



**ASEAN STRATEGY ON SUSTAINABLE BIOMASS ENERGY
FOR AGRICULTURE COMMUNITIES AND RURAL DEVELOPMENT
IN 2020-2030**

I. OVERVIEW

1. Biomass energy definition

Based on FAO's Unified Bioenergy Terminology (FAO, 2004), bio-energy can be defined as energy obtained from biological and renewable sources (biomass); bio-energy may be derived in the form of heat or transformed into electricity for distribution. Biomass is organic material that comes from plants and animals, and it is a renewable source of energy (IEA). Biomass also can be transformed into biofuels, which are portable feedstock for use in the generation of bio-energy. Biofuels are defined as feedstock intended for the production of bio-energy, produced directly or indirectly from biomass. Biofuels can be in solid form (fuelwood, charcoal, wood pellets, briquettes etc.) or liquid (bioethanol, biodiesel).

With the emerging development on bio-energy today using more modern technology, biomass energy can be divided into traditional biomass and modern bio-energy. Traditional biomass is the main source of energy used in developing countries primarily for cooking and space heating at the household level, mostly using three-stone stoves, or in some areas improved cooking stoves. This source of energy is in the form of fuelwood and charcoal, crop residues and animal dung and is often collected by women and children on a daily basis. In some areas traditional biomass is also traded within villages and among villages or with nearer townships. Another characteristic of traditional biomass is using traditional technology with low efficiency due to poor design, uncontrolled and open burning, which have important health implications. Modern bio-energy, is used mostly for the generation of electricity, heat from agricultural organic residues at community level or liquid biofuels for transportation such as ethanol and biodiesel are examples of the emerging energy alternatives. In the context of rural communities, this strategy will focus on the modern biomass energy (including biogas) source use in rural area rather than the biofuel mostly used at industrial level.

2. Introduction

In ensuring long-term food security in the ASEAN region, reduction of cost of agricultural inputs (i.e. fertilizers, energy for farm use, etc.) combined with mitigating impacts of climate change from agriculture sector have been recognized as priority intervention areas. The biomass energy development has an important role in food and energy security in the ASEAN region. Its potential benefits as well as risks are acknowledged, and it will be supplemented in a regional energy need, as well as it could achieve the global targets for CO₂ emissions. Biomass energy systems are sustainably supplied and also can be low-carbon, or carbon neutral. The CO₂ released from biomass combustion is drawn from agricultural and forests, which are continually absorbing and releasing carbon over time. The CO₂ released from burning is reabsorbed from the atmosphere by new forest or plant growth. Therefore, the process is actually replicating natural cycle of CO₂. In comparison, fossil fuel extracts carbon source from underground. Thus, the combustion process adds CO₂ to the atmosphere.

In ASEAN countries rural area, the rate of access to electricity still low in majority of countries. The electricity price had also tendency to raise, so this is the constraint to rural households. Over the past years, biomass energy is extensively used in ASEAN countries, particularly in Indonesia, Malaysia, Philippines, Thailand and Viet Nam. However, technologies for biomass energy still need to be improved and shared with other member states to make the best of available and appropriate

technologies. It is also recognized that dissemination of information and transfer of technology are still limited, including access to data and research carried out by academic and research institutions.

Furthermore, the collection and utilization of wood for fuel in rural areas exacerbates the problem of deforestation and global warming. On the other hand, wood and other forestry products are properly valued by the communities as an important income resource and likely to be protected.

Given the fact that the use of biomass energy, particularly from agricultural wastes and residues, is perceived useful not only in providing low-cost energy sources and reducing costs of agricultural inputs but also in minimizing the negative impacts of agriculture production systems on the environment, ASEAN needs to review current status of use and consumption of bioenergy, conduct pilot activities, and promote use of models and practices, as well as appropriate technologies that significantly contribute to sustainable agriculture and rural development in the region.

3. Biomass energy potentials of agricultural sector in ASEAN region

According to the IAE report (2012), the biomass energy represents only 8% comparing to the total energy mix supply capacity. This low percentage seem low comparing to the potential sources of agricultural residue in the region because most of ASEAN member countries is strong agricultural countries except Singapore.

The presents biomass sources and their energy potential in the Southeast Asian countries show that the total quantity of the residues from the agriculture and forest sector is estimated at over 500 million tons per year. Additionally, the total biomass energy potential in the countries has over 8000 million gigajoules (cited by Maw Maw Tun & al., 2019). The biomass sources and biomass energy utilization in each of the Southeast Asian countries are briefly described as follows:

Brunei Darussalam

With plentiful oil and gas resources, Brunei Darussalam relies majorly on fossil fuel not only for its national energy security and booming economy. For this reason, it had minimal interest in the use of renewable energies, but due to mounting worldwide interest in this and in order to diversify its energy sources and bolster its energy security, it set out a goal of adopting 10% electricity from renewable energies in 2035. Biomass sources in the country account for coconut shell, coconut fiber, corn fiber, rice husk, and saw dust, with approximately 8.773 kilo GJ of the annual biomass energy potential (cited by Maw Maw Tun & al., 2019).

Cambodia

Cambodia has 10,094,000 hectares of forest area, having 57% of the total area of the country. Therefore, wood and wood charcoal account for approximately 80% of the total energy consumption in Cambodia. Approximately 80% in urban and 94% in rural areas are used for cooking. The other major biomass sources come from agricultural residues including rice husk, rice straw, corn cob, cassava stalk, sugarcane residue and bagasse, groundnut shell and husk, and coconut shell and front. Currently, the total installed capacity from biomass is about 23 MW. Cambodia is planning to produce 73 MW of installed capacity from biomass by 2030 (cited by Maw Maw Tun & al., 2019).

Indonesia

Among the Southeast Asian countries, Indonesia has an abundant growing stock in forests due to its most extensive forest area, having 94,432,000 hectares. Besides, in

Indonesia economies, important biomass fuels are derived from agriculture residues and used in both traditional and modern applications. The major agriculture biomass sources are oil palm residues, sugarcane bagasse, rice husk and rice straw, and corn cob. It is estimated that Indonesia produces 146.7 million tons of biomass per year, equivalent to about 470 million gigajoules (GJ) per year. The total estimated capacity potential from biomass accounts for approximately 50,000 MW, with 312 MW of installed capacity (cited by Maw Maw Tun & al., 2019). The Indonesia government has issued Energy Law in 2007, having priority on the use of renewable energy and bioenergy. The target for biofuel will be 5% by 2025.

Lao PDR

With 68% of the forest cover, Lao PDR has an abundance of biomass resources from the forest sector. Since the majority of the population live in the rural areas, 80% of the households rely on fire wood and charcoal, having 68% of its primary energy supplies. In addition to the forest sector, the agriculture could provide a wealth of biomass resources due to its agriculture economy. The main agricultural residues were pig and cattle manure, rice residues and corn cob. The installed capacity of biomass energy is about 40 MW and is being planned to achieve 58 MW by 2025 (cited by Maw Maw Tun & al., 2019).

Malaysia

Malaysia has a huge forest area, with around 62% of the total land area. Agriculture also covers approximately 4,890,000 hectares of the whole country. Therefore, Malaysia has the numerous biomass resources such as oil palm residues, sugarcane residues, and coconut residues and the biogas in the palm oil mills. The palm oil industry alone contributes to about 8% or over RM 80 billion to the country's gross national income (GNI), making it by far the largest contributor within the agricultural sector, naturally generating the largest amount of biomass. Industry figures put this amount at 83 million dry tons in 2012 and this is likely to increase to 100 million dry tons by 2020. The total installed capacity potential from biomass is estimated at 29,000 MW, with 211 MW of the installed capacity (cited by Maw Maw Tun & al., 2019). Malaysia government has issued the National Renewable Energy Action plan and Policy in 2010. The target of RE use in the total energy mix consumption will be 11% by 2020 and 14% by 2030.

Myanmar

Myanmar is an agriculture country, covering 45% of the area with forest. Myanmar produces over 20 million tons of paddy annually. Therefore, the major biomass sources of the country are obtained largely from the forest and agriculture sector. The main agricultural residues were rice husk, rice straw, bagasse, corn cob and cassava stalk. Since 70% of the population resides in rural areas, they are mostly dependent on solid biomass fuels. Approximately 65% of the total energy consumption of the country comes from biomass sources. The total capacity potential from biomass and biogas is estimated at 6899 MW and 4741 MW, respectively. Out of this, the total installed capacity has reached 115 MW (cited by Maw Maw Tun & al., 2019).

Philippines

As the energy needs of the Philippines rely predominantly on the imports of fossil fuels, the government have looked at renewable energy for possible alternatives. Among the alternatives, biomass energy is crucial to the country and nearly 30% of the energy for the 100 million people living in the Philippines come from biomass and are mainly used for household cooking by the rural population. Additionally,

biomass industry is rapidly advancing, with 276.7 MW of a total installed capacity around the country. Biomass energy application accounts for around 15% of the primary energy use in the Philippines (cited by Maw Maw Tun & al., 2019). The Philippines government has issued the Biofuel law with target biofuel blends B20 and E20/85 by 2030. The biomass roadmap 2011-2030 also build with the biomass fit rate 6,63 Php/kwh. The Philippine government had also incentive price policy for bagasse electrisification.

Singapore

Being composed of 63 islands, Singapore has a total area of 722.5 square kilometers and approximately two hectares of forest area. In 2007, Singapore identified clean technology as a key driver of economic growth, allocating S\$700 million to fund research and development (R&D), innovation, and manpower development in the sector. Singapore has gained a reputation as a clean, green “garden city”. Utilization of horticultural and wood wastes processed by ecoWise could produce approximately 0.9 MW of electricity and 5.4 MW of heat for co-generation plant. The total biomass energy potential from biomass accounts for approximately 2.901 million GJ and the installed capacity from biomass sources accounts for 220 MW (cited by Maw Maw Tun & al., 2019).

Thailand

Thailand is an agricultural country, with a huge biomass energy potential for fulfilling additional energy requirements of the country. Biomass sources could cover up to 15% of the energy demand of the country. The main agricultural residues were bagasse, rice straw and husk, cassava residues and maize residues. The capacity potential from utilization of biomass and biogas is estimated at 7000 MW and 190 MW, respectively. Most of the biomass-fired industrial facilities are large-scale, centralized plants operating at economies of scale. The installed capacity from biomass and biogas accounts for 1610 MW and 46 MW, respectively, with 3.630 GW of installed capacity for a project target by 2021. Thailand’s board of investment (BOI) promotes the production of electricity or steam from renewable energy, such as biomass by an eight-year tax holiday, exemption of import duty on machinery, raw, or essential materials used in manufacturing export products (cited by Maw Maw Tun & al., 2019). Thailand has developed the Alternative Energy Development plan 2012-2021 (AEDP) with the target of 25% of renewable energy in the total energy consumption by 2021 including solar/wind, hydro power, bioenergy and biomass energy. For the bioenergy the production target in 2021 will be 9 million liter/day of bioethanol and 7, 2 million liter/day of biodiesel. The Thailand government had also incentive price policy for bagasse electrisification.

Viet Nam

Being an agricultural country, Viet Nam has an abundance of biomass energy sources, with over 300 GW of theoretical capacity potential. Biomass is mainly used in households (76%), and the rest (24%) is used in small industrial boilers and combined heat and power (CHP) plants in sugar mills. The major biomass sources include wood residues (estimated 7,5 million of ton in 2010), agricultural wastes such as rice husk, rice straw, bagasse, cane trash, maize trash, cassava stem, peanut shell, coffee husk, coconut shell (estimated 74,5 million of ton in 2010) and livestock manure (estimated 10 billion m³/year of biogas). Currently, at industry level, Vietnam has a total installation of 378 MW bagasse power, provide electricity for sugar factories and exported to the national grid. There is about 100MW of rice husk

and 70MW of woody biomass power are in the investment preparation stage. Vietnam has a potential for the development of 5 - 6GW biomass to electricity.

At farm level, Viet Nam is focusing the priority in the biogas from livestock manure in rural area. The Viet Nam Biogas Program (BP) 2003-2020, funded by The Netherlands and German Government, implemented by The Netherlands Development Organization SNV and MARD, achieved 180 000 biogas digesters at livestock farms for clean energy for cooking at household level. The BP has facilitated the construction of a total 285,000 biogas digesters in 58 provinces of Vietnam through other programs funded by Asian Development Bank (LIFSAP, LCAPS) and World Bank (QSEAP) The project has also great impact on the reducing GHG emission with around 1 million of ton CO₂ per year and in total, 3 millions of carbon credit had been sold in the international voluntary market. The main energy consumption potential in Viet Nam is aimed at municipal and industrial co-generation power plants. Viet Nam has set a target of having a combined capacity of 437,22 MWh of biomass power by 2020, which is raised to 473,53 MWh in 2030 (GIZ, 2017). Viet Nam Government has issued the Strategy for renewable energy to 2030, vision to 2045. This Strategy aim the use of RE (including wind, solar, biomass and biofuel) in the total energy 15-20% by 2030, 25-30% by 2045. In 2020, government just had policy on incentive price for biomass electricity from bargass and wood waste but still lower than in Thailand and Philippine.

In brief, the majority of ASEAN member countries have great potential for RE and especially biomass energy due to the rich agricultural waste resource. Some countries had the Strategy and policy for the RE and biofuel such as Thailand, Malaysia, Indonesia, Thailand and Viet Nam, but no country has yet strategy for modern biomass energy in rural area. Some countries had promoted the biogas project with successful results such as Thailand, Viet Nam, Malaysia, Indonesia and Lao, but there was a gap of comprehensive strategy for biomass energy. In the RE strategies, the priorities focus more on biofuel for industry sector and less emphasis on biomass energy from agricultural waste.

II. TRADITIONAL APPROACH AND SUSTAINABLE APPROACH TO BIOMASS ENERGY

Due to the climate change, fast growing populations, and economic growth in the region, the Southeast Asian countries have outlooked the renewable and alternative energies to reduce the greenhouse gas emissions and other environmental impacts from the energy sectors. Out of them, utilization of biomass energy derived from the enormous biomass sources from agriculture and forest residues has become a crucial factor of meeting the future energy needs. In addition to environmental and energy benefits, the economic benefits from utilization of biomass energy could also be gained largely from the production of value-added biomass fuel and agriculture nutrients, fewer imports of fossil fuels and agricultural nutrients from other foreign countries, reduced cost of waste disposal, and local job opportunities that could increase the household incomes of local people. In some ASEAN members, the access to electricity is high rate, but the demand increases faster than electricity supply, so the electricity price became expensive for rural community. So with the capacity to produce heat and electricity from biomass, the modern biomass energy use will support for rural communities less dependent on imported energy with raising prices and have access to more stable energy supply with reasonable prices.

For the efficient utilization of biomass sources, the countries will need to develop the way forward from traditional management depending on wood and charcoal to

sustainable one at community level. As the traditional management of biomass sources in most of the Southeast Asian countries, it is observed that firstly, the management process generally seems to go through harvesting and storage, then traditional consumption patterns follow animal feed, traditional consumption for cooking and heating, open burning and dumping, and traditional agriculture nutrients. However, if a sustainable approach is considered, the appropriated and innovative technology applied for the use of agricultural residues as energy, the aspects about policy and institutions, targets and goals, funding, stakeholder involvements, research and development, and public awareness and educational trainings will become crucial. Based on policy and goals, research-development would need to be promoted from the growing stages of biomass resources to market development.

III. PROBLEMS AND CHALLENGES

Scaling up sustainable, modern forms of bioenergy will be crucial both to address the energy access challenge, and to increase renewable energy use in both industry and transport. Policy and institutional aspects are crucial to development of biomass energy sector. However, specific goals and targets on the biomass energy development could not clearly seen in most of the countries yet. Meanwhile, as driven by the low economy growth of the countries, lack of sufficient funding for research and development and purchase of technologies is one of the biggest challenges in the development of biomass energy sector in most of the Southeast Asian countries such as Myanmar, Lao PDR, and Cambodia. Likewise, public and private sector involvement is still uncertain owing to the uncertain profits and risks of utilization of biomass energy, since utilization of biomass sources concerns with low energy contents, bulky volume of biomass sources, need for large storage systems and high transportation costs, data reliability issues, underdeveloped biomass industries, and lack of local skilled personnel. Additionally, some of the useful and important information about biomass sources are not widespread among the local people thorough education and training programs. Consequently, the cooperation of the local people in the development of the bioenergy sector remains weak. As one of the most crucial things, market development still seems slow because of lack of sufficient funding, research and development, and weakness of all stakeholder involvement.

One of the underlying causes is the misconception and lack of support on biomass energy production from public sector. It is sometimes assumed that biomass energy is a traditional commodity which cannot be sustained financially and socially. Some local governments believe that the initial cost of biomass energy production is relatively high, and the collection of wood/forestry by-products and agriculture wastes/residues is not cost-effective.

It is also recognized that there are several institutions in the region implementing research and development on biomass energy production and use on a commercial basis. However, such activities have not yet received adequate attention in the ASEAN region. Besides, fundamental practices of technology transfer do not sufficiently take into-account the local conditions under which the technology has to be operated and managed, the training required for its use, maintenance requirements and capacities, and backstopping arrangements.

Moreover, the Government policies and strategies related to the biomass energy development are not yet clearly defined. Only limited platforms exist for information exchange and experience sharing with regard to the use of appropriate biomass

energy technologies amongst implementing agencies organizations within the ASEAN region. Also, the lack of appropriate technologies is directly translated into a lack of confidence of national governments and rural communities to realize and optimize the potentials of biomass energy in the region.

Furthermore, the lack of mechanisms to encourage and stimulate self-help capacities among local communities is identified. No dedicated system exists for information flow on research and development in biomass energy. This needs to be established and regularly upgraded. Currently, most of the technologies introduced are considered high cost. These technologies are not sustainable for the farmers and local communities. Additionally, technology development also requires a system that is affordable but effective. Local agencies and research institute should embark on research collaboration with international counterparts that include developing technologies for smallholder farmers.

Above all, the lack of financial and human resources is also recognized as one of the underlying causes of the above-mentioned issues that need to be addressed.

IV. RATIONALE OF THE STRATEGY

Potential depletion of fossil fuel and climate change have globally accelerated the demand in renewable and alternative energy. Most of the Southeast Asian countries have an abundance of biomass sources for the energy sector due to their agriculture-based economy and enormous forest resources. The strategy of biomass energy for rural communities in the Southeast Asia countries to convey the environmental and economic benefits from the available biomass sources in the region. The biomass energy extended use at community level will contribute to the sustainability of rural energy supply, with less dependence on imported energy such as charcoal, fossil fuel, electricity with progressive raise price. The Biomass energy use could be as options for reduction of GHGs emissions, carbon, reduce open burning of organic residues in the ASEAN countries.

In order to achieve the aim, the strategy synthesized and evaluated the biomass sources, energy potential, utilization, and management in the region, based on the secondary data and field pilots. It was found that the major biomass sources in this region were fuelwood, wood residues, rice husk, rice straw, sugarcane residues, oil palm residues, and coconut residues. The total annual quantity of the biomass potential from agriculture and forest sector in the region was estimated at more than 500 million tons per year and equal to over 8000 million gigajoules of total energy potential. In order to implement the sustainable utilization of biomass sources, the strategy will identify the barriers and challenges of biomass utilization in these countries and proposed a sustainable approach of biomass energy, by comparing the way of traditional biomass utilization.

Currently, biomass energy utilization and market development in the region seems progressive among ASEAN members. Some of the Southeast Asian countries such as Thailand, Malaysia and Viet Nam have effectively developed more innovative solutions to biomass energy utilization despite the barriers and challenges. Therefore, along with the advancements of technologies (such as electrification, torrefaction, improved cook stoves, household biogas, biomass gasification, biochar and community biofuels...) research and development, growing energy markets, and knowledge and technology transfer from the other developed countries, biomass energy could be crucial in offering the environmental and economic benefits in the near future of the energy sector in the region.

In term of regulatory framework for community biomass energy, among ASEAN member countries there is a gap, while some countries had the renewables energy or industrial biofuels regulations and policies. So, the need to have an ASEAN common strategy on biomass energy and national policies on promoting community biomass energy is in the agenda in the context of circular economics. At technical level, there a need of knowledges and innovations sharing through diverse communication tools such as ASEAN platform website and guidelines.

V. ASEAN STRATEGY ON SUSTAINABLE BIOMASS ENERGY FOR AGRICULTURE COMMUNITIES AND RURAL DEVELOPMENT IN 2020-2030

1. Vision

a. Vision

To promote the biomass energy as reliable, affordable and sustainable energy resource in rural communities to address the increasing energy demand and sustainable rural development of ASEAN member countries by 2030.

b. Mission

To enhance the living standards of rural peoples and communities by modernizing the use of biomass energy at rural community through the supports activities to assist the transition with shared researches and educational trainings on biomass energy; through creating public policies and awareness; through market development, knowledge and data sharing, technology transfer and capacity development in biomass energy; as well as through efficient use of modern biomass energy among ASEAN member countries.

2. Objectives

a. Overall Objective

To increase the access to modern biomass energy and hence contributing to the environment conservation by transforming traditional biomass energy use into appropriated technology, sustainable and clean energy in rural communities of ASEAN member countries by 2030.

b. Specific objectives

The specific objectives of strategy are mentioned as follows:

- i. To contribute to energy supply and energy security to rural communities by generating modern biomass energy (electricity, heat, torrefaction...) through management of agricultural residues and organic wastes in order to achieve 10% of total mix energy consumption at 2030
- ii. To support the employment and income generation through the entrepreneurship development in biomass energy; and to reduce the existing dependency on imported energy and reducing the use of wood fuel and charcoal through effective, efficient production and utilization of biomass energy.

3. Strategy

To achieve above mentioned objectives, the following outcome-based strategic thrusts will be adopted:

Strategic Thrust 1: *To increase production of sustainable modern biomass energy by utilizing agriculture, forest residues and organic wastes to 10 % of total energy mix by 2030 among ASEAN rural communities.*

Action plan:

- i. Develop and adopt ASEAN modern biomass energy roadmap by 3 periods:
 - a. 2020-2023 (6% of total mix energy consumption)
 - b. 2024-2026 (8% of total mix energy consumption)
 - c. 2027-2030 (10% of total mix energy consumption)
- ii. The ASEAN members to enhance and implement modern biomass energy from agricultural waste policy and targets: To arrange appropriate contributions from the government, private sector and beneficiaries/consumers in order to make the production and utilization of biomass energy reliable and sustainable; to provide financial and technical assistance and credit for the production and utilization of modern, affordable and efficient biomass energy technologies from 2020 to 2030.
- iii. The ASEAN members to ensure necessary awareness, capacity building, promotion and technology transfer, regional and national best practices sharing for the production and commercialization of modern biomass energy from forest, agriculture and animal residues through the utilization of biomass energy from 2020 to 2030.
- iv. Monitor modern biomass energy from agricultural waste capacity deployment of the ASEAN members on an annual basis from 2020 to 2030.

Strategic Thrust 2: *To increase effectiveness and efficiency in the utilization and production of biomass energy at rural communities through establishing network of research-development and educational training in ASEAN region.*

Action plan:

- i. For the production and utilization of various forms of biomass energy and for making the biomass energy technologies and implementation process efficient, effective, affordable, appropriate and result-oriented; an emphasis will be given for necessary research, studies, technology transfer and development/extension. Agencies implementing the programs by each period related to the biomass energy will be encouraged to carry out the applied research collaborating with the educational, research institutions and private sector for 2020-2023, 2024-2026 and 2027-2030.
- ii. To provide technical and financial assistance from government for research and educational training on modern efficient, affordable biomass energy technologies, data on the energy generation for different biomass sources (electrification, biogas, gasifier, briquettes, pellets, industrial boiler, cogeneration, waste to energy etc.) for determining their feasibility, goals, quality control, emission standards, technology development and improvements for 2020-2023, 2024-2026 and 2027-2030.
- iii. The innovative solutions should be encouraging to update the ASEAN guideline. Establish a network of research institutions or universities to promote R&D and training cooperation, technology development, sharing of research facilities and exchange of researchers on renewable by 2020.
- iv. To promote the regional technology transfer and best practices sharing and training at regional level through the development of ASEAN guideline for biomass energy for rural communities by 2021.
- v. Develop the ASEAN modern biomass energy website as resource knowledges, data and develop tool for online training courses. The data and knowledge

production on the energy production from biomass resources will be served for climate change policy dialogue at national and regional levels by 2020.

- vi. To develop project to use of geospatial tools for inventory and mapping of biomass feedstock at ASEAN level by 2023.

Strategic Thrust 3: *Enhance awareness on the role and best policy practices of biomass energy among policy makers, private sectors and public.*

Action plan:

- i. To carry out public awareness and promotional activities with the participation of local stakeholders for effective and efficient use of biomass energy and for expansion of modern, efficient and affordable technologies by 2020.
- ii. To develop national regulations and policies on sustainable biomass energy resources and biomass energy prices for biomass energy commercialization (electricity, heat) by period 2020-2023.
- iii. Develop network of ASEAN multi-stakeholder on modern biomass energy by 2022.
- iv. Establish information sharing mechanism among ASEAN member on renewable energy data, policy instruments, policy update, and best practices for promoting modern biomass energy by 2021.
- v. Conduct 03 high level policy dialogues on modern biomass energy, 1 in each period on market price for biomass energy (bagasse electricity...), advanced technology (torrefaction...) by 2021, 2025 and 2028.
- vi. Conduct annual technical training on integrating modern biomass energy into rural development policies from 2020.
- vii. To formulate and revise timely quality standards of biomass energy technologies for their quality assurance from 2020.
- viii. To apply the biomass energy pathway sustainability study using GBEP indicator by FAO for policy building by 2022.

Strategic Thrust 4: *Increase the promotion of biomass energy financing schemes, national biomass energy markets and regional biomass energy technology markets.*

Action plan:

- i. To promote the technology transfer and scaling up from public and private sector to rural communities for production and marketing of improved and modern biomass energy technologies (e.g. electricity, cogeneration, torrefaction, biogas, gasifier, cook stoves, briquettes/pellets, waste to energy, etc.) from 2020 to 2030.
- ii. To adopt and implement financial support for public-private partnership; the capacity building for local staff/community leaders and to enhance coordination and cooperation between concerned agencies in biomass energy value chain for 2020-2023.
- iii. To develop national market for commercialization of biomass energy and to ensure the sales and distribution of sales of the produced biomass energy and hence benefit from 2024-2030.

- iv. To develop ASEAN biomass using platform website (website, social medias, documents...) for sharing the best practices and policies experiences about biomass energy among ASEAN member countries by 2020.
- v. Establish a network with national regional/international financial institutions for biomass energy financing by 2021.
- vi. Develop a guideline of biomass energy support Mechanism for Bankable Projects with PPP to attract private investment by 2022.
- vii. Conduct trainings on biomass energy financing from 2023 to 2026.

4. Institutional Structure

4.1 At ASEAN level

The ASEAN Secretariat will realize this strategy to 2030. At ASEAN secretariat level, a Taskforce for biomass energy and other uses will be established. This taskforce and platform will be linked with different institutions under ASEAN:

- ASEAN Center for Energy (ACE)
- ASEAN Crops Website (ASEC)
- ASEAN sectoral working Group on crops (Thailand)
- ASEAN technical working group on ARD
- Agriculture Research and Development information system (ARDIS) under ATWGARD (Indonesia)
- In part for the development of regional proposal for climate finance, or carbon finance for biomass use
- Renewable energy target of ASEAN members under NDCs, NAPs, NAMAs
- ASEAN Climate resilience network (CRN)

4.2 At National level

For the implementation of the Sustainable Biomass Energy for Agricultural Communities and Rural Development Strategy in ASEAN, there will be important roles to play by the relevant government agencies (such as Ministry of Agriculture and Ministry of Industry) related to forestry, agriculture, energy, supplies, environment and local development in collaboration, coordination and support of the envisaged activities.

The regulation and incentive policies for biomass energy use should be integrated into the national policies framework for Sustainable Agriculture and Rural Development of each member's ASEAN countries, in particularly to the Renewable energy target of AMS under NDCs, NAPs, NAMAs and climate finance proposal.

5. Financing and mobilization mechanism

As the biomass energy is a new, but raising market in ASEAN members among RE energy sources, but this strategy related to a large number of family living in rural area. The biomass energy Taskforce should build a project named "Project supporting the transition to biomass modern energy in rural communities of ASEAN members 2020-2030" in order to achieve sustainability in rural energy.

a. Financial budget

The total financial estimation will be about 10 million of USD (1 million USD per year). The project will be organized by three of 3-years phases.

b. Mobilization mechanism

The possible donors will be green and climate funding mechanisms. The different funding sources for biomass energy should be:

- Source of funding from the countries allocated according to priority
- Countries can integrate into national target programs, target programs, programs, plans or projects that they are implementing.
- Mobilize capital from bilateral donors or multilateral organizations and foreign non-governmental organizations depending on the capabilities of each country.
- Funding from organizations, individuals or businesses interested in investing in using Biomass energy. For the private sector investment in each country, the PPP mechanism should be promoted under the regional guidelines for biomass energy in ASEAN.

VI. MONITORING AND EVALUATION

Each ASEAN member will realize their activities according to the timeline in the approved action plan.

Monitoring and evaluation of the implementation of this strategy will be the responsibility of the Biomass energy Taskforce at ASEAN secretariat. The regional coordination committee will review the monitoring and evaluation carried out by national focal point of each member country; will provide necessary instruction from time to time; and will arrange for the publication of the report and communication of the results.

REFERENCES

1. ASEAN-MARD. *Workshop report on Biomass for growth: Potentials and challenges of bioenergy in Agricultural Communities and Rural Development in ASEAN Region*. Bangkok, 2019.
2. ACE. *ASEAN plan of action for Energy cooperation (APAEC) 2016-2025. Phase I: 2016-2020*. 2015.
3. GIZ-GGGI. *Sweetening the Deal for Biomass Energy in Viet Nam's Sugar Industry*. 2018.
4. GIZ-MOIT. Study supporting the policy for biomass electricity network in Viet Nam. 2014.
5. Gumartini T., *Biomass energy in the Asia-Pacific region: Current status, Trends and Future setting*. Working paper series. FAO. 2009.
6. FAO. *Biomass Energy in ASEAN member countries*. WS proceeding.
7. FAO. *Small scale bioenergy initiatives in ASEAN +3*. Report. 2014.
8. Tiziana Pirelli, Andrea Rossi and Constance Miller. Sustainability of Biogas and Cassava-based Ethanol value chain in Viet Nam. FAO WP. Roma. 2018.
9. Maw Maw Tun , Dagmar Juchelkova , Myo Min Win, Aung Myat Thu and Tomáš Puchor. *Review Biomass Energy: An Overview of Biomass Sources, Energy Potential, and Management in Southeast Asian Countries*. Resource. MDPI Basel. 2019.
10. Kimuras, S. Energy Efficiency and Conservation in Southeast Asia. In Proceedings of the IEA/ERIA/EMA Joint Workshop, Singapore, 26–27 March 2009.
11. International Energy Agency (IEA). Southeast Asia Energy Outlook 2017. Available online: <https://www.iea.org/southeastasia/> (accessed on 20 March 2019).
12. Asian Development Bank. *The Economics of Climate Change in Southeast Asia: A Regional Review*; ADB: Manila, Philippines, 2009.
13. Carlos, R.M.; Khang, D.B. Characterization of Biomass Energy Projects in Southeast Asia. *Biomass Bioenergy* **2008**, *32*, 525–532.
14. Klimowicz, G. Southeast Asia Set for Biomass Boom. Available online: <https://www.eco-business.com/news/southeast-asia-set-biomass-boom/> (accessed on 15 March 2019).
15. Zafar, S. Bioenergy Perspectives for Southeast Asia. Available online: <https://www.bioenergyconsult.com/bioenergy-southeast-asia/> (accessed on 15 March 2019).
16. IRENA and ACE. *Renewable Energy Outlook for ASEAN: A REmap Analysis*; International Renewable Energy Agency (IRENA), Abu Dhabi and ASEAN Centre for Energy (ACE): Jakarta, Indonesia, 2016.
17. The World Bank. CO2 Emissions per Capita in ASEAN. Available online: <https://data.worldbank.org/indicator/EN.ATM.CO2E.PC> (accessed on 15 March 2019).
18. Energy Consumption in Laos. Available online: <https://www.worlddata.info/asia/laos/energy-consumption.php> (accessed on 15 March 2019).
19. Asian Development Bank. *Renewable Energy Developments and Potential in the Greater Mekong Subregion*; Asian Development Bank: Mandaluyong City, Philippines, 2015.
20. Asia Biomass Office. Forest Resources in ASEAN Countries. Available online: https://www.asiabiomass.jp/english/topics/1111_04.html (accessed on 10 March 2019).
21. IRENA. Renewable Energy Market Analysis, Southeast Asia. 2018. Available online: <https://www.irena.org/publications/2018/Jan/Renewable-Energy-Market-Analysis-Southeast-Asia> (accessed on 10 March 2019).
22. Yosiyana, B. Renewable Energy Development in ASEAN. ASEAN Centre for Energy. In Proceedings of the 2nd Asia Renewable Energy Workshop, Jakarta, Indonesia, 2–4 December 2015.
23. Singh, B.K. South Asia Energy Security: Challenges and Opportunities. *Energy Policy* **2013**, *63*, 458–468.

24. Akgun, O.; Korkeakoski, M.; Mustonen, S.; Luukkanen, J. Theoretical Bioenergy Potential in Cambodia and Laos. In Proceedings of the World Renewable Energy Congress, Linköping, Sweden, 8–13 May 2011.
25. Prastowo, B. Biomass Resource in Indonesia: Indonesia's Solid Biomass Energy Potential. In Proceedings of the Indonesia-German Workshop and Seminar, Institute Technology of Bandung, Kota Bandung, Indonesia, 26–27 September 2012; pp. 1–15.
26. Shafie, S.M.; Mahlia, T.M.; Masjuki, H.H.; Ahmad-Yazid, A. A Review on Electricity Generation Based on Biomass Residue in Malaysia. *Renew. Sustain. Energy Rev.* **2012**, *16*, 5879–5889.
27. Bakar, M.H.; Ahmad, N.; Islam, M.N.; Ani, F.N. *Characterization of Biomass Solid Wastes of Brunei Darussalam for Their Pyrolytic Conversion into Liquid Oil*. In Proceedings of the 5th Brunei International Conference on Engineering and Technology (BICET 2014), Bandar Seri Begawan, Brunei, 1–3 November 2014.
28. Oh, T.H.; Pang, S.Y.; Chua, S.C. Energy Policy and Alternative Energy in Malaysia: Issues and Challenges for Sustainable Growth. *Renew. Sustain. Energy Rev.* **2010**, *14*, 1241–1252.
29. Laemsak, N.; Haruthaithanasan, M.; Potential of Biomass Utilization in ACMECS (Laos, Myanmar, Cambodia, Viet Nam and Thailand). Kasetsart University, Thailand. Available online: <https://www.oew.ac.at/forebiom/WS2lectures/02-02-NLAEMSAK.pdf> (accessed on 16 June 2017).
30. Shead, B. Biomass Industry in the Philippines. ASEAN BRIEFING, 2017. Available online: <https://www.aseanbriefing.com/news/2017/05/19/biomass-industry-philippines.html> (accessed on 15 March 2019).
31. Tun, M.M. An Overview of Renewable Energy Sources and Their Energy Potential for Sustainable Development in Myanmar. *Eur. J. Sustain. Dev. Res.* **2019**, *1*, em0071.
32. LIRE, Biomass. Lao Institute for Renewable Energy. 2019. Available online: <http://lao-ire.org/topics/biomass.html> (accessed on 15 March 2019).
33. Das, K. Renewables in Viet Nam: Current Opportunities and Future Outlook. Viet Nam Briefing, 2019. Available online: <https://www.vietnambriefing.com/news/vietnams-push-for-renewable-energy.html/> (accessed on 15 March 2019).
34. GEMCO. Biomass Fuel in Viet Nam. 2019. Available online: <http://www.gemcopelletmills.com/biomass-energy-in-vietnam.html> (accessed on 10 March 2019).
35. Viet, Z.S. Biomass Energy in Viet Nam. 2019. Available online: <https://www.bioenergyconsult.com/biomass-energy-vietnam/> (accessed on 10 March 2019).
36. Vidaurri, F. Renewable Energy and Investment in ASEAN. 2015. ASEAN Briefing. Available online: <https://www.aseanbriefing.com/news/2015/11/04/renewable-energy-and-investment-in-asean.html> (accessed on 7 March 2019).
37. Zafar, S. Biomass Energy Potential in Philippines. 2018. Available online: <https://www.bioenergyconsult.com/tag/biomass-energy-in-philippines/> (accessed on 5 March 2019).
38. Dalusung, B.; Biomass Energy in the Philippines. Potential Cooperation Partners and Current Biomass Projects. 2012. Available online: <https://www.giz.de/fachexpertise/downloads/2012-en-dalusung-pep-informationswork-philippinen-biomasse.pdf> (accessed on 5 March 2019).
39. Zafar, S. Biomass Energy in Indonesia. Available online: <https://www.bioenergyconsult.com/biomass-energy-resources-in-indonesia/> (accessed on 5 March 2019).
40. Zafar, S. Biomass Energy in Thailand. Available online: <https://www.bioenergyconsult.com/biomass-thailand/> (accessed on 15 March 2019).
41. Netherland Enterprise Agency. *Biomass Market Opportunities-Thailand*; Netherland Enterprise Agency: Utrecht, The Netherlands, 2014; pp. 1–12.
42. Pugadmin. Biomass Facilities in Thailand. Available online: <https://pugnatorius.com/biomass/> (accessed on 15 March 2019).

43. Asia Biomass Office. Current State of Renewable Energies in Brunei Darussalam. Available online: https://www.asiabiomass.jp/english/topics/1311_05.html (accessed on 1 March 2019).
44. Asia Biomass Office. One of the World's Largest Power Plants Using Biomass Now under Construction in Singapore. Available online: https://www.asiabiomass.jp/english/topics/1111_03.html (accessed on 1 March 2019).
45. Department of Alternative Energy Development and Efficiency, Ministry of Energy; Executive Summary Report; *Developing of Biomass Database Potential in Thailand*; 2012; pp. 1–45. Available online: <http://weben.dede.go.th/webmax/sites/default/files/Biomass%20Database%20Potential%20in%20Thailand.pdf> (accessed on 5 March 2019).
46. Intelligent Energy Systems. Towards 100% Renewable Electricity by 2050. Cambodia Report; Power Sector Vision; Greater Mekong Region. 2019, pp. 1–138. Available online: <http://awsassets.panda.org/downloads/regional.pdf> (accessed on 6 March 2019).
47. Institute of Renewable Energy Promotion, Ministry of Energy and Mines. Renewable Energy Data in Lao PDR. In Proceedings of the EAST and Southeast Asia Renewable Energy Statistic Training Workshop, Bangkok, Thailand, 12–14 December 2016.
48. SIEW. Singapore's First Biomass-Solar Energy Plant. Singapore International Energy Week, 2019. Available online: <https://www.siew.sg/newsroom/articles/detail/2012/06/04/singapore-s-first-biomass-solar-energy-plant> (accessed on 1 March 2019).
49. Chang, Y.; Fang, Z.; Li, Y. Renewable Energy Policies in Promoting Financing and Investment among the East Asia Summit countries: Quantitative assessment and policy implications. *Energy Policy* **2016**, *95*, 427–436.
50. Ministry of Foreign Affairs. Biomass Opportunities in Viet Nam. 2013. Available online: <https://english.rvo.nl/sites/default/files/2013/12/Factsheet%20Biomass%20opportunities%20in%20Vietnam.pdf> (accessed on 1 March 2019).