BIOMASS UTILIZATION IN MALAYSIA:
CURRENT STATUS OF CONVERSION OF BIOMASS INTO BIOPRODUCTS

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Energy Requirement

- **Global scenario :**
  - Rising fossil fuels prices
  - Rapid depletion of reserves
  - Deep water oil production – rising cost
  - Complications in oil recovery – rising cost
  - Political uncertainties – oil producers
- **Malaysia scenario :**
  - Growing demand - becoming developed nation by 2020
  - Limited fossil fuel reserves, only 30–40 years
  - Net oil importer from 2040

Environmental issues: Usage of fossil fuels

- **Uncontrolled anthropogenic release of Greenhouse Gases**
  - **Increased heat trapped in the atmosphere 0.6-2.5^{o}C (last 50 years), 1.4-5.8^{o}C (21st century)**
- **Detrimental effects to global climate:**
  - **Increase in sea level (10cm – 20cm) submerging of lowlands, deltas & islands**
  - **Changing weather patterns**
  - **Increase moisture precipitation & evaporation frequent rainstorms & drier soils**
  - **Decline in soil moisture – low crop yield**
  - **Change in water supplies – unpredictable weather**
- **Adversely affecting the WORLD FOOD PRODUCTION and the WORLD ECOSYSTEM**

Biomass as an Alternative ?

- **Shifting of paradigm towards BIOMASS**
  - **Renewable energy**
  - **Sustainable**
  - **Environmentally friendly**
  - **Abundant**
  - **Untapped energy**

- **Uncertainties of BIOMASS**
  - **Technological proven ?**
  - **Economically feasible ?**
  - **Constant supply ? (quality and quantity)**
  - **Availability & distribution ? (worldwide)**

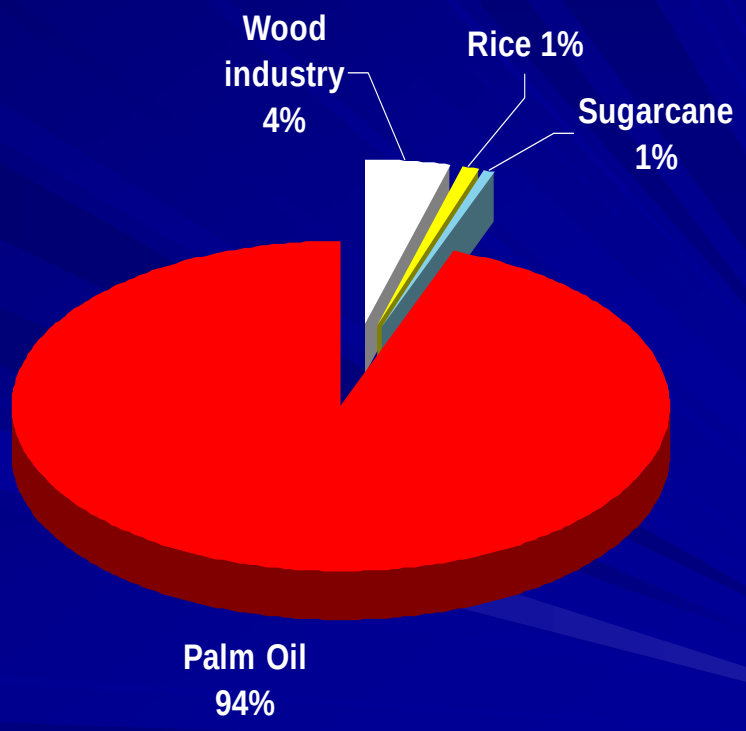
Biomass in Malaysia

- **Biomass:**
  - **by-products with no or low profit generated from agricultural or industrial processes**

- **Main sources of biomass in Malaysia**
  - **Domestic wastes (MSW)**
  - **Agricultural residues**
  - **Animal wastes**
  - **Effluent sludge/wastewater**
  - **Wood chips**

Biomass resources: Agricultural residues

- Most abundant in Malaysia (> 70 million tonnes annually)
- Production of biomass throughout the year – high sunlight intensity/time and high rainfall
- Main contributor of biomass – palm oil industry
  - Empty fruit bunches (EFB)
  - Palm oil mill effluent (POME)
  - Mesocarp fiber
  - Palm kernel shells
  - Palm kernel cake (residue)
- Mainly ligno-cellulosic materials



Palm Oil Industry: Biomass

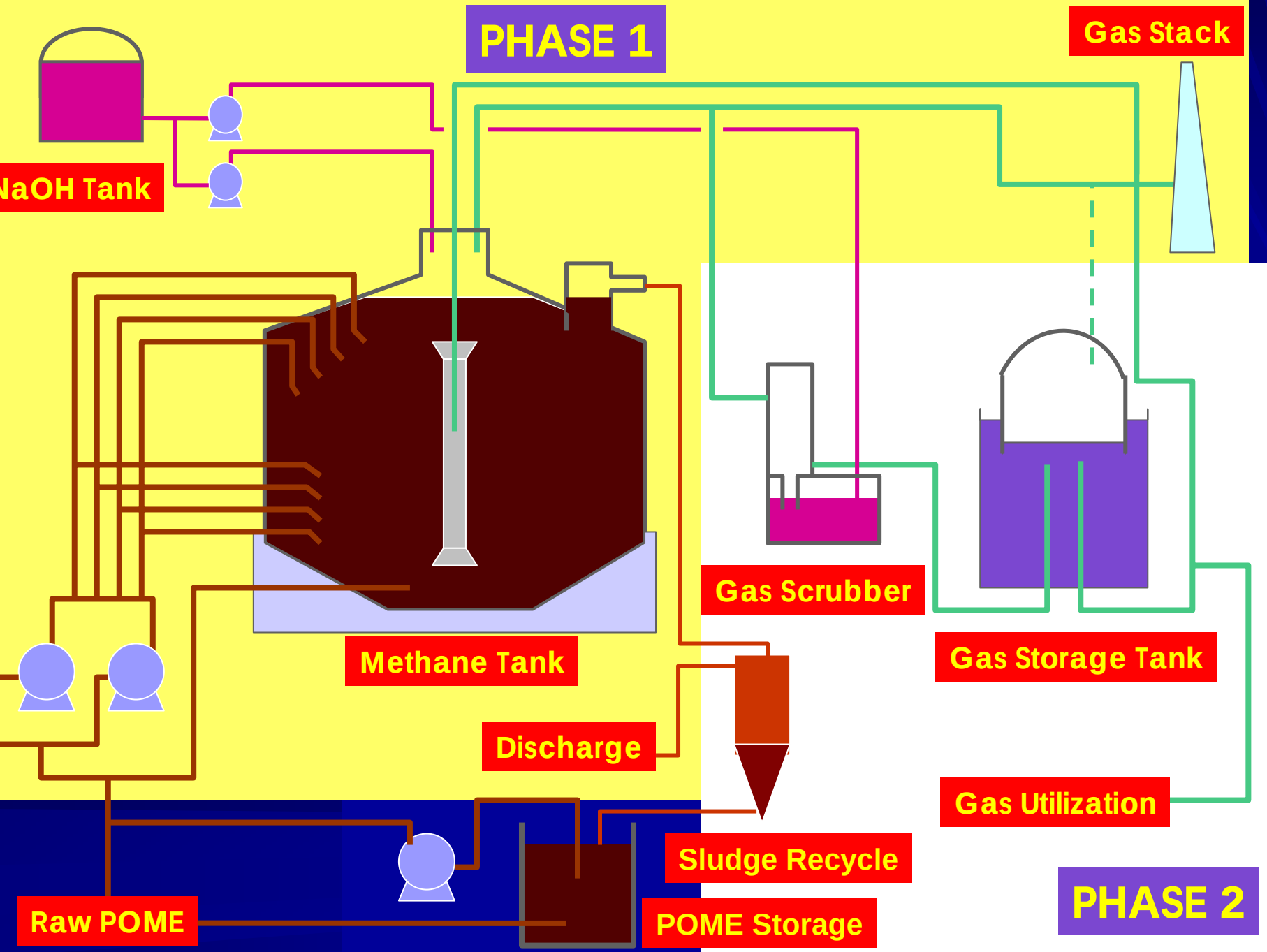
- **Biomass production (2003)**
  - **Empty fruit bunch (EFB) – 14 million tonnes**
  - **Palm kernel shell - 8 million tonnes**
  - **Mesocarp fiber – 5 million tonnes**
  - **Abundant and concentrated in the mills (business as usual)**

Thermal conversion: Biomass

- Thermal conversion of biomass
- Mainly in power/electricity generation
- Commercially used in the industries
  - Palm oil mills – boilers and steam turbines
  - Landfills – methane combustion
- Technology proven and high demand for energy
- Low efficiency boiler system – meant for waste disposal in the mill

Biological conversion: CH_4 generation

- Collaborative Partners – University Putra Malaysia Kyushu Inst. of Technology FELDA Palm Industries Sumitomo Heavy Industries
- CH_4 generation from POME anaerobic treatment
- Pilot plant operation - 500 m^3 improved design methane tank, POME holding tank, settling tank, gas scrubber, gas storage tank
- Conversion into electricity using gas turbine


PHASE 1
Gas Stack
NaOH Tank
Gas Scrubber
Gas Storage Tank
Methane Tank
Discharge
Gas Utilization
Sludge Recycle
PHASE 2
Raw POME
POME Storage

Biological Conversion: Organic Acids

- Collaborative partners – UPM, FELDA, KIT
- Established fermentation technology of organic acids from POME anaerobic treatment
- Production of acetic, propionic and butyric acids
- Up scaling the process to pilot plant operation

RAW POME

ANAEROBIC TREATMENT

PURIFIED ORGANIC ACID

Biological Conversion: Bioplastics

- Collaborative Partners - UPM, KIT & FELDA
- Utilization of acetic, propionic and butyric acids from POME
- Fermentation of organic acids into poly-hydroxyalkanoates
- The whole process will utilize excess energy from biogas plant
- Current stage – Distillation of organic acids and downstream processing of PHA

Biological Conversion: Bio-compost

- Organic compost was successfully produced using POME sludge, shredded EFB, MSW and domestic sewage sludge
- Good properties such as pH 6-8, C/N 20 and comply to USEPA standards
- Performance was comparable with commercial composts
- Suitable for vegetables and ornamental plants
- Commercially available

Biological Conversion: Animal Feedstock

- **Palm-based feedstock:**
  - Oil palm fronds with added nutrient supplements
  - Palm press fiber
  - Palm kernel cake
  - POME sludge
- **Sago-based feedstock:**
  - Pith residue (starch)
- **Most of the feedstock from palm-based and sago-based are commercially available**
- **Others:**
  - Enzyme production by SSF (cellulase, amylase)
  - Acetone-butanol-ethanol (ABE)
  - Mushroom cultivation

Palm oil Industry: Towards Zero Emission

Concentration of biomass

Oil Extraction

Empty Fruit Bunch

Palm Oil Mill Effluent

Sugars (Polylactate)

Cellulose

Bioplastics (PHA)

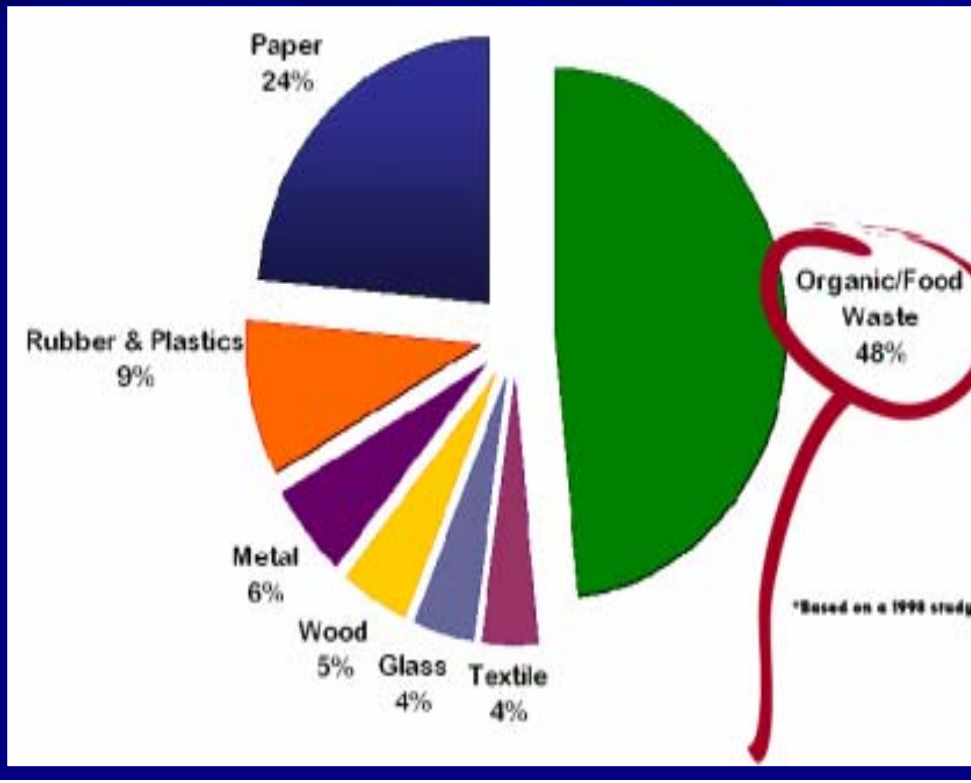
Bio-acids

Methane

Biofuel

Municipal Solid Waste: Biomass

- Malaysia generates in excess of 15,000 tons of solid waste per day
- The life span of landfills : 5 – 10 years ONLY 80% of the 230 landfills will be closed in TWO years
- Non biodegradable plastics is widely used in supermarkets
- Malaysian government recognizes the importance of preserving the environment by promoting recycling (4R)



Organic waste is the highest contributor

Municipal Solid Waste: Biomass

- Energy (methane) for power/ electricity generation
  - 1st IPP Ayer Hitam Landfill 2 MW
- Chemicals
  - Organic acids production – lactic, acetic, propionic and butyric acids
  - Bioplastics – PHA or poly-lactate
- Fertilizer – Bio-compost

Challenges: Biomass Utilization

- Biomass has great potential as renewable resources
- Two major problems:
  - Technological shortcomings in realization of fermentable products from biomass
    - Complex and sensitive system (biological agents)
    - Production of several products in a single process
    - Complexity in downstream processing
  - Socio-economics
    - Not competitive compared to fossil fuels
    - Accountability in pollution and global warming
    - Sustainability of process and technology

Outlook: Biomass Utilization

- **Malaysia has great potential in biomass utilization as renewable resources**
- **Significant reduction in GHG emission**
  - **to achieve sustainable development via quantification of emission limitation and reduction of GHG under Kyoto Protocol**
  - **Clean Development Mechanism (CDM) projects generate Certified Emission Reduction (CER) for sale or export**
  - **The CER can be used towards developed nations commitments to mitigate their GHG emissions**
- **Biomass utilization promises sustainable development of both the industry and environment**

Acknowledgement

- Organising committee
- Thank you…