

INTEGRATING RENEWABLE ENERGY EDUCATION IN JUNIOR AND SENIOR HIGH SCHOOLS' CURRICULUM IN INDONESIA

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INTEGRATING RENEWABLE ENERGY EDUCATION IN JUNIOR AND SENIOR HIGH SCHOOLS' CURRICULUM IN INDONESIA

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ABSTRACT

Energy crisis due to the depletion of fossil fuel becomes a global issue nowadays since it will risk the energy security. To overcome the challenge, the effort on renewable energy development as substitute energy sources of fossil fuel has been widely conducted. Technology on producing many type of renewable energy has improved significantly. However, to reach a successful implementation of renewable energy at large scale utilization, the public literacy and confidence on renewable energy application is absolutely required. Renewable energy literacy starts from renewable energy understanding. The citizen's understanding on renewable energy can be developed systematically through education. The topic on renewable energy can be introduced into the classroom for the junior and senior high school students. This topic can be delivered as an integrated part of the curriculum of both science and social subjects. Sciences teacher can focus on the topic of energy form, renewable energy technology and application, and the impact of many type of energy sources utilization. On the other hand, social teacher can focus on enhancing the student's awareness on renewable energy utilization, citizen role on energy conservation and management, and improving social behavior which supports the energy sustainability. Energy education needs active participation of the students. Students involvement on the energy education can be enhanced through some activities such as: classroom discussion, small projects activity, field trip, and social campaign. The integrated teaching in both sciences and social classes will provide not only knowledge to the students, but also insight and renewable energy literacy. Energy education also provides the students with an understanding of the technologies and the political and economic systems that will put a platform for a clean, sustainable energy future. Energy education is important to be given since the earlier age of the youth to prepare the students as the future leaders.

Keywords: Renewable energy, energy education, energy literacy, students, teacher

INTRODUCTION

Energy crisis and environmental problem caused by fossil fuel have become a global issue nowadays. The world's energy demand has been increasing rapidly. On the other hand, the fossil fuel reserve is reducing. This situation has raised the problem related to energy security at global and national level [1].

Energy security itself relates to safeguarding the country's energy future by securing a stable and secure supply of energy at affordable prices. Indonesia is still far from having energy security in the future. Pertamina, the Indonesian Oil company, has reported that the total primary energy consumption in Indonesia has increased by more than 50% between 2000 and 2010. On the other hand, oil production is only reaches 861,000 barrels per day in 2012. Meanwhile, the oil reserves have declined by more than 1.9 billion barrels since 1992 [2].

To overcome the challenge, the effort on renewable energy development as substitute energy sources of fossil fuel has been widely conducted. Technology on producing many type of renewable energy has improved significantly. Besides, Indonesian government has determined a long term plans to build an energy mix that includes a larger proportion of renewable energy sources. Therefore, the current issues on environmental pollution and the decreasing of fossil fuels reserves have promoted the concern on the development of

the alternative energy sources [3]. Renewable energy is prospective to fulfill the energy demand in Indonesia as green and clean energy resources today and in the future. However, to reach a successful implementation of renewable energy at large scale utilization, the public literacy and confidence on renewable energy application is absolutely required. Renewable energy literacy starts from renewable energy understanding [4].

The citizen's understanding on renewable energy can be developed systematically through education. The topic on renewable energy can be introduced into the classroom for the junior and senior high school students. This topic can be delivered as an integrated part of the curriculum of both science and social subjects. Sciences teacher can focus on the topic of energy form, renewable energy technology and application, and the impact of many type of energy sources utilization. On the other hand, social teacher can

focus on enhancing the student's awareness on renewable energy utilization, citizen role on energy conservation and management, and improving social behavior on energy usage in correlation with environmental aspect. The integrated teaching in both sciences and social classes will provide not only knowledge to the students, but also insight and renewable energy literacy.

Energy Literacy itself is defined by the US Department of energy as "an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems". Energy-literate citizen means that the people can track energy flows; know the quantity, source, and purpose of energy they use; understand the impact and consequence of their energy utilization [5]. *Energy literacy should be developed by the support of natural science as well as social science since energy issues need an understanding of science, engineering and technology, mathematics, social and economic aspects.*

The teaching of sciences and social subjects involving renewable energy education for students at junior and senior high schools will become a primary step to build community literacy on renewable energy. The understanding on renewable energy since their earlier age is an excellent platform for developing citizen's literacy on renewable energy. It is because the today's students will be the future's leader and policymaker. The successfulness of renewable energy education model for students in USA, Greece, Turkey, and Jordan can be adopted as a role model in Indonesia with some modification [6, 7, and 8].

3. RENEWABLE ENERGY TOPIC IN SCIENCES SUBJECTS

In the high school curriculum, renewable energy topic can be embedded in science subjects such as integrated sciences (IPA Terpadu) for junior high school and in subjects such as Biology, Chemistry, and Physics for senior high school. The teaching on renewable energy should consist of main sub-topics which is beneficial to develop renewable energy literacy. The important sub-topic are as follows: 1). Energy definition and form of energy; 2). Types of Energy Sources: Renewable and Non-Renewable Energy Resources; 3). Types of

Renewable Energy Resources; 4). Utilization of renewable energy in daily life; 5). Advances in renewable energy technology; 6). Energy utilization and environmental impact.

The first sub-topic is an introduction on the energy definition and the form of energy. Initially, teacher can present the basic concept of energy and energy source, where the energy comes, and the significance of energy in nature. To raise the students' interest in this topic, teachers can ask students to identify and explore the form of energy in their surroundings. To elaborate and go deeper on the topic discussed, teacher can conduct a field trip which provides an opportunity for the students to have insight on the energy terminology.

After the students comprehend the basic energy concept, they further learn about the two types of energy resources, renewable and non-renewable energy resources. This sub-topic starts from fact that energy is important in our daily life and become the engine of sustainable development. Energy availability is also one of the indicators of life quality [9]. Starting from this point, teacher explains that nowadays the main energy source is fossil fuel and it becomes a global problem since the oil reserve is diminishing. The depletion of fossil fuel stocks causes the world's energy crisis. Teacher illustrates the long way and duration needed by the nature for the formation of fossil fuel as depicted in Figure 1 [10]. Teacher then concludes that fossil fuel is among the non-renewable energy resource since it takes such a long time to create it.

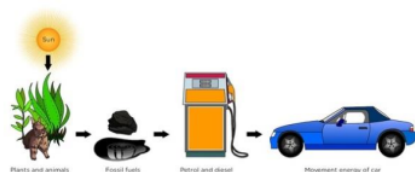


Figure 1. Illustration of Fossil Fuel Formation

As an alternative to this non-renewable energy source, teacher describes about renewable energy resources. Comparison between non-renewable and renewable energy resources is demonstrated in Figure 2 [11]. To increase the students' critical thinking, teacher

invites the students to give opinion and perception about the important of renewable energy resource for sustainable development. This is the basic step towards renewable energy literacy.

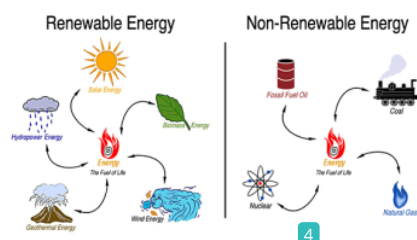


Figure 2. Comparison between Renewable and Non Renewable Energy Resources

The subsequent topic is types of renewable energy resources. At the beginning of the class, teacher explains the definition of renewable energy and the importance of this alternative energy in this era. Students are requested to explore kinds of renewable energy resources in their surroundings. Teacher elaborates by stating the types and forms of renewable energy such as solar, wind power, hydroelectricity, biomass, hydrogen and fuel cell, geothermal power, energy from tides, ocean wave energy, hydrogen fusion, etc. [12].

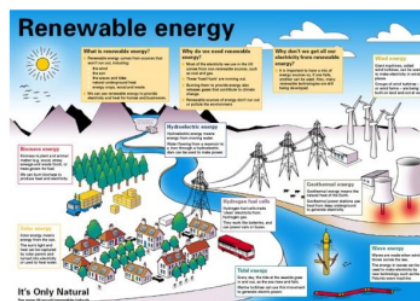


Figure 2. Illustration of Renewable Energy Sources

While discussing this topic, students are encouraged to search and evaluated the types of renewable energy which are abundantly available in Indonesia, low-cost, and applicable. They are given a worksheet to identify the real example of each renewable energy source in Indonesia, the advantage

and disadvantage, and the possible application. They are also asked to critically identify the source of renewable energy in Indonesia which has not been optimally utilized yet, and furthermore the students should write a short idea about how to optimize the renewable energy potential to support energy sustainability in Indonesia. Small project on renewable energy development will be an interesting part of deeply learning this topic.

Advanced technology on renewable energy development is the next interesting topic to be taught in the classroom. Discussion on the application of solar cell, wind energy, technology for biodiesel and bioethanol production at industrial scale, biogas production at small village, biogas at large scale production as bio-methane source, micro hydro-electricity for rural area, fuel cell for electric car are among will motivate the students to learn more on renewable energy theme.



Figure 3. Electric Car Prototype “Pandawa”



Figure 4. Sample of Biodiesel as Alternative Fuel for Diesel Cars and Machines

To make this topic easy to understand by the youth, it is also useful to use interactive learning

media to explain the recent development on renewable energy technologies. Many videos are available in You Tube. The videos are presented in various style of demonstration, such as animations of advanced industrial processes of renewable energy production, the showing of real industrial process, exhibiting the application of renewable energy in daily life, the laboratory development of renewable energy process, etc. The example of you tube videos on the development of biodiesel technology can be accessed through this link: <https://www.youtube.com/watch?v=5FR5g9JDXgI>. The video about the principle of photovoltaic system and its application in daily life are also accessible in You-Tube, such as: <https://www.youtube.com/watch?v=xHUw97XGiK0>. Many other attractive videos related to renewable energy are also available and can be searched in You-Tube.

After watching the video together, teacher can take the students to the future vision. Ask them to build their idea of future invention related to renewable energy development and utilization. Students can present their idea by writing a paper or drawing a picture describing their innovative idea. Their ideas are then shared to the class through a presentation and interactive discussion. Teacher should appreciate each idea to develop the students' awareness on renewable energy utilization.



Figure 5. Bus Fueled by Bio-Methane in England

Renewable energy literacy is completely built when students understand the impact of energy utilization to the environment and human life. Firstly, teacher should introduce the concept of carbon cycle. The Carbon cycle is the process by which carbon moves from the atmosphere into the earth and its organisms and then back again. Carbon is important since it is an element which becomes a key component of every living organism and our atmospheric air. Carbon compound cycles through

the earth, living organism and air continuously as exhibited in Figure 6.

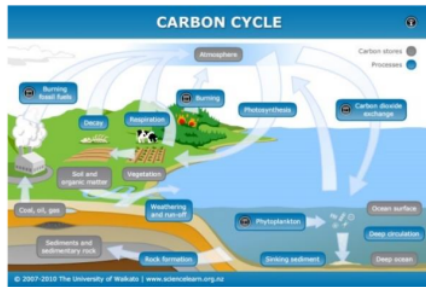


Figure 6. Carbon Cycle Diagram

Carbon cycle is important because carbon is the fundamental building block of life. For the ecosystem, it is essential since carbon-containing gases in the atmosphere affect the earth's climate. If the balance of the carbon cycle cannot be reached, it results in many environmental problems such as global warming and climate change. Utilization of fossil fuel will disturb the carbon cycle, which as consequence, brings about negative impact to the environment and human life. When *fossil fuels are burned*, the stored *carbon* is discharged into the atmosphere as CO_2 . The *carbon* is then free to *travel* through the Earth and can shift the natural balance of the *carbon* available. It hence can cause climate change and global warming in the earth.

While explaining the carbon cycle topic, teacher can motivate the students to share their opinion on how to overcome the environmental problem caused by fossil fuel utilization. In this session, teacher also guides the students to concern on the utilization of low carbon or zero carbon energy sources as replacement to the fossil fuel. Teacher gives example of low-carbon feed-stocks of energy such as biomass-based energy. Teacher show the diagram of carbon on biomass cycle (Figure 7) and ask the student to share their idea to describe the reason that stating biomass-based energy as low-carbon energy.

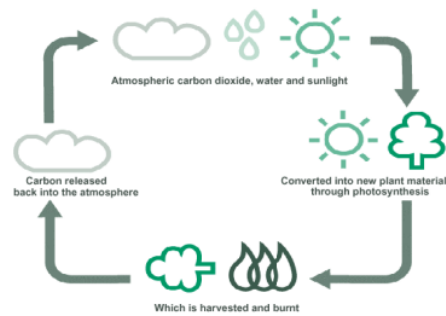


Diagram Figure 7. Carbon in Biomass [13]

The other alternative to fossil fuel is the non-carbon containing energy resources such as solar power, wind power, hydro-electricity. Teacher can invite the students to reveal the advantage of these types of renewable energy source to the environment and human life. To finish the topic of renewable energy education in class, teacher can give assignment to the students in groups for a small scientific project related to renewable energy topic.

4. RENEWABLE ENERGY TOPIC IN SOCIAL SUBJECTS

Renewable energy education to raise the students' on energy literacy can also be delivered in the social classes. Social teacher is more expected to build the students' awareness on energy efficiency and social acceptability of renewable energy utilization and technology. Meanwhile, the basic knowledge of energy and renewable energy have been explained by science teachers. Social teacher can compose the lesson plan on renewable energy education with the different sub-topics as follows: 1). The role of energy to human life and sustainable development; 2). Current issue on the fossil fuel oil depletion and the impact to social-economy aspects and national security; 3). Recent development of renewable energy to enhance energy availability in Indonesia; 4). Regulatory reformation to increase economic and social acceptability of renewable energy utilization; 5) Human factor in energy conversion management; 6) Character building: citizen awareness on energy efficiency and renewable energy application as the platform of future energy sustainability.

Teacher can start the class by explaining the recent progress in modern human life such as: transportation sector, industry, and national development. This growth happens by the support of energy as the driving force of human life and sustainable development [9]. In this discussion, teacher can ask the students to mention example of the function of energy in social life. Then, teacher asks the students' opinion about the current issue on the depletion of fossil fuel as the primary energy source to date. Teacher elaborates the students' opinion with an insight about the impacts of fossil fuel availability on social-economy aspects as well as national security. National security is supported by energy security, which relates to safeguarding the country's energy future by securing a stable and secure supply of energy at affordable prices. Teacher underlines that energy security and the easy energy accessibility strongly correlates to the social welfare [14].

While fossil fuel reserve is critically reducing, development of renewable energy sources is important to ensure the energy security. To comprehend the discussion, teacher invites the students to mention examples of renewable energy in Indonesia as well as their application in the community. Teacher concludes that development on renewable energy will enhance the energy availability. For example, the usage of biodiesel and bioethanol for automobile substitute-fuel provides significant benefits. It also saves the Indonesian foreign exchange income.

The portion of renewable energy utilization is still small compared to the potency available in Indonesia. Thus, teacher can ask the students on their ideas to improve utilization of renewable energy in Indonesia. To improve the students' critical thinking, teacher can elaborate with the idea of the reformation on regulatory, marketing aspect, distribution system, and social campaign to improve the social confidence and acceptability on renewable energy utilization in larger-scale application.

Energy education is also a part of character building in social point of view. Hence, teacher can deliver the topic of energy conversion management and energy efficiency by self-evaluating on the energy usage in daily life. Teacher assigns the students to do self-assessment on their attitude of energy utilization in their daily life. The students should assess themselves whether they have put on the energy saving principle while they use energy in their daily life. They also asked to evaluate their

portion on renewable energy usage. After the evaluation, students are invited to make recommendation of suggested behavior that support energy efficiency and renewable energy utilization.

The systematic theme given in energy education topic will provide the students with an understanding of the technologies and the political and economic systems that will put a platform for a clean, sustainable energy future.

In the end of the class, assignment related to social campaign on energy efficiency and renewable energy utilization can be given to students. Social campaign will give opportunity for the students to improve the public energy literacy. Social campaign can be presented in social media, exhibition, or by other means of publicity. This activity is a part of the pathways to prepare the students as the future leaders and agent of changes.

5. STUDENTS INVOLVEMENT

Student involvement in energy education is important in order to build the energy literacy and renewable energy awareness of the students. Students' active participation can be carried out through the following methods:

- a. Evaluating students' perception on efficiency and renewable energy utilization.
Students are given questioner to self-assess their life-style on energy usage in daily life, their perception on energy efficiency, and their basic knowledge on renewable energy. This questioner is provide before and after the energy education is taught to reveal the impact of energy education on the students' energy literacy.
- b. Small project on renewable energy
Small project related to renewable energy technology is attractive and can provide deep understanding to the students. Some simple activities to conduct for small project are, just mention a few: conducting laboratory activity to prepare biodiesel from waste cooking oil, composing biogas from animal waste, making miniature of wind turbine generator for demonstration.
- c. Field Trip
Field trip to renewable energy sites will improve the students understanding on renewable energy issues as well as enhance their enjoyment in learning. Some interesting sites to visit for instances are: bioethanol factory in Yogyakarta, biogas center in tofu industry in Central Java, micro hydro- electricity system in rural area, etc.
- d. Social campaign

Social campaign will increase students' participation in rising public's energy literacy and renewable energy awareness. Social campaign can be conducted by writing a feature in social media, writing in mass media, making a poster, making a video presented in you-tube, socialization and training to the community, and so on.

The systematic education on energy issues is important as the means for assisting the students to deal with present and future energy necessity and the implementation of appropriate attitudes, lifestyle practices and behavior which support energy sustainability.

6. CONCLUSION

Citizen's literacy in energy and renewable energy is important to support future energy sustainability. Integrating energy education in junior and senior high school curriculum is an excellent step to systematically build energy literacy at earlier age of young generation. Energy education can be delivered both by science and social teacher and should involve the students' active participation through classroom discussion, small project, field trip, social campaign, and other activities. The systematic lesson given in energy education to ³ will provide the students, as future leader, with an understanding of the technologies and the political and economic systems that will put a platform for a clean, sustainable energy.

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