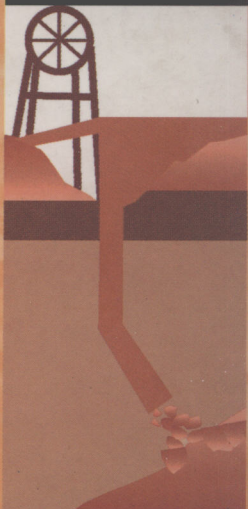
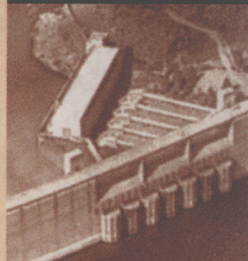
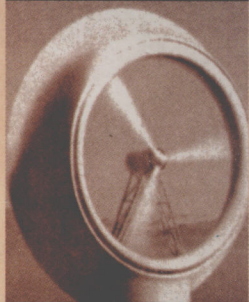


Energy Studies

Second Edition

W. Shepherd
D. W. Shepherd



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PREFACE

The industrially developed countries of the world have become rich and prosperous by the profligate use of fossil fuels: coal, oil and natural gas. Countries of the developing areas of the world, mainly in the Pacific Rim and Far East, are starting to use fossil fuels, especially oil, at increasing rates. But both oil and natural gas reserves are fast depleting and are non-renewable. Each source has only a few tens of years of stock remaining. How is future world energy demand to be met?

To address such a fundamental problem, it is vitally important that all of the various elements comprising the problem are well understood. In the case of world energy, the problem elements are the individual energy sources, both old and new.

At least ten distinct types of energy source exist:

- coal
- oil
- natural gas
- nuclear
- geothermal
- biological/chemical
- hydroelectric
- wind
- wave/tidal
- solar energy

Each of these sources is examined in *Energy Studies*, in an attempt to take stock of the development of each, towards either depletion or viable widespread utilisation. Environmental implications, economic assessments and industrial risks are also considered.

By doing this, the authors are able to conclude with an illustrative example of an energy strategy with which to address the world energy future, so encouraging readers to weigh for themselves the complex problem which now stares mankind in the face.

Chapter 1 is written mainly for students of the physical sciences and engineering. More general readers are advised to begin reading from Chapter 2.

W. Shepherd and D. W. Shepherd
July 1997

PREFACE TO THE SECOND EDITION

In the five years that have elapsed since the original publication, the issues of energy matters and environmental concerns have become prominent. Energy supply and use is now a matter of frequent reports, not only in trade journals but in the popular press.

Up-to-date figures are now given for items of fuel supply and also for the use of renewable sources such as wind energy and photovoltaics. The chapters on geothermal energy and nuclear energy have been extended. Increased coverage is given to waste and waste disposal, in Chapter 13.

The energy strategy proposed in the first edition is unchanged. It is the view of the authors that this remains the logical, sensible and workable way to proceed.

W. Shepherd and D. W. Shepherd
June 2002

ACKNOWLEDGEMENTS

Much of the material in this book has been taught in undergraduate and post-graduate courses at the University of Bradford, England, and Ohio University, Athens, Ohio, USA. The authors are grateful to both universities for permission to reproduce teaching and examination materials.

The information was obtained from a vast number of sources, some original. Wherever possible the authors have attributed their sources. Thanks are due to the publishers of pre-existing material for their generous permission to reproduce previously published information. The authors apologise if any pre-existing material is not adequately attributed — this is not an attempt to deceive but due to inadvertence.

Dr James Brooks of Glasgow, Scotland, a distinguished geochemist, read the manuscript. His many helpful criticisms and suggestions have enhanced the presentation, especially the chapters on fossil fuels and on geothermal energy.

The authors' work was greatly helped by the superb facilities of the Alden Library at Ohio University. Special thanks are due to Lars Lutton, photographer, Samuel Girton and Scott Wagner, graphic artists, and especially to Peggy Sattler, graphic design manager in the Instructional Media and Technology Services Unit.

We are grateful to Mr Michael Mitchell of Bradford, England, for his valuable help with the computer-generated diagrams.

The typing of the manuscript, with its many revisions during the evolution, was largely done by Suzanne Vazzano of Athens, Ohio. Her professionalism and good nature were indispensable in its completion.

Athens, Ohio, USA
1997

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The authors would like to thank the publishers of the many new sources that are included in this second edition, in addition to re-acknowledgement of the original sources.

Once more the chief sources of information are British Petroleum plc of London, England, and the US Energy Information Administration of Washington, DC, USA.

Dr James Brooks of Glasgow, Scotland, has once again reviewed the chapters on the fossil fuels plus the work on geothermal energy. His careful scrutiny and helpful suggestions are much appreciated. Ms Ann Mandi of Brown University, USA, also reviewed the manuscript and made many helpful suggestions.

Much of the artwork is due to the staff of the Instructional Media Services Unit at the Alden Library of Ohio University. Special mention must be made of Kelly Kirves, graphic artist, and Emily Marcus, media artist. Particular thanks are due to Lara Neel, graduate assistant, who transferred the manuscript, including artwork, onto computer discs. All of this work was supervised by Peggy Sattler, the production manager of the unit. The book cover is only a small part of Peggy's significant contributions to the overall presentation.

The typing of the revised manuscript, with its many revisions, was largely done by Suzanne Vazzano, helped by Erin Dill, Tammy Jordan, Juan Echeverry and Brad Lafferty. Their professionalism and good nature were indispensable to its conclusion.

Athens, Ohio, USA

2002

CONTENTS

<i>Preface</i>	v
<i>Preface to the Second Edition</i>	vii
<i>Acknowledgements</i>	ix
<i>Acknowledgements for the Second Edition</i>	xi
 CHAPTER 1 ENERGY AND POWER	 1
1.1. Energy Conversion	1
1.2. Mechanical Energy	3
1.2.1. Linear motion	3
1.2.2. Rotational motion	6
1.3. Electrical Energy	9
1.4. Chemical Energy	9
1.5. Nuclear Energy	9
1.6. Thermal Energy	9
1.7. Thermodynamics and Heat Energy	10
1.7.1. Quantity of heat	10
1.7.2. Mechanical equivalent of heat	10
1.7.3. The first law of thermodynamics	11
1.7.4. The second law of thermodynamics	13
1.7.4.1. Ideal heat engine	13
1.7.4.2. Practical heat engine	14
1.7.4.3. Ideal reverse heat engine	15
1.7.5. Worked examples on thermodynamics and heat energy	16
1.8. Entropy	19
1.8.1. Entropy in heat-work systems	19
1.8.2. Entropy on a cosmic scale	20
1.9. Power	21
1.10. Units and Conversion Factors	23

1.11.	Problems on Energy and Power	24
	References	28
CHAPTER 2 ENERGY RESOURCES AND ENERGY USE		29
2.1.	Energy Input to the Earth	29
2.1.1.	Solar radiation rate and annual variation	29
2.1.2.	Terrestrial energy from inside the earth	31
2.1.3.	Tidal (gravitational) input energy	31
2.2.	Energy Flow upon the Earth from Natural Sources	31
2.3.	Energy Outflow from the Earth	32
2.4.	Energy Stored Within the Fossil Fuels	32
2.5.	Energy Production and Consumption	37
2.5.1.	Energy consumption in the world	37
2.5.2.	Energy production and use in the UK	46
2.5.3.	Energy production and use in the USA	50
2.5.4.	World fossil fuel production and consumption	53
2.6.	Risks Associated with Energy Systems	54
2.6.1.	Industrial accidents and industrial diseases	55
2.6.2.	Large-scale accidents and sabotage	55
2.6.3.	Management of energy waste	55
2.6.4.	Ecosystem effects	56
2.6.5.	Water supply problems	56
2.6.6.	Emissions	56
2.6.6.1.	Carbon dioxide emissions	58
2.6.6.2.	Gaseous emissions and the “greenhouse” effect	59
2.7.	Summary — Where Do We Go from Here?	62
2.7.1.	An energy strategy	62
2.8.	Problems and Review Questions	63
	References	65
CHAPTER 3 ELECTRICITY		67
3.1.	Introduction	67
3.2.	Some Basic Electrical Relationships	67
3.2.1.	Voltage, current and power	67
3.2.2.	Worked examples on electrical circuits	71
3.3.	The Generation of Electricity	72
3.4.	The Siting of Electrical Power Plants	73
3.4.1.	Fuel supply	74
3.4.2.	Water supply	74
3.4.3.	Land elevation	74
3.4.4.	Road and rail access	74
3.4.5.	Height of the structures	75
3.4.6.	Disposal of waste products	76

3.4.7.	Proximity to populated areas	76
3.4.8.	Environmental implications	76
3.5.	World Electricity Consumption	76
3.6.	UK Electricity	79
3.6.1.	Consumption and supply	79
3.6.2.	Organisation of the UK electricity supply industry in 2001	81
3.7.	US Electricity Consumption and Production	83
3.8.	Combined Heat and Power (CHP)	85
3.8.1.	CHP in the UK	86
3.8.2.	CHP in the USA [15]	87
3.9.	Efficient Utilisation of Electrical Energy	88
3.9.1.	Avoiding waste	88
3.9.2.	Monitoring and control	89
3.9.3.	Redesigning to reduce energy costs	89
3.9.4.	Maintenance of equipment	89
3.9.5.	Power factor correction	89
3.9.6.	Maintenance of supply current waveform	89
3.9.7.	Choice and use of electric motors	90
3.9.8.	Load factor	90
3.9.9.	Choice of lighting systems	90
3.10.	Problems and Review Questions	92
	References	94

CHAPTER 4 COAL 97

4.1.	Introduction	97
4.1.1.	Composition and ranking of coal	97
4.1.2.	Coal mining	98
4.2.	World Reserves, Production, and Consumption of Coal	100
4.2.1.	World coal reserves	100
4.2.2.	World coal production	103
4.2.3.	World coal consumption	105
4.2.4.	UK coal production and consumption	107
4.2.5.	US coal production and consumption	110
4.3.	Coal Transportation	112
4.3.1.	Surface transportation	112
4.3.2.	Coal slurry pipelines	112
4.4.	Emissions and Effluents from Coal	113
4.4.1.	Open coal fires	113
4.4.2.	Effluents due to coal burning	114
4.4.2.1.	Sulphur oxides	114
4.4.2.2.	Nitrogen oxides	114

4.4.2.3.	Particulates	115
4.4.2.4.	Carbon dioxide	116
4.4.2.5.	Carbon dioxide emissions due to coal	116
4.5.	Advanced Coal Technologies	116
4.5.1.	Fluidised-bed combustion	117
4.5.2.	Combined-cycle generation	118
4.6.	Liquid Fuels from Coal	119
4.6.1.	Indirect liquefaction	120
4.6.2.	Pyrolysis	120
4.6.3.	Solvent extraction	120
4.6.4.	Direct hydrogenation (catalytic liquefaction)	121
4.7.	Problems and Review Questions	121
	References	122

CHAPTER 5 PETROLEUM 125

5.1.	Introduction	125
5.2.	History and Development of the Petroleum Industry	126
5.2.1.	The Seven Sisters [6]	127
5.2.2.	European oilfields	127
5.2.3.	OPEC	128
5.3.	World Oil Reserves	131
5.4.	World Production and Consumption of Crude Oil	136
5.4.1.	World oil production	136
5.4.2.	World oil consumption	137
5.4.3.	UK oil production and consumption [10–12]	142
5.4.4.	US oil production and consumption	146
5.5.	Synthetic Crude Oil	151
5.5.1.	Shale oil	151
5.5.2.	Tar sands	153
5.6.	Environmental Issues	154
5.7.	Problems and Review Questions	156
	References	158

CHAPTER 6 NATURAL GAS 161

6.1.	Introduction	161
6.2.	History and Development	162
6.3.	Natural Gas Reserves	162
6.4.	Production and Consumption of Natural Gas	167
6.4.1.	World natural gas production	167
6.4.2.	World natural gas consumption	167
6.4.3.	UK natural gas production and consumption	173
6.4.4.	US natural gas production and consumption	178
6.5.	Coal-Bed Methane	180

6.5.1.	World reserves of coal-bed methane	180
6.5.2.	US reserves of coal-bed methane	181
6.6.	Natural Gas Hydrates	183
6.7.	Environmental Aspects of Natural Gas	184
6.8.	Synthetic Gas from Coal	184
6.9.	Problems and Review Questions	186
	References	187

CHAPTER 7 GEOTHERMAL ENERGY 189

7.1.	Introduction	189
7.2.	Geological Structure of the Earth	189
7.3.	Origin of Geothermal Heat Flow	192
7.4.	Geothermal Energy Resources	193
7.5.	Geothermal Reservoirs	193
7.6.	Locations and Types of Principal Geothermal Sources	197
7.6.1.	Dry steam sources	197
7.6.2.	Wet steam sources	197
7.6.3.	Hot brine sources	197
7.6.4.	Dry rock sources	198
7.6.5.	Molten magma	198
7.7.	Worldwide Applications of Uses of Geothermal Energy	199
7.8.	Geothermal Prospects in the UK	199
7.8.1.	Shallow drilling	199
7.8.2.	Worked example	201
7.9.	Geothermal Uses in the USA and Elsewhere	201
7.9.1.	Hot springs and bathing spas (balneology)	202
7.9.2.	Agriculture	202
7.9.3.	Aquaculture	202
7.9.4.	Industry	202
7.10.	Geothermal District Heating	203
7.11.	Geothermal Heat Pumps	203
7.12.	Electricity Generation from Geothermal Sources	204
7.12.1.	Worldwide geothermal electrical power production	204
7.12.2.	Technologies of geothermal electrical power generation	206
7.12.3.	Locations of geothermal electricity-generating stations	206
7.13.	Environmental Features of Geothermal Power	207
7.13.1.	Geothermal site exploration and development	207
7.13.2.	Protection of the local atmosphere	208
7.13.3.	Protection of ground water	208
7.13.4.	Enhancement of reservoir water	208
7.13.5.	Ecological effects of geothermal plants	208
7.13.6.	Effects on local geological structure	209

7.14.	Problems and Review Questions	209
References		210

CHAPTER 8 NUCLEAR ENERGY 213

8.1.	Basic Atomic Theory	213
8.2.	Basic Nuclear Theory	214
8.2.1.	Nuclear fission	214
8.2.2.	Worked examples	216
8.3.	Radioactivity	217
8.3.1.	Nature of radioactivity	217
8.3.2.	Energy and decay rate	217
8.3.3.	Worked examples	218
8.4.	Nuclear Radiation	220
8.4.1.	Forms of radiation	220
8.4.2.	Units of measurement of radiation	221
8.4.3.	Effects of nuclear radiation	222
8.4.4.	Sources and amounts of nuclear radiation	223
8.4.4.1.	Natural radiation sources	223
8.4.4.2.	Man-made sources	223
8.4.5.	Uses of nuclear radiation	224
8.4.5.1.	Geological dating	224
8.4.5.2.	Archaeological dating	224
8.4.5.3.	Medical tracer elements	224
8.4.5.4.	Small nuclear power packs	225
8.4.5.5.	Biological effects on human tissue	225
8.5.	Nuclear Reactors	226
8.5.1.	Thermal (fission) reactors	226
8.5.2.	Uranium supplies	229
8.5.3.	Plutonium	231
8.5.4.	Fast breeder reactors	234
8.5.5.	Reactor safety	235
8.5.6.	Nuclear reactor accidents	236
8.5.6.1.	Three Mile Island	237
8.5.6.2.	Chernobyl	237
8.6.	Nuclear Waste	239
8.6.1.	Sources of waste	239
8.6.2.	Waste disposal	241
8.6.3.	Terrorist action	242
8.7.	Nuclear-Powered Electricity Generation	242
8.7.1.	Nuclear generation in the USA	243
8.7.2.	Nuclear generation in the UK	244
8.8.	Nuclear Fusion	244

8.8.1.	Basic theory	244
8.8.2.	Nuclear fusion reactors	248
8.8.2.1.	Nuclear plasma properties	248
8.8.2.2.	Heating of the plasma	249
8.8.2.3.	Plasma confinement	250
8.8.2.4.	Fusion reactor research	250
8.9.	Problems and Review Questions	253
	References	254

CHAPTER 9 WATER ENERGY 257

9.1.	Hydroelectric Power Generation	257
9.1.1.	Principles of hydroelectric plant operation	261
9.1.2.	Types of hydraulic turbine	263
9.1.2.1.	Impulse turbines	263
9.1.2.2.	Reaction turbines	265
9.1.2.3.	Axial flow turbines	265
9.1.3.	Pumped storage systems	265
9.1.4.	Worked examples on hydroelectric power generation	268
9.2.	Tidal Power Schemes	269
9.2.1.	Tidal power sites	270
9.2.2.	Principles of tidal power operation	272
9.2.3.	Costs of tidal barrage schemes	274
9.2.4.	Combination of a pumped storage facility with a tidal barrage scheme	275
9.2.5.	Features of tidal barrage schemes	276
9.2.6.	Worked examples on tidal energy schemes	278
9.3.	Wave Power	279
9.3.1.	Basic properties of ideal deep-water waves [5]	281
9.3.2.	Power extractable from practical deep-water waves	283
9.3.3.	Worked examples on wave energy	285
9.3.4.	Types of wave power converters	286
9.3.5.	Worked examples on wave energy devices	290
9.3.6.	Features of wave power systems — summary	292
9.4.	Ocean Currents and Underwater Turbines [15, 16]	293
9.5.	Problems and Review Questions	294
	References	296

CHAPTER 10 WIND ENERGY 299

10.1.	Background and History	299
10.2.	Availability of Wind Supply	300
10.2.1.	Wind energy supply in Europe	300
10.2.2.	Wind energy supply in the USA	306
10.3.	Theoretical Power Available in the Wind	306

10.4.	Theoretical Maximum Power Extractable from the Wind	309
10.5.	Practical Power Extractable from the Wind	311
10.5.1.	Power coefficient	311
10.5.2.	Axial thrust (pressure)	312
10.5.3.	Tip-speed ratio (TSR)	314
10.5.4.	Solidity factor	315
10.5.5.	Shaft torque and power	316
10.6.	Efficiency of Wind-Powered Electricity Generation	318
10.7.	Large Wind Machine Systems	319
10.7.1.	Historical background	319
10.7.2.	Facing the wind — the yaw effect	320
10.7.3.	Centrifugal forces	321
10.7.4.	Gyroscopic forces and vibrations	321
10.7.5.	Modern large wind power installations	322
10.7.6.	Worked examples on wind turbine operation	327
10.8.	Vertical Axis Wind Machines	332
10.8.1.	The Savonius design	332
10.8.2.	The Darrieus design	334
10.8.3.	Other forms of vertical axis machine	334
10.9.	Small and Medium Size Machines	335
10.10.	Electrical Engineering Aspects of Wind-Generated Electrical Power	336
10.10.1.	Electricity generator systems	336
10.10.2.	Small electrical generators	337
10.11.	Wind Machine Site Selection	339
10.12.	Pros and Cons of Wind-Generated Electrical Power	340
10.13.	Problems and Review Questions	341
	References	345

CHAPTER 11 SOLAR HEATING OF WATER OR AIR 347

11.1.	Radiation from the Sun	347
11.2.	Seasonal Variation of Solar Radiation	352
11.3.	Classification of the Collection of Solar Energy	357
11.4.	Solar Water Heating (Domestic)	358
11.4.1.	The “greenhouse” effect	358
11.4.2.	Solar flat-plate collectors	360
11.4.3.	A typical domestic solar water heating system	368
11.4.4.	Worked examples involving solar flat-plate collectors	370
11.5.	Solar Water Heating (Industrial)	373
11.5.1.	Solar tracking systems	374