

# Contents

<b>1</b>	<b>Introduction.....</b>	<b>1</b>
1.1	Introduction to Energy Sources .....	1
1.2	Short Supply of Fossil Fuels.....	4
1.2.1	Petroleum in the World.....	4
1.2.2	Natural Gas as the Fastest Growing Primary Energy Source in the World .....	10
1.2.3	Coal as a Fuel and Chemical Feedstock.....	15
1.3	Introduction to Renewable and Biorenewable Sources .....	18
1.3.1	Non-combustible Renewable Energy Sources .....	20
1.3.2	Biorenewable Energy Sources .....	31
	References.....	43
<b>2</b>	<b>Biomass Feedstocks.....</b>	<b>45</b>
2.1	Introduction to Biomass Feedstocks .....	45
2.1.1	Definitions.....	46
2.1.2	Biomass Feedstocks .....	54
2.2	Biomass Characterization .....	58
2.2.1	Characterization of Biomass Feedstock and Products .....	59
2.2.2	Biomass Process Design and Development .....	60
2.3	Biomass Fuel Analyses.....	61
2.3.1	Particle Size and Specific Gravity.....	62
2.3.2	Ash Content .....	62
2.3.3	Moisture Content .....	62
2.3.4	Extractive Content.....	62
2.3.5	Element Content.....	63
2.3.6	Structural Constituent Content.....	63
2.3.7	The Energy Value of Biomass .....	63
2.4	Biomass Optimization and Valorization.....	65
2.4.1	Fuels from Biomass .....	67
2.4.2	Chemicals from Biomass .....	70

2.4.3	Char from Biomass .....	72
2.4.4	Adhesives from Biomass .....	74
2.4.5	Valorization of Wood.....	78
	References.....	81
<b>3</b>	<b>Biofuels .....</b>	<b>87</b>
3.1	Introduction to Biofuels.....	87
3.1.1	Economic Impact of Biofuels.....	90
3.1.2	Environmental Impact of Biofuels .....	94
	References.....	99
<b>4</b>	<b>Biorenewable Liquid Fuels .....</b>	<b>103</b>
4.1	Introduction to Biorenewable Liquid Fuels.....	103
4.1.1	Evaluation of Gasoline-Alcohol Mixtures as Motor Fuel Alternatives.....	104
4.1.2	Evaluation of Vegetable Oils and Diesel Fuel Mixtures as Motor Fuel Alternatives.....	105
4.2	Bioalcohols.....	105
4.2.1	Alternate Fuels to Gasoline.....	106
4.3	Bioethanol .....	108
4.3.1	Synthetic Ethanol Production Processes .....	108
4.3.2	Production of Ethanol from Biomass .....	109
4.3.3	Sugars from Biomass by Hydrolysis.....	111
4.3.4	Bioethanol Production by Fermentation of Carbohydrates.....	115
4.3.5	Bioethanol Feedstocks .....	119
4.3.6	Fuel Properties of Ethanol.....	120
4.4	Biomethanol .....	122
4.5	Vegetable Oils .....	126
4.5.1	Alternatives to Diesel Fuel.....	131
4.5.2	Vegetable Oil Resources .....	133
4.5.3	The Use of Vegetable Oils as Diesel Fuel.....	137
4.5.4	New Biorenewable Fuels from Vegetable Oils.....	143
4.5.5	Properties of Triglycerides.....	153
4.5.6	Triglyceride Economy.....	156
4.6	Biodiesel.....	156
4.6.1	The History of Biodiesel .....	158
4.6.2	Definitions of Biodiesel .....	160
4.6.3	Biodiesel from Triglycerides via Transesterification.....	162
4.6.4	Recovery of Glycerol .....	171
4.6.5	Reaction Mechanism of Transesterification.....	173
4.6.6	Current Biodiesel Production Technologies .....	176
4.6.7	Biodiesel Production Processes.....	180
4.6.8	Basic Plant Equipment Used in Biodiesel Production .....	185
4.6.9	Fuel Properties of Biodiesels .....	186

4.6.10	Advantages of Biodiesels.....	193
4.6.11	Disadvantages of Biodiesel as Motor Fuel.....	198
4.6.12	Engine Performance Tests.....	199
4.7	Bio-oils from Biorenewables.....	211
4.8	Other Alternate Liquid Fuels.....	217
4.8.1	Glycerol-Based Fuel Oxygenates for Biodiesel and Diesel Fuel Blends .....	217
4.8.2	P-series Fuels .....	220
4.8.3	Dimethyl Ether (DME) .....	221
4.8.4	Fischer–Tropsch (FT) Liquid Fuel from Biomass .....	221
4.8.5	Other Bio-oxygenated Liquid Fuels.....	222
	References.....	223
<b>5</b>	<b>Biorenewable Gaseous Fuels.....</b>	<b>231</b>
5.1	Introduction to Biorenewable Gaseous Fuels .....	231
5.2	Biogas.....	232
5.2.1	Aerobic Conversion Processes.....	233
5.2.2	Anaerobic Conversion Processes .....	233
5.2.3	Biogas Processing .....	236
5.2.4	Reactor Technology for Anaerobic Digestion.....	242
5.3	Landfill Gas.....	245
5.4	Crude Gases from Pyrolysis and Gasification of Biomass .....	248
5.5	Biohydrogen from Biorenewable Feedstocks.....	249
5.5.1	Hydrogen from Biorenewable Feedstocks via Thermochemical Conversion Processes.....	250
5.5.2	Biohydrogen from Biorenewable Feedstocks .....	254
5.6	Gaseous Fuels from Fischer–Tropsch Synthesis of Biomass .....	255
	References.....	257
<b>6</b>	<b>Thermochemical Conversion Processes .....</b>	<b>261</b>
6.1	Introduction to Thermochemical Conversion Processes.....	261
6.2	Thermal Decomposition Mechanisms of Biorenewables .....	264
6.3	Hydrothermal Liquefaction of Biorenewable Feedstocks .....	266
6.3.1	The Role of Water During the HTL Process.....	270
6.3.2	HTU Applications.....	270
6.4	Direct Combustion of Biomass.....	271
6.4.1	Combustion Efficiency .....	273
6.5	Direct Liquefaction.....	275
6.6	Pyrolysis Processes.....	277
6.6.1	Reaction Mechanism of Pyrolysis.....	281
6.7	Gasification Research and Development.....	283
6.7.1	Biomass Gasification .....	285
6.7.2	Biomass Gasification Systems .....	287
6.7.3	Electricity from Cogenerative Biomass Firing Power Plants.....	293

6.7.4	Fischer–Tropsch Synthesis (FTS) .....	296
6.7.5	Supercritical Steam Gasification .....	299
	References.....	302
<b>7</b>	<b>Biofuel Economy</b> .....	<b>305</b>
7.1	Introduction to Biofuel Economy .....	305
7.2	Biofuel Economy.....	307
7.2.1	Estimation of Biofuel Prices .....	309
7.2.2	Biodiesel Economy .....	309
7.2.3	Bioethanol Economy.....	313
7.2.4	Biorenewable Energy Costs and Biohydrogen Economy.....	315
	References.....	316
<b>8</b>	<b>Biofuel Policy</b> .....	<b>319</b>
8.1	Introduction to Biofuel Policy .....	319
8.2	Biofuel Policy.....	320
8.2.1	Biodiesel Policy .....	321
8.3	Global Biofuel Projections .....	325
	References.....	328
	<b>Index</b> .....	<b>331</b>

Biofuels

Securing the Planet's Future Energy Needs

Demirbas, A.

2009, X, 336 p., Hardcover

ISBN: 978-1-84882-010-4