Contents

Preface	X
PART 1 INTRODUCTION TO RISKS	
1 Introduction	3
Risks of the past	3
Early energy sources	5
The conquest of epidemic disease	6
Wind, water and steam power	7
2 The Risks of Modern Life in Britain	8
Unequal attitudes to death or injury	9
The causes of death in modern Britain	9
Why young people are concerned with very small new risks	12
Numerical prediction of risk	14
Prediction of the risks of multiple deaths	16
Acceptable risks	18
Strong drink	20
Public perception of risks	21
3 Risks of Cancer and Mutation—the Background	27
Cancers in Britain	28
How honest statistics can be made to tell damned lies	30
Chemical causes of cancer	32
Collective dose of carcinogens	33
Identification of carcinogens	34
4 Radiation and Cancer	37
Atoms and radioactivity	38
Half-life	39
Measurement of radiation dose	40
International Commission on Radiological Protection	41

The information available on cancer production	42
BEIR Committee estimates	46
Later evidence from Hiroshima	50
Risk of mutation by radiation	51
Low dose rates and continuous exposures	52
Natural radiation background	54
The Argonne study	56
Animal experiments on cancer production	57
Extension of life by radiation	58
Summary	
PART 2 POWER PRODUCTION, CONSERVATION AND NEEDS	
5 Energy Supplies—'Renewable' Resources	67
Definitions	67
Variety of Energy Sources	68
Direct use of solar energy	69
Photoelectricity	70
Hydroelectricity	75
Tidal energy	76
Current biological sources of energy	77
Wind energy	79
Wave energy	84
Geothermal power	86
Summary	87
6 Energy Supplies—Coal, Oil, Gas and Nuclear	88
Coal	88
Production of electricity	88
Petroleum	90
Natural gas	92
Nuclear power	92 95
Thermal reactors Fast neutron reactors	102
	102
Fusion	103
How do we choose? Future needs	104
Future needs	104
7 Conservation of Energy	107
Efficiency of use of primary energy	107
Heat pumps	108
District heating	109
Desalination and fish farms	110
Industrial heat and power and combined heat and power	r 110

	Contents	vii
	Conservation of biowastes	111
	Power in reserve in Dinorwig	113
	Conservation in the home	115
	Summary	118
PA	ART 3 QUANTITATIVE DISCUSSION OF RISK	
8	Accidental Risks to the Public due to Energy Production	121
	The relative importance of different accidents	121
	The threshold of concern	122
	The risk of an accident that has never happened	123
	Dam failures in hydroelectric systems	124
	Accidents involving natural and petroleum gas	126
	Oil accidents	131
	Chlorine	132
	Coal accidents	133
	Accidents involving renewable energy	133
	Nuclear accidents	134
	Summary	153
9	The Numbers Killed in Routine Power Production	156
	Introduction	156
	The dangers associated with coal mining	156
	Effects of coal use on the public	159
	Present death rates from air pollution	161
	Cancers produced by fossil fuels	163
	Dangers associated with routine use of oil and gas	164
	Carcinogenic effects of air pollution in Britain	165
	Routine risks of nuclear power	168
	Nuclear power—risks to the public	170 172
	Routine risks of wind, wave and direct solar power	172
	The radiation danger due to heat conservation	173
	Summary of figures	177
	The saving of life by power production Summary	178
	Summary	
10	Wastes from the Nuclear Power Industry	182
	Wastes coming directly from power reactors	182
	Transport and treatment of spent fuel	183
	Liquid wastes from Sellafield	186
	Storage of wastes	188
	Low-level liquid effluent	189
	Wind-blown plutonium from the silt	191
	Concentration in living organisms	192

viii Contents

	Collective dose from Sellafield effluent	192
	Accidents	195
	Waste disposal procedures	198
	The natural reactor at Oklo	211
	The risk from natural uranium and its decay products	212
	Decommissioning	214
	Summary	215
11	Wastes from other Power Sources	216
	Wastes from coal	216
	Wastes from oil and gas	225
	Decommissioning of coal, oil and gas	225
	Wastes from renewable alternatives	226
	Summary	227
PA	ART 4 ENVIRONMENTAL EFFECTS, THE OPPOSITION	
	TO NUCLEAR POWER, CONCLUSION	
12	Terrorism and Proliferation	231
	Terrorists and nuclear power	232
	Terrorists and fossil fuels	236
	Proliferation	237
13	The Environmental Effects of Power Production	242
	Environmental effects of burning oil and coal	243
	Environmental effects of nuclear power	252
	Environmental effects of renewable alternatives	253
	Hydroelectric power and the environment	253
	Biomass and the environment	254
	Direct solar power and the environment	255
14	The Opposition to Large-scale Power Production	257
	The simple life?	257
	Small-scale power units	258
	The fear of nuclear power	259
	Union of Concerned Scientists	261
	Fears of low doses of radiation	262
	The exaggeration of risks of accidents	267
	Why pick on nuclear power?	271
	The danger of exaggeration	274
	Summary	276

Contents	
Contents	•

15 Finale	277
What of the future?	278
How to avoid irradiation in the future	278
How to hurt or help our descendants	279
Summary and conclusions	281
Appendix 1 A mechanism of cancer initiation	283
Appendix 2 Some properties of radioactive nuclides	289
Appendix 3 The nuclear physics of reactors	295
Glossary	299
References	303
Index	308