

Table of Contents

1	AR	eview c	on Renewable Energy	1
	1.1	Introd	uction	1
	1.2	Why R	enewables?	2
	1.3	Fossil	Fuels	2
		1.3.1	Why Fossil Fuels are considered as	
			Non-renewable Sources of Energy?	3
		1.3.2	Fossil Fuel: A boon or a curse	3
		1.3.3	Consequences of Fossil Fuel Combustion	4
		1.3.4	Renewable Energy Sources	5
		1.3.5	Hydropower	5
		1.3.6	Geothermal Energy	6
		1.3.7	Wind Energy	7
		1.3.8	Marine Energy	8
		1.3.9	Bioenergy	8

			Solar Energy	9
	1.4		Fuel and Nuclear Energy	11
		1.4.1		11
		-	Natural Gas	14
			Petroleum	18
			Nuclear Energy	20
	1.5		•	21
	1.6	Refere	nces	21
2	Intro	ductio	n to Thermal Science	22
	2.1	Introdu	uction	22
	2.2	Therma	al Science	23
	2.3	Therm	odynamics	24
		2.3.1	Heat and other forms of Energy	25
		2.3.2		27
			Energy Transfer	30
			The first law of Thermodynamics	31
			Energy Transfer for a Closed System	33
		-	Energy Transfer for Steady-flow System	33
			Saturation Temperature and Saturation Pressure	33
	2.4	Heat T		35
		-	Conduction	36
			Thermal Conductivity	36
			Convection	37
			Radiation	38
	2.5		Nechanics	39
		-	Viscosity	40
		2.5.2		42
	2.6		ochemistry	43
		2.6.1	Fuels and Combustion	44
			Theoretical and Actual Combustion Process	44
		2.6.3	Enthalpy of Combustion	45
		2.6.4	First-law Analysis of Reacting Systems	45
	2.7		ngines and Power Plants	46
		2.7.1	Thermal Efficiency	46
		2.7.2	Overall Plant Efficiency	47
	2.8	0	erators and Heat Pumps	47
	2.9	Conclu	sion	48

viii

Tak	ole of C	ntents i	
	2.10	References	48
3	Impl	ications of Solar Energy	49
	3.1 3.2 3.3	Introduction Conservation of Solar Energy 3.2.1 Flat Plate Solar Collector 3.2.2 Concentrating Solar Collector 3.2.3 Solar Power Tower 3.2.4 Solar One 3.2.5 Solar One 3.2.6 Solar Two 3.2.6 Solar Pond 3.2.7 Passive Solar Building Design 3.2.8 Passive Energy Gain References	49 50 51 55 56 61 64 65 70
4		d Energy	70
	 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 	Introduction 4.1.1 Wind Energy: The Technology 4.1.2 Efficiency and Application 4.1.3 Wind Electricity 4.1.4 Wind Pumps 4.1.5 An overview of Wind Energy Development of Wind Energy 4.2.1 Potentials 4.2.2 Challenges Types of Wind Turbines 4.3.1 Horizontal Axis 4.3.2 Vertical Axis 4.3.3 Ducted Wind Turbines Power Performance Curve Potential of Wind Power Issues with Wind Energy Wind Power Density Wind Turbine Efficiency References	71 73 74 75 75 76 77 77 78 79 80 81 83 84 83 84 83 84 86 88 89 90 90
5		ropower	93
-	5.1	Introduction	93

Х		Renewable E	nergy
	5.2	Working of Hydropower?	95
	5.3	The Economy of Running	
		a Hydroelectric Power plant	96
	5.4	Impulse Turbines	97
		5.4.1 Impulse Turbines and its Types	97
		5.4.2 Impulse Turbines and their Various Components	s 98
		5.4.3 Working Mechanisms of an Impulse Turbine	99
	5.5		99
	5.6	Run-of-River plants	101
		5.6.1 Advantages of run-of-river Projects	102
		5.6.2 Disadvantages of the run-of-river	103
		5.6.3 Major concerns of the run-of-river	104
	5.7		104
		5.7.1 Types of Water Wheel	105
		5.7.2 Various types of Water Wheel5.7.3 Various Water Developments	109 110
	5.8	•	112
	5.0 5.9		112
6	Geo	thermal Energy	113
	6.1	Introduction	113
	6.2	Advantages of Geothermal Energy	114
	6.3	Application of Geothermal Energies	114
	6.4	Heating Via Geothermal Process	121
		6.4.1 Annual Energy Consumption using	
		degree-day Method	121
	6.5	-	128
		6.5.1 Absorption Cooling System	129
	6.6	Geothermal Heat Pump System	132
		6.6.1 Heat Pump System	132
		6.6.2 Heat Pump Systems that use Groundwater	
	67	Source Power Production Via Geothermal Methods	133
	6.7 6.8	Geothermal Cogeneration	134
	6.9	Reference	137 138
	0.9	hererence	
7	Oce	an Energy	139
	7.1	Introduction	139

		7.1.1	Potential	140	
		7.1.2	Technology	141	
		7.1.3	Purposes of Technology	143	
	7.2	Tidal E	nergy	144	
		7.2.1	Various Advantages and Disadvantages		
			of Tidal Energy	145	
		7.2.2	Technologies used in Conservation	146	
	7.3	Wave E		146	
	7.4		Thermal Energy Conversion	148	
	7.5 Marine Energy			151	
	7.6 Various forms of Ocean Energy			152 154	
		7.7 Development in the Fields of Marine Energy			
	7.8 Environmental Effects			154	
	7.9 Economical Impacts7.10 Ocean Energy and its Benefits7.11 Blockades of Ocean Energy		•	155	
				155	
				156	
	-	Conclu		156	
	7.13	Refere	nces	158	
8	Hyd	rogen a	and Fuel Cells	159	
	8.1	Introdu	uction	159	
		8.1.1	Energy Sources	160	
		8.1.2	Uses of Hydrogen	162	
	8.2	Hydrog	gen- An Energy Carrier	162	
		8.2.1	Hydrogen and its Utilization	167	
		8.2.2	Relationship of Hydrogen and Automobiles	168	
	8.3	Produc	tion of Hydrogen	169	
		8.3.1	Hydrogen Production from Hydrocarbons	171	
		8.3.2		171	
		8.3.3	Using Integrated Processes in		
			Hydrogen Production	175	
		8.3.4	Final thoughts on Hydrogen Production		
			Processes	175	
	8.4	-	e of Hydrogen and its Distribution	176	
	8.5	Fuel Ce		177	
		8.5.1	<u>, , , , , , , , , , , , , , , , , , , </u>	180	
		8.5.2	Fuel cell and its Thermodynamics	182	
	8.6	Refere	nces	185	

xii		Renewable	e Energy
9	Rene	ewable Energy and Their Economics	186
	9.1	Introduction	186
	9.2	Renewable Energy Sources	188
	9.3	Economics of Engineering	190
	9.4		193
		9.4.1 Inflation and Taxation on interest rates	
		and their Effects	194
	9.5	Analysis of Life Cycle Costs	195
		9.5.1 Analysis of Cost Benefits	197
		9.5.2 Product Cost per Unit9.5.3 Comparison of Projects Based on Life Cycle	200
		Analysis	200
	9.6	Analysis of Payback Period	200
	-	Conclusion	207
		References	207
10	10 Environment and Energy		208
	10.1	Introduction	208
	10.2	Air Pollutants	210
		10.2.1 Particulate Matter	213
		10.2.2 Sulfur Dioxide	214
		10.2.3 Nitrogen Oxides	216
		10.2.4 Acid Rain, Ozone and Smog	217
	10.3	Automobiles and Their Emissions	219
	10 /	10.3.1 Catalytic Converters The Greenhouse Effect	221 222
	10.4	10.4.1 Production of Carbon Dioxide	222
	10.5	References	224
Index			227