Towards the opening of AEC: What would be Thailand's Position in Bioenergy Technology?

With the abundant biomass resources and past successes in bioenergy promotion, Thailand holds a strategic position to promote biomass utilization in ASEAN. Towards the opening of ASEAN Economics Community (AEC) in 2015, the readiness of bioenergy science and technology for Thailand will be required not only to overcome the challenges within and outside the country, but also to tap the unharnessed potential of biomass efficiently and economically**.** Towards the opening of ASEAN Economics Community (AEC) in 2015, Thailand's readiness preparation is realized in various aspects. Energy security is one of the key areas to be concerned and pursued for regional cooperation. Apart from hydropower, bioenergy is the other potential renewable energies in ASEAN. With the abundant biomass resources and past successes in bioenergy promotion, Thailand holds a strategic position to promote biomass utilization in ASEAN. However, the regional capacity in term of status and systematic database of biomass potential and utilization of each member country is needed to establish the country's direction and necessary collaborations. The Joint Graduate School of Energy and Environment (JGSEE) and National Science Technology and Innovation Policy Office (STI), as the working group for **"Bioenergy Science Technology and Innovation Policy for Thailand in the context of AEC"** or **"ASEAN Biomass STI"**, have been conducting a study to establish and evaluate the ASEAN status on bioenergy technology as well as to identify possible collaboration through bioenergy science and technology research.

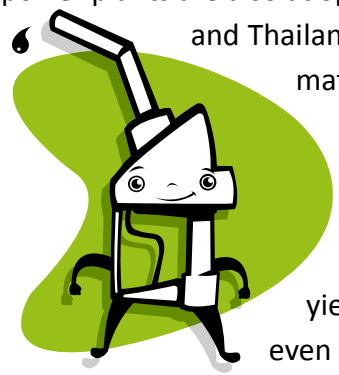
ROLE OF BIOENERGY IN ASEAN

ASEAN has a fast growing energy demand driven by its economic and demographic between 2005 and 2030 by an average annual growth rate of 4%. While being highly dependent on oil and gas imports, the issue on climate change mitigation will pose constraints on the use of coal which is the dominant energy source of the region. Therefore, meeting the region's energy needs is a challenge and diversification of energy resources as well as seeking for any available and possible energy resources should be pursued.

Renewable energy has received increasing attention because of worldwide efforts to prevent global warming and alleviated soaring oil price. In 2011, the contribution of renewable energy share in ASEAN power generation was 29.33%. Biomass is the second largest source of renewable energy resources after hydropower and accounts for 3.64% of total power generated.

Biomass is an important energy source since it is renewable, widely available, carbon neutral and has the potential to provide significant employment in the rural area. The utilization of biomass as an essential energy resource is increased continuously. In ASEAN,

energy from biomass such as wood and agricultural residues represents about 12.41% of total renewable energy consumption in 2011. Wood and agricultural wastes are widely used as fuels in the domestic sector and small-scale industries for cooking and heating, while modern biomass systems including combined heat and power generation and large-scale power plants are also adopted in many countries such as Indonesia, Malaysia, the Philippines and Thailand. Sugar/starch rich and oil rich plants have also been used as raw materials for bioethanol production mainly in Thailand and biodiesel mainly in Malaysia, Indonesia and Thailand. Nevertheless, energy production from biomass still has a significant potential since a large portion of biomass is still under-utilized. Moreover, increasing potential of energy crop and development of plant yield improvement technology will extend the bioenergy potential even more. Therefore, biomass is considered as a major issue in both national and regional future strategic energy planning as an alternative energy for the energy demand.



CURRENT STATUS OF BIOENERGY TECHONOLOGIES IN ASEAN

Among biomass technologies for heat and power generation, combustion is most commonly used in all ASEAN countries, except Brunei and Singapore which do not have or have a limited biomass resource. Biomass combustion applications include tradition uses for cooking and heating, heat and steam generation or combined heat and power generation (CHP) in industry and large-scale power plants. In some countries like Malaysia, Thailand and Vietnam, biomass combustion for electricity, heat and CHP is considered as fully commercial with local capability for manufacture. However, very high efficiency boilers and related components are still imported from China, Japan and Europe. Large-scale biomass power plant projects are also implemented in Laos and Philippines solely by foreign companies. Types of technology are mainly grate fired and some are fluidised bed.

In Thailand, biomass combustion technology is well established for heat, power and CHP application. It is reported that installed capacity of biomass projects can contribute over 4300 ktoe of heat and almost 2000 MW of power (830 MW of which are on grid) in 2013 and almost all use combustion technology. The most commonly used feedstocks in power generation and CHP is rice husk, bagasse, palm oil residues and rubber wood residue, which are the wastes from agro-processes. Technologies are mainly grate-fired and less of fluidised bed type, which is often adopted to be used for rice husk and co-firing with coal. At the present, more than 10 units of the CFB plants with capacities range of 22-150 MW have been used to produce the process steam and electricity in factories. Although direct combustion of biomass has been proven to work well and high efficiency systems have been

in place, the average efficiency is still low. Many existing boilers have low efficiency and no plan for replacement due to the lack of energy production demand. Technical problems caused by the undesirable biomass properties such as high moisture, high alkaline and chloride in biomass, etc, also result in reduce combustion efficiency.

In ASEAN countries, municipal solid waste (MSW) is mostly disposed by landfill. Waste incineration is adopted only in Thailand, Malaysia, and Singapore. In Thailand, only the 700 tons/day MSW incineration power plant in Phuket is currently under operation.

Apart from combustion, biomass gasification has also been adopted for energy production but for smaller scales. Gasification converts solid biomass into combustible gases (i.e. CO, H_2 and CH_4,), which can be further used for heat and power generation. Commonly used biomass gasification technologies are fixed-bed downdraft and fluidized bed. Many countries in ASEAN have developed gasification technology in different stages. In Thailand, biomass gasification for heat production has been successfully applied in industry though with a limited reference, while gasification for power production is still considered pilot scale and demonstration stage due to technical problems to be overcome. Fixed-bed downdraft gasifiers are mainly used for power generation with capacity ranging from tens of kW to 1 MW, while fluidized bed gasifiers are often chosen for larger system capacity. Small-scale biomass gasification is also actively implemented in Myanmar, Cambodia and Vietnam for rural energy purposes. The technologies are found to come from imports as well as self development. The major barriers for biomass gasification for power generation are similar in all countries, including the problem of high tar content in product gas, the lack of technical skills and the need of local development to reduce the cost of technology.

Advanced Fuel Processing Laboratory (AFPL)

The main focus of the Advanced Fuel Processing Laboratory is the research and development of fuel processing technology to serve the needs for the country's energy security and environmental protection. A broad range of topics related to coal, biomass, biogas upgrading and waste processing from fundamental research to practical approach are parts of the research activities of AFPL.

Project involved

Bioenergy Science Technology and Innovation Policy for Thailand in the context of AEC

The production of liquid biofuels, both ethanol and biodiesel, is increasing in several countries in ASEAN i.e. Thailand, Indonesia, Philippines and Malaysia during the past two decades. The main driving force for the development of biofuels is the concern for energy security particularly to reduce the import of oil. Ethanol is produced mainly from sugarcane and cassava, while the major feedstock for biodiesel production is palm oil. At present, the largest producer of ethanol in ASEAN is Thailand, followed by Philippines and Indonesia. The largest biodiesel production in ASEAN is Indonesia, followed by Thailand, Philippines and Malaysia.

In Thailand, ethanol is produced mainly from sugarcane molasses and with increasing capacity from cassava, while biodiesel is produced from palm oil. In March 2013, ethanol production capacity is 2.3 million liters/day, which is approximately 25% of ethanol production target in 2021. The total capacity of biodiesel production from 14 production plants was 5.21 million liters/day, which is already close to the 2021 target, however the average use is only 2.8 million liters/day. Although ethanol and biodiesel have been promoted at the same time in Thailand, ethanol successfully penetrated the market before biodiesel due to the readiness of feedstock supply. Lack of supply of palm oil due to the lack of suitable land for palm oil plantation and the land competition with rubber tree plantations are the barriers for biodiesel production. Apart from commercial liquid fuels, there are R&D studies ongoing in universities and private companies such as ethanol production from lignocellulosic feedstocks, biodiesel production from algae, etc.

Biogas production converts organic materials via a biological process in an absence of air into methane-rich (~60%) gas, which can be further used for energy production. Thailand can be considered as the technology leader among ASEAN countries for both development and implementation of biogas production. Due to the strong and continuous government supporting policy to promote biogas production, thousands of digesters have been installed in animal farms and other industries such as tapioca factories, palm oil factories, etc., producing biogas from conventional feedstocks like organic wastewaters for their own uses or selling to the grid. Reported in March 2013, the existing biogas utilization in Thailand was 458 ktoe for heat and 196.96 MW for electricity. Biogas technologies applied in Thailand depend on type of raw materials. For animal manure, fixed dome and UASB was applied for small-scale and medium to large-scale, respectively. Agro-industrial wastewater was used UASB, aerobic fixed film, CSTR, anaerobic baffle reactor, covered lagoon and hybrid reactor. To expand the feedstocks for biogas production, research and development on biogas production from lignocellulosic feedstocks is ongoing.

OPPORTUNITIES AND CHALLENGES FOR THAILAND

Towards the opening of ASEAN Economics Community (AEC) in 2015, the readiness of bioenergy science and technology for Thailand will be required not only to overcome the challenges within and outside the country, but also to tap the unharnessed potential of biomass efficiently and economically.

As abovementioned, Thailand is well positioned to promote biomass utilization in ASEAN. Various areas in which the country has technological strength include crop/biomass yield improvement, low- and medium-pressure biomass boilers, biogas digesters and community-scale liquid biofuels production. However, there are a number of technical and non-technical challenges to be solved including

- Imported technologies & equipment not entirely suitable for local biomass feedstocks and need adaption
- The lack of know-how of technology, skilled labors as well as experts in the field
- Lack of collaborations with industry for co-development and therefore low uptake of local R&D for commercialization
- Competing use of biomass (leading to issues of availability and cost)
- No long-term S&T roadmap and funding policy to promote bioenergy RD&D
- Frequent change of energy policy and targets, which defers bioenergy project investment

Major recommended strategies can be derived as following

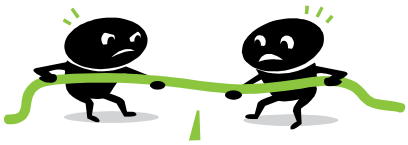
Improvement of local capability for commercialization

Local development of the technologies and equipment to suit the properties of local biomass should also be promoted. Industry should get involved from the beginning stage of RD&D and government supporting measures should be implemented.

Capacity building

Human resource in the field of bioenergy should be developed through knowledge transfer, technical training, researcher development, etc., is needed.

Reducing competitiveness of biomass use



The food vs. fuel dilemma due to the increased utilization of biomass may be avoided by crop/biomass yield improvement and agricultural zoning. Advanced or improved energy conversion technologies can also help optimize the efficiency of resource utilization.

Government policy and support

Government should have a well-structured short-term and long-term national bioenergy S&T roadmap that provides a framework to coordinate technology developments to meet the national energy goals. Energy policy and targets should also be clear and continuous. Effective support should also be given through R&D funding, support industry for technology deployment, financial incentives, and so on.

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