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Research & Design Showcase 2022

The Potentials of Co-pyrolysis of Empty Fruit Bunch (EFB) and Disposable Face Mask wastes.

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Presentation Outline

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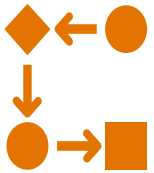
Introduction

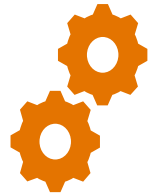
Literature review

Methodology



Results

Research impact



Conclusion

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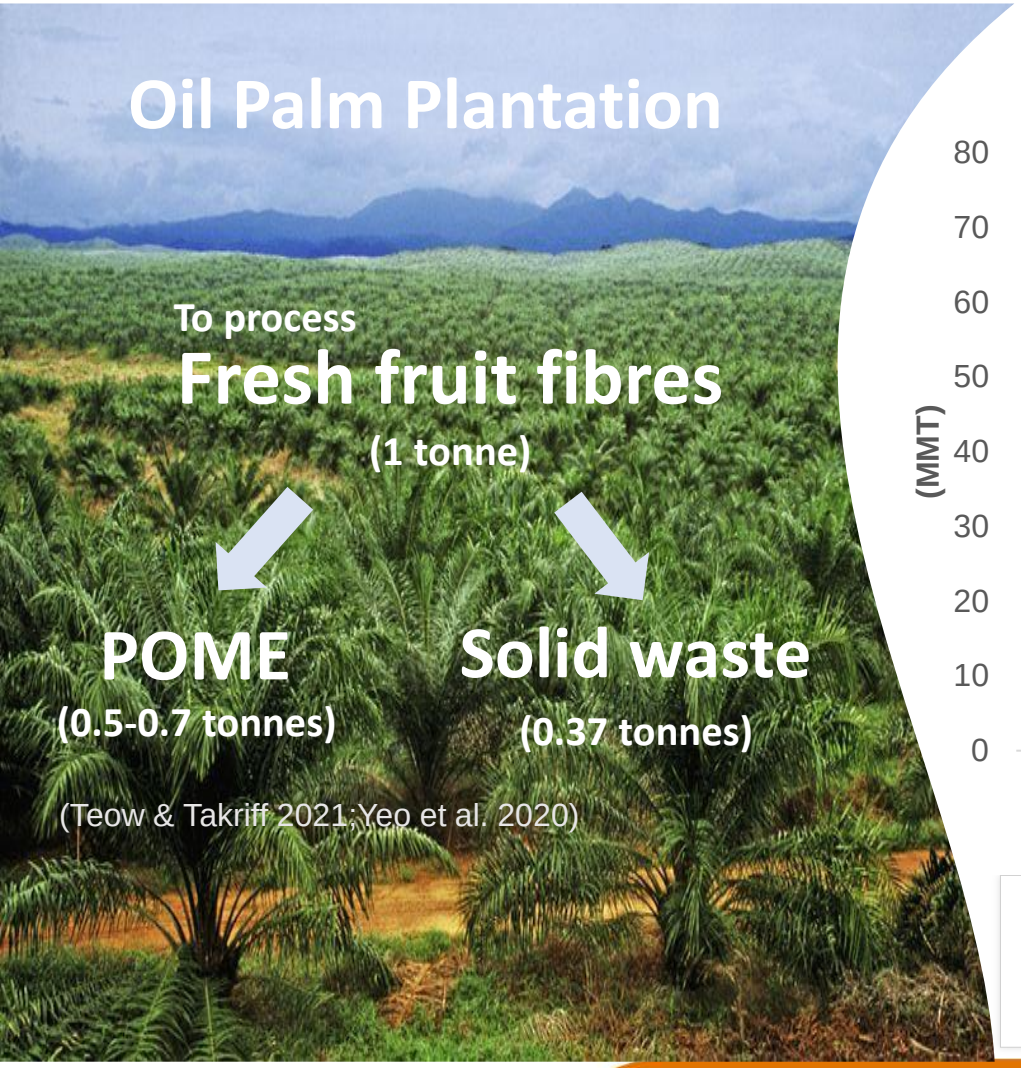
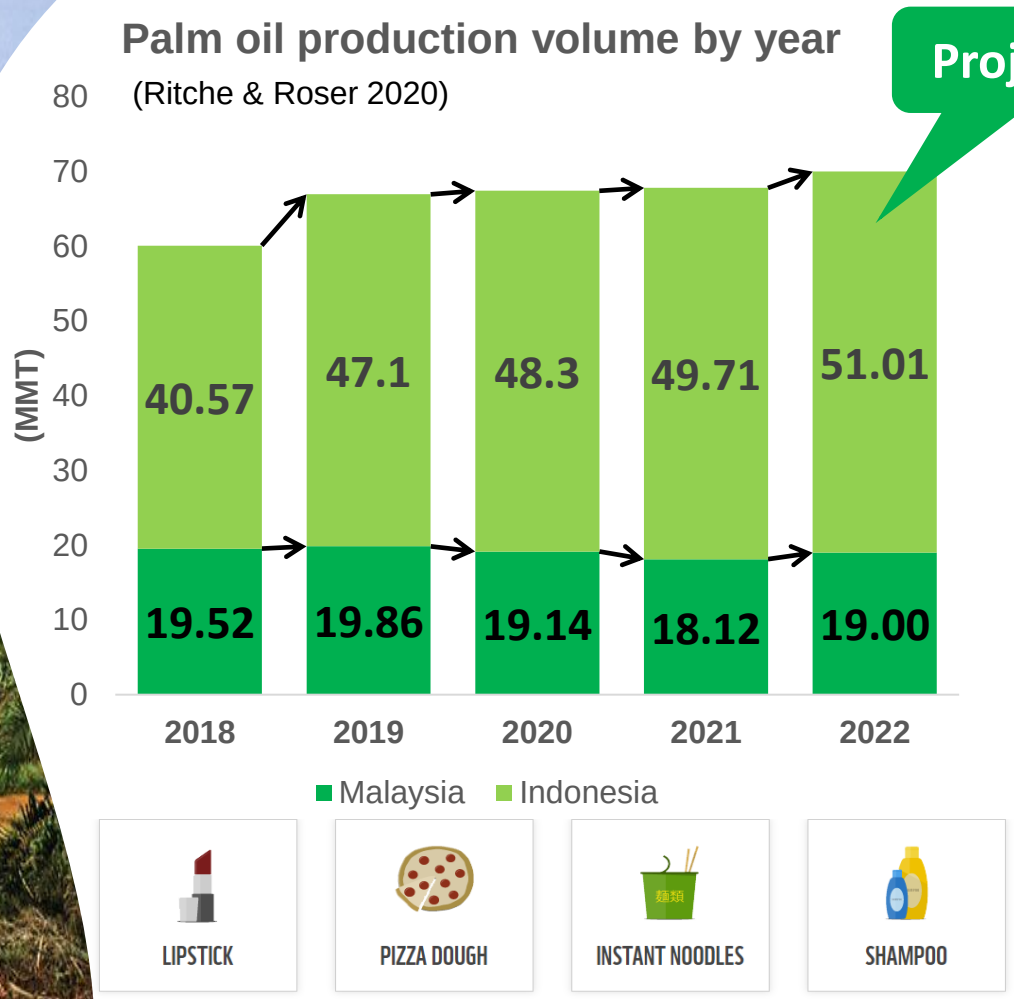
Introduction

Keywords:

Oil Palm Biomass, COVID-19, Disposable Face Mask waste, Co-pyrolysis

Background





Common biomass reduction methods:

- Direct combustion
- Fertilizers
- Landfill

(Abdullah & Sulaiman 2013)

Background

'More masks than jellyfish': coronavirus waste ends up in ocean – the Guardian (Kassam 2020)

Disposable face mask (DFM)

- Single-use plastic waste
- 73.33% Polypropylene (PP)
- 13.77% Polyethylene (PE)

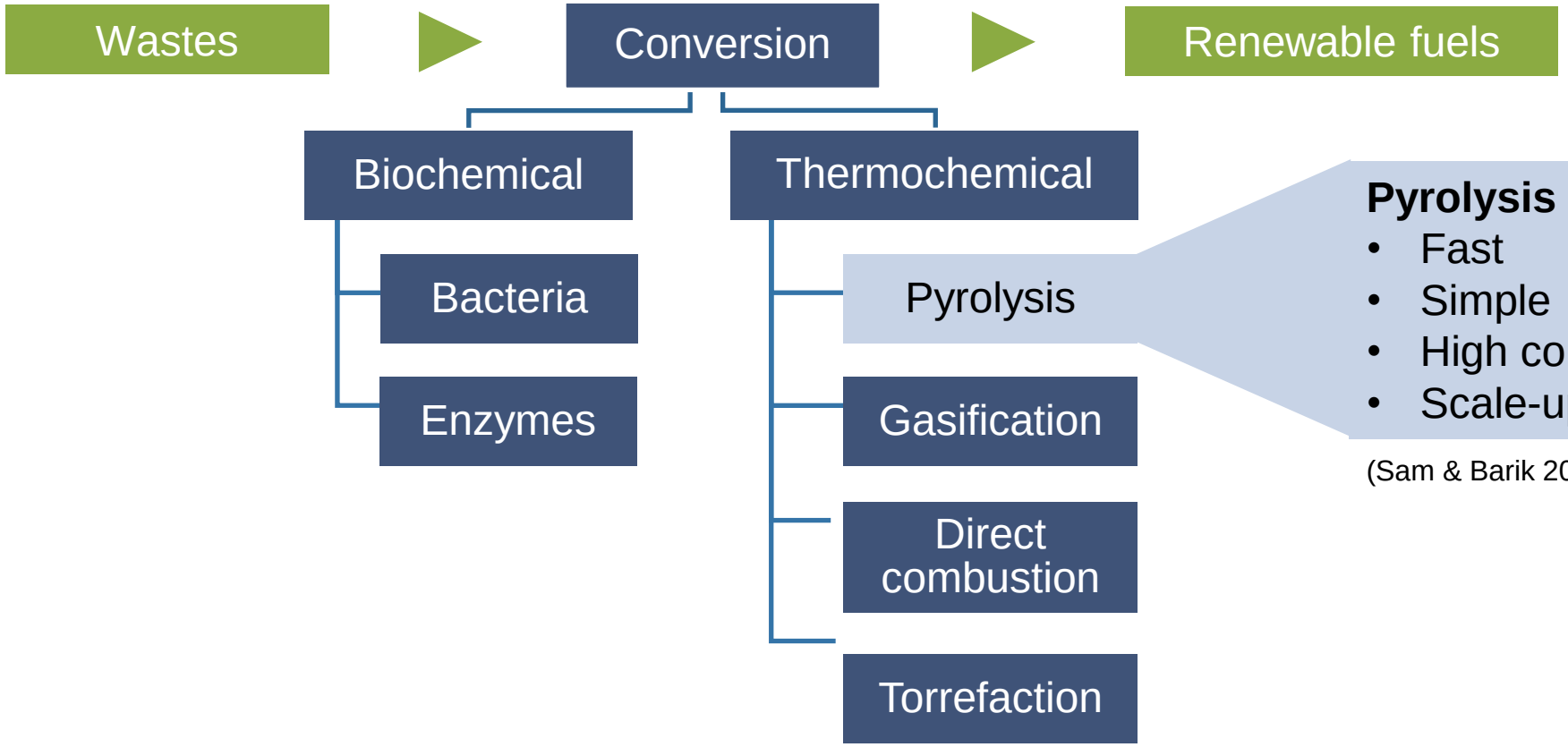
(Jung et al. 2021)

Consequences

- Microplastic pollution
- Landfill

(Li et al. 2022; Hui Li et al. 2022; Wang et al. 2022)

Background

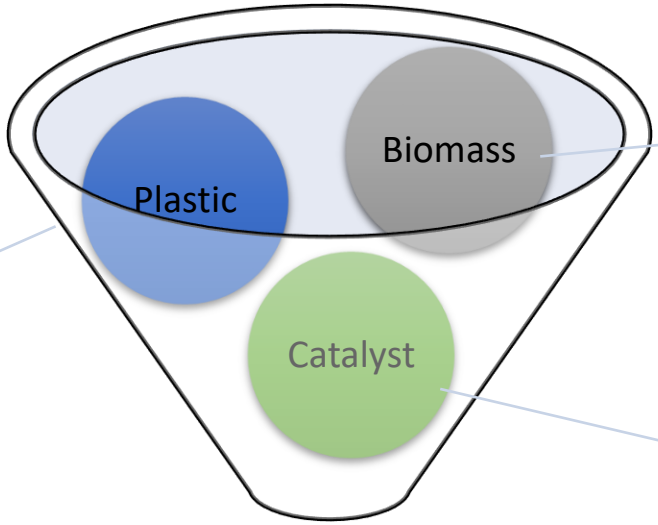


Pyrolysis advantages

- Fast
- Simple
- High conversion%
- Scale-up ready

(Sam & Barik 2019; Singh et al. 2015)

Background



Simple configuration design

Strong selectivity of desired aromatics

Reduce coke formation on catalyst

Renewable fuels

(Johansson et al. 2018; Xu et al. 2021)

Problem Statement

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Can we reduce these wastes via co-pyrolysis?

Research gaps

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- **Thermo-kinetic data**
- **Product quality and quantity**

Aims and Objectives

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Aim

- **Thermo-kinetic** parameters
- **Bio-oil yield%** and **composition** of the bio-oil

Objectives

- To perform Thermogravimetric analysis (**TGA**) and Distributed Activation Energy Model (**DAEM**)
- To synthesize bio-oil via **furnace tube reactor**
- To analyze bio-oil via Gas Chromatography Mass Spectrometry (**GC-MS**)

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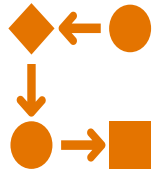
Methodology

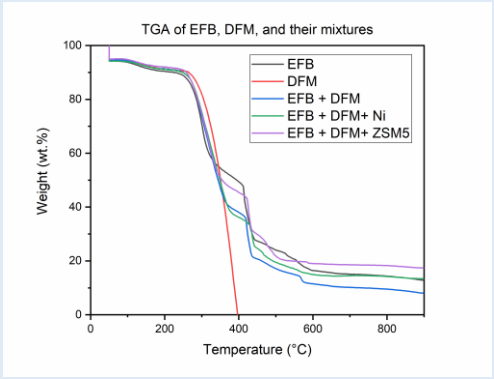


Thermogravimetric analysis (TGA)

Gas Chromatography Mass Spectrometry (GCMS)

Methodology

TGA



TGA data

$$ln\left(\frac{\beta}{T^2}\right) = ln\left(\frac{A\,R}{E}\right) + 0.6075 - \frac{E}{R\,T}$$

DAEM kinetic model

Thermo-kinetic Parameters

A, E, ΔH, ΔS, ΔG

Furnace Tube Reactor (Pyrolyser)

Bio-oil

GC-MS

Bio-oil yield% & quality

- Product distribution
- Carbon number
- Bio-oil composition

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Results

Thermo-kinetic results

Product analysis

Results

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Single feedstock and binary mixture pyrolysis

The content on this slide is not available to the POPSIG members and participants, until further notice, as it contains the author's unpublished data. The result will be presented during the seminar.

Results

Effect of heating rate on the catalytic co-pyrolysis process

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Results

- Thermo-kinetic analysis results:

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Results

- Co-pyrolysis product yield distribution

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Results

- Co-pyrolysis product yield distribution

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Results

- Bio-oil composition distribution

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Results

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Research impacts

Contributions to the palm oil industry

Compliance to SDGs

Research Impact

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- Produce value-added products
- Bio-oil quality

- Cost effective alternative to pretreatment
- Circular economy
- Solving the abundance of palm oil waste

- Creating solutions to reduce ghg
- Reduce face mask waste going into the river/sea waters causing microplastic pollution

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Future Study & Conclusion

What's next?

In a nutshell,..

Future Study

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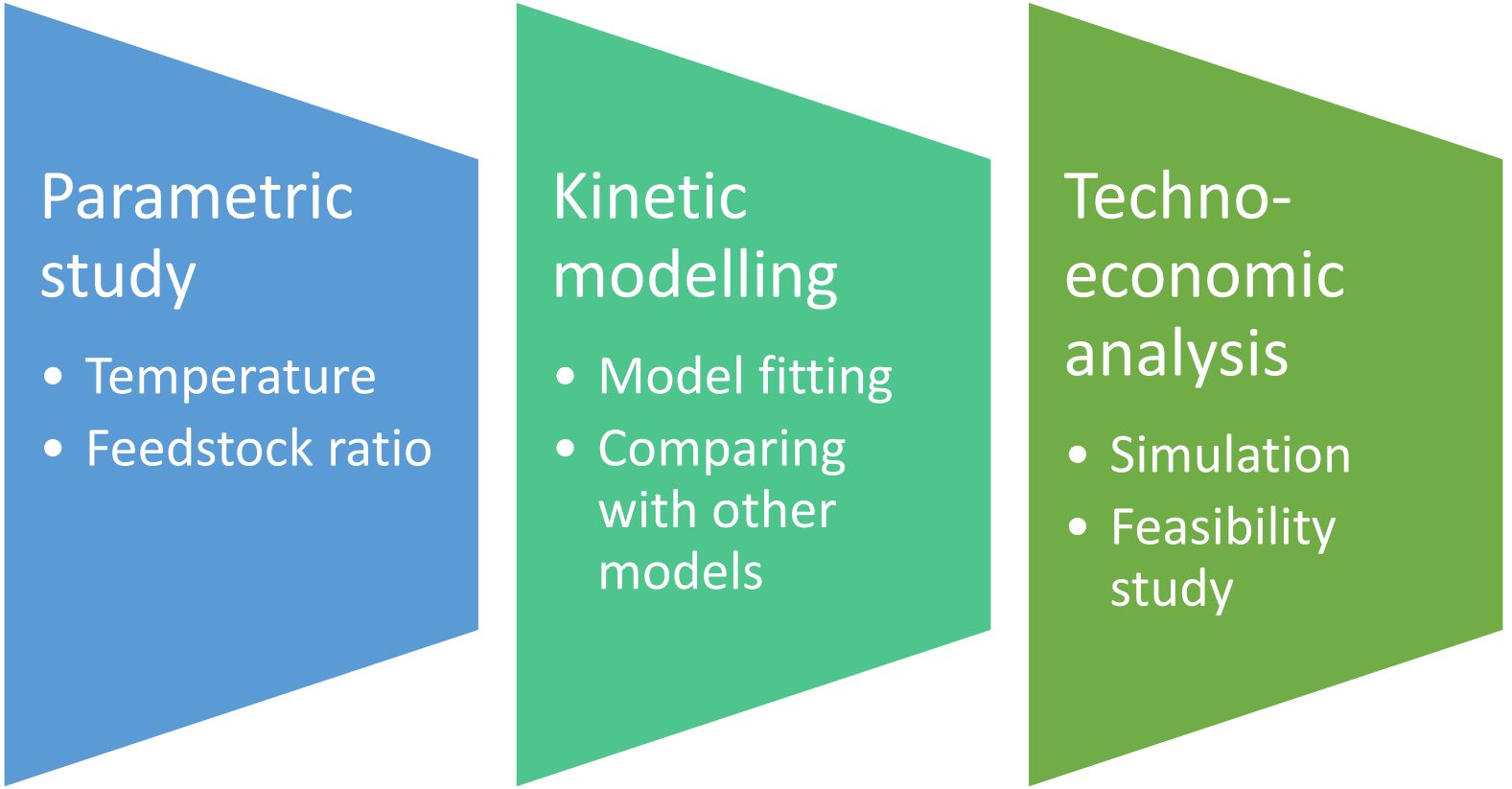

Conclusion

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Aims & Objectives

TGA and DAEM

- To determine the thermo-kinetic parameters, *A, E, ΔH, ΔS, ΔG*

Findings

- ✓ The thermo-kinetic parameters of the co-pyrolysis of EFB and DFM were determined
- ✓ The effects of heating rate is significant, increasing heating rate, increases the degradation rate.
- ✓ The performance of Ni and ZSM-5 catalyst were evaluated, **ZSM-5 > Ni** in terms of E **54.22 vs 59.49 kJ/mol**

Conclusion

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Aims & Objectives

Bio-oil synthesis & analysis

- To determine the bio-oil yield & composition

Findings

- ✓ The product distribution of the co-pyrolysis of EFB and DFM were determined.
- ✓ The addition of Ni and ZSM-5 catalyst were evaluated, Ni catalyst increased the biogas yield, while ZSM-5 increased the bio-oil yield
- ✓ Co-pyrolysis enhances the formation of aromatic hydrocarbons, and reduces the C-number selectivity hence improved the quality of bio-oil as a bio-fuel.

Support

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- **Dr. Bridgid Chin Lai Fui**, Associate Professor, Faculty of Engineering and Science, Curtin University Malaysia.
- **Dr. Agus Saptoro**, Professor, Faculty of Engineering and Science, Curtin University Malaysia
- **Ir. Dr. Jaka Sunarso**, Professor, Faculty of Engineering, Computing and Science, Swinburne University of Technology Sarawak
- **Ir. Dr. Chew Jiuan Jing**, Discipline Leader, Faculty of Engineering, Computing and Science, Swinburne University of Technology Sarawak
- **Ir. Dr. Suzana Yusup**, Principal Researcher and Head of Section, Fuel and Combustion, Generation unit, Department of Generation and Environment Tenaga Nasional Berhad Research.

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