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GREEN BUSINESS MODEL OF BIOMASS VERY SMALL POWER PRODUCERS IN THAILAND

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ABSTRACT: Electricity from biomass energy business in Thailand can be produced from agricultural waste in large quantity. However, without proper management, electricity production from biomass, specifically biomass very small power plants located in communities across the country, may cause pollution and health threats impacting the environment, public health, and conflict from the pollution-affected communities around the biomass power plants. This research aimed to construct Green Business Model for electricity production using biomass for Biomass Very Small Power Producers in Thailand by applying the Sustainability Balanced Scorecard and to evaluate the model by interviewing experts and stakeholders of biomass electricity production. The study showed that the concept of green business model of Biomass Very Small Power Producers consisted of four key aspects namely 1) Stakeholders perspective including business entrepreneurs, feedstock producers/suppliers, feedstock transport operators, community, government, and non-governmental organizations 2) Sustainability management perspective including economic management, social management, and environmental management 3) Effectiveness perspective including Social Return on Investment and 4) Learning & growth perspective including training/learning and innovation/technology. Biomass Very Small Power Producers could deploy the concept of this model to generate profit coupled with responsibility for the environment and society. Consequently, the green business model of Biomass Very Small Power Producers could benefit the agricultural and community sectors such as energy security, reduction of energy import, support of agricultural waste management, local occupation in community, and revenue generation within communities from agricultural waste. It would lead to sustainable development and benefit all stakeholders in the biomass energy supply chain.

Keywords: Green business model, Biomass, Sustainability Balanced Scorecard, Social Return on Investment

1. INTRODUCTION

The growth of the economy focuses on highly consumption-oriented production which in turn relies on limited natural resources and cannot generate a new replacement or may require a longer period of time to build up a replacement such as petroleum, coal, and natural gas which are unclean raw materials for energy production**.** The rising raw material costs and the use of natural resources in the international market cause higher production costs for the industry, as well as climate change, and increase waste, wastewater, and air pollution**.**

The concept of green economy has been presented by the United Nations Environment Programme to adjust the current capitalist economic system towards more sustainable economic system**.** An economic system enhances quality of life and social justice. At the same time, it can reduce the environmental risk and the problem of resource scarcity in accordance with business outcomes in the economic, social, and environmental dimensions based on the Triple Bottom Line concept [1]. The concept of "Green Business" emerged at the end of the 20th century in the wake of the ever-increasing public concern about the sustainability of economic development as an ideology and practice for business unit in the economic system**.** However, green business practices are still not universally embraced and applied by different business entities around the world [2].

Electricity from non-renewable energy comes from natural resources such as fossil fuels**.** However, burning fossil fuels is harmful to the environment**.** When fossil fuels are combusted **(**heated**)**, they release carbon dioxide **(**CO_2**)** into the atmosphere**.** Carbon dioxide is a gas that keeps heat in the earth's atmosphere, a process called the "greenhouse effect**.**" This causes temperatures to rise faster than organisms can acclimate [3] .

Renewable energy such as solar, hydropower, wind power, biogas, waste, and biomass are related to people's well-being and the country's development**.** In the past, the Thai government was the only producer and manager of electricity production from non-renewable energy. But the undertaking was not sufficient to cover the needs of communities in such a developing country like Thailand that was growing rapidly and affected the investment of power supply as it required large budget each year**.** Therefore, to reduce the burden

on government investment in the construction of the power plant to meet the demand and to stabilize the country's electrical system, in 1994 Electricity Generating Authority of Thailand encouraged private sector participation in power generation business through purchasing of electricity from cogeneration power plants of the Independent Power Producers that used waste or residues in the agricultural sector **(**Biomass**)** as feedstock to produce electricity and heat**.** Heat left over from the manufacturing process could be used to produce electricity for sale to a transmission line to promote generation efficiency and public investment in the production and distribution of electricity**.** Private power producers therefore had a role as business unit in Thailand's electricity production**.** Subsequently in 1998, the National Energy Policy Council approved Very Small Power Producers (VSPP) **(**capacity not larger than 10 MW**)**. More VSPPs were set up in remote areas to participate in the production of electricity from renewable energy in accordance with Thailand Power Development Plan 2015-2036 with the focus on **(**1**)** Energy security, to supply energy in response to the energy demand which was consistent with the rate of economic growth, the rate of population growth, and the growth of urban areas, as well as the diversification of energy to appropriate resources. **(**2**)** Economy, taking into account the reasonable energy costs without posing obstacle to the country's long-term economic and social development**.** The structure of fuel prices was reformed in line with costs and tax burden reasonable to level up national energy utilization performance with the promotion of energy efficiency**. (**3**)** Ecology, with increased domestic renewable energy production and energy production with high performance technologies to reduce the impact on environment and community [4] .

In 2017, biomass could produce electricity to Thailand about 651**.**1 MW, highest of all renewable energy sources [5]**.** Although Thailand is an agricultural country and is appropriate for biomass energy, electricity production from biomass may cause pollution impacting the environment, public health, and resistance from the affected citizens, if there is no proper management**.** Another factor is the provision of law that stipulates VSPP to conduct an Initial Environmental Examination (IEE) instead of Environmental Impact Assessment **(**EIA**)** that is a full assessment of the effects of the project on the environment which is a more detailed and comprehensive study of environmental impact than IEE [6]**.** In Thailand the biomass power plant with the generating capacity of 9**.**9 MW **(**<10MW**)** is not required to conduct the EIA, only conduct the IEE**.** Therefore, entrepreneurs can avoid conducting the environmental impact assessment by constructing the VSPP with lower investment in pollution management and technology than small power producers (SPP) (>10MW capacity). Subsequently, VSPP tend to pollute more than SPP**.** Therefore, VSPP must ensure that they carry out their business responsibly**.**

Under the green business topics, there are several education issues about green business practices in consumer products and services such as the ecolabeling **(**also known as green or environmental labeling, or green branding**)** [7], green behavior "4Rs" – reduction, reuse, recycling, and recovery [8], increased revenue from green business [9], etc**.** Therefore, the researchers anticipated that the concept of green business constructed from Sustainability Balanced Scorecard (SBSC) concept [10] and Biomass Supply Chain for Energy Production concept [11] could be deployed with public utility business such as biomass very small power producers electricity production. Consequently, biomass very small power (BVSPP) could generate profit coupled with responsibility for the environment and society**.**

2. OBJECTIVE

The objective of this study was to construct the Green Business Model of Biomass Very Small Power Producers which could bring sustainable benefit to BVSPP by-product from cost reduction along with reducing environmental impact and establishing good relation to society and communities surrounding the power plant.

This model was suitable for adoption by BVSPP which would assist in develop the green business potential of the biomass power plants as it was an economic approach that promoted sustainable development in all sectors of the country, including economy, society, and environment.

3. METHODOLOGY

This study was qualitative research. Secondary data was collected through books, documents, information media, and research works relevant to green business, biomass energy, stakeholders, and SBSC to formulate the (draft) of the Green Business Model of Biomass Very Small Power Producers conceptual framework.

Then, the Green Business Model of Biomass Very Small Power Producers was constructed by semi-structured interviews relevant to indicator criteria of SBSC concept to investigate the appropriateness of the issues in the (draft) of the Green Business Model of Biomass Very Small Power Producers conceptual framework, as well as the appropriateness of the content and language.

Total of semi-structured interviews were conducted with 18 stakeholders each from biomass supply chain including 3 business entrepreneurs of BVSPP, 3 feedstock producers/suppliers, 3 feedstock transport companies, 3 community leaders, 3 government officers and 3 non-governmental organizations (NGOs) as shown in Table 1.

Table 1 Key Informants of the Study

Types of stakeholders	Participants
Business entrepreneurs	1-3 BVSPP entrepreneurs
Feedstock producers/ suppliers	1-3 Farmers as biomass feedstock suppliers
Feedstock transport	1-3 Private companies providing transport services
Community	1-3 Community leaders living within the radius of 3 kms from the power plant
Government	1 Ministry of Industry officer 1 Local administration organization officer 1 Electricity Generating Authority of Thailand (EGAT) officer
NGOs	1 NGO 2 Academics

The (draft) of Green Business Model of Biomass Very Small Power Producers conceptual framework investigated and suggested by 18 interviewed persons usage of main structure to create the Green Business model of Biomass Very Small Power Producers in accordance with the context of SBSC concept.

4. GREEN BUSINESS MODEL OF BIOMASS VERY SMALL POWER PRODUCERS

This research was the study of the green business model of BVSPP by using the green business concept taking into account the economic, social, and environmental contexts as foundation, and the conceptual framework of SBSC [10,12,12–15] developed from the balanced scorecard concept [16]. The objective was to apply it to the business context of biomass power generation covering the stakeholders in the overall process in line with the concept of biomass supply chain Management [11,17–20] consisting of the following contexts in line with the green economy concept. The researchers formulated the green business model of Biomass Very Small Power Producers conceptual framework as shown in Figure 1.

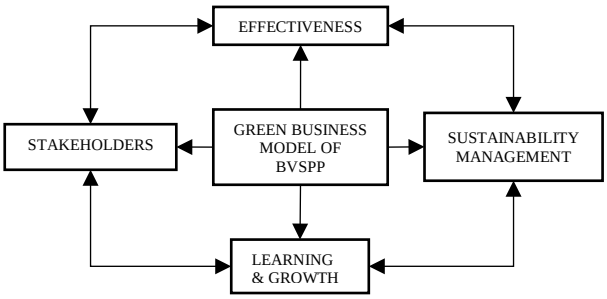

Fig. 1 Green Business Model of Biomass Very Small Power Producers

The green business model of Biomass Very Small Power Producers presented the four key aspects similar to four key perspectives of the SBSC consisting of: Learning and growth aspect, Sustainability management aspect, Stakeholder aspect, and Effectiveness aspect. Each aspect is detailed as follows:

4.1 Stakeholders

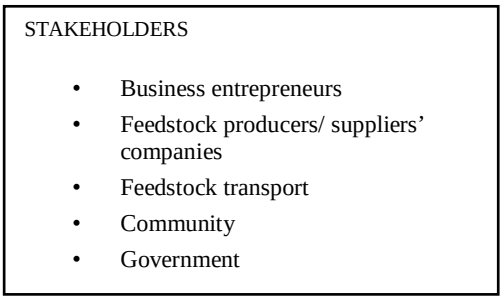

Fig. 2 STAKEHOLDERS aspect in Green Business Model of Biomass Very Small Power Producers

The conceptual framework of stakeholders' aspect was investigated by 18 key informants from stakeholders of biomass supply chain. It focused on specifying type of stakeholders and reflected on how the business was creating stakeholders' value through its strategy and actions. In other words, it was the perspective on how to specify the stakeholders in the concept of Biomass Supply Chain [11,17,18,18–20]. The conceptual framework of stakeholders' aspect was developed from the customer perspective in line with the SBSC concept.

To specify the target groups of stakeholders in green business model of biomass energy power plant, business should use the stakeholder's guideline framework developed from the evaluation of key informants to define type of stakeholders relevant to own operation of biomass power plant as

shown in Table 2.

Table 2 Guideline Framework of Stakeholders

Types of stakeholders	Stakeholders
Business entrepreneurs	- BVSPP entrepreneurs - Shareholders - Officials relevant to process of biomass power generation
Feedstock producers/ suppliers	- Farmers as biomass feedstock suppliers - Communities as biomass feedstock suppliers
Feedstock transport	Feedstock logistics includes all of the unit operations necessary to move biomass feedstock from the land to the bio refinery and to ensure that the delivered feedstock meets the specifications of the bio refinery conversion process [21]. - Private companies providing transport services
Community	- Community leaders - Locals living within the radius of 3 kms from the power plant
Government	Responsible officials from: - Provincial Industry Office - Department of Industrial Works - Ministry of Industry - Office of Energy Regulatory Commission - Local administration organization - Metropolitan Electricity Authority, Provincial Electricity Authority, Electricity Generating Authority of Thailand
NGOs	- NGOs - Academics

4.2 Sustainability management

SUSTAINABILITY MANAGEMENT

Variable Costs

Economic management
- Feedstock provision
- Feedstock transport management
- Biomass feedstock storage
- Shareholder management
- Personnel management
- Quality control of power generation

Social management
- Participation of personnel and community
- Employment of local labor force
- CSR
- Agreement between BVSPP and community
- Community development fund in area surrounding power plant

Environmental management
- Environmental impact management in Biomass Supply Chain (air, energy, water, eco system,

Fig. 3 Sustainability Management aspect in Green Business Model of Biomass Very Small Power Producers

Sustainability management aspect based on the evaluation of business entrepreneurs' interviews was the internal business process perspective that indicated business processes in key internal dimensions. It was the perspective of the management process of BVSPP in the economic, social, and environmental contexts. Most of the business entrepreneurs and officers commented that each activity in Sustainability management aspect including Economic management, Social management, and Environmental management was the variable cost of the investment in power generation. Sustainability management aspect was developed from the internal process perspective in line with the SBSC concept consisting of:

4.2.1. Economic management

- Feedstock provision: Rigorously inspect the quality of biomass bought in each lot in accordance with the standards of quality control of feedstock (Certification of testing of biomass composition).

- Feedstock transport management: Process to manage removal and storage of biomass feedstock during transport from feedstock suppliers to power plant.

- Biomass feedstock storage: Systematic feedstock storage management worth the investment, quality control of storage, prevention, reduced loss of operation for minimum operating costs and maximum use of storage space for

biomass feedstock (depending on distance and seasons).

- Shareholder management: Safeguard and distribute return to shareholders to prevent conflict of themselves, partners, and business.
- Quality control of power generation: Control the process of power generation with stability (Output of electrical units was consistent depending on quality of feedstock such as humidity causing brownout).

4.2.2 Social management

- Community participation: Provide opportunity for the public to determine their own needs for resouce management, decision-making, and control of various activities related to community.
- Employment of local labor force: Employment of local people as part of business operation of BVSPP.
- Social responsibility: Organize Corporate Social Responsibility (CSR) and environmental activities both in and outside the organization towards sustainable development such as donation for social assistance.
- Agreement between BVSPP and community (Commitment): Contribute to the fund according to installation capacity of power plant, grant scholarship to community, improve basic infrastructure to community such as roads, temples, clinics, restrooms.

4.2.3 Environmental management

- Management of environmental impact from power generation processes (air, water, eco system, noise, waste): Determine measures to reduce environmental impacts from power generation processes such as dust filter system from combustion chamber, management of impact on water system, management of eco system around biomass power plant, management of noise pollution, "Eco efficiency" strategies or 4Rs such as disposal or use of waste from combustion.
- Raise environmental awareness: Campaign to raise awareness to personnel in power plant to learn about environment, as well as raising awareness of the environmental problems at national and global levels.
- Compliance with law relevant to operation of power plant: Implementation of policy, targets, rules and regulations, including law, stipulations, standards of environment and safety.

4.3 Learning & growth

Fig. 4 Learning & Growth aspect in Green Business Model of Biomass Very Small Power Producers

Based on information from business entrepreneurs' interview, learning and growth aspect was measures of how well the business prepared to meet the challenges of the future obstacles through leveraging its organizational and human assets. It was BVSPP's learning and growth strategy by which each activity was the variable cost of the investment in power generation covering the impact on the stakeholders of the overall biomass supply chain management consisting of:

4.3.1 Training / learning

- Process of systematic learning management to create or enhance knowledge, skills, ability, and attitude that would improve the efficiency of operation, including raising awareness and campaigning for environment.

4.3.2 Innovation / technology

- Technology usage to increase efficiency in working system, reduce Input (feedstock) and increase Output (electric current) and pollution disposal system.

4.4 Effectiveness

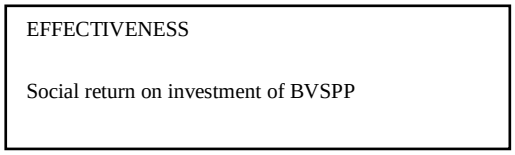

Fig. 5 Effectiveness aspect in Green Business Model of Biomass Very Small Power Producers

Based on information from stakeholders' interview, effectiveness aspect of Biomass Very Small Power Producers production should show the stakeholders' interests and the link between strategic objectives and financial, social, and environmental impacts. It was the perspective that BVSPP executives could inspect the success of BVSPP in economic, social, and environmental fields. Measure the results by using the processing tools from the social return on investment (SROI)

analysis [22] existing in cost–benefit analysis. Which was a methodology for calculating SROI to explain that, for every investment of every single baht, the amount of money the society would receive in return (effectiveness) from the use of biomass to generate power. The analysis and the division of SROI covered economic, social, and environmental dimensions, both in monetary and non-monetary terms, in line with the sustainable development guideline [23]. The SROI could be calculated as follows:

$$\text{SROI of BVSPP} = \frac{\text{Benefits received by BVSPP from investment in power generation}}{\text{Cost of investments in biomass power generation}}$$

The information from key informants revealed that the investment costs in biomass power generation consisted of the following: Fixed costs were the total costs that did not change according to the amount of power generation during the time of operation (machinery useful life) including equipment, machinery, construction, land, feedstock, etc. as shown in Table 3.

Table 3 Guideline Framework of Fixed Costs

Fixed costs	Value
Project development	Baht/Useful Life
Land value	Baht/Useful Life
Equipment, machinery	(Cost Price of Asset – Scrap Value) / Useful Life
Construction (basic infrastructure)	Baht/Useful Life
Commissioning	Baht/Useful Life
Lending interest all through the project	Baht /Useful Life

Variable Costs were the total costs that changed in proportion to the change in the level of activity or amount of power generation which included the following: sustainability management costs and learning & growth costs as shown in Table 4.

Table 4 Guideline Framework of Variable Costs

Variable costs	Value
Fuel	Baht/year
Labor	Baht/year
Feedstock storage	Baht/year
Utilities	Baht/year
Machinery repair and maintenance	Baht/year
Feedstock transportation	Baht/year
Personnel training	Baht/year
Contribution to community development fund in the area around power plant	Baht/year

The information of the value added received by BVSPP from investment in power generation consisted of the following: economic, social, and environmental benefits as shown in Table 5.

Table 5 Guideline Framework of Benefits

Economic benefits	Value
Income from sale of electricity	Baht/year
Reduce import value of petroleum	Baht/year
Social benefits	**Value**
Employment of local labor force	Baht/year
Community income from feedstock of biomass fuel	Baht/year
Feedstock transport in community	Baht/year
CSR activities	Baht/year
Community income from community development fund in the area around the power plant	Baht/year
Environmental benefits	**Value**
Reduced amount of greenhouse gas emission from biomass fuel usage instead of fossil fuel	Baht/year (value of carbon credit from the reduced CO_2)

The effectiveness aspect of Biomass Very Small Power Producers production analysis was then conducted on the SROI Ratio assigning a monetary value to investment costs and benefits (inputs and outcomes), using that assignation to calculate a ratio. For example, if the SROI Ratio is 5:1, which means that every baht allocated on investment costs will generate benefit worth five baht.

5. CONCLUSION

Without establishment of effective mechanism for sustainable management of the business combine with Economic, environmental and social impacts from biomass power production may pose a risk and conflicts to stakeholders of biomass business sectors in Thailand. Green Business Model of Biomass Very Small Power Producers concept is an effective scheme for Biomass Very Small Power Producers as business strategy and its performance focusing on four specific aspects: Learning and growth aspect, Sustainability management aspect, Stakeholders aspect, and Effectiveness aspect. Each aspect has shown a strong and positive link

between successful implementation of a business strategy of Biomass Very Small Power Producers with social and environmental strategies.

Green Business Model of Biomass Very Small Power Producers is innovative and required at a specified time for sustainable operations of biomass power plants in Thailand. It directly leads to sustainable management and benefit in term of social return on investment for all of the stakeholders in biomass energy supply chain (Economic benefits), all of which respond to the environment and reduce greenhouse gas emissions, particle pollution and carbon-monoxide emissions (Environmental benefits). That also makes immense and positive contribution to rural economy of Thailand **(**Social benefits) in terms of income and employment to farmers, entrepreneurs at village level, and rural youth. Which also leads to development of other value-added products such as biofuels and establishment of small-scale industries such as biomass briquetting plants.

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