

# Introduction to the

# CROSS LABORATORY

東京科学大学 環境・社会理工学院 融合理工学系 クロス研究室

Institute of Science Tokyo, School of Environment and Society  
Transdisciplinary Science and Engineering



# and Engineering Thinking



# Prof. Jeffrey S. Cross

## About

### ● Education

- 1988-1992 Ph.D., Major: Ch.E., Minor: Mater. Sci., Iowa State University, Ames, IA, USA
- 1986-1988 M.S., Ch.E., University of Arkansas, Fayetteville, AR, USA
- 1982-1986 B.S., Ch.E., Kansas State University, Manhattan, KS, USA (Honors program)

## Teaching

- **Doctoral courses**
  - Academic Writing A & B
- **Undergraduate courses**
  - Online course creation
  - Educational Video-making
  - Engineering Measurements
  - Materials and Molecular Engineering



# Prof. Jeffrey S. Cross

## Career in Japan

- 1993 arrived at NIRIM, Tsukuba, Japan as NSF Post-doc fellow
- 1994 CGP-NSF Post doc fellow, Fujitsu Lab Ltd., Atsugi, Japan
- 1996 Fujitsu Lab Staff Researcher, Semiconductor Memories
- 2002 Part-time visiting Assoc. Prof. Tokyo Tech
- 2004 Fujitsu Lab Group Leader, Memory Reliability
- 2008 Professor Tokyo Tech, International Engineering Programs
- 2014 Created Online Education Development Office, edX Member
- 2016 Started Cross Lab for research and lab based education



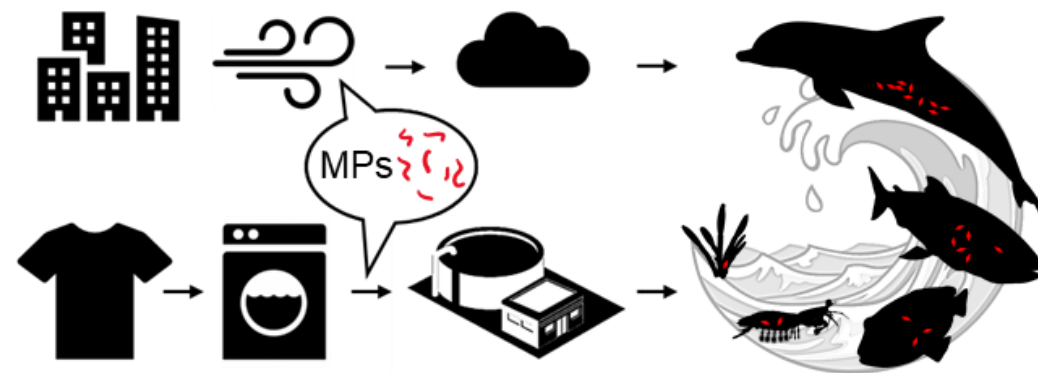
# Assistant Prof. Cheng Shuo (Tei)

## Education:

- Environmental Science and Technology, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, Japan
- 2013-2016 Ph.D.

## Research:

- Hazardous waste treatment, environmental/ecotoxicology, microbial fuel cells
- 3 students supervising



Ecotoxicological studies about MPs

Ecological risk assessment of MPs

Risk management policy for MPs control



# Dr. Sasipa Boonyubol

- Lecturer - 

## Education:



B. Eng  
(Thailand)  
-2013-



東京工業大学  
Tokyo Institute of Technology

M. Eng  
(Japan)  
-2016-



東京工業大学  
Tokyo Institute of Technology

D. Eng  
(Japan)  
-2020-

## Undergraduate courses in English:

- Engineering Thermodynamics
- Biological Engineering
- Engineering Measurements
- Industrial Chemistry
- Visionary Project

## Research Projects:

- Hydrogen separation membrane (collaboration with Thailand)
- JST AJ-Core Nano-biochar augmentation for dry anaerobic digestion (collaboration with South Africa and Mozambique)

# Visiting researchers



**Tokyo Tech Emeritus  
Prof. Koichi MIKAMI**

Research area:

- Asymmetric Synthesis
- Drug Design
- Organofluorine
- Organometallic
- Material Design



**Dr. Nopphon Keerativoranan, researcher  
in Takada Lab**

Research and activities:

- Personalized learning
- Machine learning
- Online Educational Technology
- Wireless communication, WiFi

# Current students

- **Current students: 17**
  - Doctoral students: 11
  - Master's students: 3
  - Bachelor's student: 1
  - Research student (doctoral student): 1
  - Visiting Junior Fellow: 1
- **Students' nationalities:**
  - Bangladesh, Cambodia, Canada, China, India, Indonesia, Japan, Malaysia, Pakistan, Togo, Trinidad & Tobago, Ukraine/UK, USA
- **Diversity of students' nationalities**
  - English as a *lingua franca*

## Biofuels group



Harussani  
(D3)



Eric  
(D2)



Md. Rubel  
(D1)



Ishikawa  
(D1)



Dongkuan Zhang  
(Exchange PhD student -  
Visiting junior fellow)



Aldian  
(M1)

## Environmental toxicology group



Kimleng  
(D2)



Snehal  
(D2)



Haoge  
(M2)

## Edtech group



Luc  
(D3+)



Tony  
(D3+)



Don  
(D1)



Denys Prociuk  
(Research student)



Yuka  
(M2)



Hiroyuki Sato  
(B4)

## Energy policy group



Avinash  
(D3+)



Jinesh  
(D1)

# Thai visiting Assoc. Prof.

## Assoc. Prof. Chinnathan Areeprasert, D.Eng.

(Visiting Associate Professor at Science Tokyo)

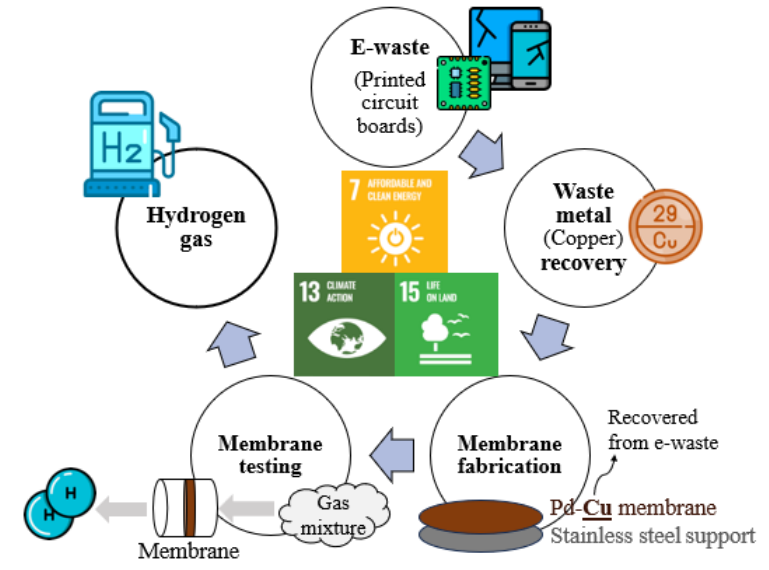
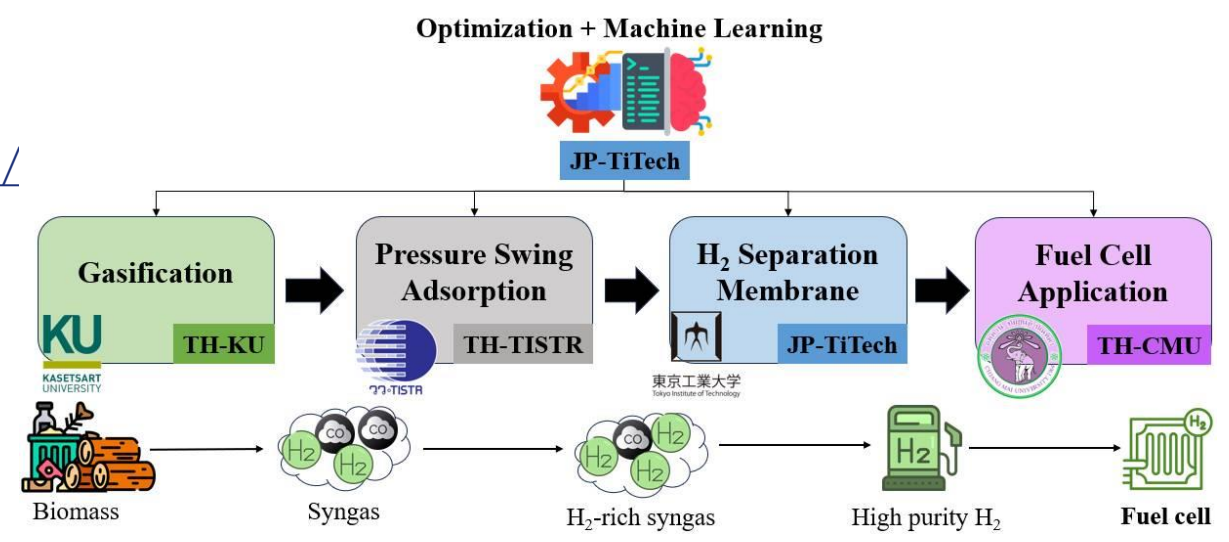
- Department of Mechanical Engineering, Faculty of Engineering, Kasetsart University
- Research area: Hydrothermal Processing of Biomass; Thermochemical Conversion of Waste/Biomass; Waste Management; Hydrogen Production from Biomass Gasification



Assoc. Prof. Chinnathan



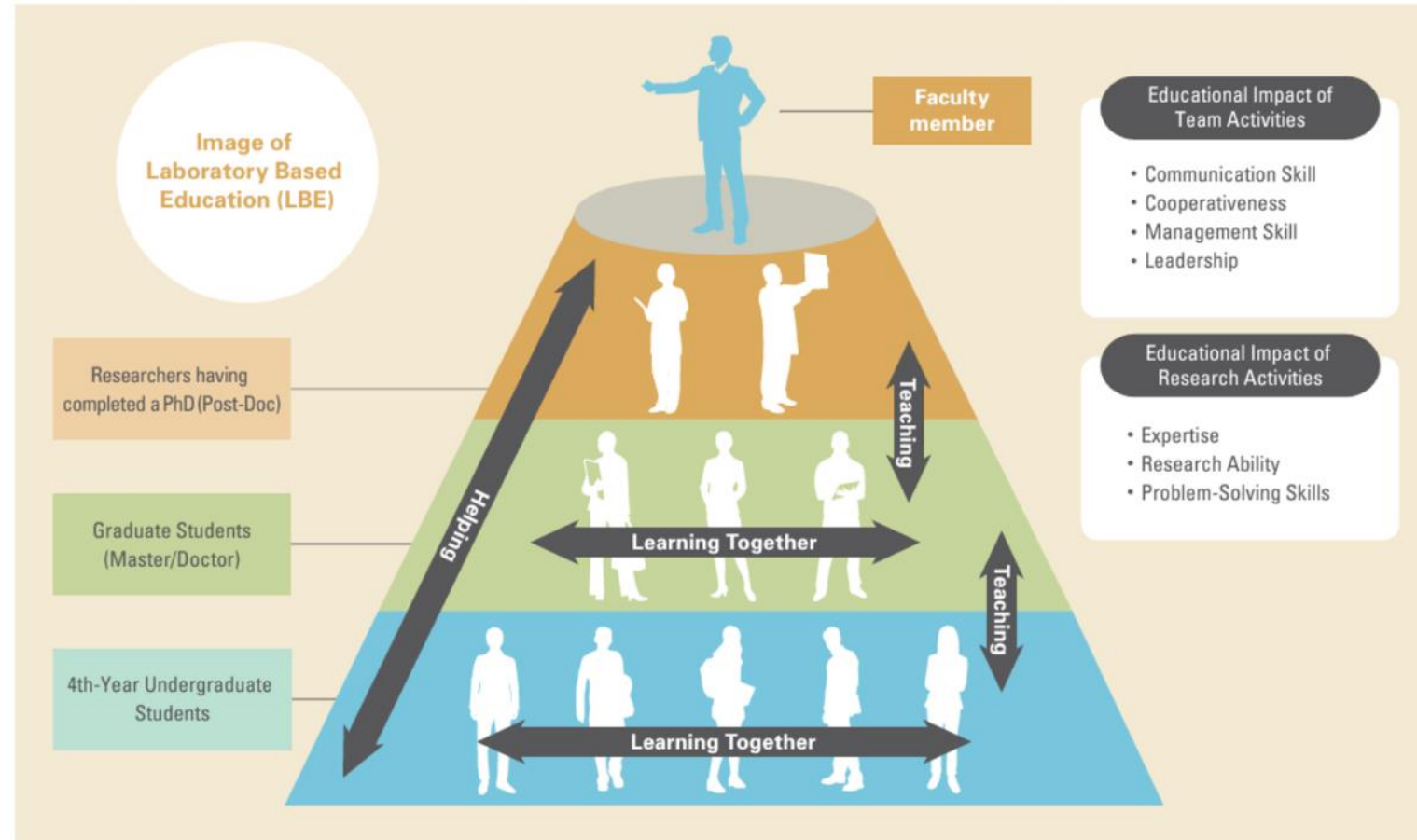
<https://wbc-lab.com/>





# Student Independent Researcher Ability Dev.

- New student research topic and discussion
- Published literature gap ?
- Write Research Proposal
  - Literature review
  - Research Objective
  - Research Plan & budget
  - Expected Outcome
- Conduct Research
- Write paper/Conf. presentation
- Graduation



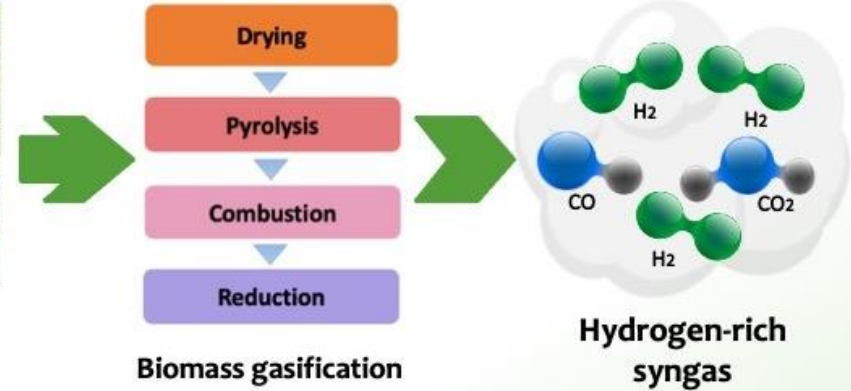
# Biofuels Research Group



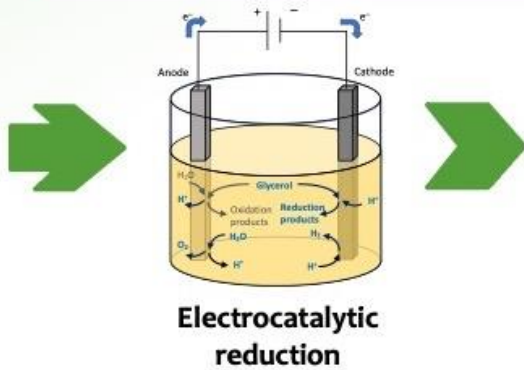
The **Biofuels research group** transforms wastes into sustainable aviation fuel, chemicals, and materials by using knowledge of chemical engineering processes, catalysts, and machine learning. They are also doing research on flow batteries utilizing electro-chemistry. The group also develops Pd-Cu membrane technology for green hydrogen gas separation and storage.



Agricultural waste: coconut husk



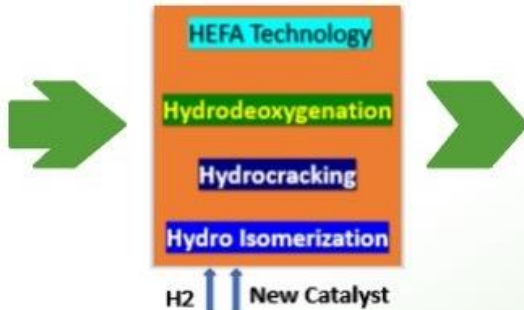
Waste glycerol



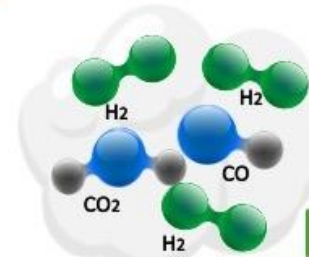
Alternative biofuel - biopropanol



Waste cooking oil



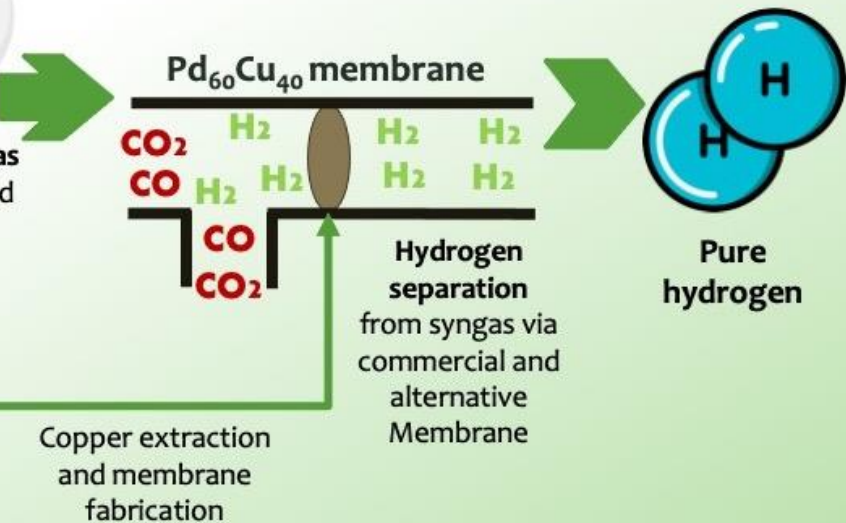
Sustainable aviation fuel



Hydrogen-rich syngas from gasification and water gas shift reaction



Waste Printed Circuit Board Char



# Japan Science and Technology Agency (JST) AJ-CORE project

- “Water wise waste management: Two ends of the size scale, macro and nano augmentation for dry anaerobic digestion optimization”
- Africa-Japan Collaborative Research



Japan



South Africa

Agricultural Research Council



Mozambique

- External Funding AY2025-AY2027 (April 1<sup>st</sup>, 2025 – March 31<sup>st</sup>, 2028)

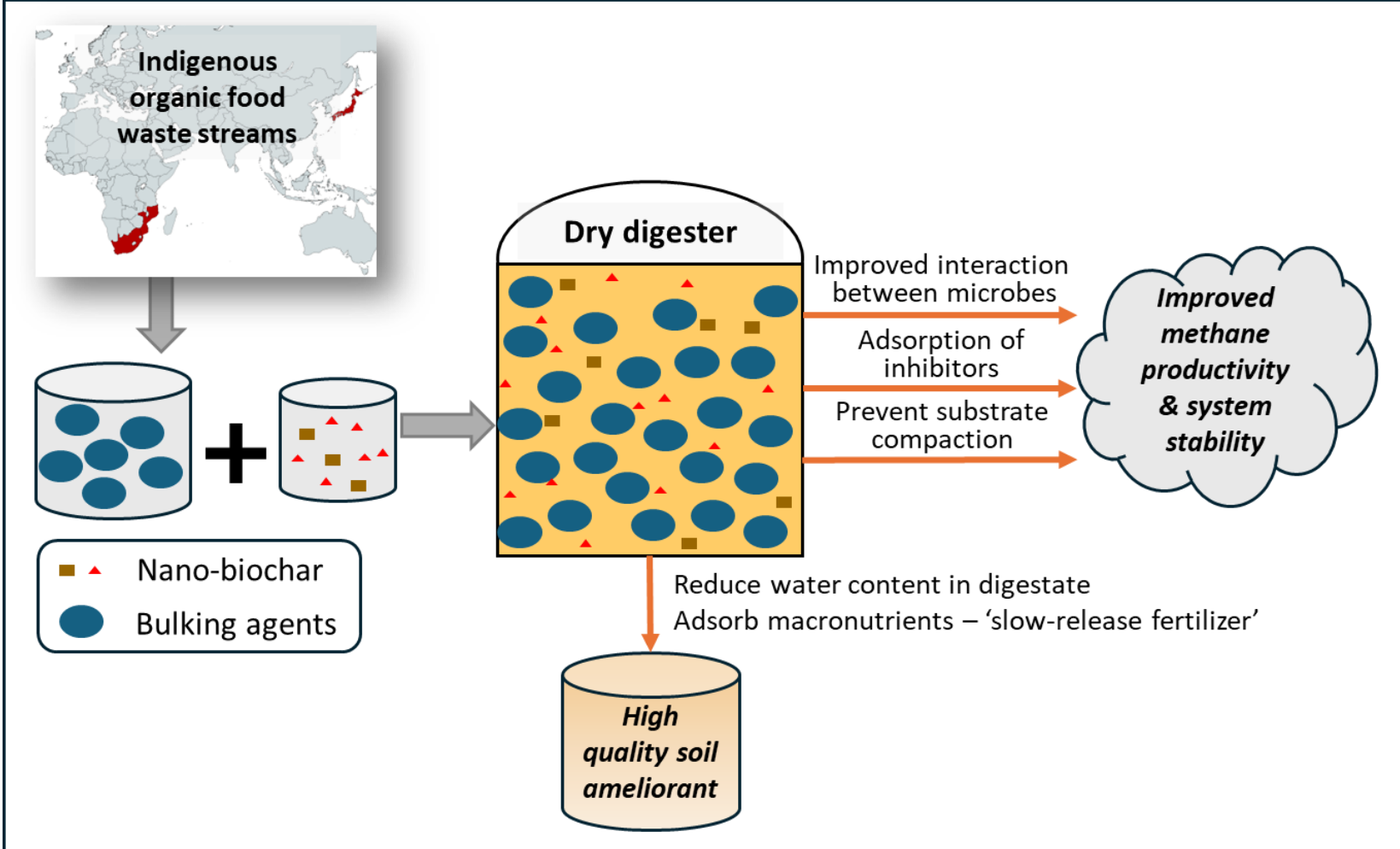
# Overview of JST AJCORE project

- Dry anaerobic digestion (solid-state anaerobic digestion)
  - Dry AD: Total solid content: 15 - 40% (Wet AD: <10% TS)
  - Smaller reactor volume
  - Lower water demand
  - Lower moisture content of digestate

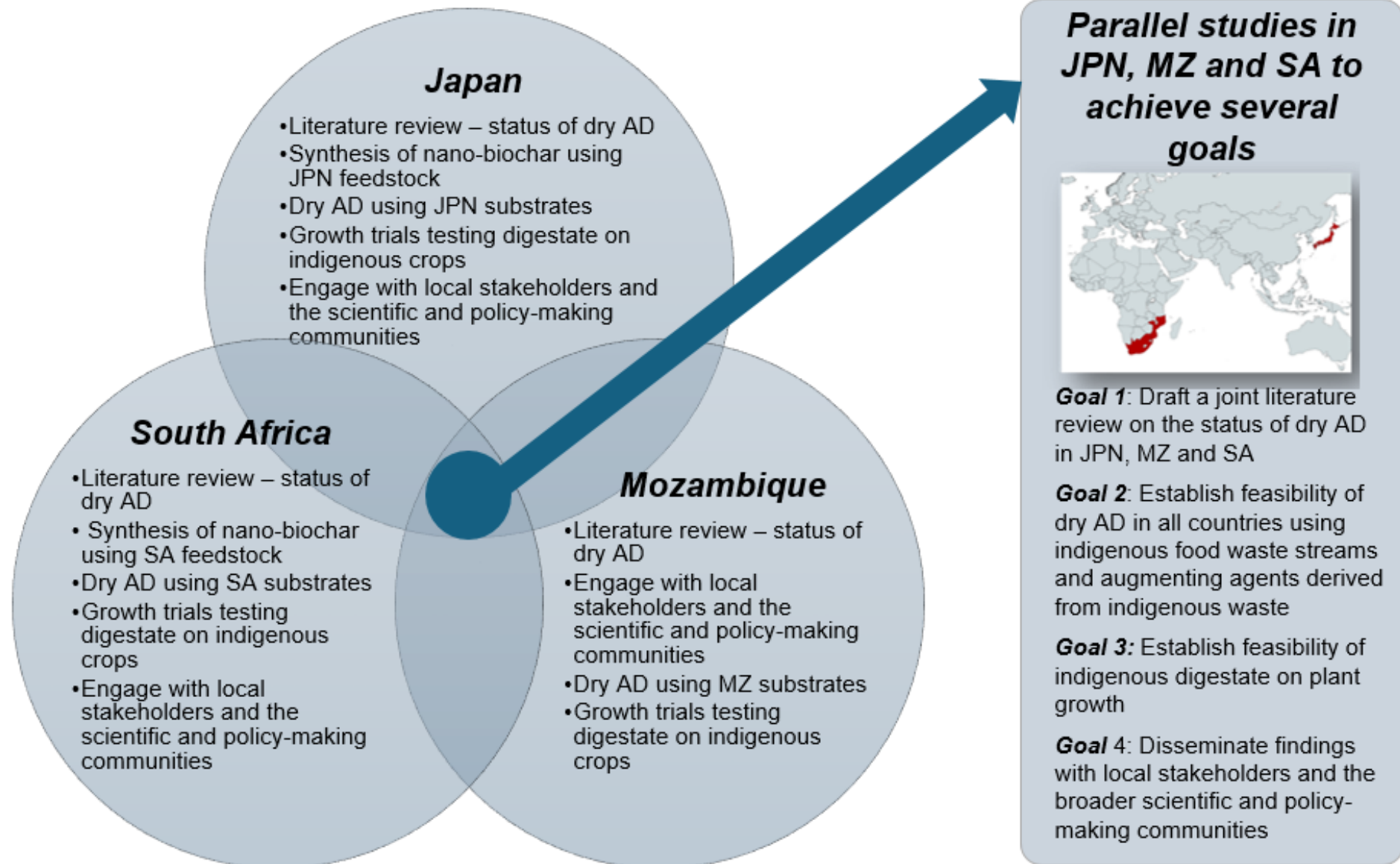
- Lack of effective mixing
- Substrate compaction
- Reduced mass transfer efficiency



**Lower biogas productivity**



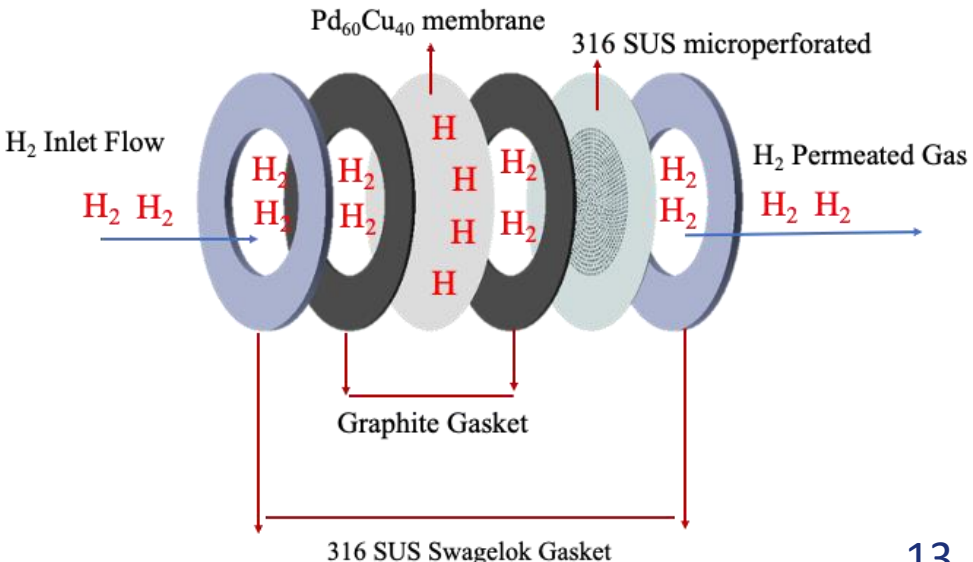
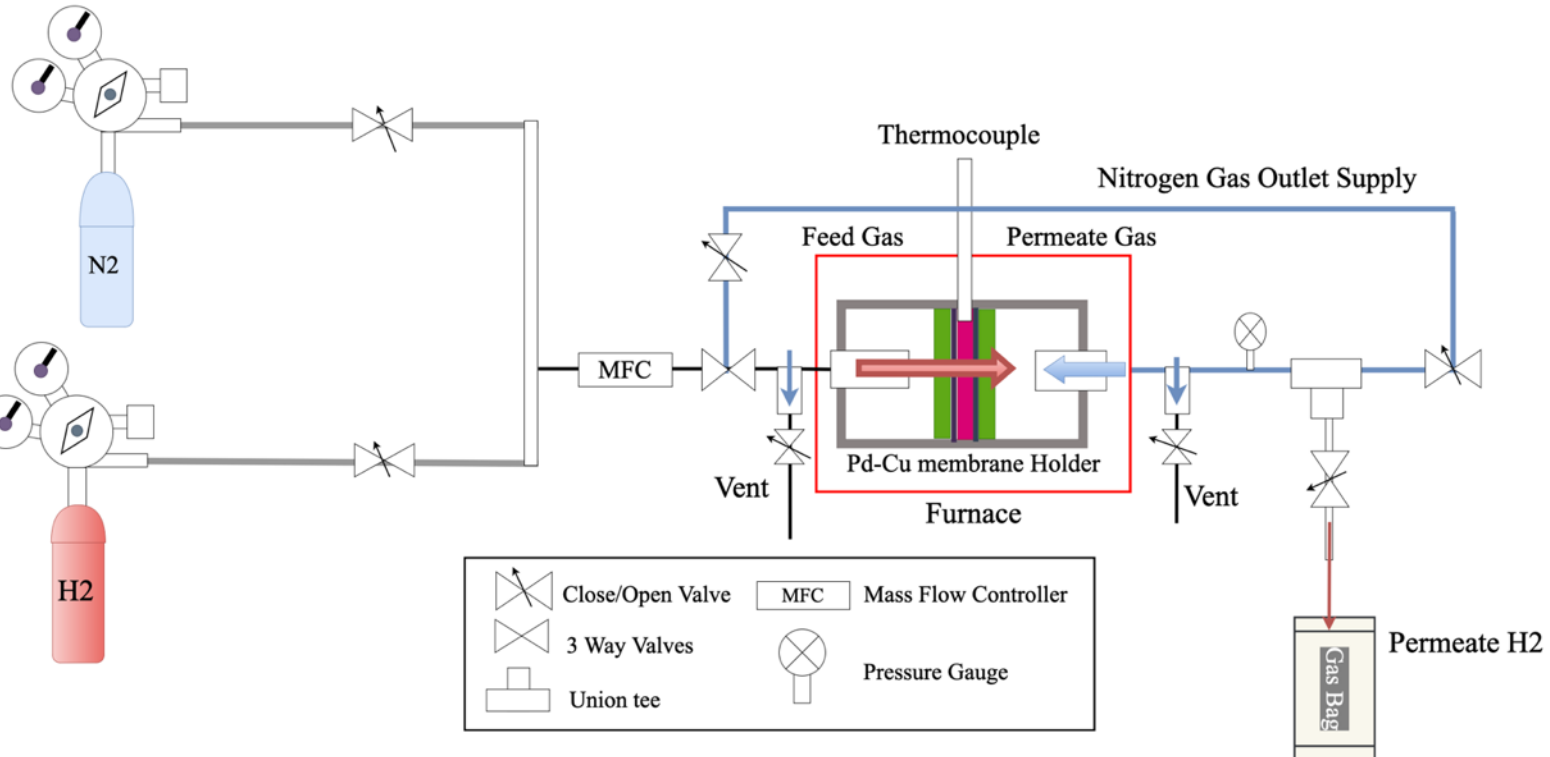
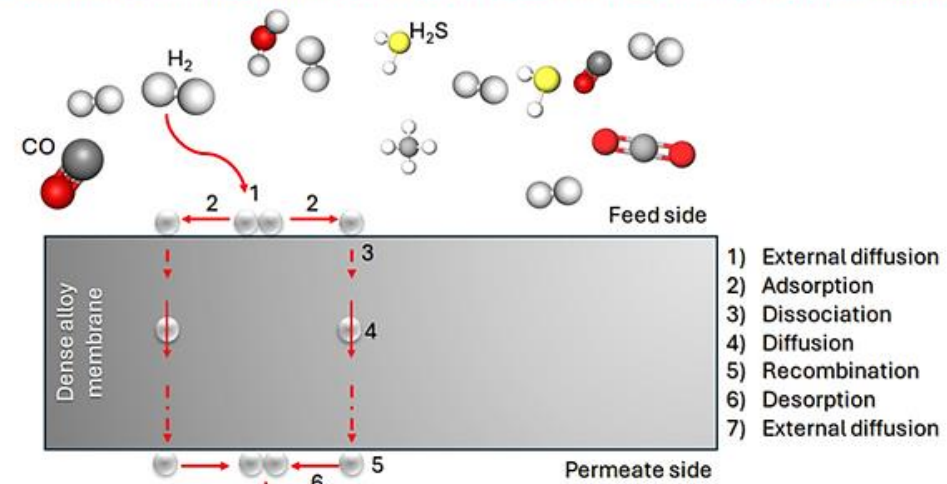
# Overview of JST AJCORE project



# Palladium Copper (PdCu) membrane-based hydrogen gas separation

Since 2021, the Cross lab has been undertaking hydrogen gas separation research using a Swagelok VCR based 20 cm diameter PdCu membranes of 10 and 15 microns thick, from Tanaka Kinzoku Ltd, Tokyo, Japan

Schematic of the mechanism of mixed gas separation using dense metal membranes



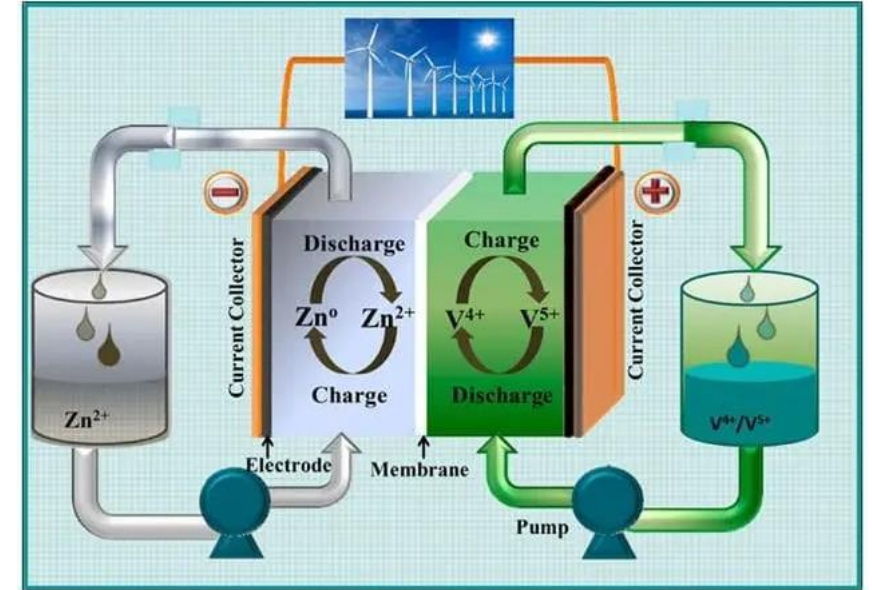
# Redox Flow Battery Research Projects

## NATO project with Greek Univ.

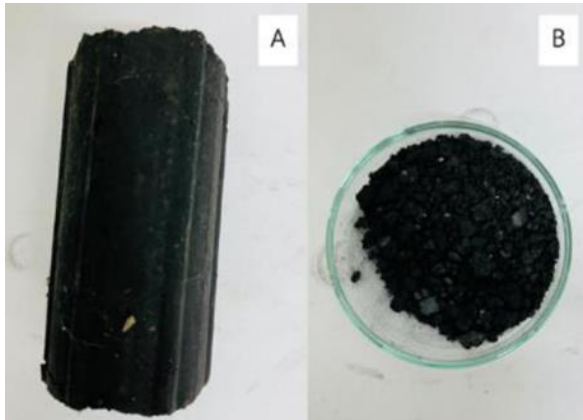
- starts May 2025
- electrode modification to increase charge storage
- new membrane to decrease costs

## Boron Flow battery – Doctoral student research

- hydrogen storage material
- high efficiency



# Hydrogen production and separation

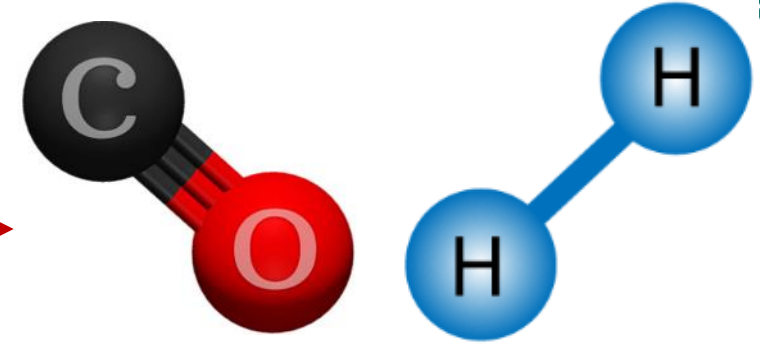


Coconut shell char [fuel]

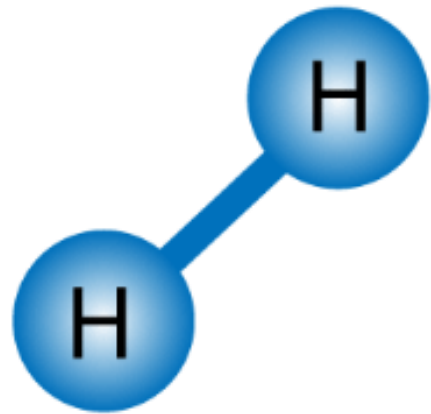
700-800 °C



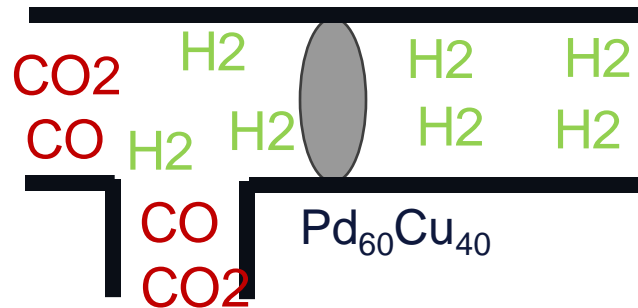
Gasifier



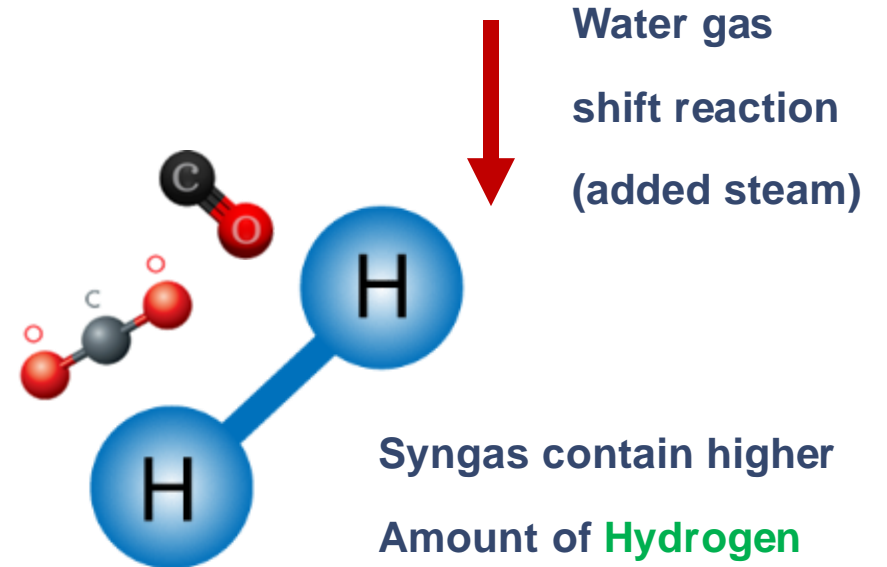
Syngas contain rich **Hydrogen**  
And **Carbon monoxide**



Pure **Hydrogen**



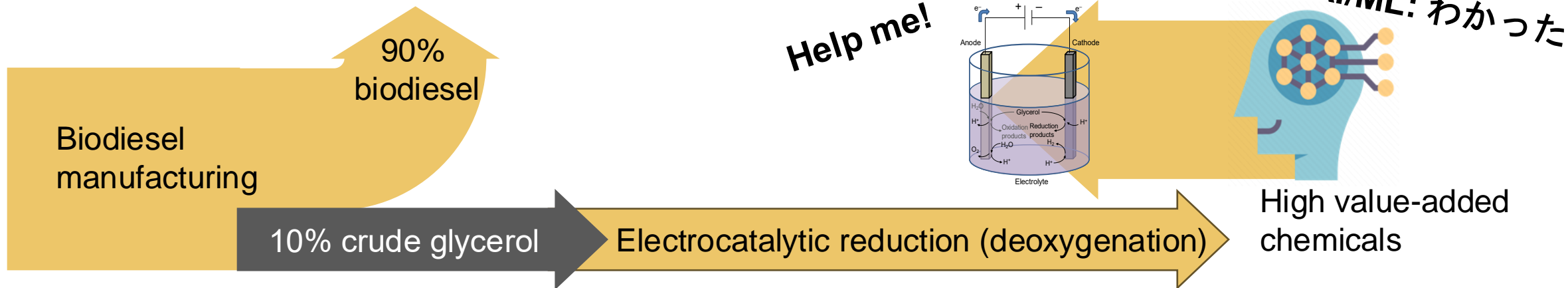
Hydrogen separation



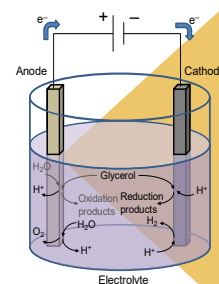
Syngas contain higher  
Amount of **Hydrogen**



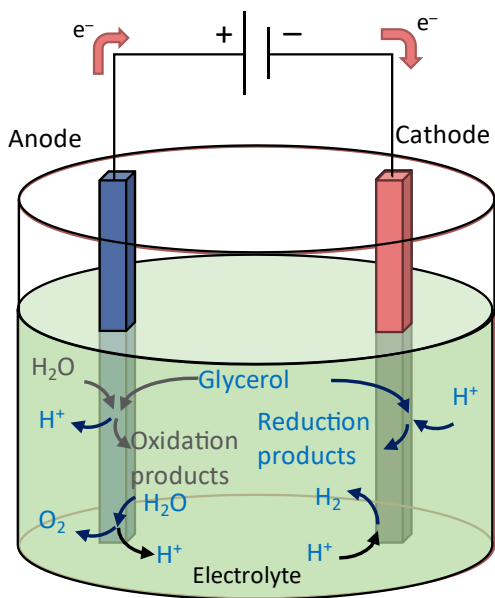
# Electrocatalytic reduction of glycerol assisted with machine learning



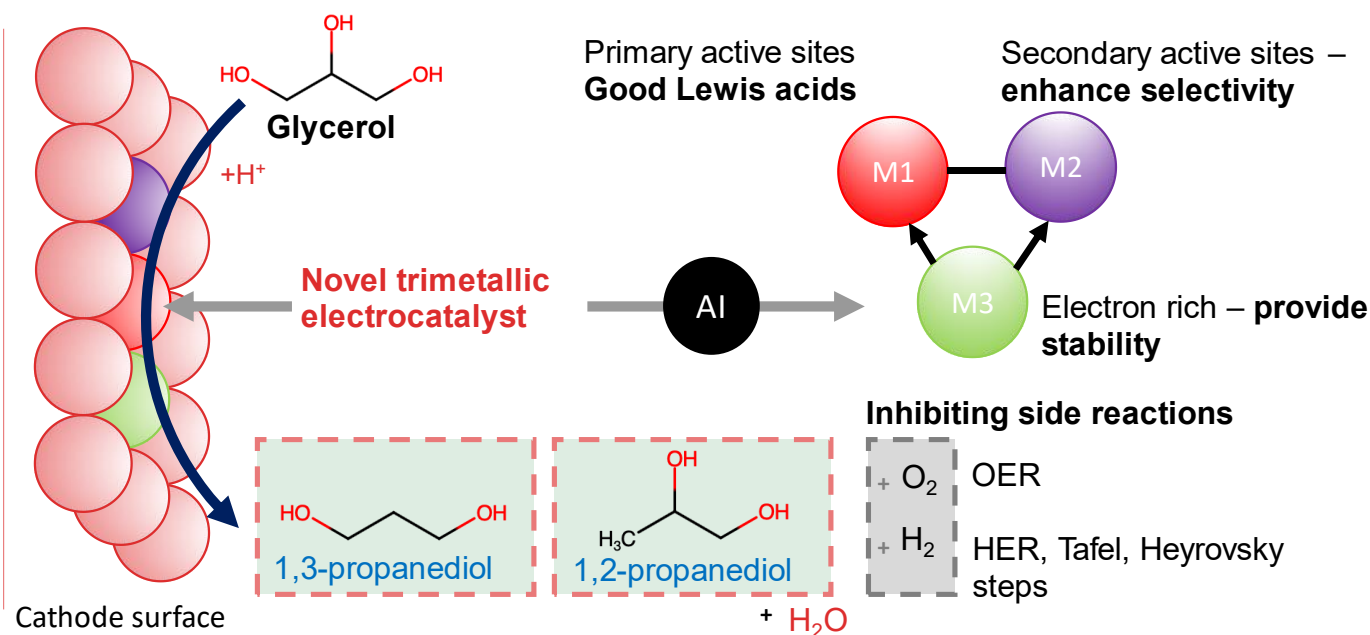
Help me!



AI/ML: わかった

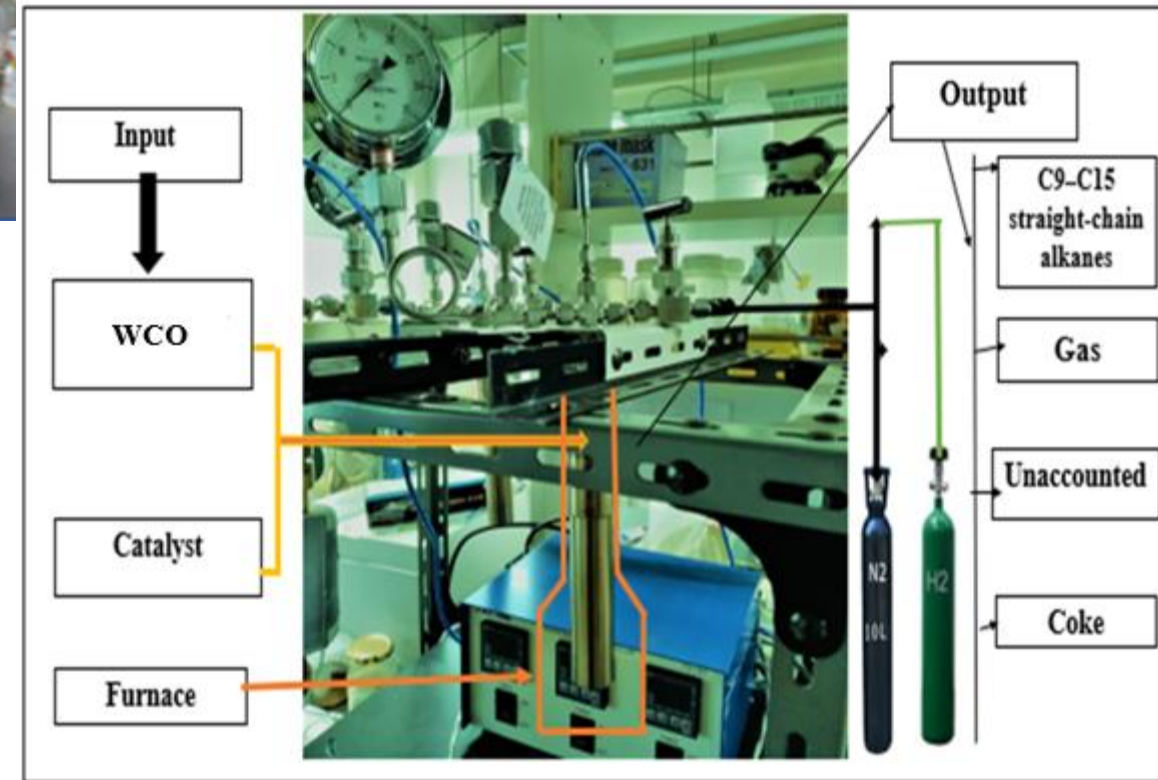
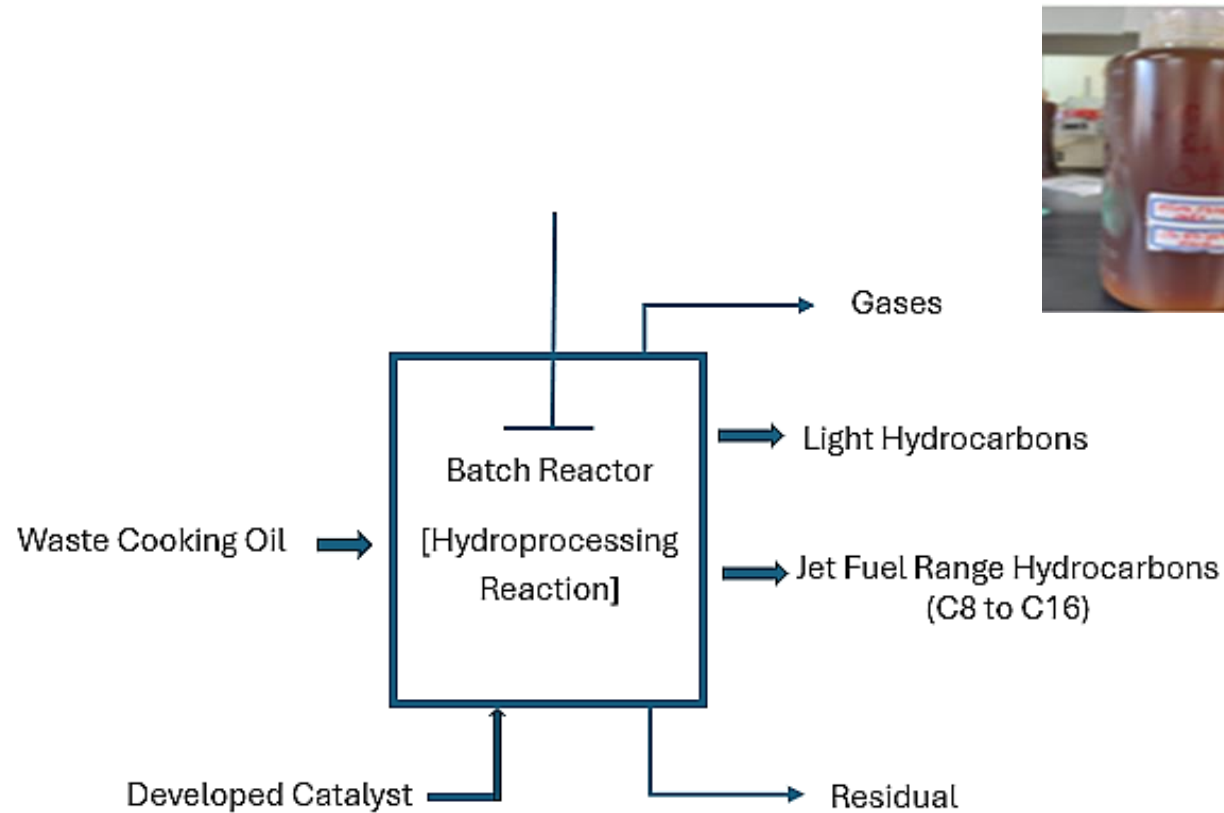


(a)



(b)

# Sustainable aviation fuel (SAF) synthesis from waste cooking oil (WCO)



Symmetric illustration of the Hydroprocessed Esters and Fatty Acids (HEFA) process

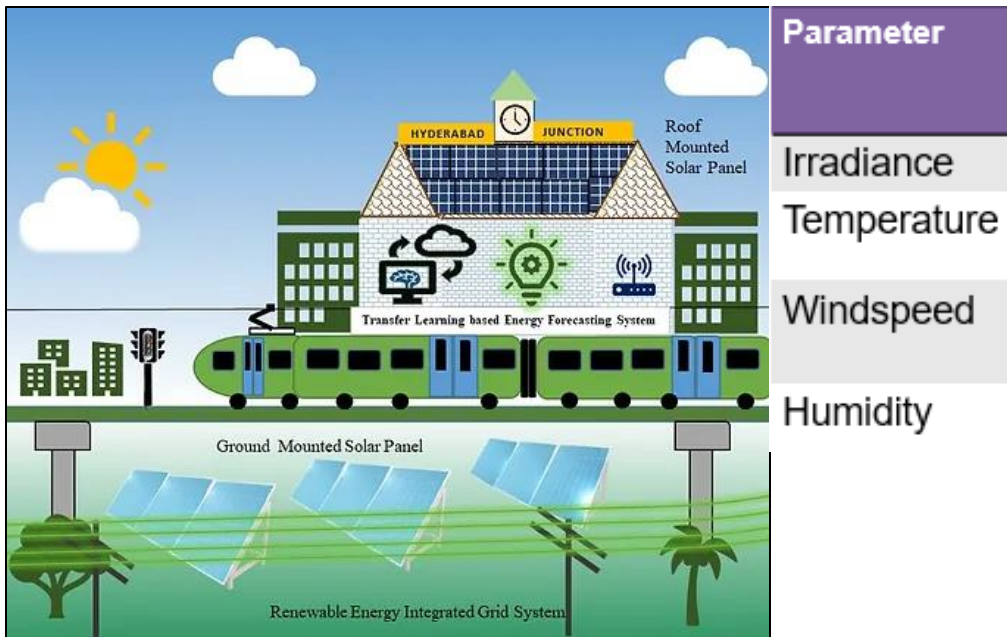
Schematic illustration of high-pressure reactor unit

# Renewable Energy Policy Research Group



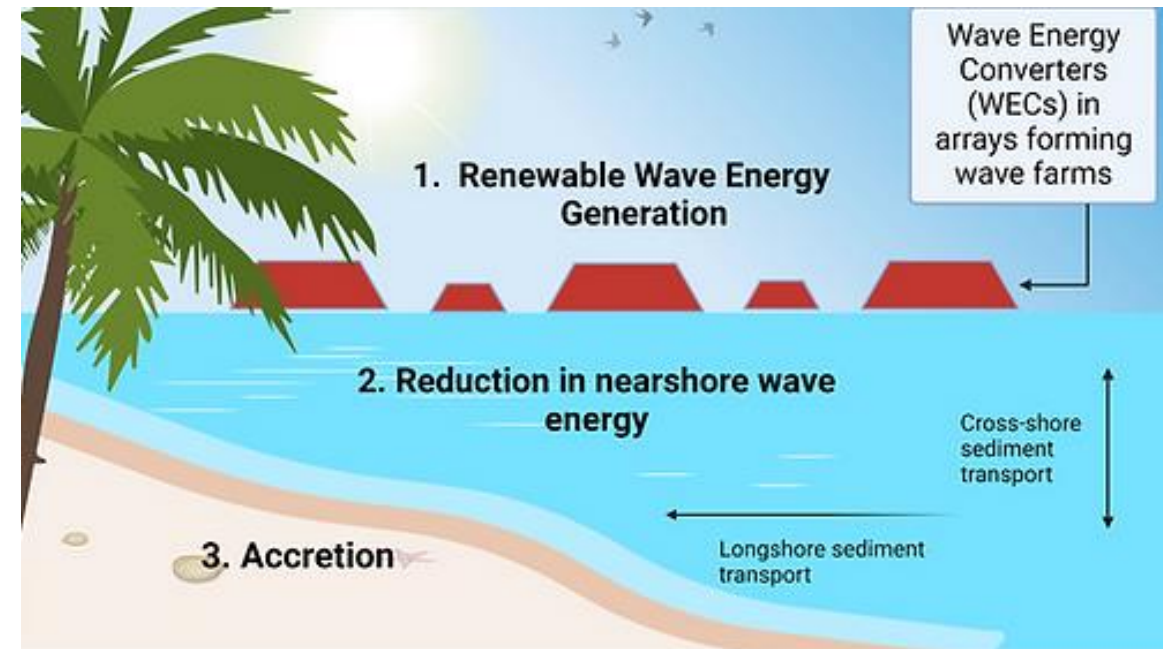
- Conduct research to provide renewable energy solutions to the challenges faced by society

## Transfer Learning Method to Overcome Data Scarcity in Photovoltaic Power Estimation



Railway Station Solar Power Forecasting

## The Dual Use of Wave Energy Converters and Wave Farms for Coastal Protection and Renewable Energy Generation



# Education Technology Research Group



- Design-based approaches to introduce improvements to education using technology
- Research topics:
  - Virtual Reality (VR) assisted English language and mathematics learning
  - Automated essay grading
  - Computer vision in sign language learning
  - Life-long learning
  - Computational thinking skills
  - Metacognition
  - Personalized learning
  - AI use in education of Japanese English language learners



- Embodiment and Iconicity for English as a Foreign Language Learning in Virtual Reality



# Cross lab seminar in English, Researcher dev. (3 groups x 100 min/week x 28 week/yr)



Presentation skill

Speaking skill

Listening skill

Constructive criticism

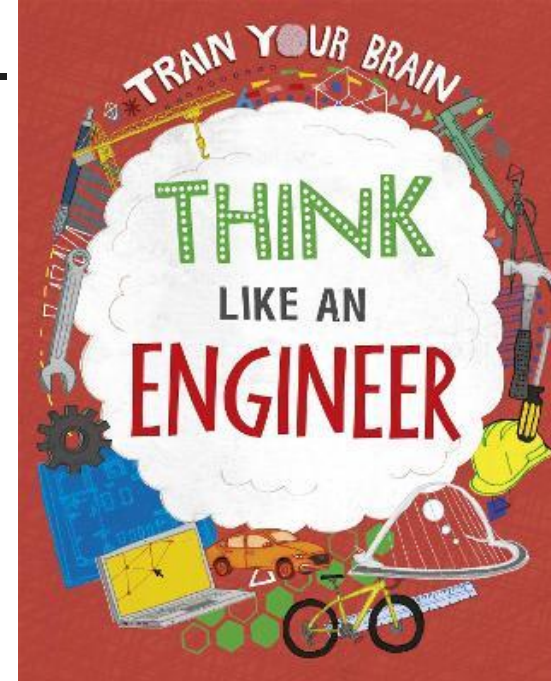
Critical thinking skill

English presentation  
skill improvement

Engineering thinking skill

# Using engineering thinking for lab research

- **Seeing systems:** visualize problems as parts within a larger system.
- **Identifying needs:** define specific needs and then create solutions.
- **Using systematic processes & iteration to solve problems.**
- **Balancing criteria and constraints to design solution**
- **Applying math and science to design solutions.**
- **Learning from failure & try again to solve problem**



Engineering thinking differs from scientific thinking in that engineers use common sense and knowledge about the physical world to solve problems. Engineers also design technologies that address the needs of society and the environment.

# Cross lab students win best presentation awards at graduate student workshop (MISW)

Xing  
2024



Tony  
2023



May 2019

2021 four students awarded



# Cross lab visitors 2023-24



UP ISC (Philippines)



TransBio WS (Thailand, Vietnam, Kenya)



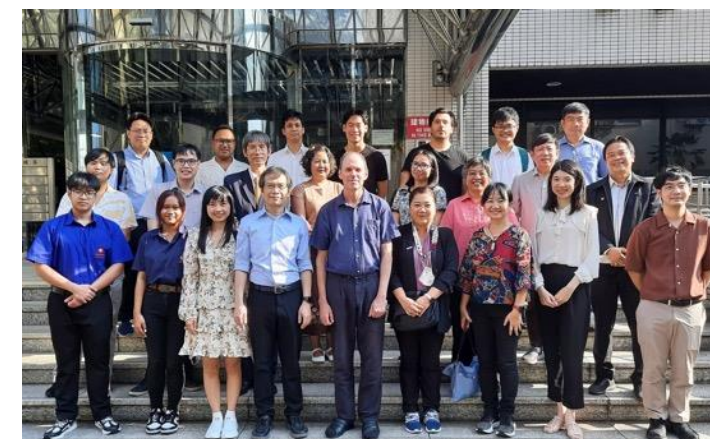
Prof. Singh, PEDU, India



NRCT, NSTDA, Thailand



NANOTEC, Thailand

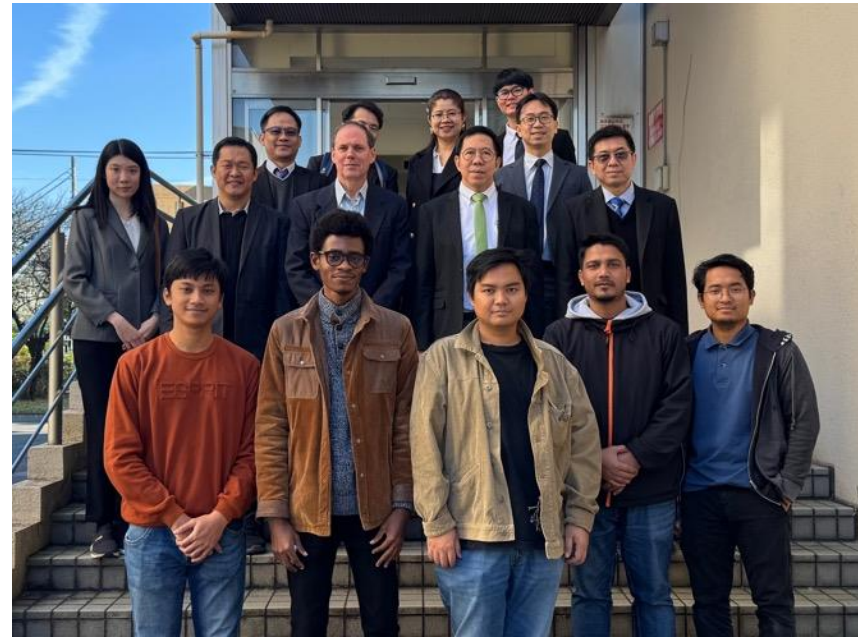


Khon Kaen U., Thailand

# Cross lab visitors 2024



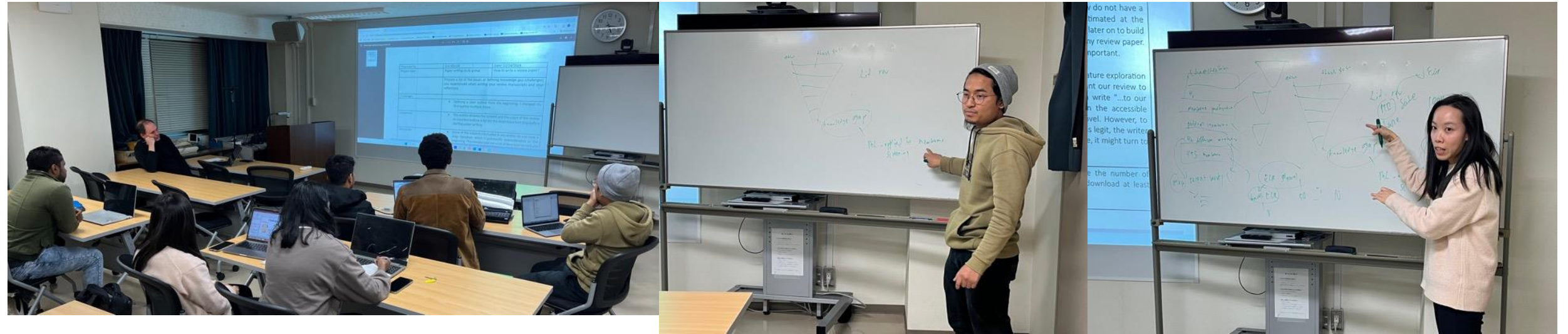
Institute Tech Bandung  
Indonesia



Thammasat Univ., SIIT (Thailand)

# Lab journal review paper writing workshops

## Dec 2024 – March 2025



### Topic: how to write review papers efficiently?

- created a guide for students to follow when writing review papers
- most doctoral students in the lab write one review paper and two journal papers
- lab is a place for sharing knowledge.

# Cross laboratory



## Lab Output per year

6 journal papers

5 Conf. papers

Several Conf. invited talks

Prof. Cross retires in March 2029 and lab closes

# Thank you!



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FB: <https://www.facebook.com/CrossLaboratoryTokyoTech>

IG: [https://www.instagram.com/cross\\_labs/](https://www.instagram.com/cross_labs/)