ASEAN Bioenergy Technology Status Report 2014

- ASEAN Bioenergy Highlights
- Role of Bioenergy in ASEAN
- Bioenergy Basics
- Biomass Potential Status
- Bioenergy Technology Status
- Bioenergy Policy and Target
- Success Stories of Bioenergy in ASEAN
- Working Groups

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

Foreword

As all are aware, ASEAN has embarked on the next stage of its dynamic development after four decades of regional cooperation to build the ASEAN Community in 2015. Regional cooperation is even more important to help accelerate the development in ASEAN. ASEAN Ministers on Science and Technology endorsed “Krabi Initiative 2010” as a strategic direction to raise competitiveness for sustainable and inclusive ASEAN using science, technology and innovation. Energy security is one of the eight thematic tracks as key areas to be pursued and bioenergy is one of the highest potential renewables, which not only contributes to energy security but also reduces greenhouse gas emission. However, due to the lack of status and systematic database of bioenergy technology in ASEAN, the regional capacity and research collaboration is partially bound for establishment.

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”, has recently updated the status of ASEAN bioenergy technology and disseminated in this report.

Contents

1. ASEAN Bioenergy Highlights

Myanmar

With significant amount of untapped biomass, Myanmar has high potential in both bioenergy and biofuel production. So far, more than 1,000 gasifiers, both self developed and imported, installed for heating and power production. Biomass combustion also applied in SMEs for power generation, especially rice mills. Myanmar is moving toward to increase share of biomass in biofuels and bioenergy

Vietnam

Being a major exporter of agricultural products, Vietnam is highly abundant in biomass. Various biomass feedstocks are used as boiler fuels for heat application in industry, while rice husk is main fuel for future power plants. Boilers are from local made and import. Gasification for CHP is under demonstration stage, while gasification for heat is already adopted in industry. Multiple policies are in forced to increase production and utilization of biofuel and bioenergy.

Philippines

Abundant in biomass which is used as fuels mainly for CHP application. A number of biomass power plants in operation and many more in the national plan. Small-scale gasifiers developed locally are widely used in many SMEs for heat application. There is a lot of bioethanol and biodiesel production from sugarcane and coconut, respectively. A long term plans with mandates in biofuel and bioenergy production and utilization are ongoing.

Laos

Still abundant unused biomass. Tradition fuel use, i.e. biomass and charcoal, represents around 69% of the total energy consumption. Currently, there are a few on-going biomass combustion project through international collaboration and foreign investment and more are planned

Thailand

High potential of agricultural and agro-processing wastes. With advancement in yield improvement technologies, energy crops also one important contributor. Combustion is fully commercialized, though large scales mainly imported. Locally developed gasification for heat already has some references, while gasification for power and pyrolysis still under demonstration stage and R&D. Biogas technology is widespread. Strong government policies/mandates promote the production and utilization of bioethanol and biodiesel.

Cambodia

Still abundant unused biomass. Biomass mostly used for small-scale gasification or use in SMEs. Government policy highly promoting gasification but no policy for biofuel.

Brunei

Brunei is solely dependent on oil and natural gas. No short term bioenergy related projects due to the small country, but looking at the development of biomass energy in the long term.

Singapore

Singapore has limited biomass resources and therefore no practical utilization of biomass. However, some technologies developed for export, e.g. drying, pelletization. Currently, all MSW and sewage sludge are incinerated due to limited area for land fill.

Malaysia

Oil palm is major agricultural product and therefore palm wastes are major fuels for CHP and power generation. Biomass also converted into pellets for export. Palm oil industry including biodiesel production is the most advanced in the region.

Indonesia

The country with the most abundant biomass resources in ASEAN. Various kinds of biomass are used for boiler fuels for power and CHP application. Currently, around 1,700 MWe of biomass-fired power plants are installed. There is still untapped potential of biogas production. Indonesia is a considerable biodiesel producer. Ethanol is produced mainly for non-energy purpose, however is promoted for transport sector. More bioenergy production is also aimed.

2. Role of Bioenergy in ASEAN

Introduction

ASEAN has a fast growing energy demand driven by its economic and demographic growth. ASEAN's primary energy need is projected to triple between 2005 and 2030 by an average annual growth rate of 4%. Renewable energy has received increasing attention because of worldwide effort to mitigate global warming and alleviate 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.

In ASEAN, energy from biomass represented 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, Philippines and Thailand. Sugar-rich, starch-rich, and oil-rich plants have also been used as raw materials for bioethanol production mainly in Thailand and for biodiesel mainly in Malaysia, Indonesia and Thailand.

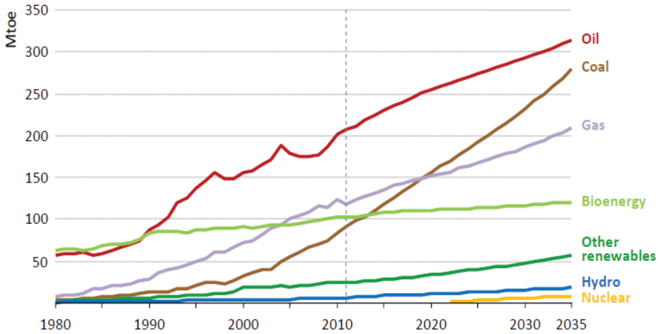
Nevertheless, energy production from biomass still has a significant potential since a large portion of biomass is still underutilized. Moreover, increasing potential of energy crops and development of plant yield improvement technology will extend the bioenergy potential even more. Therefore, biomass is considered as a promising alternative energy source in future strategic energy planning both national and regional context.

Access to modern energy services in ASEAN, 2011

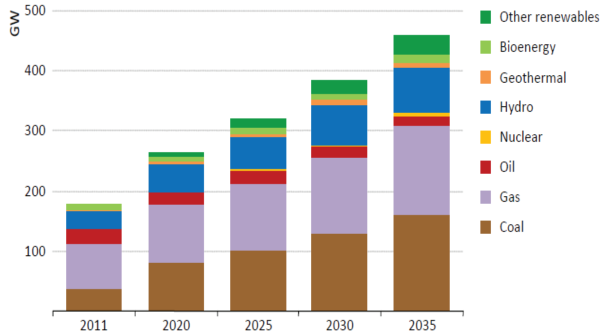
	Population without access to electricity		Population relying on traditional use of biomass for cooking*	
	Million	Share (%)	Million	Share (%)
Brunei	0	0%	0	0%
Cambodia	9	66%	13	88%
Indonesia	66	27%	103	42%
Laos	1	22%	4	65%
Malaysia	0	1%	1	3%
Myanmar	25	51%	44	92%
Philippines	28	30%	47	50%
Singapore	0	0%	0	0%
Thailand	1	1%	18	26%
Vietnam	3	4%	49	56%
Total ASEAN	**134**	**22%**	**279**	**47%**

* Preliminary estimates based on IEA and World Health Organization (WHO) databases.

ASEAN primary energy demand by source



ASEAN electricity generation capacity



Source: SOUTHEAST ASIA ENERGY OUTLOOK: World Energy Outlook Special Report, IEA 2013

3. Bioenergy Basics

- **What is biomass and bioenergy?**

Biomass is any organic matter derived from plants or animals available on a renewable basis. Biomass includes wood and agricultural crops, herbaceous and woody energy crops, municipal organic wastes as well as manure.

Bioenergy is energy derived from the conversion of biomass which may be used directly as fuel, or processed into liquid and gas forms.

- **Why bioenergy?**

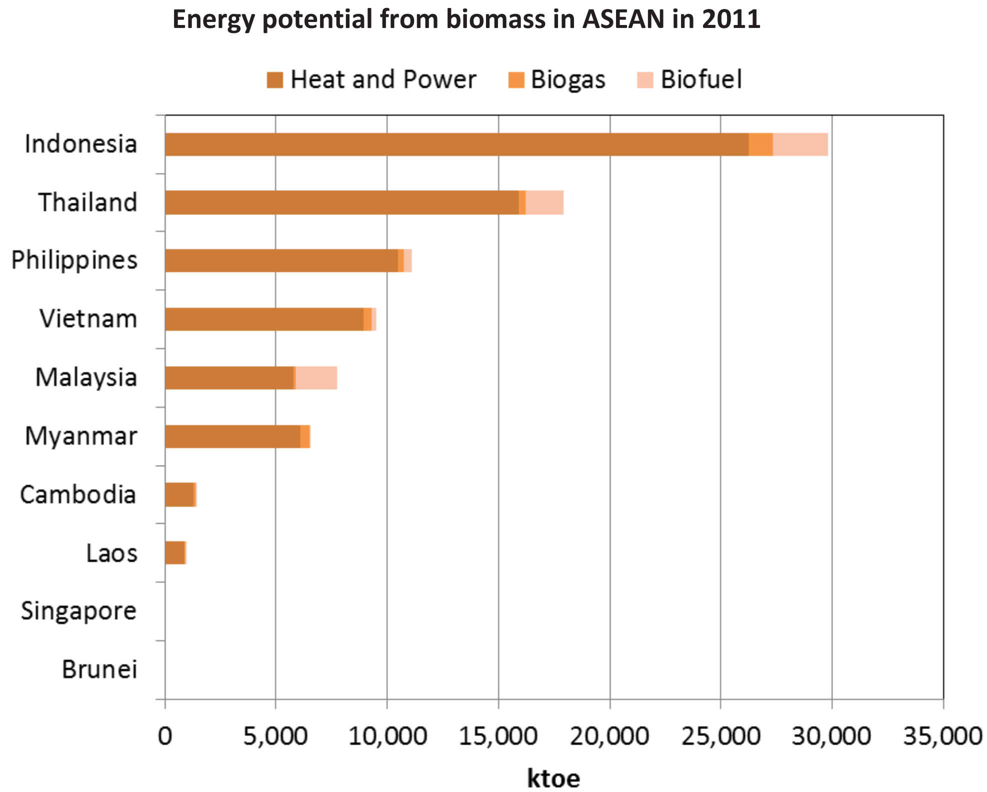
Bioenergy is an important energy resource since it is renewable, widely available and carbon neutral. Using bioenergy as an alternative to fossil fuels – which are limited resources - is one way to reduce GHG emissions and improve energy security. Moreover, since bioenergy can be generated from energy crops, biomass residues as well as organic wastes, there is considerable potential for new sources of income along the whole value chain, from cultivation to harvest, processing and conversion into energy.

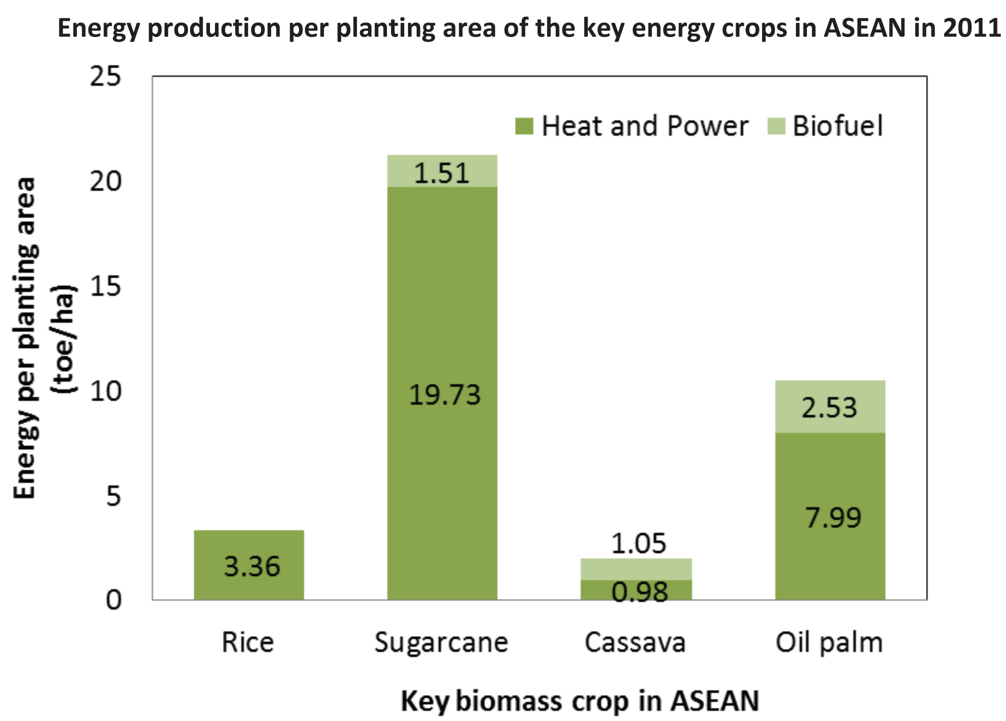
- **Bioenergy process**

Thermochemical process	
Combustion	The cycle used is the conventional rankine cycle with biomass being burned (oxidized) in a high pressure boiler to generate steam. The exhaust of the steam turbine can either be fully condensed to produce power or partly or fully used in other thermal applications. In addition to the exclusive use of biomass combustion to power a steam turbine, biomass can be co-fired with coal in a coal-fired power plant.
Gasification	Gasification is achieved by the partial combustion of the biomass in a low oxygen environment, leading to the release of a gaseous product (producer gas or syngas).
Pyrolysis	Pyrolysis is a thermochemical degradation of organic matter at relatively high temperatures (450 °C to 600 °C, resulting in the production of a liquid bio-oil, as well as gaseous and solid products. The bio-oil is considered as a promising alternative to conventional fuels if upgraded.
Biochemical process	
Anaerobic digestion	Anaerobic digestion is a process which takes place in almost any biological materials and is favored by warm, wet and airless conditions. The resulting gas mainly consists of methane and carbon dioxide which are so-called biogas. The biogas can be used, after cleaning, in internal combustion engines, micro-turbines, gas turbines, fuel cells and stirling engines or it can be upgraded to biomethane for distribution.
Liquid biofuels process	
Ethanol	Commercial bioethanol can be produced from many types of feedstock, including sugarcane, sugar beets, corn (maize), wheat, potatoes, sorghum and cassava.
Biodiesel	Commercial production of biodiesel is based on transesterification of vegetable oils (chemically or mechanically extracted from rapeseed, palm seeds, sunflowers, etc.), animal fats and waste oil through the addition of methanol and catalysts, with glycerine as a by-product.
Advanced biofuel	To address the sustainability issues of conventional biofuels, advanced biofuel technologies focus on non-food feedstock, including agricultural and forest residues, organic and woody fraction of urban waste, short-rotation forestry (e.g. eucalyptus, poplar, robinia, willow), genetically modified crops and perennial grasses (e.g. miscanthus, switch grass, jatropha) grown on marginal, infertile, though with moderate yields.

4. Biomass Potential Status: Current Availability

Biomass is an organic matter obtaining from crops, animal manure and wastes that can be converted to many usable forms of energy. There are 3 types of bioenergy classified by end-products of biomass conversion processes: heat and power, biogas and biofuel.





Biomass Potential Status in ASEAN

Biomass	Status of ASEAN Biomass Potential									
	BRU	CAM	IND	LAO	MAL	MYA	PHI	SIN	THA	VIE
1. Heat & Power Production										
1.1 Field-based crop										
1.1.1 Rice straw	S	R	R	R	R	R	R		R	R
1.1.2 Wheat straw						S			S	
1.1.3 Millet stalk						S				S
1.1.4 Maize stalk		S	R	S	S	S	R		R	R
1.1.5 Cassava stalk	S	S	S	S	S	S	S		F	F
1.1.6 Cotton stalk		S	S	S		S	S		S	S
1.1.7 Soybean straw & pod		S	R	S		R	S		S	R
1.1.8 Jute stalk		S				S			S	S
1.1.9 Tobacco stalk		S	S	S	S	S	S		S	S
1.1.10 Sugarcane top & leave		S	R	S	S	S	R		R	R
1.1.11 Cocoa pod			S		S		S		S	
1.2 Process-based crop										
1.2.1 Rice husk	S	R	R	R	R	R	R		F	R
1.2.2 Maize cob		S	R	S	S	S	R		R	R
1.2.3 Maize husk		S	R	S	S	S	R		R	R
1.2.4 Coconut shell	S	S	R		S	S	R	S	S	S
1.2.5 Coconut husk	S	S	R		S	S	R	S	S	S
1.2.6 Groundnut husk		S	F	S	S	F	S		S	F
1.2.7 Groundnut straw		S	F	S	S	F	S		S	F
1.2.8 Oil palm fiber			R		R		S		F	
1.2.9 Oil palm shell			R		R		S		F	
1.2.10 Oil palm bunch			R		R		S		F	
1.2.11 Sugarcane bagasse		S	F	S	S	F	F		F	F
1.2.12 Coffee husk		S	R	S	S	S	S		S	R
1.3 Agro-based wood										
1.3.1 Oil palm solid			R		R		S		F	
1.3.2 Coconut solid	S	S	R		S	S	R	S	S	S
1.3.3 Rubber solid			F		F				F	F
1.3.4 Eucalyptus solid			F	S	F	F	F		F	F
1.4 Process-based wood										
1.4.1 Rubber sawdust			F		F				F	F
1.4.2 Rubber bark			F		F				F	F
1.4.3 Eucalyptus bark			F	S	F	F	F		F	F
1.4.4 Black liquor			F	S	F	F	F		F	F
2. Biogas production										
2.1 Manure		R	R	R	S	R	R	S	R	R
2.2 MSW			R		R				R	
3. Biofuel production										
3.1 Ethanol										
3.1.1 Molasses		S	R	F	F	R	R		R	R
3.1.2 Cassava		R	S	S	S	S	S		R	R
3.1.3 Maize			S	S	S	S	R		S	S
3.2 Biodiesel										
3.2.1 Crude palm oil			R	R	R		S		R	
3.2.2 Coconut oil	S	S	S		S	S	R	S	S	S
3.2.3 Soybean oil		S	S			S	S		S	S
3.2.4 Sunflower oil						S			S	
3.2.5 Castor oil		S					S		S	S
3.2.6 Jatropha			S	R		R				

Remark

- **S** Very small amount of feedstock available
- **F** High amount of feedstock but fully used
- **R** High amount of feedstock and remaining for utilization

Agricultural residue feedstocks for heat and power production

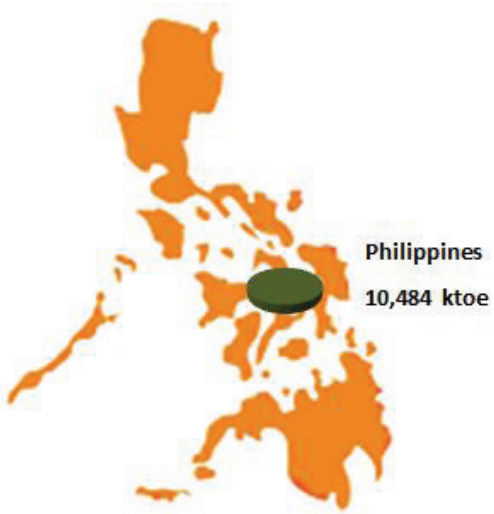
The figure presents the maximum capacity of agricultural residue feedstocks for heat and power production, in terms of oil equivalent, in each country. It is estimated from the amount of generated leftover, moisture content and collection efficiency of each biomass residue type while the amount of current consumption is not considered in this report.

Agricultural residue feedstocks for heat and power production

Crops generating residues to serve as feedstocks for heat and power production

Country	Rank				
	1st	2nd	3rd	4th	5th
Indonesia	Rice	Maize	Oil Palm	Coconut	Sugar cane
Thailand	Sugar cane	Rice	Maize	N/A	N/A
Philippines	Coconut	Sugar cane	Maize	Rice	N/A
Vietnam	Rice	Maize	Sugar cane	N/A	N/A
Myanmar	Rice	Groundnut	Sugar cane	N/A	N/A
Malaysia	Oil palm	N/A	N/A	N/A	N/A
Cambodia	Rice	N/A	N/A	N/A	N/A
Laos	Rice	N/A	N/A	N/A	N/A

N/A means no available data



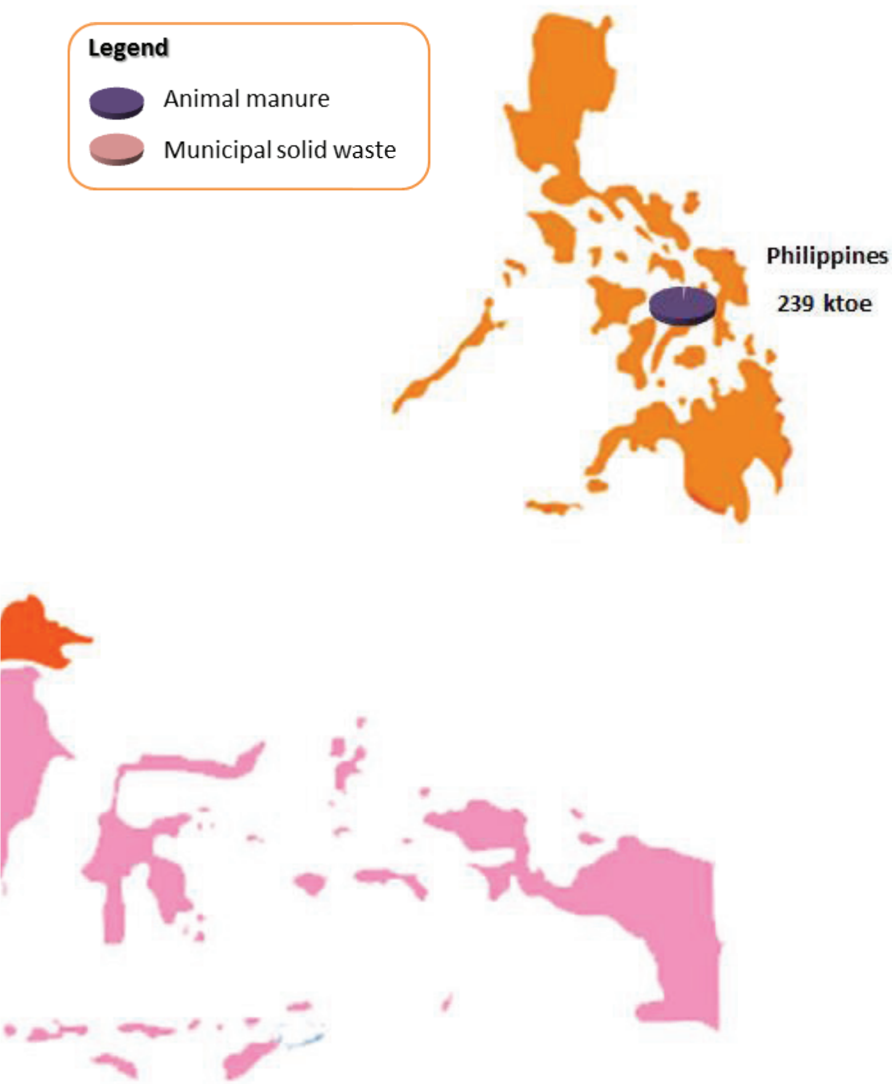
Municipal solid waste and animal manure feedstocks for biogas production

The maximum capacity of biogas production from municipal solid waste and animal manure in ASEAN is shown in the figure. The capacity of municipal solid waste is estimated from the amount of animal manure generated and the collection efficiency of each animal type. In case of municipal solid waste, it is calculated from the amount of collected waste that is disposed in the landfill. Note that the amount of current consumption is not considered in this report.

Solid waste and animal manure feedstock for biogas production

Biogas production (ktoe) classified by type of feedstock

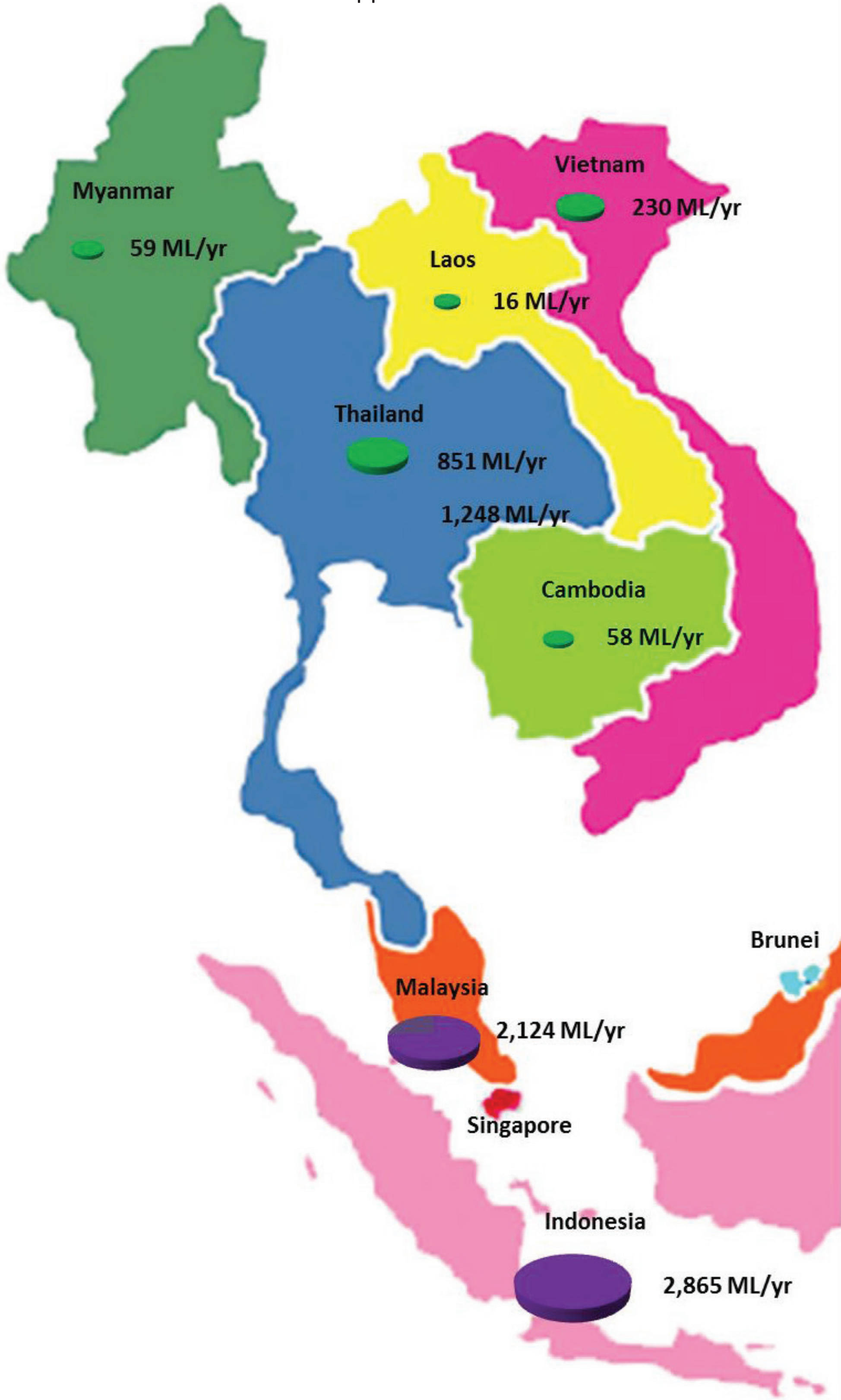
Country	Solid waste	Buffalo manure	Cow manure	Swine manure	Total
Indonesia	766	34	256	68	1,124
Myanmar	7	81	244	92	424
Vietnam	19	71	94	236	420
Thailand	128	44	115	67	354
Philippines	7	81	44	107	239
Malaysia	87	3	16	15	121
Cambodia	2	18	59	17	96
Laos	1	31	27	23	82



Biofuel production capacity

The raw materials used in ethanol and biodiesel production vary by resources of each country.

Ethanol: Thailand uses sugarcane, molasses and cassava as feedstocks for ethanol production, while Vietnam and Philippines use only molasses and cassava.
Biodiesel: the raw materials used in ASEAN are crude palm and coconut oils. Crude palm oil is used in Thailand, Malaysia and Indonesia whereas coconut oil is used in Philippines.

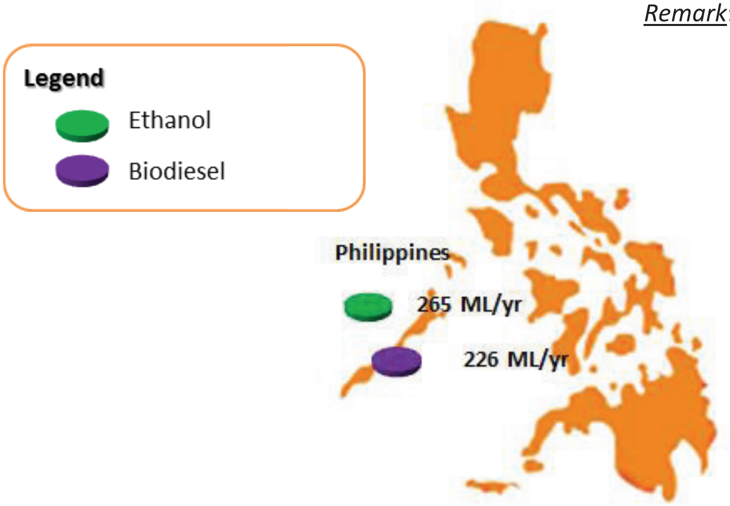


Biofuel production capacity

Feedstocks for biofuel production

Country	Ethanol			Biodiesel	
Indonesia	Molasses [a]	Cassava [a]		Crude Palm Oil	
Thailand	Molasses	Cassava	Sugarcane juice	Crude Palm Oil	
Philippines	Molasses	Cassava		Coconut Oil	
Vietnam	Molasses	Cassava		-	
Myanmar	Molasses	Cassava	Broken Rice	Coconut Oil	Crude Palm Oil
Malaysia	-			Crude Palm Oil	
Cambodia	Cassava			-	
Laos	Cassava	Molasses		Crude Palm Oil	Jatropha

Remark: [a] In Indonesia, ethanol is used only in industrial chemicals.



The potential of ethanol production in ASEAN is estimated from the total amount of raw materials including:
1) The current raw materials used in ethanol production;
2) 10% of the dried cassava chip exported; and
3) 50% of molasses production.

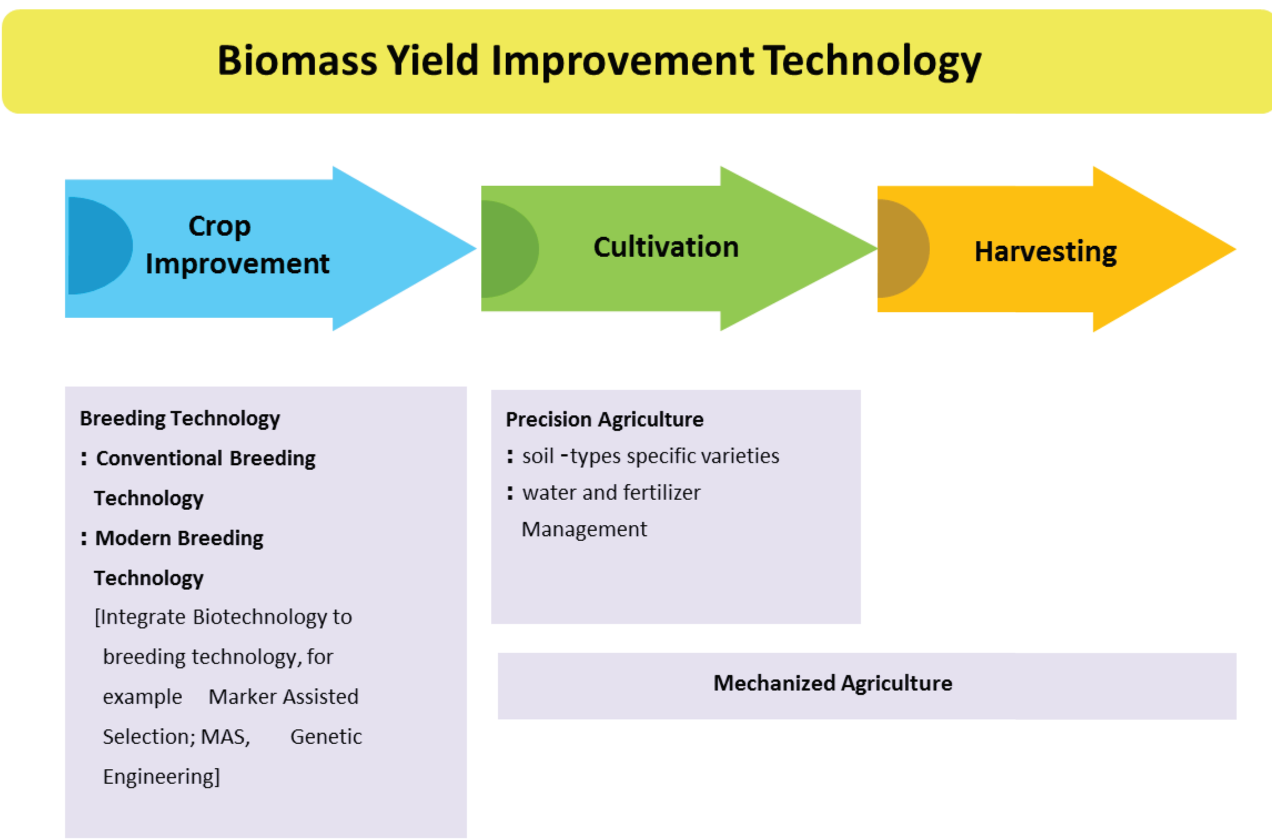
The potential of biodiesel production in ASEAN is estimated from the total amount of raw material including:
1) The current raw material used in biodiesel production; and
2) The beginning stocks of materials*.

**Beginning stock of materials referred to materials which are not consumed during the previous marketing year. This is the stock carried over into the current marketing year and added to the stocks produced during the crop year.*

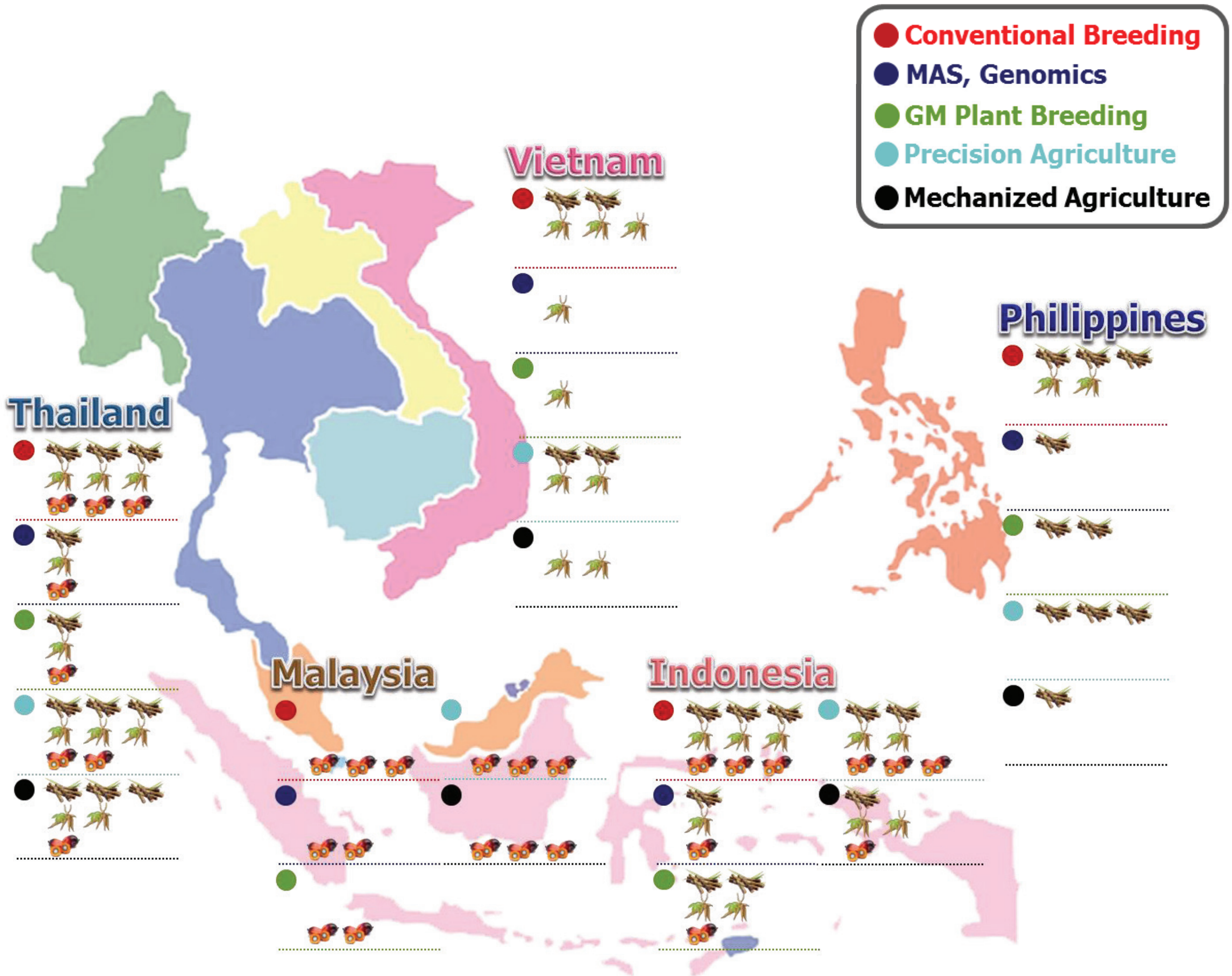
Biomass Potential Status:
Yield Improvement Technology

ASEAN has high capability producing agricultural products. Therefore, many countries have launched their own policy to develop bioenergy from biomass in order to promote energy security and strengthen their agricultural sector. However, nowadays bioenergy production in ASEAN is still below the desired target. The lack of feedstock management and high price of raw materials cause bioenergy production unattractive. Approximately 70-80% of the production cost of bioethanol and biodiesel is the cost of raw materials. To improve the competitiveness, the productivity of energy crops per area has to be increased for economic assessment. Currently, technology to increase yield include:

1) Plant breeding technology;
2) Precision agriculture; and
3) Mechanized agriculture.




Sugarcane
Cassava
Oil palm

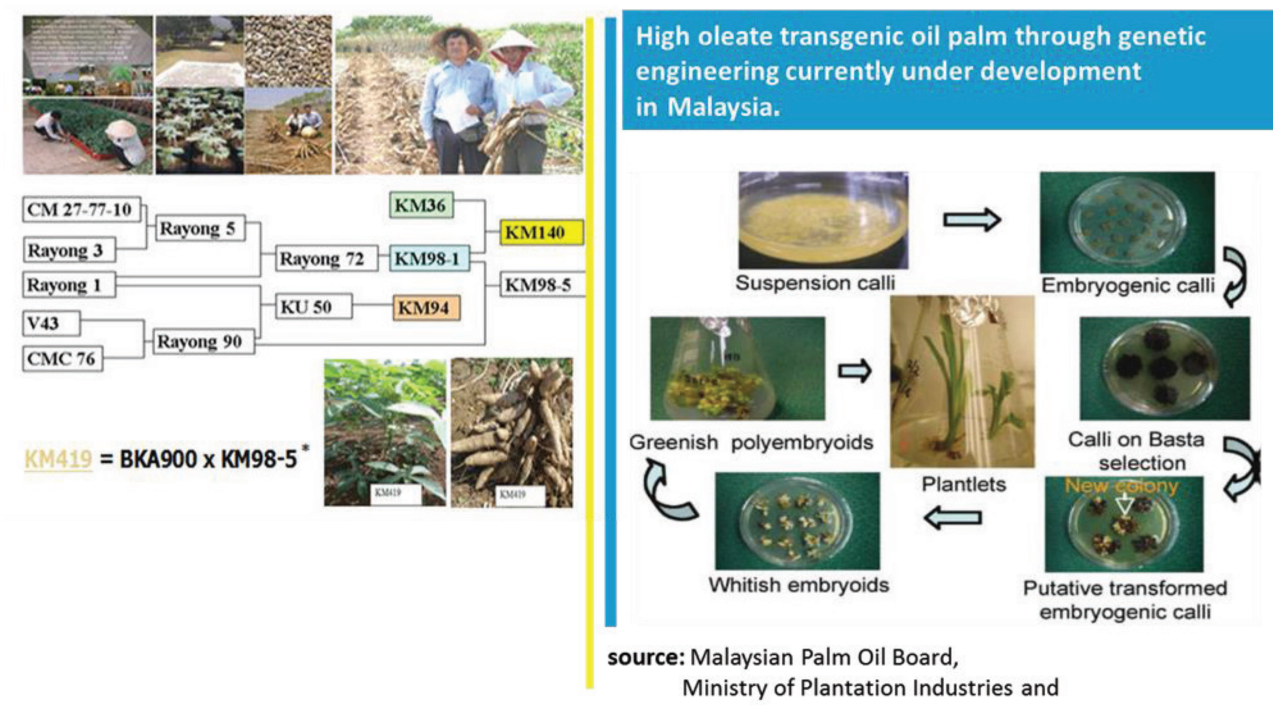

Conventional Breeding
MAS, Genomics
GM Plant Breeding
Precision Agriculture
Mechanized Agriculture
Vietnam
Philippines
Thailand
Malaysia
Indonesia


: R&D,
: field trial, pilot/prototype stage,
: implementation

Plant breeding technology

Plant breeding technology is a technology to improve plant varieties such as higher yields, drought tolerance and nitrogen use efficiency. ASEAN countries have utilized conventional breeding and tissue culture in their agricultural activities. Currently, several biotechnologies (i.e. MAS and genetic engineering technique) have been used to speed up the process of plant improvement. Malaysia, Thailand, Philippines, and Vietnam are regarded as high capability of improving plant varieties.

Examples of breeding activities in ASEAN

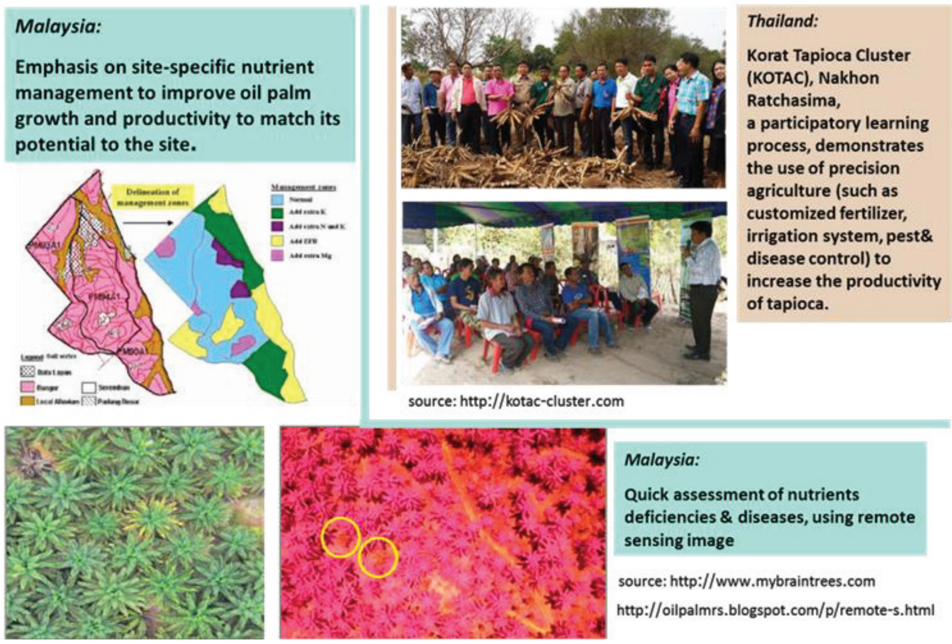


source: Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia

Precision agriculture

Precision agriculture is the use of technology to manage farm areas. Specific technologies in this group include resource management technology which improves efficiency of water and fertilizer use, drip irrigation technology as well as technology for selecting suitable varieties in particular cultivation area. Currently, the use of precision agriculture in ASEAN is in infancy stage of development. Many projects and initiatives are in the pilot or prototype stage. Malaysia and Thailand are positioning in the highly capable group that has precision technology for agriculture. Malaysia is also standing out for using precision technology in oil palm cultivation with the aim of environmental sustainability. Meanwhile, Thailand is applying this technology in sugarcane and cassava farming in order to increase the efficiency of farm management and ability to select the suitable varieties for cultivation and production.

Examples of precision agriculture implementation in ASEAN



Mechanized agriculture

Mechanized agriculture refers to the use of tools or machines in farm operation such as land preparation, planting, harvesting, processing and storage. Currently, mechanized agriculture has received high attention because of the on-farm labor shortage and increase of crop planting. In ASEAN, most mechanical equipment and machinery are imported. However, Malaysia has ability to develop and export machines and equipment for oil palm planting. Vietnam, Indonesia, Philippines and Thailand have ability to develop equipment and machines for land preparation, planting, and harvesting of sugarcane and cassava but most of the machines used in field are imported.

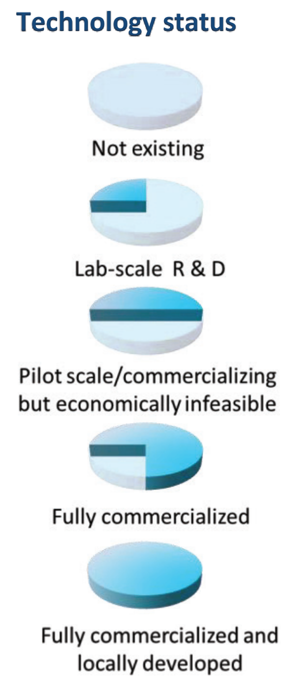
Examples of mechanized agriculture implementation in ASEAN

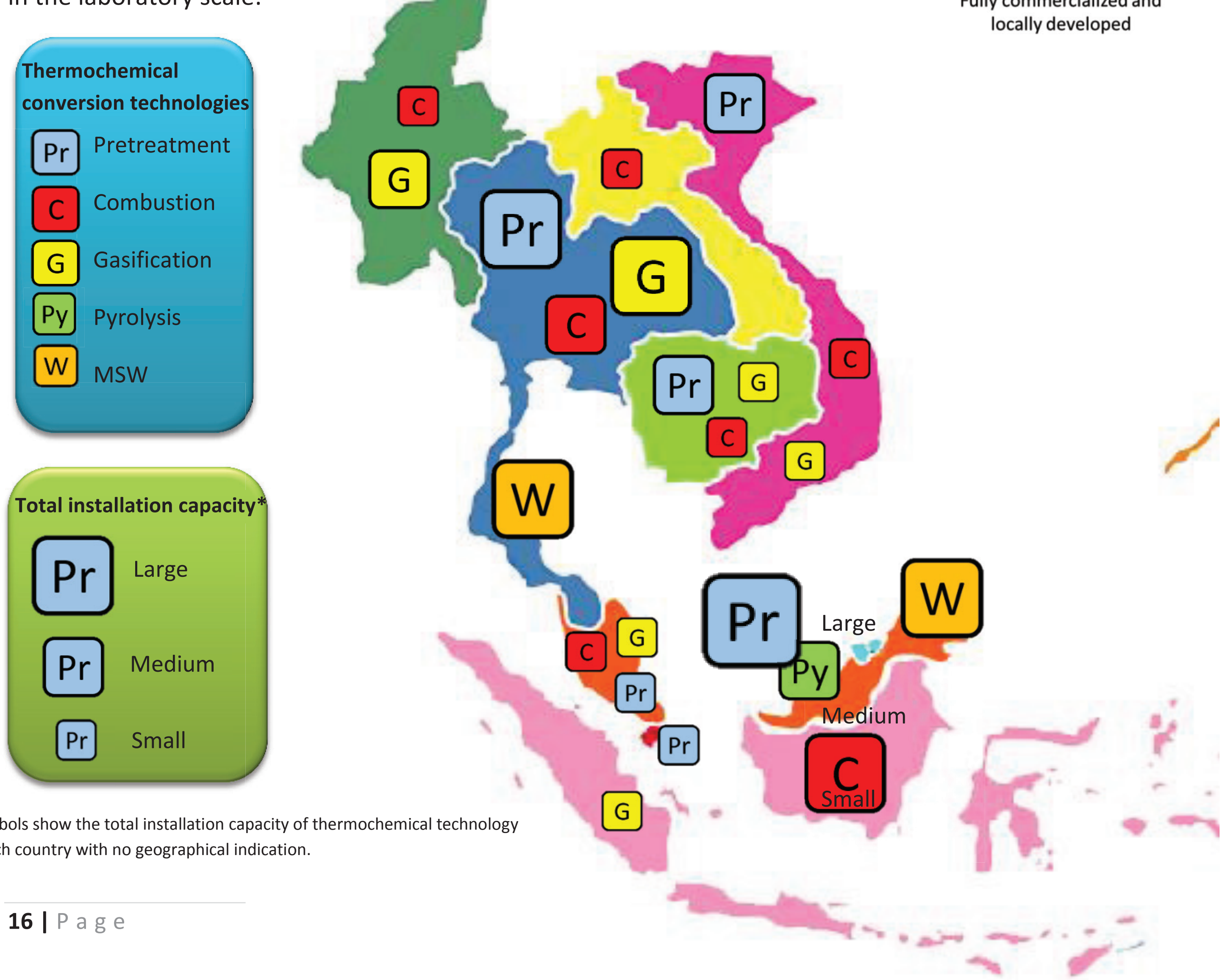
5. Bioenergy Technology Status: Thermochemical Conversion Technology for Heat and Power

Biomass can be converted into energy in form of heat and/or power via thermochemical processes, which are combustion, gasification and pyrolysis. With the abundant resources of biomass generated from agriculture, biomass has been utilized in all ASEAN countries (except Singapore and Brunei due to their limited biomass resources) for both traditional uses like cooking and heating and in commercial practice.

One of the challenges for biomass utilization is the process of handling and feeding biomass into processes. Therefore, biomass pretreatment prior to energy conversion processes is often needed to ease transportation and improve the energy conversion efficiency. Drying, pelletizing and briquetting are already in commercial practice, while torrefaction is still in R&D stage.

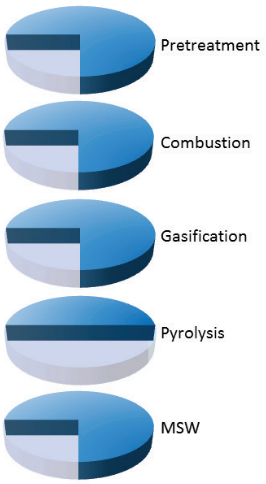
Among biomass thermochemical conversion technology, combustion is the most commonly used in ASEAN countries. Biomass combustion applications include traditional use for cooking and heating in household and SMEs, industrial boilers for heat and steam generation, combined heat and power generation (CHP), biomass and MSW power plants. Apart from combustion, biomass gasification has also been adopted for energy production especially for heat application with fixed-bed downdraft type for small scale and fluidized-bed design for medium to large scale. Biomass pyrolysis is mostly still in the laboratory scale.





*Symbols show the total installation capacity of thermochemical technology in each country with no geographical indication.

Thailand

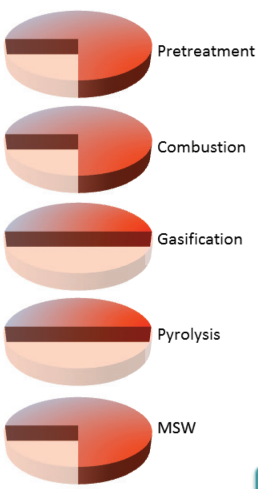


Combustion technology in Thailand is fully commercialized for heat, power and CHP. Locally developed gasification for heat already has some references in industry, while gasification for power and pyrolysis are still under demonstration stage in parallel with R&D. MSW is disposed of by incineration for power plant. There is only one MSW incineration power plant with an installed capacity of 14 MWe located in Phuket province, which use the combustion technology. The majority of pretreatment technology such as drying or densification, however, is not locally developed.

Biomass Pellet Thai produced 3 tons/hr of wood pellet using machines and technology from Germany.

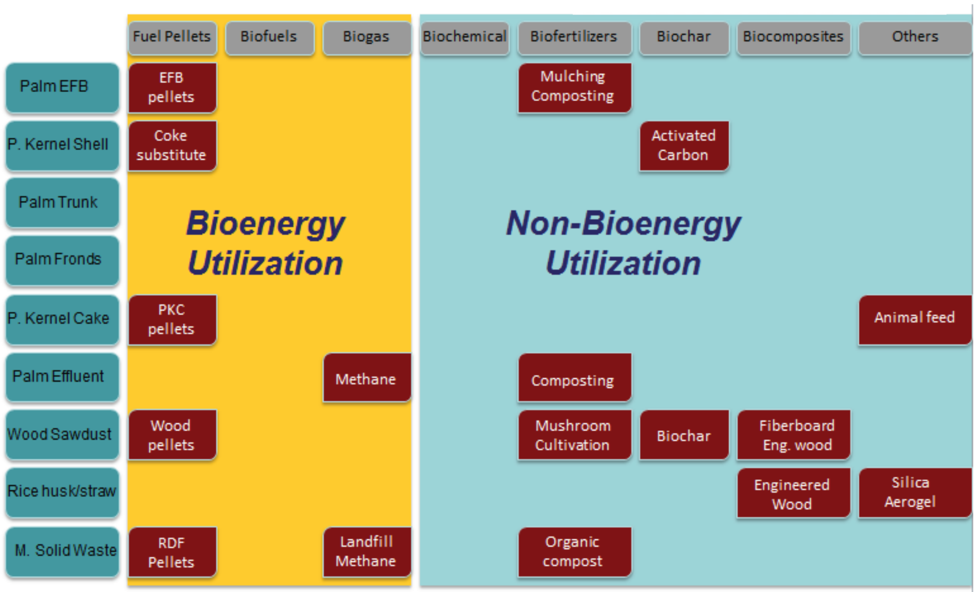
Biomass power plant in Chainat province has used rice husk as a fuel with the potential capacity of 6.0 MWe.

Malaysia



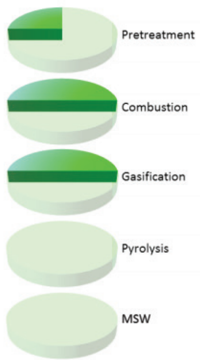
Combustion technology employed is grate-fired or fluidized-bed boilers. Oil palm wastes are major boiler fuels for CHP and power generation in Malaysia. Bio-oil from palm EFB is produced by pyrolysis technology. Most types of biomass are also pelletized prior to utilization or as high value fuels for export. There are a number of projects of MSW-to-energy projects in Malaysia, both main land and islands. It is also burned to produce energy.

LEE SENG ANN (Kelantan, Malaysia) produced the pallets with capacity of 2 tons/hr for exporting to Japan, South Korea, and China.



Source: Status of Bioenergy in Malaysia, Tang Kok Mun, 2013

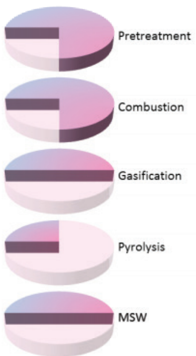
Cambodia



Gasification is the major biomass conversion technology in Cambodia for rural electrification or use in SMEs. The technology is imported from India. Rice husk or corn cob, wood chip, coconut shell and bagasse are used as feedstocks. Pretreatment technology in Cambodia is not yet advanced. For example, biomass briquettes are simply produced and locally used.

Biomass briquettes in Cambodia are locally produced by using traditional knowledge and technology. A biomass gasifier and a generator driven by three diesel engines were installed by Batt Daeng Electricity Company.

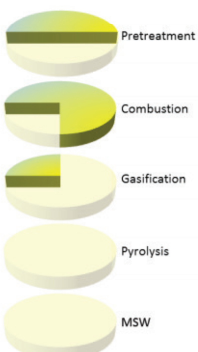
Indonesia



Various kinds of biomass are used as boiler fuels for power and CHP applications in Indonesia. Currently, approximately 1,700 MWe of biomass-fired power plants are installed. Gasification for power generation are also being studied and demonstrated.

Palm kernel shells approximately 59,400 tons/yr from palm oil factory in Dumai (Riau province) were used for heating bleached palm oil and generating electricity of 3 MW.

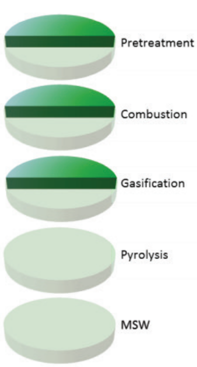
Laos



Energy use in the country is mainly in the form of traditional fuels, i.e. the use of biomass such as wood and charcoal for cooking and heating in rural areas. Tradition fuel consumption represents about 69% of total energy consumption. Currently, Laos has only used combustion technology to produce electricity from bagasse. Moreover, there are a few ongoing biomass combustion projects and more are planned.

Bagasse power plant of Hoang Anh Sugar Mill was installed in Phouvong, district Attapeu Province with the capacity of 30 MW.

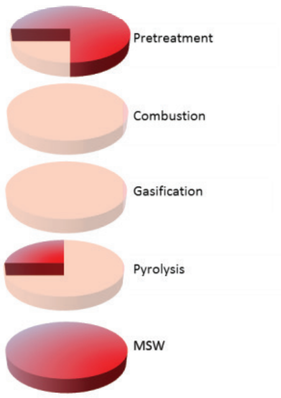
Myanmar



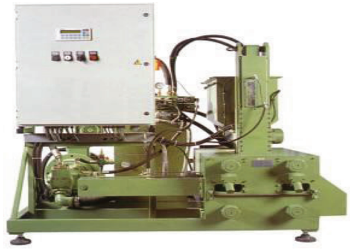
More than 1,000 gasifiers, either self-developed or imported, have been installed in Myanmar remote areas and industrial sector for heating and power production. Biomass combustion is also applied in SMEs for power generation, especially rice mills. Research on combustion for power generation is also being conducted.

A rice husk gasifier was locally used to power a water pump in Meik-hti-lar Township, Mandalay.

Singapore

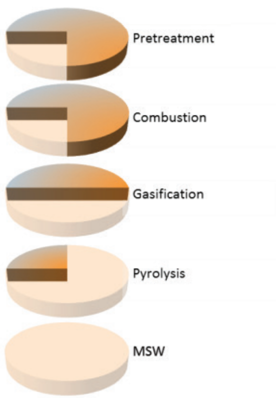


Singapore is an energy importing country. The utilization of biomass for heat and power is not yet in practical but in R & D stage. Currently, all MSW and sewage sludge are incinerated due to limited area for landfill. However, Singapore is a technology provider for biomass pretreatment such as briquetting machines.



Briquetting of biomass uses hydraulic press with a capacity of 3 tons/hr in Singapore. The raw materials for this process are wood ashes as well as saw dust from jute fiber, oil palm wastes, shredded paper hay and straw.

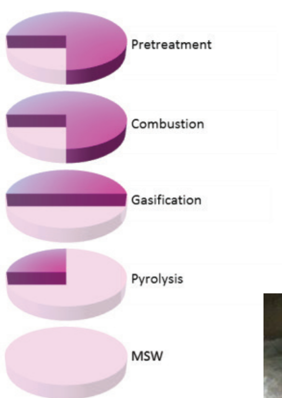
Philippines



Biomass is used as a fuel mainly for CHP application. There are a number of biomass power plants in operation and many more in the future plan. At present, steam and power generation consumes most of the biomass in the industrial sector. User of biomass fired-boiler systems are mainly plants with large steam demands such as those for sugar processing, logging or wood products and paper processing. Small-scale gasifiers developed locally are widely used for heat application. Pyrolysis is still under demonstration stage in the country.

San Carlos BioPower project is an ongoing project and will be in operation in December 2014. The plant is 18 MW of capacity and is installed at San Carlos City, Negros Occidental.

Vietnam



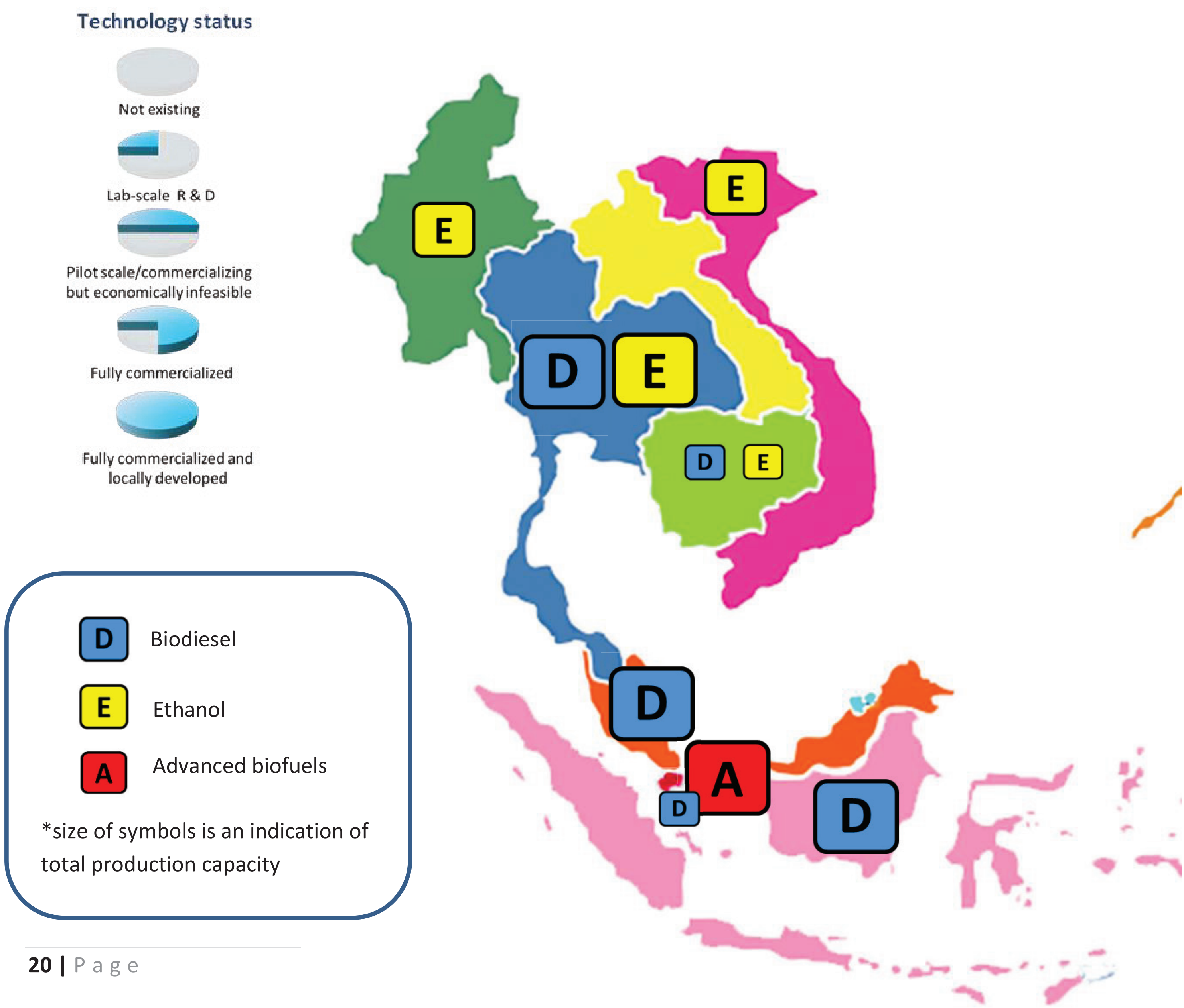
Various biomass feedstocks such as rice, coffee, coconut and cashew nut are feedstocks in boiler for heat application in industry, while rice husk is the main fuel for power plants. CHP applications are common for sugar and paper industry. Burning biomass for energy co-generation uses bagasse from sugar mills as a fuel and the majority of energy produced is used to crush sugarcane and refine sugar. Boilers are both developed locally and imported. Pelletization of rice husk in Vietnam in a larger scale has already utilized in small and medium industrial boilers. Gasification for CHP is under demonstration stage, while gasification for heat is already adopted in industry. R&D on gasification is continuously conducted.

Briquettes and pellets were made from rice husk with a capacity of 4-6 tons/hr in Tien Giang and Ho Chi Minh City. These products are already utilized for supplying to small and medium industrial boilers and exporting to South Korea, Philippines, and EU.

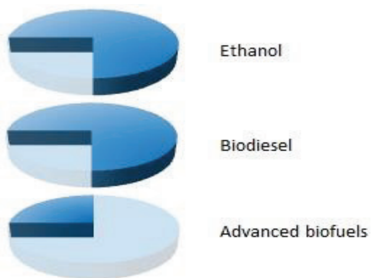
Bioenergy Technology Status: Liquid Biofuel Production Technology

The liquid biofuel production in ASEAN consists of two distinct sectors, ethanol and biodiesel. In ASEAN, Indonesia, Malaysia, Philippines and Thailand have accelerated their attempts to develop the liquid biofuel industry. Singapore is aiming to become the hub of biodiesel refinery in the region. In Cambodia, Laos, Myanmar, and Vietnam, the biofuel projects are still in the small-scale plants, or in the demonstration phase. There is no official activity regarding biofuel utilization in Brunei because the country does not possess its own feedstock for biofuel production.

Liquid biofuel in ASEAN is produced from a variety of first generation feedstocks using conventional conversion technology. Ethanol production is mainly produced in Thailand while Indonesia and Malaysia are major producers of biodiesel. Singapore has high production capacity of biofuel using advanced technology, i.e. biohydrogenated diesel or BHD.



Thailand



www.biodiesel.eng.psu.ac.th

http://global.kmutt.ac.th/2012/07/14/the-launch-of-ethanol-buses-ed-95

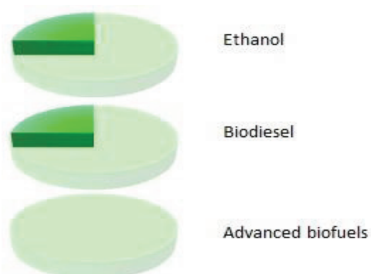
Thailand is a pioneer among ASEAN in establishing policies to promote liquid biofuel production and use in an attempt to reduce its dependency on oil imports and to capitalize on its abundant supplies of feedstock from its agricultural sector. Thailand started a Royal R&D project on ethanol and biodiesel production from sugarcane and palm oil in 1985. Although ethanol and biodiesel had been promoted at the same time in Thailand, ethanol could penetrate into the market successfully than biodiesel because of its feedstock supply readiness.

Ethanol production in Thailand is produced from sugar molasses and cassava, while B100 biodiesel from palm oil products only. Ethanol production in Thailand is surplus and, thus, can be exported to other countries while B100 production is totally absorbed by domestic consumption. As a result, Thailand does not export or import biodiesel.

The current commercialized liquid biofuels in Thailand are ethanol and biodiesel. Majority of ethanol production is produced by the fermentation of molasses, a by-product of sugar industry, while biodiesel is obtained from the transesterification of palm oil. R&D projects in Thailand have been expanded to the second generation biofuels, with pilot projects on producing ethanol from agricultural by-products (bagasse) and biodiesel from non-food crops (Jatropha) or residues (waste cooking oil). Biodiesel production from algae is also under development but still at the early stage.

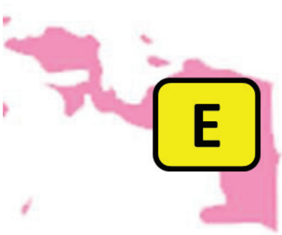
Other advanced biofuel, such as BHD, FT-diesel as well as bio-propanol or bio-butanol, remain in the experimental stage. The advanced biofuel projects are expected to take several years turning into a viable commercial production.

Cambodia

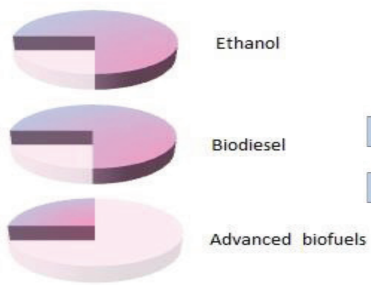


MH Bio-Energy Group's bio-ethanol plant in Kandal province
http://www.phnompenhpost.com/national/cambodias-first-bio-ethanol-plant-launch-october

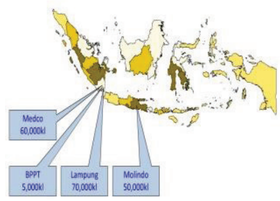
Bioethanol from cassava and biodiesel from Jatropha are potential sources of new energy in Cambodia. However, the biofuel projects are still in the early stages driven by private sector from Korea, China, Thailand, Malaysia and Singapore. For the biodiesel production, Maharishi Vedic University installed a biodiesel refinery of a capacity producing 200 liters per day. The raw materials for the refinery are waste vegetable oil from hotels, restaurants, and bars with the plan to use Jatropha in the near future. MH Bio-Energy Group of South Korean planted in Cambodia could produce ethanol from cassava almost 10 million gallons per year in 2009. However, the plant has been shut down in May 2010 because of rising crop price.



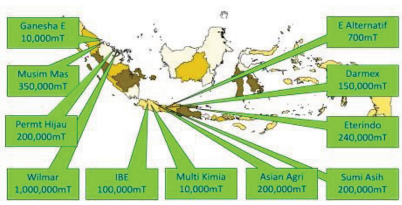
Indonesia



BIOETHANOL INDUSTRY CAPACITIES



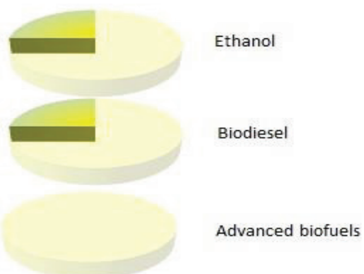
BIODIESEL INDUSTRY CAPACITIES



http://www.docstoc.com/docs/44786632/The-Indonesian-biofuel-industry-Sustainability-today-tomorrow

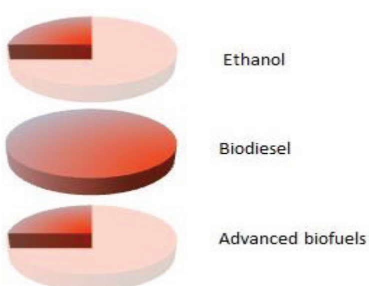
Indonesia is the world's leading producer of palm oil and the second largest exporter (after Malaysia). Biodiesel is produced from crude palm and Jatropha oil while biodiesel from Jatropha is still under development. Blending product of conventional automotive diesel oil and biodiesel in Indonesia is called BioSolar. Large-scale ethanol production and distribution has not yet established in Indonesia. To date, most ethanol has been produced from molasses, which is a by-product of sugar refining and therefore a relatively cheap feedstock. However, this resource is limited and future production especially for energy purposes will need to utilize sugarcane or cassava, which cost tends to increase. As of June 2008, there were three commercial-scale fuel ethanol facilities in Indonesia using sugar molasses or cassava as feedstocks.

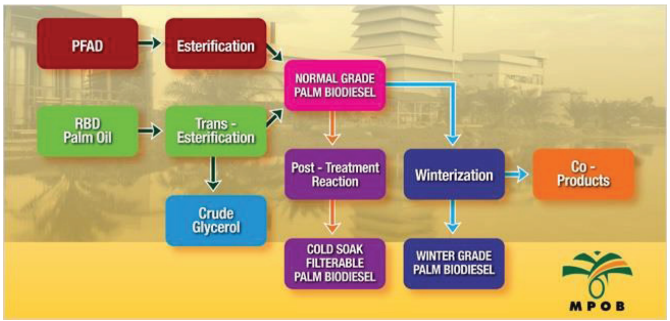
Laos



In Laos, there is no full-fledged commercial bioethanol and biodiesel manufacturing plants yet. Most of the biofuel projects are still in the planning and demonstration phase. In Laos, cassava, maize, and sugarcane (molasses) are the major feedstocks for bioethanol whereas oil from Jatropha, coconut, palm, and castor are the main feedstocks for biodiesel.

Malaysia

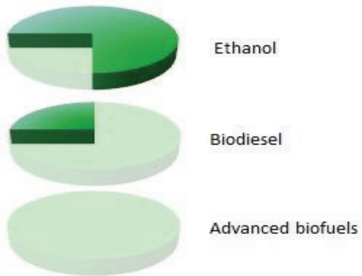




Palm biodiesel (normal winter grade)
http://oiltek.com.my/products-nfa-pbp.php

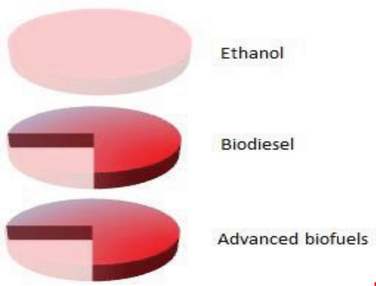
Malaysia mainly produces biodiesel from palm oil. Bioethanol production capacity in Malaysia is much lower than biodiesel production because oil palm can be grown more easily in Malaysia. However, agricultural wastes such as palm empty fruit bunch, coconut shell, and rubber chips are promising raw materials for ethanol production. In 2013, Malaysia has initiated crude palm oil refining and palm oil-to-Oleochemical industry; therefore, the palm oil processing is the main industry of Malaysia. Malaysian Palm Oil Board (MPOB) has developed biodiesel production technology from palm oil and transfer knowledge to many countries. The transesterification in the presence of NaOH as the catalyst is employed in biodiesel production. Moreover, the country has conducted research on the biodiesel production from algae and a large pilot plant has been installed in Kuala Lumpur using CO_2 from flue gases as a food source for algae.

Myanmar



Biomass for ethanol production in Myanmar is sugarcane, cassava, maize and sweet sorghum. The Myanmar Economic Corporation (MEC) constructed a large ethanol plant which capacity reaches 68 million liters/year. Moreover, Great Wall Company can also produce anhydrous ethanol that obtained from fermentation of sugarcane with an approximate capacity of 14,000 liters per day. The ethanol production in Myanmar employs azeotropic technology and molecular sieve for distillation and purification, respectively. The country imports technology from Fritz Werner Company (Germany) to produce ethanol from molasses. The projects of biodiesel are still in the early stage.

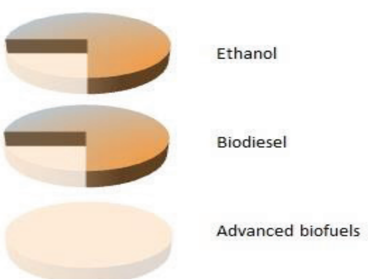
Singapore



Neste NExBTL-plant, Singapore
http://www.hlinsulation.com/news/?issue=4

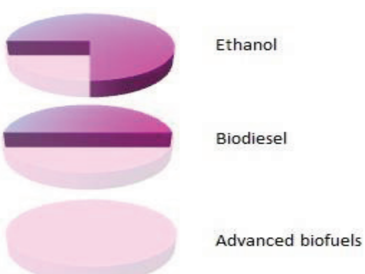
Singapore has limited biomass resources for energy production but aims to be the center of bioenergy development including biofuel production from palm oil that obtained from Malaysia and Indonesia. Biofuel Research Pte.Ltd., is one of small biodiesel plants producing biodiesel from cooking oil with a capacity of 1,500 tons/month. Moreover, Singapore is cooperated with Nexsol Company and has a plan to produce biodiesel 100,000 tons/year from palm oil in Jurong Island. The Neste Oil Company from Finland operates a BHD plant in Singapore to produce synthetic biodiesel and this is the largest alternative biodiesel plant in the world.

Philippines



Sugarcane and molasses are utilized as feedstocks for the ethanol production (through fermentation) in Philippines, while coconut oil is considered as the most abundant feedstock for biodiesel production (through transesterification). Success of biodiesel in Philippines is primarily due to its abundance in feedstocks as being one of the world's largest coconut oil producer. In 2012, ethanol industry had 4 active players with a combined capacity of 133 million litres.

Vietnam



Cassava and catfish oil are feedstocks for the production of ethanol and biodiesel in Vietnam, respectively. Presently, the total capacity of ethanol production is 180,000 m^3/year from 8 registered companies while the status of biodiesel production is still in pilot phase. Currently, R&D activities have been expanded to the second generation biofuels on producing ethanol from agricultural by-products (seeds of cotton tree, tiboca tree) and biodiesel from non-food crops (Jatropha, tree, seeds of rubber trees) or residuals (waste cooking oil).

Bioenergy Technology Status: Biogas Technology

Biogas technology can be divided into biogas conversion and biogas cleaning processes. Biogas technology in different countries is different in types of resources and level of technology.

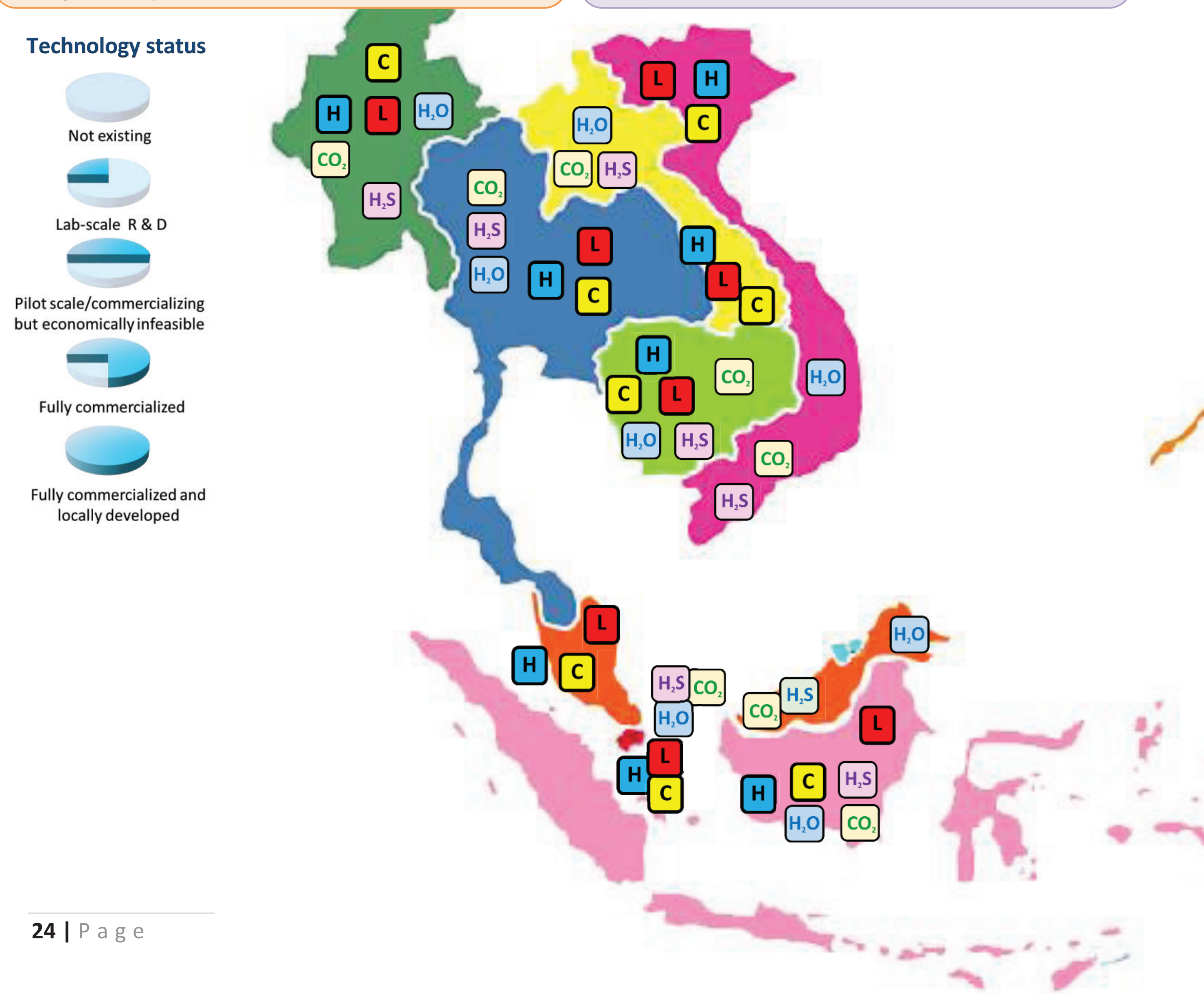
Biogas conversion processes are categorized into 3 levels in terms of performance of technology, i.e. organic loading rate (OLR) in the unit of kg COD/m^3 reactor/day[a].

- High Rate: OLR > 4
  (AFF/AF, UASB, IC, EGSB and hybrid)
- Conventional Rate: OLR = 2-4
  (CSTR and plug flow channel/ABR)
- Low Rate: OLR < 2
  (ACL and MCL)

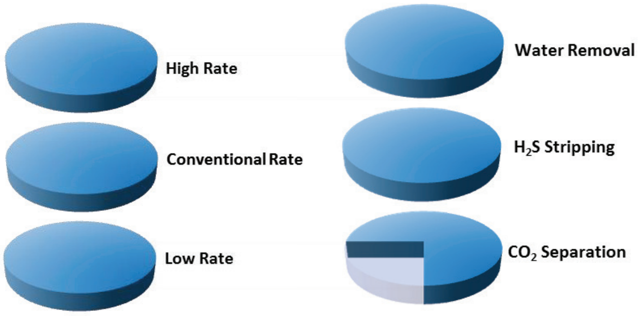
[a] Operations manual on the design, production, quality control and utilization of biogas for industry, 2013

Biogas cleaning is divided into 3 processes

- Water removal
  (Chiller and absorber)
- H_2S stripping
  (Absorption-dry process, absorption base chemical, air injection and bioscrubber)
- CO_2 separation
  (Water scrubber, pressure swing adsorption – (PSA), chemical adsorption and membrane separation)

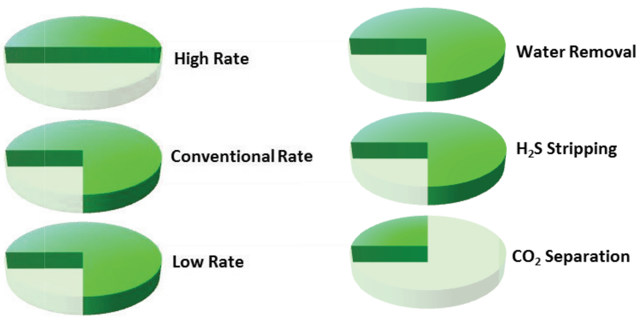


Thailand



Biogas conversion processes in Thailand is in the mature stage, i.e. they are fully commercialized, locally (country-self) developed and also exported. Successful cases are biogas in animal farms as well as agro and food industries. Biogas cleaning processes, i.e. water removal and H_2S stripping technology, are also in the mature stage and support the aforementioned biogas production. CO_2 separation technology is in the pilot and demonstration stage due to its economic unviability to generate a higher quality of biogas for other purposes.

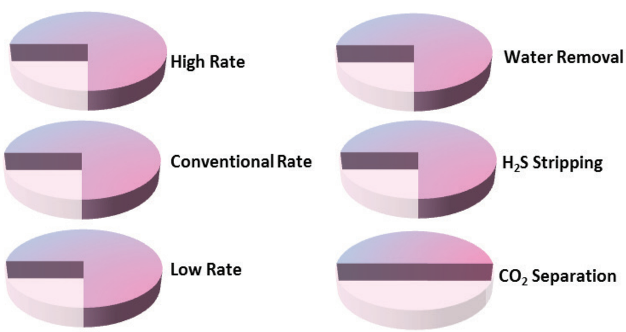
Cambodia



National Biodigester Program. http://www.nbp.org.kh. 2011

Conventional rate and low rate technology to produce biogas from animal farm and food waste in Cambodia are in the commercial scale, while high rate technology is in the development stage, i.e. lab scale with local knowledge and technology transferred from other countries. Water Removal and H_2S stripping technology are commercially available, while CO_2 separation technology is in the lab-scale stage.

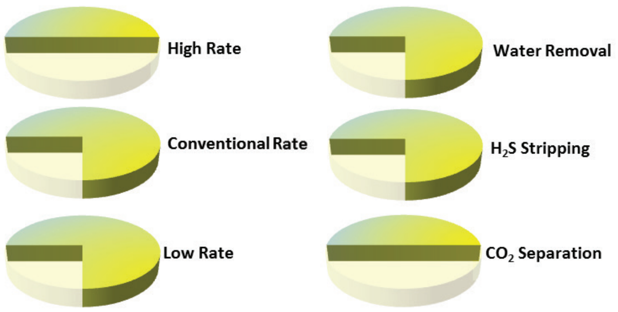
Indonesia

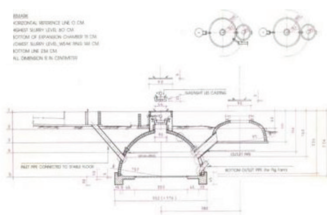


http://espaciohogar.com/como-conseguir-biogas/biogas-indonesia, 2014
Indonesia Domestic Biogas Programm

Biogas technology in Indonesia is in the fully commercialized stage with locally developed technology. Main raw materials for the biogas plant are oil palm waste, wastewater and swine manure. Biogas cleaning technology, i.e., water removal and H_2S stripping, are also in the commercial stage, while CO_2 separation technology is in the pilot or demonstration stage.

Laos

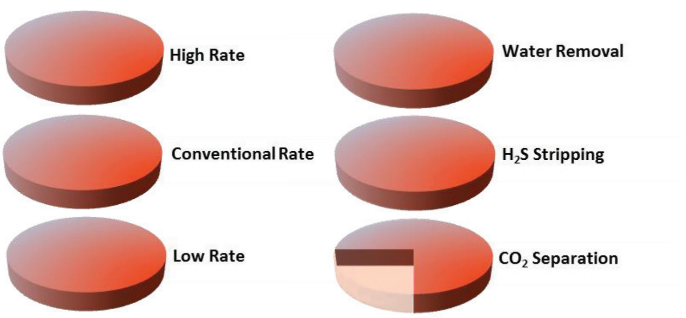




Nanthavong, K, Final Report Biogas plants in Lao PDR
http://lao-ire.org/index.php?option=com_content&view=article&id=26&Itemid=25, 2005

In Laos, biogas conversion with conventional and low rate technology is in the fully commercialized stage with locally developed. The high rate technology is in the demonstration stage. Existing biogas plants utilize starch wastewater, animal farm and food waste. Biogas cleaning technology, i.e. water removal and H_2S stripping, are in the commercially available stage, whereas CO_2 separation technology is in the pilot and demonstration stage.

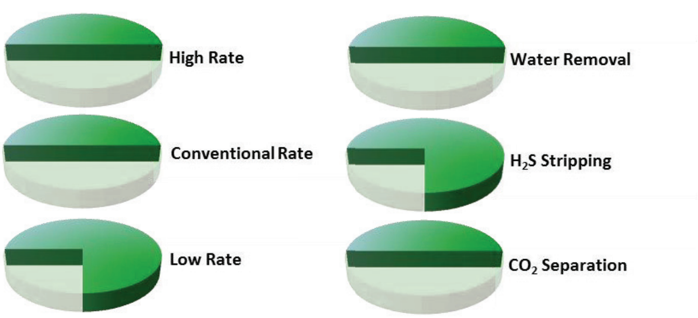
Malaysia



http://cncamda.en.alibaba.com/product/1031865121-219100801/Biogas_Power_Plant_in_Malaysia.html, 2013

Biogas technology in Malaysia is fully commercialized, locally (country-self) developed and exported. The main raw material for the biogas plants is oil palm wastewater. The technology, such UASB, CSTR, Plug flow channel, ABR, MCL and ACL is commercially available. Biogas cleaning technology, i.e. water removal and H_2S stripping, are in the mature stage to support the aforementioned biogas plants. CO_2 separation technology, on the other hand, is in the pilot and demonstration stage since it is still not economically feasible to generate a high quality of biogas for other purposes.

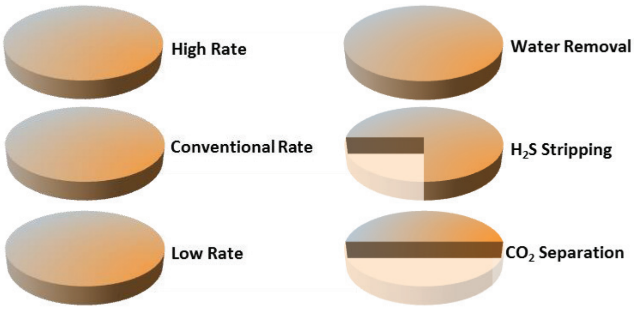
Myanmar



http://en.ynbiogas.com/zqgc_detail/newsId=29c8fd9f-1685-4f6e-bede-758659a65f18&comp_stats=comp-FrontNews_list01-1302083688213.html, 2003

Myanmar utilizes biogas technology in animal farms and food wastes. The technology is in the developing stage of pilot and demonstration scale. Fixed-dome digester is the local choice. Biogas cleaning technology is mostly in the pilot and demonstration stage. Most of biogas in Myanmar is utilized by burning directly in household.

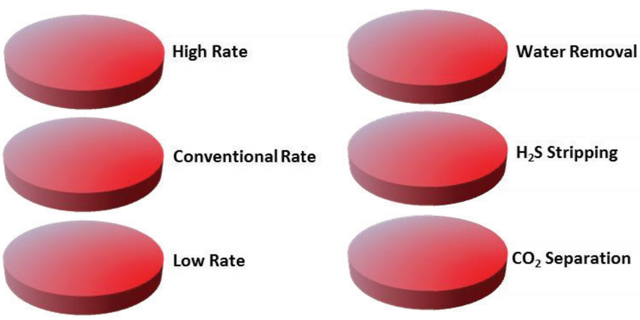
Philippines



http://www.rechargenews.com/news/biofuels/article1285997.ece, 2012,
http://www.habmigern2003.info/biogas/Baron-digester/Baron-digester.html, 2013

Biogas technology in Philippines is fully commercialized, locally (country-self) developed and exported. Biogas is popular in animal farms as well as agro and food industries to generate renewable energy. Water removal technology is in the mature stage, while H_2S stripping and CO_2 separation technology are in the developing stage.

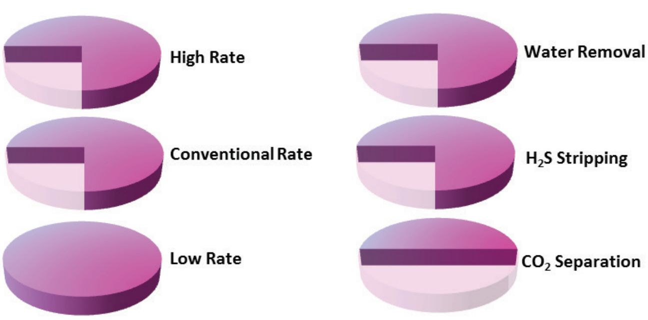
Singapore



http://www.rechargenews.com/news/biofuels/article1286595.ece, 2012

Singapore is positioning as a technology expertise in both biogas conversion and biogas cleaning technology. Even though, Singapore has limited land resources.

Vietnam

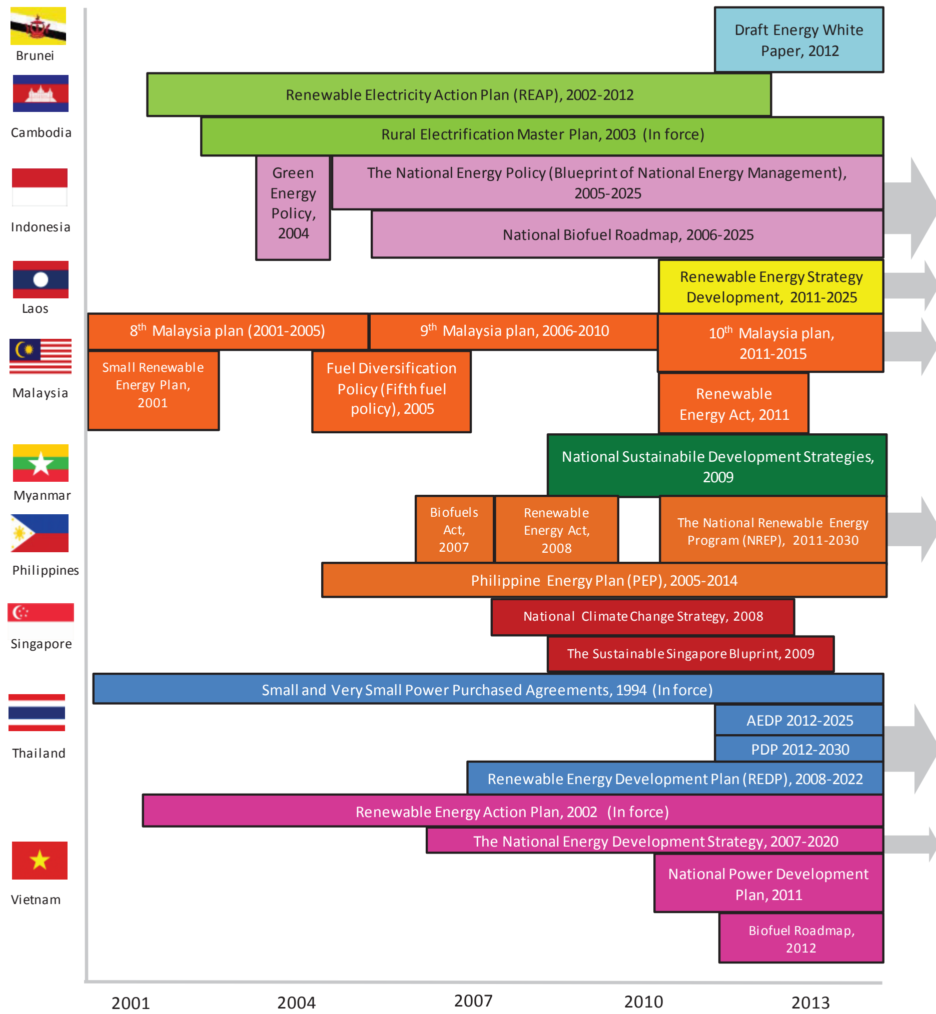


http://talkvietnam.com/2012/10/vietnam-wins-2012-humanitarian-award/#.UvZIbbRbiWg, 2012

Most biogas technology in Vietnam is fully commercialized and locally (country-self) developed. Biogas is popular in animal farms as well as agro and food industries to generate renewable energy. Water removal technology is in the mature stage, while H_2S stripping technology and CO_2 separation technology are in the developing stage.

6. Bioenergy Policy and Target

In ASEAN countries, energy demand is expected to increase steadily in coming years. Increasing the renewable energy share in total energy consumption is aimed in order to increase energy supply security and reduce greenhouse gas emission. Most ASEAN countries have set their national renewable energy target and developed the policy tools to promote the renewable energy production and utilization. Both short-term and long-term policies/plans have been endorsed. With the high potential of bioenergy in many ASEAN countries, bioenergy has major roles and significant contributions in renewable energy share.



**Based on preliminary public data on each country*

Country	Biomass for heat & power targets	Biofuel mandates/targets
Brunei	No biomass target	No biofuel target
Cambodia	Biomass gasification (87 kW)	No biofuel target
Indonesia	810 MW by 2025	Biofuel consumption in transport sector 5% by 2025
Laos	58 MW Biomass, 51 MW Biogas and 36 MW Waste by 2025	150 million liters ethanol and 300 million liters biodiesel by 2025
Malaysia	1340 MW Biomass, 410 MW Biogas and 390 MW MSW by 2020	B5/Biofuel to replace 5% of diesel in road transport
Myanmar	To achieve a collective target of 15-18% of renewable energy in the total power installed by 2020	Biofuel to replace 8% of conventional oil in road transport
Philippines	276.7 MW Biomass by 2030	Enforce E10 to all gasoline by 2012, B5 to all diesel by 2015, B10 And E20 by 2025, and B20 and E85 by 2025
Singapore	No biomass target	No biofuel target
Thailand	3,630 MW Biomass, 600 MW Biogas and 160 MW MSW by 2020	B3 & E10/Biofuel to replace 0f 44% conventional oil
Vietnam	400 MW Biomass by 2030	550 million liters of biofuel production by 2020

7. Success Stories of Bioenergy in ASEAN: Supporting Organization for Promotion and Development of Palm Oil Industry in Malaysia

The Malaysian Palm Oil Board (MPOB)

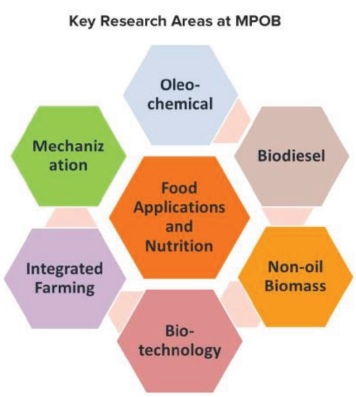
Source: http://www.mpob.gov

Malaysia is currently the world's largest exporter of palm oil although it is the second largest producer of oil after Indonesia. Malaysia's palm oil industry is regulated by ***the Malaysian Palm Oil Board (MPOB),*** which is the governmental agency to serve the oil palm industry in the country.

MPOB

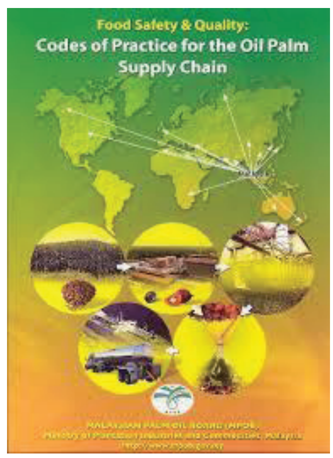
The Malaysian Palm Oil Board (MPOB) was established in May, 2000 with the key objective of promoting, developing and advancing the Malaysian palm oil industry. As the steward of the nation's palm oil industry, MPOB is responsible for providing the scientific and technological support to the Malaysian palm oil industry. MPOB's commitment to the industry is not limited to research and development (R & D), but also encompass dissemination of information, technology transfer, commercialization, registration, licensing and enforcement activities.

MPOB/UKM in Bangi



MPOB derives its funding from the collection of cess from the industry for every tonne of palm oil and palm kernel oil produced. In addition, MPOB receives a budget allocation from the government for developing research projects under the intensification of Research in Priority Areas Programme. MPOB also maintains linkages with international institutions relating to oils and fats as well as R&D institutes that help MPOB keep abreast with the latest developments in the sector.

Palm oil industry is one of Malaysia's most Important economic lifelines, so MPOB aims to ensure the sustainability of the industry. To come up with this aim, MPOB has developed codes of practice that cover the entire palm oil supply chain incorporating elements of sustainability and food safety. This is to ensure the production of sustainable, environmentally friendly and food-safe palm oil for consumers worldwide.



Success Stories of Bioenergy in ASEAN: Promotion of Biogas Technology in Thailand

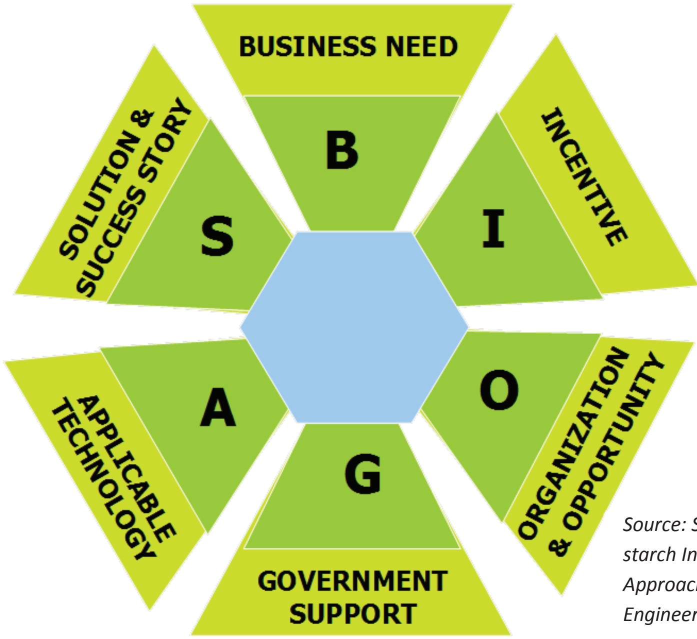
Thailand began to utilize biogas from anaerobic wastewater treatment system since 1960s. Before 1988, small size biogas plants were built for the purpose of solving sanitation problem in the community. Due to the oil price hike in 1975-1980, the Royal Thai Government initiated the promotion of biogas plant to produce renewable energy to treat wastes from animal farms; however, most systems at that time did not perform as expected due to the lack of construction experience as well as knowledge of system control and management. In 1988, the Department of Agriculture Extension (DoAE) under the Ministry of Agriculture and Cooperatives, the Biogas Advisory Unit of Chiangmai University (BAU), and the Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH on behalf of the German Government collaborated to initiate the Thai-German Biogas project. The project encouraged the use of biogas plant in small-size livestock farms by building biogas systems less than 50 m^3 in volume with the fixed-dome digestion technology. At the end of 1992, more than 150 biogas plants were built as a result of this project. After the project was concluded in 1995, DoAE and BAU requested the subsidization from the National Energy Policy Office (NEPO) to extend their project comprehensive to include the livestock farm sector. This was the systematic promotion that initiated the current development of biogas technology in Thailand.

A) Fixed-dome system
Source: Department of Agricultural Extension

B) Biogas system in swine farm **C) Biogas plant in tapioca starch factory**
Source: The Excellent Center of Waste Utilization and Management (EcoWaste), 2010

In early 2002, the government initiated a proactive approach to enhance the investment in the construction of the biogas production. The Energy Policy and Planning Office (EPPO or previously known as NEPO) under the Ministry of Energy provided a 30% subsidization for the design and construction cost. In all, 9 cassava/starch factories were subsidized. In addition, since 2002, the Ministry of Science and Technology (MOST) has supported the promotion of biogas technology through the soft loan scheme. The soft loan program provides up to 75% of investment but does not exceed 30 million Baht (US$ 0.9 million). In addition to the financial support in investment, other measures include tax incentive, promotion for Energy Service Company (ESCO), Small Power Purchase Tariff and environmental law enforcement.

Biogas – Key to Success



Source: Suwanasri, K. and Songkasiri, W. "Biogas from cassava starch Industries in Thailand: Technology and Policy Approaches." Policy Report, National Center for Genetic Engineering and Biotechnology, 2012

According to the achievement of biogas energy implementation in cassava/starch industries, the key successful factors are summarized in the "BIOGAS Theory".

B: Business Need = Business need is a primary factor to promote biogas production. The understanding of the industrial needs helps the government sector formulate the measures that meet the need. The incentives to reduce the limitation of capital investment lead to the increase of research and development in biogas technology which is accepted and assured by the investors.

I: Incentive = Good incentives, especially grants, soft loans and tax privileges, encourage the decision making process. However, these measures should be monitored and adjusted periodically in order to attract the investment and to increase the number of biogas production.

O: Organization = Cooperation among public and private organizations helps in the continuous development of the biogas production technology. This cooperation facilitates the initiation of R&D activities, tax incentive from the Board of Investment (BOI) and other measures.

O: Opportunity = The energy crisis provided the opportunity for investors to find alternative sources of energy.

G: Government Support = The policy setting helps direct the goal of the nation and force the coordination among organizations in the area of R&D and incentive privileges.

A: Applicable Technology = Because of the technology readiness, the industrial factories are assured and can make an investment decision with confidence.

S: Solution and Successful Study = The success of the cassava/starch factories is a good example to encourage more investment in biogas technology and reaffirm adaptation of similar technology in other industries.

8. Working Groups

Advisory committees

Prof.Dr.Naksitte Coovattanachai	STI
Assoc.Prof.Dr.Bundit Fungtammasan	KMUTT
Dr.Pichet Durongkaveroj	STI
Assoc.Prof.Dr.Somchai Chatratana	STI
Assoc.Prof.Dr.Sirinthornthep Towprayoon	JGSEE

Leading Groups

Assoc.Prof.Dr.Suneerat Fukuda	JGSEE
Dr.Boonrod Sajjakulnukij	JGSEE
Dr.Surachai Sathitkunarat	STI
Dr.Kanchana Wanichkorn	STI
Dr.Suchat Udomsopagit	STI
Dr.Jakapong Pongthanaisawan	STI
Ms.Chalisa Chaipattanapruck	STI
Dr.Srichattra Chaivongvilan	STI
Dr.Yatika Somrang	MTEC
Ms.Supatchaya Konsomboon	JGSEE

Group 1: Thermochemical Conversion Technology

Assoc.Prof.Dr.Suneerat Fukuda	JGSEE
Asst.Prof.Dr.Nakorn Worasuwannarak	JGSEE
Ms.Supatchaya Konsomboon	JGSEE
Mr.Supachai Jetsadajerm	JGSEE

Group 2: Liquid Biofuel Technology

Assoc.Prof.Dr.Navadol Laosiripojana	JGSEE
Dr.Pornlada Daorattanachai	JGSEE
Ms.Jiraporn Payormhorm	JGSEE

Group 3: Biomass Potential

Assoc.Prof.Dr.Savitri Garivait	JGSEE
Dr.Penwadee Chewapongpan	JGSEE
Dr.Agapol Junpen	JGSEE

Group 4: Yield Improvement Technology

Ms.Kulwarang Suwanasri	BIOTEC
Ms.Nataporn Chanvarasuth	BIOTEC
Ms.Watcharin Meerod	BIOTEC
Ms.Duangkamol Prasitnaraphan	BIOTEC

Group 5: Biogas Technology

Assoc.Prof.Dr.Pawinee Chaiprasert	KMUTT
Dr.Warinthorn Songkasiri	KMUTT
Ms.Sivalee Tarkulvichien	KMUTT

Renewable energy also creates more jobs than other sources of energy – most of these will be created in the struggling manufacturing sector, which will be pioneer the new energy future by investment that allows manufacturers to retool and adopt new technologies and methods.

By Jay Inslee

Photo by: Warid Siriphittayaroj, STI

For more information please contact:
The working group for Bioenergy Science Technology and Innovation Policy for Thailand in the context of AEC

National Science Technology and Innovation Policy Office
319 Chamchuri Square BD., 14, Phayathai Rd., Patumwan, Bangkok, 10330
Telephone: 02-160-5432 Fax: 02-160-5438

The Joint Graduate School of Energy and Environment
King Mongkut's University of Technology Thonburi, 126 Prachauthit Rd, Bangmod, Tungkru, Bangkok, Thailand 10140
Tel : 66-2-4708309 to 10 #4147 Fax : 66-2-8726978, Email : aseanbiomass@gmail.com