

Contents

Acknowledgments *xv*

Abbreviations *xix*

1	The Commodity Case – Introduction	1
1.1	Commodity Cycles – Past and Present	1
1.2	The Most Precious Commodity: Energy	3
1.3	Cheap and Expensive	5
1.4	Federal Reserve	7
1.5	Transformation to a Low-Carbon Society	8
1.6	Commodity Costs	9
1.7	The “ <i>Per Capita</i> ” Factor	10
1.8	Demographics: India and China	12
1.9	Oil, and First- and Second-Generation Biofuels	13
1.10	Nuclear Energy	14
1.11	Eleven Megaforces	15
1.12	Resource Wars	17
1.13	Geopolitical Shift in Oil Production	18
1.14	Oil Companies, Production, and Transportation	18
2	First- and Second-Generation Biofuels	21
2.1	Second-Generation Requirements	21
2.2	Applications	22
2.3	First-Generation Feedstock: What Speaks against Biofuels of the First Generation?	22
2.4	Second-Generation Feedstock	24
2.5	Biomass	24
2.6	Bioethanol and Biodiesel Production	26
2.7	Biodiesel Refining	26
2.8	Benefits of Biodiesel	27

Second Generation Biofuels and Biomass: Essential Guide for Investors, Scientists and Decision Makers,
First Edition. Roland A. Jansen.

© 2013 Wiley-VCH Verlag GmbH & Co. KGaA.

Published 2013 by Wiley-VCH Verlag GmbH & Co. KGaA.

2.9	The Big Biofuel Inventors	28
2.9.1	Rudolf Diesel	28
2.9.2	Henry Ford	29
3	Biofuels Feedstock: <i>Jatropha curcas</i>	31
3.1	Characteristics	31
3.1.1	Plants in Marginal Growing Conditions	31
3.1.2	Nature Around the Equator	32
3.1.3	Plant Description	33
3.1.4	Where Does <i>Jatropha</i> Originate?	34
3.1.5	Properties	34
3.1.6	Toxicology	34
3.1.7	Whole Plant and Food/Fodder	35
3.1.8	Light in the Dark	35
3.1.9	Medicine	36
3.1.10	Pressing the Oil	36
3.1.11	Biokerosene	37
3.1.12	Breeding Objectives	37
3.1.13	Survival in Harsh Conditions	38
3.1.14	Breeding Method	38
3.1.15	Ecological Aspects	39
3.1.16	Agronomy	39
3.1.17	Harvesting and Man-Hours	40
3.1.18	Mechanical Harvesting	40
3.1.19	Managed and Contract Farming	40
3.1.20	Storage	41
3.1.21	Yield Comparisons and Research	41
3.1.22	Propagation Methods	42
3.1.23	Pricing	43
3.1.24	<i>Jatropha</i> Facts Related to Biodiesel	43
3.1.25	Pests and Diseases	44
3.1.26	Limitations of the Crop	44
3.1.27	Prospects	45
3.1.28	Research Needs	45
3.1.29	Cracking the Nut	45
3.2	<i>Jatropha</i> Products	46
3.2.1	Main Products	46
3.2.1.1	Glycerin	46
3.2.1.2	Medical Applications	46
3.2.1.3	Organic Fertilizer and Animal Feed	47
3.2.1.4	Insecticides and Pesticides	47
3.2.2	Byproducts	48
3.2.2.1	Active Carbon	48
3.2.2.2	Biochar	49

3.2.2.3	Woodpellets	49
3.2.2.4	Polyol	49
3.2.2.5	Paint	49
3.2.2.6	Electricity	49
3.2.2.7	Carbon Dioxide Collection	50
3.2.2.8	Smog Reduction in Chimneys	50
3.3	Advantages and Risks of <i>Jatropha</i>	51
3.3.1	Overview	51
3.3.2	Domestication	51
3.3.3	Potential Negative Effects	52
3.3.4	Variable Yields	53
3.3.5	Diesel Demand, Diesel Cars, and Demography	53
3.3.6	<i>Jatropha</i> Jet Fuel Demand	55
3.3.7	Significant Events	56
3.3.8	Yield Comparisons	56
3.3.9	Global <i>Jatropha</i> Demand	56
3.3.10	How Large is the Biokerosene Market?	57
3.3.11	Energy Security, US Military, and Fuel Costs	58
3.4	Negative Aspects and Risks	58
3.4.1	<i>Jatropha</i> in Ghana	58
3.4.2	Africa's "Land Grab"	59
3.4.3	More Examples of Land Grab Attempts [2]	60
3.5	Water Use	62
3.6	Invasiveness	63
3.7	Opinion of the UN FAO	64
3.8	Opinion of the World Bank	64
3.9	Code of Conduct	65
3.10	Summary of <i>Jatropha</i>	66
3.11	Where Does <i>Jatropha</i> Grow?	67
3.12	Genetic Improvement of <i>J. curcas</i>	68
	References	69
4	Other Biofuel Feedstocks	71
4.1	<i>Pongamia pinatta</i>	71
4.2	Algae	72
4.2.1	Introduction	72
4.2.2	Yield	75
4.2.3	Benefits of Algae	76
4.2.4	Navy Orders	76
4.3	Palm Oil	77
4.3.1	Roundtable on Sustainable Palm Oil	77
4.3.2	Controversy	77
4.3.3	The Other Oil Spill	78
4.3.4	Clean Start	79

4.3.5	Threat from Facebook	81
4.3.6	Rainforests and Palm Oil	81
4.3.7	Sustainable Palm Oil [12]	83
4.4	<i>Camelina</i>	83
4.4.1	The Basics	83
4.4.2	Rotation with Wheat	84
4.4.3	<i>Camelina</i> as a Biofuel	84
4.4.4	<i>Camelina</i> Agronomy	85
4.4.5	Crop Potential	86
4.4.6	Shock Wave!	87
4.5	<i>Crambe</i>	88
4.5.1	Basics	88
4.5.2	EMPRAPA	89
4.6	Cheers!	90
4.7	Pennycress	90
4.8	<i>Moringa</i>	91
4.8.1	Planting: Seeds and Cuttings	92
4.8.2	Medicinal Applications	92
4.8.3	Biogas	93
4.9	Castor	93
4.10	Halophytes	93
4.11	Sugarcane	94
4.12	<i>Miscanthus</i>	94
4.13	Grass to Ethanol: Napier Grass	94
5	Cropping Methods	97
5.1	Intercropping and Double Cropping	97
5.2	Reliance Life Sciences	99
5.3	Nestlé	99
6	Socially Responsible Investing	101
6.1	Principles	101
6.2	Practice: <i>Jatropha curcas</i>	101
6.3	Breaking the Cycle of Poverty	102
6.4	Food First	103
6.5	A Wider Context	104
6.6	Guatemala	104
6.7	Corporate Governance	105
6.7.1	Business	105
6.7.2	Bee Hives/Honey Harvesting	106
6.7.3	Company–Community Committees	106
6.7.4	Education	106
6.7.5	Employment Opportunities	107

- 6.7.6 Farmland Preservation 107
- 6.7.7 Fire Control and Prevention 107
- 6.7.8 Healthcare 108
- 6.7.9 Hiring Women 108
- 6.7.10 Outgrower Program 108
- 6.7.11 Safe Drinking Water and Sanitation 109
- 6.7.12 Soil Fertility 109

7 Sustainability 111

8 Biomass 113

- 8.1 What Is Biomass? 113
- 8.2 Five Basic Categories 114
- 8.3 Benefits of Biomass 114
- 8.4 Feedstock of Biomass 115
 - 8.4.1 Trees and Woodpellets 115
 - 8.4.2 Woodchips 115
 - 8.4.3 Palm Kernel Shells 116
 - 8.4.4 *Miscanthus* Pellets 116
 - 8.4.5 Agripellets 117
- 8.5 Biomass Potential in Brazil 118
- 8.6 Sustainability of Agripellets 119
- 8.7 Agripellets versus Coal and Lignite 120
- 8.8 Energy Density: Gigajoules per Tonne 120
- 8.9 Why Is Biomass in High Demand? 121
- 8.10 EU Environmental Regulations: Poland 124
- 8.11 The Challenges 125

9 Carbon Credits 127

- 9.1 Carbon is the Enemy 127
- 9.2 Jatropha Kerosene: A Monster Market Emerges 128
- 9.3 Carbon Reductions 130
- 9.4 Global Warming Around Us 130
- 9.5 Extreme Weather Patterns 131

10 Biofuels in Europe – EU Policies 133

- 10.1 EU Policy in 2008 133
- 10.2 Heated Debates 133
- 10.3 National Policies 134
- 10.4 EU Rift in Biofuel Policy 135
- 10.5 Indirect Land-Use Change 136
- 10.6 Where Do We Stand Now? 136

11	Biofuels in the United States	137
11.1	Biomass Demand in the United States	137
11.2	Second-Generation Biofuels for the United States	138
11.3	A Growing Shortage of Domestic Oil Production	139
11.4	Fuel Use at the USDA	140
11.5	Partnership with the FAA	140
12	Biofuels in China	141
12.1	Clean Energy? Go to China	141
12.2	China is Going Green	142
12.3	China's 12th 5-Year Plan	143
12.4	Inclusive Growth	143
12.5	The Beneficiaries	144
12.6	China's Energy Consumption	145
12.7	Staggering Car Sales Numbers	146
12.8	China's Diesel Pricing Mechanism	149
12.9	China–United States Biofuel Pact	150
12.10	China's Biofuels Expansion	151
12.10.1	2007	151
12.10.2	2010	151
12.10.3	An Area of 13 Million Hectares	152
12.10.4	Barren Lands in Southwest China	154
12.10.5	Hainan	154
12.10.6	Biodiesel Refineries	155
12.10.7	Poverty and <i>Jatropha</i>	156
12.10.8	Subsidies	157
12.10.9	Tax Exemptions for Biodiesel	158
13	Biofuels in Brazil	159
13.1	Introduction: Biofuel Industry Leader	159
13.2	Comparison with the United States	160
13.3	What is Driving the Urgency in Renewable Jet Fuel?	160
13.4	Biofuels from Sugarcane	160
13.5	Sugar Production	161
13.6	Ethanol Production and Flex-Fuel Cars	162
13.7	Bagasse, Bioelectricity, and Biofuels	162
13.8	Flex-Fuel = Biofuel	163
13.9	Fuel Consumption	163
13.10	Greenhouse Gas Reductions	164
13.11	Energy Balance	165
13.12	Sugarcane for Biofuels	165
13.13	Sugarcane Straw: A Growth Opportunity	166
13.14	Bioplastics	166

13.15	Biofuels and Public Health	167
13.16	Cautionary Notes	167
13.17	The Bottom Line	168
14	Biofuels and Biomass in Africa	169
14.1	Dependency on Fossil Fuels	169
14.2	Africa's Potential	170
14.3	Three African Examples	171
14.3.1	Ghana	171
14.3.2	Ethiopia	171
14.3.3	Nigeria	172
15	General Aviation and Biofuels	173
15.1	Important Aviation Facts	173
15.2	Carbon Reduction of Carbon Dioxide Emissions	173
15.3	Biofuels – Providing Diversified Supply	174
15.4	Lifecycle of Carbon Dioxide	174
15.5	Green Aviation	175
15.6	Why Use Biokerosene?	176
15.7	Global Emissions of Carbon Dioxide	176
15.8	Sustainable Aviation Fuel Users Group	178
16	Aviation and Carbon Credits	179
16.1	Greenhouse Gases	179
16.2	EU Emission Trading Scheme	179
16.3	Cap and Trade	180
16.4	Carbon in Chains	180
16.5	Biokerosene Targets	181
17	Biokerosene	183
17.1	Airline Industry Lifts Biofuel Development	183
17.2	Safety	184
17.3	Ready for Take-Off – A Monster Market in the Making: Aviation Biofuels	184
17.4	Refining	185
17.4.1	Biodiesel	186
17.4.2	Biokerosene	186
17.4.2.1	Hydrogenation	186
17.4.2.2	Fischer–Tropsch Process	187
17.4.2.3	Nanoemulsion	188
17.5	Benefits	188
17.6	Jet Fuel Standards	189
17.7	Certification of Biofuels	189

17.8	ASTM	190
17.9	Intensive Testing	190
18	Fermenting Fuels	193
18.1	New Generation	193
18.2	What are Hydrocarbons?	193
18.3	What are Enzymes?	193
18.4	What are “Drop-In Fuels”?	194
18.5	Converting Feedstock into Fuels	194
18.6	Cellulosic Ethanol	194
18.7	Biokerosene	196
19	Airline Test Results with Biofuels	197
19.1	Air New Zealand	197
19.2	Qatar Airways	198
19.3	Japan Airlines Test Flight – Biofuels Tested: <i>Jatropha</i> , <i>Camelina</i> , and Algae	198
19.4	KLM – Biofuel Tested: <i>Camelina</i>	199
19.5	Continental Airlines	199
19.6	TAM	200
19.7	British Airways	201
19.8	The Milestone: Lufthansa’s Daily Flights	202
19.9	Cathay Pacific	203
19.10	Air China	205
19.11	Alaska Airlines	205
19.12	Aeromexico: First Transatlantic Biofuel Flight	206
20	Investment Opportunities	207
20.1	The Opportunity of a Lifetime	207
20.2	Eight Ways to Invest in Biofuels and Biomass	208
20.2.1	Agricultural Land	208
20.2.2	Invest in Trees	209
20.2.3	Start Your Own Plantation	209
20.2.4	Your own Biofuel/Biomass Production Company	210
20.2.5	Invest in Private Equity Funds	211
20.2.6	Biofuel Companies	211
20.2.6.1	Introduction	212
20.2.6.2	Company List	212
20.2.7	Mother Earth Biokerosene Index	220
20.2.8	Managed Account	221
20.3	Investments Check-Up	221

21	<i>Jatropha</i> Projects, Research, and Joint Ventures	223
21.1	Waterland	223
21.2	KUOSOL: Repsol and KUO	224
21.3	SG Biofuels and Bunge	224
21.4	Shell and Brazil's Cosan	225
21.5	JOil	225
21.6	Others	226
22	The Future	227
22.1	Conclusions	227
22.2	From Nuclear to Renewable Energies	227
22.3	The Future of Waste	228
22.4	Future of <i>Jatropha</i> Feedstock	230
22.5	Future of Sugarcane	231
22.6	Low-Carbon Economy	232
22.7	Zero-Waste Economy	232
22.8	Our World in 2030	233
	Glossary	235
	Index	239

