapter on nuclear power.

THIELHEIM, K. O. *Primary energy*. Springer-Verlag, 1982.

Half the book is devoted to various aspects of nuclear power.

VENDRYES, G. A. 'Superphenix: a full-scale breeder reactor'. *Scientific American*. **236**(3), Mar. 1977, pp. 26–35.

Readable description of the French fast reactor.

WHITLEY, S. 'The uranium ultracentrifuge'. *Physics in Technology*. **10**, 1979, pp. 26–33.

How reactor fuel is produced.

B Nuclear fusion

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources, but the list may give an idea of what is available and where it may be found. The monthly magazine *Atom* is a particularly useful source for this option, see page 3. Many of the articles from *Atom* listed below are also available as offprints from UKAEA. (See page 5 for details.)

CONN, R. W. 'The engineering of magnetic fusion reactors'. *Scientific American*. **249**(4), 1983, pp. 44–55.

Readable introduction to the topic.

FISCH, N. J. 'Pushing particles with waves'. *American Scientist*. **71**, 1983, pp. 27–35.

New techniques applied to fusion. More suitable for later work.

FURTH, H. P. 'Reaching ignition in the tokamak'. *Physics Today*. **38**(3), 1985, pp. 53–61.

Useful account for those who want more technical details.

GLASSTONE, S. *Fusion energy*, US Dept. of Energy, 1980.

Readable text suitable as an introduction or for further work.

KNOEPFEL, H. 'The role of technology within the European fusion programme'. *Physics in Technology*. **11**, 1980, pp. 49–55.

Fascinating details showing the scale of fusion devices.

PEASE, R. S. 'The potential of controlled nuclear fusion'. *Physics in Technology*. **8**, 1977, pp. 144–151.

Very useful as an introduction.

PEASE, R. S. 'Progress and prospects of nuclear fusion'. *Journal of the Royal Society of Arts*. **129**(5301), 1981, pp. 584–599.

Simple enough to be introductory, but with enough detail for further work.

PEASE, R. S. 'International fusion research'. *Atom*. Jan. 1983, pp. 2–9.

Detailed survey.

PEASE, R. S. 'Fusion: the next steps'. *Physics Bulletin*. **36**, 1984, pp. 471–473.

A short introduction to tokomaks.

PITTS, J. H., HOVINGH, J., and WALTERS, S. 'Inertial-confinement fusion'. *Mechanical Engineering*. **104**(10), Oct. 1982, pp. 48–57. Provides introduction and reasonable detail.

WALTERS, S. 'The age of fusion: on the brink'. *Mechanical Engineering*, **104**(7), Jul. 1982, pp. 22–33.

Gives an overview of magnetic confinement systems in a readable form.

C Nuclear safety

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources, but the list may give an idea of what is available and where it may be found. The monthly magazine *Atom* is a particularly useful source for this option, see page 3. Many of the articles from *Atom* listed below are also available as offprints from UKAEA. (See page 5 for details.)

COHEN, B. L. 'The disposal of radioactive wastes from fission reactors'. *Scientific American*. **236**(1), June 1977, pp. 21–31.

Wide-ranging, quite detailed.

COLLIER, J., DAVIES, M., and GARNE, L. 'Design for safety'. *Atom*. June 1982, pp. 127–131.

Pressure vessels for pressurised water reactors.

COTTRELL, A. *How safe is nuclear energy?* Heinemann, 1982.

Readable approach to a complex topic.

DAY, D. H. *et al.* 'The management of radioactive wastes'. *Reports on Progress in Physics*. **48**, 1985, pp. 101–169.

A long, authoritative article, with much technical detail. Good for 'dipping into'.

DOWIE, J. and LEFRERE, P. (Eds.) *Risk and chance*. Open University Press, 1979.

A collection of articles, some of which are separately referenced below.

DUNSTER, H. J. 'The assessment of the risks of energy'. *Atom*. Jan. 1982, pp. 2–6.

Descriptive article refers to large-scale enterprises.

ERNST, M. L. and MURPHY, J. A. 'Regulation of nuclear power plants'. *Mechanical Engineering*. **106**(11), Nov. 1984, pp. 31–35.

The application of probabilistic risk assessment to nuclear power plants.

FISCHHOFF, B., HOHENHEMSE, C., KASPERSON, R., and KATES, R. 'Handling hazards', in Dowie and Lefrere, *Risk and chance* (see above).

FLOWERS, B. 'Nuclear power: a perspective of the risks, benefits and options'. *Bulletin of the Atomic Scientists*, Mar. 1978, pp. 21–57.

Considers different kinds of reactor, alternative sources, safety and politics, in a readable way.

FREMLIN, J. *Power production: what are the risks?* Hilger, 1985.

See page 10.

GONZALES, S. 'Host rocks for radioactive-waste disposal'. *American Scientist*. **70**, Mar./Apr. 1982, pp. 191–200.

Extensive but readable article.

HAYES, D. J. 'Water leaks in sodium-heated fast reactor boilers'. *Physics in Technology*. **9**, 1978, pp. 96–100.

Using liquid sodium as a coolant sounds difficult. It is!

HILEMAN, B. 'Hazardous waste control'. *Environmental Science and Technology*. **17**(7), 1983, pp. 281–285.

Concerned with all kinds of waste.

HILL, J. 'Risk v. benefit'. *Atom*. Mar. 1981, 64–69.

Comparisons between various energy sources.

HOOTON, B. W. 'Physics in nuclear safeguards'. *Physics in Technology*. **15**, 1984, pp. 92–98.

Explains how checks are made on quantities of hazardous material. [See also Hesketh, R. *Physics in Technology*. **15**, 1984, pp. 117–119, for an extension of the debate on the social responsibility of physicists.]

IAEA/WHO *Facts about low-level radiation*. IAEA, 1981.

Simple booklet.

JAWOROWSKI, Z. 'Natural and man-made radionuclides in the global atmosphere'. *IAEA Bulletin*. **24**(2), 1982, pp. 35–39.

Comparison of radiations from nuclear power plants and other sources.

JOLLY, W. (Ed.) *Irradiation and radioactivity*. Hobsons Press, 1984.

Short, readable introduction.

KLINGSBERG, C. and DUGUID, J. 'Isolating radioactive wastes'. *American Scientist*. **70**, Mar./Apr. 1982, pp. 182–190.

Detailed article but still quite readable.

LEWIS, J. B. 'Radioactive wastes and nuclear power: methods of treatment'. *Physics in Technology*. **7**, 1976, pp. 77–83.

General, introductory article.

MACDONALD, H. F. 'Radioactive waste and nuclear power: sources'. *Physics in Technology*. **7**, 1976, pp. 11–20.

Companion article to Lewis (above).

MARSHALL, W. 'Nuclear power and the proliferation issue'. *Physics in Technology*. **9**, 1978, pp. 115–127.

Good introduction to important aspects of safety: 'establishment' view.

MARSHALL, W. 'A UK view of the management of high-level waste'. *IAEA Bulletin*. **24**(2), 1982, pp. 25–29.

Readable article on the vitrification of wastes.

MARSHALL, W. 'Talking about accidents'. *Atom*. Oct. 1982, pp. 210–215.

Introductory article.

MAYNEORD, W. V. and WHEATLEY, B. M. 'Nuclear power: putting the risks into perspective'. *CEGB Research*. Jan. 1981, pp. 31–40.

Compares the risks from nuclear power with those from other sources.

NIEHAUS, R. 'The future role of risk assessment in nuclear safety'. *IAEA Bulletin*. **25**(4), 1983, pp. 30–36.

Deals with the background to risk assessment as well as the application to nuclear power.

OSTERBERG, C. L. 'Why not in the ocean?' *IAEA Bulletin*. **24**(2), 1982, pp. 30–34.

Argues that the sea is a safer repository for nuclear waste than the land.

OTWAY, H. and PALMER, P. 'Risk assessment', in Dowie and Lefrere, *Risk and chance* (see page 15).

PEARCE, F. 'Not in my backyard!' *New Scientist*. 3 Nov. 1983, pp. 346–351.

Non-technical description of the nuclear waste problem.

RINGWOOD, T. 'A rocky graveyard for nuclear waste'. *New Scientist*. 15 Sept. 1983, pp. 756–758. A way of eliminating liquid wastes.

ROM, N. W. and LEE, J. 'Energy alternatives: What are their possible health effects?' *Environmental Science and Technology*. **17**(3), 1983, pp. 132–144. Health risks – not limited to nuclear power.

SAUNDERS, P. 'Genetic effects of ionising radiation'. *Atom*. June 1981, pp. 146–151. and

SAUNDERS, P. 'The effects of radiation on Man'. *Atom*. Aug. 1981. pp. 198–202.

Introductory articles on different kinds of damage.

SAUNDERS, P. 'Radioactive waste management "can be very safe indeed"'. *Atom.* Jan. 1985, pp. 10–14.

The UKAEA view.

SLOVIC, P. and FISCHHOFF, B. 'How safe is safe enough?', in Dowie and Lefrere, *Risk and chance* (see above).

WADE, B. 'Radiation and nuclear power'. *Atom.* Nov. 1981, pp. 289–299.

Comprehensive and detailed article.

WALKER, G. 'Criticality safety'. *Atom.* Sept. 1983, pp. 196–199.

Preventing nuclear reactions starting accidentally.

WHEATLEY, B. M. 'Physics in radiological protection'. *Physics in Technology.* **11**, 1980, pp. 87–91.

Measurement, units and all that!

D Passive solar energy and solar energy generally

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources but the list may give an idea of what is available and where it may be found. The International Solar Energy Society (U.K. section) or UK-ISES, publishes a variety of useful documents on solar energy. They can be contacted at 19 Albermarle St, London W1X 3HA for details of their current publications.

COYNE, P. 'Solar UK?' *Energy Manager.* Feb. 1983, pp. 38–40.

Report of a study on the value of renewable energy use.

ELKINGTON, J. *Sun traps.* Penguin, 1984.

Excellent readable chapters on many aspects of solar energy including passive solar energy.

JACKSON, R. 'Ambient energy and building design'. *Energy World.* June 1981, pp. 12–13. Conference report – a good overall survey but little detail.

JESCH, L. F. *Solar energy today.* UK-ISES, 1981. Includes a chapter on passive solar energy as well as other aspects.

McKEE, J. S. C. 'Power from the Sun'. *Physics Bulletin*, **29**, 1978, pp. 565–566.

Short, introductory article.

McVEIGH, J. C. *Sun power.* 2nd edn. Pergamon, 1983.

Useful overall survey on passive and active systems, and photovoltaics.

MILLAR, J. H. 'Solar energy systems'. *Journal of the Royal Society of Arts.* **128**(5291), 1980, pp. 721–745.

A wide-ranging and readable survey of all kinds of solar energy systems.

STEADMAN, P. *Energy, environment, and building.* Cambridge University Press, 1975.

Includes a substantial section on passive solar energy, as well as sections on wind and biomass.

TAYLOR, R. H. *Alternative energy sources.* Hilger, 1983.

Excellent resource material on those sources, including solar energy, suitable for the centralised generation of electricity. Contains theory and details but remains readable.

WILLIAMS, R. H. (Ed.) *Towards a solar civilisation.* MIT Press, 1978.

A chapter on passive solar energy.

WILSON, J. I. B. *Solar energy.* Wykeham, 1979.

Mainly on photovoltaics but with some material on other solar devices.

E Active solar energy

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources but the list may give an idea of what is available and where it may be found. The International Solar Energy Society (U.K. Section) or UK-ISES, publishes a variety of useful documents on solar energy. They can be contacted at 19 Albermarle St, London W1X 3HA for details of their current publications. Useful information may also be found in the general references in Section D above, and in the general bibliography on pages 10 to 13.

CURTO, P. A. and STERN, G. 'Central solar receivers – applications for utilities and industry'. *Mechanical Engineering*. **104**(7), July 1982, pp. 54–57.

Describes how efficiency can be increased by combining technologies.

ELKINGTON, J. *Sun traps*. Penguin, 1984.
Excellent readable chapters on many aspects of solar energy including active solar techniques.

GILLET, W. B. and HUTCHINS, M. G. *Heating water by the sun*. UK-ISES, 1981.

Twenty-one page introduction, with considerable useful detail.

JESCH, L. F. *Solar energy today*. UK-ISES, 1981.
Includes a chapter on active solar energy as well as other aspects. Extensive references.

JESCH, L. F. (Ed.) *Solar energy in public buildings*. UK-ISES, 1982.

Detailed but readable account of the use of active solar energy systems in schools.

KETTLEBOROUGH, C. F. 'Solar-assisted comfort-conditioning'. *Mechanical Engineering*. **105**(12), Dec. 1983, pp. 48–55.

Air conditioning consumes much fuel, and in some countries is used at a time of year when solar energy is abundant. This article describes various systems.

KREITH, F. and BEZDEK, R. 'Can industry afford solar energy?' *Mechanical Engineering*. **105**(3), March 1983, pp. 35–41.

The economic and technical requirements for using solar energy in industry.

LEIBOWITZ, L. and HANSETH, E. 'Solar thermal technology – outlook for the 80s'. *Mechanical Engineering*. **104**(1), Jan. 1982, pp. 30–35.
A description of research on higher temperature and higher efficiency systems.

LOF, G. O. G. and KARAKI, S. 'System performance for the supply of solar heat'. *Mechanical Engineering*. **105**(12), Dec. 1983, pp. 33–47.
Lots of useful, practical information in a readable framework.

REID, R. L. 'Solar ponds'. *Mechanical Engineering*. **105**(12), Dec. 1983, pp. 24–31.
Readable article describing the theory and practice of an intriguing collector system.

UK-ISES. *Storage in solar systems*. UK-ISES, 1978.

Conference report giving details of a range of active solar systems.

WILLIAMS, R. H. (Ed.) *Towards a solar civilisation*. MIT Press, 1980.

A chapter on active solar energy.

F Photovoltaics

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all these sources but the list may give an idea of what is available and where it may be found. The International Solar Energy Society (U.K. Section) or UK-ISES, publishes a variety of useful documents on solar energy. They can be contacted at 19 Albermarle St, London W1X 3HA for details of their current publications. Useful information may also be found in the general references in Section D above, and in the general bibliography on pages 10 to 13.

COUTTS, T. J. 'Solar cells'. *Physics in Technology*. **9**, 1978, pp. 254–261.

Introductory article covering the physics and the economics of these devices.

ELKINGTON, J. *Sun traps*. Penguin, 1984.

Excellent readable chapters on many aspects of solar energy including photovoltaics.

FERBER, R. R. 'Photovoltaic power – an important new energy option'. *Mechanical Engineering*. **105**(12), Dec. 1983, pp. 17–23.
A useful introductory article.

HARRIS, L. B. 'Solar electricity – a low power technology'. *Physics in Technology*. **13**, 1982, pp. 190–195.

Wide-ranging, useful, introductory article.

JESCH, L. F. *Solar energy today*. UK-ISES, 1981.
Includes a chapter on photovoltaics as well as other aspects.

KAMMER, D. W. and LUDINGTON, M. A. 'Laboratory experiments with solar cells'. *American Journal of Physics*. **45**(7), 1977, pp. 602–605.

Some theory, and some experiments to try out.

MIALHE, P. and CHARETTE, J. 'Experimental analysis of I - V characteristics of solar cells'. *American Journal of Physics*. **51**(1), 1983, pp. 68–70.

A fairly simple experiment to determine the solar cell parameters.

TREBLE, F. C. 'Photovoltaics – from daylight to electricity in one step', in Jesch, L. F. (Ed.) *Solar energy benefits evaluated – techniques and results (M3)*, UK-ISES, 1982.

Construction of solar cells.

WILLIAMS, R. H. (Ed.) *Towards a solar civilisation*. MIT Press, 1980.

A chapter on photovoltaics.

WILSON, J. I. B. *Solar energy*. Wykeham, 1979. See page 17.

G Biomass

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

BUNGAY, H. R. (III) 'Commercializing biomass conversion'. *Environmental Science and Technology*. **17**(1), 1983, pp. 24–31.

Useful for those with an interest in chemical engineering.

BURCH, T., MAPLES, D., and DYER, D. 'Energy from wood: a survey of industrial use of wood waste'. *Energy Progress*. **4**(3), 1984, pp. 181–185. Useful detail without being too technical.

CROSS, M. (Ed.) *Grow your own energy*. Blackwell, 1984.

A collection of *New Scientist* articles on many aspects of biomass.

DEPARTMENT OF ENERGY (ETSU) *The potential for straw as a fuel in the UK*. AERE, Harwell, 1984. A short booklet dealing at an appropriate level with a rather surprising fuel.

ELKINGTON, J. *Sun traps*. Penguin, 1984. Excellent readable chapters on many aspects of solar energy including biomass.

HALL, D. O. 'Biomass for energy: fuels now and in the future'. *Journal of the Royal Society of Arts*. **130**(5312), 1982, pp. 457–471. Excellent introductory article – wide-ranging and readable.

HIRA, A. U., MULLONEY, J. A., and D'ALESSIO, G. J. 'Alcohol fuels from biomass'. *Environmental Science and Technology*. **17**(5), 1983, pp. 202–213.

Considerable detail, of particular interest to potential chemical engineers.

JESCH, L. F. *Solar energy today*. UK-ISES, 1981. Includes a chapter on biomass as well as other aspects of solar energy.

JONES, M. 'Papyrus: a new fuel for the Third World'. *New Scientist*, 11 Aug. 1983, pp. 418–421.

The utilisation of papyrus as peat or briquettes.

MONTCLAIR ENVIRONMENTAL MANAGEMENT TEAM 'Analysis of wood burning stoves as a supplemental heat source'. *International Journal of Environmental Studies*. **20**, 1983, pp. 307–315. The sort of analysis which is necessary to assess the feasibility of alternative fuel sources.

PARKER, H. W. 'Engine fuels from biomass'. *Mechanical Engineering*. **104**(5), May 1982, pp. 54–59.

Useful introduction to this aspect of biomass conversion.

SLESSER, M. and LEWIS, C. *Biological energy resources*. Spon, 1981.

Comprehensive survey of the whole field. Probably too much detail for an introduction but excellent for later work.

STEADMAN, P. *Energy, environment, and building*. Cambridge University Press, 1975.

Includes a substantial section on biomass, as well as wind and passive solar energy.

VAILLANCOURT, M. 'Putting a tree in your tank'. *Science Dimension*, **16**(4), 1984, pp. 19–24. Attractive and interesting article on converting biomass to fuel.

WHITE, L. P. and PLASKETT, L. G. *Biomass as fuel*. Academic Press, 1981.

Comprehensive source of information with many references. Most useful for later work.

WILLIAMS, R. H. (Ed.) *Towards a solar civilisation*. MIT Press, 1980.

A chapter on biomass.

H Wind energy

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

CALVERT, N. G. *Windpower principles: their application on the small scale*. Griffin, 1979.
Useful introductory material.

CLARE, R. and MAYS, I. D. 'The Musgrove variable geometry vertical axis wind turbine'. *Modern Power Systems*. Dec. 1982.
Useful for later work on particular systems.

ELDRIDGE, F. R. *Wind machines*. 2nd edn. Van Nostrand, 1980.
Wide-ranging, well-illustrated and readable book, providing plenty of detail at the right level.

FAGENBAUM, J. 'Harnessing wind power'. *Mechanical Engineering*. **104**(4), Apr. 1982, pp. 64–73.
Useful for later work on particular systems.

HERMAN, S. W. and CANNON, J. S. *Energy futures*. Ballinger, 1977.
Chapters on many systems.

JESCH, L. F. *Solar energy today*. UK-ISES, 1981. (See page 17 for details of UK-ISES.)
Chapters on wind energy as well as many other aspects of solar energy.

JOHNSON, C. 'Small is competitive'. *Energy Manager*. Mar. 1982, pp. 26–30.
Decentralising power generation.

LIPMAN, N. H., MUSGROVE, P. J., and PONTIN, G. W-W. (Eds.) *Wind energy for the 80s*. Peregrinus, 1982.
Wide-ranging, detailed resource book, especially

useful for later work, but individual sections are readable.

MECHANICAL ENGINEERING STAFF 'The new age of sail'. *Mechanical Engineering*. **105**(2), Feb. 1983, pp. 71–87.

New versions of an old technology.

MUSGROVE, P. J. 'Wind energy'. *Journal of the Royal Society of Arts*. **129**(5301), 1981, pp. 553–567.

Useful as an introduction and for further work.

PARK, J. *The wind power book*. Cheshire Books, 1981.

Intended for those who want to make a windmill – but also contains theory and details of many systems. Excellent as an introduction and for later work.

PELKA, D. G., PARK, R. T., and SINGH, R. 'Energy from the wind'. *American Journal of Physics*. **46**(5), 1978, pp. 495–498.

Mathematical but not unreasonably so. Includes a simple derivation of the Betz limit.

SCHWALLER, A. E. *Energy technology*. Davis, 1980.

Wide-ranging, useful introduction to many topics.

SMULDERS, P. T. 'Physical aspects of windmill design'. *Physics in Technology*. **7**, 1976, pp. 208–214.

Wide-ranging article. An excellent introduction, not because it is simple but more because it is a good basis for further work.

TAYLOR, D. 'Fair wind'. *Energy Manager*. Jan. 1982, pp. 48–51.

Short, descriptive, introductory article.

TAYLOR, R. H. *Alternative energy sources for the centralised generation of electricity*. Hilger, 1983.
Chapter on wind energy, and references.

TAYLOR, R. H. 'Wind power technology'. *Physics Bulletin*. **35**, 1984, pp. 377–380.

A very useful introductory article.

VIGARS, N. *Alternatively speaking*. Shell Education Service, (undated).

Simple and attractive introduction.

WAILES, R. *Windmills and watermills*.

Ward Lock, 1979.

Very useful historical treatment, well illustrated.

WILSON, R. E. and THRESHER, R. W. 'Electrical energy from the wind'. *Mechanical Engineering*. **106**(1), Jan. 1984, pp. 60–69.

A very useful introductory article.

WIND POWER GROUP *Development of large wind turbine generators*. Department of Energy. 1979. General background and some detail of particular examples.

I Power stations and fossil fuels generally

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

ATWOOD, G. 'The strip-mining of Western coal'. *Scientific American*. **233**(6), Dec. 1975, pp. 23–29.

The environmental cost of recovering resources.

BARON, S. 'Costing thermal electric power plants'. *Mechanical Engineering*. **104**(10), Oct. 1982, pp. 41–47.

Includes comparison costs of different systems including non-fossil.

CAMERON, D. S. and RYAN, F. J. 'Power generation using fuel cells'. *Physics in Technology*. **15**, 1984, pp. 18–22.

Describes developments of fuel cells, originally designed for small-scale operations, which can now be considered for large-scale installations.

CHESTER, P. F. 'Perspectives on acid rain'. *Journal of the Royal Society of Arts*. **31**(5326), Sept. 1983, pp. 587–603.

Surveys the evidence for damage produced by acid rain.

DAYKIN, K. W. and RUMSEY, J. C. V. 'Using physics in the coal industry (2). Research and development'. *Physics in Technology*. **6**, 1975, pp. 245–250.

Describes a wide range of research areas.

DEPARTMENT OF THE ENVIRONMENT *Acid rain: the Government's reply to the 'Fourth report from the environment committee'*. HMSO, 1984. (Cmnd. 9397).

Typical of the sort of short report which is helpful in keeping up-to-date in a volatile area.

DRAKE, E. and REID, R. C. 'The importation of liquefied natural gas'. *Scientific American*. **236**(4), Apr. 1977, pp. 22–29.

Problems presented by the need to transport a useful fossil fuel.

FUNNELL, I. R. and THELWELL, M. J. 'IR systems to monitor electrical power plant'. *Physics in Technology*. **9**, 1978, pp. 141–147.

Describes interesting ways of using modern optical equipment.

GIBSON, J. 'The future for coal and the environment'. *Journal of the Royal Society of Arts*. **129**(5297), Apr. 1981, pp. 273–285. Methods of reducing pollution due to coal burning.

GLOWIAK, B. J. and PACYNA, J. M. 'Radiation dose due to atmospheric releases from coal-fired power stations'. *International Journal of Environmental Studies*. **16**, 1980, pp. 23–28. Alleging high levels of radiation dose due to coal-fired power stations.

GRIFFITH, E. D. and CLARKE, A. W. 'World coal production'. *Scientific American*. **240**(1), Jan. 1979, pp. 28–37.

Well-presented introductory material, with emphasis on USA.

HAMMOND, G. 'Combining district heating and power generation'. *Physics in Technology*. **8**, 1977, pp. 163–166.

Short, introductory article.

HAWTHORNE, W. 'The use of coal'. *Energy World*. May 1981, pp. 2–12.

Future uses for coal described.

JOHNSON, A. H. and SICCAMA, T. G. 'Acid deposition and forest decline'. *Environmental Science and Technology*. **17**(7), 1983, pp. 294–305.

A question mark over the role of acid rain.

- JONES, J. R. 'Coal – who needs it?' *Mechanical Engineering*. **105**(3), Mar. 1983, pp. 50–54.
Dealing with the economic advantages, transportability, and availability of coal.
- KAYE, W. G. and PEIRCE, T. J. 'Prospects for coal: technical developments'. *Physics in Technology*. **14**, 1983, pp. 183–189.
Describes the developing technology for using coal.
- LANGTON, N. H. and ELLINGTON, H. I. 'The physics of power stations. Part I: Fossil fuelled power stations'. *Physics Education*. **12**, 1975, pp. 448–452.
and
LANGTON, N. H. and ELLINGTON, H. I. 'The physics of power stations. Part II: Nuclear power stations'. *Physics Education*. **12**, 1975, pp. 504–508.
Useful for all levels of work.
- MADDOCK, B. J. 'Superconducting power cables'. *Physics in Technology*. **6**, 1975, pp. 266–272.
Describes how to reduce transmission power losses.
- MARSHALL, W. 'Energy conservation using combined heat and power'. *Physics in Technology*. **11**, 1980, pp. 46–48.
Summarises the evidence from a variety of Government papers.
- NATIONAL RESEARCH COUNCIL ON NUCLEAR AND ALTERNATIVE ENERGY SYSTEMS *Energy in transition 1985–2010*. W. H. Freeman, 1979.
Chapters on many systems.
- ORCHARD, W. R. H. and SHERRATT, A. F. C. (Eds.) *Combined heat and power*. Godwin, 1980.
Plenty of accessible information.
- POCHIN, E. E. 'Biological risk involved in power production'. *Physics in Technology*. **11**, 1980, pp. 93–110.
Clear and expert appraisal of a difficult area.
- REVELLE, R. 'Carbon dioxide and world climate'. *Scientific American*. **247**(2), Aug. 1982, pp. 33–41.
Evidence for increasing concentration, and suggestions of possible effects.
- RIETJENS, L. H. 'The future for MHD power generation'. *Physics in Technology*. **10**, 1979, pp. 216–221.
Describes a method of generating electricity different from the usual steam cycle.
- ROBERTS, T. M. 'Effects of stack emissions on agriculture and forestry'. *CEGB Research*. No. 12, 1981, pp. 11–24.
Readable article which goes into some detail about techniques and results.
- SCHWALLER, A. E. *Energy technology*. Davis, 1980.
Wide-ranging, useful introduction to many topics.
- SHARPE, J. 'The technology and economics of coal fired ships'. *Physics in Technology*. **15**, 1984, pp. 197–204.
Describes how coal-fired ships can compete with most oil-powered ships.
- SINHA, S. K. 'The impact of carbon dioxide on agriculture in developing countries'. *Impact of Science on Society*. **32**(3), 1982, pp. 311–323.
Discusses complex factors in an understandable way.
- SPROSON, J. C. 'Using physics in the coal industry (1). Scientific control'. *Physics in Technology*. **6**, 1975, pp. 201–208.
Companion article to Daykin and Rumsey (page 21).
- TOMLINSON, G. H. (II) 'Air pollutants and forest decline'. *Environmental Science and Technology*. **17**(6), 1983, pp. 246–256.
Companion article to that by Johnson and Siccama (page 21) on a complex topic.
- TURNPENNY, A. W. H., LANGFORD, T. E., and ASTON, R. J. 'Power stations and fish'. *CEGB Research*. **17**, 1985, pp. 27–39.
Why the CEGB doesn't like fish, and vice-versa!
- WOODWELL, G. M. 'The carbon dioxide question'. *Scientific American*. **238**(1), Jan. 1978, p. 34.
Well-presented treatment of complex problems.
- WRIGHT, S. J. 'Combustion of coal in fluidised beds'. *Physics in Technology*. **8**, 1977, pp. 244–248.
Describes a modern method of burning coal.

J Alternative sources of fossil fuels

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

COCHRAN, N. P. 'Oil and gas from coal'. *Scientific American*. **234**(5), May 1976, pp. 24–29.
Well-presented, short, introductory article.

DRY, M. E. 'The production of hydrocarbons from coal'. *Endeavour*. New Series, **8**(1). 1984, pp. 2–4.
A short article which provides technical details, while remaining readable.

FAGENBAUM, J. 'Back to coal power'. *Mechanical Engineering*. **105**(8), Aug. 1983, pp. 39–45.
Information about coal gasification, cleaning and pollution control.

GIBSON, J. 'Liquid fuels from coal'. *Journal of the Royal Society of Arts*. **32**(5329), 1983, pp. 41–51.
Compact survey of the field.

HERMAN, S. W. and CANNON, J. S. *Energy futures*. Ballinger, 1977.
Chapters on many systems.

NATIONAL RESEARCH COUNCIL ON NUCLEAR AND ALTERNATIVE ENERGY SYSTEMS *Energy in transition 1985–2010*. W. H. Freeman, 1979.
Chapters on many systems.

SCHWALLER, A. E. *Energy technology*. Davis, 1980.
Wide-ranging, useful introduction to many topics.

THIELHEIM, K. O. *Primary energy*. Springer-Verlag, 1982.
Useful chapters on many sources.

THOMPSON, P. N. 'Gasifying coal underground'. *Endeavour*. New Series. **2**(2), 1978, pp. 93–97.
Article which gives technical details in an accessible form.

WALTERS, S. 'Oil from rock'. *Mechanical Engineering*. **104**(2), Feb. 1982, pp. 32–41.
Useful survey of different methods.

WEINBERG, F. J. 'Novel methods of winning, burning, and conserving fuels'. *Physics in Technology*. **6**, 1975, pp. 95–102.

Useful, introductory article which describes several methods of using fossil fuels.

K Geothermal

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

ALLABY, M. 'Hot rocks draw the crowds'. *New Scientist*, 18 Aug. 1983, pp. 467–470.
Principles and practice of geothermal energy in Cornwall.

ARMSTEAD, H. C. H. 'Geothermal energy: technological aspects of exploitation'. *Physics in Technology*. **10**, 1979, pp. 244–251.
Ways of using geothermal energy.

ARMSTEAD, H. C. H. 'Future prospects for geothermal energy'. *Physics in Technology*. **11**, 1980, pp. 2–7.
Describes ways of increasing the use of geothermal energy.

ARMSTEAD, H. C. H. *Geothermal energy*. 2nd edn. Spon, 1983.
Authoritative and comprehensive.

GARNISH, J. D. 'Progress in geothermal energy'. *Endeavour*. New Series, **2**(2), pp. 66–71, 1978.
and
GARNISH, J. D. 'Geothermal energy and the UK'. *Physics Education*. **13**(6), 1978, pp. 372–377.
and
GARNISH, J. D. 'Geothermal energy and the UK'. *Atom*. Sept. 1978.

and
GARNISH, J. D. 'Heat from the Earth'. *Coal and Energy Quarterly*. Spring 1979, pp. 9–19.
and
GARNISH, J. D. 'Geothermal development in the UK and overseas'. *Coal and Energy Quarterly*. Autumn 1981, pp. 10–18.

and
GARNISH, J. D. 'Mining the Earth's heat'. *Physics Bulletin*. **35**, 1984, pp. 381–383.
These six articles provide a useful perspective on the topic in the UK and world-wide.

HAENEL, R. 'Prospecting for geothermal energy by geophysical methods'. *Physics in Technology*. **8**, 1977, pp. 213–218.

Ways of finding geothermal deposits.
Introductory article.

HERMAN, S. W. and CANNON, J. S. *Energy futures*. Ballinger, 1977.
Chapters on many systems.

NATIONAL RESEARCH COUNCIL ON NUCLEAR AND ALTERNATIVE ENERGY SYSTEMS *Energy in transition 1985–2010*. W. H. Freeman, 1979.
Chapters on many systems.

SCHWALLER, A. E. *Energy technology*. Davis, 1980.
Wide-ranging, useful introduction to many topics.

TAYLOR, R. H. *Alternative energy sources for the centralised generation of electricity*. Hilger, 1983.
Chapter on geothermal energy, and references.

THIELHEIM, K. O. *Primary energy*. Springer-Verlag, 1982.
Useful chapters on many sources.

L Heat pumps

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

ENERGY TECHNOLOGY SUPPORT UNIT
UK workshop on heat pumps. Department of Energy, 1977.
More useful for follow-up than introductory work.

HEAP, R. D. *Heat pumps*. Spon, 1979.
Wide-ranging survey with many useful references.

JOLLY, W. (Ed.) *Heat engines, heat pumps and energy conservation*. Hobsons Press, 1982.
Short introductory booklet linking a number of areas.

LAWTON, J. 'Drying: the role of heat pumps and electromagnetic fields'. *Physics in Technology*. **9**, 1978, pp. 214–220.
Interesting applications of physics ideas to a common process.

McMULLAN, J. T. and MORGAN, R. *Heat pumps*. Hilger, 1981.
Suitable for more advanced work only.

NEAL, W. E. J. 'Heat pumps for domestic heating and heat conservation'. *Physics in Technology*. **9**, 1978, pp. 154–161.
Introductory article on basic theory and application of heat pumps to solar energy systems, etc.

NEAL, W. E. J. *et al.* 'Heat pumps'. *Energy World* (Supplement) Oct. 1981.
A number of articles covering basic theory and applications in the UK, and world-wide.

M Combustion of refuse

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

CATHCART, T. and JARRETT, M. 'The Sumner County solid waste energy recovery facility'. *Energy Progress*. **4**(2), 1984, pp. 82–84.
A description of an actual installation.

HERMAN, S. W. and CANNON, J. S. *Energy futures*. Ballinger, 1977.
Chapters on many systems.

MARNET, C. 'Utilisation of urban waste for the cogeneration of electricity and district heat'. *Journal of the Institute of Energy*, Sept. 1982, pp. 144–152.
Rather technical so more suitable for later work. Not, however, difficult to read.

PORTEOUS, A. 'Fuel from refuse'. *Endeavour*. New Series, **6**(3), 1982, pp. 114–118.
Useful introductory article which provides an overview at a suitable level.

WALTERS, S. 'Benefits from biowaste'. *Mechanical Engineering*. **107**(4), 1985, pp. 70–76.
Description of a process which can convert waste into fertilizers and fuel.

N Hydro-power

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

FAGENBAUM, J. 'Brazil's Itaipu dam'. *Mechanical Engineering*. **104**(11), Nov. 1982, pp. 20–29. World's largest hydroelectric project.

THIELHEIM, K. O. *Primary energy*. Springer-Verlag, 1982.

Useful chapters on many sources.

WAILES, R. *Windmills and watermills*. Ward Lock, 1979.

Very useful historical treatment, well illustrated.

O Wave energy

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found. Many of the more general books listed earlier in this book contain sections on wave energy, and are well worth consulting to start with.

CURRAN, S. C. and CURRAN, J. S. *Energy and human needs*. Scottish Academic Press, 1979. See page 10.

CHARLIER, R. H. 'Oceans and electrical power (Part I)'. *International Journal of Environmental Studies*. **18**, 1982, pp. 159–168.

CHARLIER, R. H. 'Oceans and electrical power (Part II)'. *International Journal of Environmental Studies*. **19**, 1982, pp. 7–16.

Two articles covering much more than wave energy. Useful introduction.

COUNT, B. M., FRY, R. and HASKELL, J. H. 'Wave power: the story so far'. *CEGB Research*. Nov. 1983, pp. 13–24.

Useful wide-ranging introductory article.

SALTER, S. H. 'Wave power'. *Nature*. **249**, 1974, pp. 720–724.

A short and useful account by one of the UK pioneers.

SALTER, S. H. 'Wave energy: problems and solutions'. *Journal of the Royal Society of Arts*. **129**(5301), 1981, pp. 568–583.

Wide-ranging article suitable as introduction and for further work.

TAYLOR, R. H. *Alternative energy sources for the centralised generation of electricity*. Hilger, 1983. Substantial section on wave energy, as well as other sources.

P Tidal energy

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but this list may give an idea of what is available and where it may be found.

BAKER, A. C. 'Renewable energy: the Severn Barrage'. *Physics Bulletin*. **35**, 1984, pp. 384–387. An excellent introductory article.

DEPARTMENT OF ENERGY Energy paper No. 46. *Tidal power from the Severn Estuary*. Volume 1, *Report from the Severn Barrage Committee*. HMSO, 1981.

Detailed but readable and attractively presented treatment suitable for introduction and further work: includes environmental factors.

GARRETT, C. 'Tides and tidal power in the Bay of Fundy'. *Endeavour*. New Series. **8**(2), 1984, pp. 58–63.

Readable article containing much useful technical material. More useful for later work.

RIDDY, A. *Energy from the tides*. Hobsons Press, (undated).

One of the 'Physics Plus' publications. Excellent introductory material. Short and to the point.

TAYLOR, R. H. *Alternative energy sources for the centralised generation of electricity*. Hilger, 1983. Substantial section on tidal energy, as well as other sources.

THIELHEIM, K. O. *Primary energy*. Springer-Verlag, 1982.

A section on tidal power stations, and others.

Q Domestic conservation

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these sources but the list may give an idea of what is available and where it may be found. The advertising literature from firms who market fuel-conserving systems, such as double glazing, and cavity-wall and roof insulation is worth examining to assess the claims which are made. It is sometimes possible to obtain technical data from the firms; this is usually much more informative than the general advertising material. The magazine *Energy Manager* contains many useful articles in this area.

COHEN, B. L. 'Cost per million BTU of solar heat, insulation, and conventional fuels. *American Journal of Physics*. 52(7), 1984, pp. 614-617. Short, readable article, using ideas introduced elsewhere in this Unit.

DEPARTMENT OF ENERGY Advisory Council on Energy Conservation, Energy paper No. 48. *Energy conservation in the production of domestic hot water*. HMSO, 1981. Useful data source.

DEPARTMENT OF ENERGY *Energy efficient domestic wet central heating systems*. HMSO, 1983. Useful as background. Intended for installers.

EEC Research Report No. 7. *Improving the energy efficiency of domestic electrical appliances: a survey of development work in the UK*. Available from Electricity Consumers' Council, Brook House, 2/16 Torrington Place, London WC1E 7LL.

LEACH, S. J. 'Energy conservation in buildings'. *Physics in Technology*. 7, 1976, pp. 195-201. Introductory article developing some of the ideas introduced in Section G3.

RAINE, J. H. 'General physical characteristics of draught-proofing devices'. *Energy World*. Aug./Sept. 1981, pp. 14-15. Short, descriptive article.

RAYNHAM, E. A. 'Thermal insulation of buildings'. *Physics in Technology*. 6, 1975, pp. 164-169. Excellent introductory article which uses ideas first met in Section G3.

STANSELL, P. 'Save it not sell it'. *New Scientist*. 13 Oct. 1983, pp. 85-87. Useful introduction to static heat exchangers and heat wheels.

R Industrial conservation

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these sources but the list may give an idea of what is available and where it may be found.

BASSETT, J. W. 'Heating a factory building for nearly nothing'. *Energy World*. Nov. 1982, pp. 2-7. Describes how process heating can be diverted to space heating.

DEPARTMENT OF ENERGY Energy paper No. 32. *Energy conservation, research, development, and demonstration*. HMSO, 1978. Useful as a source of detailed data.

DEPARTMENT OF ENERGY Energy paper No. 34. *Heat loads in British cities*. HMSO, 1979. Good source of background data on the viability of district heating.

DEPARTMENT OF ENERGY Energy paper No. 35. *Combined heat and electrical power generation in the United Kingdom*. HMSO, 1979. Better for later study than for an introduction.

DEPARTMENT OF ENERGY Advisory Council on Energy Conservation, Energy paper No. 49. *Report to the Secretary of State for Energy*. HMSO, 1982. A quite short overview of the potential savings to be made in buildings, transport and industry.

DEPARTMENT OF ENERGY Energy paper No. 50.
Energy conservation investment in industry.
HMSO, 1982.

Rather detailed and technical economics approach, but useful for those wanting more than a general overview.

DEPARTMENT OF ENERGY Energy paper No. 53.
Combined heat and power district heating feasibility programme. Stage 1. HMSO, 1984.
Much data; more suitable for later work than for an introduction.

DEPARTMENT OF ENERGY Energy Efficiency Office
Energy efficiency demonstration scheme: a review.
HMSO, 1984.

A detailed overview of conservation in industry and commerce. Apparently daunting at first sight but each section is short and to the point. An excellent resource.

DEPARTMENT OF ENERGY Energy Efficiency Office
Proving the technology of energy conservation.
1983.

From Enquiries Bureau, ETSU, Building 156, AERE, Harwell, Didcot, Oxfordshire, OX11 0RA.

Short description of energy conservation projects.

DEPARTMENT OF ENERGY Energy Technology Series 1, *Energy management systems.* Energy Technology Support Unit, 1983.

General principles and some examples.

DEPARTMENT OF ENERGY Energy Technology Series 2, *Infrared thermography.* Energy Technology Support Unit, 1984.

Readable introduction to the technique and its uses.

HUDSON, G. C. 'A small heat wheel for the classroom'. *School Science Review*. 63(220), 1981, pp. 94-99.

Excellent introductory article which describes both the principles and a model which could form the basis of an investigation.

NUMARK, N. J. and BARTLETT, A. A. 'Energy waste in a university building'. *American Journal of Physics*. 50(4), 1982, pp. 329-331.

Description of an exercise in fuel saving.

ORCHARD, W. R. H. and SHERRATT, A. F. C. (Eds.)
Combined heat and power. Godwin, 1980.
Detailed and comprehensive.

S Conservation in transport

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these sources but the list may give an idea of what is available and where it may be found.

ALSTON, L. L. *Railways and energy.* (World Bank Staff Working Papers No. 634.) The World Bank, 1984.

Rather specialised, but readable.

ANNAND, W. J. D. 'The physics of petrol engine development'. *Physics in Technology*. 10, 1979, pp. 20-25.

Describes the processes of internal combustion and shows how it is possible to increase efficiency and reduce emissions.

BREWER, G. D. 'Fuel for future transport aircraft'. *Mechanical Engineering*. Jan. 1983, pp. 50-55.
The possible role of liquid hydrogen.

BUMBY, J. R. and CLARKE, P. H. 'The role of the internal combustion engine/battery electric hybrid vehicle in the UK'. *Energy World*. Dec. 1982, pp. 2-11.

Useful, wide-ranging introductory article.

DEPARTMENT OF ENERGY Advisory Council on Energy Conservation. Energy Paper No. 28.
Energy for transport: long term possibilities. HMSO, 1978.

A short overview of the possibilities which provides a useful introduction.

DEPARTMENT OF ENERGY Advisory Council on Energy Conservation. Energy Paper No. 18.
Road vehicle and engine design: short and medium term energy considerations. 2nd edn. HMSO, 1979.

Useful introduction. (Out of print.)

FAGENBAUM, J. 'The Stirling - a "hot" engine for the 80s?' *Mechanical Engineering*. 105(5), May 1983, pp. 18-29.

Wide-ranging introductory article.

FRANCIS, R. J. and WOOLLACOTT, P. N. Energy Paper No. 45. *Prospects for improved fuel economy and fuel flexibility in road vehicles*. HMSO, 1981.

Wide-ranging publication, very useful for follow-up work.

GOODGER, E. M. 'Future trends in automotive fuels'. *Energy World*. Mar. 1981, pp. 8–18. An introductory article which contains some useful technical data.

McKIM, F. *The efficiency of large trucks*. Hobsons Press, 1985.

One of the 'Physics Plus' publications describing a novel system for increasing efficiency.

THRING, R. H. 'Gasoline engines and their future'. *Mechanical Engineering*. **105**(10), Oct. 1983, pp. 40–51.

Useful introductory article.

WILLIAMS, L. O. 'Hydrogen: its place in future energy systems'. *Physics in Technology*. **11**, 1980, pp. 181–186.

Introductory article placing the use of hydrogen in context.

WILSON, D. G. 'Research needs for human-powered vehicles'. *Mechanical Engineering*. **105**(4), Apr. 1983, pp. 42–49.

Interesting article, on an alternative which could be useful if all else fails!

T Storage

This is not an exhaustive list of sources of information. Other sources already exist, and additional ones will become available in the future. It would not be reasonable to expect to find all of these particular sources but the list may give an idea of what is available and where it may be found.

BOOM, R. W. and BISCHKE, R. F. 'Inductor-converter superconductive magnetic energy storage for electric utility usage'. *Physics in Technology*. **13**, 1982, pp. 18–27.

Interesting application of new technology, suitable for later work.

DURRANT, O. W. and BRAUN, M. J. 'High temperature thermal energy storage for power generation'. *Mechanical Engineering*. **106**(3),

Mar. 1984, pp. 71–75.

Using storage systems to improve utilisation and efficiency.

INTERNATIONAL SOLAR ENERGY SOCIETY *Storage in solar energy systems*. UK-ISES, 1978 (see page 17 for details of UK-ISES).

A collection of conference papers. Some are useful for later work on storage, others for work on active solar systems.

JENSEN, J. *Energy storage*. Butterworth, 1980. The need for storage systems, their theory and parameters.

McGEEHIN, P. 'Energy storage by batteries'. *Physics in Technology*. **11**, 1980, pp. 8–15. Much information within a short space, therefore rather dense, but not otherwise difficult to read.

MARLAND, G. 'Extracting energy from warm seawater'. *Endeavour*. New Series. **2**(4), 1978, pp. 165–169.

Ocean Thermal Energy Conversion (OTEC) has vast potential but some problems. This article describes both effectively.

MECHANICAL ENGINEERING STAFF 'Seasonal thermal energy storage'. *Mechanical Engineering*. **105**(3), Mar. 1983, pp. 28–34.

Article describing the use of storage media, mainly water.

NEAL, W. E. J. 'Thermal energy storage'. *Physics in Technology*. **12**, 1981, pp. 213–226.

Wide-ranging article suitable for further work on storage and solar systems.

RAMAKUMAR, R. 'Storage options for harnessing wind energy'. *Mechanical Engineering*. **105**(11), Nov. 1983, pp. 74–83.

Comprehensive article introducing most of the basic ideas.

SCHWALLER, A. E. *Energy technology*. Davis, 1980.

Chapter on energy storage as well as many other topics.

WALSH, W. J. 'Advanced batteries for electric vehicles – a look at the future'. *Physics Today*. June 1980, pp. 34–41.

A wide-ranging, detailed article, which is suitable as an introduction to storage.

**General editor,
Revised Nuffield
Advanced Physics**
John Harris

Consultant editor
E. J. Wenham

Editor of this book
Maurice Tebbutt

Energy sources: data, references, and readings **has been produced to support 'Energy sources' in Students' guide 1 of the Revised Nuffield Advanced Physics course; it should also be useful in conjunction with other courses dealing with energy issues. There are four sections.**

The first section provides some data about energy supply and use.

This is followed by a section listing useful sources of data and other information: publications, for example, magazines and journals which may be of use; organizations and companies which will supply schools and colleges with information; and teaching aids, for example posters, videos, and computer programs.

The third section, 'Where to look', is designed to help students to seek out suitable material when they are working on their own.

Finally, there is a comprehensive annotated bibliography, divided into two parts: the 'General bibliography', which covers Unit G as a whole, has sections on energy supply and demand, the principles of nuclear fission, and thermal conduction as dealt with in the Unit; the 'Specialized bibliography' lists references relating to the twenty Energy options, including nuclear fusion, biomass, wind energy, etc., which are studied in Section G4 of Students' guide 1.

ISBN 0 582 35425 0