


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



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# Introduction

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- 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

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- 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

**Manufacturing Engineering  
Services (s) Pte Ltd**

Hongguan  
System  
Pte Ltd

**Biomass Utilization  
and Conversion**

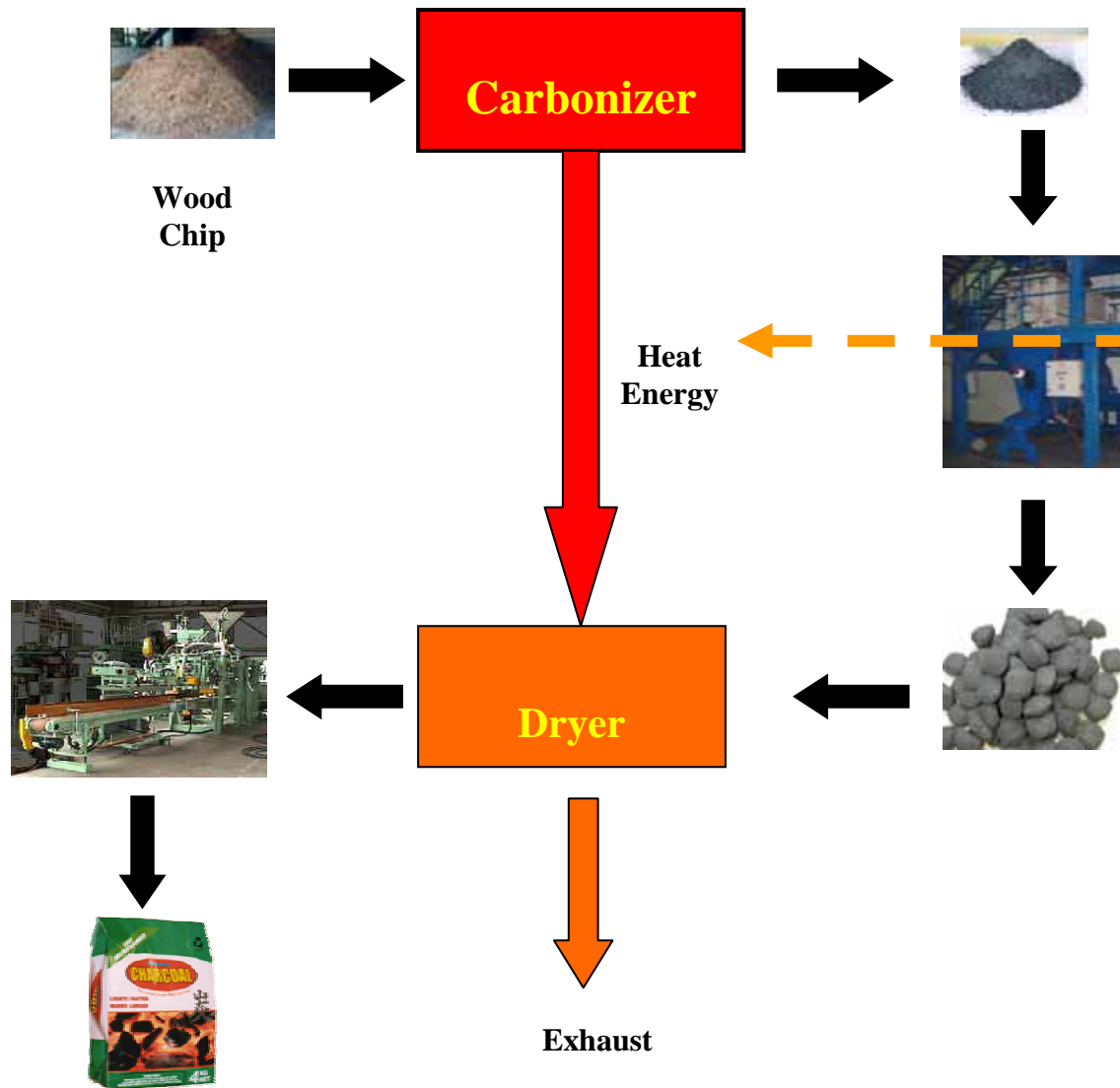
EMS  
Management  
Pte Ltd

# Biomass-to-Charcoal Production Stages

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- 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

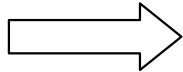


Heat energy from Carbonizer is channeled to the Drying machine for the drying operation.

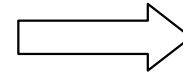
# Manufacturing Process Flow



Shredding



Wood Chips



Carbonization

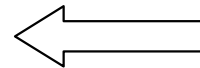


**Low Yield !**

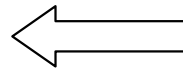
**High Maintenance !**



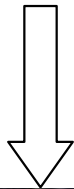
Charcoal Chips



Mixing/Briquetting



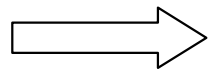
Charcoal Briquette



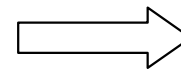
**Low Utilization rate !**



Drying



Packaging



Packed Briquettes

# Bottleneck: Carbonizer

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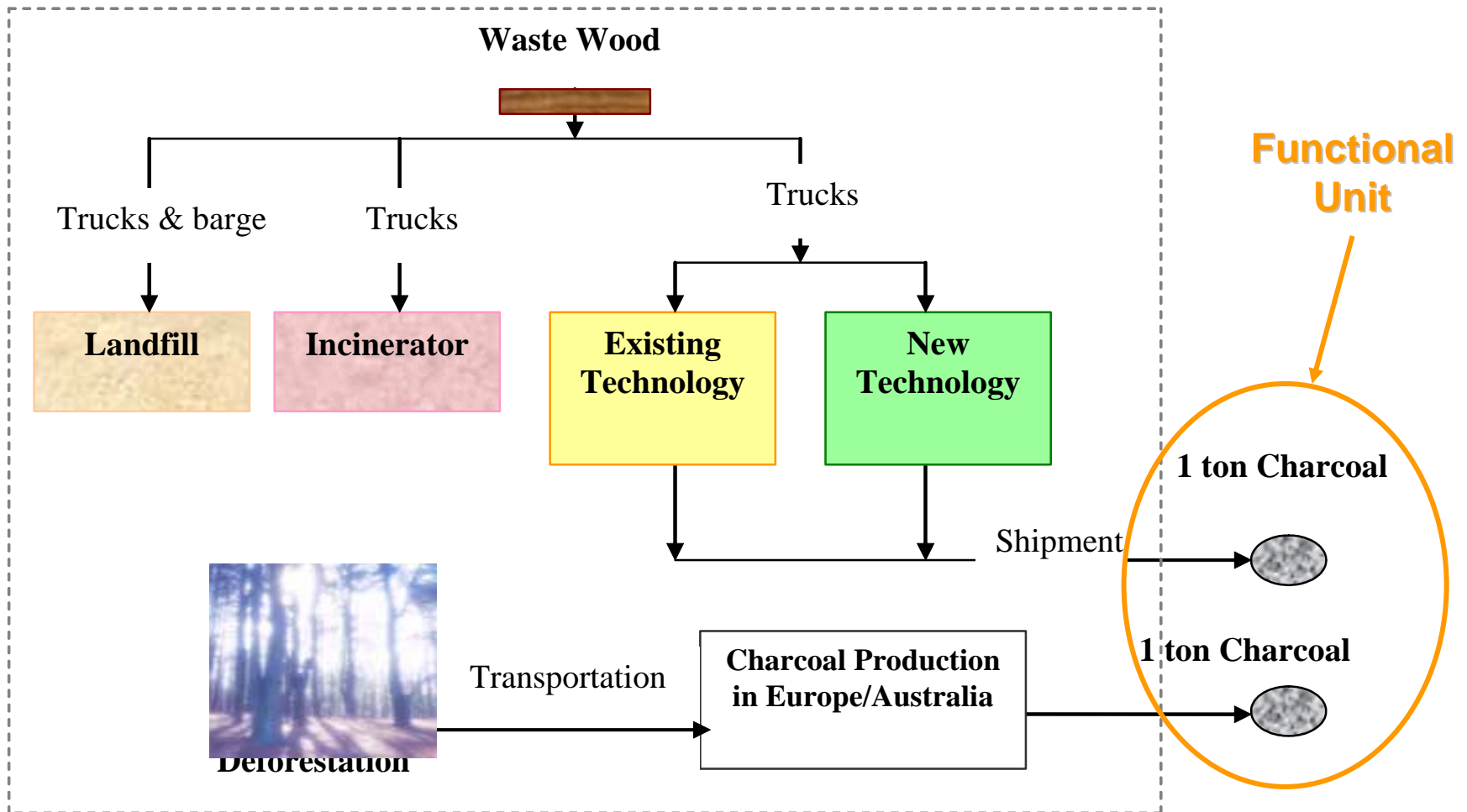
- ❑ Equipment to convert wood chips into charcoal chips
- ❑ Efficiency of process depends on:
  - *Temperature (T)*
  - *Surface Area (S)*
  - *Moisture Content (M) of wood chips*
- ❑ The yield of each Carbonizer is as low as **10%-13%**
- ❑ **High maintenance** rate (about every 10 days)
- ❑ The machine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

# Project Objectives

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- ❑ **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



# Data Requirements

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-  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

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## 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 <sub>2</sub>	7.39E+08	HCl	55.90
CH <sub>4</sub>	2.52E+08	HF	11.18
SOx	509039	H <sub>2</sub> S	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 <sub>2</sub>	5.86E+08	PM	0.06
SO <sub>2</sub>	2.06E-01	Dioxins / furans	3.12E-08
NOx	0.483		

# Expected Supports

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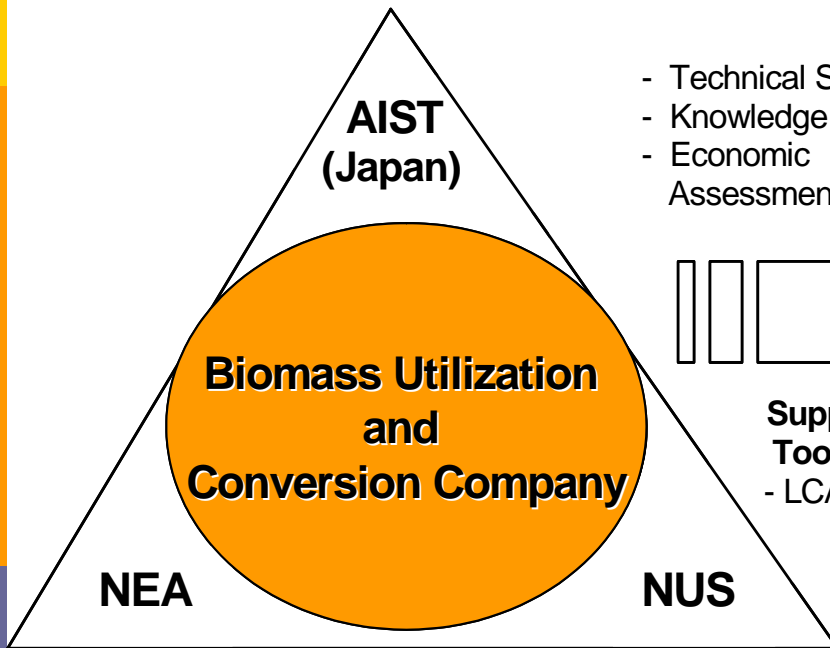
- Technological support from Japan (knowledge exchange, economic assessment)
- LCA knowledge and gathering of data from NUS
- Grant from NEA (National Environmental Agency) of Singapore

# Potential Benefits

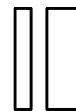
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- ❑ **Wastes to landfill/incineration**
- ❑ **Recycling of wood**
- ❑ **Deforestation and CO<sub>2</sub> levels**  
**(from conventional charcoal production)**
- ❑ **Economical benefits**  
**(including employment)**

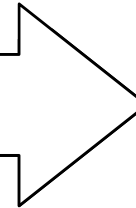
# Overview



- Technical Support
- Knowledge Exchange
- Economic Assessment



**GOALS**



- Support Tools**
- LCA/LCCA



- Biomass Utilization** ✓
- Recycling Rate** ✓
- Business Impact** ✓
- Singapore Green Plan 2012** ✓
- Sustainable Development** ✓
- CO<sub>2</sub> Reduction** ✓