the 6th Biomass Asia Workshop
in Hiroshima
18-20 November 2009

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IETC Osaka

Waste Agricultural Biomass Conversion

Takehiro NAKAMURA
Director
UNEP International Environmental
Technology Centre (IETC)

IETC Shiga

United Nations Environment Programme (UNEP) – International Environmental Technology Centre (IETC)

- UNEP Centre established in 1992 with the aim of facilitating transfer of Environmentally Sound Technologies to developing countries and countries with economies in transition. The three focal areas for its work:
- 1. Waste management taking a 3R approach – converting waste into energy and other resources;

  2. Water and Sanitation – wastewater reuse

- 3. Disaster Management

Why Waste Agricultural Biomass?

- Globally 140 billion metric tons of biomass is generated every year from agriculture which is equivalent to approximately 50 billion tons of oil. This lead to substantial reduction in green house gas (GHG) emissions on two fronts:

  1. Controlling the methane emissions from rotten waste biomass and CO_2 from open burning

  2. Replacing dirty energy source with clean energy from waste biomass – Agricultural biomass waste when converted to energy can help to reduce the dependency on fossil fuel, reduce emissions of greenhouse gases and provide renewable energy

- Some types of waste agricultural biomass could be converted into useful materials. For example, compost for soil stabilization and as a fertilizer, fibers (and subsequently cloth) can be made from waste banana plants and pineapple plants. Bagasse (waste biomass from sugarcane) can be converted into paper

- Composts can replace use of chemical fertilizers – leading to reduced use of energy for chemical fertilizers and emission of green house gases.

Issues in developing countries in adopting ESTs

- Limited information on available good practices that can also be applied to local environmental and economic conditions;
- Capacity is required to develop and implement an approach to utilise available agricultural waste biomass into resources;
- Local and national policy setting is needed, facilitating adoption of best available technologies and practices;
- Lack of investment.

Converting Waste Agricultural Biomass into Energy/Material

- Compendium of Technologies
- Assessment Methodology
- Demonstration of EST

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Compendium of Technologies

1. Background
2. Rationale
3. Scope and Limitations
4. The Compendium
5. Conslusion
6. Recommendations

Annexure 1: EST for Energy Conversion - Commercial

Annexure 2: EST for Energy Conversion – Pilot

Annexure3: EST for Energy Conversion - Research

Annexure 4: EST for Material Conversion – Commercial

Annexure 5: EST for Material Conversion – Pilot

Annexure3: EST for Material Conversion - Research

In cooperation with Development Academy of the Philippines (DAP)

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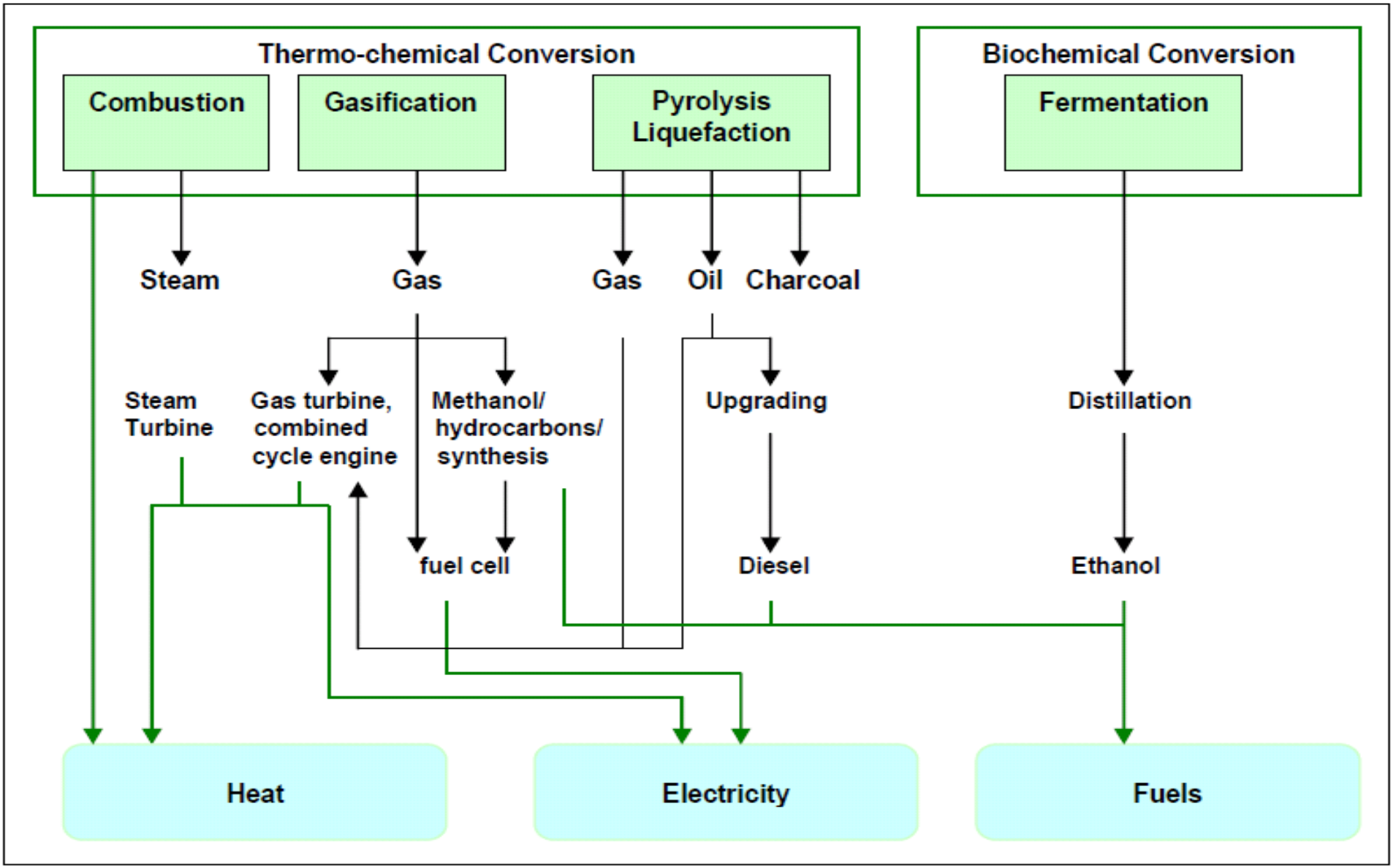
Conversion Routes



Level of Technology Use

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Energy

Research	Pilot Demonstration	Commercial
Bio-chemicals Bio-oil applications	Pyrolysis Gasification	Combustion Carbonization Briquetting Household energy

Material

Research	Pilot Demonstration	Commercial
Bio-reduction Bio-refinery	Hydro-separation Hot melt process Molding	Pulping Tuxying Decortication Twining

Web-based Compendium

http://cshd.dap.edu.ph/unep_biomass/

Compendium of Waste Biomass Conversion Technologies

Compendium Report on Technologies Utilizing Agricultural Waste Biomass

Waste Biomass Conversion to Energy

Waste Biomass Conversion to Materials

Crop/Type > Coconut > Husks

Process

Combustion	Gasification

Compendium of Waste Biomass Conversion Technologies and Assessment

Waste Biomass Conversion to Energy

Crop / Type	Waste
Agricultural Crops - This refers to a variety of agricultural crops, specific samples of which were not indicated in the source materials.	Crop Residue
Barley	Waste
Coconut	Fronds Husks Shell
Coffee	Bean Husks Grounds Husks Shells
Corn	Biomass-Derived Carbohydrates Cobs Shelled Corn Leaves Stalks Stover Syrup

Crop/Type > Coconut > Husks > Gasification

Equipment	Technology Details	Assessment Details	Product
Prototype modular downdraft biomass gasifier coupled with an internal combustion engine	ModularDowndraft_USA	To be updated	Electricity

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Example from the Compendium

COMPENDIUM
OF WASTE BIOMASS CONVERSION TECHNOLOGIES
PART I: CONVERSION TO ENERGY

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Modular downdraft gasifier[1]
USA, Pilot Demonstration

Crop	Coconut, sugarcane, rice, wood, palm
Residue	coconut shells and husks, bagasse, rice hulls, wood residues, rubber wood, and palm nutshells
Process	Gasification
Equipment	Prototype modular downdraft biomass gasifier coupled with an internal combustion engine
Main Product	Electricity

Technical Description of Technology

The prototype modular down-draft biomass gasifier coupled with an internal combustion engine was developed by Community Power Corporation (CPC) through a cost-fund sharing with the US

Global, Regional & Local Data

development academy of the philippines
The National Productivity Organization

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DAP-CSHD Site
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Using Agricultural Biomass Waste for Energy and Materials:

Resource Conservation and GHG Emission Reduction

A Biomass Assessment and Compendium of Technologies Project

Read more...

Global Assessment on Cellulosic Waste Biomass	Compendium of Waste Biomass Conversion Technologies	Other Documents
Global Assessment on Total Biomass from Crop Residue	Compendium Report on Technologies Utilizing Agricultural Waste Biomass	Nueva Ecija Biomass Situationer
Annex A. Regional Data on Total Crop Production, Total Biomass from crop Residue, and Total Biomass Energy of Agricultural Crops	Waste Biomass Conversion to Energy	Region III Biomass Baseline Report
Biomass Characteristics Report	Waste Biomass Conversion to Materials	Policy Framework for Biomass Use
Annex B. Characteristics of Biomass		Local Workshop
Regional Assessment on Specific Waste Biomass		
Annex C. Details on Region Country Specific Waste Biomass		

Assessment of Various Crops

development academy of the philippines
The National Productivity Organization

Home	**Using Agricultural Biomass Waste for Energy and Materials:**
Project Updates	Resource Conservation and GHG Emission Reduction
CSHD Site	A Biomass Assessment and Compendium of Technologies Project

Regional Data on Total Crop Production, Total Biomass from crop Residue, and Total Biomass Energy of Agricultural Crops

Alfalfa Africa.xls
Alfalfa America.xls
Alfalfa Asia.xls
AlfalfaEurope.xls
AlfalfaOceania.xls

AlmondAfrica.xls
AlmondAmerica.xls
AlmondAsia.xls
AlmondEurope.xls
AlmondOceania.xls

BarleyAfrica.xls
BarleyAmerica.xls
BarleyAsia.xls
BarleyEurope.xls
BarleyOceania.xls

CassavaAfrica.xls
CassavaAmerica.xls
CassavaAsia.xls
CassavaOceania.xls

CoconutAfrica.xls
CoconutAmerica.xls
CoconutAsia.xls
CoconutOceania.xls

CornAfrica.xls
CornAmerica.xls
CornAsia.xls
CornEurope.xls
CornOceania.xls

HazelnutAfrica.xls
HazelnutAmerica.xls
HazelnutAsia.xls
HazelnutEurope.xls

LeekAfrica.xls
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OatAfrica.xls
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OatsAfrica.xls
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OatsAsia.xls
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OatsOceania.xls

OnionAfrica.xls
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OnionAsia.xls
OnionEurope.xls
OnionOceania.xls

PineappleAfrica.xls
PineappleAmerica.xls
PineappleAsia.xls
PineappleOceania.xls

PotatoAfrica.xls
PotatoAmerica.xls
PotatoAsia.xls
PotatoEurope.xls
PotatoOceania.xls

riceafrica.xls
riceamerica.xls
riceasia.xls
riceeurope.xls
riceoceania.xls

SoybeanAfrica.xls
SoybeanAmerica.xls
SoybeanAsia.xls
SoybeanEurope.xls
SoybeanOceania.xls

SpinachAfrica.xls
SpinachAmerica.xls
SpinachAsia.xls
SpinachEurope.xls

SugarbeetAfrica.xls
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SugarbeetAsia.xls
SugarbeetEurope.xls

SugarcaneAfrica.xls
SugarcaneAmerica.xls
SugarcaneAsia.xls
SugarcaneEurope.xls
SugarcaneOceania.xls

WalnutAfrica.xls
WalnutAmerica.xls
WalnutAsia.xls
WalnutEurope.xls

WheatAfrica.xls
wheatamerica.xls
wheatasia.xls
wheateurope.xls
wheatoceania.xls

Example of Assessment

Sugarcane

Region: Asia

Table 1. Rate of Residues Produced from a Special Crop (kg/kg)

	Wheat	Rice	Corn	Soybean	Tuber	Sorghum	Miller	Cotton	Oil-Crop	Others
Rates of Residues (d)	1	1	2	1.5	1	2	1	3	2	1

Country	Area Harvested	Yield per hectare (kg/Ha) | 2006 (S)	* Total Biomass from Crop Residues	^Total Biomass Energy (TOE) *Mean Value (KJ)*	Total Biomass Energy *Mean Value (kWh)*	Oil Equivalent (Tonnes)	CO2 (tonnes)/day reduction	CH4 (tonnes)/day reduction
Afghanistan		19,000.00	19000	347,662,000.00	96,580.50	8.30	41.53	872.12
Bangladesh	157,200	40,861.58	40861.58	747,685,190.84	207,706.95	17.86	89.31	1,875.59
Cambodia	8,296	31,219.51	31219.51	571,254,593.98	158,694.53	13.65	68.24	1,433.01
China	1,220,000	17,081.00	17081	312,548,138.00	86,825.87	7.47	37.34	784.04
India	4,200,000	82,527.87	82527.87	1,510,094,965.26	419,504.38	36.07	180.39	3,788.12
Indonesia	370,000	66,945.24	66945.24	1,224,964,001.52	340,295.00	29.26	146.33	3,072.86
Iran, Islamic Rep of	63,397	81,486.49	81486.49	1,491,039,794.02	414,210.85	35.62	178.11	3,740.32
Japan	23,000	87,234.81	87234.81	1,596,222,553.38	443,430.63	38.13	190.68	4,004.18
Laos	7,200	10,833.33	10833.33	198,228,272.34	55,067.81	4.73	23.68	497.26
Lebanon	0	54,347.83	54347.83	994,456,593.34	276,260.04	23.75	118.79	2,494.63
Malaysia	12,000	33,333.33	33333.33	609,933,272.34	169,439.46	14.57	72.86	1,530.04
Myanmar	140,000	75,000.00	75000	1,372,350,000.00	381,238.83	32.78	163.93	3,442.59
Nepal	62,058	52,142.86	52142.86	954,110,052.28	265,051.77	22.79	113.97	2,393.42
Oman	24	39,681.81	39681.81	726,097,759.38	201,709.96	17.34	86.74	1,821.44
Pakistan	907,300	21,715.48	21715.48	397,349,853.04	110,383.79	9.49	47.47	996.77
Philippines	392,280	49,229.03	49229.03	900,792,790.94	250,240.24	21.52	107.60	2,259.67
Sri Lanka	21,580	62,060.53	62060.53	1,135,583,577.94	315,465.12	27.13	135.65	2,848.65
Syrian Arab Republic	0	52,669.14	52669.14	963,739,923.72	267,726.95	23.02	115.12	2,417.57
Thailand	936,227	50,904.43	50904.43	931,449,260.14	258,756.60	22.25	111.27	2,336.57
Viet Nam	285,100	54,993.34	54993.34	1,006,268,135.32	279,541.29	24.04	120.20	2,524.26

**** Total Biomass From Crop Residues = S X d***
^Total Biomass Energy (TOE) = *Total Biomass From Crop Residues X Heat Value of Crop
Heat Values (KJ/Kg) = Mean Value (18, 298)
Conversion of Kilojoules to Kilowatt/hour = Multiply by 0 . 0002778
1 tonne Oil Equivalent = 11630 kWh
CO2 emissions in tonnes = Energy Consumption (kWh) X Fuel Emission Factor for Electricity Use (0.43kg CO2/kWh) X Global Warming Potential of CO2 / 1000) 0.001
CH4 emissions in tonnes = Energy Consumption (kWh) X Fuel Emission Factor for Electricity Use (0.43kg CO2/kWh) X Global Warming Potential of CH4 / 1000) 0.023
N20 emissions in tonnes = Energy Consumption (kWh) X Fuel Emission Factor for Electricity Use (0.43kg CO2/kWh) X Global Warming Potential of N20 / 1000) 0.31
SF6 emissions in tonnes = Energy Consumption (kWh) X Fuel Emission Factor for Electricity Use (0.43kg CO2/kWh) X Global Warming Potential of N20 / 1000) 0.0239

Sources:

http://www.princeton.edu/~energy/publications/pdf/2001/Li_01_ESD_China_biomass_energy.pdf
http://faostat.fao.org/site/567/DesktopDefault
http://www.ecn.nl/phyllis/Multi.asp?Selected=6:-1:-1
http://www.tedmontgomery.com/convrsns/index.html
http://www.carbontrust.co.uk/resource/measuring_co2/Measuring_CO2_Methodologies.htm

Demonstration of EST

Nepal, Pakistan, Philippines and Sri Lanka

1 July 2009 to 30 September 2010

1. Training materials on characterisation and quantification of waste agricultural biomass and assessment of its current management system
2. Baseline report on characterisation and quantification of waste agricultural biomass with future projections for project area
3. Baseline report on assessment of current waste agricultural biomass management system and practices at national and local level.
4. A report on the issues of concern
5. A report on identification, assessment and selection of EST for converting waste agricultural biomass into material/energy
6. Detailed report on pilot project with economic and environmental feasibility and recommendation on policies. This report includes detailed designs and implementation strategy of the EST for pilot project
7. Implementation of EST
8. Training materials for operation and maintenance of EST
9. Generic guidelines on the process to develop strategies and projects for converting waste agricultural biomass into material/energy

Possible associated action

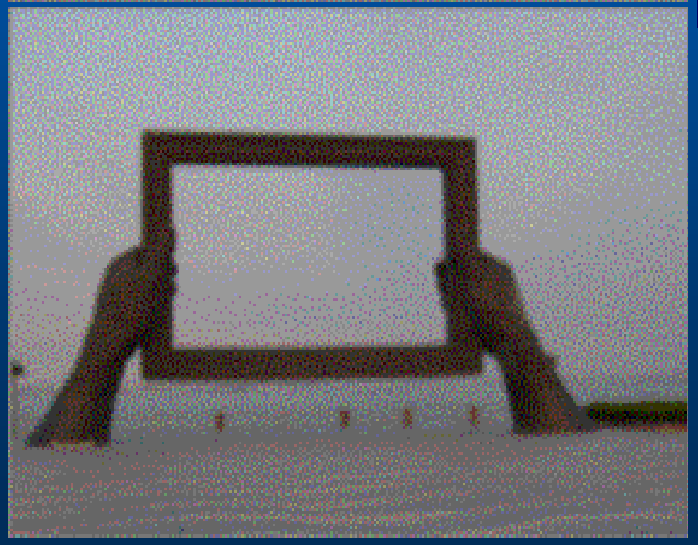
- To discuss a strategy to conduct feasibility study of CDM potential or to study possible business models for four demonstration projects on waste agriculture biomass
- To identify possible further partners, Governments, financial institutions, etc.

Palm Oil Trees

1. Palm oil production has reached 45 m/m tons/year worldwide (USDA 2008): Malaysia (18 m/m tons/year) and Indonesia (20 m/m tons/year)
2. Substantial number of destroyed palm trees are available in addition to end of life palm trees
3. Those trees are left to be rotten and then there are major environment impacts, especially in terms of methane emissions
4. Proper removal of the trees could reduce the untapped methane emissions as well as to clear the land for cultivation of new trees
5. Those palm trees could be converted into materials and energy source based on resource augmentation by utilising waste approach

Possible Partnership on Palm Oil Trees

- UNEP IETC - Capacity building
- JIRCAS - Sugar content of palm tress is about equal to that of sugarcane and possible yield of ethanol by sugarcane is from 4.5 to 7.0 kilo litter per hectare while it is from 9.5 to 10.3 kilo litter per hectare for palm trees.
- Forest Research Institute Malaysia and University Science Malaya
- GEC – CDM feasibility



Thank You…

UNEP International Environmental Technology Centre (IETC)

2-110 Ryokuchi koen
Tsurumi-ku, Osaka
tel. 06-6915-4581
fax 06-6915-0304

www.unep.or.jp
ietc@unep.or.jp