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Biomass Energy Technology Transfer in the Philippines: Assessment and Strategy Formulation

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Abstract – *This paper aims to develop a framework of strategies for successful technology transfer in the Philippines, particularly for biomass energy technologies (BETs). Evaluation of nine candidate BETs using seven selection criteria resulted in identification of three most promising BETs for the Philippines namely: Stirling engine, cogeneration and bio-diesel production. These technologies can mitigate climate change, and are characterized by ease of replication and commercialization, and low level of effort requirement for technology transfer and capacity building. Country experiences on technology transfer show that the continuity of technology acceptance largely depends on government support and capacity to conduct testing and performance evaluation, and private sector involvement. The barriers to technology transfer include lack of access to information; weak human/institutional capacities; financial/economic, trade, and policy barriers; and institutional limitations. For facilitating international technology transfer, an enabling environment has to be established. Supportive policies, capacity building (both human and institutional), financial system and resource development, and institutional strengthening are recommended for this purpose.*

Keywords – Biomass energy, strategy framework, technology transfer.

1. INTRODUCTION

Developed countries have already spent time, resources and efforts to develop environmentally sound technologies (ESTs), which include modern BETs. It is high time for the developing countries to acquire these technologies by creating enabling environments for technology transfer. Successful implementation of technology transfer will enable developing countries to mitigate greenhouse gas (GHG) emission, and will also help to achieve economic development in a sustainable manner.

This paper aims to develop a framework of strategies for promoting transfer of BETs. For this purpose, nine candidate modern BETs were considered for transfer and their suitability was assessed. These were: modern wood-fired power plant, whole tree energy, biomass co-firing, biomass integrated gasification combined cycle, gasifier-engine system, stirling engine, cogeneration, ethanol, and bio-diesel production.

To develop the framework of strategies, an assessment of the host country's technology transfer institutional framework including its policies on research and development (R and D), foreign direct investment (FDI) and import/transfer policies was done. Moreover, some lessons were derived from a review of country experiences on technology transfer. These could serve to identify a proper approach for promoting technology transfer and whatever gaps that exist in the current institutional setup.

2. REVIEW OF INSTITUTIONAL FRAMEWORK AND POLICIES RELATED TO TECHNOLOGY TRANSFER

The Philippines' current energy systems (majority of which are fossil fuel-based) were put in place in the backdrop of a unique institutional set-up and were supported by different policies of diverse objectives. For promoting transfer of ESTs, including BETs, a review and assessment of the national institutional set-up and policies is required.

National Institutions for R and D and Technology Transfer

The review of R and D institutions focuses on two main government agencies: the Philippines Department of Energy (DOE) and the Department of Science and Technology (DOST). DOE and DOST do not focus on R and D on renewable energy (RE) alone. Both agencies also engage in policy formulation and their programs are meant to support and contribute to the country's overall development priorities.

The DOE's programs on *New and Renewable Energy* and *Power Development* strongly support the development of renewable energy resources for catering the power needs of small island grids and off-grid areas [1]. However, as in most government programs, success is anchored mainly on the availability of funding, favorable policies or incentives to attract greater private sector participation.

While the DOE focuses more on exploration, development, utilization and management of all energy resources (local and imported), the DOST gears towards scientific and technological R and D in all areas deemed vital for the country's economic growth including, but without preference to, RE technologies. DOST's sectoral

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councils like Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), and Philippine Council for Industry and Energy Research and Development (PCIERD) undertake some RE related research and development activities. PCARRD's program on *Natural Resources Management* has provisions for environmental hazard protection. RE systems can be included in its framework to manage and protect the environment. PCIERD's program on *Energy and Utilities* also deals with the development of new energy sources (like the DOE) [2], [3].

One of DOST's R and D institutes, the Forest Products Research and Development Institute (FPRDI), works on efficiently utilizing forest-based biomass resources. FPRDI's program on *Chemical Products and Biomass Energy* led to the development and commercialization of the Fluidized Bed Combustion technology [2]. The FPRDI also established the Biomass Cookstove Testing Laboratory during the early '90s. Improved cookstoves (i.e. FPRDI stove) were developed and commercialized during the project, but was not sustained after the collaborative project duration.

DOST's Industrial Technology Development Institute (ITDI) also contributes to RE development through the Fuels and Energy Division (FED). FED is engaged in adaptive R and D on new and advanced energy conversion technologies. It also has provisions for technology transfer of energy technologies. One of the division's important contributions is the development of ESTs, which include pyrolysis, direct combustion, and gasification systems that can utilize locally available resources [4].

Among technology transfer institutions, only DOST's International Technology Cooperation Unit (ITCU) is mandated to carry out international technology transfer activities [2]. The other three institutions of DOST, i.e., TAPI (Technology Application and Promotion Institute), PCIERD and ITDI generally provide and seek favorable environment mainly for internal technology diffusion (technology transfer within the country) and focus on promotion and commercialization of technologies [5].

ITCU focuses on international relations and cooperation for all Science and Technology (S and T) related projects but without particular focus on modern ESTs [2]. A small unit like ITCU needs longer time to handle all promising projects given the limited manpower that it currently has. Creation of a similar unit for RETs alone can accelerate their transfer to the Philippines. If this is not possible due to resource constraints, then ITCU itself can be strengthened and restructured.

With regards to internal technology diffusion, only TAPI has a clear mandate to undertake technology promotion to facilitate diffusion of technologies developed by most of DOST's R and D institutes. Like ITCU, TAPI gives no preferential treatment to RETs.

On the other hand, PCIERD recently established its Technology Assessment, Utilization and Transfer (TAUT) unit for internal diffusion of industrial and energy technologies. TAUT has no significant achievements to its credit yet, but it has significant potential. ITDI also has its own arm for technology transfer – the Rural Technology and Information Division (RTID). RTID's marketing and promotional strategies can be considered effective. However it focuses in general on all industrial technologies and not solely on RETs.

The above-mentioned R and D institutes have covered almost all available renewable resources and energy conversion options. Some systems developed by these have even reached full commercialization (e.g. biogas) while some reached pilot and demonstration stage.

Currently, the country has rather low institutional capacity with regard to international transfer of BETs. Preferential attention to transfer of BETs is required for the Philippines to effectively contribute to the global efforts of reducing GHG emissions.

National Policies Relevant to Renewable Energy

In line with the government's policy commitment to pursue liberalization and privatization, DOE pursues continuous development and use of New and Renewable Energy (NRE) as one of the major strategies to attain energy self-sufficiency along with environmental protection.

Energy planning in the Philippines is embodied in the Philippine Energy Plan. One major strategy of the Philippine government to ensure stable and secure energy supply is to enhance utilization of RE by encouraging private sector participation including foreign investment not only in the exploration and utilization of these energy resources but also in the manufacturing of RE systems and components [1].

Foreign Direct Investment Policies

The country's foreign direct investment policies related to the development of RE technologies, including BETs, are:

i) *Energy Regulations (ER) No. 1-95* entitled "Rules and Regulations implementing Executive Order 215 on Private Sector Participation in Power Generation" was promulgated to make investment attractive to private sector [6].
ii) *Omnibus Investments Code (OIC) - Executive Order No. 226*, extends fiscal incentives to stimulate the establishment and assist initial operations of the enterprise [7].
iii) *Presidential Decree No. 66* entitled business establishments operating within the ECOZONES with fiscal incentives provided for under the law creating the Export Processing Zone Authority [8].
iv) *Republic Act No. 6957- BOT Law* seeks to provide appropriate incentives to mobilize private resources for the purpose of financing the construction, operation, and maintenance of infrastructure and development projects, which include power plants and hydro-power projects [9].

Technology Transfer Policies

In spite of the *Industrial Incentives Act* and its obvious attractions, industrial growth was very modest in the 1970s. In 1973, there were only 131 firms registered with the government. It is clear that entrepreneurs had no real interest in new, pioneering ventures- an attitude that persists up to the present. This could be because the incentives did not include a provision on the transfer of technology and assurance of a learning process for local technology recipients. Although a Technology Transfer Board was created, the main motivation was to safeguard the interests of local investors and not to ensure real technology transfer.

In line with the *Medium Term Plan (1999-2004)*, the DOST would pursue programs and activities guided by the principles of competence, competitiveness and conscience. The following strategies would be pursued: implementing high priority flagship programs; strengthening and continuous refocusing of ongoing programs; and improving S and T governance and management. The *Integrated Program on Cleaner Production Technologies* aims to promote sustainable development and strengthen the competitiveness of the Philippine industries, particularly small and medium enterprises (SMEs), by providing technical information and assistance in adopting cleaner production technologies that include waste minimization and pollution prevention techniques. The DOSTs *Technology Transfer and Commercialization Program* will be strengthened to hasten the delivery, adoption and commercialization of appropriate technologies to farmers and entrepreneurs. It will respond to the MTPDP's call for the promotion of foreign capital and technology to augment domestic resources and improve the country's technological stock as well as the provision of improved product matching and technology exchange services [2].

3. TECHNOLOGY TRANSFER EXPERIENCE OF THE PHILIPPINES

The review of technologies, which gained entry to the country's RE scene, establishes a trend of how technologies (local and foreign) are adapted and implemented. Nine local technologies were reviewed. Six of these were solar-based systems, two were micro-hydro power projects and one a wind turbine generator. The projects are: Villa Escudero Micro-Hydro Project, NPC 10-kW Pilot Stand-Alone Pagudpud Wind Turbine Generator, Solar Home System Project in Gregorio del Pilar, Bubunawan Hydropower Plant in Mindanao, Solar PV Dissemination Project, Solar Electrification in Remote Areas, DOE-DILG Municipal Solar Infrastructure Project, BELSOLAR Project, and Burias Island NRE Project.

These projects were made possible through the financial and technical assistance granted by different institutions such as USAID-Winrock International, Preferred Energy Investment (PEI), German Agency for Technical Cooperation-GTZ, Solar Electric Company and Development Bank of the Philippines (DBP). These past experiences show that in general clean technologies can be transferred even to the remotest of sites in the Philippines.

Private sector involvement, local government support and community participation were key to achieving the basic elements of technology transfer. Capacity building was carried out for concerned local communities to utilize and manage the wind turbine generator, solar home systems and micro-hydro systems. The technical assistance provided by local agencies (such as PEI, DOE and DILG) made it possible to adapt these technologies to the local setting. Specific to the Solar PV Dissemination Project, replication of the system in six (6) provinces was technically achieved with the help of Solar Electric Company, USAID-Winrock International and PEI.

Four cases of technology transfer from abroad were reviewed, namely, Fluidized Bed Combustion, Circulating Fluidized Bed Combustion, Natural Gas fueled Vehicle and Wood Gasification.

The introduction and transfer of the *Fluidized Bed Combustion* technology in the Philippines was through the ASEAN-Australia Economic Cooperation Program. In January 1994, a 0.30-MW differential fluidized bubbling bed (DFBB) unit was constructed for operation and testing. The technology was adopted by the Asia Rattan Manufacturing, Incorporated (ARMI) and Calfurn Manufacturing Company at Angeles City, Pampanga. Financial requirement for the unit was shouldered by the company while the design and technical supervision was provided by FPRDI.

The *Circulating Fluidized-Bed (CFB) Combustion of Indigenous Coal* project was an offshoot of former President Fidel V. Ramos' state visit to Japan in March 1993. A 10-ton per hour boiler having low emission levels of NOx, SOx, particulates, etc was donated for demonstration and evaluation. The demonstration project was completed in December 1997. However, the unit is no longer in use.

With the vision of implementing a *Natural Gas Vehicle (NGV) Program* in Asian countries, the ASEAN-New Zealand Economic Cooperation Program provided financial assistance to ASEAN member countries including the Philippines to undertake a study on natural gas. As a part of this study, a diesel-fuelled vehicle was converted into natural gas fuelling.

A *Wood Gasification Project*, implemented in collaboration with the Engineering Advancement Association of Japan commissioned by the Ministry of International Trade and Industry of Japan (MITI) and ITDI, aimed to design, construct and operate a pilot power plant utilizing fluidized bed gasification technology. The power facility was designed to treat 140-kg sawdust per hour and to produce 70 to 100-kW power. It was installed inside a research institution, but no cooperation with potential industrial users surfaced. The program was not sustained after the grant expired.

Experience in the Philippines shows that in-country diffusion of technologies was successful when there are private sector participation, and provisions for training the end-users on how to operate and manage the systems. The lease-purchase arrangement scheme was effective in transferring systems (as in the case of the micro-hydro and wind turbine generator projects), which will eventually be owned and managed by the people in the community. In the case of CFB and Wood Gasification projects from Japan, technology transfer was not fully achieved because no dedicated government programs were meant to sustain their operation after the grant duration.

The review on the four cases of technology transfer from abroad shows the disadvantage of not having a dedicated program/entity for RETs. While foreign technology acquisitions have occurred in different ways, there was no end-user field implementation of the technologies. This suggests the need for involving local industry partner/private sector participation in the technology transfer process for adaptation of the technologies to suit local conditions and their commercialization.

To date, the most significant project sponsored by the United Nations Development Program (UNDP) - Global Environment Facility (GEF) is on "Capacity Building to Remove Barriers to Renewable Energy in the Philippines". The project is executed by the DOE (since 2002) for a period of 5 years. It aims to remove key market, policy, technical and financial barriers to renewable energy in the Philippines [10]. As the goals of the project are realized, international transfer and internal diffusion of clean technologies would be facilitated.

4. ASSESSMENT OF TECHNOLOGY TRANSFER NEEDS

Technology transfer is fundamentally a country-driven set of processes. Assessment of the country's technology transfer needs has to set its priorities and the most effective mechanism to address them.

Identification and Assessment of Candidate Modern BETs

Nine candidate modern BETs were identified and assessed for selecting three most promising technologies for transfer. These are the Modern Wood-fired Power Plant (WFPP), Whole Tree Energy (WTE), Biomass Co-firing (BCF), Biomass Integrated Gasification Combined Cycle (BIGCC), gasifier-engine system (GAS), Stirling engine (STE), Cogeneration (COGEN), Ethanol production (ETH), and Biodiesel production (BIO-D).

Criteria for Selection of BETs for Transfer

Technology transfer in the context of climate change mitigation is meant to facilitate the access of developing countries to ESTs like BETs so that they can deploy these to meet their growing energy demand and reduce GHG emission as well [11]. Hence, in the selection of a modern BET for transfer, its *contribution to climate change mitigation/mitigation potential (CCC)* is of prime importance. Mitigation potential can be in terms of the amount of carbon dioxide equivalent (tonnes) reduced compared to a baseline technology.

Diffusion potential/ implementation potential (DIF) refers to the expected degree or scale of technology diffusion within the host country.

Similarly, each modern BET's *acceptability by the users (ACC)* is an important criterion to be considered. Acceptability depends on the merits of a BET in terms of its ability to satisfy the users' needs and preferences.

A BET's *ability to meet development goals/development benefits (DEV)* is likewise important. A modern BET would be of greater priority if, aside from being able to mitigate climate change, it can also help a host country meet its development priorities such as economic growth, poverty alleviation, environmental protection, etc.

Commercialization possibilities (COM) refer to the potential of the benefits of BETs to exceed their costs. From the perspective of business enterprises (private sector players) or technology suppliers, the opportunity to maximize profit is of utmost importance. As long as the percent return on investment (ROI) is greater than the opportunity cost of capital, the technology has the potential for commercialization.

The *possibility of local manufacturing and availability of local spare parts (LOC)* may not appear to be so important in the early stages of technology transfer. However, once a technology transfer program results in field implementation of modern BET, success of the technology transfer process is evaluated in terms of its wider acceptance through replication of the technological device in question. Such replication will be more efficient and possible if there is enough human resources and capacity to manufacture provided the necessary components and needed raw materials are also available locally.

The *presence of various technology suppliers from developed countries (SUP)* is also considered. With various suppliers, competition among them will yield better systems for buyers of the technology to choose from. Table 1 shows a matrix used for evaluating the nine modern BETs based on seven selected criteria.

Table 1. Evaluation of modern BETs based on 7 criteria

Modern	Criteria						
BETs	CCC	DIF	ACC	DEV	COM	LOC	SUP
WFPP	+	LO	MED	MED	MED	x	HI
WTE	+	LO	MED	MED	MED	x	HI
BCF	+	LO	MED	MED	MED	x	HI
BIGC	+	MED	HI	HI	MED	x	HI
GAS	+	HI	HI	MED	HI	√	HI
STE	+	HI	HI	HI	HI	√	HI
COGEN	+	HI	HI	HI	HI	√	HI
ETH	+	MED	HI	MED	HI	√	HI
BIO-D	+	HI	HI	HI	HI	√	HI

+ possible once operational
HI, MED, LO with high, medium, low potential /acceptability /benefits /COM/SUP
x none/nil

All modern BETs considered are expected to contribute to climate change mitigation (CCC) once they are installed and operational. GHG mitigation potential of each BETs would have been a more accurate measure of the CCC. However, quantifying the mitigation potential would require a comparison of the BET in question with a fossil fuel-based technology baseline. This was not done in this study.

The degree or scale of technology diffusion is *high* for gasifiers, Stirling engines, cogeneration and bio-diesel; *medium* for BIGCC and ethanol production; and *low* for wood-fired power plant, Whole Tree Energy, and biomass cofiring. The presence of a number of possible applications (like shaft-power and direct-heat) for gasifiers creates a larger range of target end-users including industries, agricultural operations, small-scale enterprises, etc. On the other hand, Stirling engines can be used for decentralized power generation for meeting energy needs of far-flung areas of the country. Cogeneration and bio-diesel are especially significant to uplift the current status of the sugar and coconut industry of the country. WFPP and WTE have low diffusion potential because of possible wood feedstock supply problems. Both would require dedicated energy plantations in order to assure continuous operation. Biomass cofiring diffusion potential is also low because not all existing coal power plants are fit for retrofitting, modification or conversion.

The technologies' acceptability to end-users is *high* for BIGCC, gasifiers, Stirling engine, cogeneration, ethanol production, and bio-diesel while it is *medium* for WFPP, WTE, and biomass cofiring. A BIGCC plant would have high acceptance once installed and operational because of its high efficiency and benefits to a large number of potential end-users. Gasifiers, Stirling engine, cogeneration, ethanol and biodiesel production have more or less direct impact on end-user level as these technologies can be deployed right where the source of biomass is.

Potential to meet development goals is *high* for BIGCC, Stirling engine, cogeneration and bio-diesel; and *medium* for WFPP, WTE, biomass cofiring, gasifiers, and ethanol production. Benefits of a Stirling engine system in the countryside, can be very significant. Cogeneration and bio-diesel can bring about significant benefits to the sugar and coconut industries, respectively.

Commercialization possibilities is *high* for gasifiers, Stirling engine, cogeneration, ethanol, and bio-diesel production; while it is *medium* for WFPP, WTE, biomass cofiring, and BIGCC. While all the modern BETs can be considered financially viable, systems of large capacities such as the power plants (WFPP, WTE, cofiring and BIGCC) may not be suitable due to biomass supply constraints. The small-scale technologies having relatively lower demand for biomass fuels per installation are likely to be suitable for various applications.

The possibility of local manufacturing and availability of local spare parts is considered *none/nil* for WFPP, WTE, biomass cofiring and BIGCC because these have been mainly developed abroad and would require enormous efforts for capacity building and technology transfer. On the other hand, for gasifiers, Stirling engine, cogeneration, ethanol and bio-diesel production, (though considered modern and foreign systems), local manufacturing is possible. In fact, it already exists to some extent because the principles behind these systems are not so complex.

Finally, the presence of various sources or technology suppliers is relatively *high* for all the modern BETs considered, especially those systems for which local R and D and local manufacturing are feasible.

Promising BETs

The three most promising BETs as based on the seven selected criteria are the *Stirling engine, cogeneration and bio-diesel production*. These technologies are responsive to the need to mitigate climate change through GHG emission reduction, and have great possibility for local manufacturing, replication and commercialization in the country, with relatively low level of effort required for technology transfer and capacity building.

A Stirling engine is an external combustion engine, working on the principle of the Stirling thermodynamic cycle, the engine converts external heat from any suitable source, e.g. solar energy or combustion of fuels (biomass, coal, natural gas etc.) into power. These engines may be used to produce power in the range from 100 watts to several hundred kilowatts. Stirling engines can also be used for cogeneration using the rejected heat for space or water heating, or absorption cooling [12].

The overall system efficiency of a 2.5 kWe Stirling engine system (similar to that developed by Sunpower Inc.) has been reported by [12] to be 22% with an expected life of 10 years. Although biomass fueled Stirling engines are not yet available commercially, they are likely to become available in the near future and may emerge as an attractive option for application in remote off-grid areas.

Cogeneration or combined heat and power is an efficient and a cost effective means to save energy and reduce pollution. With a potential primary fuel savings of about 35%, cogeneration is particularly beneficial in agro-processing units, like sugar mills, where demand for both heat and power exists and a processing residue i.e bagasse is available as fuel.

Biodiesel is a generic term for fuels for diesel engines that are derived from vegetable oils or animal fat. Physical and chemical properties of biodiesel are similar to petrodiesel. Of special interest are the high cetane nature of biodiesel and the absence of sulfur or aromatics. Also noteworthy is the increased lubricity of biodiesel. These physical and chemical properties make biodiesel a premium grade diesel fuel substitute.

The use of biodiesel in the Philippines was promoted only in 2002. At present, a National Clean Diesel Task Force has been formed to oversee the implementation of the Philippine Coconut Biodiesel Program. One of its proposals is the mandatory use by all government diesel vehicles of 1 to 2 percent blend of coconut biodiesel with petroleum diesel. PCIERD, in cooperation with the local government and a cooperative based in Romblon Province, has set up a coconut biodiesel plant to showcase the production process and its utilization for power and transport in an island.

5. FORMULATION OF STRATEGIES TO PROMOTE TRANSFER OF BETs

To promote successful transfer of BETs, barriers at different stages must be identified and measures for overcoming them must be formulated.

Barriers to BETs transfer

Barriers of varying nature exist at every stage of the technology transfer process. These barriers range from lack of access to information; insufficient human and institutional capacities; financial/economic barriers; trade and policy barriers and institutional limitations.

The *lack of access to information* is particularly crucial during the technology assessment stage of technology transfer. Adequate information regarding promising technologies including their techno-economic characteristics and environmental performance is necessary for this purpose.

Insufficient human and institutional capacities can be a hindrance at every stage of every the technology transfer process. Capacity is necessary to assess, select, adopt and replicate appropriate technologies.

The *financial/economic barriers* are often the major barriers in a technology transfer process. The barriers include lack of funding support, high project cost, insufficient capital, lack of financing instruments and risks for foreign investors.

The *trade and policy barriers* hinder transfer of technologies from foreign countries due to insufficient incentives to such transfers and presence of subsidy to conventional systems. If policy support were provided in the form of incentives to the private sector, then there would be higher possibility of successful technology transfer.

The *institutional limitations* refer to the lack of coordination and linkages among private and government institutions, inadequate legal and regulatory frameworks, insufficient assessment of technology needs and implementation plans.

Measures for Overcoming Barriers to Successful Transfer of BETs

An enabling environment for technology transfer can be created through government actions and would require measures for overcoming the major barriers to technology transfer as outlined below.

Lack of Access to Information **-** Dissemination of information on modern BETs, including government policies and incentives regarding their transfer is important for promoting technology transfer.

Insufficient Human and Institutional Capacities **-** The country's technology absorption capacity needs to be developed. Existing technology infrastructure should be strengthened by identifying and remedying gaps in its existing capacity.

Financial and Economic Barriers **-** The financial system and financial resources need to be developed. It is important to diversify funding sources and to develop capital markets which could support BET projects.

Pollution charges or taxes on fossil fuel systems would raise the price of fossil-fuel energy making BETs more competitive. Enforcement is key to enabling private companies to switch to greener energy technologies.

The government needs to raise both domestic and foreign financial resources such as commercial loans and Official Development Assistance (ODA) in order to direct financial support to BETs. Government support can be in the form of a venture capital and bridging capital, and long-term loan packages with lower interest rates and flexible amortization schedules. There is also a need to mobilize greater private sector participation in terms of investment.

Policy Barriers **-** Pollution charges could help promote technology transfer, as could voluntary agreements between government and private sector, and product/performance standards.

Policy initiatives to attract private investment in clean energy systems are needed, as are regulatory policies that lead to market transformation. Environmental codes, intellectual property rights protection, and foreign direct investment would also encourage technology transfer.

Voluntary agreements between government and private sector regarding GHG emission reductions should also be pursued.

Institutional limitations **-** An institutional strengthening programme needs to be pursued to build institutional capacity and to improve information dissemination. Capacity building among institutions will help enhance their work structure with clear-cut responsibilities and arrangements.

6. CONCLUSION

Acquiring promising modern biomass energy technologies from abroad is vital for the Philippines to harness its abundant biomass resources as energy source and contribute towards the global efforts to reduce GHG emissions.

The preliminary assessment and evaluation of the nine candidate modern BETs identified a set of three most promising BETs based on seven selected criteria. These are the Stirling engine, cogeneration and bio-diesel production. These technologies are more or less responsive to the need to mitigate climate change through GHG emission reduction, have potential for replication and commercialization in various sites of the country, with relatively low level of effort requirement for technology transfer.

Major barriers to transfer of modern BETs to the Philippines include lack of access to information, insufficient human and institutional capacities, financial and economic barriers, trade and policy barriers. Measures to remove these barriers are vital to promote the technology transfer process and to accelerate use of modern biomass energy in the country.

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