



# Role of R&D for Supporting Decentralized Renewable Power Plant and Integration with Smart Grids

**Pratip Vongbandit, Ph.D.**

Deputy Governor  
Research & Development Group for Sustainable Development

# Outline

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Paris agreement and COP26

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Thailand's Situation and Policy

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TISTR's Role on R&D of Decentralized Power Plant

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# Greenhouse Gas Emission



*"We are the **first generation** to feel the effect of climate change and the **last generation** who can do something about it."*

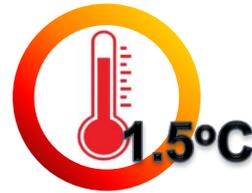
**Barack Obama, Former US President**

*"The eyes of **all future generations** are upon you. And if you choose to fail us, I say - we will **never forgive** you."*

**Greta Thunberg, UN Climate Summit, New York, 23 September 2019**



# Paris Agreement & COP meetings



PM affirms Thailand's willingness to be more aggressive in addressing climate change challenges at COP26

1. to limit the average global temperature increase to well below 2 degrees centigrade (and pursue efforts to limit it to 1.5 degrees)
2. to enhance resilience to climate impacts, many of which will be unavoidable due to greenhouse gases already emitted
3. to align financial flows in the world with these objectives.

Aiming at reaching carbon neutrality in 2050, and Net Zero Emission in or before 2065. With the adequate, timely, and equitable support of technology transfer and cooperation, and most importantly, the availability of and access to ample green financing facilities.

As Thailand will host the APEC Summit in 2022, the country has set the Bio-Circular-Green Economic Model or BCG as the main agenda of the meeting.



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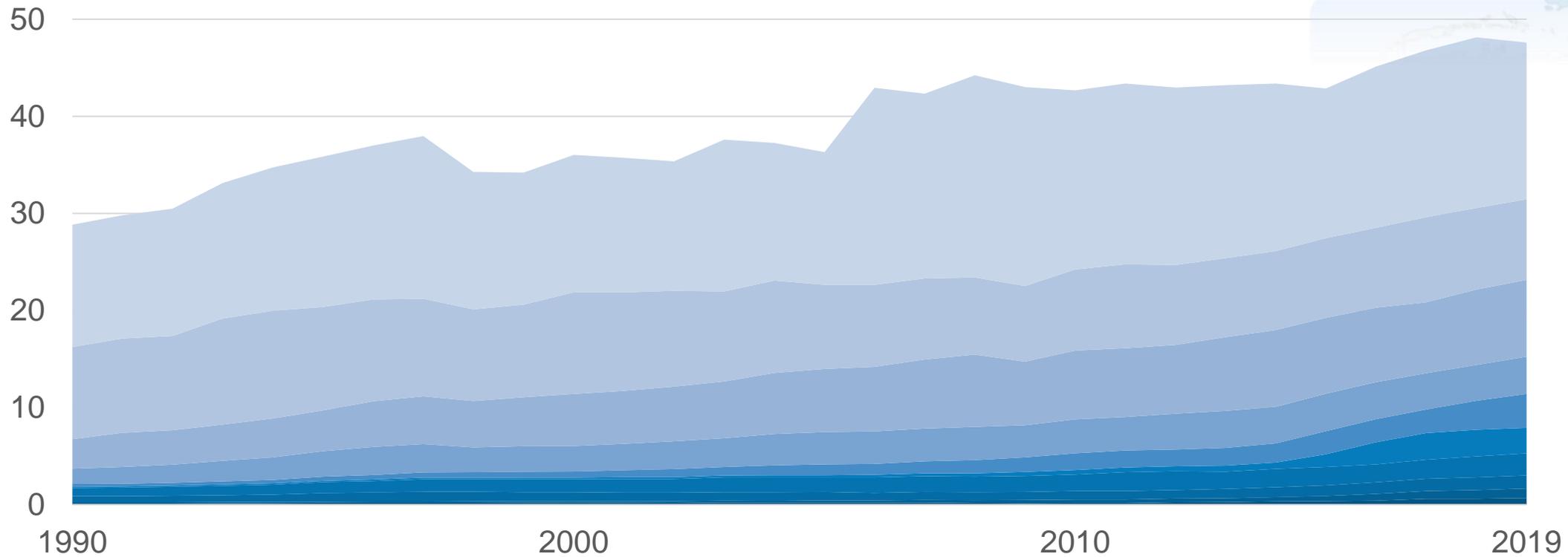
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# ASEAN's Emission

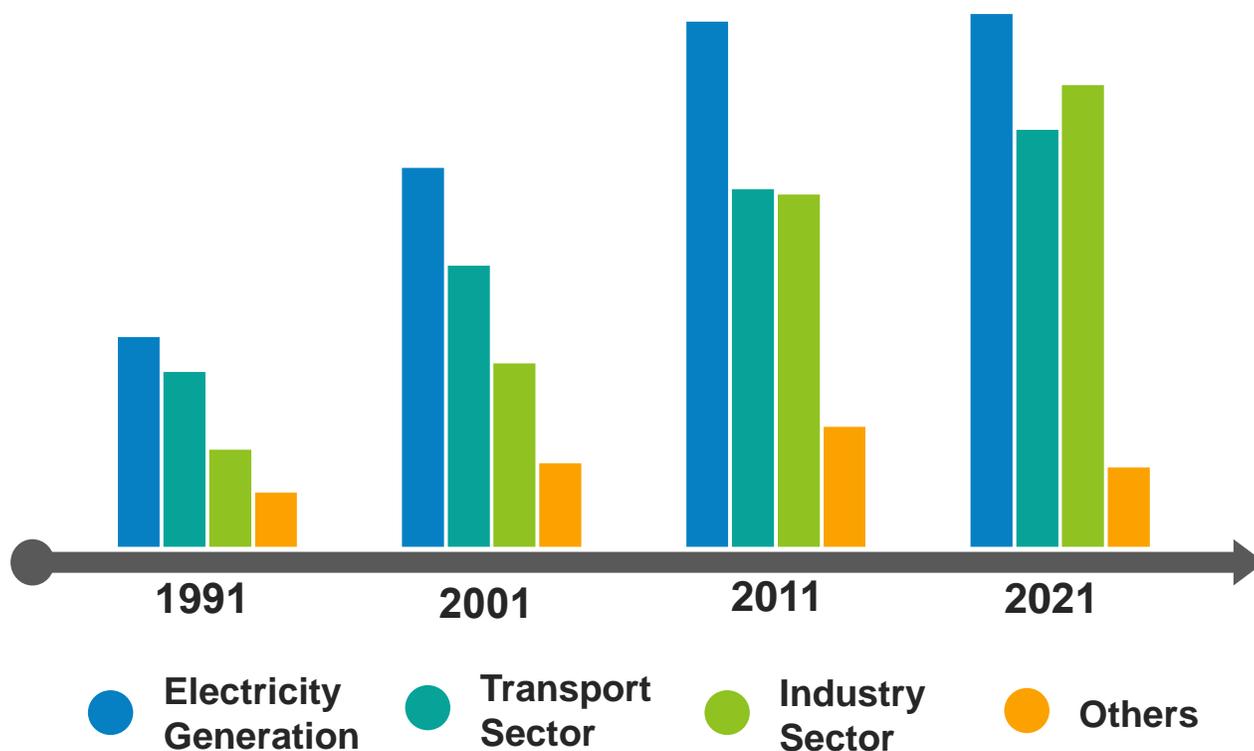
## CO<sub>2</sub> Emission (metric ton per capita)

- Myanmar
- Cambodia
- Philippines
- Indonesia
- Lao PDR
- Vietnam
- Thailand
- Malaysia
- Singapore
- Brunei Darussalam

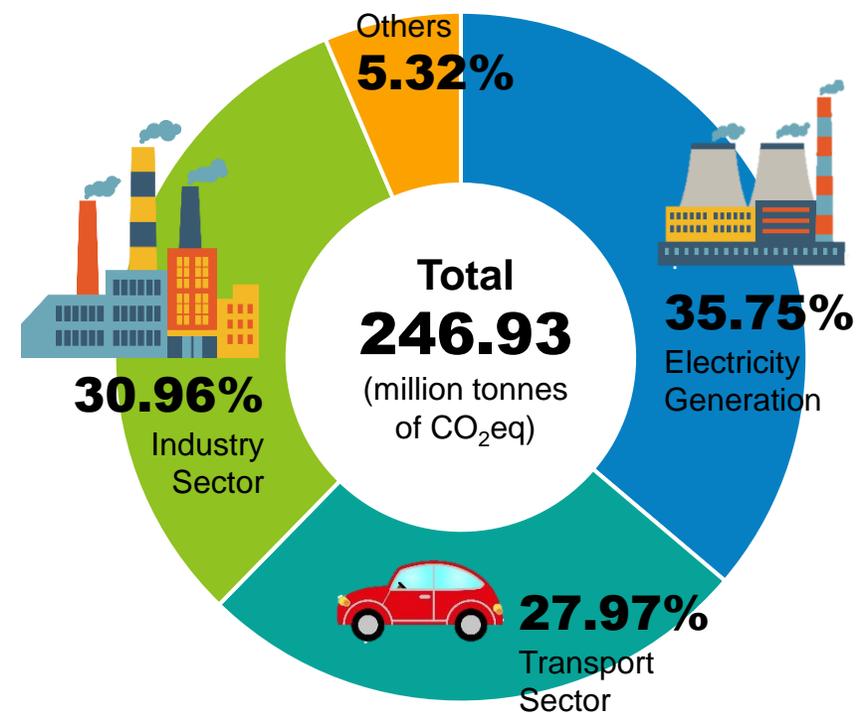


# Thailand's Emissions by Sector

## Trend of Emission



## In 2021

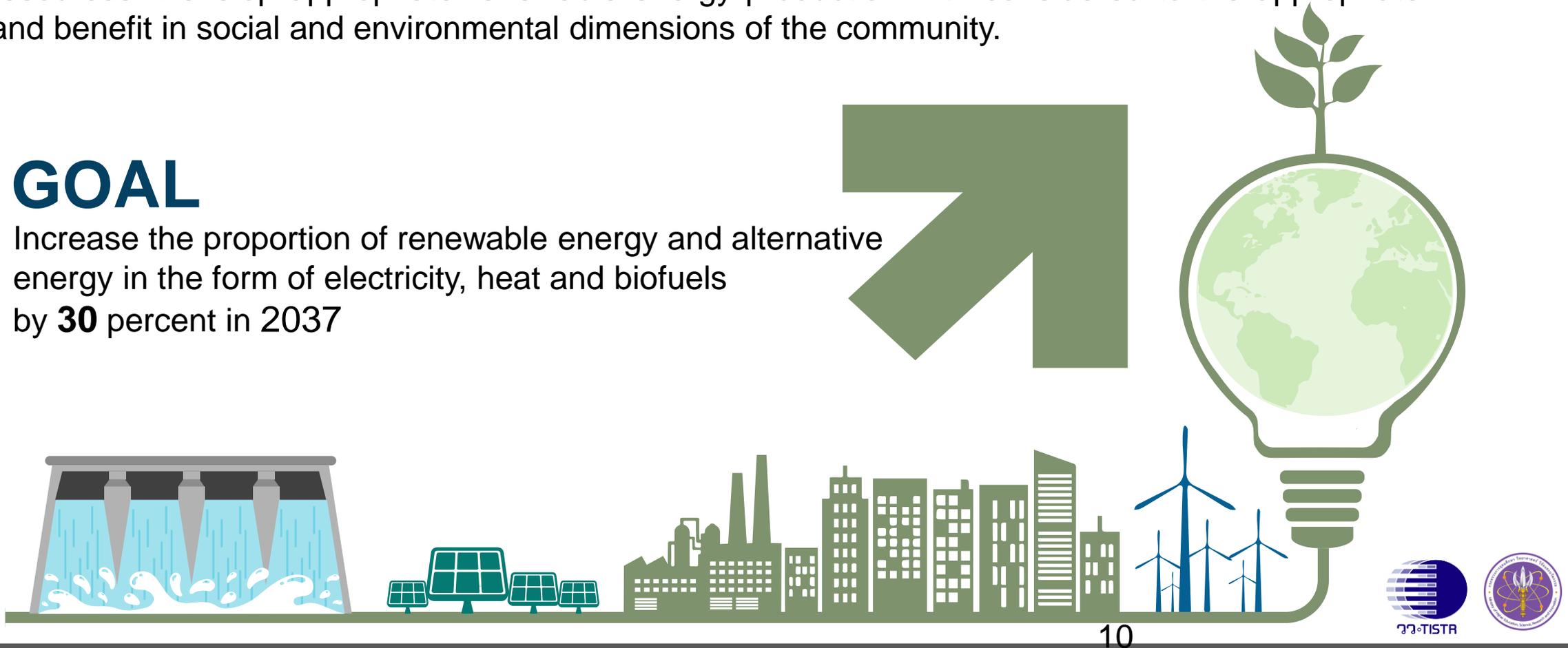


# Alternative Energy Development Plan (AEDP2018)

**AEDP2018** was the one of master plans in Thailand Integrated Energy Blueprint (TIEB) that was developed by Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy for promoting energy production within the full potential of domestic renewable energy resources. Develop appropriate renewable energy production with considered to the appropriate and benefit in social and environmental dimensions of the community.

## GOAL

Increase the proportion of renewable energy and alternative energy in the form of electricity, heat and biofuels by **30** percent in 2037



# Thailand Power Development Plan (PDP)

Thailand Power Development Plan (PDP) is a master plan for electric power generation and supply in the long term for 15-20 years aiming to strengthen the power system security and ensure the adequacy of power capacity.



1. Creating stability of power generation system, power transmission system, and power distribution system by area, and creating balance electrical systems by region
2. Considering power plants for stability at an appropriate level to accommodate in an energy crisis situation, as well as to increase the grid flexibility
3. Promoting low-cost electricity production to reduce the burden on electricity fee and no obstacle on economic and social developments in long term
4. Preparing the power system for competition in power generation which will increase overall efficiency and reflect real cost
5. Reducing environmental impacts
6. Promoting the power generation from renewable energy and increasing power system efficiency both in production and usage
7. Developing a smart grid system to support the changing trends of customer to be prosumer

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# Thailand Institute of Scientific and Technological Research (TISTR)

TISTR is a state enterprise under Ministry of Higher Education, Science, Research and Innovation (MHESI) with the vision of A leading organization in the integration of science, technology and innovation for the creation of a sustainable innovation-based society



TISTR R&D Group for Sustainable Development is responsible for conducting integrated R&D projects following the National policies on sustainable development. The group comprises 3 centres and 1 research station as following

1. Expert Centre of Innovative **Clean Energy and Environment**
2. Expert Centre of Innovative **Materials**
3. Expert Centre of Innovative **Industrial Robotics and Automation**



InnoEn conducts R&D on clean energy technology and innovation from biomass (including water, residue from agricultural and industrial sectors and waste from communities), R&D on environmental management, projects on energy-related resources, and projects on climate change and biodiversity.



## Renewable Energy Demonstration Plant from Biomass and Waste



To tackle with the problems of energy scarcity, environmental harm, pollution control and agricultural waste issues, as well as, to reduce adverse impact to the quality of life and to generate income return to local people and communities in the line of Bio-Circular-Green (BCG) Economy Model, TISTR by Expert Centre of Innovative Clean Energy and Environment (InnoEn) has established 'Renewable Energy Demonstration Plant from Biomass' at Lam Ta Khlong Research Station, Nakhon Ratchasima Province



Renewable Energy Demonstration Plant from Biomass and Waste





2-stage Anaerobic Baffled Reactor  
Biogas Production



Generator  
200 kW



3-stage Gasification  
Syngas Production



Generator  
200 kW



# Biogas production technology with 2-stage 'Anaerobic Baffled Reactor'

**Biogas** is a gas produced from the decomposition of organic waste or biomass by microorganisms in anaerobic conditions (Anaerobic Digestion). Most of the gas is 50-70% methane, which is easily flammable. and provide high heat Therefore, it can be used as a good fuel in the power generation system.



Two stage anaerobic digestion can provide both biogas plant process stability and the high rates of biogas production .

- The two-stage process could handle higher OLRs at Lower HRTs compared to the single-stage process.
- The required reactor volume was decreased considerably in the two-stage process.
- Optimal operating conditions for diverse microorganism consortia.
- Effective in readily biodegradable substrate treatment.
- Augmented methane yield.
- Better process control .

# 3-stage Gasification Technology

**Gasification** is a thermochemical process in which the reactions between fuel and the gasification agent take place to produce syngas under absence of oxygen. The syngas is mainly composed of CO, H<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, and some hydrocarbons (CH<sub>4</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, etc.)



- ❑ Gasification reactors consists of 3 zones, classify by temperature and order of fuel flow path which are drying and pyrolysis, oxidation and reduction zones.
- ❑ 3-stage Gasification has been developed with the purpose to increase an efficiency and minimize tar content.
- ❑ The 3 reaction zones are disaggregated and it can be controlled fuel flow rate and temperature in each zone separately.

# Covid-19's Impact on Waste Sector

Redistribution of waste production. Waste production has shifted from industry and commercial centers to residential areas.

- Medical waste has increased by up to 40%
- Hazardous waste production has grown with higher production from the pharmaceutical and medical sectors.
- Municipal waste has increased in volume, effectively overwhelming existing waste collection and disposal systems.

The formation mechanisms are generally relevant to most combustion systems in which organic material is burned with chlorine with a range of 200° to 450°C.



# Future works and Roadmap

2020 - 2023



R&D on Renewable Energy Production from Biomass and Waste with Demonstration Plant Level

2023 - 2026



Smart Microgrid Integration

2027 ~



Collaboration Platform for R&D and Technology Transfer

R&D on Renewable Energy Production from Biomass and Waste for the decentralized power plants and Built a platform for joint researches and learning centers at the national and ASEAN levels



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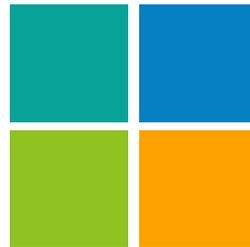
# ASEAN Network of Excellence Centre of Biomass Conversion Technology (ANEC)

**ANEC** submitted by TISTR as ASEAN Committee on Science and Technology (COST) Cooperation Project through Sub-Committee on S&T Infrastructure and Resources Development (SCIRD) during 2019 – 2020. Presently, ANEC has continued and drive a network to exchange knowledge on biomass conversion technology among countries.



## Regional Biomass Database

The properties of available biomass in Thailand comprising of fuel properties, lignocellulosic analysis, and composition analysis together serve as useful datasets for estimating the potential of biomass to contribute to the total energy mix.



## Action Research and Regional workshops

Capacity building activities through workshops and on-site visits for sharing knowledge, experiences and best practices as well as planning joint action through collaborative research. Set up ASEAN infrastructure and platform for dissemination of biomass conversion technology.

# ASEAN Network of Excellence Centre of Biomass Conversion Technology (ANEC)

- The initiative meeting of ANEC was held during 29-30 May 2019 at TISTR, Thailand. Participants: 14 experts from 7 countries, i.e. Cambodia, Indonesia, Malaysia, Myanmar, Lao PDR, Philippines and Vietnam.
- Action research on high quality biodiesel technology among TISTR and REMI, Lao PDR has been carried out.
- Action research on algae technology among TISTR and Universiti of Kebangsaan, Malaysia has been carried out.
- The new collaboration among TISTR and University of Science and Technology of Hanoi (USTH), Vietnam has been started by MOU signed for action research and other activities under ANEC.

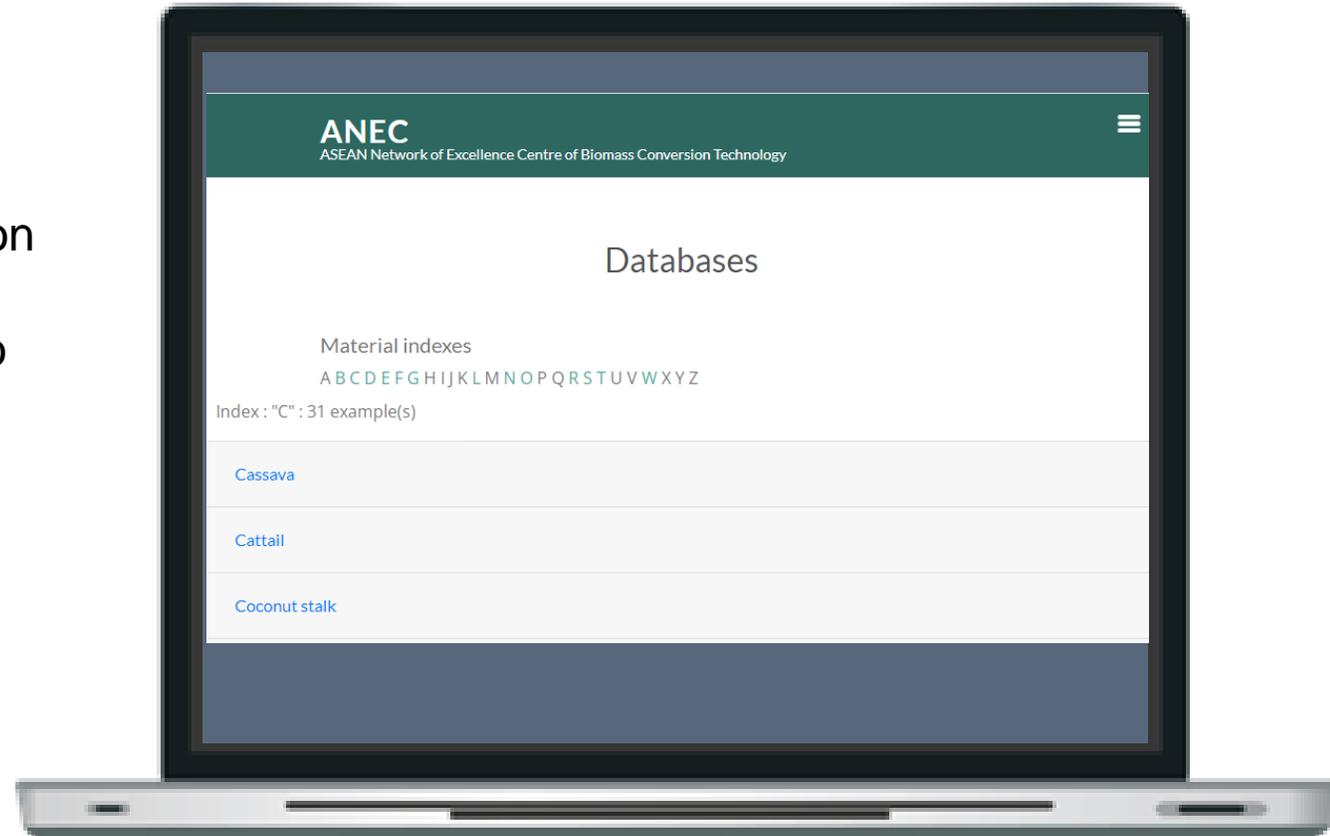


# ANEC Website

<https://www.tistr.or.th/RDSinter/index-anec.php>

## Biomass Database

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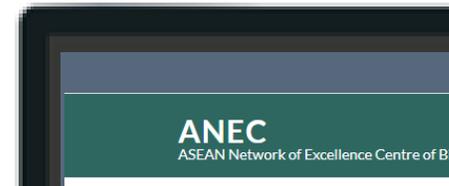


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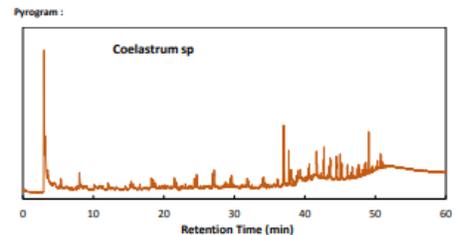


**Coelastrum sp**

Sample Preparation:  
 Drying Temperature, °C: 35  
 Particle size, µm: 75-150

Condition of analysis:

Part	Condition
Pyroprobe	- Pyrolyzed at 500°C for 0.20 min of hold time
Column	- (UAS-3000-0.25), 30m, 0.25mm i.d., 0.25 m film thickness)
Inlet	- split ratio at 1:25 - 280°C of injector temperature
Oven	- initial temperature: 40°C (3 min) to 200°C (heating rate at 5°C/min) - final Temperature: 350°C (heating rate at 10°C/min) and 10 min of hold time
MS	- operate in IE mode - mass spectra scan from 20 to 800 m/z



Product selectivity:

Sample	Functional Group of Composition												
	HC				Oxygenated								
	Aromatics	Aliphatics	Acids	Fatty acids	Alcohols	Aldehydes	Esters	Ethers	Ketones	Phenols	N-Com.	Others	Residuals
Coelastrum sp	7.16	23.76	0.00	0.00	7.43	0.00	0.00	0.00	9.77	2.54	9.55	0.00	0.00

### Fuel Properties

Property	Unit	as received	dry material	daf	lab	date	method
Proximate Analysis							
Moisture content	wt%	5.232	-	-	TISTR	2015-11-18	ASTM D7582
Volatile matter	wt%	50.224	52.997	99.006	TISTR	2015-11-18	ASTM D7608
Ash at 550 C	wt%	44.04	46.471	-	TISTR	2015-11-18	ASTM D7582
Fixed carbon	wt%	0.504	0.532	0.994	TISTR	2015-11-18	ASTM D7582
Ultimate Analysis							
Carbon	wt%	19.053	20.105	37.559	TISTR	2015-11-18	ASTM D5373
Hydrogen	wt%	2.887	2.433	4.545	TISTR	2015-11-18	ASTM D5373
Nitrogen	wt%	1.531	1.616	3.018	TISTR	2015-11-18	ASTM D5373
Sulphur	wt%	0.093	0.098	0.183	TISTR	2015-11-18	ASTM D4239
Oxygen	wt%	32.396	29.277	54.694	TISTR	2015-11-18	ASTM D5373
Calorific Values							
Net calorific value (LHV)	kcal/Kg	1147.15	1210.48	2261.37	TISTR	2015-11-18	ASTM D5865
Gross calorific value (HHV)	kcal/Kg	1293.46	1364.87	2549.79	TISTR	2015-11-18	ASTM D5865

### Lignocellulosic Analysis

Property	Unit	as received	dry material	daf	lab	date	method
Lignin	wt%	1.03			Animal Nutrition Laboratory	2016-01-28	Forage Fiber Analysis, Goering and Van Soest, 1970
Hemicellulose	wt%	16.29			Animal Nutrition Laboratory	2016-01-28	Forage Fiber Analysis, Goering and Van Soest, 1970
Cellulose	wt%	9.34			Animal Nutrition Laboratory	2016-01-28	Forage Fiber Analysis, Goering and Van Soest, 1970

### Composition Analysis by GC-MS pyrolyzer (% area)

HC				Oxygenated							
Aromatics	Aliphatics	Acids	Fatty acids	Alcohols	Aldehydes	Esters	Ethers	Ketones	Phenols	N-Com.	
7.16	23.76	0.00	0.00	7.43	0.00	0.00	0.00	9.77	2.54	9.55	

# Summary



Increasing of GHG emissions and climate change effects lead us to concern what happened on our world. During COP26, there was common agreements among countries including Thailand, e.g. the average global temperature limitation, GHGs mitigation, etc.

Thailand ranks 4<sup>th</sup> in ASEAN and 100<sup>th</sup> in the world for GHG emissions generation. Thailand has determined policies and measures related to renewable energy in order to mitigate GHG emissions, e.g. DEDEP and PDP.

TISTR, as national research institute, is responsible for driving country via STI. TISTR has conducted biomass conversion technologies in demonstration plants to support decentralized power plant policy achievement.

The other role of TISTR is creating platform to share technology, best practice, etc. among countries for driving ASEAN to achieve GHG mitigation target through energy sector via the network namely ANEC.



# Thank you for your attention



0-2577-9494



TISTR@TISTR.OR.TH



[www.tistr.or.th/innoEN/](http://www.tistr.or.th/innoEN/)



35 Mu 3, Khlong Ha, Khlong Luang,  
Pathum Thani 12120, Thailand