Biogas Production Technology Organic Waste: Thailand Case Study

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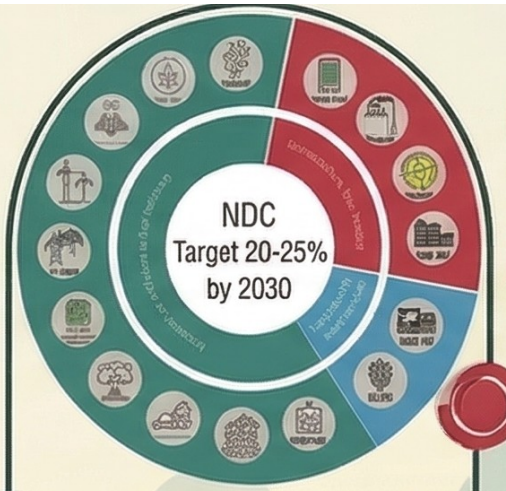
THAILAND'S REVISED CLIMATE ACTION TIMELINE:

A PATH TO NET-ZERO GHG



NDC

Aims to reduce GHG by 40% with international support

REVISED:

Target 40-45% by 2030 (with conditional targets)

2030

- Increase and Rotain Primary Fore
- Regenarnle Natural Forest Area
- Increase Economic Forest Area
- Increase and Renzail Crephisst
- Reduce Bermess Berning

Achievement of CO_2 removals of 120 $MICO_{2eq}$

2050

NET-ZERO GHG Emissio

- while looking forward to enha international cooperation support on finance, techno and capacity-building to ach this ambition

2021

- **NDC**
  Nationally Determined Contribution Implementing starts
- Submission of **LT-LEDS**
  Long-Term Low Greenhose Gas Emission Developmer Strategy Implementing towards achieving net care GHG mission and Carbon Naturality with this country

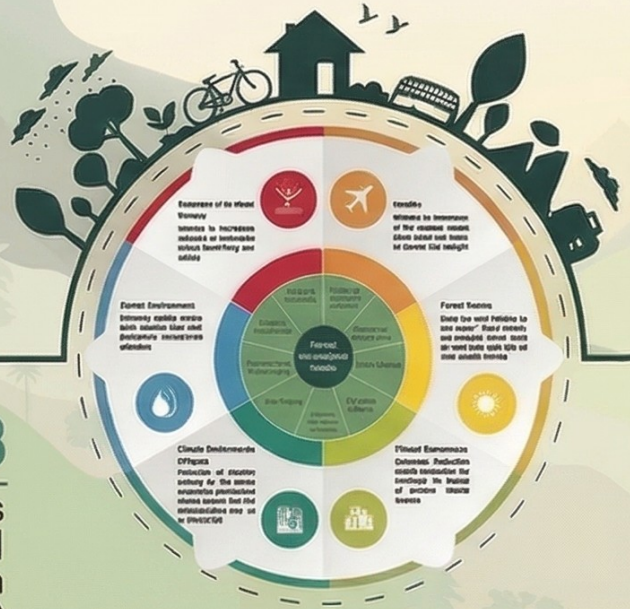
Improve Enery Efficiency and Promote Enegy Sustem
Transformation thrugh

- Decarbanisation
- Deregulation
- Digitalizatio
- Etachication
- Decentralization

2037

2035

69% share of electric vehicles of new vehicles in the market



2018

Thailand's National Adaptation Plan (NAP)

VISIGN

Thailand is resilient with adaptive expacity to climate change impacts and moves towards sustainable development.

Thailand Biogas Technology Development

1990 Fixed Dome R&D

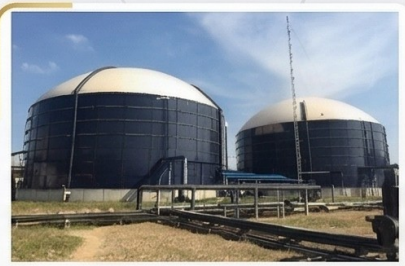
Development of the 1st biogas plant prototype.

2002
Large Farm supporting program

3rd supporting program for large agricultural operations.

2010 R&D / Demo CBG

Development & demonstration of Compressed Biogas for Local Grid.



2020 Competitive Bidding: Community Power

Launch of competitive bidding for Energy Crop projects.

1990 1995 2000 2005 2010 2015 2020

1996 First Demo: Large Swine Farm

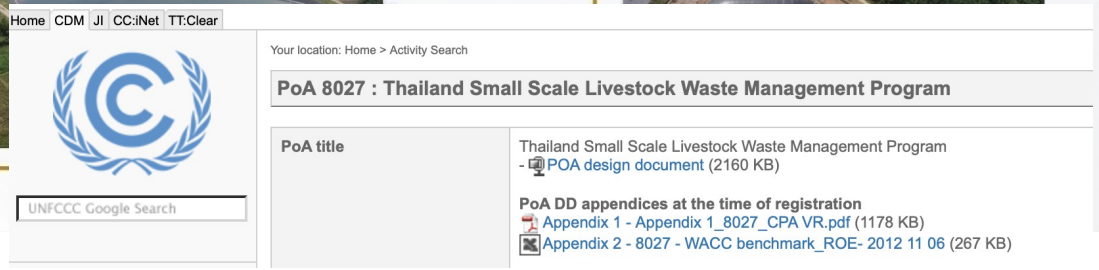
Initial demonstration of large swine farm wastewater lagoon.

2006 Agro Industries Agro Industries Supporting Program

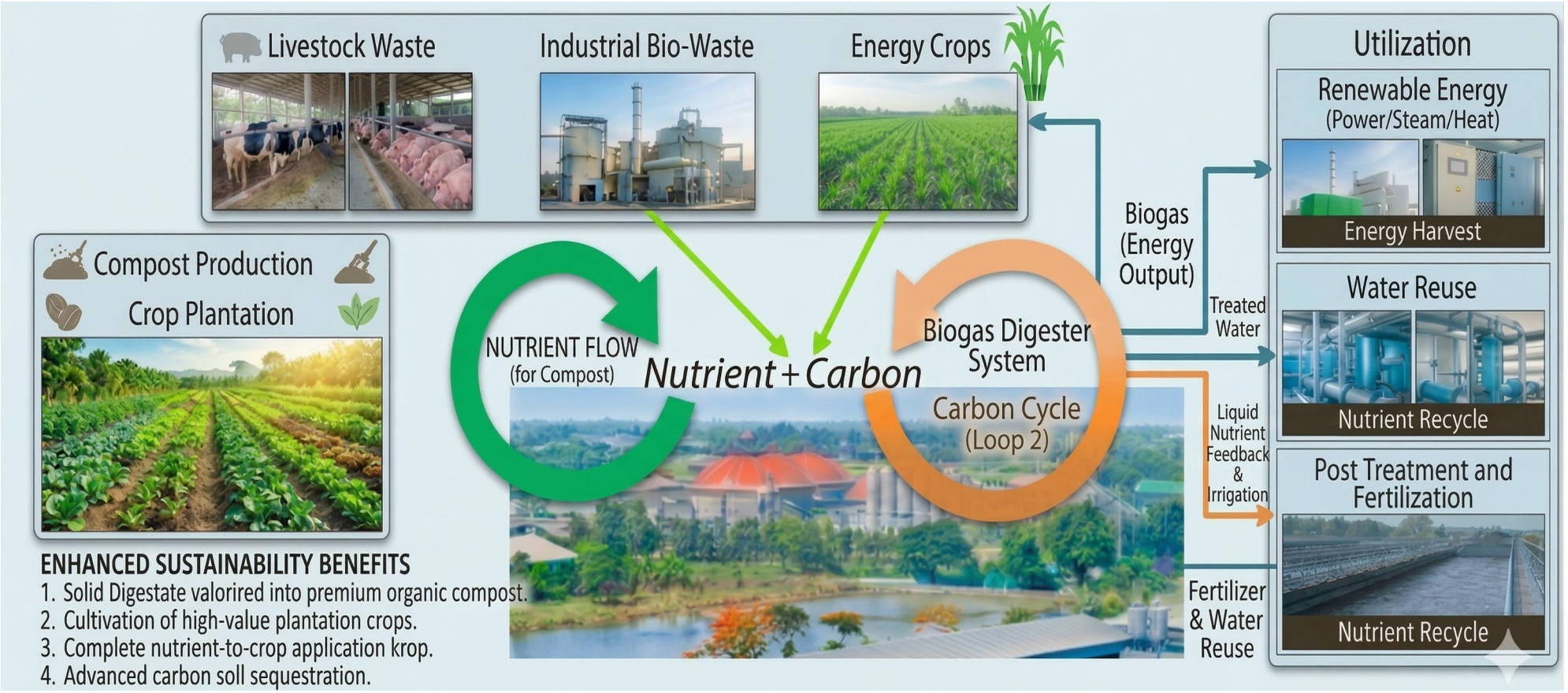
First program tailored for Large Agro Industries: Palm, Starch, Sugar.

2016 First Demo: MSW Dry Fermentation

Initial demonstration prototype for Municipal Solid Waste.



Environmental Management, Energy Harvest and Nutrient Recycle Through Biogas System



Biogas as Common practice for farm waste management

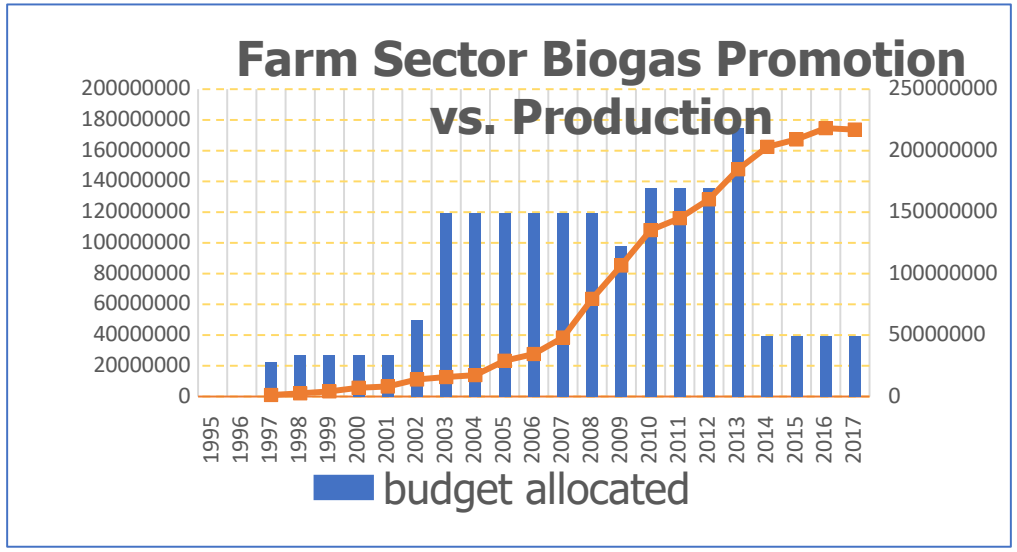
Governing laws and regulations:

- Pollution control on treated wastewater quality
- Community Impact and odor control

Biogas as pollution control and RE for agro. industries

- Wastewater treatment
- Renewable energy production and sales
- Community engagement

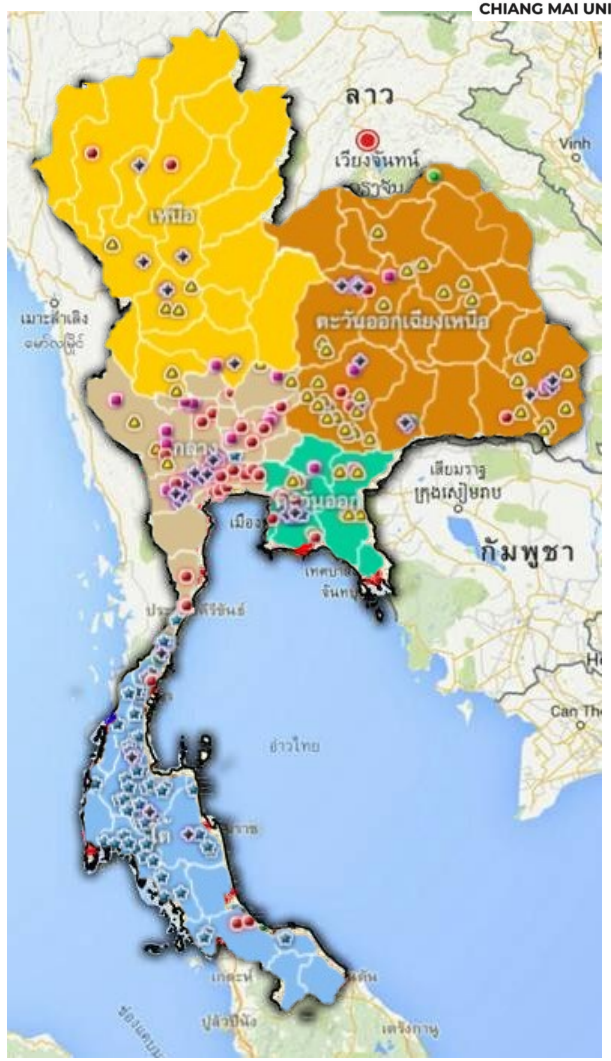
Thailand Biogas Capex Subsidy Schemes 1995-2017



Biogas Promotion Budget

1996 : First Farm Biogas Demonstration
1997 : 1st Subsidy; 5 farms 50% Capex
1999 : 2nd Subsidy; 10 farms 50%
2003 : 3rd Subsidy; 300 farms 30%
2004 : 4th Subsidy; 1000 farms 30%
2010 : 1st Subsidy for agriculture industries; palm, starch, ethanol 20%

Biogas from Livestock



Biogas from Ind. Waste

‘PROVINCIAL ORGANIC WASTE & CH4 ENERGY POTENTIAL: THAILAND (PCD Data: 2023-2024)

OVERVIEW & METHODOLOGY

TOTAL COUNTRY WASTE OVERVIEW

TOTAL MSW (~2.1 Million m3/day)
GWh Equiv: (e.g., 7,800 GWh/year)
LPG Equiv: [e.g., 180,000 Tonnes/year]

ENERGY GENERATION:
(Biogas & MSW Incineration)

NEW CH4 POTENTIAL CALCULATION BASIS

STEP 1: **MSW (Total)** → STEP 2: **ORGANIC WASTE** (* 0.4 kg Org / kg MSW) → STEP 3: **VOLATILE SOLIDS (VS)** (* 0.2 kg VS / kg Organic) → STEP 2: **METHANE (CHA) POTENTIAL** (*350 L CH4 / kg VS)

FW Humidity: ~90%
VS: ~10% (TS basis)
kg VS / kg FW: ~0.1

KEY CALCULATED POTENTIAL VALUES

(Phuket Focus)

TOTAL COUNTRY CH_4 POTENTIAL:
(Keep as national baseline)

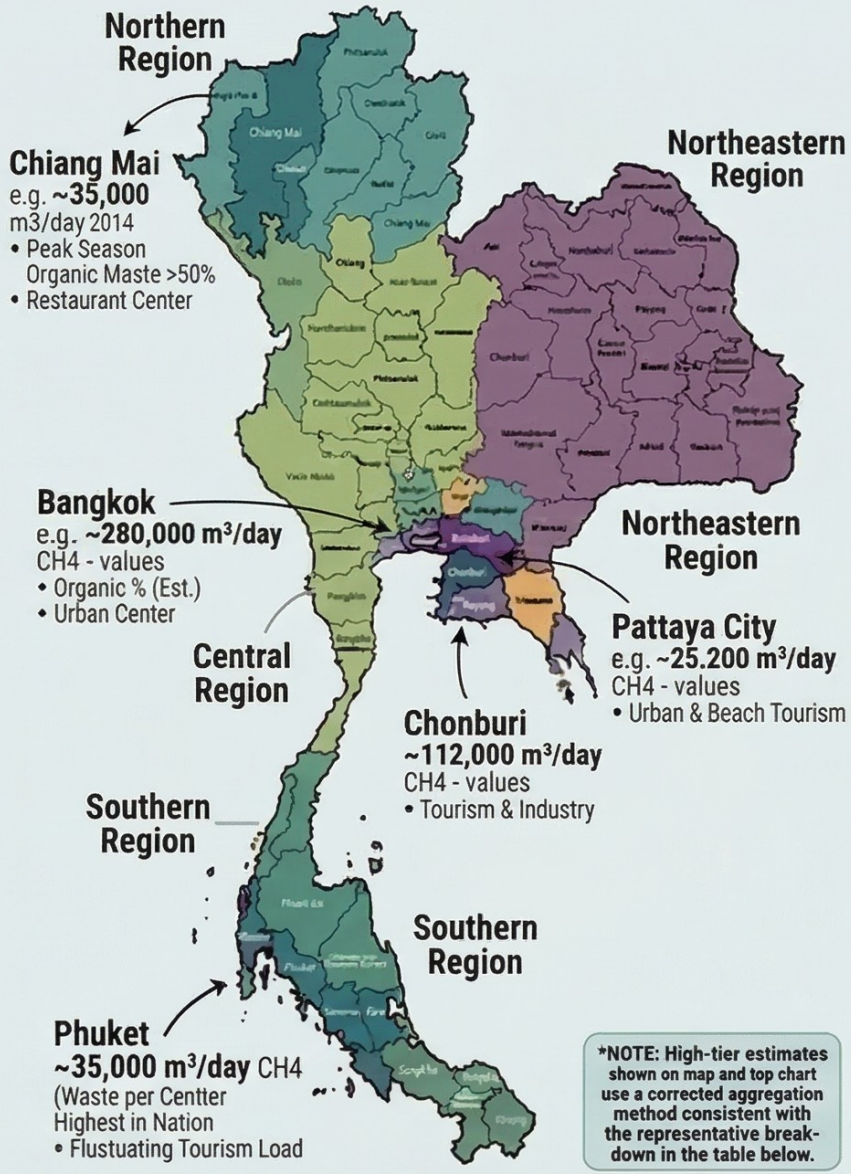
PHUKET CH_4 POTENTIAL:
[Illustrative consistent value from May, e.g., ~35,000 m³/day]

GWh Equiv: [e.g., ~3,100 GWh/year]

LPG Equiv: [e.g., ~770,000 Tonnes/year]

SAMPLE BREAKDOWN FOR BANGKOK	
MSW	~10,000
Org	~4,000
VS	~800
CH_4	~280,000

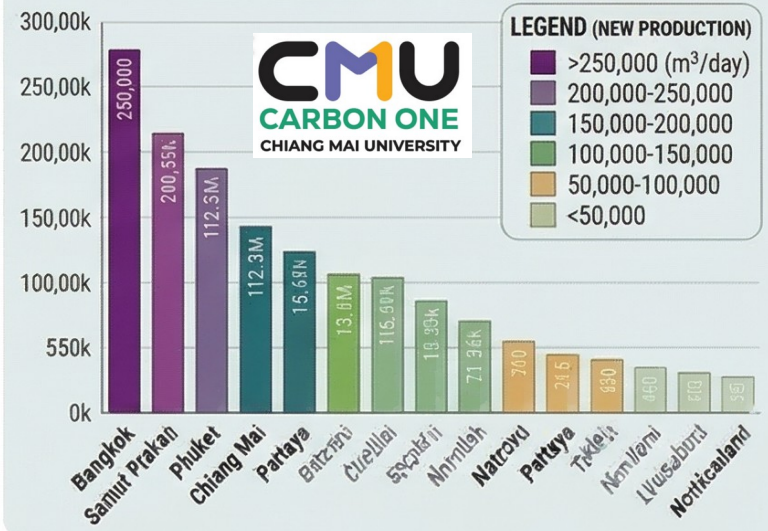
THAILAND MAP



*NOTE: High-tier estimates shown on map and top chart use a corrected aggregation method consistent with the representative break-down in the table below.

BARS & TABLES

DAILY m3/day BY PROVINCE



TOP 15 PROVINCES CH_4 POTENTIAL BREAKDOWN

Province	Est. MSW Tonnes/day mece illustrative ont raopeatonme datarie	Est. Organic Tonnes/day -calculated from value	Est. VS Tonnes/day -calculated from tire value	Correct. CH_4 Potential m3/day potential value value
Bangkok	-10,000	-1,250	-350	-250,000
Chonburi	-400	400	120	4,250,000
Phuket	-300	400	120	4,250,000
Chiang Mai	-300	400	120	3,500,000
Pattaya	-300	500	100	3,000,000
Chonberi	500	250	90	3,000,000
Chonburi	550	250	90	2,250,000
Phoket	250	250	50	2,300,000
Phoket	250	250	45	1,300,000
Chiang Mai	250	150	70	1,300,000
Pattaya	150	200	30	1,300,000
Phuket	150	150	20	1,300,000
Pattaysa	150	150	20	490,000
Pattsyok	150	120	15	450,000
Bangkok	150	100	5	450,000

Source: Pollution Control Department (PCD)

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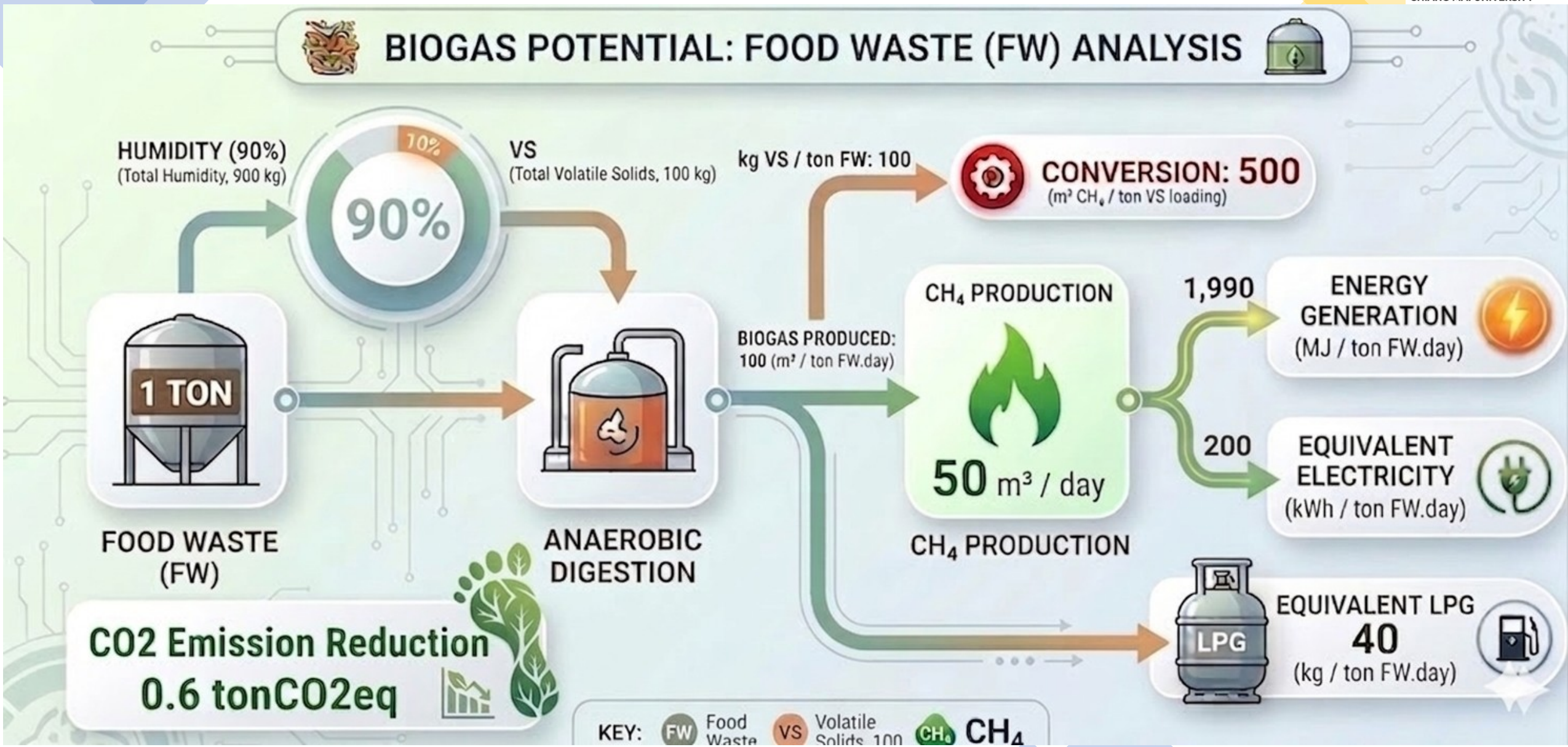
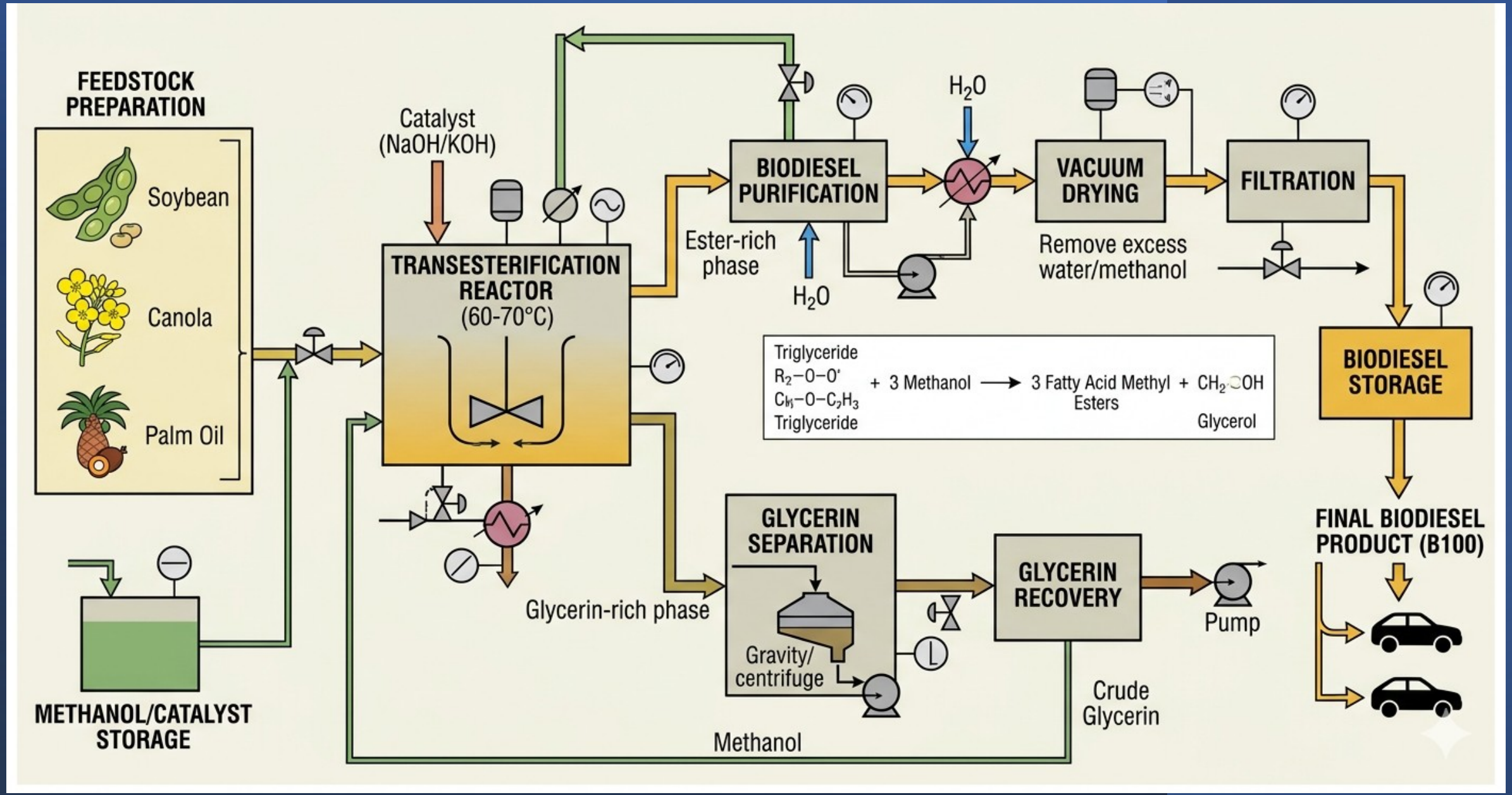


Bio Diesel From Used Cooking Oil



Biogas Technology Selection

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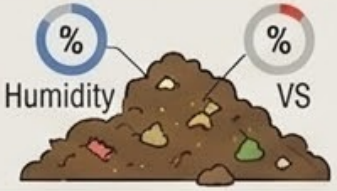
1 POSSIBLE FEEDSTOCK & ANALYSIS

1. **WASTE**
   - Semidry Waste
     - Cassava pulp
     - Palm decanter
     - Bagasse
   - Dry Waste
     - Straw / Stover
     - Organic MSW
2. **ENERGY CROPS**
   - Corn
   - Grass

FOOD WASTE (FW) ANALYSIS & YIELD (kg VS/ kg FW basis)



Humidity	90%
VS kg VS / kg FW	10%
Conversion (m3 CH_4/ kg VS loading)	0.5
CH_4 produced (m3/day)	0.05
Biogas produced (m3/kg FW.day)	0.10
Heating Value (MJ/kg FW. Day)	1.99
Equivalent Electricity (kWh/kg FW.day)	0.55
Equivalent LPG (kg/kg FW.day)	0.04

2 PRETREATMENT / FEEDSTOCK MANAGEMENT

1. **STORAGE AND MANAGEMENT**
   - Larg Grinder
2. **PRE-TREATMENT**
   - Size Reduction
   - Heat Treatment
   - Chemical Treatment
   - Hydrolysis / Acidification
   - Leeching based reactors

3 AVAILABLE TECHNOLOGY & DIGITAL OPTIMIZATION

CSTR WET FERMENTATION
(e.g., for Wet / Semidry Waste)

DRY / SEMI-DRY FERMENTATION
(e.g., for Dry / MSW Waste)

4 POST DIGESTER MANAGEMENT

1. **LIQUID**
   - STORAGE AND APPLICATION

2. **SOLID**
   - COMPOST STORAGE AND APPLICATION

5 CONVERTED ENERGY PRODUCTS

CH_4 PRODUCTION
X m^3 CH_4 / tonne FW

EQUIVALENT ELECTRICITY
Y kWh / tonne FW

EQUIVALENT LPG
Z kg LPG / tonne FW

Referencing 0.5 kg VS / tome kg VS / m^3 loading

Legend: Liquid storage | VS | Equivalent electricity | Chemical | Fertilizer

Available Technology

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WET FERMENTATION

Lagoon Based

Tank Based

	Food waste (FW)
Humidity	90%
VS	10%
kg VS / kg FW	0.10
Conversion (m3 CH4/ kg VS loading)	0.5
CH4 produced (m3/day)	0.05
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FOOD WASTE (FW) CHARACTERISTICS & ENERGY POTENTIAL

DRY FERMENTATION

TS >20%

Continuous Dry AD Process

https://www.jrma.com/projectsdetails/smartferm-ad-system

TS 15-20%

Batch Dry AD Process

CMU Waste Management Center

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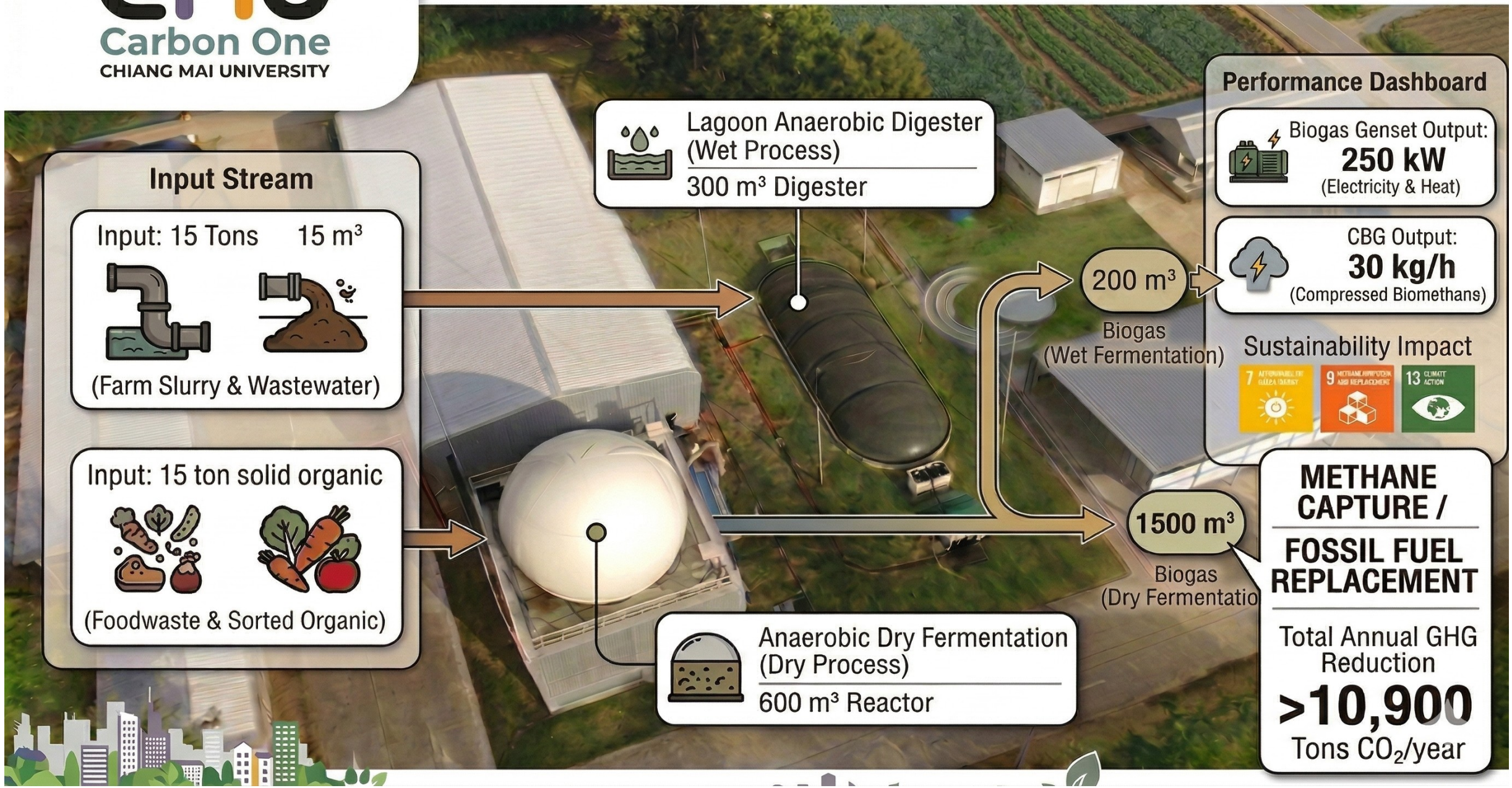


Input Stream

Input: 15 Tons 15 m³

(Farm Slurry & Wastewater)

Input: 15 ton solid organic

(Foodwaste & Sorted Organic)

Lagoon Anaerobic Digester (Wet Process)

300 m³ Digester

Anaerobic Dry Fermentation (Dry Process)

600 m³ Reactor

200 m³

Biogas (Wet Fermentation)

1500 m³

Biogas (Dry Fermentatio

Performance Dashboard

Biogas Genset Output:
250 kW
(Electricity & Heat)

CBG Output:
30 kg/h
(Compressed Biomethans)

Sustainability Impact

7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

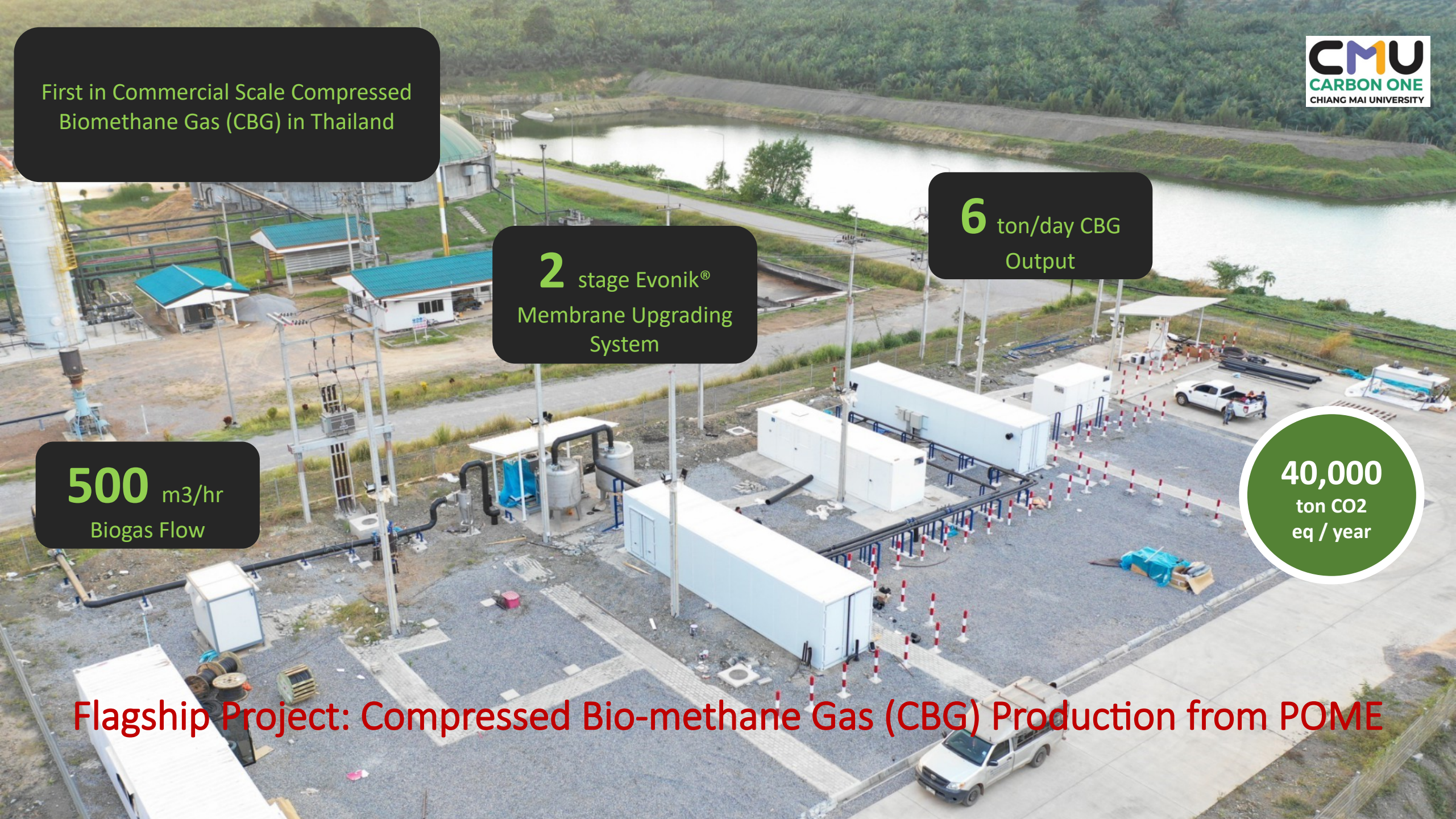
13 CLIMATE ACTION

METHANE CAPTURE / FOSSIL FUEL REPLACEMENT

Total Annual GHG Reduction

>10,900

Tons CO_2/year


First in Commercial Scale Compressed Biomethane Gas (CBG) in Thailand
2 stage Evonik® Membrane Upgrading System
6 ton/day CBG Output
500 m3/hr Biogas Flow
40,000 ton CO2 eq / year
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Flagship Project: Compressed Bio-methane Gas (CBG) Production from POME

Future Prospect Liquefied Bio Methane (LBM)

- First plant in operation in Krabi Thailand, Sept. 2025
- Capacity 16 TPD/day
- Biogas Production from Palm oil mill effluent

Ref. Bio Fusion Sawang Company Limited

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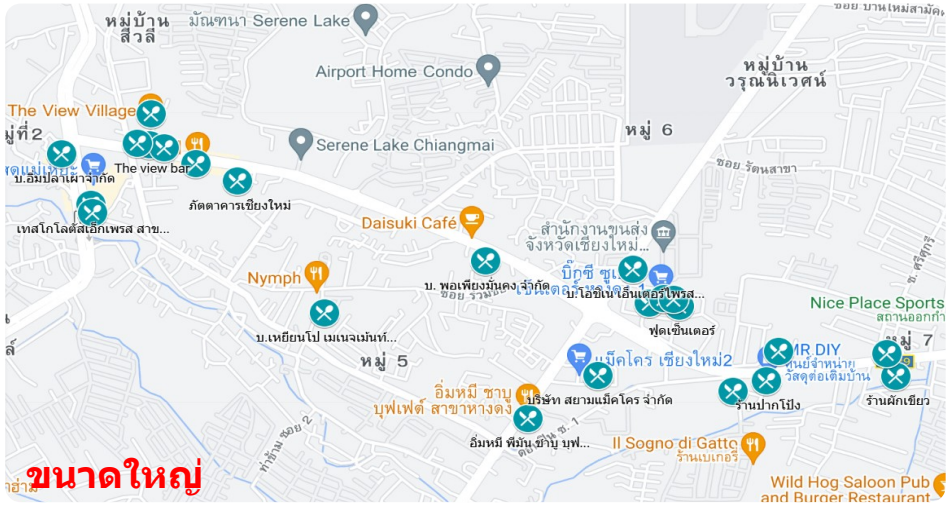
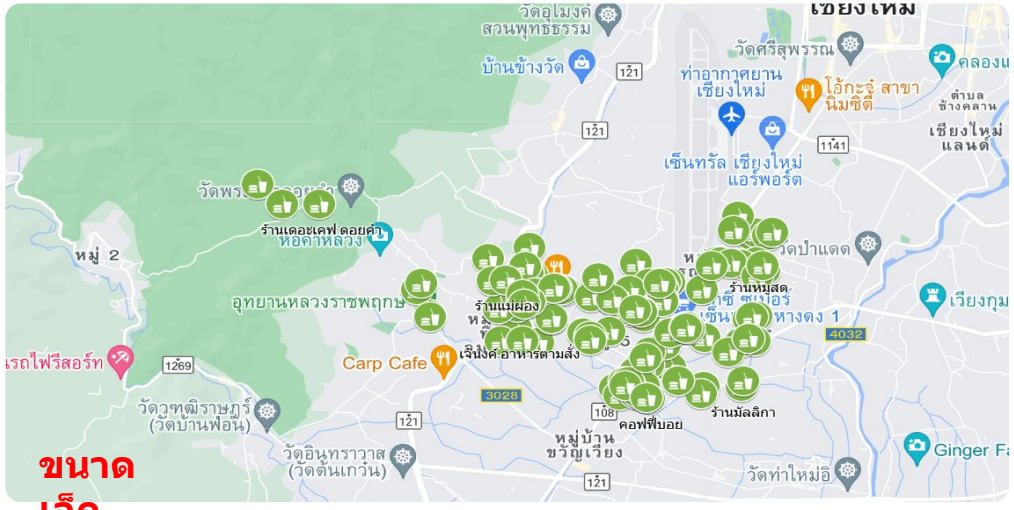
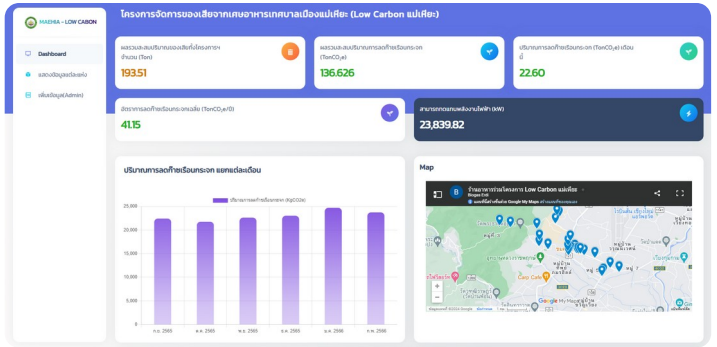
Future Prospects

Digitalized Platform for Food Waste Collection and Methane Management and Leakage Tracking







Future Prospects

Agri-Voltaic Farms

Double Use of Land

Recycling of compost from biogas system.

Firming the supply with Biogas Generation

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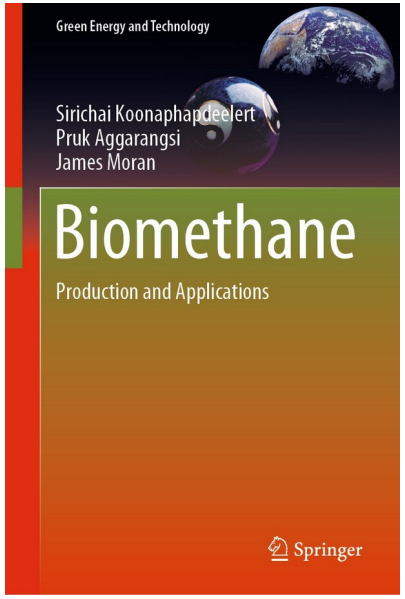
Conclusion



Biogas can be Environment Management Tools
For Farms and Organic Waste
with
Energy and Nutrient Benefits

Methane Capture is GHG Emission Reduction
by Nature

Demand for Clean Firm Electricity
Clean Natural Gas will grow continuingly

1 Ton of FW = 100 m3 Biogas
= 200 kW

Thank you for your kind attention

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Financial Model of a Biogas Project

Case Study 1 MW Wastewater to Electricity Power Plant

Gross Profit (EBITDA)

711,000 USD/year

Gross PBP

4 – 5 years

Financial Model of a Biogas Project

Case Study 1 MW Wastewater to CBG Plant

Revenue

CBG Sales 0.68 USD/kg

Gross Profit (EBITDA)

624,000 USD/year

Gross PBP

6-7 years

**CBG price 0.60 USD/kgCBG

Flagship Project: Chaing Mai Fresh Mild Dairy Farm

0.3 MW
Biogas Genset

4,000 m^3
Channel Digester

Approx. 4,200 ton CO_{2eq} / year

First in Dairy Farms in Thailand to obtain Low Footprint Milk Products CBG used in farms tractor activities

Flagship Project: Multi Waste Power Plant KCF Green Energy

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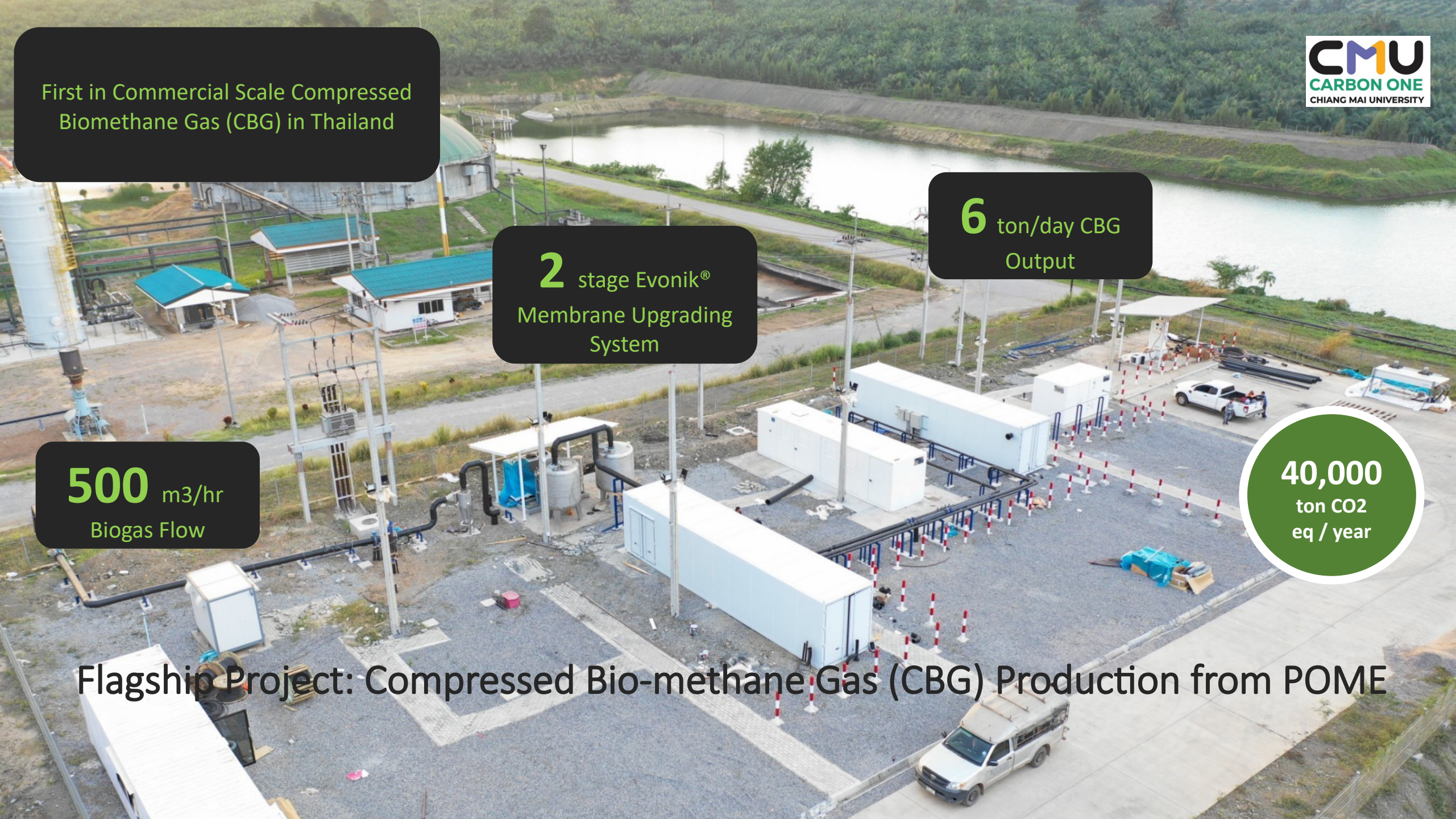
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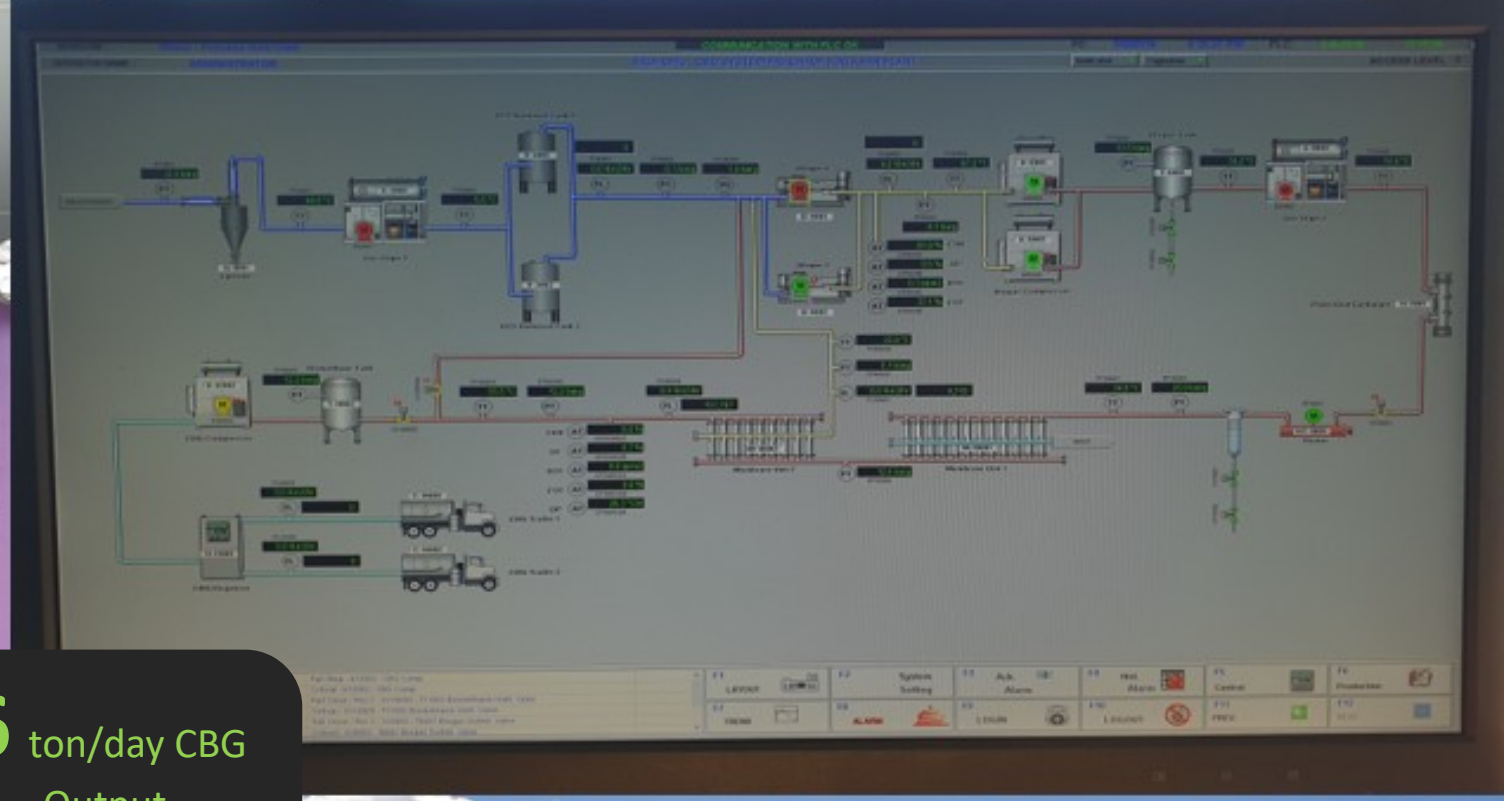

6 ton/day CBG Output Delivered to Commercial CNG Station

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Flagship Project: NBL 195,000 m³ Biogas Digester from Tapioca Wastewater