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Analysis of the Need to Develop the Concept of Sustainable Energy Education (SEE) to Support the Socialization of the Clean and Affordable Energy Transition in Indonesia

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Abstract

Global boiling, a term illustrating the severe effects of global warming and climate change, highlights the urgent need for Sustainable Energy Education (SEE) to transition from conventional to clean energy sources. Despite its critical importance, research on SEE is limited, and no comprehensive concept exists in Indonesia. This study aims to address this gap by developing a phased and systematic SEE framework designed to promote the gradual adoption of clean energy solutions. Using qualitative descriptive methods, including observation and interviews, the research identifies educational needs and stakeholder support for SEE. Findings indicate a strong consensus on the concept's relevance and potential to enhance public understanding of renewable energy. The proposed framework represents a novel approach to energy education, crucial for Indonesia's clean energy transition. To ensure successful implementation, it is recommended that schools incorporate SEE into their curricula, while the government and renewable energy sectors support this initiative through regulatory facilitation and financial backing. Such coordinated efforts are essential for achieving a sustainable and impactful transition to clean energy.

Keywords: education; clean and affordable energy; SDGS 7, sustainable energy education

1. Introduction

Global warming is a phenomenon where the earth's average temperature increases. In the last 100 years, the earth's temperature has increased quite rapidly, an average of 0.6–0.9 degrees (Ardiani, 2023). The earth feels increasingly hot. The era of global warming is now over. However, UN Secretary-General António Guterres says the Earth now faces a more severe era of global warming, or global boiling, as scientists have confirmed that July 2023 will be the hottest month on record (Niranjan, 2023). Global warming is a term used metaphorically to describe conditions of extreme climate change. The term "global warming" paints a dramatic picture of the growing problem of climate change and calls for collective action to address it (Megasari, 2023).

SDGS (Sustainable Development Goals) is a set of sustainable development goals launched by the United Nations as a global effort to address various social, economic, and environmental challenges around the world (Ardiani, 2023). The SDGs include 17 goals with specific targets that must be achieved by 2030 (Arfandi, 2020). One of these goals is Goal 7, which is "Clean and Affordable Energy" (Arlianti, 2022). SDGs 7 (7th Sustainable Development Goal) is one of the 17 Sustainable Development Goals set by the United Nations (UN) in the 2030 Agenda for Sustainable Development. SDGs 7 focuses on "Clean and Affordable Energy". The goal of SDGs 7 is to ensure universal access to affordable, reliable, sustainable, and modern

energy by 2030 (Indonesia, 2023). This goal includes several key targets that reflect the urgency and importance of energy in sustainable development.

Education for Sustainable Development (ESD) is an effort to give individuals the ability to be maximally productive and creatively respond to global challenges, with the ultimate goal of creating a sustainable and thriving society (Ardiani, 2023). ESD seeks to empower current and future generations to meet their needs through a balanced and integrated approach to economic, social, and environmental aspects of development. By integrating key sustainable development issues into teaching and learning—such as climate change, natural disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption (Arfandi, 2020)—ESD also entails participatory teaching and learning methods that encourage and empower learners to change their behavior and take action toward sustainable development. Therefore, sustainable development education promotes skills such as critical thinking, envisioning future scenarios, and collaborative decision-making.

The importance of educating the public about the renewable energy transition in Indonesia cannot be underestimated, given the crucial role of society as the main driver of change. This education aims to raise awareness and understanding of the benefits and urgency of using renewable energy, which not only supports environmental sustainability but also enhances national energy independence. Through proper education, the public will be better prepared to embrace and adopt renewable energy technologies, thereby accelerating the shift from fossil fuels to clean, affordable, and sustainable energy sources. Moreover, effective education will encourage active public participation in supporting government policies related to renewable energy, fostering a harmonious collaboration between the government, private sector, and society in achieving energy transition targets in Indonesia.

The Statement above is also support by Satria.Ardhi.N (2023) that The transition to renewable energy is a key target in achieving Net Zero Emissions by 2060. Currently, the use of coal accounts for 35.36%, natural gas for 19.36%, and oil for 34.38%. Nearly all sectors, including industry, transportation, agriculture, and housing, rely on fossil fuels that contribute to carbon emissions and result in climate change. The dry season, which typically begins around this time based on past patterns, has yet to arrive, and some areas are already experiencing water shortages. As individuals, there is much we can do, such as regulating electricity usage and shifting to public transportation. The continued rise in fossil fuel consumption is unsustainable and harmful. Moreover, the growth of renewable energy has not yet met expectations, which calls for urgent action.

The urgency for implementing Sustainable Energy Education in Indonesia is critical, as much of the population remains unfamiliar with clean and renewable energy sources. Continuous education is essential to raise awareness and empower communities to make informed choices, ensuring widespread support for the transition to sustainable energy. This also accordance to Darma et al. (2019) that Indonesia lags behind in the implementation of renewable energy, despite the numerous benefits it offers, such as lower greenhouse gas emissions, reduced environmental impact, and minimal pollution. Due to a perceived lack of attractive investment opportunities, Indonesia has fallen behind other countries in the region. According to the 2018 Renewable Energy Country Attractiveness Index, Indonesia ranked 38th, trailing behind China, India, the Philippines, and Thailand.

Collaboration among schools, government, renewable energy industries, NGOs, and communities is essential to support the transition to sustainable energy. By integrating efforts across these sectors, we can create a unified approach to promote renewable energy adoption and raise awareness. Schools can educate the next generation, while governments can implement supportive policies. Renewable energy industries can drive innovation, NGOs can advocate for change, and communities can embrace and support these initiatives. Together, this collective action will strengthen the movement towards a cleaner and more sustainable energy future.

This research seeks to address the critical need for advancing energy education in Indonesia by developing a comprehensive and sustainable concept of Sustainable Energy Education (SEE). The primary objective is to create a phased approach that can be systematically implemented, fostering gradual and widespread adoption of clean energy solutions. By designing an education framework that integrates incremental and continuous learning strategies, this research aims to facilitate a deeper understanding and broader acceptance of renewable energy technologies. This approach is essential for achieving the goal of transitioning to a predominantly clean energy system in Indonesia, ensuring that educational initiatives effectively support the nation's energy sustainability goals and contribute to a greener future.

2. Method

This research uses a qualitative descriptive method. Sukmadinata & Syaodih (2017) states that descriptive research is a type of research that aims to describe existing phenomena, both natural and man-made (Ardiani, 2023). The research can include various aspects such as activities, characteristics, changes, relationships, similarities, and differences between one phenomenon and another. In this context, descriptive research is usually used to describe or explain a particular event or object without trying to explain the cause-and-effect relationship between the observed variables. Descriptive studies aim to collect and analyze data in order to provide the most accurate and detailed description of the specific topic under study (Arfandi, 2020).

2.1. Research Location

This research was conducted in Makassar City, South Sulawesi Province, Indonesia. The implementation of this research has been carried out from September 6, 2023, to October 13, 2023.

2.2. Sample of Research

The samples used in this study were representatives of elementary school teachers, junior high school teachers, senior high school teachers, and also community representatives, namely non-governmental organizations (NGO). The researched aspect is the need to develop the concept of sustainable energy education to support the socialization of the clean and affordable energy transition.

2.3. Data Collection Technique

The data collection techniques used in this research are observation and interview. The observation technique serves to provide an initial overview to analyze the needs of sustainable energy learning concepts that will be made as a form of support for

the socialization of clean and affordable energy in Indonesia for students and the community. Then, for interview techniques, structured interview techniques are used that present questions that have been summarized, which are then asked of the source. Data collection through interviews by teacher representatives from various levels of education and also community representatives is useful for knowing and analyzing materials related to clean energy or renewable energy to be adjusted to the development of the concept of sustainable energy education, and while for community representatives, namely NGOs, it is useful to see the other side of the community in digging up information and analyzing people's views on clean energy in order to obtain accurate data to adjust to the concept being developed.

2.4. Data Analysis Technique

The data analysis carried out in this study involves reducing the data that has been obtained from observations and interviews. The process of reducing the data is to take the main data that is considered important from other data that researchers get from the observation and interview process that has been carried out, so that all data in the research instrument obtained will be analyzed in order to obtain specific data. The data obtained from this research will be displayed descriptively through the presentation of tabular data from the interview results that have been analyzed, so that in this study, conclusions will be obtained about the concept of sustainable energy education.

3. Results and Discussion

3.1 Result

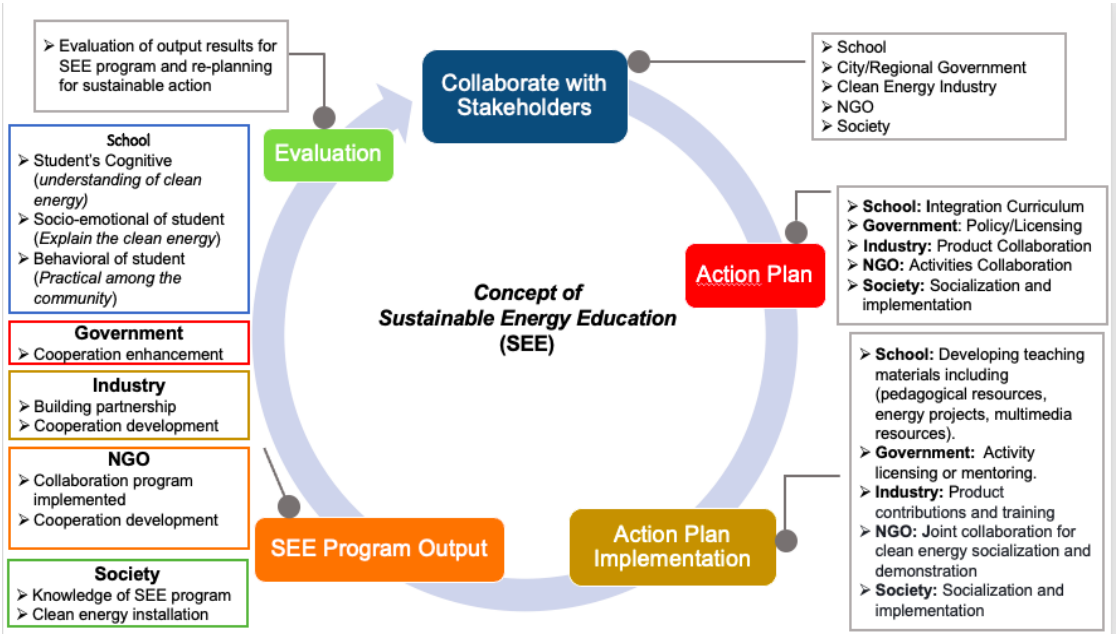

Figure 1. Concept of Sustainable Energy Education (SEE)

The results of the needs an analysis of the development of the concept of sustainable energy education in supporting the socialization of clean and affordable energy transitions

based on the results of observations, documentation, and interviews conducted shows that people must pay more attention to clean energy in Indonesia so that clean energy in Indonesia can develop and clean and affordable energy transitions can be applied to everyday life. The following is the concept of SEE (Sustainable Energy Education).

In the concept, there are stakeholders. Stakeholders are groups without whose support the organization would cease to exist and who will play a role in the concept, which consists of the destination school, city or regional government, industry NGOs, and the community.

First, there is an action plan to be carried out in schools: the creation of an integrated curriculum to educate students about the SEE concept; the government can give permission to carry out the SEE concept in the community; industry can collaborate with products to make this concept; NGOs can make collaborative activities; and the community can socialize or implement this concept.

The second is implementation, where schools can prepare teaching materials (including pedagogical resources, energy projects, multimedia, and educational) for children so that they can understand the importance of the SEE concept; the government can give permission for activities or assistance for SEE coverage activities; industry can contribute and train on SEE concept products; NGOs can collaborate on socialization and energy demonstrations; and the community can socialize, implement, or share information about this concept.

Furthermore, the output of the SEE program or the results of conducting the SEE program in schools are expected to help students understand, explain, and practice clean energy. Then there is the government, which is expected to increase cooperation because the community has been interested in products made by the industry; therefore, it can increase cooperation. There is also an industry that is expected to build partnerships and develop cooperation because the community has been interested in products made by the industry. That is more or less the same as the government. And there are also NGOs that are expected to carry out the planned collaboration program. Finally, there is the community that is expected to have knowledge about the SEE program and clean energy installation, or it can be said that the community is expected to practice this SEE.

To evaluate the output results of the SEE program and re-plan for sustainable action, the implementation phase will focus on specific roles for schools, government, and industries. Schools will be responsible for developing comprehensive teaching materials, refining teaching methods, enhancing facilities, and integrating multimedia resources to effectively deliver the SEE curriculum. The government will play a crucial role in facilitating licensing processes and providing ongoing mentoring to support the program's execution. Industries will contribute by offering renewable energy products and training related to their installation, further enriching the program. Expected outcomes include the creation of a curriculum that incorporates renewable energy education and its impacts, continued government support, and industry partnerships that provide essential products and financial subsidies. Additionally, strong collaboration with NGOs and community organizations will be essential to ensure broad implementation and effective program delivery. The SEE concept is designed to be sustainable and adaptable, allowing for repeated application and continuous improvement, as evidenced by its comprehensive and iterative framework.

The following are the results of interviews that have been conducted with resource persons, namely teachers who teach in elementary, junior high, and senior high schools and members of NGOs. The results of the interviews are interpreted only in the form of a few words, and then a thorough discussion will be carried out in the discussion section after Table 1.

3.2 Discussion

Table 1. Results of Interviews with Elementary Teacher

No	Question	Analysis Result
1	What do you think about the issue of clean and affordable energy transition in Indonesia?	It is an important issue for all parties. It also needs to be taken seriously because it is the foundation of our hopes.
2	Do you think the clean and affordable energy transition is important in Indonesia?	It is important, because the ecological problems of Indonesia and all countries demand a transition to clean and affordable energy. This needs to be socialized and continuously improved in society.
3	Do you think it is important to socialize clean and affordable energy for the community?	It is important, because people are the ultimate hope. Also, Indonesia has a lack of information and knowledge regarding the utilization of clean and affordable energy.
4	Do you think sustainable energy education is important to teach to students in schools?	Very important, as it is something that should be taught and needs to be known at an early age. It is also an effective way to raise environmental awareness.
5	What do you think about the concept of sustainable energy education in supporting the socialization of clean and affordable energy in Indonesia?	The government and education stakeholders should put more effort and creativity into thinking of better alternatives.

Table 2. Results of Interviews with Junior High School Teachers

No	Question	Analysis Result
1	What do you think about the issue of clean and affordable energy transition in Indonesia?	Clean energy in Indonesia itself has been done but not maximized, because people do not know about the concept of clean energy.
2	Do you think the clean and affordable energy transition is important in Indonesia?	It is very important, because Indonesia is one of the most populous countries in the world, which inevitably uses more energy.

3	Do you think it is important to socialize clean and affordable energy for the community?	It is important, because in this day and age clean energy is running out, and with energy socialization, we can use energy without scarcity.
4	Do you think sustainable energy education is important to teach to students in schools?	Importantly, it should also be introduced at an early age (kindergarten, elementary school) so that the next generation can know about clean energy and can also practice it.
5	What do you think about the concept of sustainable energy education in supporting the socialization of clean and affordable energy in Indonesia?	It is important to know. But it is best to introduce this concept to students first. Because with this educational concept, students can share this information with the neighborhood.

Table 3. Results of Interviews with High School Teachers

No	Question	Analysis Result
1	What do you think about the issue of clean and affordable energy transition in Indonesia?	Clean energy is still lacking, especially in Jakarta. Due to the heavy use of vehicles or pollution generated in factories.
2	Do you think the clean and affordable energy transition is important in Indonesia?	Important, for the survival of living things, especially humans, who can be affected by pollution.
3	Do you think it is important to socialize clean and affordable energy for the community?	It is important that people have an awareness of our environment.
4	Do you think sustainable energy education is important to teach to students in schools?	It is important, because students are the next generation of the and it is important for them to be educated on the importance of clean energy.
5	What do you think about the concept of sustainable energy education in supporting the socialization of clean and affordable energy in Indonesia?	Students should be taught from a young age so that they can influence the nation in the future.

Table 4. Results of Interviews with Members of NGOs

No	Question	Analysis Result
1	What do you think about the issue of clean and affordable energy transition in Indonesia?	The issue of Clean Energy Transition is already very difficult, especially in Indonesia, which is far from clean

		energy, but it may be a dream for the future.
2	Do you think the clean and affordable energy transition is important in Indonesia?	I think it is important because there are many factors that will result if clean and affordable energy is not implemented immediately.
3	Do you think it is important to socialize clean and affordable energy for the community?	It is important because the position of the participants as the community and not as educators, is also very minimal knowledge of this clean energy.
4	Do you think sustainable energy education is important to teach to students in schools?	It's important, but maybe if it's in school it will be a little heavy for school children but hopefully it can be implemented to be used as curriculum or teaching material in schools.
5	What do you think about the concept of sustainable energy education in supporting the socialization of clean and affordable energy in Indonesia?	It is important, because the modern era requires energy to survive, if we do not use energy we will be left behind in development and difficult to adapt, especially in modern life.

According to Iraveratika (2023), the issue of energy transition is attracting the attention of the global community, especially with regard to the desire to preserve human life and maintain a sustainable economic system. It can be concluded that people should pay more attention to clean energy in Indonesia so that clean energy in Indonesia can develop. We must take this as a serious matter because, currently, clean energy in Indonesia is starting to be difficult to find.

According to the Coordinating Ministry for Economic Affairs of the Republic of Indonesia (2023), the energy transition currently taking place in Indonesia is a key strategy to address energy security and advance the country's green economy. It also demonstrates Indonesia's commitment to expanding the use of cutting-edge technologies to support the development of a stronger, higher-quality economy. The issue of clean and affordable energy transition in Indonesia is very important to be implemented in Indonesia, especially in the current case in Indonesia, more precisely Jakarta, where excessive vehicle use and factory factories there cause pollution. Indonesia is also still not too familiar with this concept. Although some areas in Indonesia have implemented this sustainable energy system, it is still not fully implemented.

According to data from Jogja Dataku (2022), energy is a basic human need that is very important for the health of a country's economy and society. Therefore, distribution strategies and strategies for distributing goods are very important. Energy demand will continue to increase along with population growth, and the amount of energy used will also decrease, thus requiring the identification and use of alternative energy sources. The socialization of clean and affordable energy for the community is important. The socialization of clean and affordable energy is very necessary to start and continue to be carried out in a sustainable and planned manner so that people have awareness about clean and affordable energy. Also, because it is

getting depleted day by day. Therefore, we must socialize clean and affordable energy in the community.

One effective way to increase environmental awareness and encourage technological innovation among students, it is important to provide renewable energy education in schools. Because facing global energy challenges requires understanding and the skills to develop these solutions, From the data above, it can be stated that the responses of the participants indicate that sustainable energy education is important to be taught to students in schools. and should be applied from an early age because students are the successors of the nation, and it is important for them to know about the concept of sustainable energy even if they can make a curriculum.

Also, it is important to teach about renewable energy in schools because it can increase awareness about environmental sustainability among students, teach about the latest technology in energy, help increase students' understanding and awareness of the importance of renewable resources, increase students' interest in science and technology, and inspire students to get involved in building a more environmentally friendly area. From the data above, it can be stated that the participants' responses regarding the socialization of clean and affordable energy can be used as an innovation for the future to instill cleanliness in energy because, if not one day, it will cause a problem if we do not immediately apply it.

4. Conclusion

Based on the results of the analysis and the development of the latest concept of Sustainable Energy Education, we can conclude that all interviewees unanimously supported the concept as both relevant and crucial for advancing the clean energy transition in Indonesia. They recognized that sustainable energy education holds significant potential to enhance public understanding and awareness of clean energy while fostering more sustainable energy behaviors. This strong consensus among stakeholders underscores the necessity of integrating sustainable energy education into Indonesia's clean energy transition efforts. Furthermore, this research presents a novel contribution by introducing a phased and sustainable approach to energy education, a concept that has not yet been explored in this manner. This innovative framework is expected to play a vital role in achieving a more effective and enduring transition to clean energy in Indonesia.

As a recommendation, we suggest that the implementation of this concept should be pursued with broad support from all sectors, including schools, government, renewable energy industries, environmental NGOs, and the community. Specifically, we propose that schools integrate this education into their curricula to inform and engage students, who can then spread this knowledge throughout their communities. Additionally, the government should facilitate this process by providing necessary approvals and easing regulatory requirements, while also collaborating with renewable energy industries through subsidies and budgeting to ensure the practical application of clean energy technologies. Such coordinated efforts are essential for the successful realization and widespread adoption of this sustainable energy education framework.

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