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**Education on Renewable Energy and Power Energy Saving**  
**Considering Environmental Behavior for Vocational Schools**

Siti Sendari<sup>\*</sup>, Waras, Yuni Rahmawati

*State University of Malang, Jl. Semarang No. 5, Malang-65145*  
**INDONESIA**

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**Abstract**

This paper studies technologies of saving energy, renewable energy and students' awareness behavior. State University of Malang as a learning university, proposes a pilot project in learning method called **Energy Education**, which aims to empower students to consider energy awareness using action-oriented learning. Energy Education will be studied considering three important parts, i.e., Technology, Academic Community (Students and Lecturer), and Officer (Rector, Dean, and Head of Department), which are mutually dependent. In order to realize the Energy Education in Malang in a competitive way, the research collaboration between the State University of Malang and State University of Kitakyushu is proposed, where this research integrates Technologies, Awareness Behavior and Government policy. Beside of improving technologies, the behavior awareness of academic community in State University of Malang will be improved by sharing the knowledge of Energy Education, where this research will also provide suggestions to the department to enhance the Energy Education.

*Keywords* : Energy education, renewable energy, saving energy, students' awareness behavior.

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**1. Introduction**

The availability of energy becomes an important requirement to develop countries, where the consumption is mostly used for industry, transportation, public services, and residential. According to the world energy statistics [1], public services and residential consume energy higher than the others, which grows from 44.1% in 1973 to 56.9% in 2010. Here, fossil fuels supplied 75% of total consumption of the electricity generation since 1971 to 2010. Considering of decreasing fossil fuels production, costs, and air pollution, the sustainability of this energy becomes a main issue, which should be highly anticipated.

Even though, Indonesia is a country which produces fossil fuels 2.7% of the world [1], the government aims to control the economics to maintain the sustainability of energy, because the production of fossil fuels was decreased in past 5 years [2]. Then, the discovery and addition refineries should be done to increase oil reserves. However, this recovery is not proportional to the rate of depletion of fuel production. In order to encourage the sustainability of energy, the government determines a blueprint of national energy management for 2006 to 2025, that is, Indonesia needs to control energy demands, which achieve 41% reduction of total primary energy supply (TPES) in 2025 [3].

Currently, the development of diversification and renewable energy to decrease dependency on fossil fuels becomes a major issue, which is planned by many countries to maintain the sustainability of energy. The renewable energy studies on diversification of energy, integration opportunities, challenges, and implications of utilizing biomass, geothermal, hydropower, solar resources, wind-powered system and ocean technologies for generation technology improvement, electric system operational constraint, and electricity demand [4]. Indonesia has a large new and renewable-energy potential as explained by the Director General of Electricity

and Energy Conservation at the Focus Group Discussion on the Supply and Demand of New and Renewable Resources [5]. However, the utilization of renewable and alternative energy is very low compared to the existing potential. The alternative energy is still limited to electrical power generator, where total of electrical energy is about 25.3TWh or 15% of total electrical resources in 2010 [6]. On the other hand, the energy consumption continues to rise along with economic growing.

In order to support the National Energy Conservation Plan (*Rencana Induk Konservasi Energi Nasional*, or RIKEN) [3], power energy saving can be supported by improving efficiency of utilization energy implemented on the energy providers, utilization equipments, and user. Here, user is the last key in the utilization of energy, where the energy user in Indonesia tend to lead to wasteful and consumptive nature, which is evidenced by the high index of energy consume while the economic growth is still low. Therefore, the behavior of energy consumption requires to be changed involving various stakeholders, especially the government.

There are two meanings of energy efficiency, i.e., better use of energy through energy-efficient technologies and energy saving through changes of users' awareness and behavior. The meaning of energy efficiency which is explained by the government is about a new technology which uses the best technology to consume less energy, such as, using low-energy light bulbs and keeping appliances in standby mode [6]. After all, new technologies can only have little effect to the energy efficiency if users do not support the efficient behavior. The effective method to change the consumptive behavior of citizens is to give knowledge and attitude of energy utilization through a change of behavior / habits. Thus, an education on energy could be an appropriate method for changing the behavior. Some countries, like Brazil, Spain, Belgium, and Italian show how effective energy education can save energy and promote energy efficiency [7].

In order to realize the technologies of saving energy, renewable energy and users' awareness behavior, State University of Malang as the learning university proposes a pilot project in learning method called **Energy Education**, which aims to empower students to consider energy awareness using action-oriented learning. Energy Education will be studied considering three important parts, i.e., Technology, Academic Community (Students and Lecturer), and Officer (Rector, Dean, and Head of Department), which are mutually dependent.

- a. In the case of technology, the State University of Malang develops the Energy Education by developing a Laboratory as an infrastructure to practice the Energy Education under the Faculty of Engineering. This laboratory will support activities to design, implement, and analyze renewable energy systems, automatic saving energy, and also systems with environmental friendly. Here, technology is urgent to be prepared because many vocational schools enhanced their curriculum with renewable energy [8], where Malang City has many renewable energy potentials, which need to be explored more [9-11].
- b. In the case of Students, the aim of the State University is to produce prospective teachers for vocational schools. Then, it is very urgent to involve the students of State University of Malang to participate on Energy Education, where the graduated students will teach vocational schools which may enhance their curriculum with renewable energy. The learning method which will be used here using action-oriented learning, where students study the subject of renewable energy systems, automatic saving energy, and also systems with environmental friendly, they also practicing the behavior to maintain the environment and energy.
- c. In the case of Officer (Official Department), the successfully Energy Education will be also depended on the rules determined by Officer. Then, this research also aims to analyze the rules which will support the Energy Education.

The University of Kitakyushu is a Campus model in Japan, which built the campus considering the environmental friendly and is equipped with renewable energy and energy saving systems. The both of University of Kitakyushu and the State University of Malang has a Memorandum of Understanding (MOU) to make a joint research which has been signed in March 25<sup>th</sup>, 2014 in order to support Energy education in State University of Malang as a pilot project in Malang city.

The objectives of this research aims in the first year can be determined as follows.

- a. Considering the environment of the campus which is surrounded with trees while the waste is left to rot in an open field, while it could be used a potential useful renewable energy. Then, this waste could be processed using a biomass system to produce an alternative energy such as electricity. Thus, the objectives

of this research are to develop a biomass system and to analyze the potential to produce the electricity.

- b. On the other hand, the behavior of the people when using the energy (here, we focus on electricity uses) should be observed in order to realize energy education to improve the energy efficiency. Thus, a method to improve the behavior awareness will be proposed and analyzed, where it will be compared with a method used in Japan.

### *Energy Education*

The students of engineering, physical science, and social science courses are interested to study energy and renewable-energy fields. Hence, the enhanced model which incorporates renewable-energy education into engineering curricula has been studied in [12]. It consisted of four steps, i.e., (a) to develop an energy minor curriculum with a track dedicated to renewable energy, (b) to develop an upper-division undergraduate engineering course on renewable energy, (c) to form a student energy club, and (d) deliver a ten-week summer research program that engages undergraduate students in renewable-energy. These steps were carried out by an interdisciplinary team of faculty, staff, and scientist, which prepared students for careers in renewable energy to meet workforce needs. This research has been awarded a three-year grant.

The energy education is also possible to be integrated to the curriculum of vocational schools such as electrical engineering [13], computer engineering [14], while energy education as well can be collaborated and disseminated to the Pre-University Power Lessons [15], furthermore the Oregon Institute of Technology has begun a new Bachelor of Science Program in Renewable-Energy Systems [16]. The curriculum of the renewable-energy systems has been organized in the power electronics curriculum [17]. While the main goal of the power electronic technology is to convert electrical power from one stage to another stage as efficient as possible with a high level of intelligence, the fundamentals and the inter-disciplinary technical fields are important to cover the power electronics technology in a competitive way in the curriculum.

As explained before that inter-disciplinary technical fields are promising to be integrated as education energy as performed by Humboldt State University, which integrates energy and power to environmental engineering curriculum with just-in-time teaching [18]. The assessment activities for the entire course indicate that the course activities boost students' confidence in their major choice and also their technical skills. This concept is attracted, which could be possible to develop a curriculum, which integrated the electrical engineering with environment engineering to overcome the problem in the campus. The curriculum examines inter-disciplinary technical fields as the combinations of renewable-energy with electric engineering in order to overcome the garbage. In order to develop an appropriate curriculum, this research is supported by the Faculty of Environment Engineering of the University of Kitakyushu, Japan, which has a huge experience in environmental problems.

Since there is a number vocational school in Malang, such as Diploma degree and vocational senior high schools; the curriculum should be appropriate to those students. Chen, et al. [19] have observed a power system and energy curricula for high-school students, which shows that a positive attitude toward engineering among high-school students. The research suggested that the program can be improved by adding activities to increase students' confidence in their ability to succeed in engineering career, such as adding more emphasis on creativity in the designs. Furthermore, DeWaters [20] observed a Project-based Learning Pedagogies to study Improving Energy Literacy showed greater cognitive gains to the related topics.

The proposed method here is used a collaborative learning, which can be divided into : (1) In-class Group Activities, (2) Peer Learning, (3) Adjunct Collaborative Frameworks, (4) Extended Team-based Tasks, (5) Out-of-class Distributed Activities, and (6) Group Programming.

Researches in peer learning have been conducted in schools, which have come to be used to increase improbable learner groups. Peer learning is increasingly found in colleges and universities, where the implementations could be controlled to measure the process systematically. Furthermore, peer learning has increasingly could also be used in implementations of domestic or community contexts, voluntary organisations, after-school clubs, because the population involved as helpers and helped whom have their own considerable intrapersonal challenges [22].

Considering the characteristics of learning, which could involve students together with benefits to helpers and helped, Peer learning is considered to be used in this research. Peer learning will involve the faculty member, student organization, and new comer. The following aspects of organisation in peer learning need to be

considered [23].

- Context – there will be problems and opportunities specific to the local context.
- Objectives – consider what you hope to achieve, in what domains.
- Curriculum area.
- Participants – who will be the helpers, who will be the helped, and how will you match them? There will also have to be trainers and quality assurers.
- Helping technique – will the method used be packaged or newly designed?
- Contact – how frequently, for how long, and where will the contact occur?
- Materials – what resources will be required, and how will they need to be differentiated?
- Training – this will be needed for staff first, then for helpers and helped.
- Process monitoring – the quality assurance of the process must be considered.
- Assessment of students – the product and the process should be assessed; consider whether any of this should be self and/or peer assessment.
- Evaluation – you will need to find out whether it worked.
- Feedback – this should be provided to all participants, to improve future efforts.

## 2. Methodology

In order to realize an Energy Education in State University of Malang, besides of developing technologies, the behavior awareness of academic community in State University of Malang should be improved by sharing the knowledge of environment and energy awareness, called behavior awareness. Furthermore, in order to accomplish Energy Education successfully, rules or policies of head department are needed. Thus, the model of Energy Education can be figured as Fig. 1. Here, the Energy Education's objectives are described as follows.

- The technology of renewable energy systems is introduced using video learning to show how the systems work and their impacts to the environments. On the other hand, a small scale biomass system is built to give experiences to students to process garbage and improve their awareness to the environment. This biomass system is selected considering the environment of the Malang-Batu city, so it could be implemented to the community service.
- Behaviour awareness is to educate students to save energy usage and aware the environment.
- Policy/rules, which support saving energy and environment awareness, are proposed to the head of department in order to enhance Energy Education.

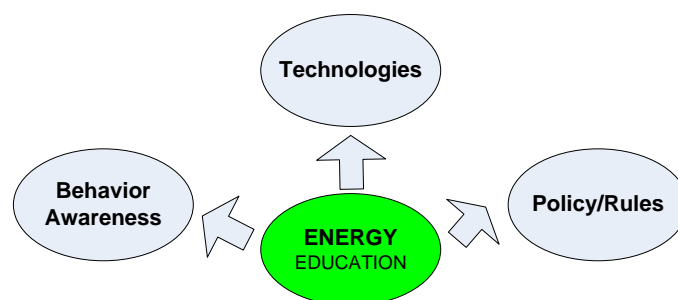


Figure 1 Developing Energy Education

### 2.1. Developing Learning Media of Renewable Energy

Introducing renewable energy is very important to support Energy Education. Instead of developing and implementing the technologies which take high cost, video and animation could be used as a media learning. to

introduce renewable energy systems. Kitakyushu is an eco-town in Japan, where the technology of renewable-energy could be referred for developing the learning media. Here, the model of introducing learning media in the proposed Energy Education adopts the electric energy systems using renewable energy introduced by Capesta [24] as shown in Fig. 2. Thus, discussion of renewable energy consists of :

- a. Renewable energy systems
  - Biomass energy systems
  - Photovoltaic array / Solar cell syatems
  - Wind turbine systems
  - Hydro power system
- b. Energy Conversion systems
- c. Power electrical grid

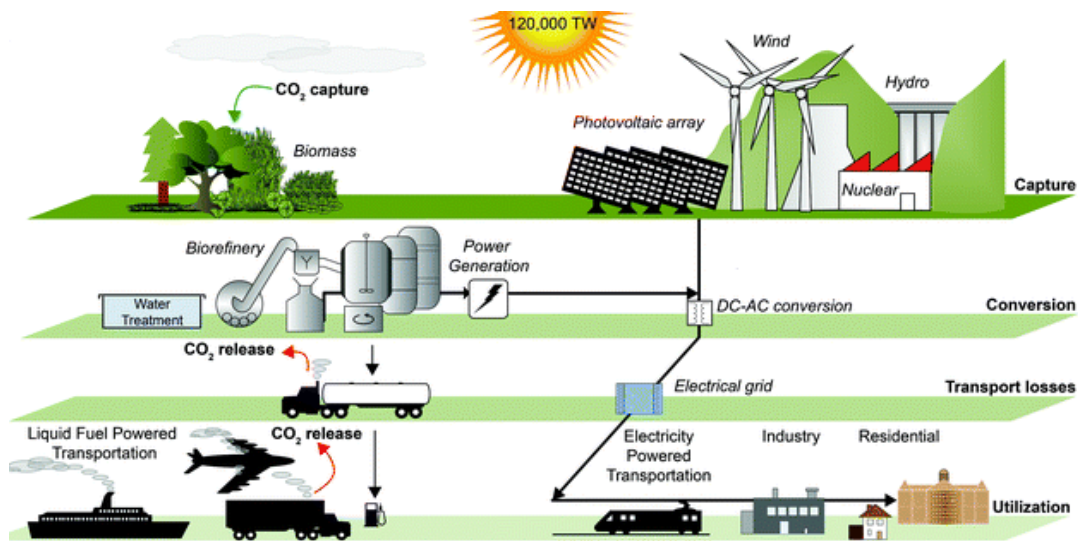
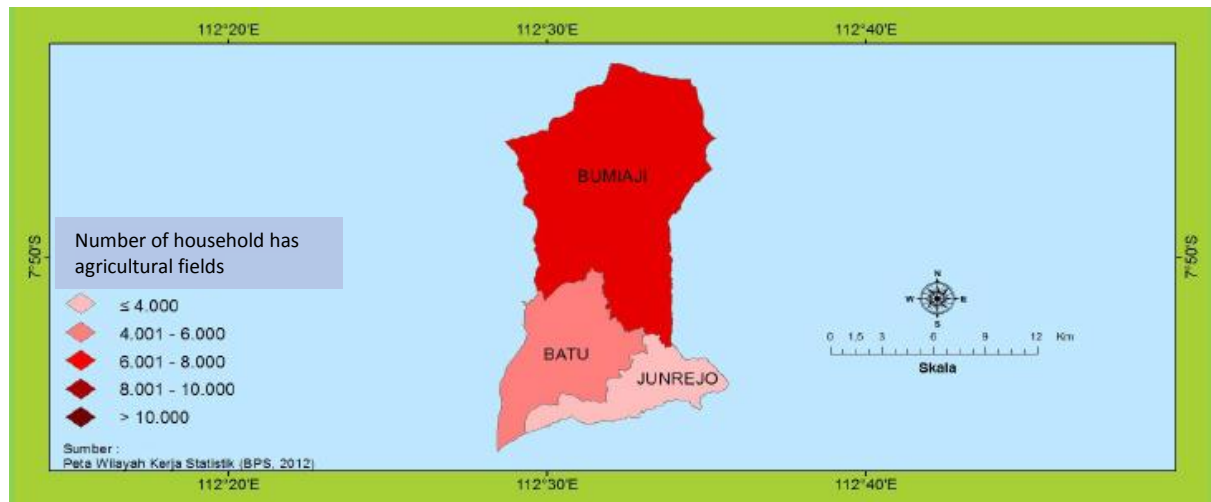


Figure 2 Overview of complete electric energy systems using renewable energy [24].

## 2.2. Developing a Small Scale Biomass System

In order to give experiences to students in garbage processing and improve environment awareness, developing a biomass system is needed. This system is selected considering the environment of Malang-Batu, where there are many residues as potential materials to produce alternative energy, especially in Batu, there are many agriculture fields and farms for producing biomass energy, as shown by Statistical bureau in Fig. 3.



(a)



(b)

Figure 3 Agriculture field and farming in Batu [25]

Considering the characteristic of the city that the farms are treated traditionally by household farmers, thus a small scale biomass systems is more appropriate to be developed. The construction of the developed biomass system is shown in Fig. 3.

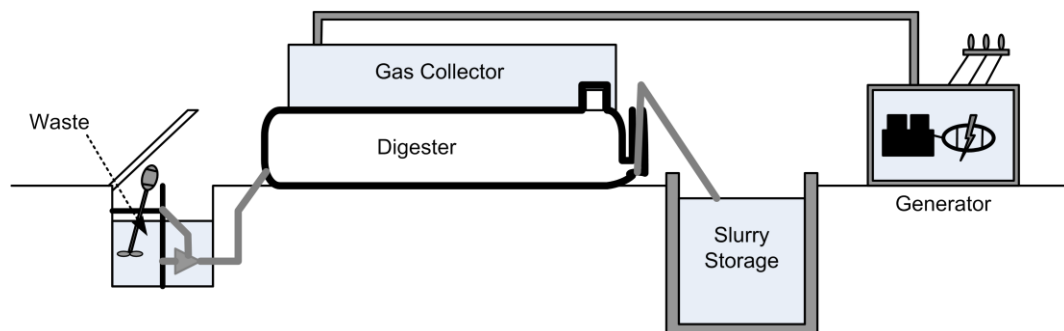


Figure 4 the designed small scale biomass systems

The objective developing small scale biomass here is to observe :

- Observe the volume of biomass gas while using manure, house hold garbage, animal manure.
- Observe the length of producing biomass gas while using manure, house hold garbage, animal manure.

### 2.3. Observing Students' Behavior in Energy Usage and Environment Awareness

Students' behavior in energy usage is observed using an exercising where students should be able to estimate their personal electricity usage as a mean of introducing basic facts about energy issues. Using this exercise, students could estimate the annual electricity consumption for their bedroom (not an entire house). The activities consist of creating a list of electrical devices, recording the rated wattage, estimating the hours the device is used, and calculating the annual cost estimation [26].

The learning model for behavior awareness is proposed as shown in Fig. 5. This learning model integrates the department officials, student official, class group and students in general. The learning process is carried out using peer learning.

The objective of this learning is to improve the awareness of the students in energy usage and finally transform the awareness to the community service.

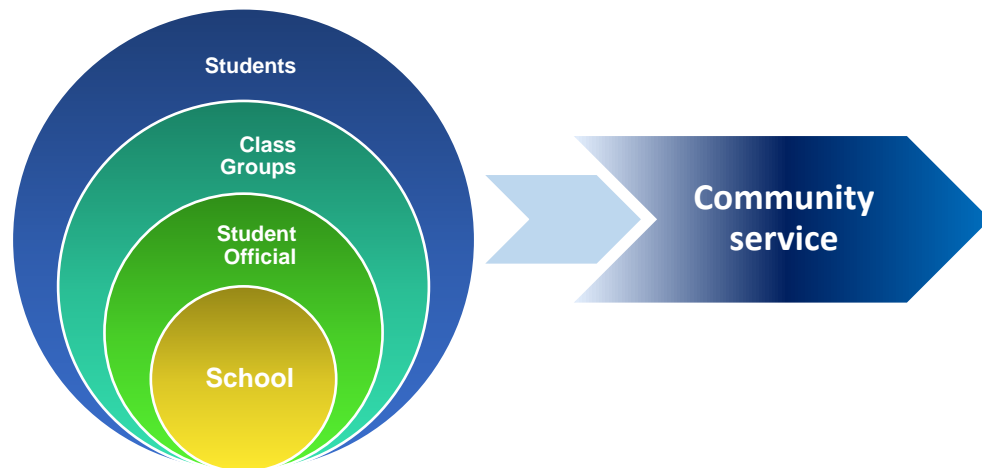


Figure 5 Learning model for energy education

### 3. Conclusion and Future Work

This research studies a method of educating energy to a community in order to support government policy to reduce energy consume. The method is named as energy education, which integrates school and community. Here, peer teaching method is used, so educating from a small group will be spread to a larger number of community.

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