14th e-ASIA Workshop on Alternative Energy

25 November 2024

Participating MOs under the Alternative Energy

BRIN
BADAN RISET
DAN INOVASI NASIONAL

Indonesia: National Research and Innovation Agency (BRIN)

Japan Science and Technology Agency

Japan: Japan Science and Technology Agency (JST)

Ministry of Science and Technology (MOST)

DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE COUNCIL FOR INDUSTRY, ENERGY AND EMERGING TECHNOLOGY RESEARCH AND DEVELOPMENT (DOST-PCIEERD)

Philippines: Department of Science and Technology (DOST-PCIEERD)

วช.
NRCT

National Research Council of Thailand (NRCT)

Objective of the Joint Call and Research Area

The Joint Call aims to **develop a vibrant and collaborative research community in Science and Technology** to promote innovation in the East Asia region and to contribute to the region's economic development

Alternative Energy Topics

Participating MO	Hydrogen (Production & Storage; Biohydrogen & Hydrogen from Waste)	Fuel (Biofuel & Aviation Fuel)	Energy Storage
Indonesia (ID)	√	√	√
Japan (JP) (Support MO)	√	√	√
Myanmar (MM)			
The Philippines (PH) (Main MO)	√	√	√
Thailand (TH)	√		

excerpt of the Alternative Energy Call Guidelines

Research Areas

Sub-topic 1: HYDROGEN (Production & Storage; Biohydrogen & Hydrogen from Waste)

1.1Green Hydrogen and Hydrogen Economy

Hydrogen, in addition to being an alternative energy source, has applications as an alternative fuel and offers environmentally friendly combustion. However, the commercial use of clean hydrogen fuel faces economic challenges related to its production, storage, transportation, and utilization.

Research Areas

Sub-topic 2: FUEL (Biofuel & Aviation Fuel)

2.1Bioenergy: Bioenergy& Biofuels

Bioenergy, encompassing biofuels and bio-based energy sources, harnesses the potential of biomass. This biomass comprises a range of materials, including agricultural and forest residues, energy crops, sewage sludge, biogenic components in municipal solid waste, microalgae, and various organic materials

Research Areas

Sub-topic 3: Energy Storage

Topic will focus centers on advancing Electrochemical Energy Storage (EES) technologies, serving the dual purposes of electric vehicles (EVs) and stationary energy storage applications.

Research Areas for Alternative Energy

SUB-TOPIC 1: HYDROGEN
Production & Storage
Biohydrogen
Hydrogen from Waste

Cost-effective Biohydrogen Production and Water Bio-Splitting

Research on Green Hydrogen for Heavy Industries

Study on Development of Hydrogen Economy Ecosystem

SUB-TOPIC 2: FUEL
Biofuel
Aviation Fuel

Utilization and Advancement of Agricultural Waste for Alternative Energy and Carbon Mitigation

Zero-Waste Approach to Biomass Collection and Conversion Technologies

Integration of Biomass-to-Energy Technologies into Existing Industries

Development of Sustainable Transportation Fuels

Hydrogen Production from Biomass and its Diverse Application

SUB-TOPIC 3: ENERGY STORAGE

Fuel Cell and Hydrogen Technologies

Supercapacitors

Rechargeable Batteries

Development of Conductive Materials as Additives

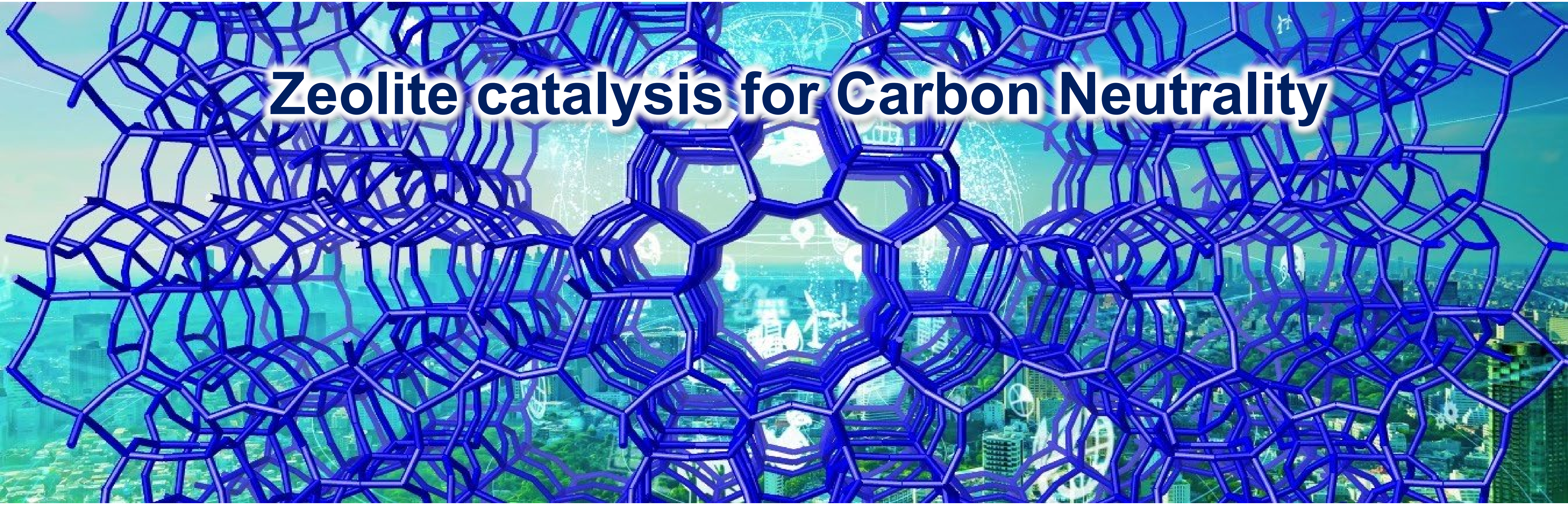
Recycling of Spent Battery Materials

Carbon-based Materials (from agricultural and kitchen waste)

14th e-ASIA Workshop on Alternative Energy

25 November 2024

Zeolite catalysis for Carbon Neutrality



Toshiyuki Yokoi, PhD, Professor

Nanospace Catalysis Research Unit, Institute of Integrated Research, Institute of Science Tokyo

Institute of
SCIENCE TOKYO

National University Corporation **Institute of Science Tokyo (東京科学大学)**

by integrating

- Tokyo Institute of Technology **(東京工業大学)**
- Tokyo Medical and Dental University **(東京医科歯科大学)**

Catalytic Chemistry
*for effective utilization of **diverse resources***

Plastics | Nylon | Rubber | Paint | Detergents Adhesives | Drugs, Agrochemicals

Cat.

Cat.

Functional & Fine Chemicals

Basic chemical feedstock

Ethylene, Propylene, Butenes, Butadiene, BTX

Zeolites

Diverse carbon resources

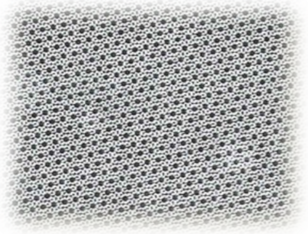
Unconventional resources:
- ✓ Tight Gas
- ✓ Coalbed Methane
- ✓ Shale Gas & Oil
- ✓ Heavy Oil/Tar sands
- ✓ Methane Hydrates
- ✓ Biomass
- ✓ CO_2

Conventional resources:
- ✓ Oil
- ✓ Coal
- ✓ Natural gas

Nanospace Catalysis Unit

Novel nanospace catalysts

- **Zeolites**

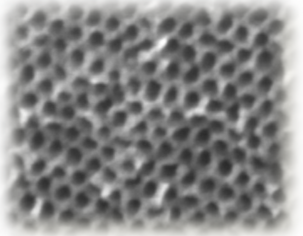


0.3-1.0 nm

- Hydrothermal synthesis
- Zeolite transformation
- Template-free synthesis
- Core-Shell structure
- Distribution of hetroatom
- Hydrothermal stability

… …

- **Mesoporous Materials**

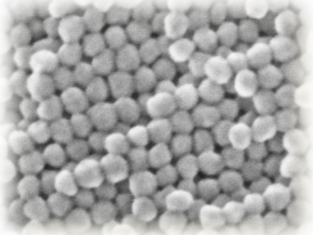


1-20 nm

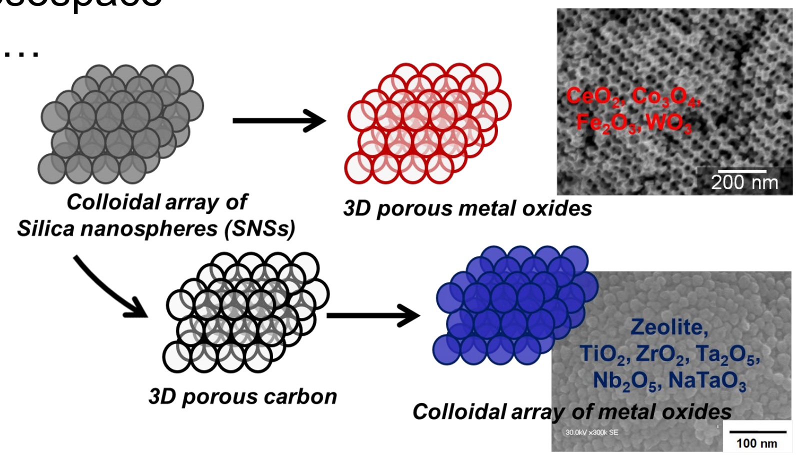
- Monodisperse spherical mesoporous silica
- Porous silica with chiral mesospace

… …

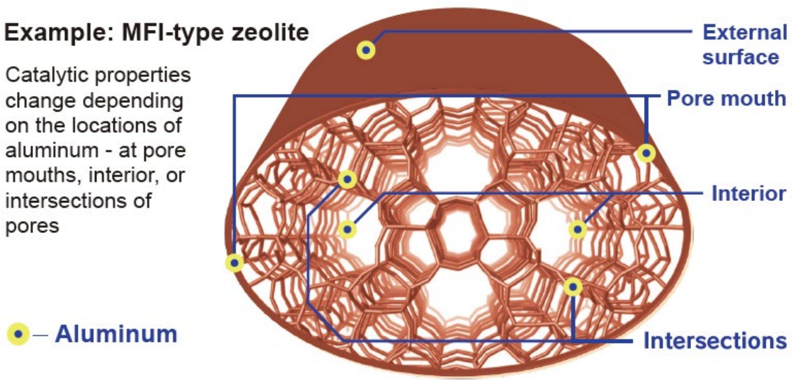
- **Nano Particles**

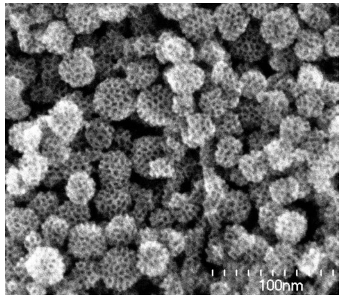


5-500 nm



Selective production of chemical substances by controlling the position of aluminum at the atomic level





Ti-containing mesoporous silica nanospheres

Nanospace Catalysis Unit

Catalytic process

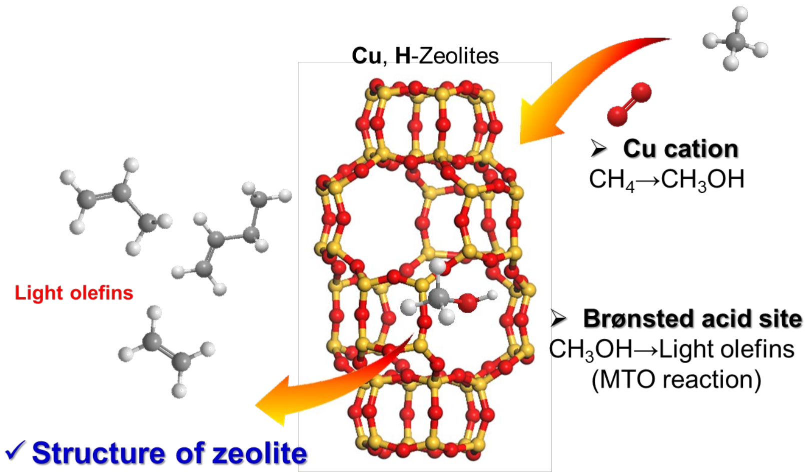
- FCC process (naphtha cracking)
- Methanol to olefins (MTO)
- Methane to methanol (MTM)
- Methane to olefins
- CO_2 conversion
- Selective Catalytic Reduction of NO_x with NH_3 (NH_3-SCR)
- Benzene to phenol (BTP)
- Biomass catalysis
- Baeyer-Villiger oxidation
- Epoxidation over titanosilicate
- Base catalysis

… …

Characterization methods

- Solid state NMR (JEOL ECA600)
- In-situ FT-IR, UV-vis,
- Ramann
- SEM/STEM（Hitachi SU9000）

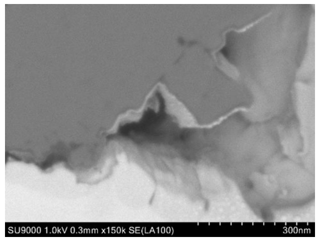
… …

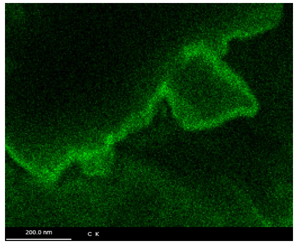


✓ **Structure of zeolite**

✓ **Amount, State and Distribution of Al and Cu species**

Deactivated ZSM-5





Cross-section image **Distribution of coke**
























JEOL

Institute of SCIENCE TOKYO

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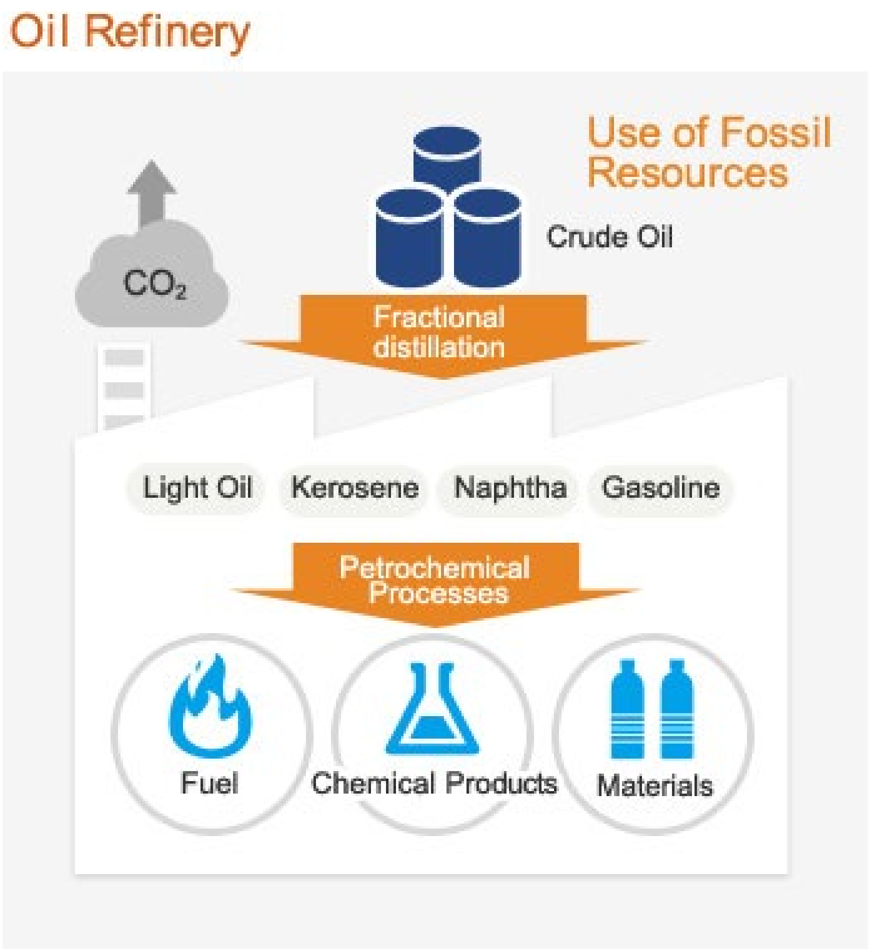
2024 Spring: 19 students

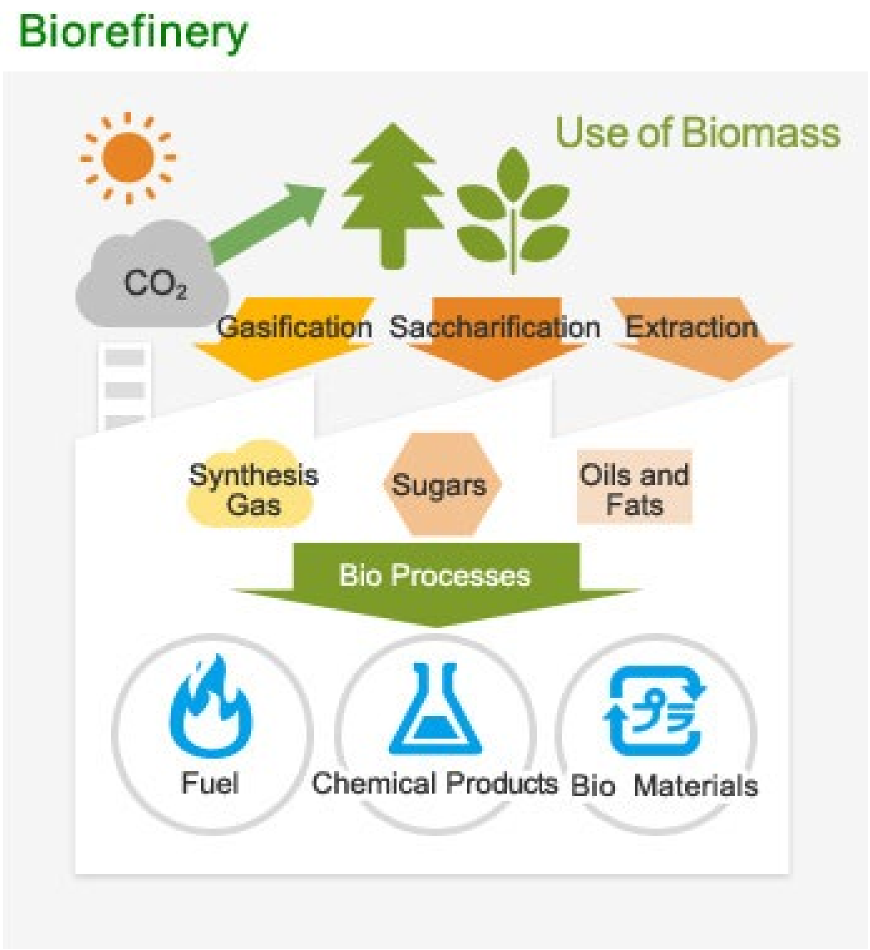
- PI: Prof. Yokoi 1
- Visiting Prof. 1
- Postdoc 2
- Technical staff 3
- PhD candidates 11
- (8 from oversea)
- Master 6
- (4 from oversea)
- Bachelor 2

2023FY – 2025FY

Utilization of Biomass toward Future Energy

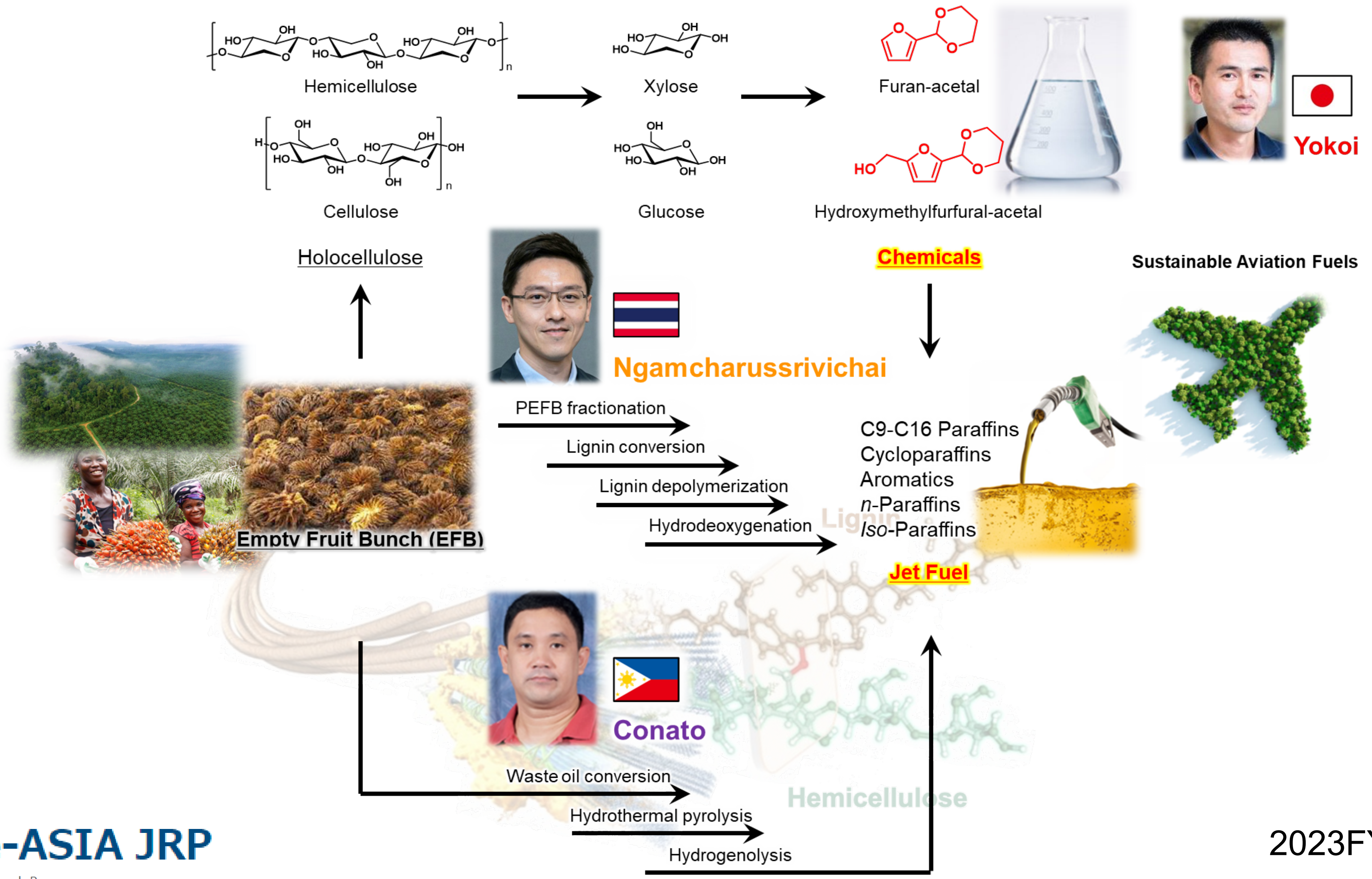
Biorefinery mostly based on "gasification"





NIPPON PAPER GROUP https://www.nipponpapergroup.com/english/research/organize/biomass.html

Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch “ACT-PEFB”



Japan Science and Technology Agency

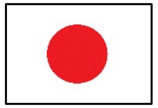
SICORP e-ASIA JRP

Strategic International Collaborative Research Program

2023FY – 2025FY

2003. March

Basis for research and state of preparations




SCIENTIFIC REPORTS
natureresearch

Check for updates

Natural rubber as a renewable carbon source for mesoporous carbon/silica nanocomposites

Satit Yousatit[1,2], Hannarong Pitayachinchot[1], Apinya Wijitrat[1], Supphathee Chaowamalee[1,2,3], Sakdinun Nuntang[4], Siriwat Soontaranon[5], Supagorn Rugmai[5], Toshiyuki Yokoi[6] & Chawalit Ngamcharussrivichai[1,2,3]✉

This study is the first report on the preparation of mesoporous carbon/silica (MCS) nanocomposites with tunable mesoporosity and hydrophobicity using natural rubber (NR) as a renewable and cheap carbon source. A series of mesoporous nanocomposites based on NR and hexagonal mesoporous silica (HMS) were prepared via an in situ sol–gel process and used as precursors; then, they were converted into MCS materials by controlled carbonization. The NR/HMS precursors exhibited a high dispersion of rubber phase incorporated into the mesostructured silica framework as confirmed by small-angle X-ray scattering and high-resolution transmission electron microscopy. An increase in the carbonization temperature up to 700 °C resulted in MCS nanocomposites with a well-ordered mesostructure and uniform framework-confined wormhole-like channels. The NR/HMS nanocomposites possessed high specific surface area (500–675 $m^2\ g^{-1}$) and large pore volume (1.14–1.44 $cm^3\ g^{-1}$). The carbon content of MCS (3.0–16.1 wt%) was increased with an increase in the H_2SO_4 concentration. Raman spectroscopy and X-ray photoelectron spectroscopy revealed the high dispersion of graphene oxide-like carbonaceous moieties in MCS materials; the type and amount of oxygen-containing groups in obtained MCS materials were determined by H_2SO_4 concentration. The enhanced hydrophobicity of MCS nanocomposites was related to the carbon content and the depletion of surface silanol groups, as confirmed by the water sorption measurement. The study on the controlled release of diclofenac in simulated gastrointestinal environment suggests a potential application of MCS materials as drug carriers.

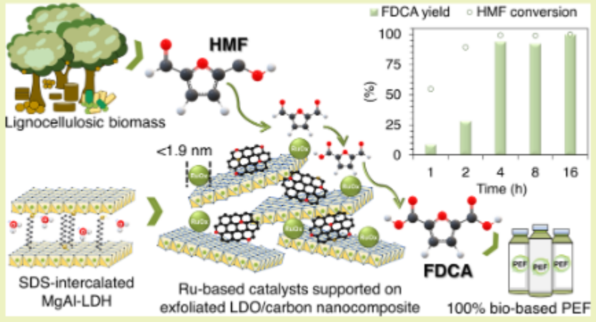
Exfoliated Layered Metal Oxide-Supported Ruthenium Catalysts for Base-Free Oxidation of 5-Hydroxymethylfurfural into a Renewable Bioplastic Precursor

Nuttapat Thiensuwan, Sivashunmugam Sankaranarayanan, Toshiyuki Yokoi, and Chawalit Ngamcharussrivichai*

Cite This: ACS Sustainable Chem. Eng. 2023, 11, 11424–11436 Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: 2,5-Furandicarboxylic acid (FDCA) is a potential biopolymer precursor for polyethylene furanoate production. This study focused on synthesizing FDCA via catalytic oxidation of 5-hydroxymethylfurfural (HMF) over Ru-based catalysts supported on exfoliated MgAl-double oxides (LDO) for the first time in a homogeneous base-free system. Effects of the exfoliation solvent, preparation method, and Ru loading level on the physicochemical and catalytic properties of the resulting catalysts were investigated. The exfoliated LDO-supported Ru catalysts exhibited enhanced textural properties, RuO_x dispersion, and basicity, resulting in better catalytic activity (at least 6 times higher FDCA yield) than conventional LDO-supported Ru catalysts in the conversion into FDCA. The Ru-based catalyst supported on an exfoliated LDO/carbon nanocomposite, Ru(3)/ESV-LDC, revealed the nearly complete HMF conversion (99.2%) at an FDCA selectivity of >98%. This was attributed to the synergistic effect derived from good RuO_x dispersion, providing a high proportion of lattice oxygen for boosting surface oxygen mobility, and high basicity, in terms of both strength and number of basic sites. Moreover, Ru(3)/ESV-LDC exhibited good reusability without a significant loss of HMF conversion and FDCA yield, suggesting strong chemical robustness of RuO_x species and a stable interaction between the active metal and support.



KEYWORDS: *5-hydroxymethylfurfural, 2,5-furandicarboxylic acid, oxidation, exfoliation, ruthenium, layered double oxide*

catalysts MDPI

Article

Selective Synthesis of Renewable Bio-Jet Fuel Precursors from Furfural and 2-Butanone via Heterogeneously Catalyzed Aldol Condensation

Atikhun Chottiratanachote [1,2], Manaswee Suttipong [1,3], Umer Rashid [4,*], Vudhichai Parasuk [5], Junko Nomura Kondo [6], Toshiyuki Yokoi [6], Ali Alsalme [7] and Chawalit Ngamcharussrivichai [1,2,3,*]

Tokyo Tech

Academic Course Access Program (ACAP)

ACAP is offered as a course-oriented program. Participants take courses offered at Tokyo tech.

- Eligibility: Undergraduate- and graduate-level students
- Period of Stay: From 1 quarter to 4 quarters (1 year)

UP OFFICE OF INTERNATIONAL LINKAGES

DOST-ITDI

Evaluation of OSDA-Free Synthetic and Post-Modified Mordenite-Type Zeolites using *n*-Hexane Cracking and its Application for Catalytic Cracking of Palm Oil

Marlon T. Conato, Ph.D.
Thesis Adviser

Toshiyuki Yokoi, Ph.D.
Thesis Co-Adviser

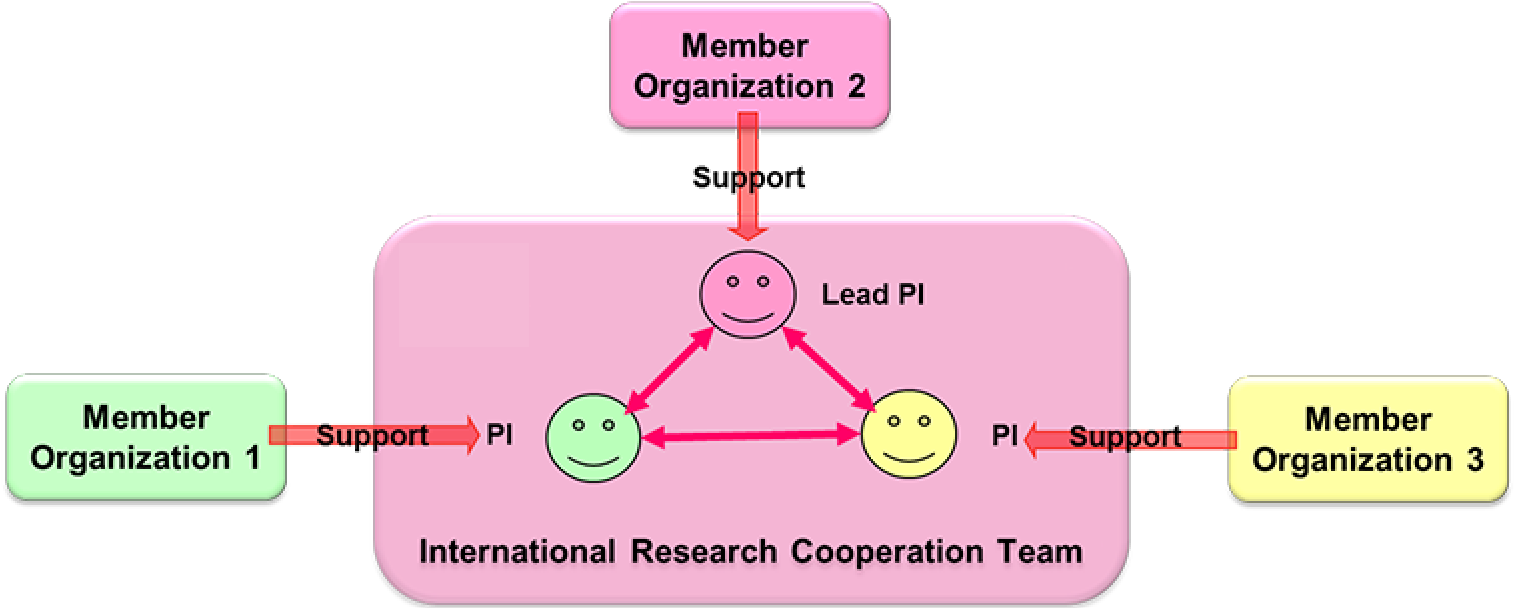
Sean Benson A. See, Ph.D.
Thesis Reader

A Thesis Defense
December 15, 2020
Charlene G. Mendoza

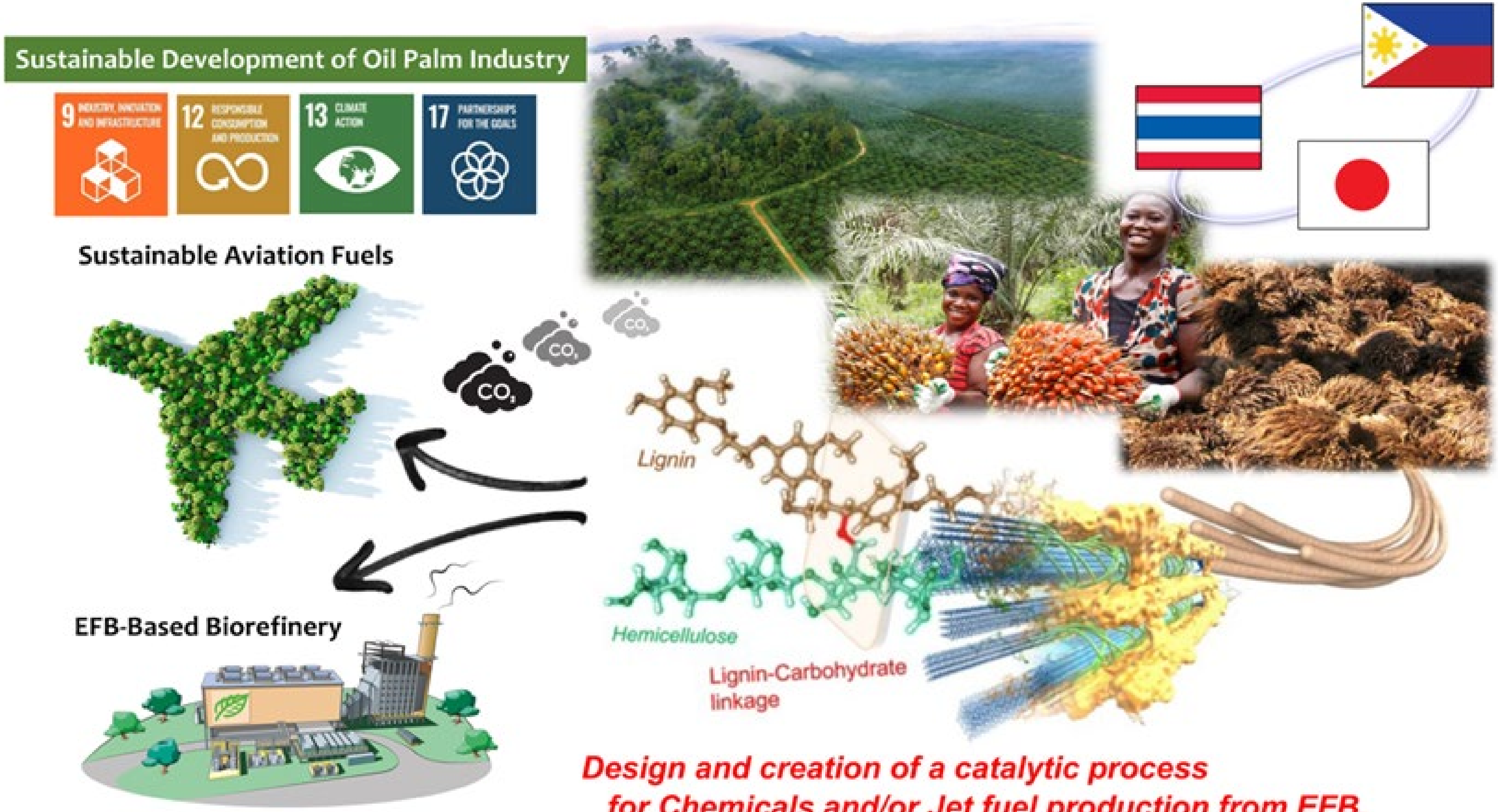
Alternative Energy

Period : FY2023~FY2025

Title	Research Leader in Japan / Research Leaders in the Overseas
Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch	○ YOKOI Toshiyuki, Associate Professor, Institute of Innovative Research, Tokyo Institute of Technology
	(Thailand) Chawalit Ngamcharussrivichai, Professor, Department of Chemical Technology, Chulalongkorn University (Philippines) Marlon Conato, Professor, Institute of Chemistry, University of the Philippines - Diliman



Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch "ACT-PEFB"



Design and creation of a catalytic process for Chemicals and/or Jet fuel production from EFB.

Japan Science and Technology Agency

SICORP e-ASIA JRP

Strategic International Collaborative Research Program

Period: 2023.4 – 2026.3

Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch "ACT-PEFB"

Previous trial

-Utilization as solid fuel-

Empty Fruit Bunch (EFB)

[Restrictions on EFB utilization]

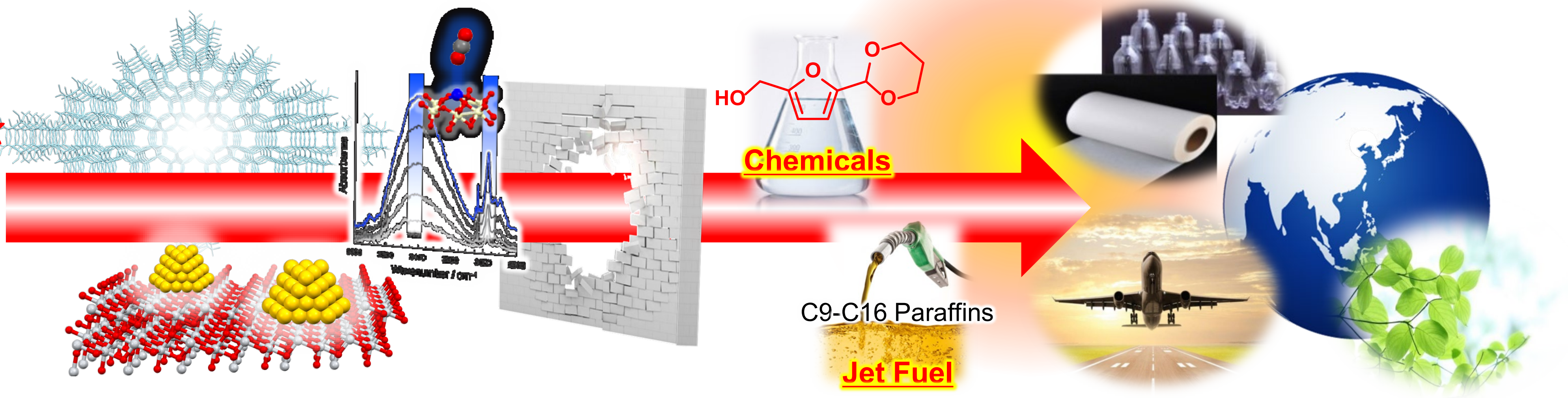
- Impurities such as water, salt, ash, etc.
- Easiness to decompose

Potential difficulty in utilizing as solid fuel

=> Potential difficulty on the contribution to the carbon-neutral society

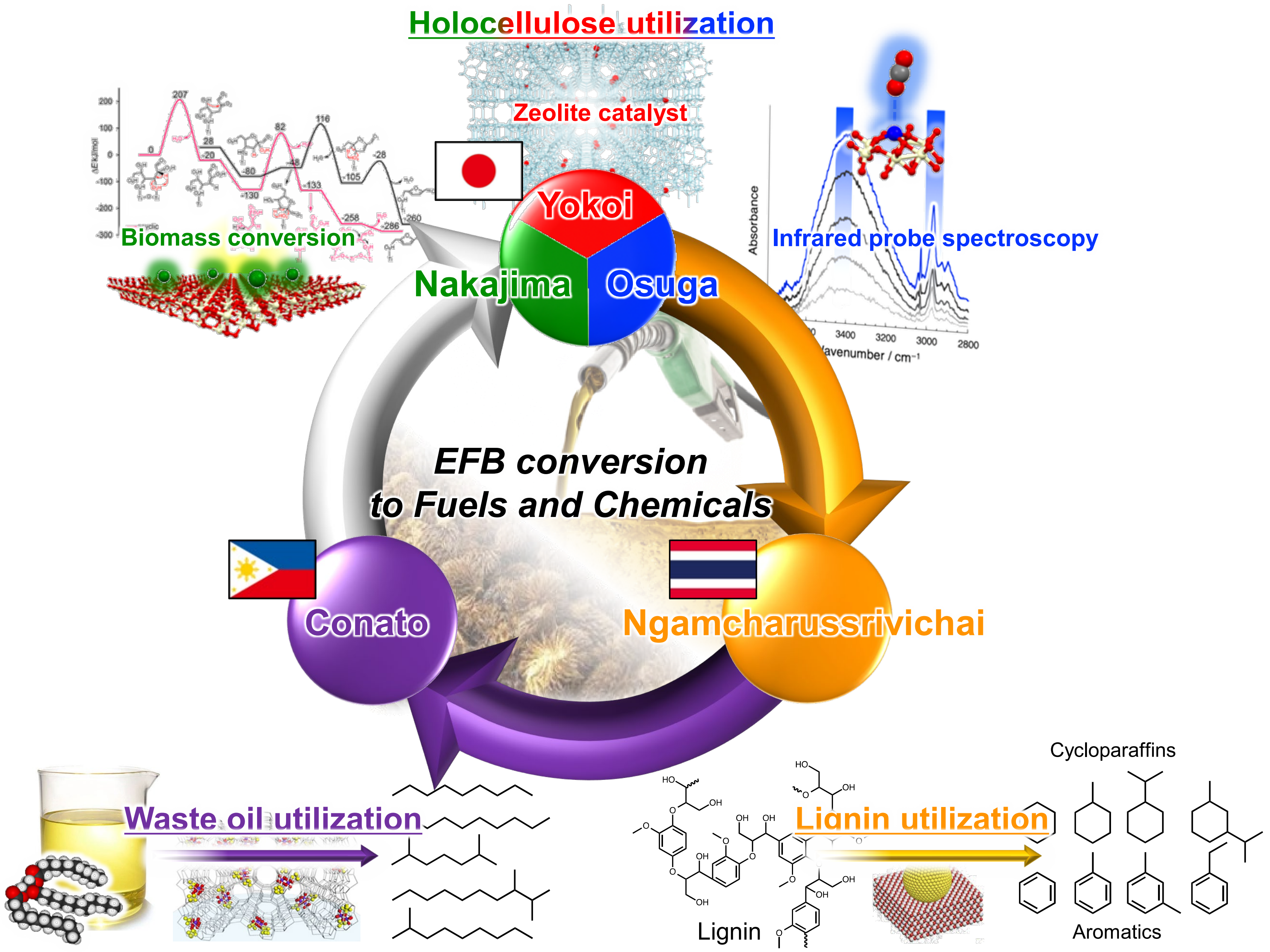
Challenge of this work

-Conversion technology into chemicals and liq. fuels-

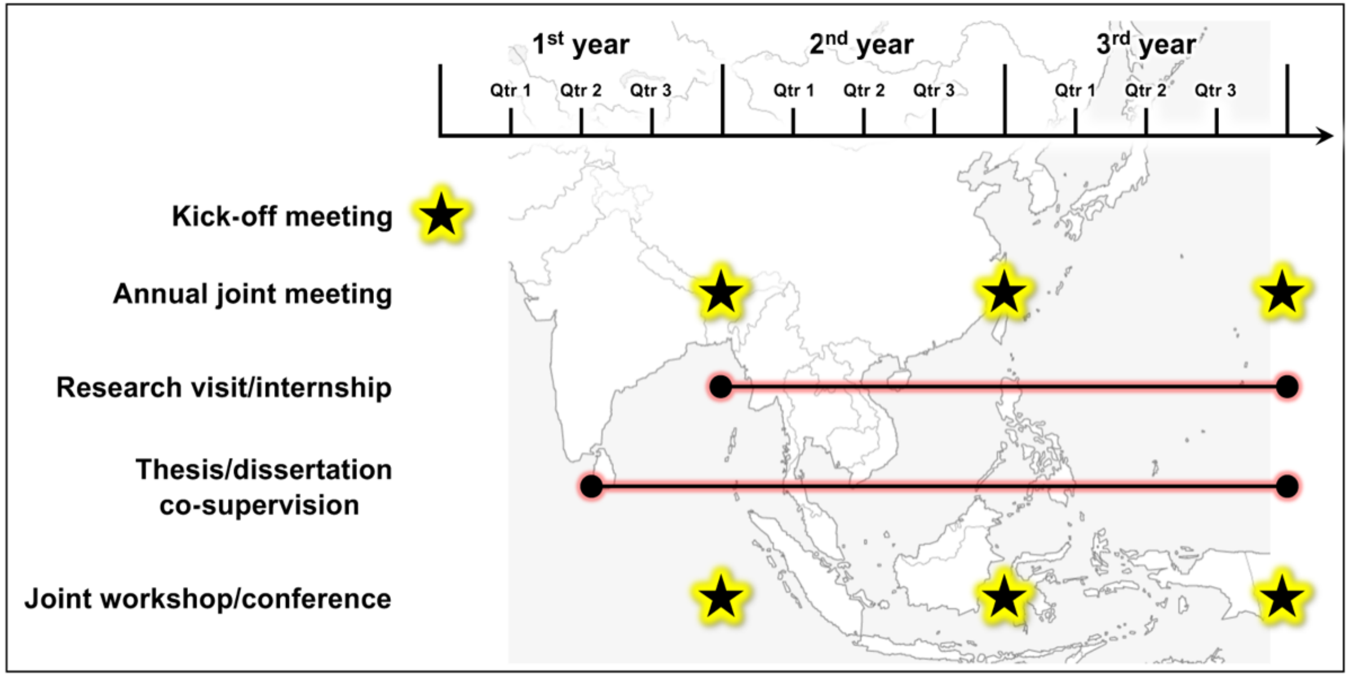


=> Creation of the EFB conversion catalytic technology that enables to contribute to the realization of the carbon-neutral society

Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch



Research Networking Plan



2023FY:

3/9: Japan team meeting
5/25-26: Kick-off meeting
May: Visiting young researcher from CU for 1 year
Sep.: D1 student will join Yokoi G via MEXT scholarship (e-Asia)
6MM update meeting
*Japan team meeting (per 2 month)

2024FY:

12MM update meeting
18MM update meeting
*Japan team meeting (per 2 month)

2025FY:

24MM update meeting
30MM update meeting
Final symposium
*Japan team meeting (per 2 month)

External Advisors

- Takashi Tatsumi, Emeritus professor of Tokyo Institute of Technology
- Toru Setoyama, Executive Fellow, Mitsubishi Chemical Corporation

Japan Science and Technology Agency

SICORP
戦略的国際共同研究プログラム

e-ASIA JRP

Kick-off meeting

Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch (ACT-PEFB)

Meeting place: 5th floor meeting room, Institute for Catalysis, Hokkaido University & Zoom
(Address: Kita 21, Nishi 10, Kita-ku, Sapporo, Hokkaido 001-0021, Japan)
Date: May 25-26, 2023

Japan Science and Technology Agency SICORP 戦略的国際共同研究プログラム Chula Chulalongkorn University CBRC PMU-B

Page 1/2

e-ASIA JRP
The 2nd Progress Meeting

Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch (ACT-PEFB)

Date and Location

- **Date:** January 15-16, 2024
- **Meeting place on-site:** Room 306 on the 3rd floor, Mahamakut Building, Faculty of Science, Chulalongkorn University, 254 Phayathai Road, Pathumwan, Bangkok, Thailand
- **Meeting place online:** Zoom URL
  https://chula.zoom.us/j/5907544954?pwd=bmNHMEJjdzlMVWh2K1BKNUxWa1dZZz09
  Meeting ID: 590 754 4954
  Password: 54915042

The 3rd Progress Meeting:
Advanced Catalytic Technologies for Sustainable Utilization of Oil Palm Empty Fruit Bunch (ACT-PEFB)

27-28 January 2025
Institute of Chemistry, University of the Philippines
Diliman, Quezon City

Venue: University Hotel, University of the Philippines, Diliman, Quezon City, Philippines

SATREPS

Science and Technology Research Partnership for Sustainable Development

Font size A A A

Japan Science and Technology Agency

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TOP | About SATREPS TOP | Projects | Evaluations | Case Studies | Invitation for Research Proposals | Announcements | For Researchers | For Public

JST Top > Science and Technology Research Partnership for Sustainable Development（SATREPS）

Project by Region/Country

Project by Research Areas

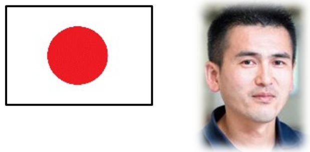
Project by SDGs

Case Studies

SATREPS

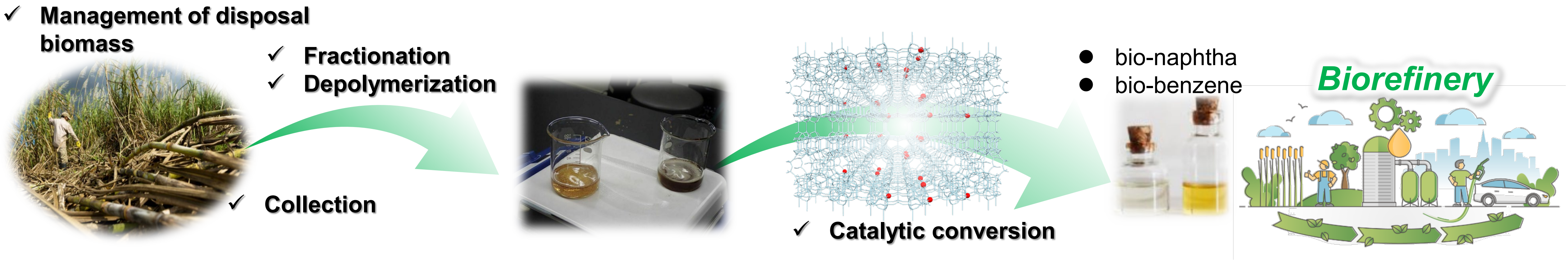
Detailed Planning Survey
Sep. 24-Oct. 3, 2024

Valorization of Disposal Biomass for Chemical Production Based on Biorefinery Concept

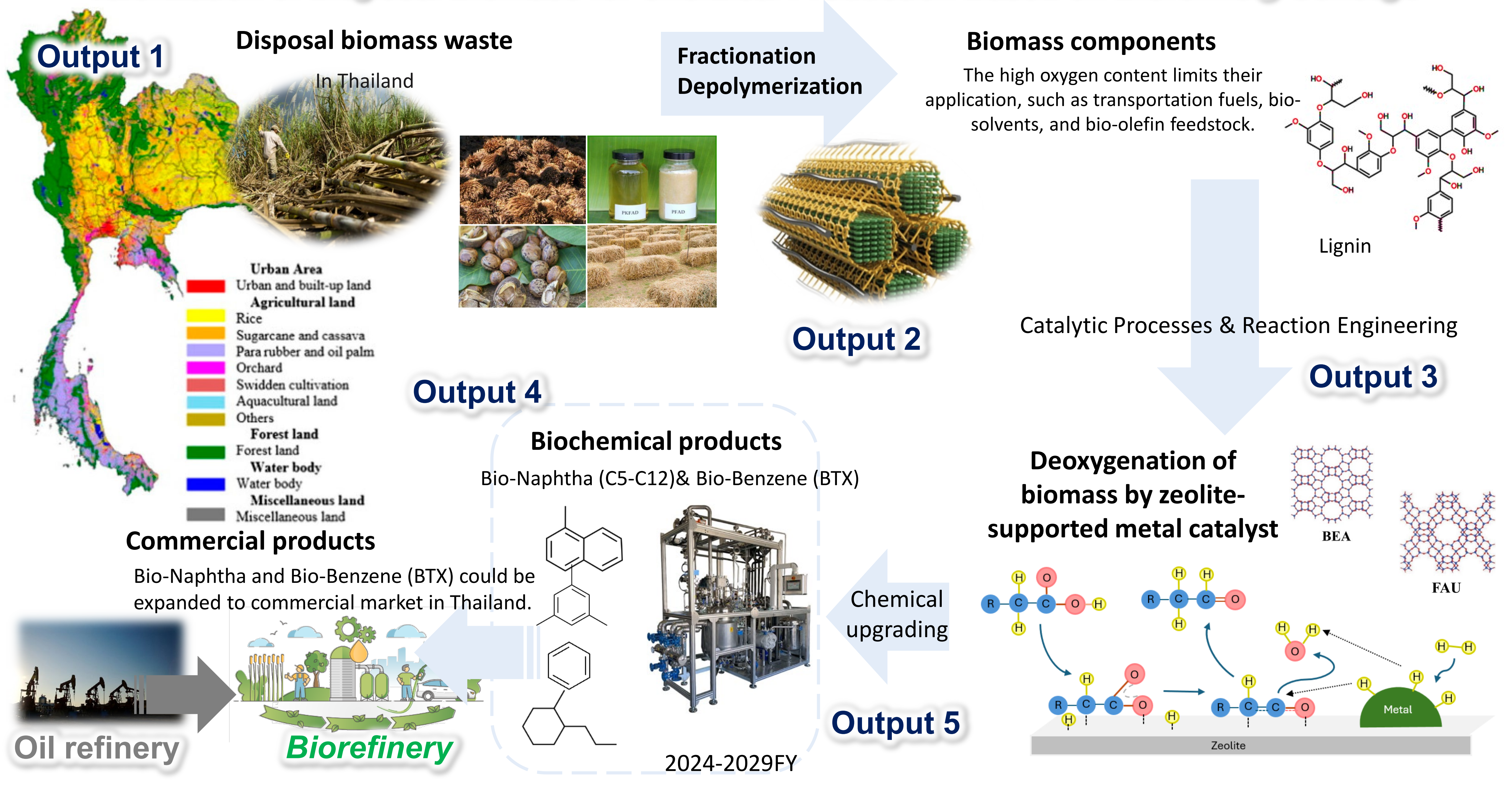


Japan side
Representative institution: **Prof. Toshiyuki Yokoi**, Science Tokyo
Collaborating institutions: Prof. Hisashi Miyafuji, Kyoto Prefectural U.
Mr. Takuya Yamaguchi, BASF Japan

Thai side
Representative institution: **Prof. Chawalit Ngamcharussrivichai,** Chulalongkorn U
Collaborating institutions: Prof. Attasak Jaree, Kasetsart U.
Assist. Prof. Somboon Sukpancharoen, Khon Kaen U.
Assist. Prof. Santi Chuetor, King Mongkut's U.
Dr. Lalita Attanatho, TISTR



Valorization of Disposal Biomass for Chemical Production Based on Biorefinery Concept



Plan to practical application and feasibility

~2029FY

2030FY~

Farm / Farmer in Thailand

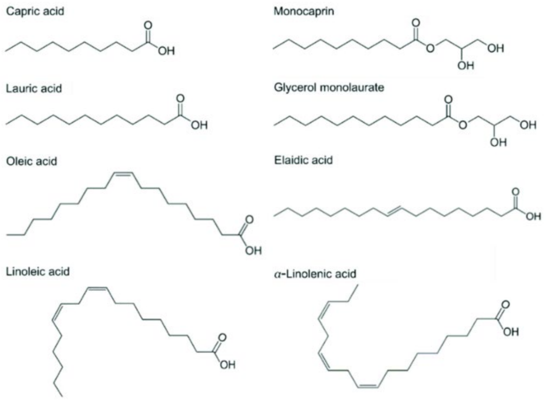
Domestic chemical company in Thailand

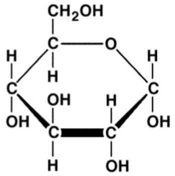
Chemical company in Asia

Disposal biomass

fats and oils, fatty acids

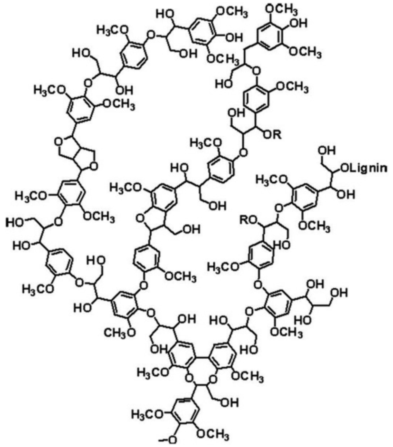
monosaccharides





Naphtha

lignin



Benzene

Biorefinery

SATREPS

Thank you for your attention

Nanospace Catalysis Unit, Tokyo Tech. since 2017

PCIEERD Alternative Energy Directions in Response to the National Energy Security:

Looking at the Philippine Biofuels R&D Landscape

Dr. Ian Dominic F. Tabañag

S&T Fellow, Philippine Council for Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD)

Regular Member, Engineering and Industrial Research Division, National Research Council of the Philippines (DOST-NRCP)

2 December 2024

Collaborative Networking Workshop in **Alternative Energy**

Looking at the Philippine Biofuels Policy Landscape…

Philippine Biofuels Landscape under the Biofuels Act of 2006 (RA 9367)

Fiscal Incentives

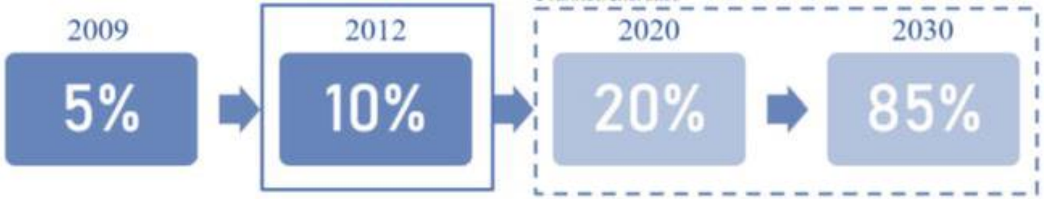
Department of Energy (DOE)

Current Scenario…

… approximately ***half of the bioethanol*** *we use is* ***imported*** *…*

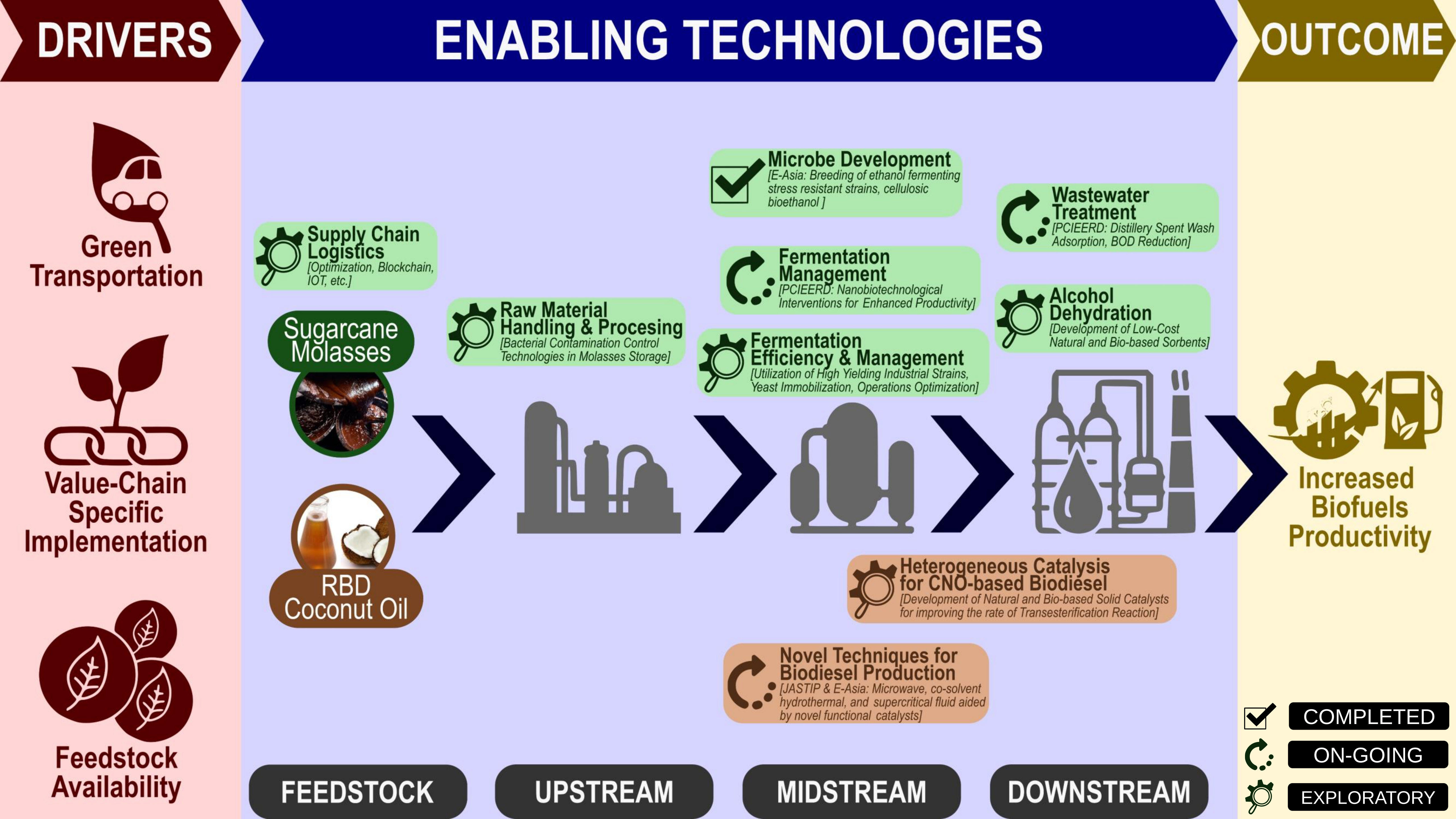
… local biodiesel supply ***barely keep up*** *with the existing demand …*

The Problem…



Inability to meet targeted biofuels blending

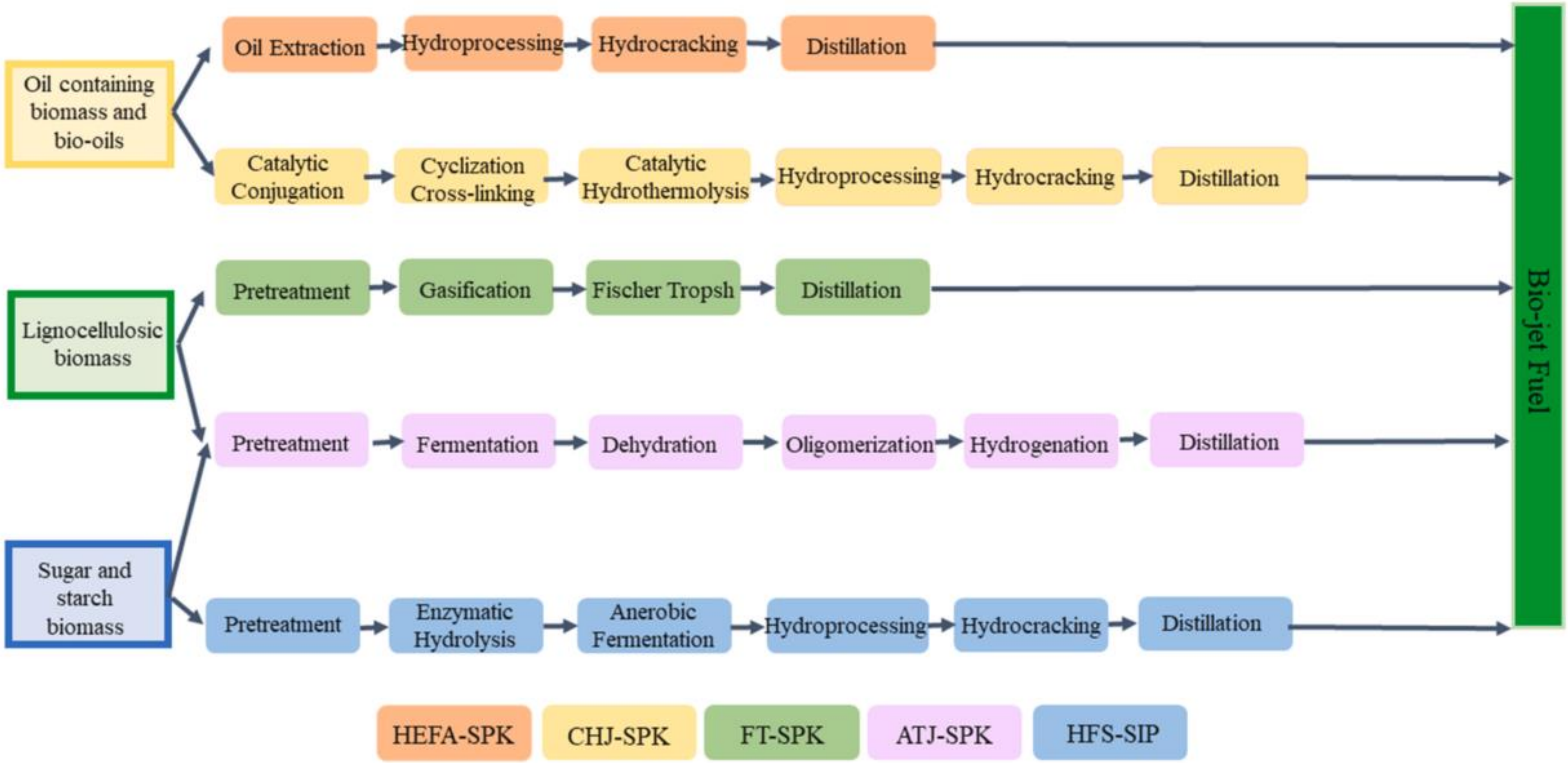
Biofuels in the Land Transportation Sector…



DRIVERS
ENABLING TECHNOLOGIES
OUTCOME
Green Transportation
Value-Chain Specific Implementation
Feedstock Availability
Supply Chain Logistics
[Optimization, Blockchain, IOT, etc.]
Sugarcane Molasses
RBD Coconut Oil
Raw Material Handling & Procesing
[Bacterial Contamination Control Technologies in Molasses Storage]
Microbe Development
[E-Asia: Breeding of ethanol fermenting stress resistant strains, cellulosic bioethanol]
Fermentation Management
[PCIEERD: Nanobiotechnological Interventions for Enhanced Productivity]
Fermentation Efficiency & Management
[Utilization of High Yielding Industrial Strains, Yeast Immobilization, Operations Optimization]
Wastewater Treatment
[PCIEERD: Distillery Spent Wash Adsorption, BOD Reduction]
Alcohol Dehydration
[Development of Low-Cost Natural and Bio-based Sorbents]
Heterogeneous Catalysis for CNO-based Biodiesel
[Development of Natural and Bio-based Solid Catalysts for improving the rate of Transesterification Reaction]
Novel Techniques for Biodiesel Production
[JASTIP & E-Asia: Microwave, co-solvent hydrothermal, and supercritical fluid aided by novel functional catalysts]
Increased Biofuels Productivity
FEEDSTOCK
UPSTREAM
MIDSTREAM
DOWNSTREAM
COMPLETED
ON-GOING
EXPLORATORY

Looking at Sustainable Aviation Fuels…

Main Process Steps and Feedstock Categories for SAF Production…



Biochemical Composition of **Feedstock *Dictates*** the **Complexity of Processing** Steps

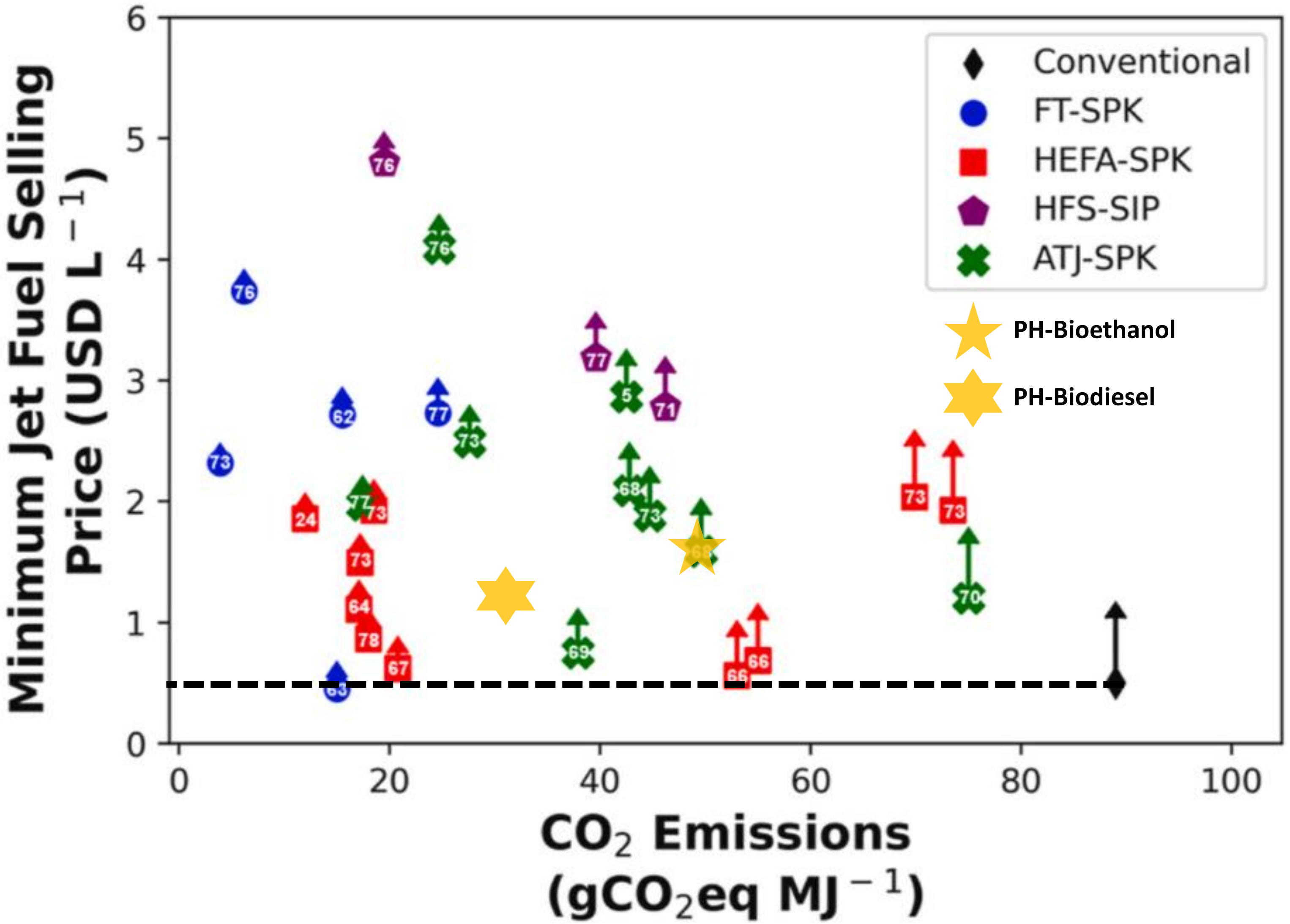
Dahal, K., S. Brynolf, C. Xisto, J. Hansson, M. Grahn, T. Grönstedt and M. Lehtveer (2021). "Techno-economic review of alternative fuels and propulsion systems for the aviation sector." Renewable and Sustainable Energy Reviews **151**: 111564.
Goh, B. H. H., C. T. Chong, H. C. Ong, T. Seljak, T. Katrašnik, V. Józsa, J.-H. Ng, B. Tian, S. Karmarkar and V. Ashokkumar (2022). "Recent advancements in catalytic conversion pathways for synthetic jet fuel produced from bioresources." Energy Conversion and Management **251**: 114974.

SAF Economic and Environmental Assessments…

SAF costs are **120% to 700%** higher than fossil-based jet fuel costs

but

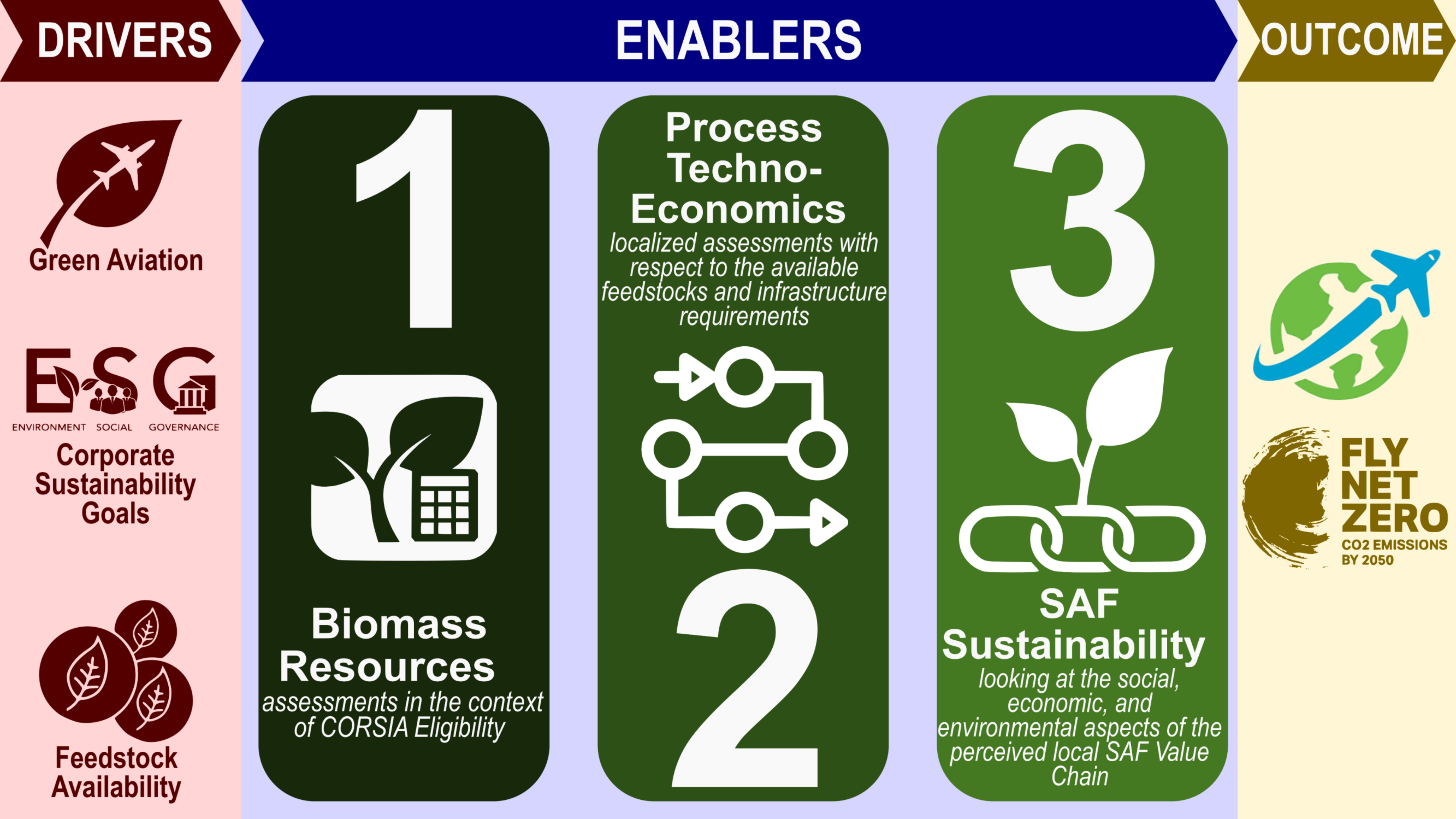
reduces CO_2 emissions between **27% and 87%**



Watson, M. J., P. Machado, A. V. da Silva, Y. Rivera, C. Ribeiro, C. Nascimento and A. W. Dowling (2024). "Sustainable aviation fuel technologies, costs, emissions, policies, and markets: A critical review." Journal of Cleaner Production: 141472.

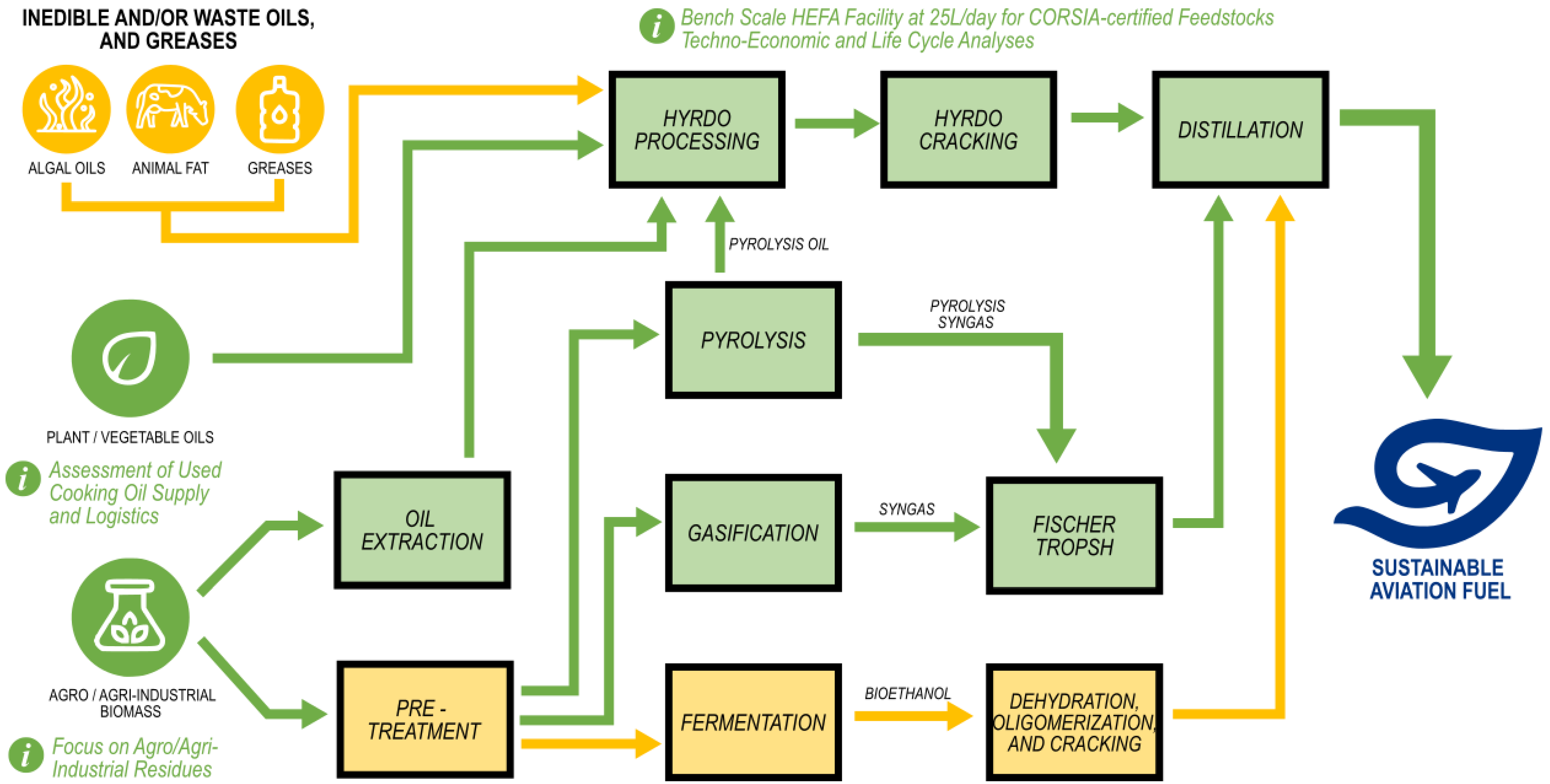
Demafelis, R. B., Magadia, B. T., & Gatdula, K. M. (2020). Carbon Footprint and Climate Change Mitigation Potential of Cocobiodiesel in the Philippines. *Philippine Journal of Crop Science (PJCS)*, *45*(3), 28-36.

Tongko-Magadia, B., Demafelis, R., & Mendoza, T. (2018). Greenhouse Gas Emission Reduction Potentials of Bioethanol Production and End-Use in The Philippines at Varying Sugarcane Yields: An Ex-Ante Analysis. *Philippine Journal of Crop Science*, *2018*, 1-11.

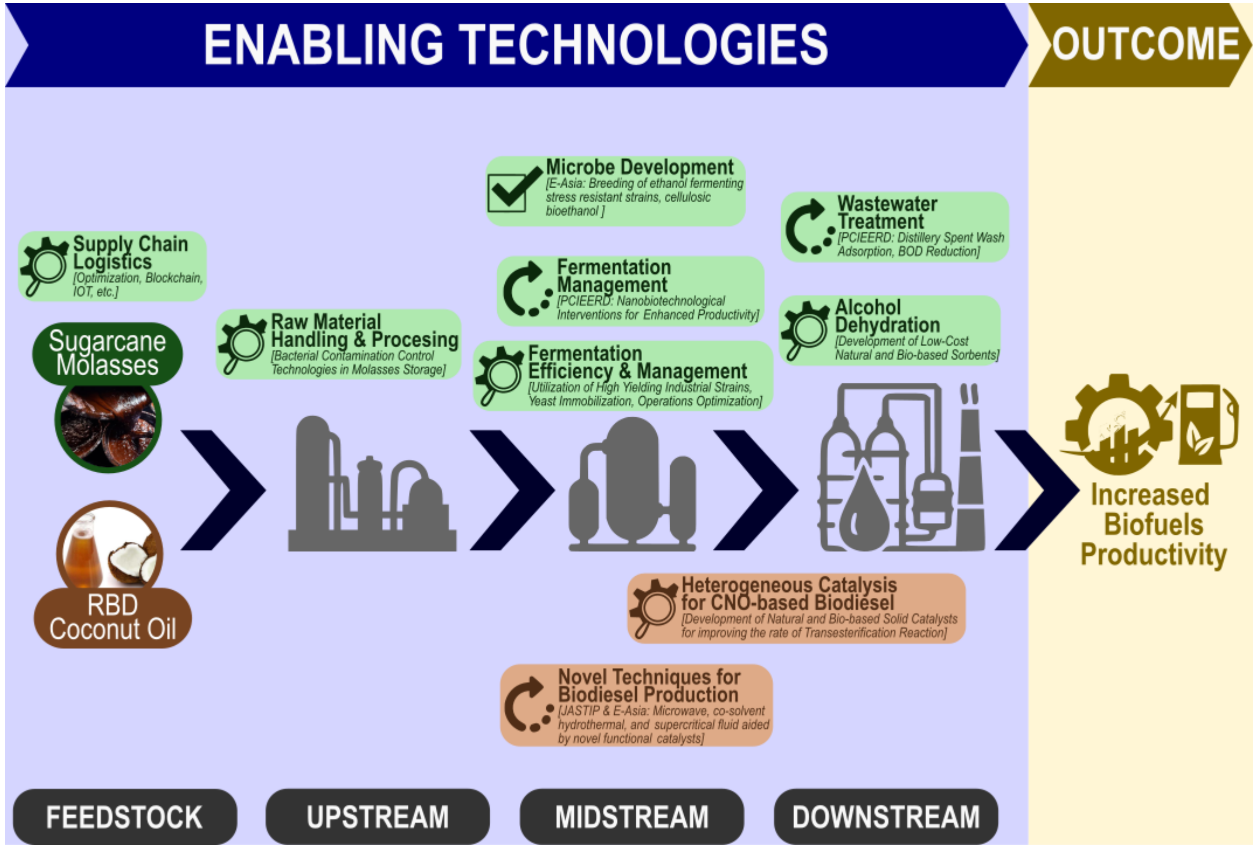

DRIVERS
ENABLERS
OUTCOME
Green Aviation
ESG
ENVIRONMENT SOCIAL GOVERNANCE
Corporate Sustainability Goals
Feedstock Availability
1
Biomass Resources
assessments in the context of CORSIA Eligibility
Process Techno-Economics
localized assessments with respect to the available feedstocks and infrastructure requirements
2
3
SAF Sustainability
looking at the social, economic, and environmental aspects of the perceived local SAF Value Chain
FLY NET ZERO
CO2 EMISSIONS BY 2050

Philippine SAF Pathways R&D Initiatives

CURRENT INITIATIVES
FOR EXPLORATION

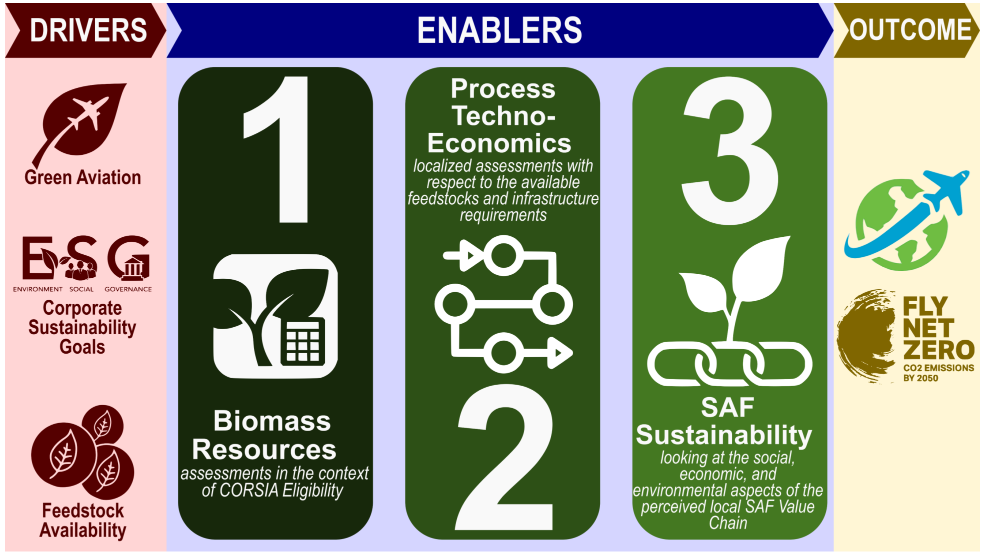


Call for Collaborations...

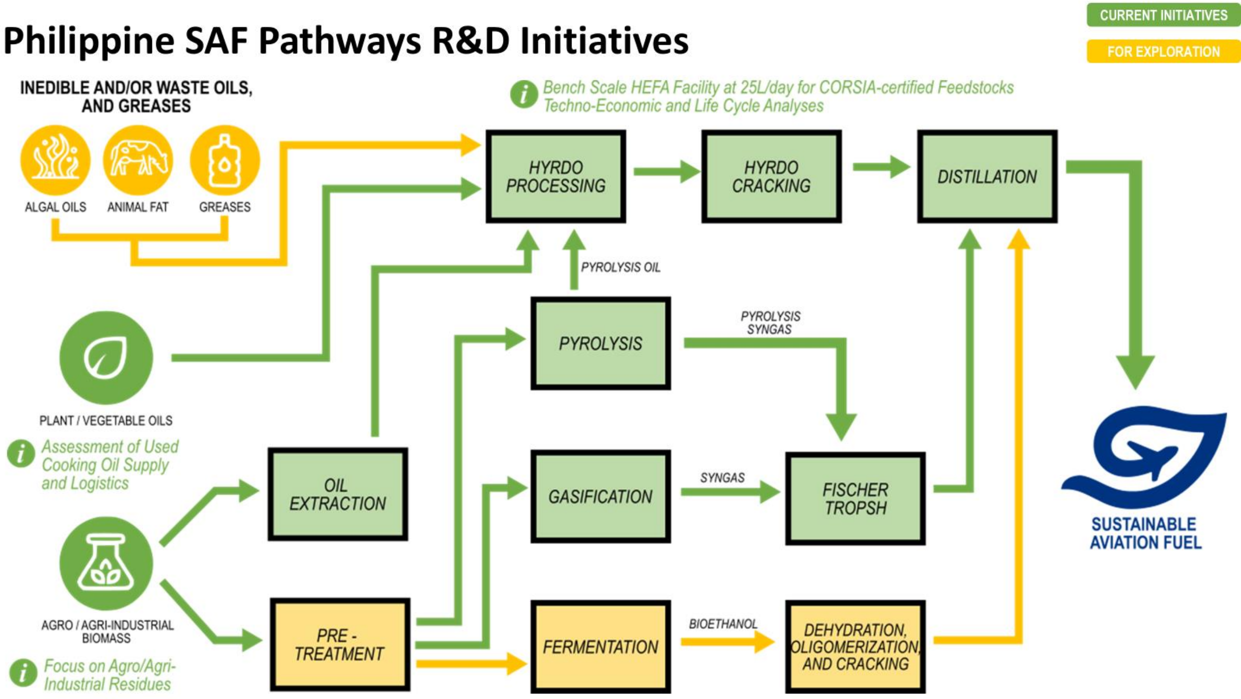


Biofuels Productivity

Sustainable Aviation Fuels



Philippine SAF Pathways R&D Initiatives



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pcieerd.dost.gov.ph

Hydrogen Utilization for Green Energy

Team members : Chiang Mai University, Thailand

1. Assoc. Prof. Dr. Konlayutt Punyawudho
2. Prof. Dr. Tanongkiat Kiatsiriroat
3. Asst. Prof. Dr. Nat Vorayos
4. Assoc. Prof. Dr. Thoranis Deethayat
5. Assoc. Prof. Dr. Attakorn Asanakham

Notable International Cooperation and Partnership

National Chung Hsing University, Taiwan

National Chung Cheng University, Taiwan

National Central University, Taiwan

Osaka University, Japan

Mie University, Japan

National University of Singapore, Singapore

University of South Carolina, USA

Jiangsu University, China

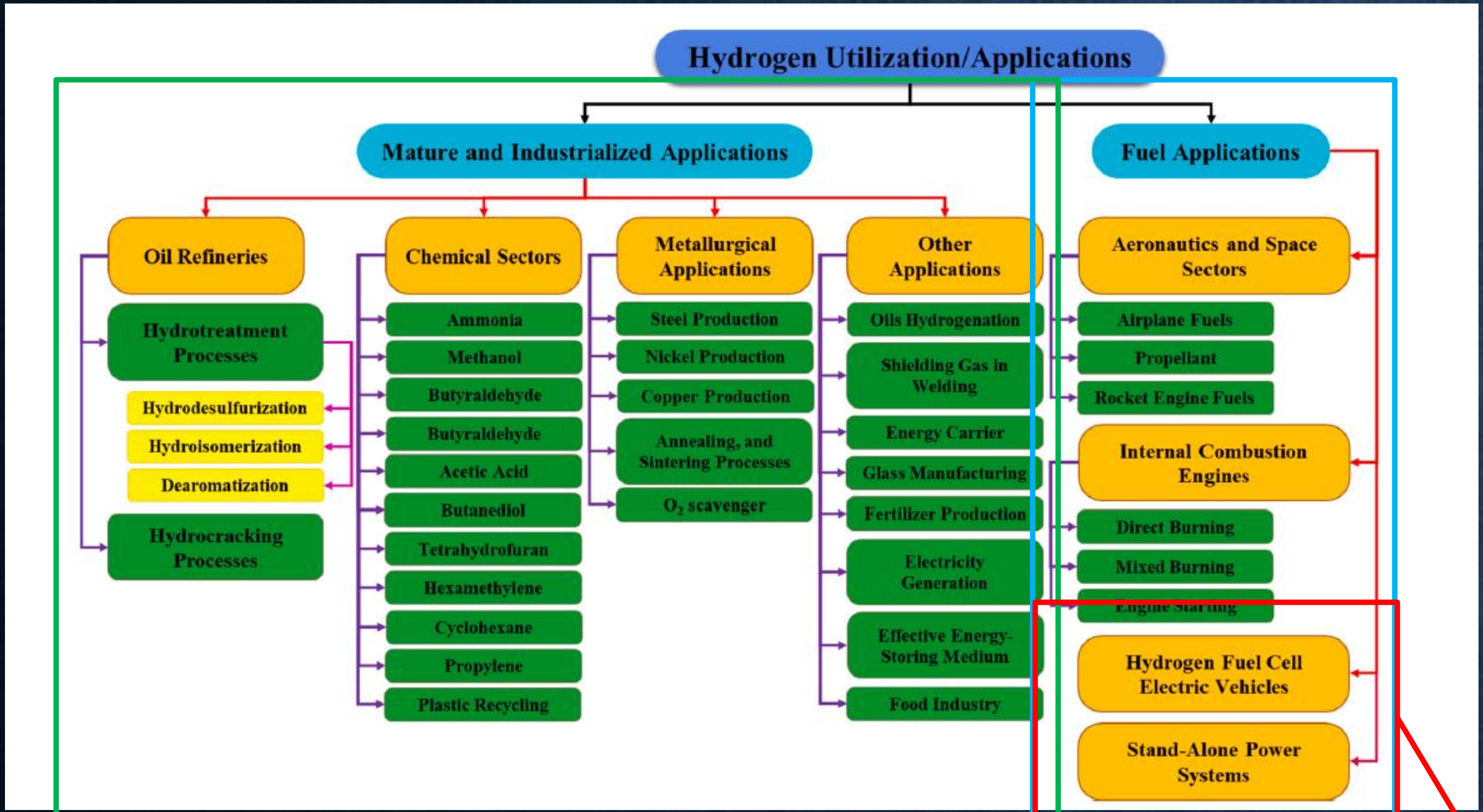
Hunan Institute of Engineering, China

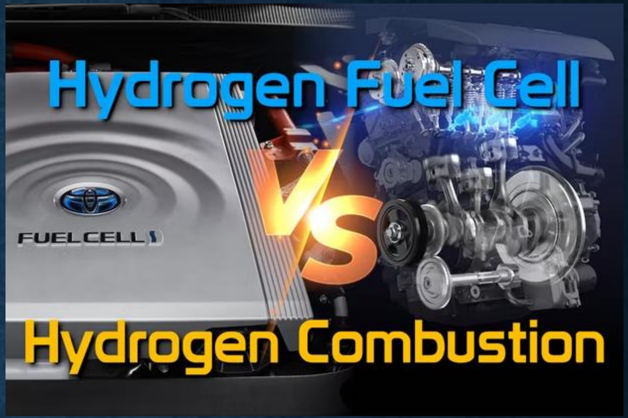
Shanghai Jiao Tong University, China

Sogang University, South Korea

Korea Institute of Energy Research, South Korea

Hydrogen Utilization and application





Technology	Hydrogen combustion	Hydrogen fuel cell
Energy efficiency	40-45%	50-60% ✓
CO_2 emission	Zero	Zero
Operating temperature	> 1,200 C (flame temp)	< 200 C (PEM), 600-800 C (SOFC) ✓
No_x emission	Yes (stoich-ratio)	Zero ✓

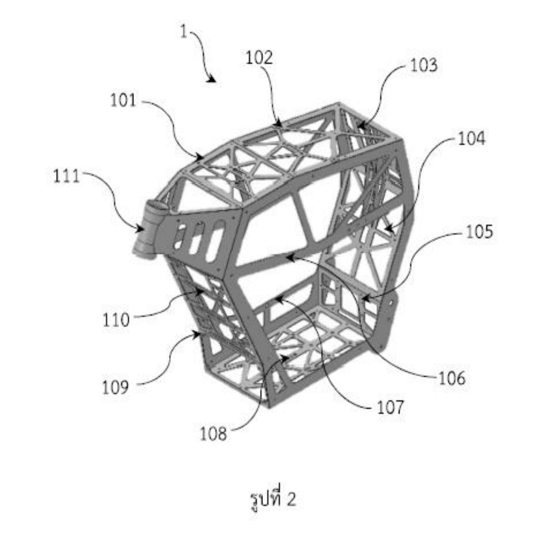
None main energy source

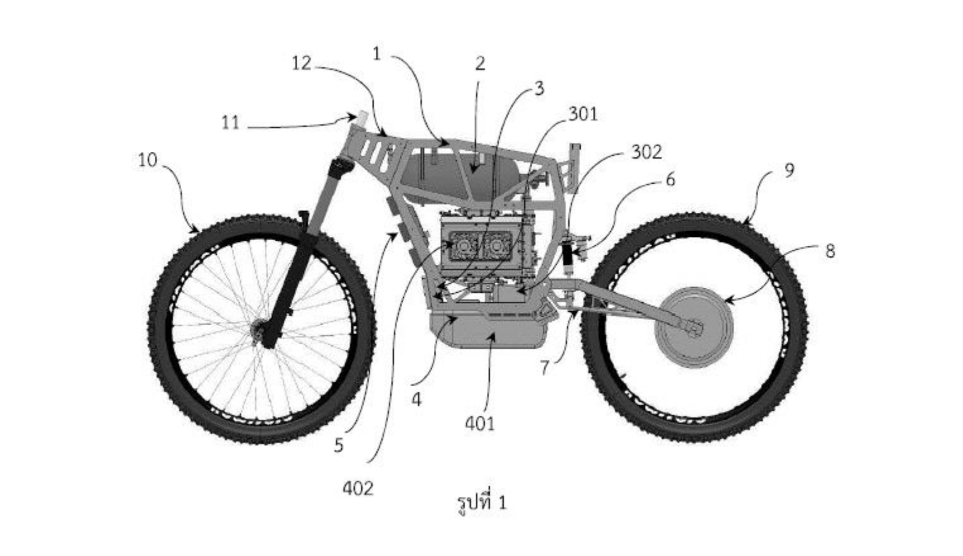
Main energy source

High potential H_2 utilization

V. M. Avargani, S. Zendehboudi, N. M. C. Saady, and M. B. Dusseault, "A comprehensive review on hydrogen production and utilization in North America: Propects and challenges", Energy Conversion and Management, 269, (2022) 115927

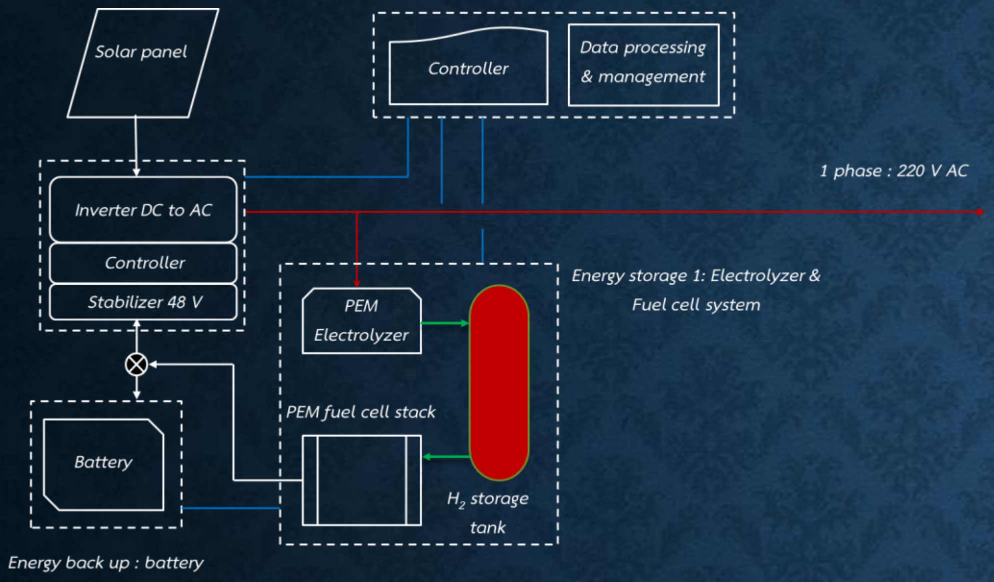
Hydrogen Fuel Cell Vehicle : E-bike





Patent in title of “Two-wheel electric vehicle driven by hydrogen” has been filed on July 12, 2024 with the request number 2403002164

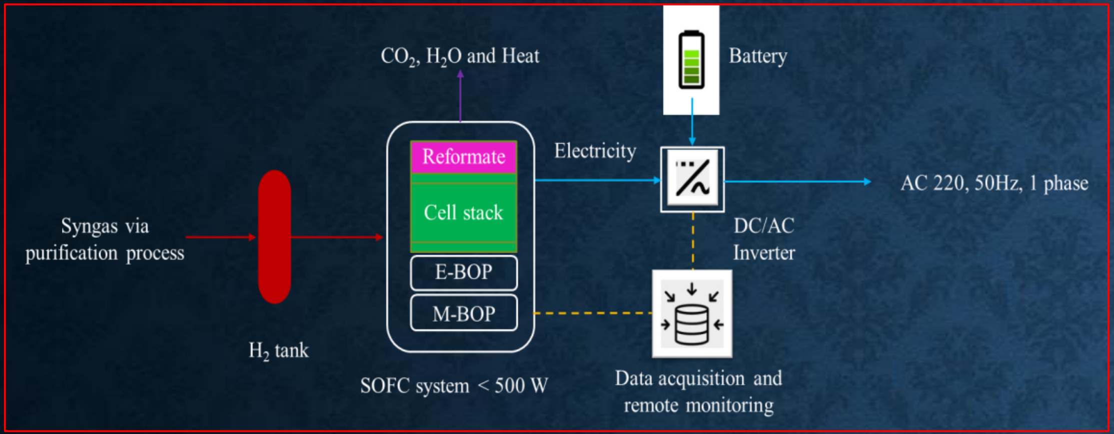
PEMFCs : Applications => Stationary

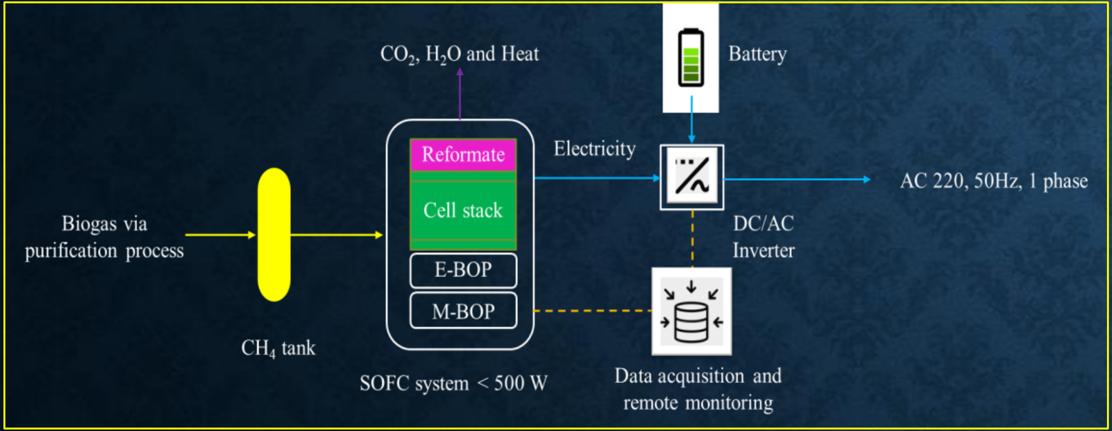


- **Lamphun site**: 3 phase with 25 kWp, Fuel cell 6 kW, Electrolyzer 1,000 L/hr, Energy storage 60 kWh (battery 50 + hydrogen 10 kWh)
- **Maemoh site**: 1 phase with 10 kWp, Fuel cell 3 kW, Electrolyzer 500 L/hr, Energy storage 36 kWh (battery 26 + hydrogen 10 kWh.

T. Chaikaew and K. Punyawudho, “Optimal voltage of direct current coupling for a fuel cell-battery hybrid energy storage system based on solar energy”, Energy Reports, Volume 7, Supplement 3, September 2021, Pages 204-208,

Stationary Applications : SOFC

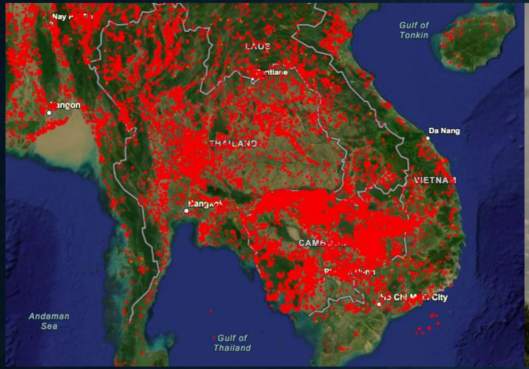




- Separate fuel sources => H_2 and CH_4
- 2 unit of SOFC power rate <u>not over</u> 250 watts each
- DC coupling with battery
- Built in Electrical and Mechanical BOP (balance of plant)
- Data acquisition with RS-232

- **SOFC :** 250 W x 2 unit
- Run with Syngas H_2 from Coal => Gasification with water gas shift and Membrane separation (for purification), H_2 purity is about 85-95%
- Run with Methane from bio-gas, fermentation of Napier grass, CH_4 purification is about 90% after

Hot spot causing haze pm2.5 in SEA



Moderate Resolution Imaging Spectroradiometer (MODIS) is a satellite base sensor used for monitor fire spot

Limitations:

- real-time data does not really exist yet
- data processing times can significantly affect the total latency
- satellites only provide a snapshot of what is happening on the ground at a given moment, and
- accuracy varies depending on factors such as cloud cover.

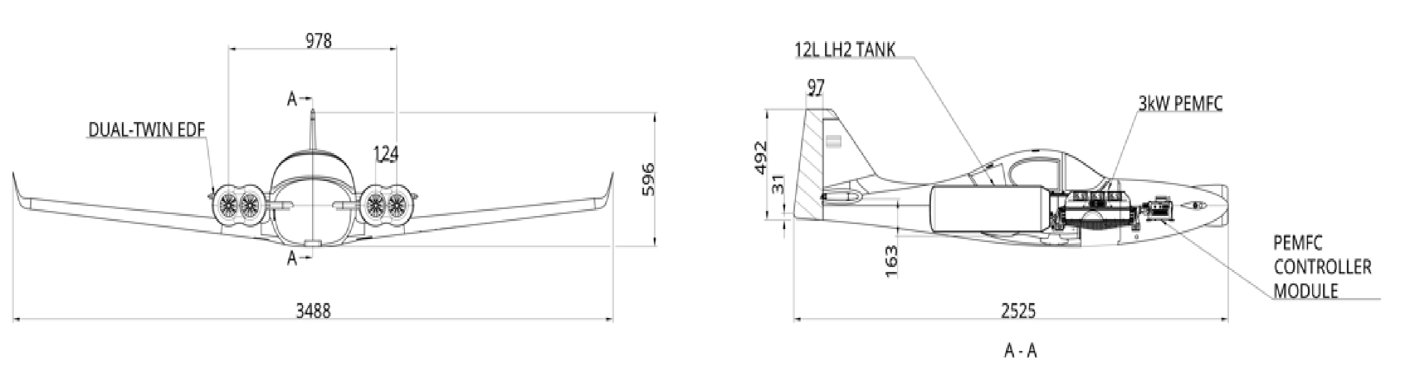
Low altitude hotspot monitoring by UAV

Advantage:

- Quick response time
- Detect smoke and tiny hotspots in early warning with accuracy

Conceptual Proposal to e-Asia

Electric UAV with fixed wings runs using PEMFC for hotspot and wildfire monitoring, minimizing PM2.5 pollution.



- 3kW PEMFC
- Liquid hydrogen tank 12 L
- 4 motors (3 kW each)
- 32 super capacitors (3V, 280 A)

Designed specification:

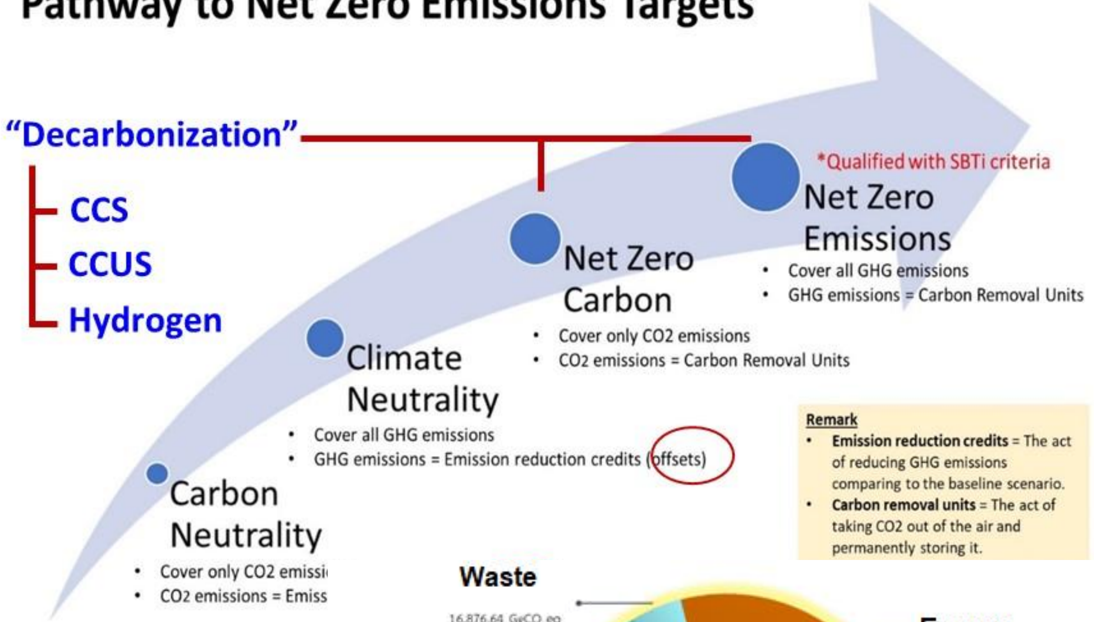
- Altitude about 500 m with hot spot scan area of 10 x 10 km
- Total distance 315 kilometers
- Cruise speed 80 km/hr (average)
- Flighting time about 4 hrs.
- Thermal Camera Field of View (FOV): 45 degrees (providing a ground coverage width of approximately 331 meters per pass).
- Partner : JFox Aircraft

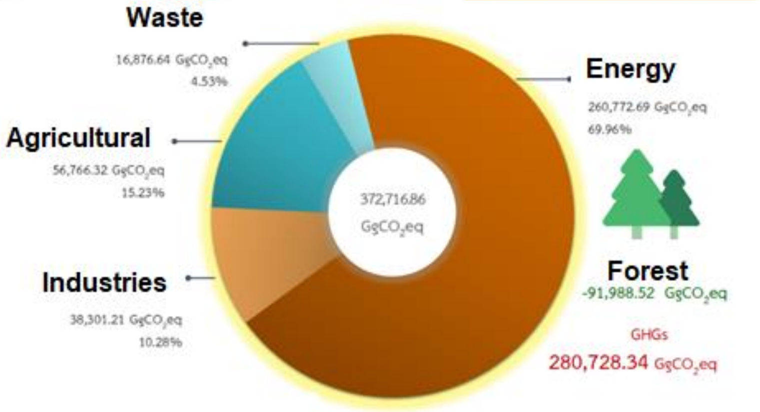
Development of Green Hydrogen Production Technology for waste Utilization in Thai Agricultural and Livestock Manufacturing to Support Net Zero Emission Achievement

Prof. Navadol Laosiripojana
The Joint Graduate School of Energy and Environment
King Mongkut’s University of Technology Thonburi, Thailand

01-12 NOV 2021
GLASGOW
COP26
IN PARTNERSHIP WITH ITALY

Pathway to Net Zero Emissions Targets

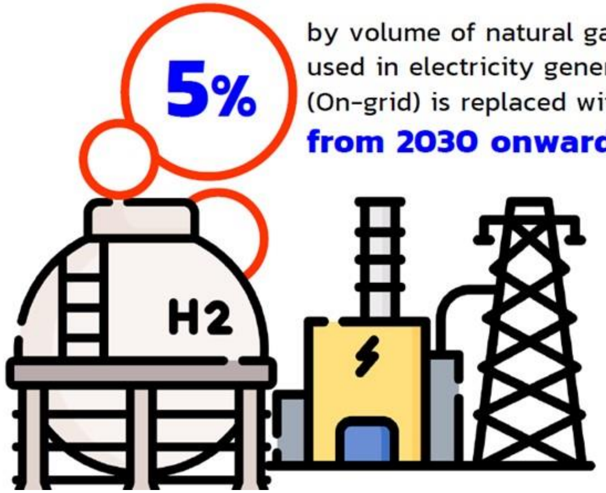




Hydrogen (H_2)

Energy Policy and Planning Office
MINISTRY OF ENERGY

In **PDP2024**, **H_2 is used as a fuel** by mixing with natural gas at **the eastern gas pipeline**.



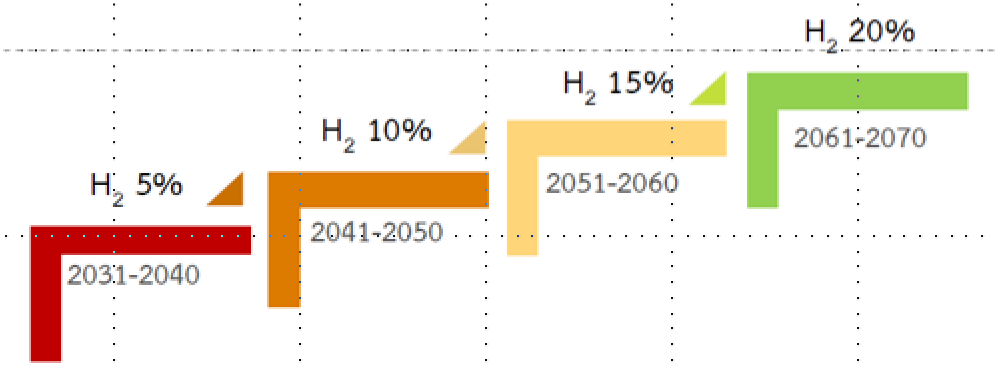
by volume of natural gas used in electricity generation (On-grid) is replaced with H_2 **from 2030 onwards.**

Q&A

Why use H_2 just 5% by vol.?

Since the government and the relevant agency needs time to find **the suppliers** and prepare **the infrastructure.**

In addition, **the users of eastern pipeline** require an appropriate time for adaptation. Thus, the mixing with 5%vol. of H_2 causes a less impact to the equipment in the production process.



Hydrogen

- Zero-emission fuel
- Be used efficiently with **fuel cell** to generate electricity
- Be produced from reforming of **several hydrocarbon compounds with the oxygen-containing co-reactants**

Reforming processes

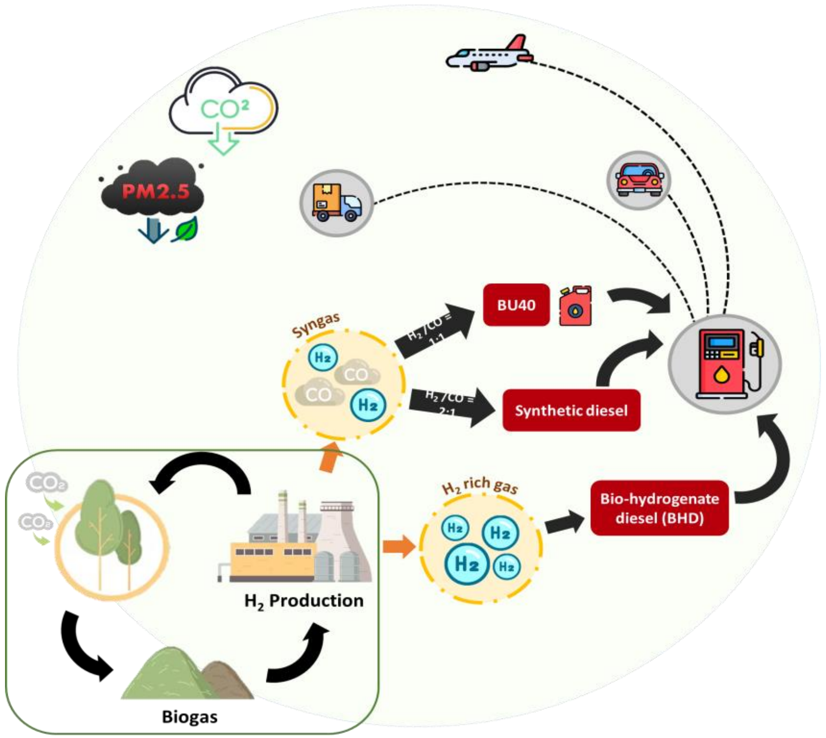
$$\text{Hydrocarbons} + \text{Co-reactant} \xrightarrow{\text{Catalyst}} H_2 + CO \text{ (synthesis gas)}$$

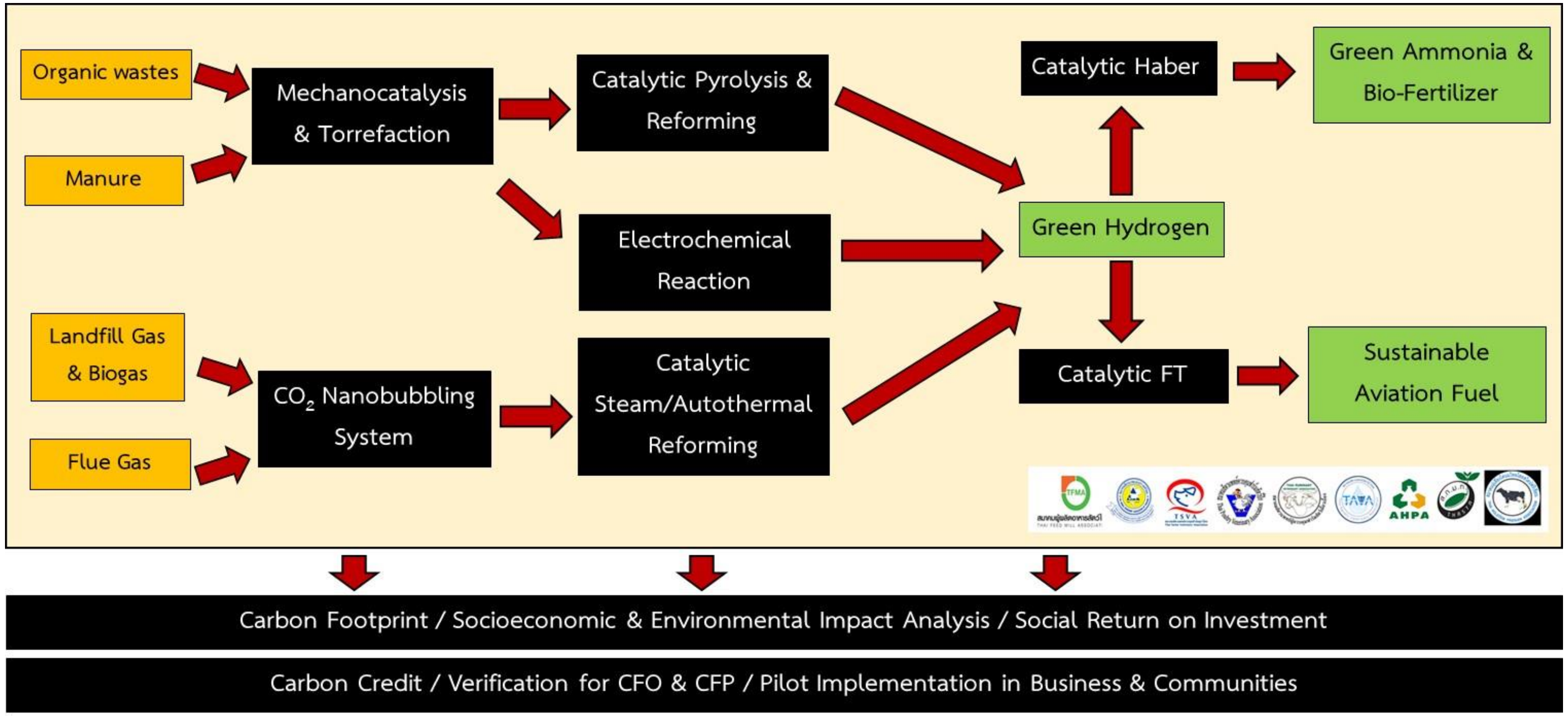
- Methane
- Methanol
- Ethanol
- Biogas
- LPG
- Natural gas

- Steam → (called "**steam reforming**")
- Carbon dioxide → (called "**dry reforming**")
- Oxygen or Air → (called "**partial oxidation**")
- Steam + Oxygen → (called "**autothermal reforming**")

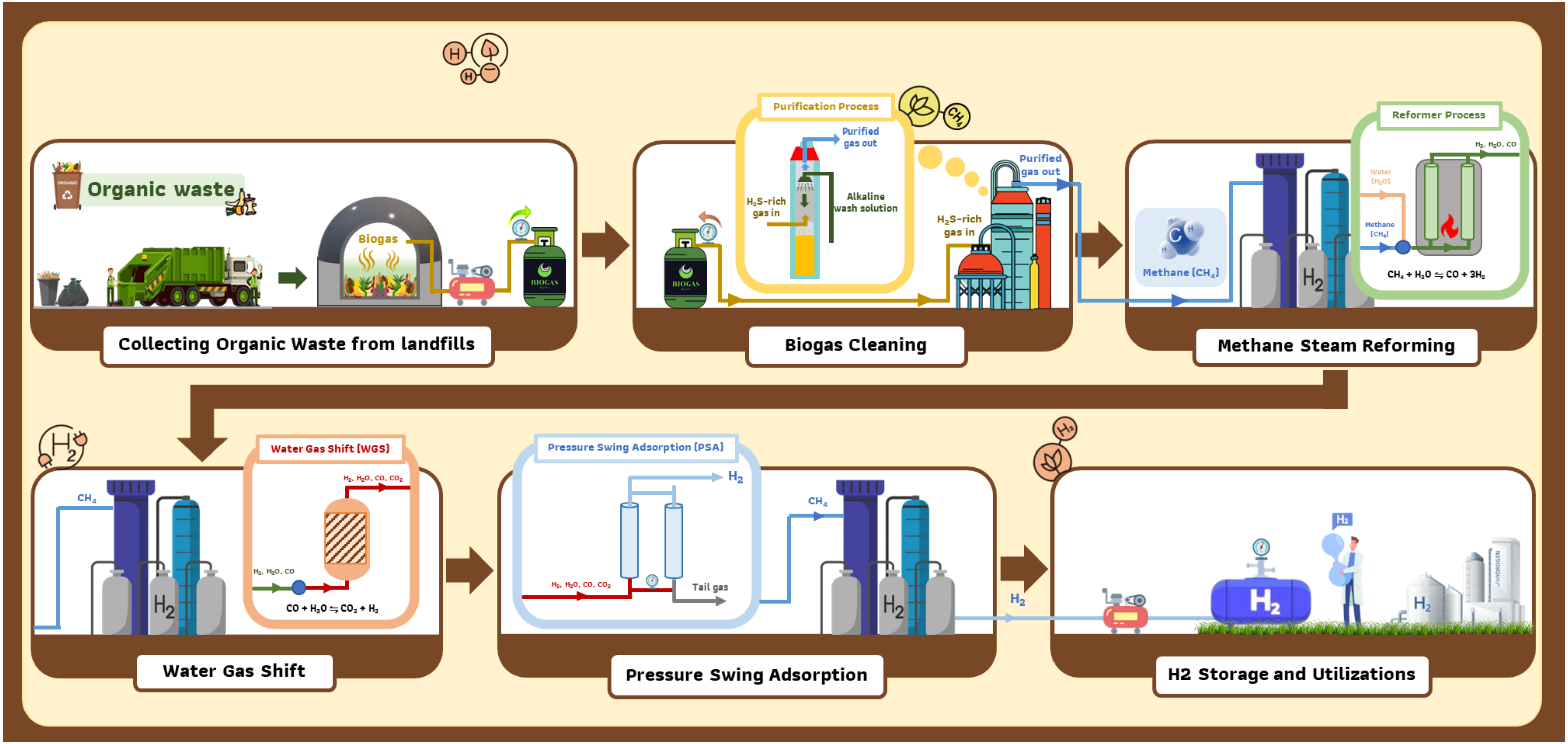
Research objectives:

- To develop and apply an "advanced technology platform" that effectively integrates green hydrogen production technologies to reduce greenhouse gas emissions in agriculture and livestock sectors, supporting the association's goal of achieving net-zero emissions.
- Substantial and diverse amount of agriculture and livestock wastes including animal manure, organic waste, biomass residues, and landfill gas will be transformed into hydrogen, clean ammonia, sustainable aviation fuel (SAF), and bio-fertilizers, creating additional revenue for farmers or industrial facilities.
- Alternatively, this contributes to reducing greenhouse gas emissions across the production chain. The benefits extend to the agriculture and livestock sectors and the nation as a whole.

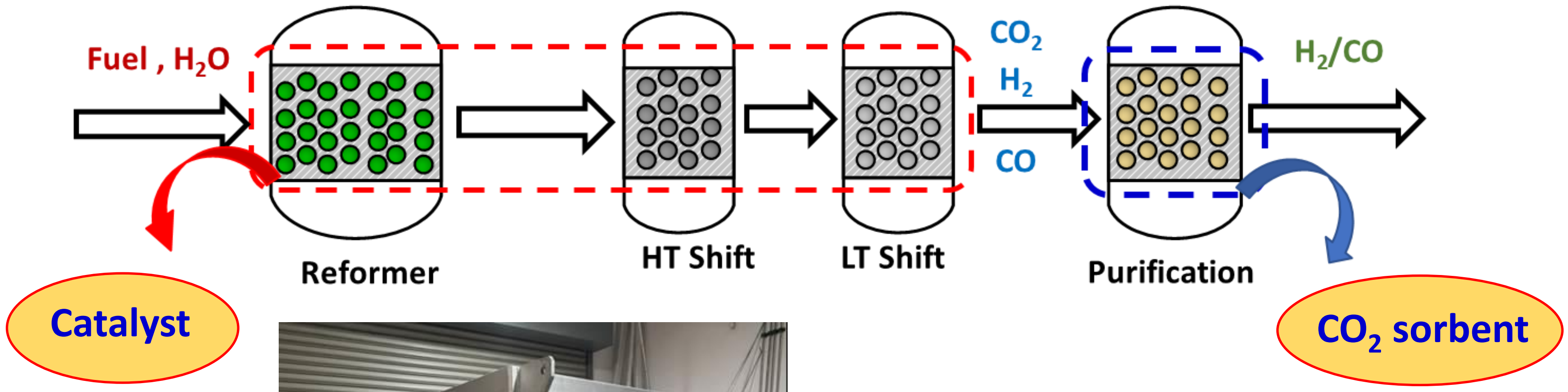




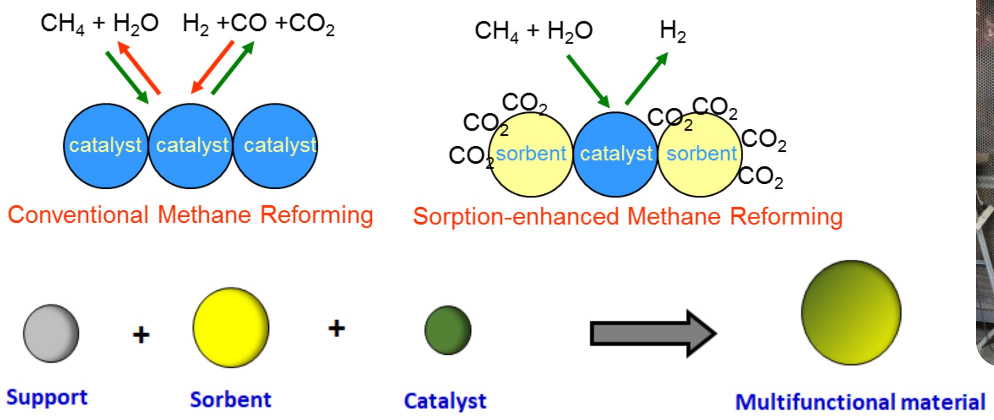
Hydrogen production using biogas & landfill from municipal waste

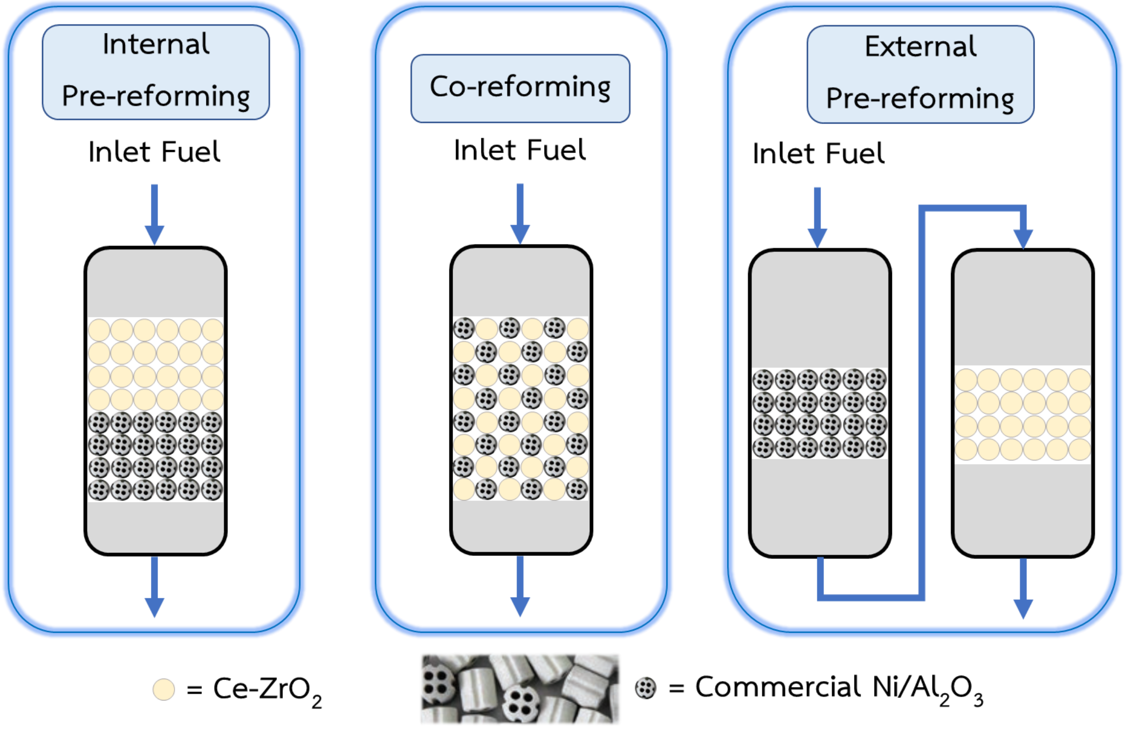


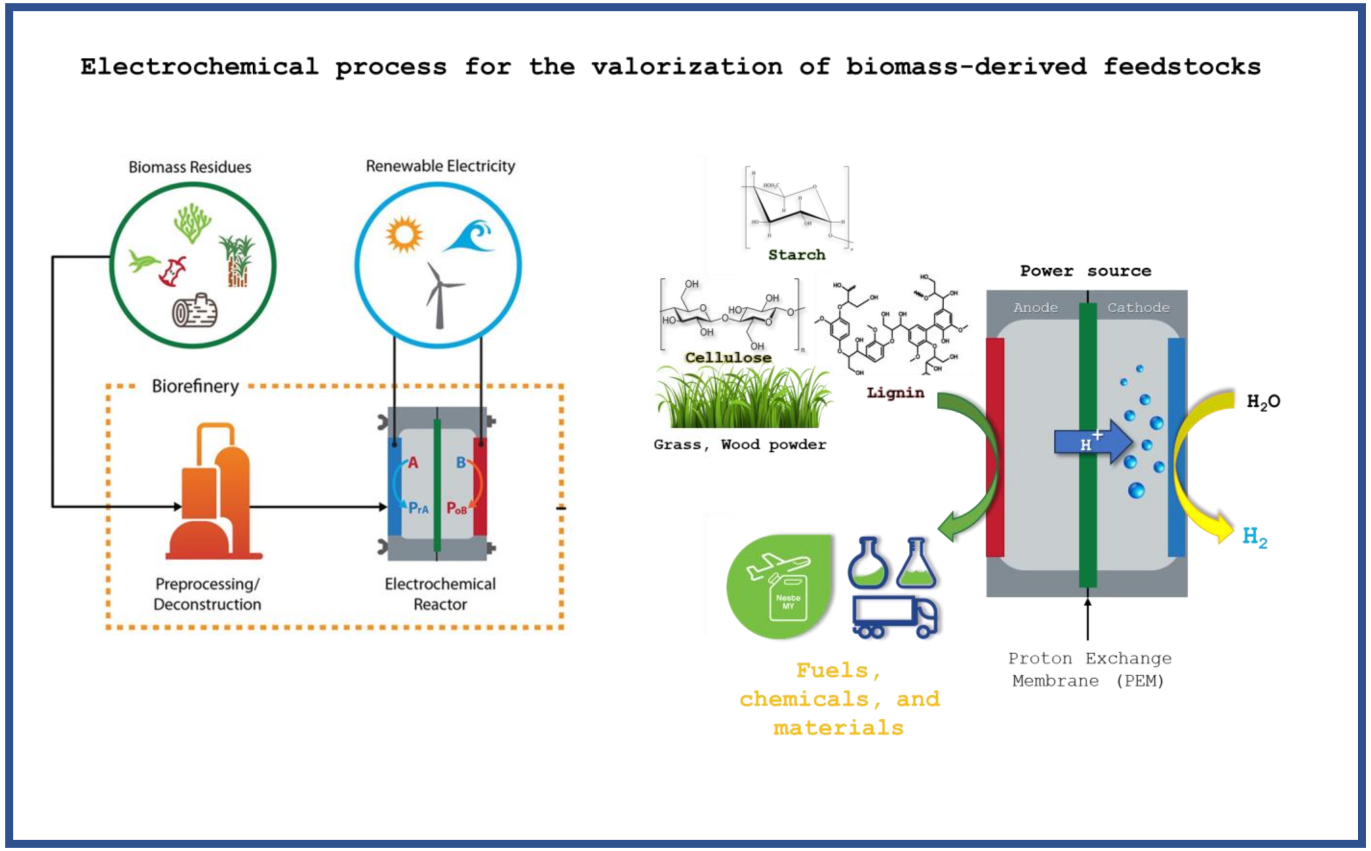
Research scale: Hydrogen production at 20 liter per min from biogas with PSA

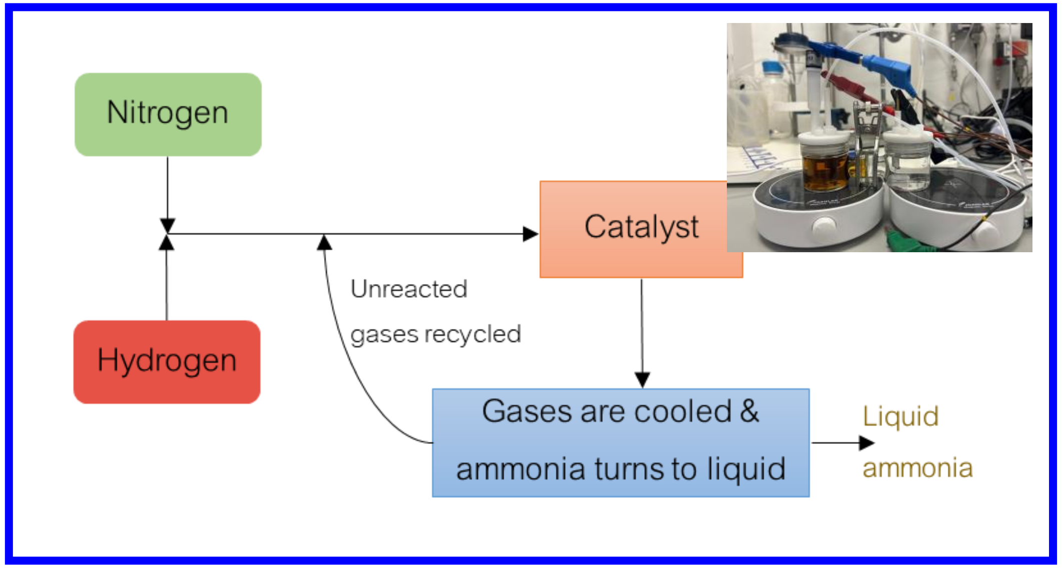


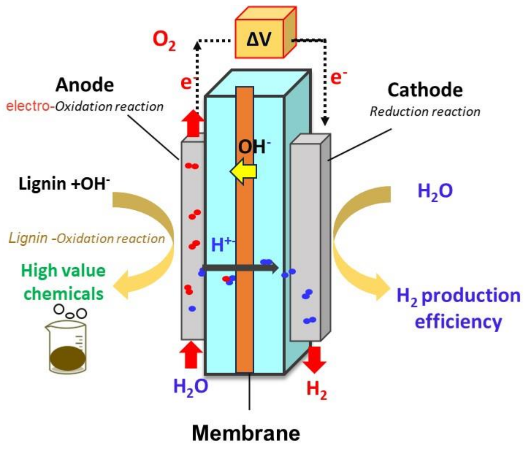
Catalyst design

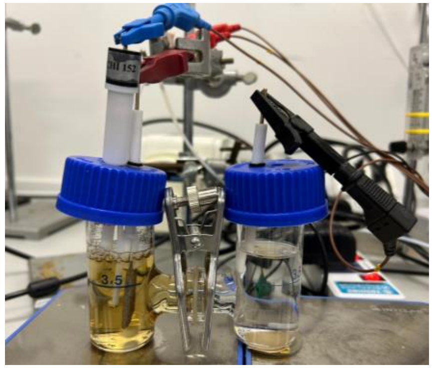


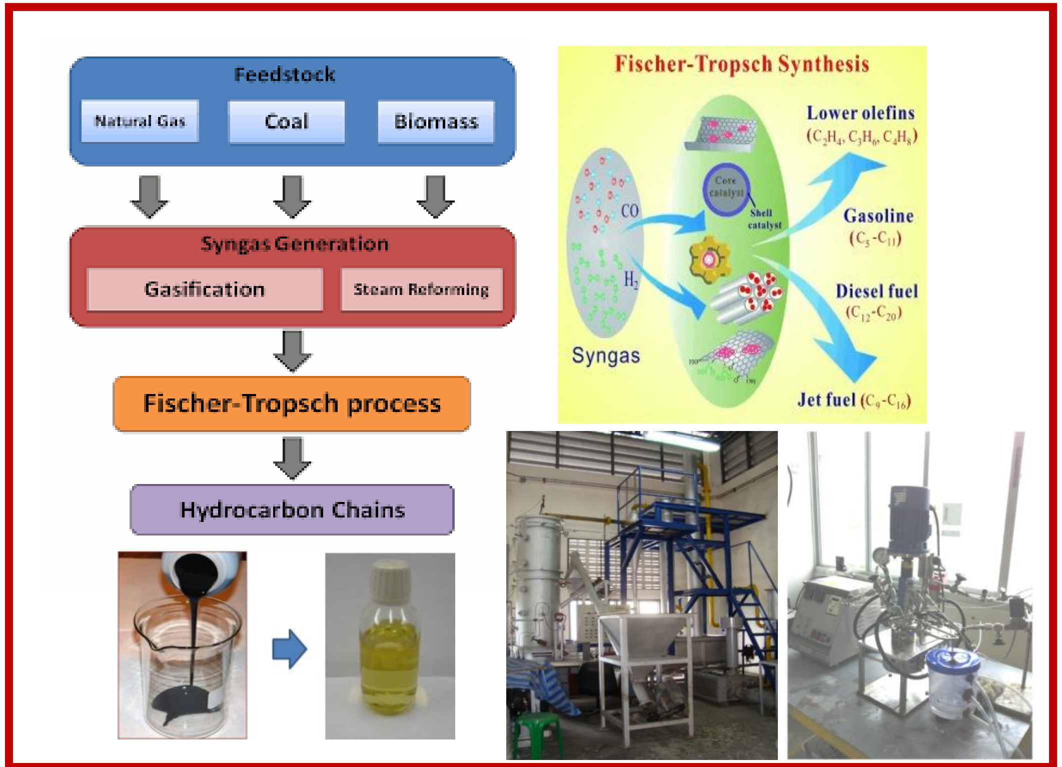



Electrochemical process for the valorization of biomass-derived feedstocks
Biomass Residues
Renewable Electricity
Biorefinery
Preprocessing/ Deconstruction
Electrochemical Reactor
Starch
Cellulose
Lignin
Grass, Wood powder
Power source
Anode
Cathode
H_2O
H_2
Fuels, chemicals, and materials
Proton Exchange Membrane (PEM)


Nitrogen
Hydrogen
Catalyst
Unreacted gases recycled
Gases are cooled & ammonia turns to liquid
Liquid ammonia


O_2
ΔV
Anode
electro-Oxidation reaction
Cathode
Reduction reaction
OH^-
Lignin $+OH^-$
H_2O
Lignin -Oxidation reaction
H^+
High value chemicals
H_2 production efficiency
H_2O
H_2
Membrane




Feedstock
Natural Gas
Coal
Biomass
Syngas Generation
Gasification
Steam Reforming
Fischer-Tropsch process
Hydrocarbon Chains
Fischer-Tropsch Synthesis
Lower olefins (C_2H_4, C_3H_6, C_4H_8)
Gasoline (C_5-C_{11})
Diesel fuel (C_{12}-C_{20})
Jet fuel (C_9-C_{16})
CO
H_2
Syngas

Interested Collaborative Research Topics:

1. Development of low-cost and high efficient multifunctional catalysts for hydrogen production from various agricultural wastes
2. Development of high efficient electrochemical process for green hydrogen production from various agricultural wastes
3. Development of low-cost and high efficient Pressure Swing Adsorption (PSA) process for purification of hydrogen produced from agricultural wastes




วช.
NRCT

THANK YOU

JGSEE
The Joint Graduate School of Energy and Environment

CEE PERDO
Center for Energy Technology and Environment

KMUTT

KMUTNB

e-ASIA Joint Research Program (JRP)

INTERNATIONAL RESEARCH SYNERGY WORKSHOP

Alternative Energy

Production of Green Hydrogen from Textile Industrial Waste Water

Presented by

Dr. Nann Soe
Director
Material Science Research Centre (MSRC),
Department of Technology Promotion and Coordination (DTPC)
Ministry of Science and Technology (MOST), Myanmar

(25-11-24)

Content

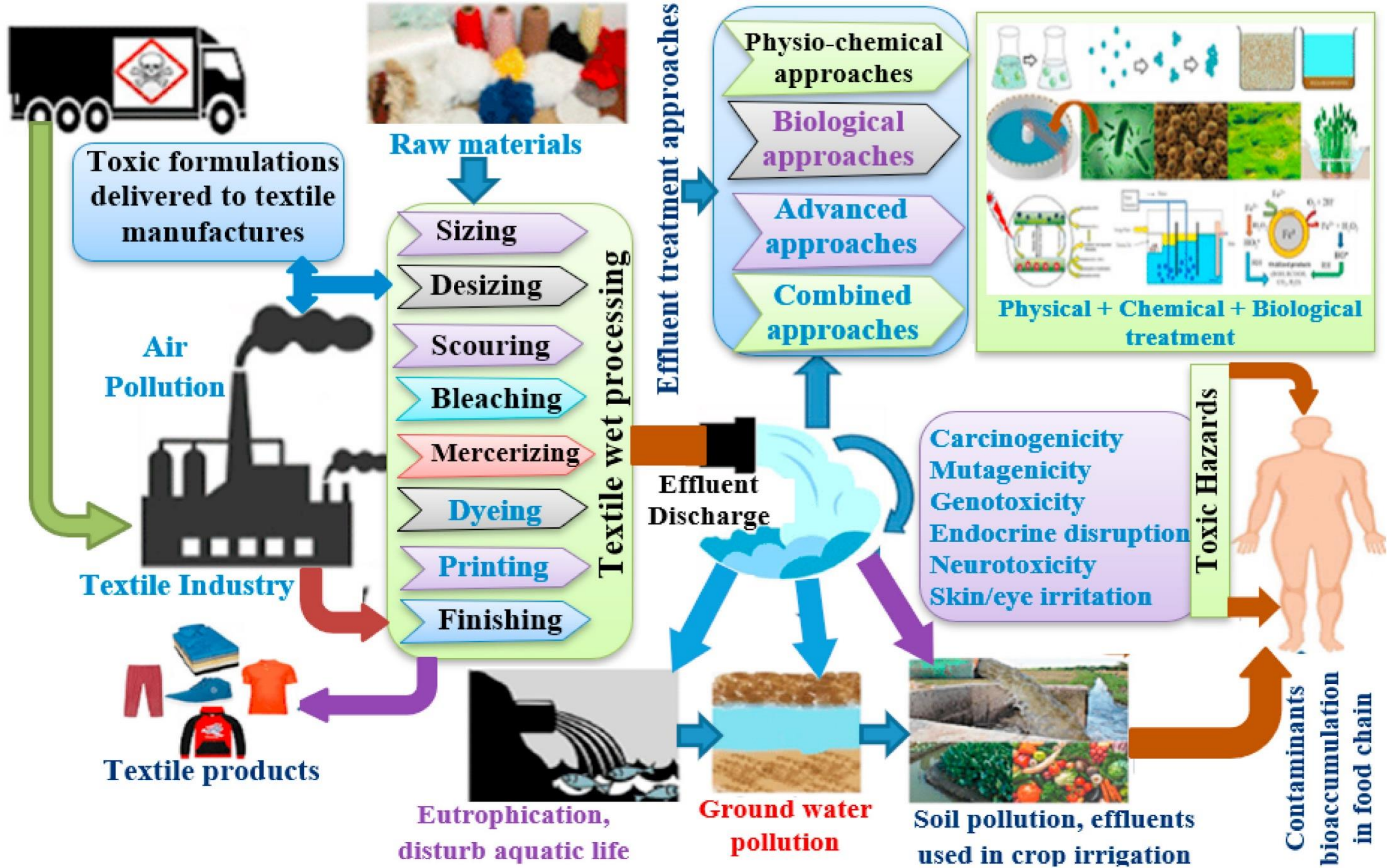
Brief Description

- We want to lead innovative approaches to utilizing waste water as a feedstock for green hydrogen production contributing to a more sustainable and circular economy because water, while abundant, is not uniformly available in all region, and its overuse or mismanagement can lead to significant environmental impacts.
- Furthermore, global energy demand and consumption are always on the rise due to an increase in population and standards of living, apart from the industrial growth of developing countries.
- So, we have planned to do the production of green hydrogen by electrolysis using from various industrial waste water to fulfil future energy demand.

Types of Wastes for Green Hydrogen

- Green hydrogen can be produced from several types of industrial waste, particularly those that contain organic materials or excess energy, such as:
  - Biomass Waste from Food and Beverage Industry
  - Sludge from Pulp and Paper Industry
  - Waste Gases from Steel and Petrochemical Industries
  - Plastic and Chemical Waste
  - Textile and Leather Industry Waste
  - Wastewater Treatment Plants (WWTP)
  - Agricultural and Livestock Waste

Processing, wastewater generation, its toxicity, and treatment approaches in textile



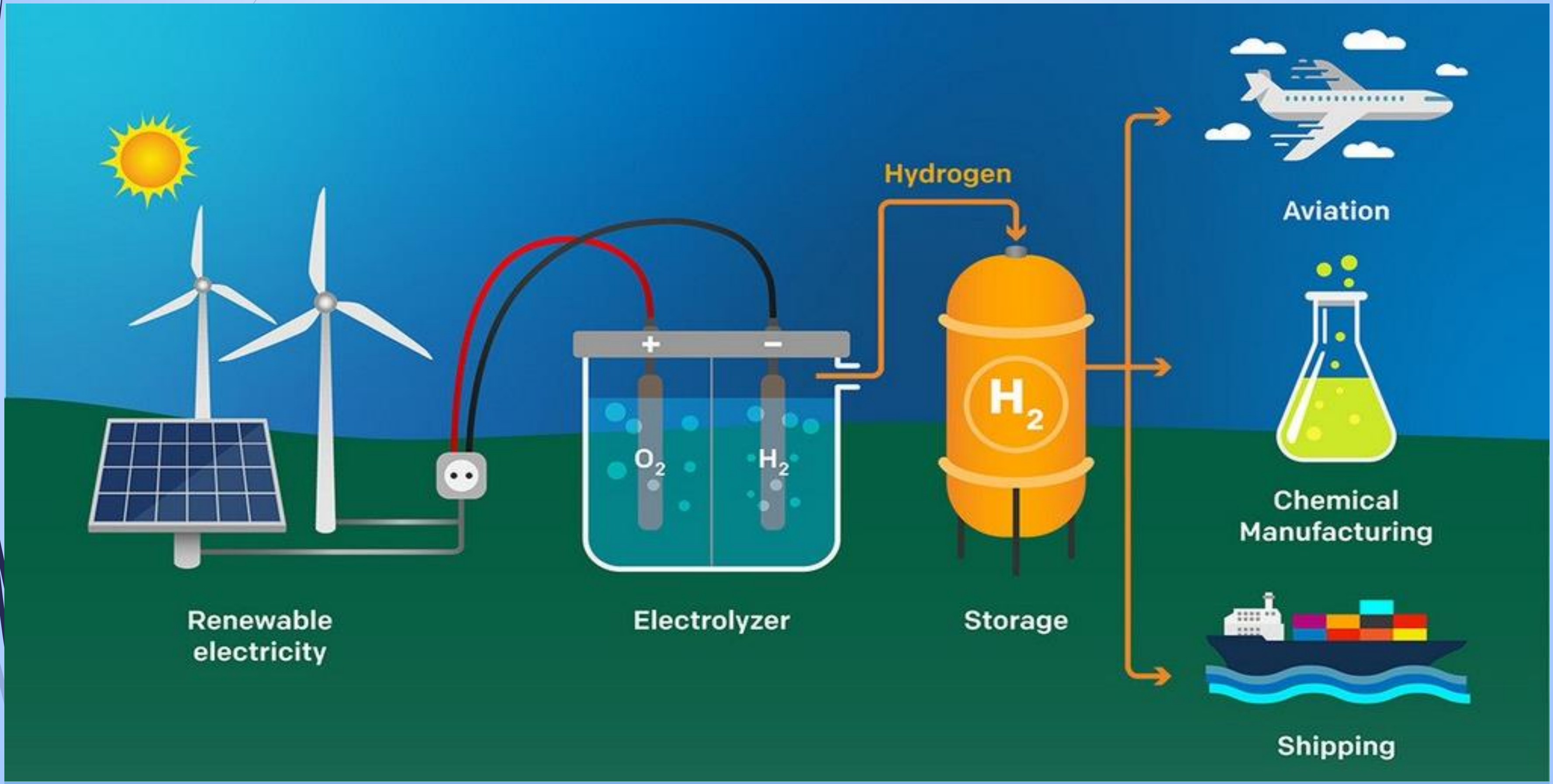
Introduction

- There are so much waste water which comes from various industries such as in all over the world and environmental impacts are observed. So, research for waste water treatment is really needed to solve this problem.
- Production of Hydrogen, especially green hydrogen, is also necessary for future energy demand because it can be used as a fuel for future energy with zero carbon emission.
- Nowadays, renewable-powered green hydrogen generation is one way that is increasingly being considered as a means of reducing greenhouse gas emissions and environmental pollution. Hence, there is an increasing interest to make the production and utilization of this green hydrogen more scalable and versatile process.

Introduction (Con’t)

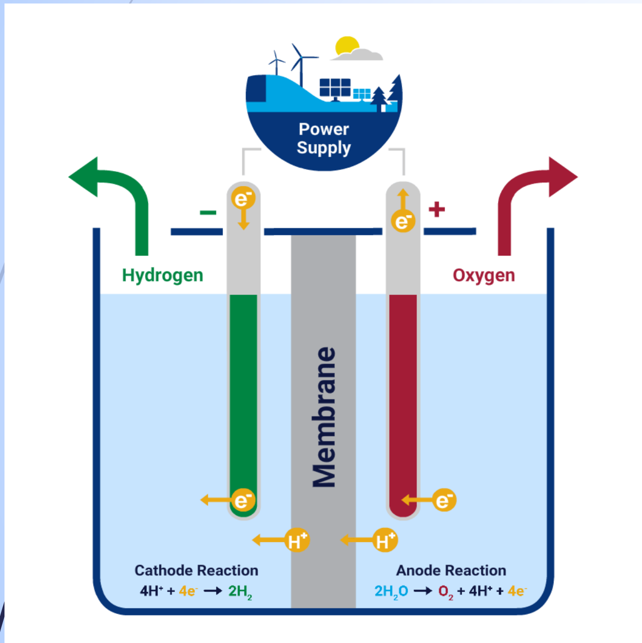
- The production of green hydrogen through electrolysis involves the use of water as the primary element which is used to produce electric current from renewable energy source in order to break it into oxygen and hydrogen gas.
- Hydrogen produced through electrolysis is 100% sustainable source of energy as it does not emit any harmful gas or cause any kind of environmental pollution during the production process.
- Green hydrogen can also be used in the chemical industries for manufacturing ammonia and fertilizers, and in the petrochemical industries to produce petroleum products, used also in steel industries.

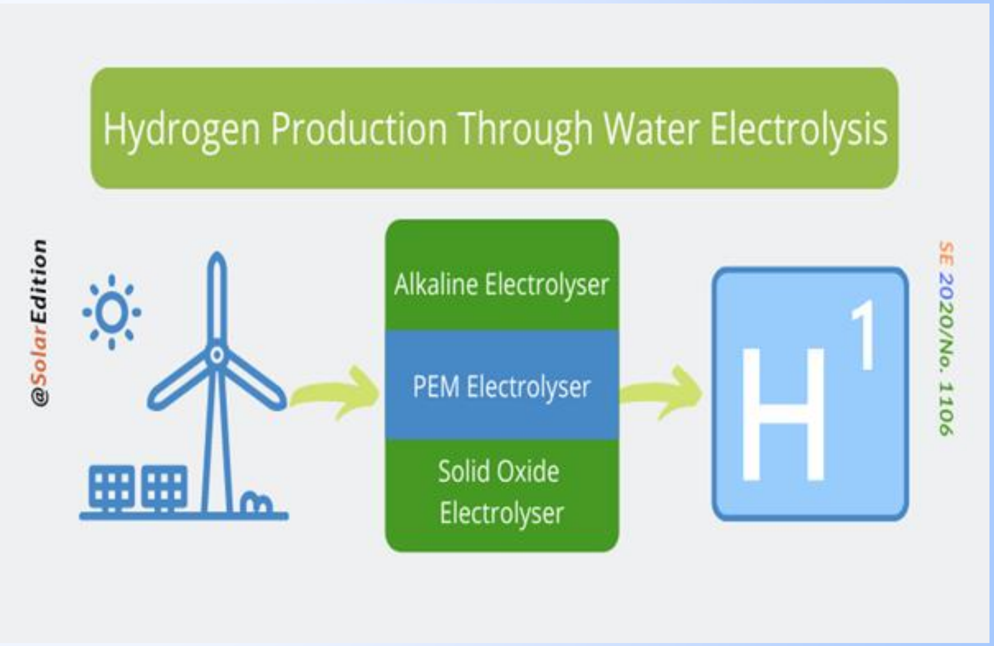
Green Hydrogen Production



Green hydrogen also known as renewable hydrogen is produced from water, using a process called electrolysis. This involves a strong electrical current generated from renewable sources like solar or wind energy being passed through purified water

Green Hydrogen Production





The produced hydrogen and oxygen can be directly used for the transportation and industrial sector as primary energy sources.

Project Background

- Our project team in Material Science Research Centre (MSRC) are now doing the waste water management research project for the laboratory wastes aiming to reduce the environmental impact caused by hazardous materials.
- To recover the valuable metals from the wastes, we are also doing researches for the recovery of lithium and other valuable metals from lithium ion battery electrode materials (Cathode & Anode) from the used Lithium ion Battery (waste).
- We have also planned to manage the various industrial waste water in Myanmar for the protection of our public environment and green hydrogen production from the treated water for future energy demand.

Project Activities

- Firstly, for waste water management we have to do sampling various industrial waste waters (near Kyaukse in Mandalay Region) and then do measuring the properties such as pH, Conductivity, BOD, COD, Acidity, Alkalinity, hardness and the contents of heavy metals etc., for these industrial wastes.
- Depending on the type of waste, we have to do required management using the Physical Separation methods such as Screening and Filtration, Coagulation and Flocculation, Sedimentation, Biological treatment methods such as aeration or activated sludge, and Chemical Separation such as Precipitation, Ion Exchange and Adsorption on activated carbon.
- Then, we have to analyze the purity of the treated water and green hydrogen production will be continued.

Summary of the project

- Waste water treatment need to be done by primary and secondary stages to get the purified water for hydrogen production. Water treatment for hydrogen production consists of a pretreatment step – determined by the sourced water and – followed by polishing. The polishing steps can differ, but will consist of one or more treatment steps from softening to deionization.
- For green hydrogen production, although there are various water electrolysis technologies and their challenges, it is required to produce viable green hydrogen by doing research with cost reduction and commercialization perspective.

Key reasons for undertaking the project

- Green Hydrogen has emerged as a key player in the fight against climate change, offering a carbon free solution for industries, transportation and energy storage.
- Nowadays, most of the developed countries are exploring an exciting innovation producing green hydrogen from waste water.
- This process not only offers a sustainable way to produce hydrogen but also provides solution to critical challenges like water conservation and waste management.

Project's expected outcomes

- After completion of the project:
  - We expect to get the waste water treatment and green hydrogen production technologies by taking researches together with project joint partners.
  - We will be able to use these technologies not only to prevent the environmental impact but also to use green hydrogen as a fuel aiming to zero carbon emission.
  - So, It leads to reduce our environmental impact causing by waste water and can also produce Green Hydrogen as alternative energy for fuel.

Project Needs

- For waste water treatment, we have some facilities and we are now doing researches in Lab scale. But we need to get technology for larger scale and advanced technology via cooperation with other developed countries.
- For the production of green hydrogen, we are still only initiating steps and so we hope to get the production technology by cooperating with other research teams in developed countries for further technological improvement.
- we would like to get trainings, fellowships, scientific visits, and workshops for human resource development.

Challenges related to Green Hydrogen

- There are so many challenges for Green Hydrogen production: High Production Costs, Limited Renewable Energy Availability, Efficiency and Technology Gaps, Storage and Transport Challenges, Policy and Regulatory Barriers, Competition for Resources, Geographic Limitations.
- The cost is high compared to the conventional blue hydrogen production because of the use of expensive materials. In order to reduce the green hydrogen cost, the future research should proceed to develop efficient and cost-effective water electrolysis technologies to mitigate the environmental and economic concerns.

Conclusion

- We need the respective technologies for the treatment of industrial waste water although we are doing research for laboratory waste water treatment, and for green hydrogen production although there are many challenges since our country is only developing country.
- Moreover, our country would like to request to cooperate with in kind and we need technical assistance.
- Since green hydrogen is increasingly being promoted to address climate change issues and meet the global net-zero challenges, on behalf of our project team in Myanmar, I would like to request for participation in this e-ASIA Joint Research Program (JRP) for our country improvement and able to do the world save.


Thanks for Your Kind Attention!