



# CONVERTING WASTE OIL PALM TREES INTO A RESOURCE

UNITED NATIONS ENVIRONMENT PROGRAMME

Copyright © United Nations Environment Programme, 2012

---

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. UNEP would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

#### Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

#### Acknowledgement

This document was developed by a team led by Dr. Wan Asma Ibrahim Head of Bioenergy Programme, Forest Products Division, Forest Research Institute Malaysia (FRIM) under the overall guidance and supervision of Surya Prakash Chandak, Senior Programme Officer, International Environmental Technology Centre, Division of Technology, Industry & Economics, United Nations Environment Programme.

# **Converting Waste Oil Palm Trees into a Resource**

Compiled by



United Nations Environment Programme  
Division of Technology, Industry and Economics  
International Environmental Technology Centre  
Osaka, Japan

## Table of Contents

	Contents	Page
	Title	1
	Table of Contents	4
	List of Figures	9
	List of Tables	11
	List of Appendices	13
	List of Acronyms	15
	Executive Summary	17
<b>1.</b>	<b>Chapter 1: Characterization and quantification of waste oil palm trees in Malaysia</b>	<b>19-59</b>
1.1	Introduction	19
1.1.1	Background	19
1.1.2	Scope and objectives	20
1.2	Characterization of waste oil palm trees (WPT)	20
1.2.1	Characterization of waste oil palm trees	20
1.2.2	Chemical composition from proximate analysis of WPT	22
1.2.3	Macro nutrient contents	24
1.2.4	Elemental analysis of carbon, hydrogen, oxygen, nitrogen and sulphur	25
1.3	Quantification of waste oil palm trees	25
1.3.1	Total oil palm plantation area	25
1.3.2	Area of potential WPT available in years 2011 – 2032	30
1.3.3	Frond availability from WPT	34
1.3.4	Potential chemical and macro nutrients available in WPT	35
1.3.5	Case study on actual locality and quantification of WPT	37
1.3.6	Feedback from oil palm plantation companies	37
1.3.7	Size of oil palm plantations	37
1.3.8	Age category of oil palm trees	38
1.3.9	Number of trees per hectare	40
1.3.10	Area of actual felling programmes from years 2010 to 2031	40
1.4	Conclusion	43
	References	44
	Appendices	45
<b>2.</b>	<b>Chapter 2: Assessment of current waste oil palm tree management systems, practices and utilization at national and local levels</b>	<b>60-76</b>
2.1	Introduction	60

2.1.1	Background	60
2.1.2	Scope and objectives	62
2.2	Waste oil palm tree management systems	62
2.2.1	Introduction	62
2.2.2	Implementation of zero burning replanting techniques in Malaysia	63
	• Drawbacks of earlier zero burning methods	64
	• Newer zero burning methods	65
	• Limitations of newer zero burning methods	66
2.3	Waste oil palm tree utilization	67
2.3.1	Methods of harvesting WPT/oil palm trunks (OPT) for value-added products	67
	• Chain sawing	68
	• Bulldozing	68
	• Bucking	68
	• Skidding	69
	• Loading and transporting	69
2.4	Utilization of WPT	69
2.4.1	WPT for value-added products	69
2.4.2	WPT for energy	70
2.5	Conclusion	71
	References	72
	Appendix 2: Machines used for WPT disposal	73
<b>3.</b>	<b>Chapter 3: Identification, assessment and selection of environmentally sound technologies (ESTs) for converting waste oil palm trees into material or energy</b>	<b>77-145</b>
3.1	Introduction	77
3.1.1	Background	77
3.1.2	Objectives	77
3.2	Potential products and renewable energy/fuel from WPT	78
3.2.1	Products from WPT	79
3.2.2	Commercialized products	80
	• Plywood	80
	• OPT lumber products	82
	• Flooring	84
	• Animal feed	85
3.2.3	Products at pilot scale	86
	• Oil palm sap	86

	• Cellulose from OPF	89
3.2.4	Products at the research and development stage	90
	• Particle board	91
	• Renewable energy/fuel	92
3.2.5	Commercialized energy/fuels from WPT	93
3.2.6	Pilot scale study of energy/fuels from WPT	93
3.2.7	Energy/fuels at research and development stage	93
3.2.8	Other possible products from WPT	94
	• Compost	94
	• Laminated veneer lumber (LVL)	95
3.3	Assessment of environmentally sound technology (EST) for conversion of WPT into resources	96
3.3.1	Assessment of technology	96
3.3.2	Assessment on environmental impact	98
	• Estimation of GHG (CO <sub>2</sub> ) emissions from decomposition of WPT	98
	• Estimation of carbon sequestered from WPT conversion into value added products and renewable energy from 50% of WPT annual availability	99
	• Estimation of CO <sub>2</sub> emissions reduction based on the current WPT utilization for the conversion into value-added products in Malaysia	103
3.3.3	Assessment of environmentally sound technology (EST) for WPT conversion into material/resources	103
	• Recommendation of EST: Scenario 1	105
	• Recommendation: Scenario 2 – centralized facilities	108
3.4	Conclusion and recommendations	108
	References	110
	Appendices	113
<b>4.</b>	<b>Chapter 4: Report of UNEP workshop on converting waste oil palm trees into a resource</b>	<b>146-160</b>
4.1	Introduction	146
4.2	Plenary sessions	147
4.2.1	Session I: Project briefing	147
	• Report 1	147
	• Report 2	148
	• Report 3	148
4.2.2	Session II: Panel discussion	149
4.3	Conclusion	150

	Appendices	151
<b>5.</b>	<b>Chapter 5: Report of techno-economic feasibility study of using waste oil palm trees for generating renewable energy</b>	<b>161-189</b>
5.1	Introduction	161
5.2	Technical feasibility	163
5.2.1	Scope	163
	• Proposed capacity	163
	• Location	163
	• Production capacity	164
	• Raw materials	164
5.2.2	Process	165
	• Bioethanol production process	165
	• Fuel pellet production process	166
5.2.3	Land requirements	167
5.2.4	Equipment & machinery	169
5.2.5	Utilities	170
5.2.6	Staff & labour requirements	171
5.2.7	Environmental & safety aspects	171
	• Safety hazards	171
	• Safety protective equipment & environment	174
5.3	Economic viability	174
5.3.1	Introduction	174
5.3.2	Fixed investment	175
5.3.3	Operating costs	176
5.3.4	Profit and loss statement	178
5.3.5	Profitability and projection	178
5.3.6	Investment decisions	180
5.3.7	Break-even point	181
5.3.8	Gross profit margin	183
5.3.9	Sensitivity analysis	184
5.4	Conclusion	186
5.4.1	Recommendations	186
	Appendices	187
<b>6.</b>	<b>Chapter 6: Business proposal for converting waste oil palm trees into renewable energy</b>	<b>190-200</b>
6.1	Summary	190
6.2	Market outlook	190

6.2.1	Market demand	190
6.2.2	Market size	191
6.2.3	Market survey	191
6.2.4	Target market	191
6.2.5	S.W.O.T. analysis	192
6.2.6	Growth potential and future plan	193
6.3	Financial analysis	193
6.3.1	Profitability & projection	193
6.3.2	Source of funding	194
6.3.3	Cash flow for 15 years	194
6.3.4	Return on investment	200
6.4	Conclusion	200

预览已结束，完整报告链接和二维码如下：

[https://www.yunbaogao.cn/report/index/report?reportId=5\\_9439](https://www.yunbaogao.cn/report/index/report?reportId=5_9439)

