

## Optimizing The Role Of Electrical Engineering Laboratories As Centers For Energy Conservation *Studies In Educational Institutions*

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### Abstract

The aim of this research is to conserve energy as a pillar of national energy management which has not received adequate attention in Indonesia. The method used in this paper is descriptive qualitative. This method is used to describe the facts in the field. The results achieved in this study are the increasing popularity of the idea of efficient energy use as a "smart way of life . " The most obvious indicator of the work carried out by the energy conservation center and other community elements is Japan's success in positioning itself as a country with the best energy productivity in the world and maintaining that position until now. The conclusion of the results obtained is the acceleration of the formation of an energy-saving culture by involving all elements of society with a religious and sociocultural approach.

**Keywords:** Electrical Engineering Laboratory, Energy Conservation

### INTRODUCTION

Energy conservation, as a pillar of national energy management, has not received adequate attention in Indonesia . Energy management in the country has so far prioritized providing energy or expanding public access to it. This has been achieved through, among other things, increased fossil fuel exploitation or rural electrification development. Energy consumption, on the other hand, continues to increase rapidly, outpacing economic growth. This is demonstrated, for example, by the demand for electricity (Zahar et al., 2024).

By conserving, it's as if we've discovered a new energy source. If Indonesia could save just 10 percent on fuel consumption, it would be as if Indonesia had "discovered" a new oil field capable of producing around 150,000 barrels per day. In reality, producing that much fuel requires significant costs for both exploration and production. This means the savings from conservation are substantial. According to Government Regulation No. 5 of 2006, energy conservation is the efficient and rational use of energy without reducing the use of energy that is truly necessary (Masni, Rahima, & Hutabarat, 2021).

The losses resulting from not implementing energy conservation programs are already being felt throughout Indonesia. The exact losses resulting from not properly implementing energy conservation have never been accurately calculated, but they are believed to be substantial. The ills stemming from unhealthy national fuel consumption patterns (fuel subsidies, smuggling, adulteration, and the resulting political costs) can be addressed to some extent if we strictly implement energy conservation, particularly in the transportation and industrial sectors (Riady & Hutabarat, 2023).

One factor hindering the development of energy conservation in Indonesia is the widespread perception among the public that Indonesia is a wealthy country blessed with abundant energy resources, and therefore, using energy sparingly is not considered a necessity. The understanding of energy conservation as a practical measure has also not developed

among the public due to the scarcity of information dissemination or campaigns regarding energy conservation techniques. Legislation regarding energy conservation has also not been developed. Likewise, the formation of a Special Agency within the government/private sector to handle energy conservation issues has not yet been established (Nuridin, Sembiring, Phongsavath, Rahmawati, & Hutabarat, 2022).

Due to the rapid growth in energy demand in Indonesia, carbon emissions into the air in Indonesia have also increased rapidly. The graph below shows the growth in carbon emissions into the air from 2000 to 2010, projected at current energy consumption patterns. It is estimated that in 2010, carbon dioxide emissions into the air in Indonesia reached 425 million tons. This is a significant figure (Almaududi, Simarmata, Hutabarat, & Tefu3, 2023).

## LITERATURE REVIEW

Japan is a developed country that has made remarkable progress in energy conservation, a result of public and government cooperation since the First Oil Crisis (1973). When the oil crisis hit, Japan's dependence on petroleum for its primary energy consumption was still around 80 percent. strictly regulate Japan's energy mix . *Energy diversification on the supply side* was carried out by replacing petroleum with natural gas and nuclear energy. Natural gas in the form of LNG was imported, among other things, from Indonesia, and nuclear power plants were developed to reduce dependence on petroleum. *Energy conservation was implemented on the demand side , particularly in activities in the industrial sector* . In 1978, the Second Oil Crisis struck. The Japan Center for Energy Conservation was established to expand Japan's already tireless energy conservation efforts. Japan's first Energy Conservation Law was enacted in 1979 and has undergone several subsequent revisions (R. Rosmiati & Hutabarat, 2023).

As a result of the movement to reduce dependence on petroleum and implement energy conservation, the share of petroleum in Japan's energy consumption portfolio has been reduced from 80 percent during the First Oil Crisis to around 47 percent today. On the consumption side, continued energy conservation efforts, particularly in the industrial sector, have led Japan to become a world leader in terms of energy productivity/GDP. The following graph shows the ratio of energy utilization to gross domestic product, which has reached 0.1. This means that in Japan, industrial energy demand is still growing, and this growth is generating GDP growth. Meanwhile, Indonesia, with its high energy demand, has not been able to significantly increase its GDP. This can be seen in the graph below, which shows Indonesia's significant energy waste, with a ratio of 1.84. Meanwhile, the United Kingdom and Germany experienced lower energy demand growth compared to their economic growth, with ratios of 0.0 and 0.12, respectively.

Japan's success in energy conservation is based on several factors, such as the issuance of the Energy Conservation Law (the Law on Rational Energy Utilization). The establishment and operation of the Energy Conservation Center with strong government support (especially from the Ministry of Economy, Trade and Industry), the preparation and dissemination of regulations and technical guidelines for energy conservation in various energy sectors to the public. Japan also utilizes its specific strengths/approaches, for example in the use of TQM ( *Total Quality Management* ) which was developed for energy conservation purposes.

The support and participation of the Japanese people in the national energy conservation program, including in developing an energy-efficient lifestyle (smart living with energy) is also a very important factor behind Japan's success in implementing the energy conservation program. Thailand actually possesses rich energy resources, such as natural gas, but it doesn't view itself as a resource-rich country. On the contrary, Thailand is one of the Asian countries that places great emphasis on how to use energy rationally and economically.

In the Thai government administration, the energy sector holds a significant place, not solely the responsibility of a technical department. This is partly based on the premise that energy is a multi-sectoral issue and because it encompasses the livelihoods of many people. Energy conservation is also a subject of concern for various departments within the Thai government administration (R. Rosmiati, Sembiring, Rahim, Pudjaningsih, & Hutabarat, 2022).

As shown in the graph below, the United States, which has a large national energy requirement, carried out energy conservation starting from 1973 until 1997 and finally in 1997 the United States was able to reduce 50% of its people's energy demand. The purpose of the Energy Conservation Law is to provide healthy national economic growth through the implementation of regulations for the rational use of energy in all utilization sectors and to develop the use of energy resources that will meet economic and environmental needs at home and abroad (Hutabarat, 2021).

The Conservation Law mandates the Minister of Economy, Trade, and Industry to establish regulations and standards for industries in energy conservation. Other relevant ministers, such as the Minister of Land, Infrastructure, and Transport, are also responsible for energy conservation guidelines and regulations, which regulate energy efficiency in offices and buildings. In principle, every energy user in Japan is subject to regulations for energy efficiency.

Japan's Energy Conservation Law, which consists of 6 articles and 30 paragraphs, essentially contains quite detailed regulations, particularly for industry (factories), buildings, and machinery/equipment. For example, industries in the Energy Conservation Law are classified into Class I and Class II industries based on their annual fuel or electricity consumption. Furthermore, different industry classes have different obligations, such as determining energy managers, coordinating medium- to long-term work plans in the field of energy management, coordinating periods for reporting on energy use, and so on. Table 1 displays the industrial grouping scheme and the obligations stipulated in the Energy Conservation Law. More detailed regulations regarding how energy conservation should be implemented are established by technical ministries, such as the Minister of Land, Infrastructure, and Transport. These regulations are generally very detailed and technical in nature. For example, for combustion in boilers, the ratio of air flow to the type of fuel used is strictly regulated, scientifically proven to ensure optimal combustion. Maintenance schedules for machinery and production equipment are strictly stipulated by national regulations. Similarly, guidelines *are* issued to electricity companies for compliance, for example, on how to minimize the costs of generating electricity (Zahar et al., 2024).

Energy conservation doesn't necessarily mean using as little energy as possible, but rather spending as little as possible on energy consumption. How to achieve this is outlined in free guides provided to various energy-using sectors. Energy managers play a crucial role in planning efficient energy use in their work units and implementing those plans within their organizations, including conducting energy conservation training for employees. Energy managers are required to participate in energy conservation training *and* competency exams held periodically by the Energy Conservation Center (Harbeng Masni, Zuhri Saputra Hutabarat, Lili Andriani, 2010).

The Energy Conservation Law also emphasizes the government's obligation to promote the energy conservation movement. This includes providing fiscal incentives for energy conservation activities by industry and service providers, as well as promoting the energy conservation movement and awareness among all levels of society. Energy audits are conducted for large energy users (factories, buildings, etc.) by energy audit experts coordinated by the Energy Conservation Center, free of charge or funded by the government. If the energy audit results recommend replacing equipment with new, energy-saving equipment,

the government can provide credit for the replacement of the energy-efficient equipment (Hutabarat, Wiryotinoyo, Masni, & Handayani, 2022).

To facilitate energy audits (and assist in implementing energy conservation measures), the Japanese government also encouraged the development of energy service companies (ESCOs), for example by providing tax breaks and capital goods. The existence of ESCOs, especially in the early stages, significantly contributed to the promotion of national energy conservation. ESCOs in Japan have now grown significantly in number and specialization of the energy conservation work they handle (Hutabarat, Masni, Zahar, Pratiwi, & Sembiring, 2024).

Increasing public awareness to conserve energy through campaigns, training and labeling activities for products, activities and *supermarkets* that have energy conservation advantages is a task encouraged by the Energy Conservation Law and in practice is often carried out by the Japan Energy Conservation Center. The Japan Energy Conservation Center is not a purely government organization, but rather a semi-private organization guided by the Ministry of Economy, Trade & Industry (METI). The Japan Energy Conservation Center was established in 1978 in response to the First and Second World Oil Crises and as a response to Japan's strategy for national energy management. The Energy Conservation Center is headquartered in Tokyo with eight branches throughout Japan. There are approximately 3,000 members (industry, offices, ESCOs, universities, etc.) who support the Energy Conservation Center's activities (Saputra Hutabarat, 2017).

The Energy Conservation Center's extensive activities provide input and are directly addressed to government offices, including community research centers and universities, energy consumption and production sectors, and the general public. Successful examples of energy conservation development across various consumption and production sectors are presented extensively throughout Japan annually. Included in the activities for the industrial sector are energy audit and energy conservation services for various types of factories, energy conservation education and training, holding state exams for energy managers, and developing industrial technology that has high energy efficiency including its dissemination. For the commercial and household sectors, the activities carried out by the Energy Conservation Center include auditing services and energy conservation for buildings, developing labeling systems for various household/building equipment products (including for stores that market these products), conducting energy saving navigation, developing international cooperation in determining high energy efficiency products, developing ESCO for the commercial and household sectors, launching instructions and standards for energy conservation for households and marketing which are distributed free of charge nationally (Hutabarat, Lela, Masni, & Pratiwi, 2024).

For the transportation sector, efforts made by the Energy Conservation Center include holding competitions and exhibitions on energy conservation in the transportation sector, popularizing various simple ways to conserve energy that can be done by the public and transportation companies (including campaigning for *the idling system*), and holding competitions for energy-efficient vehicles (including *the top runner program*) (Z. S. H. Rosmiati, 2016).

The Energy Conservation Center develops an energy conservation database, conducts open consultations (including using email and interactive dialogue on TV) on energy conservation and popularizes Japan's energy conservation model in the international environment, including by inviting participants from other countries to study energy conservation carried out by Japan. The results of the Energy Conservation Center's work have been the growing popularity of the idea of energy-efficient use as a "smart way of life" among Japanese society. The clearest indicator of the work carried out by the Energy Conservation Center and other elements of society is Japan's success in establishing itself as the country with

the best energy productivity in the world and maintaining that position to date (Pratiwi & Hutabarat, 2024).

In the Thai government administration, the energy sector holds a significant place, not solely the responsibility of a technical department. This is partly based on the premise that energy is a multi-sectoral issue and because it encompasses the livelihoods of many people. Energy conservation is also a subject of concern for various departments within the Thai government administration. It is clear from the organizational structure related to Thailand's national energy policy that energy conservation is a subject of significant concern. The Energy Conservation Committee, within the aforementioned organizational structure, is primarily concerned with energy conservation funding (Agustina & Hutabarat, 2023) and (Yusdi Andra, Denny Denmar, 2020).

## RESEARCH METHOD

The method used in this writing is descriptive qualitative. This method is used to describe the facts that exist in the field. The purpose of the method is to: 1) Collect actual information in detail by describing existing symptoms, 2) Identify problems and examine the conditions and practices that apply, 3) Make observations and evaluations of existing conditions and facts. 4) Determine what others do in facing the same problem and learn from others to determine and establish decision plans in the future.

## RESULTS AND DISCUSSION

### How is Energy Conservation in Indonesia?

Energy conservation, as a pillar of national energy management, is currently under-recognized in Indonesia. Based on energy intensity data, Indonesia has very low energy productivity compared to many Asian countries. Energy in Indonesia, including fuel, is used wastefully. The potential for energy conservation is truly vast in Indonesia. The image below displays energy consumption by type and sector of consumption in Indonesia. It is clear that fuel is the most widely consumed type of energy in Indonesia and that the transportation sector is the main user of fuel (Yati et al., 2024).

Awareness of energy conservation had already emerged in Indonesia, particularly during the World Oil Crisis of the late 1970s. The prolonged global economic recession resulting from rising oil prices at the time (though a potential *oil boom* in Indonesia) was quite concerning for a number of energy analysts in the country, particularly due to concerns that Indonesia's oil wealth would be short-lived, especially if consumption patterns were not conserved. The Presidential Instruction on Energy Conservation was issued in 1982 (Presidential Instruction No. 9/1982) which was later refined by Presidential Decree No. 43 of 1991. A Non-Governmental Organization (Masyarakat Hemat Energi) emerged within the community, focusing on energy conservation. The government established an ESCO, which later became a state-owned energy company (PT KONEBA).

The partial and small-scale energy conservation initiatives undertaken by the government and community groups have not generated significant public response or been followed by broader energy conservation measures. Especially since the 1990s, when energy consumption in Indonesia has skyrocketed, energy conservation activities have been almost forgotten. Energy consumption tends to be increasingly wasteful, energy prices are not adjusted to their economic value, and the burden of subsidies borne by the state budget (in the form of fuel and electricity subsidies) for public energy use has continued to increase. Another consequence is worsening pollution due to energy consumption, particularly in urban

transportation (Masni & Hutabarat, 2019).

Allowing wasteful energy consumption patterns to continue will be highly detrimental, both economically and environmentally, as well as to efforts to maintain the benefits of energy resources themselves. Because the "diseases" caused by ignoring energy conservation efforts are already quite severe, energy conservation, as a necessity, cannot be delayed any longer in Indonesia. Therefore, it is crucial to promote energy conservation in every energy-using sector (transportation, industry, offices, and households) and every type of energy used (especially fuel). How to "half-force" or build public/government awareness to make energy conservation a new culture needs to be developed (Meivanda & Zuhri, 2024), (Suroño et al., 2024) and (Hutabarat & Rosmiati, 2022).

## CONCLUSION

Some strategic steps that need to be taken to make the energy conservation movement effective, according to the author, are: 1) Energy saving campaigns, conducting energy audits (free of charge), disseminating energy conservation techniques, providing incentives for efficient energy use. 2) Preparing an Energy Conservation Law (as detailed as that developed by Japan, for example). 3) Establishing a National Energy Conservation Center (as done by Japan/Thailand). 4) The need for an Energy Law as a legal basis for implementing energy conservation. 5) The need for financial institutions to support energy conservation investments. 6) The need for fiscal policies (import duties & tax incentives) that focus on and support energy conservation measures. 7) Accelerating the formation of an energy saving culture by involving all elements of society with a religious and socio-cultural approach.

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