

# Contents

---

<i>Contributor contact details</i>	<i>ix</i>
<i>Woodhead Publishing Series in Energy</i>	<i>xiii</i>
<i>Foreword</i>	<i>xvii</i>
<b>Part I Introduction to waste to energy conversion</b>	<b>1</b>
1 Waste to energy (WTE): an introduction	3
N. B. KLINGHOFFER and N. J. THEMELIS, Columbia	
University, USA and M. J. CASTALDI, City University of	
New York, USA	
1.1 Energy supply and waste management	3
1.2 Biogenic fraction of carbon and calorific value of	
municipal solid waste (MSW)	
1.3 Thermal treatment of municipal solid	
waste (MSW)	
1.4 Recycling and WTE	8
1.5 Contents of this book	10
1.6 References	12
2 Environmental and social impacts of	
waste to energy (WTE) conversion plants	15
T. MICHAELS, Energy Recovery Council, USA	
2.1 Introduction	15
2.2 Contributions of WTE conversion to waste reduction	
and energy generation	
2.3 Air quality and residue management considerations of	
WTE conversion	16
2.4 Greenhouse gas profile of WTE	18
2.5 Compatibility of WTE with recycling	20
2.6 Health and safety aspects of WTE	22
2.7 Integrated planning for WTE plants	23
2.8 Future trends	24
2.9 References	25
	27

3	Lifecycle assessment (LCA) and its application to sustainable waste management S. KAUFMAN, Columbia University, USA	29
3.1	Introduction	29
3.2	Energetic comparison of waste to energy (WTE) systems and alternative waste options	31
3.3	Emissions comparison of WTE systems and alternative waste options	33
3.4	Advantages and limitations of using an LCA approach to evaluate waste management systems	34
3.5	An alternative metric to evaluate waste management systems that addresses goal-oriented needs	37
3.6	Sources of further information	40
3.7	References	41
4	Feedstocks for waste to energy (WTE) systems: types, properties and analysis T. F. McGOWAN, TMTS Associates, Inc., USA	42
4.1	Introduction	42
4.2	Types of feedstock for WTE systems and their characteristics	43
4.3	Testing of feedstocks for WTE systems	46
4.4	References	51
<b>Part II</b>	<b>Waste to energy systems, engineering and technology</b>	<b>53</b>
5	Pre-processing and treatment of municipal solid waste (MSW) prior to incineration G. C. FITZGERALD, Columbia University, USA	55
5.1	Introduction	55
5.2	Basic screening processes: mass burn	56
5.3	Fuel upgrading and enhancement processes	57
5.4	Advanced screening, separation and processing	59
5.5	Shredding and size reduction processes	65
5.6	Conclusion	69
5.7	Further reading	70
5.8	References	71
6	Municipal solid waste (MSW) combustion plants L. M. GRILLO, Grillo Engineering Company, USA	72
6.1	Introduction	72
6.2	Principles of combustion	73
6.3	Mass burn waterwall combustion systems	76

6.4	Refuse-derived fuel (RDF) combustion systems	85
6.5	Modular combustion systems	88
6.6	Advantages and limitations	92
6.7	New developments	93
6.8	Sources of further information	96
6.9	References	96
7	Waste firing in large combustion plants	98
	P. VAINIKKA, M. NIEMINEN and K. SIPILÄ, VTT Technical Research Centre of Finland, Finland	
7.1	Introduction	98
7.2	Pulverised-coal (PC) units with direct co-firing	101
7.3	Direct fluidised-bed combustion	103
7.4	Co-combustion of gasification gas in a pulverised-coal boiler	106
7.5	Retrofitting a pulverised-coal plant with fluidised-bed units	113
7.6	Controlling high-temperature corrosion in co-fired units	116
7.7	Conclusion	118
7.8	References	119
8	Waste to energy (WTE) systems for district heating	120
	L. TOBIASEN and B. KAMUK, Ramboll, Denmark	
8.1	Introduction	120
8.2	Waste boilers	123
8.3	Electricity production in waste to energy (WTE) facilities	128
8.4	WTE facilities as sources of heat	132
8.5	Optimizing energy efficiency in WTE combined heat and power (CHP) facilities	140
8.6	Conclusion	145
8.7	References	145
9	Gasification and pyrolysis of municipal solid waste (MSW)	146
	N. B. KLINGHOFFER, Columbia University, USA and M. J. CASTALDI, City University of New York, USA	
9.1	Introduction	146
9.2	Gasification and pyrolysis	147
9.3	Products and their applications	154
9.4	Process analysis and reactor design	160
9.5	Process modifications for gasification systems	164
9.6	Environmental effect of gasification	167
9.7	Technologies in operation	169
9.8	Conclusion	174
9.9	References	175

<b>Part III</b>	<b>Pollution control systems for waste to energy technologies</b>	<b>177</b>
10	Transformation of waste combustion facilities from major polluters to pollution sinks J. VEHLOW, Karlsruhe Institute of Technology, Germany	179
10.1	Introduction	179
10.2	Status of waste combustion before 1970	181
10.3	Air emission regulations and their influence upon technology	186
10.4	Dioxin emissions	195
10.5	Environmental impact of emissions from modern waste combustion plants	199
10.6	Conclusion	200
10.7	References	201
11	Air quality equipment and systems for waste to energy (WTE) conversion plants J. S. AUSTIN, University of Maryland, USA	204
11.1	Air quality considerations and regulations for municipal waste combustors	204
11.2	Acid gas scrubbing in municipal waste combustors	207
11.3	Particulate control devices utilized at waste combustion facilities	211
11.4	Control of nitrogen oxide emissions and hazardous air pollutants from waste combustors	215
11.5	Air pollution control cost–benefit analysis	221
11.6	Air quality technology innovations for municipal waste combustors	223
11.7	References	226
	<i>Index</i>	227