Contents

	Pre	face	V
1	Nuc	lear Power and the Energy Crisis	1
	1.1	Energy Consumption Versus Energy Needs Versus	
		Energy Resources	2
	1.2	Scientific Feasibility Versus Social Viability	9
	1.3	Decision Criteria for Acceptable Energy Sources	10
	1.4	Near-Term Alternatives	18
	1.5	Long-Range Alternatives	21
	1.6	Concluding Remarks	24
		Notes	27
2	The	Development of Nuclear Power	29
	2.1	A Brief History of the Development of Nuclear Power	30
	2.2	Growth in the Opposition to Nuclear Power	46
	2.3	The Nuclear Power Debate	51
		Notes	55
3	Bas	ic Concepts of Nuclear Energy Release	57
	3.1	Atoms and Nuclei	57
	3.2	Radioactivity	65
	3.3	Nuclear Reactions	73
	3.4	Nuclear Fission and Fission Chain Reactions	82
	3.5	Nuclear Fusion and Controlled Thermonuclear	
		Fusion Reactions	94
		Notes	101

viii Contents

4	Nuclear Fission Reactors	103
	4.1 Fission Chain Reactions and Nuclear Criticality	105
	4.2 Nuclear Reactor Types	111
	4.3 Nuclear Reactor Components	114
	4.4 Nuclear Reactor Operation and Control	120
	4.5 Radiation Produced in Nuclear Fission Reactors	125
	Notes	127
5	Radiation and Radioactivity	129
	5.1 Interaction of Radiation with Materials	130
	5.2 Radiation Dose and Exposure Units	133
	5.3 Our Radiation Environment	137
	5.4 Biological Effects of Radiation	140
	5.5 Radiation Standards	145
	Notes	148
6	Nuclear Power Generation	151
	6.1 Electrical Power Generation	151
	6.2 Nuclear Steam Supply Systems	171
	6.3 Nuclear Power Plants	198
	6.4 Nuclear Power Plant Safety	214
	6.5 Environmental Impact of Nuclear Power Plants	226
	Notes	233
7	The Nuclear Fuel Cycle	237
	7.1 An Overview of the Nuclear Fuel Cycle	237
	7.2 Head-end Fuel Operations	247
	7.3 In-Core Fuel Operations	262
	7.4 Tail-end Fuel Operations	265
	7.5 Nuclear Power, Sabotage, and the Bomb	278
	7.6 Plutonium Toxicity	283
	7.7 International Aspects of Nuclear Power	285
	7.8 Some Final Remarks	294
	Notes	295
8	Controlled Thermonuclear Fusion	299
	8.1 Magnetic Confinement Approaches	302
	8.2 Inertial Confinement Fusion (Laser Fusion)	3 15
	8.3 Concluding Remarks	334
	Notes	337

Contents	
Contents	1X

9	Energy Alternatives		339
	9.1	Conservation	341
	9.2	Petroleum-Based Energy Resources	347
	9.3	Coal-Based Energy Resources	350
	9.4	Geothermal Energy	358
	9.5	Solar Electric Power	361
	9.6	The Future of Nuclear Power	369
		Notes	371
В	ibliog	graphy	375
In	dex		379