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

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Research & Development Group for Sustainable Development
1. Paris agreement and COP26
2. Thailand’s Situation and Policy
3. TISTR’s Role on R&D of Decentralized Power Plant
4. ANEC Network
Outline

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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
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.

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

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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ASEAN’s Emission

CO₂ Emission (metric ton per capita)

Source: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC
Thailand’s Emissions by Sector

Trend of Emission

In 2021

Electricity Generation 35.75%
Industry Sector 30.96%
Transport Sector 27.97%
Others 5.32%
Total 246.93 (million tonnes of CO₂eq)

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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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.
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.
Expert Centre of Innovative Clean Energy and Environment

Renewable Energy Demonstration Plant from Biomass and Waste

Biomass

Waste/ RDF

Petroleum coke, coal, etc.

2-stage Anaerobic Baffled Reactor
Biogas Production

3-stage Gasification
Syngas Production

Generator
200 kW

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 provides 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, H₂, N₂, CO₂, and some hydrocarbons (CH₄, C₂H₄, C₂H₆, 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.

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.

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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.
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.
Biomass Database
The database comprise of information on the properties of available biomass in Thailand, 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.
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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 4th in ASEAN and 100th 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