Current Strategies and Future Opportunities Low Carbon Operation in Palm Oil Milling Processes

Ir. Viknesh Andiappan, Ph.D.

CEng MIChemE, PEng

Associate Professor

Swinburne University of Technology Sarawak Campus

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Palm Oil Milling Technology, Exhibition & Conference

8 – 9 Aug 2023
Imperial Hotel, Miri

Viknesh Andiappan

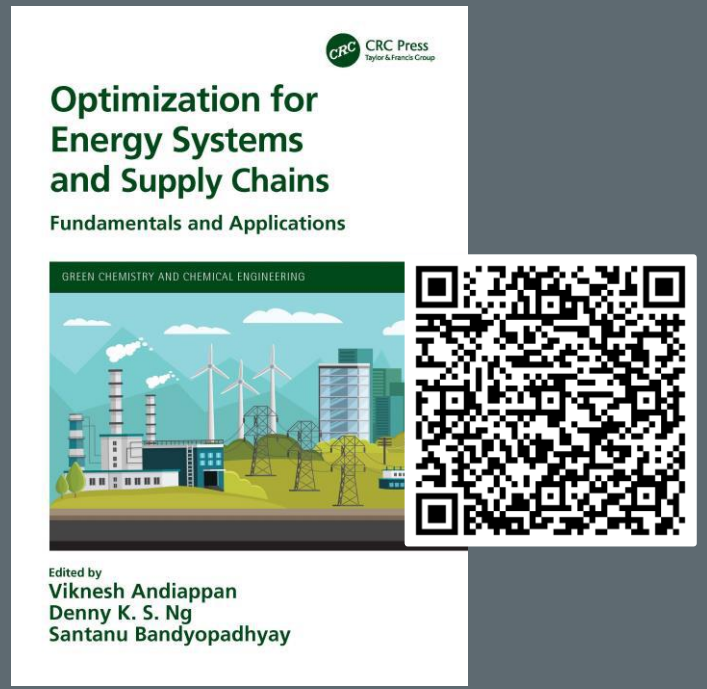
PhD, MIChemE, CEng, PEng, FHEA
Associate Professor
Chemical Engineering Discipline
Faculty of Engineering, Computing and Science

Education:

MEng (Hons.) Chemical Engineering (Nottingham, Malaysia)
PhD in Engineering (Nottingham, Malaysia)

Research Areas:

- Process and energy systems engineering
- Renewable energy systems and supply chains
- Negative emission systems
- Energy and carbon emission reduction planning
- Sustainable agricultural planning



Award and Recognitions:

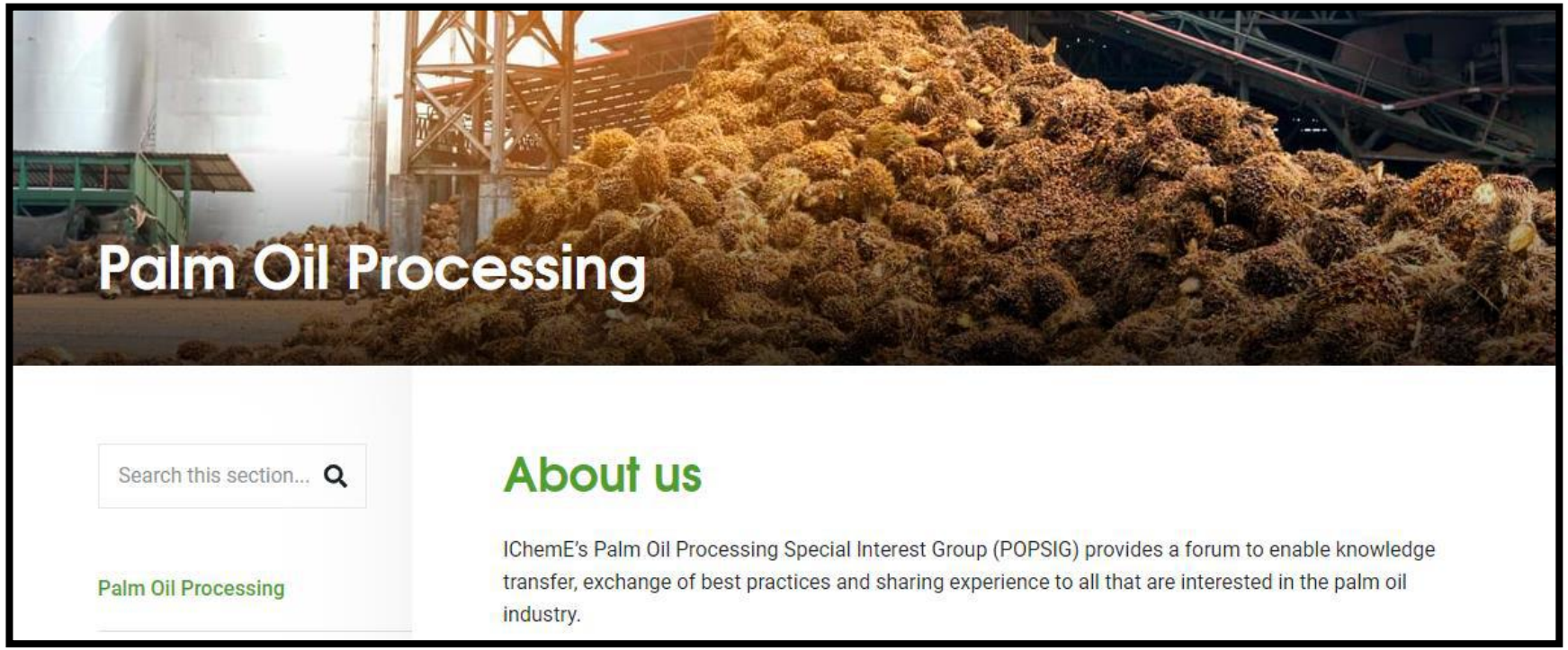
Top 2% Scientist in the World for a single year
Processes 2022 Young Investigator Award Winner
IBAE Young Researcher of the Year 2020
IChemE Young Researcher Malaysia Award Finalist 2018, 2019
Heriot-Watt PRIME Award Finalist 2021
ASEAN-ROK STI Next Innovator 2021 Top 3 Finalist
90+ publications and h-index = 18 (Scopus)
Vice Chair and Lead for Climate Action Strategy, Palm Oil Processing Special Group (IChemE – POPSIG)

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE
Palm Oil Processing Special Interest Group

Ir. Viknesh Andiappan, Ph.D.

Career highlights

- ❑ Vice Chair, IChemE Palm Oil Processing Special Interest Group (POPSIG)
- ❑ Former University Roadshow Director, IChemE Palm Oil Processing Special Interest Group (POPSIG)



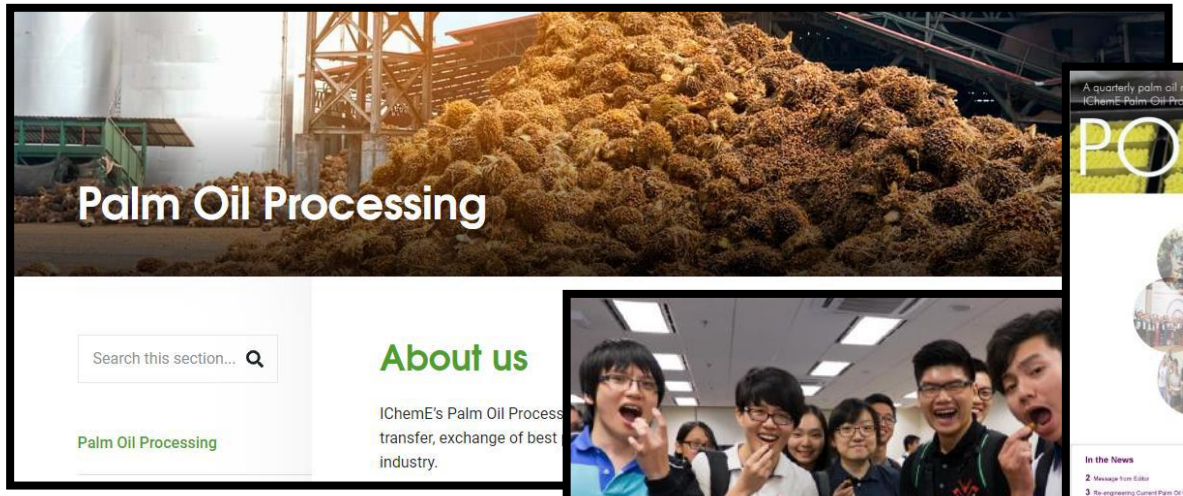
IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

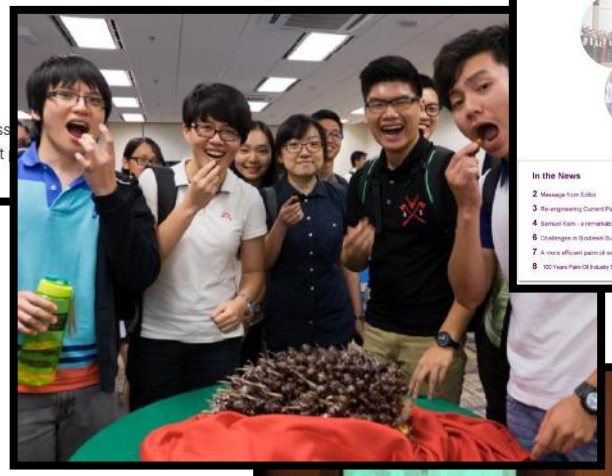
Palm Oil Processing Special Interest Group

Who are We?

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Palm Oil Processing Special Interest Group





Objectives

- share and promote best practices
- encourage innovation in processing oil palm products
- promote professional aspects of the palm oil industry
- act as a focal point for all those interested in the process aspects of oil palm processing.

Activities

- technical seminars, workshops, site visits, webinars and physical evening talks
- quarterly newsletter
- yearly forum
- support for the annual IChemE Malaysia Palm Oil Industry Award

Our Social Media

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Please Like & Follow IChemE POPSIG

Introduction

All 197 countries represented at COP26 signed the pact. Robert Perry/EPA

Major achievements of the deal

- Re-visiting emissions-cutting plans next year to try to keep 1.5ºC target reachable
- The first ever inclusion of a commitment to limit coal use
- Increased financial help for developing countries

Countries launched a package of 25 new collaborative actions in five key areas: power, road transport, steel, hydrogen and agriculture.

https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries

https://theconversation.com/cop26-experts-react-to-the-un-climate-summit-and-glasgow-pact-171753
https://www.cnbc.com/2021/11/04/cop26-live-updates-from-climate-summit-in-glasgow.html

Introduction

- Malaysia has stated commitment to achieve net zero emissions under the 12MP by 2050

Malaysia sets 2050 carbon-neutral goal

Published date: 28 September 2021

Share:

Malaysia's new prime minister Ismail Sabri Yaakob has announced a goal for the country to become carbon neutral "as early as 2050", alongside a commitment to stop building new coal-fired power plants.

Malaysia is the world's fourth-largest LNG exporter and second-biggest paln
oil producer.

"Cleaner electricity generation will be implemented through the operation c
several gas power plants in peninsular Malaysia to replace coal power plants
Ismail said when announcing the 12th Malaysia Plan for 2021-25. Gas is still
fossil fuel, albeit less polluting than coal. Coal-fired output accounts for more
than 50pc of Malaysia's generation mix.

Introduction

- To achieve net zero emissions, we need to look at:
  - Low carbon technologies
  - Emission removal technologies
  - Energy efficiency improvement

https://ukcop26.org/focus-of-energy-transition-council-etc/

All these need to be addressed holistically!

Introduction

Towards Net Zero Palm Oil By CSPO Watch

The Malaysian palm oil industry is making moves towards net zero palm oil.

The palm oil industry globally has long been targeted as an industry that contributes to climate change. As a popular scapegoat for climate change, every process in producing palm oil is scrutinized like no other product in the world.

Attention on the environmental impact of vegetable oils like soy or canola which have a much larger land footprint are mere hiccups in the media when compared to palm oil. The palm oil industry's arguments that it has contributed much to the development of third world countries falls on deaf ears when visuals like orangutans question its sustainability.

Edge Weekly

My Say: The palm oil industry can be net-zero carbon by 2040

Qua Kiat Seng and Jaybalan Tamahrajah / The Edge Malaysia
November 15, 2021 11:30 am +08

How the palm oil industry is transitioning to net-zero By Ir Hong Wai Onn

The palm oil industry is a unique position - It is no stranger to implementing strategies to achieve emission reductions and circular economy

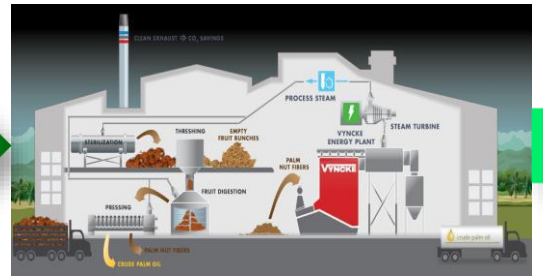
https://www.cspo-watch.com/towards-net-zero-palm-oil.html
https://www.theedgemarkets.com/article/my-say-palm-oil-industry-can-be-netzero-carbon-2040
https://www.weforum.org/agenda/2021/08/how-palm-oil-industry-is-transitioning-to-net-zero/

Palm Oil Industry

- The palm oil industry consists of the plantation, mills, refineries

OIL PALM PLANTATION

- ESTATE / SMALLHOLDERS
- FRESH FRUIT BUNCH (FFB)
- INFLUENCE OF CLIMATIC REQ ON GEO'PIC DISTRBUTION



PALM OIL MILL

- PROCESS FFB TO PRODUCE CRUDE PALM OIL (CPO)
- BIOMASS WASTES
- EFFLUENT WASTE

PALM OIL REFINERY

- IMPURTIES, ODOUR & FFA TO PRESCRIBED LIMITS
- REFINED PALM OIL

PALM OIL

- USED FOR DIFFERENT APPLICATIONS

Palm Oil Mills

- Palm oil milling process generates biomass waste such as ***PKS, PMF, EFB,*** *and effluent such as* ***POME***

Mill 60 t/h

POME 36 t/h

EFB 14 t/h

PKS 4 t/h

PMF 8 t/h

Great energy sources!

- Mill typically requires 1.5 MW for internal consumption
- But the biomass and effluent wastes contain excess energy larger than 1.5 MW
- Steam to power ratio 20:1 typically

Low Carbon Technologies and Energy Efficiency

Current Strategies

Let’s take a closer look at the main biomass and effluents

Mill

POME

EFB

PKS

PMF

Current Strategies

POME – biogas capture and utilization for electricity production

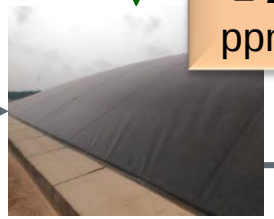
Reduces the reliance on fossil fuel power plants, achieving emission reductions

Mill

POME

Power grid

electricity



≤ 2,000 ppm H_2S

Anaerobic Digester

Raw biogas

≤ 200 ppm H_2S

Scrubber

Gas engine

≤ 10 ppm H_2S

Steam

Boiler

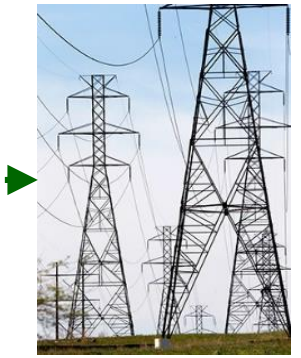
Current Strategies

Reduces the use of fresh fertilizer

EFB

Mulching

PKS



Power grid

Mill

electricity

≤ 40% moisture

PMF

Boiler

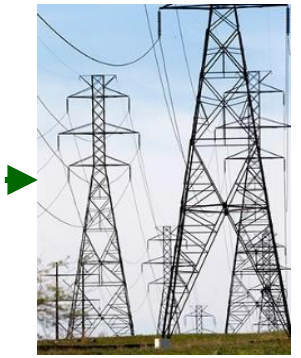
Steam

Current Strategies

EFB

Mulching

PKS



Power grid

Lowest quality for boiler fuel due to high moisture (i.e., 60%) but could be used when dried / pelletized

Mill

electricity

≤ 40% moisture

PMF

Boiler

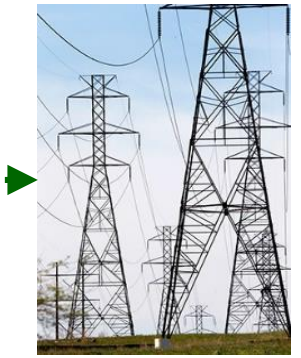
Steam

Current Strategies

EFB

Mulching

PKS



Power grid

Mill

electricity

≤ 40% moisture

PMF

Boiler

Steam

Best quality (i.e., <15%) for boiler fuel but often sold to other industries

Reduces usage of fossil fuel in other industries

Future Opportunities

- Biochar from palm oil biomass for plantations

Biochar

Fine-grained Charcoal

Applied to soil

Future Opportunities

- Biochar from palm oil biomass for plantations

Store Carbon at Stable Form

As Soil Amendment

Retention

Nutrients

Water

Carbon Storage

Future Opportunities

- Biochar from palm oil biomass for plantations
- Negative emission technology - reduces carbon emissions further

Store Carbon at Stable Form

As Soil Amendment

Retention

Nutrients

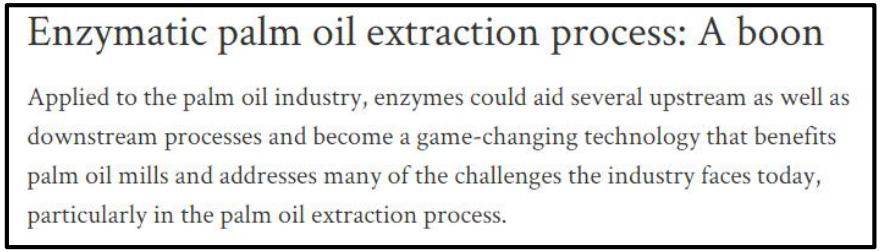
Water

Plant Growth

Carbon Storage

Future Opportunities

- Enzymatic processes vs FFB sterilization - to improve oil yield and reduce emissions

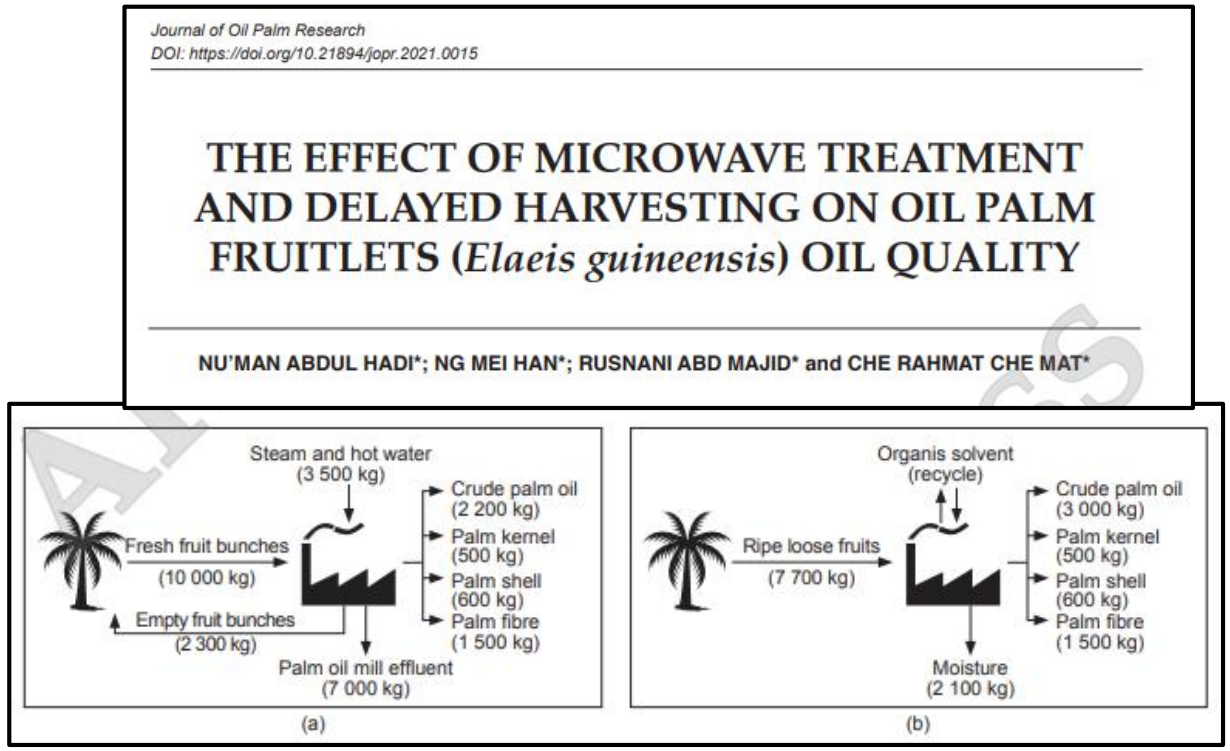


Enzymatic palm oil extraction process: A boon

Applied to the palm oil industry, enzymes could aid several upstream as well as downstream processes and become a game-changing technology that benefits palm oil mills and addresses many of the challenges the industry faces today, particularly in the palm oil extraction process.

https://www.thechemicalengineer.com/features/palm-oil-better-with-enzymes/

- Sterilization:
  - Microwave sterilization technology (FFB) – eliminates POME and reduces moisture in EFB
  - New sterilizer designs to reduce moisture content in EFB
    - Frees up other biomass for higher value-added applications – able to reduce emissions for other industries while keeping mills to low carbon



Journal of Oil Palm Research
DOI: https://doi.org/10.21894/jopr.2021.0015

THE EFFECT OF MICROWAVE TREATMENT AND DELAYED HARVESTING ON OIL PALM FRUITLETS (*Elaeis guineensis*) OIL QUALITY

NU'MAN ABDUL HADI*; NG MEI HAN*; RUSNANI ABD MAJID* and CHE RAHMAT CHE MAT*

http://gofbonline.com/4378-2/

Future Opportunities

- POME evaporation / elimination
- Large scale biomass power plants vs Co-firing biomass with existing power plants – transportation vs grid lines?
- Industrial symbiosis – processing complex or co-located plants sharing energy and materials – to utilize excess energy potential

What's Next?

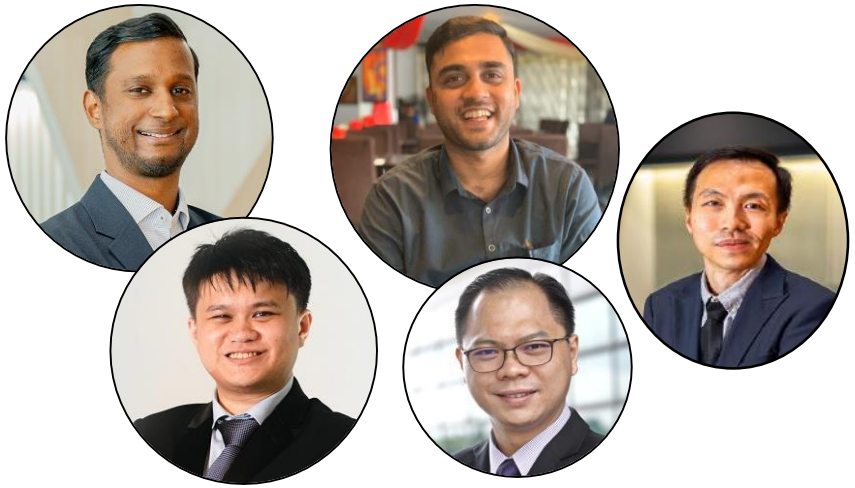
- Significant precedence available on low carbon technologies and energy efficiency in palm oil industry for net zero emissions

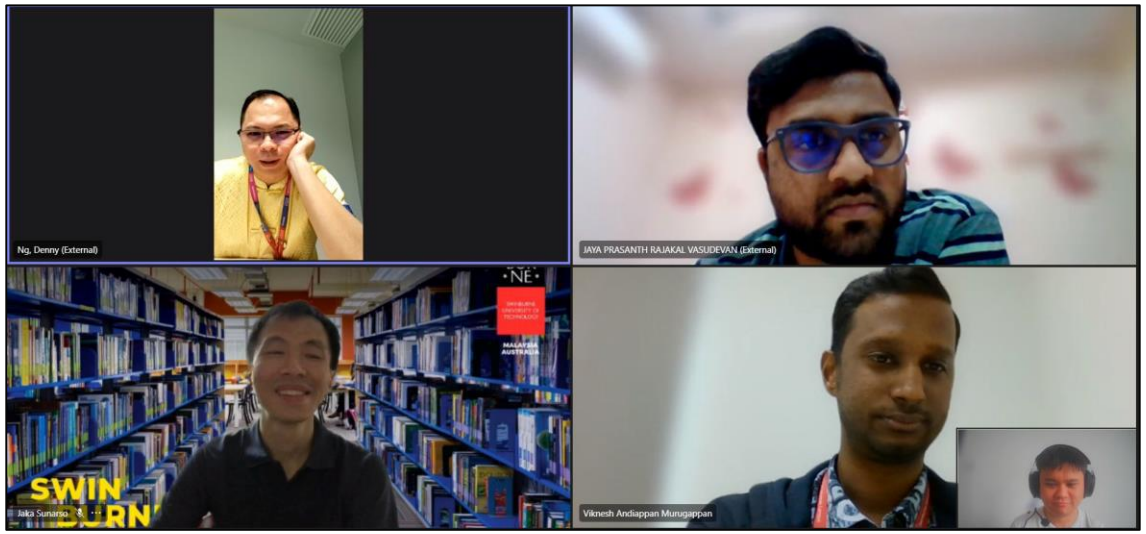
- Which is the best? Optimisation studies are required!

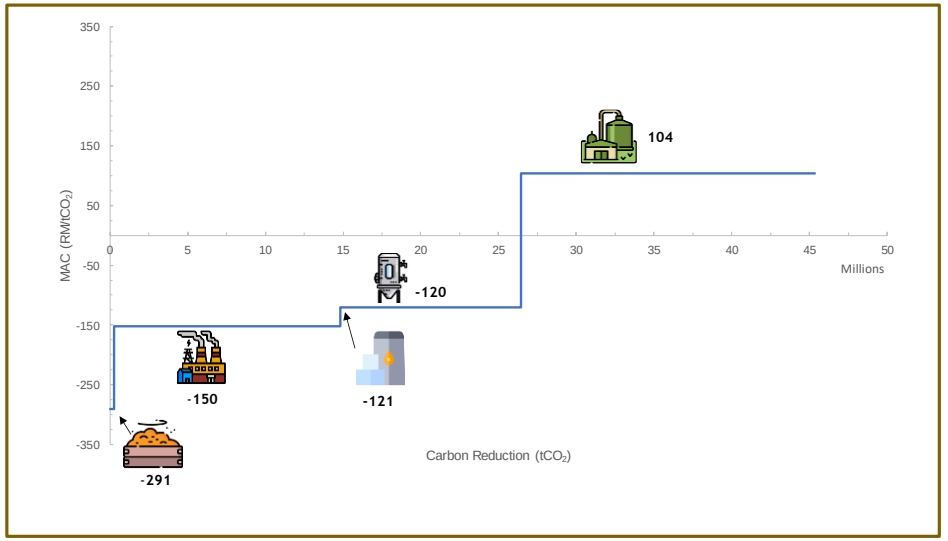
What's Next?

Developing Strategies for the Malaysian Oil Palm Estates and Mills for Net-Zero Carbon Emissions

MPOC

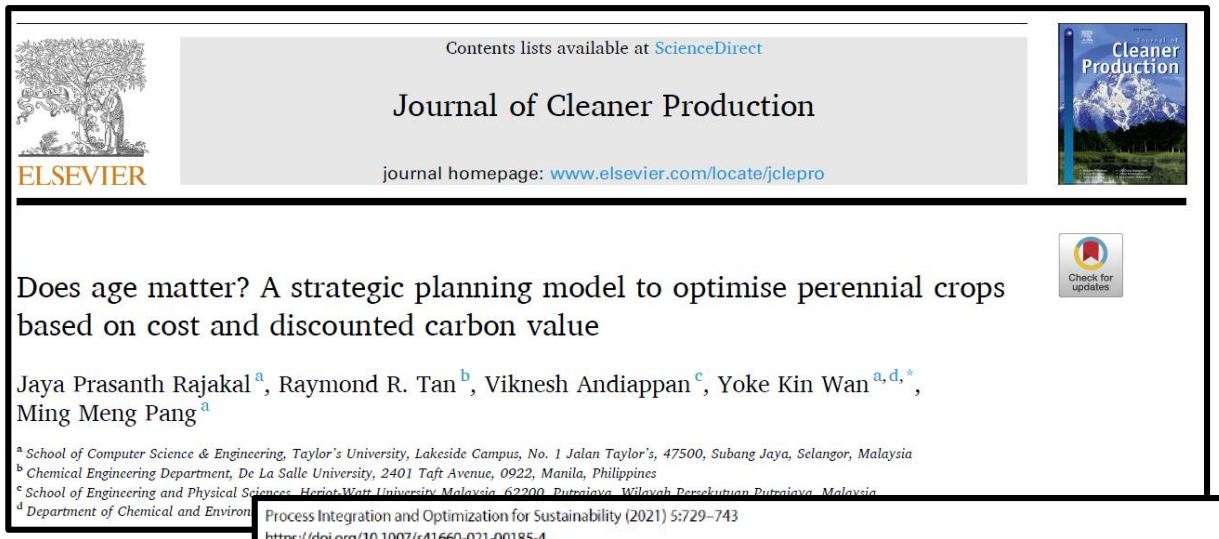






What's Next?

- Optimisation studies:
  - Optimising oil palm plantation expansion for management of carbon emissions



Contents lists available at ScienceDirect

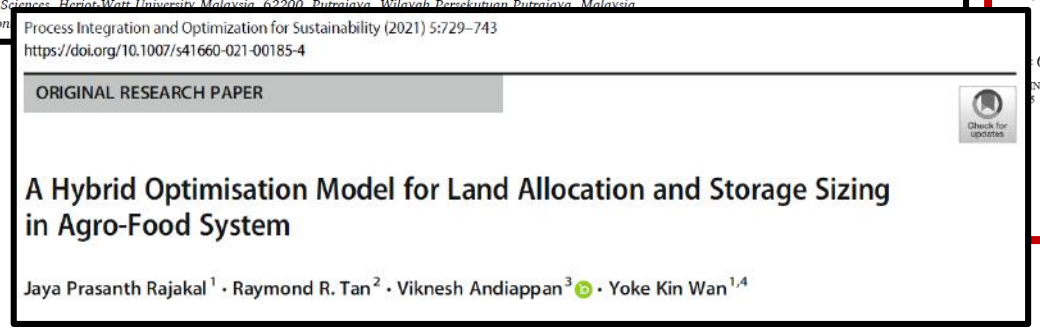
Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Does age matter? A strategic planning model to optimise perennial crops based on cost and discounted carbon value

Jaya Prasanth Rajakal [a], Raymond R. Tan [b], Viknesh Andiappan [c], Yoke Kin Wan [a,d,*], Ming Meng Pang [a]

[a] School of Computer Science & Engineering, Taylor's University, Lakeside Campus, No. 1 Jalan Taylor's, 47500, Subang Jaya, Selangor, Malaysia
[b] Chemical Engineering Department, De La Salle University, 2401 Taft Avenue, 0922, Manila, Philippines
[c] School of Engineering and Physical Sciences, Heriot-Watt University Malaysia, 62200, Putrajaya, Wilayah Persekutuan Putrajaya, Malaysia
[d] Department of Chemical and Environ

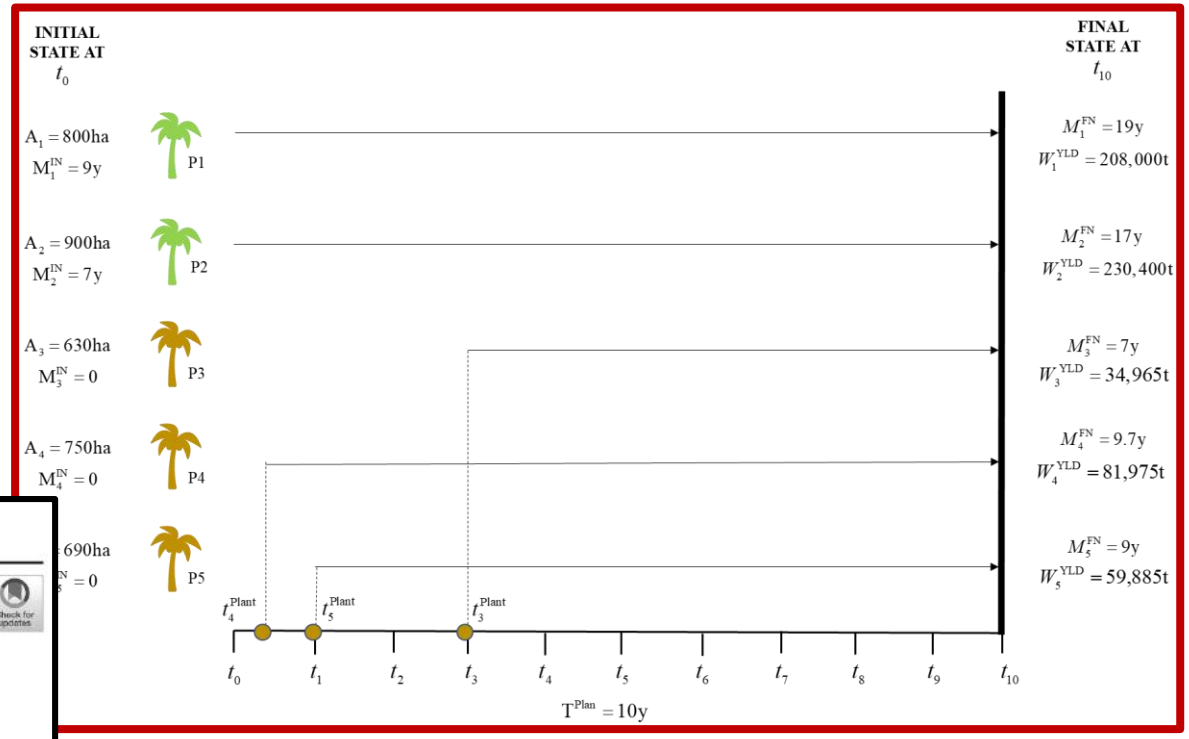


Process Integration and Optimization for Sustainability (2021) 5:729–743
https://doi.org/10.1007/s41660-021-00185-4

ORIGINAL RESEARCH PAPER

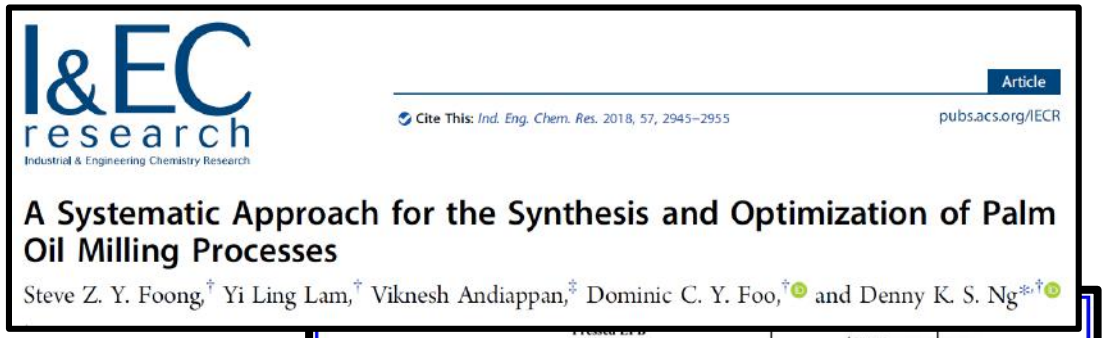
A Hybrid Optimisation Model for Land Allocation and Storage Sizing in Agro-Food System

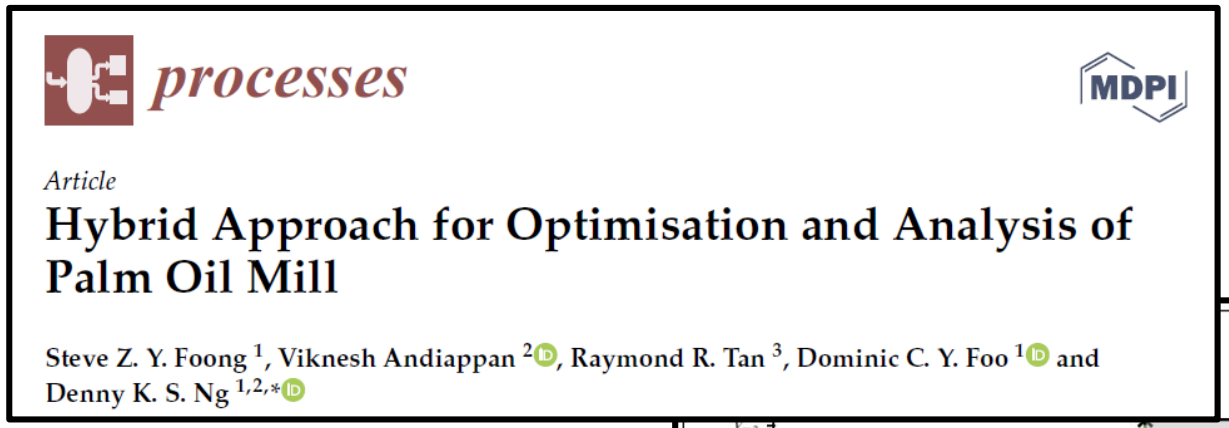
Jaya Prasanth Rajakal [1] · Raymond R. Tan [2] · Viknesh Andiappan [3] · Yoke Kin Wan [1,4]

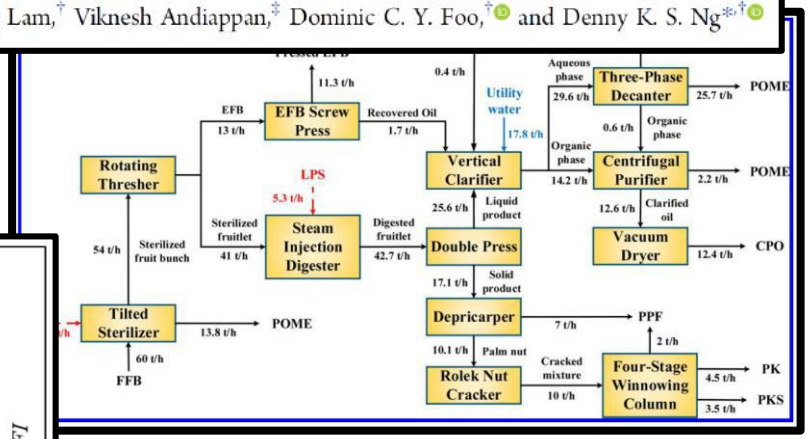


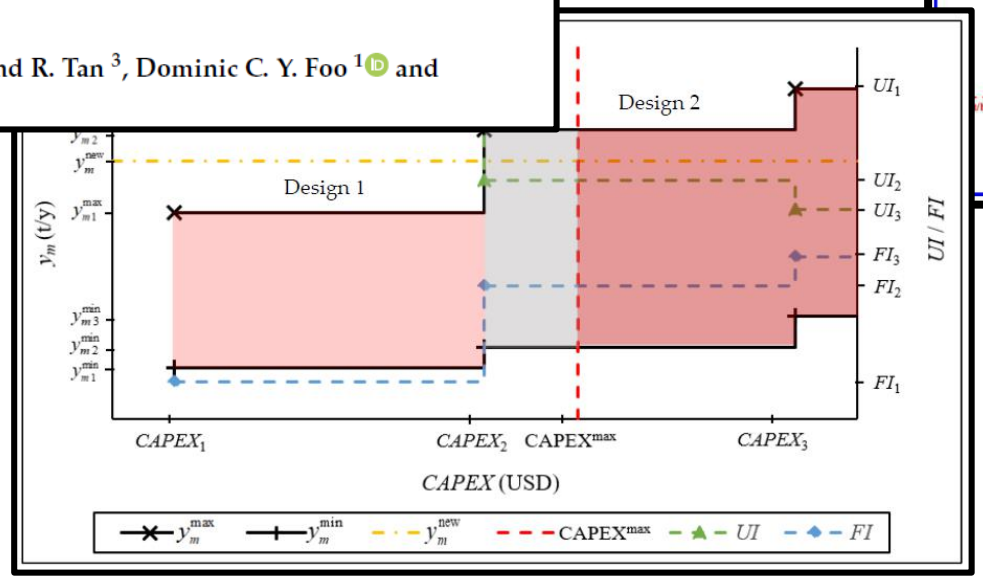
What's Next?

- Optimisation studies:
  - Optimising operations of palm oil mill process









What's Next?

- Optimisation studies:
  - Optimising palm oil processing complex

Journal of Cleaner Production 129 (2016) 496–507

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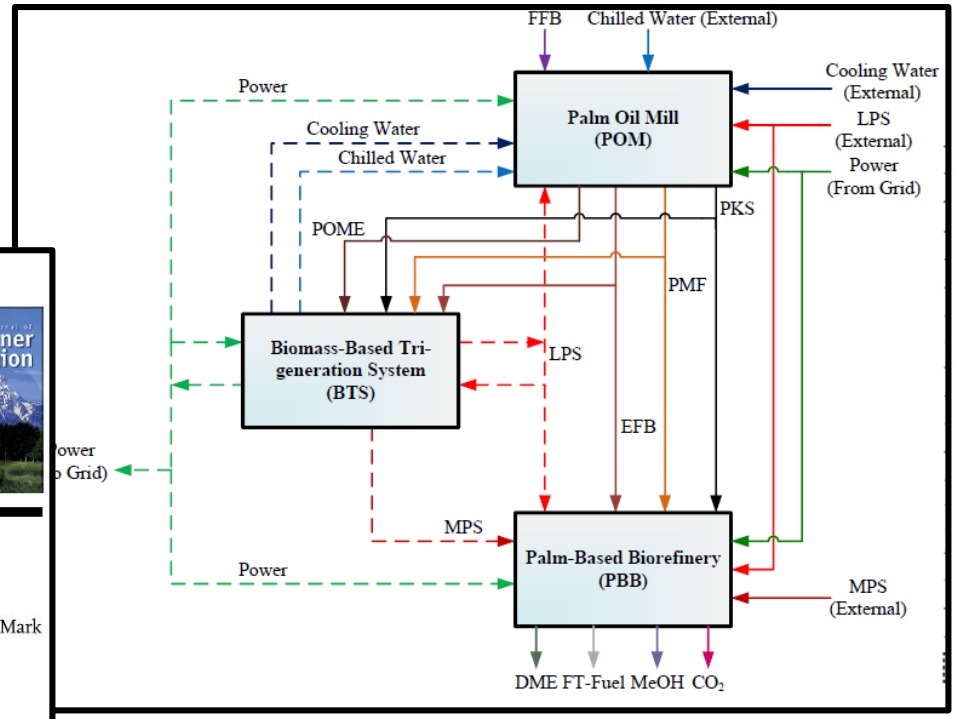
CrossMark

An optimization-based negotiation framework for energy systems in an eco-industrial park

Viknesh Andiappan [a], Raymond R. Tan [b], Denny K.S. Ng [a, *]

[a] Department of Chemical and Environmental Engineering/Centre of Sustainable Palm Oil Research (CESPOR), The University of Nottingham, Malaysia Campus, Broga Road, Semenyih 43500, Malaysia

[b] Chemical Engineering Department, De La Salle University, 2401 Taft Avenue, 0922 Manila, Philippines



Concluding Remarks

- Promising for current and future low carbon technologies

- Need to start quantifying and assessing the emissions – life cycle assessments or optimisation?
  - To provide clear proof of achievements
  - To identify areas for further improvement
  - To set reasonable targets and policies
  - To prove to the world – scientific-based evidence

- Determine net zero targets for a plantation? Mill? Refinery? or for entire industry?

Thanks for your attention

Questions are welcomed

Like to know more?

Just get in touch!

Ir Viknesh Andiappan, PhD
CEng MIChemE, PEng
Associate Professor, Swinburne University
Vice Chair, IChemE POPSIG
E-mail: vmurugappan@swinburne.edu.my