Life Cycle and Feasibility Study of Developing a High Yield Technology for Biomass-to-Charcoal Production in Singapore

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Introduction

- Biomass wastes in Singapore are mostly horticultural, wood and food wastes
- LCA is applied for evaluating the environmental impacts and benefits of producing charcoal from waste wood
- Possibility of developing a High Yield Technology for increasing the productivity levels of carbon products is proposed
- Collaboration between NUS, AIST (Japan) and a Biomass Utilization and Conversion Company (Spore company)

The company

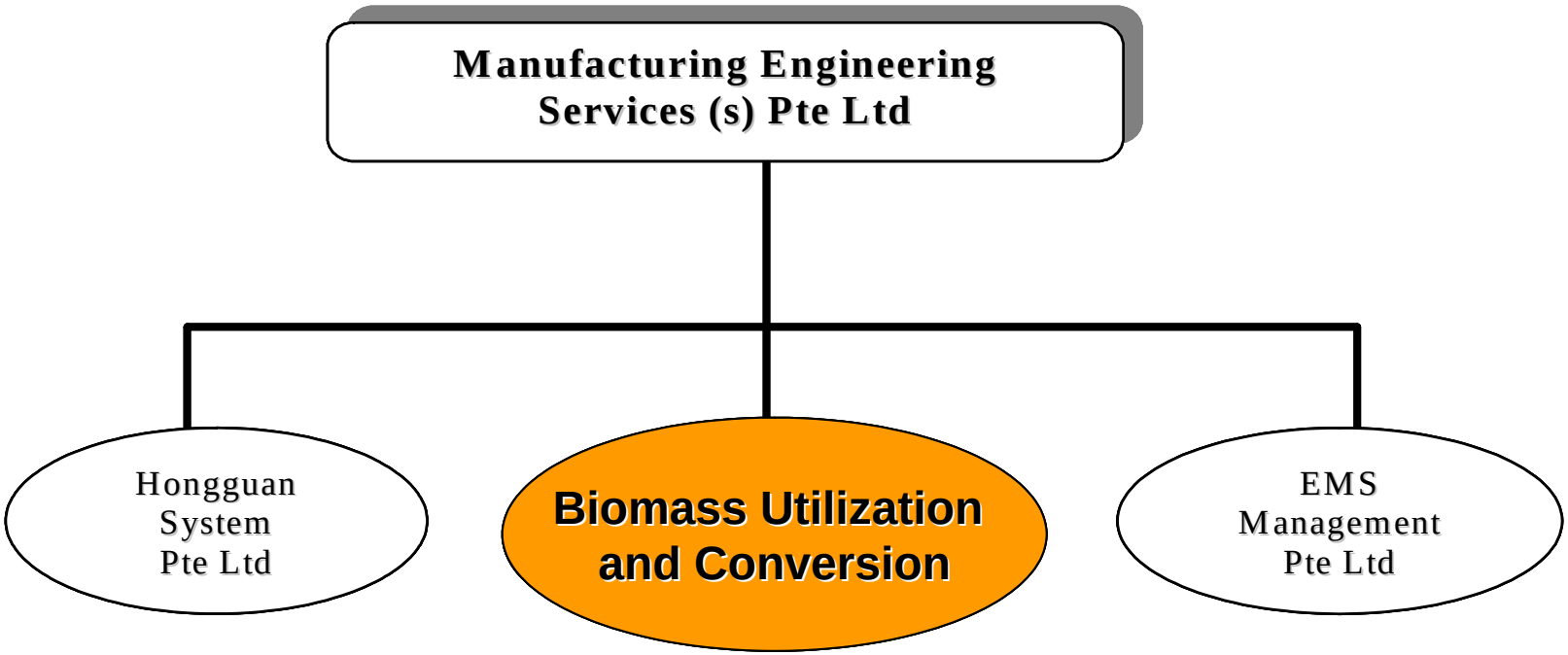
- The company is a wholly own subsidiary of Engineering Manufacturing Services (S) Pte Ltd
- Set up in Nov 2002 to produce carbon products from wood wastes
- Started production at the end of 2003 and sold its products to such countries as Germany, Denmark and Australia.

The company

Engineering Manufacturing Services (S) Pte Ltd

Authorized Capital: S$ 9.0mil

Paid up Capital: S$ 6.5mil



Biomass-to-Charcoal Production Stages

- Three main stages:

  Shredding -> Carbonization -> Briquetting-Drying-Packaging
- The Shredding process converts wood into wood chips
- Carbonization process converts wood chips into carbon chips
- The carbon chips are then crushed into powder before being mixed with binder and pressed into required shape, dried, packed and shipped.

Self-sustaining Energy

Wood Chip

Carbonizer

Heat Energy

Dryer

Exhaust

Heat energy from Carbonizer is channeled to the Drying machine for the drying operation.

Manufacturing Process Flow

Shredding

Wood Chips

Carbonization

Low Yield !

Charcoal Chips

High Maintenance !

Mixing/Briquetting

Charcoal Briquette

Low Utilization rate !

Drying

Packaging

Packed Briquettes

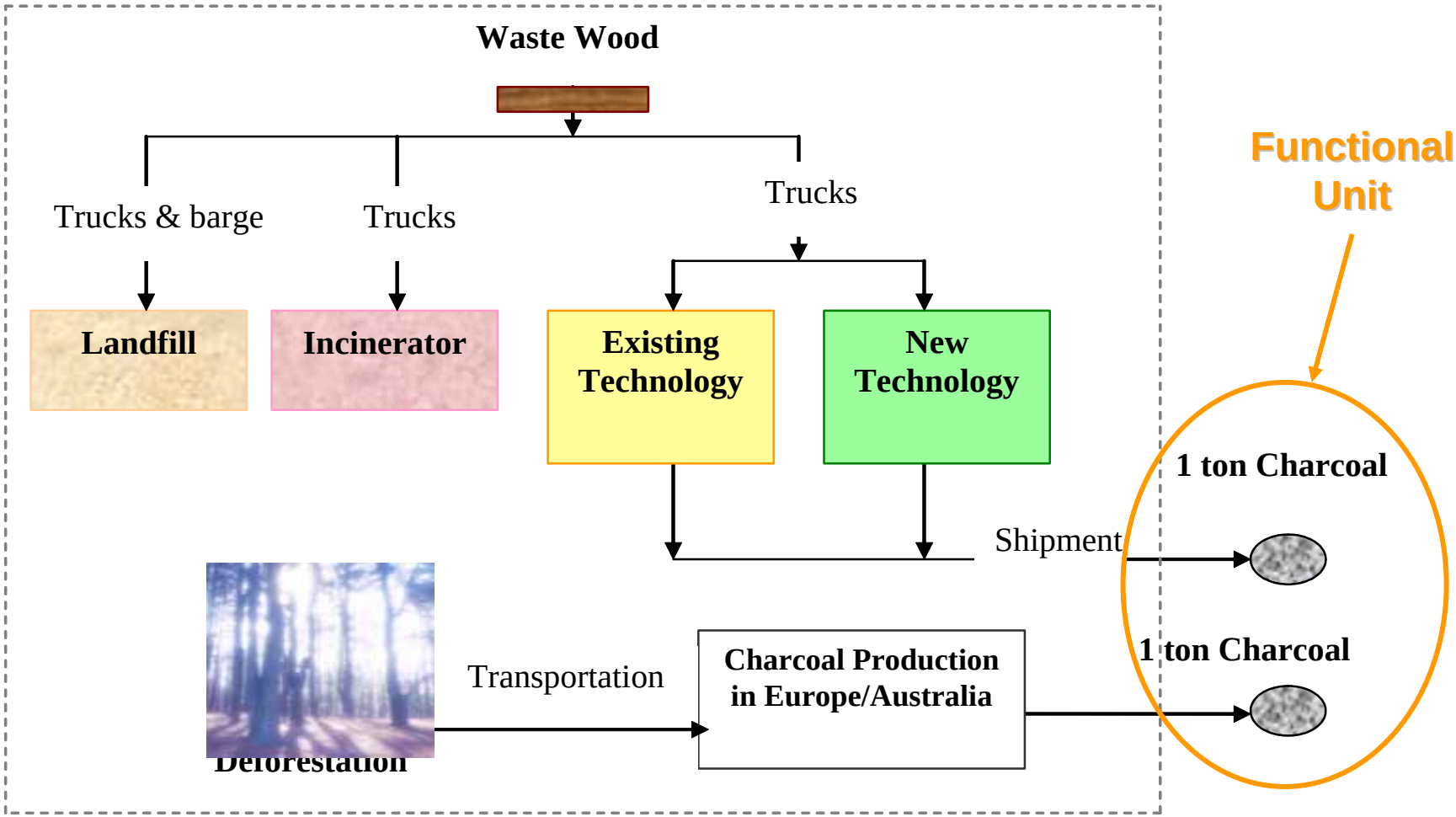
Bottleneck: Carbonizer

- **Equipment to convert wood chips into charcoal chips**
- **Efficiency of process depends on:**
  - ***Temperature (T)***
  - ***Surface Area (S)***
  - ***Moisture Content (M)* of wood chips**
- **The yield of each Carbonizer is as low as 10%-13%**
- **High maintenance rate (about every 10 days)**
- **The machine utilization rate is about 67% (20/30 days).**

Project Objectives

- **Perform an economic assessment and feasibility study of designing and developing a High Yield Carbonizer**
- **Apply for a grant from National Environmental Agency**
- **Carry out a complete LCA study - from biomass production, transportation, conversion to the final product (charcoal)**

LCA System


Waste Wood
Trucks & barge
Trucks
Trucks
Landfill
Incinerator
Existing Technology
New Technology
Functional Unit
1 ton Charcoal
Shipment
Transportation
Charcoal Production in Europe/Australia
1 ton Charcoal
Deforestation

Data Requirements

- Emissions due to landfilling of waste wood
- Emissions due to the incineration of waste wood
- Transport pollution (trucks, barge, ship)
- Emissions and waste from biomass-to-charcoal production: Existing Technology
- Emissions and waste from biomass-to-charcoal production: New High Yield Technology
- Emissions and waste from conventional charcoal production (Australia / Europe)

Data Requirements

Air Emissions due to Landfilling of Waste Wood

Air emissions (mg/ton)	Waste Wood	Air emissions (mg/ton)	Waste Wood
CO	600866	NOx	1000110
CO_2	7.39E+08	HCl	55.90
CH_4	2.52E+08	HF	11.18
SOx	509039	H_2S	58300

Air Emissions due to the Incineration of Waste Wood

Air emissions (mg/ton)	Waste Wood	Air emissions (mg/ton)	Waste Wood
CO	0.30	HCl	0
CO_2	5.86E+08	PM	0.06
SO_2	2.06E-01	Dioxins / furans	3.12E-08
NOx	0.483		

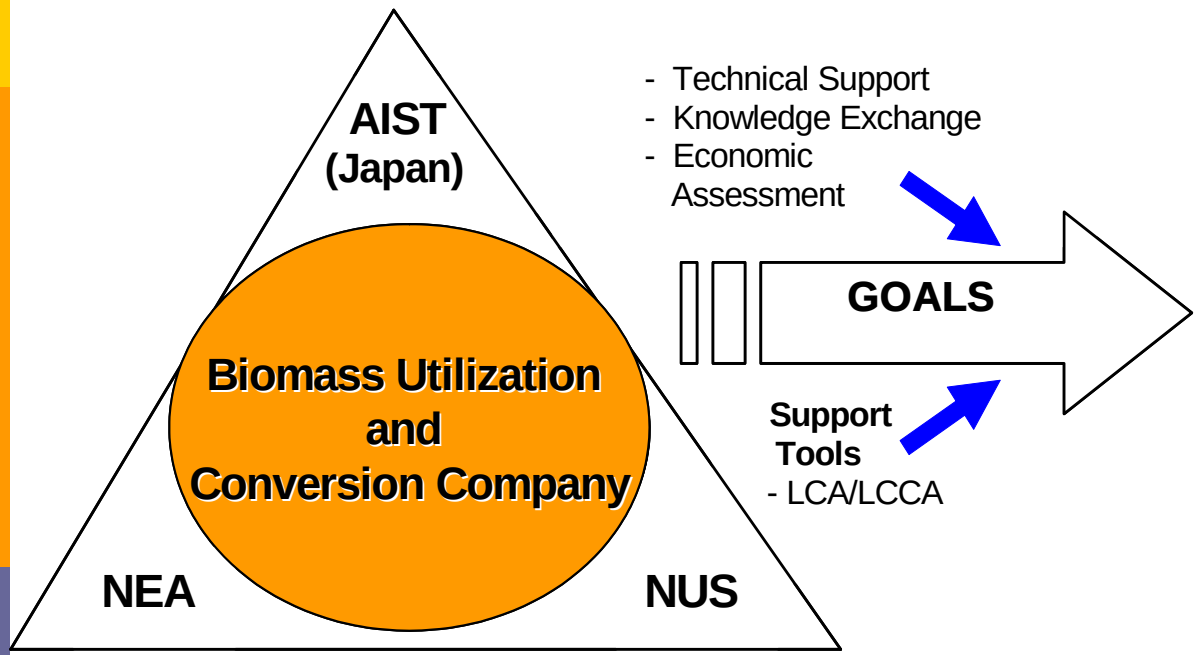
Expected Supports

- Technological support from Japan (knowledge exchange, economic assessment)
- LCA knowledge and gathering of data from NUS
- Grant from NEA (National Environmental Agency) of Singapore

Potential Benefits

- **Wastes to landfill/incineration ↓**
- **Recycling of wood ↑**
- **Deforestation and CO_2 levels ↓**
  (from conventional charcoal production)
- **Economical benefits ↑**
  (including employment)

Overview



- **Biomass Utilization √**
- **Recycling Rate √**
- **Business Impact √**
- **Singapore Green Plan 2012 √**
- **Sustainable Development √**
- **CO_2 Reduction √**