

# School Energy Management in Efforts to Improve the Quality of Facilities and Infrastructure in Schools

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## ABSTRACT

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School energy management is one of the efforts to support the Sustainable Development Goals (SDGs), which focus on using clean and affordable energy and tackling climate change. This study aims to analyze and describe the planning, implementation, evaluation, and school energy management actions to improve the quality of facilities and infrastructure at Cendekia Muda Middle School and Muhammadiyah 8 Middle School Bandung. This study uses a qualitative method with a case study approach. Data was collected through observation, interviews, and documentation—data reduction techniques, data presentation, and concluding analyzed data. The study results show that planning for school energy management in both schools involves various parties, referring to government policies and considering technical, economic, social, and environmental aspects. The implementation of school energy management in both schools includes saving electricity, using renewable energy, managing waste, and counseling students and the community. Evaluation of school energy management in both schools was carried out using quantitative and qualitative indicators and involving internal and external parties. School energy management measures in both schools took the form of improving facilities, adding alternative energy sources, developing environmental programs, and collaborating with other parties. The results of this study are that school energy management in both schools has been carried out well and has positively impacted the quality of facilities and infrastructure, saving operational costs, increasing environmental awareness, and contributing to SDG achievement. This research implies that school energy management needs to be improved by continuously innovating, monitoring, evaluating, and socializing.



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## Introduction

Sustainable Development Goals (SDGs) are a global action plan mutually agreed upon by world leaders, including Indonesia, with three significant agendas: ending poverty, reducing inequality, and protecting the environment (Pangestu et al., 2021). SDGs contain 17 Goals and 169 Targets expected to be achieved by 2030. The world is likely to contribute to achieving these goals (NAPITUPULU, 2021). In Presidential Regulation No. 59 of 2017 concerning Sustainable Development Goals, Indonesia is a member of the UN nation supporting the world program on Sustainable Development Goals (SDGs) that was previously launched by the United Nations Development Programme (UNDP). TPB/SDGs are a global and national commitment to improve the welfare of society covering 17 goals, namely (1) No Poverty; (2) Zero Hunger; (3) Good Health and Well-being; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Sanitation; (7) Affordable and Clean Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation and Infrastructure; (10) Reduced Inequalities; (11) Sustainable Cities and Communities; (12) Responsible Consumption and Production; (13) Climate Action; (14) Life Below Water; (15) Life on Land; (16) Peace, Justice and Strong Institutions; (17) Partnerships for the Goals.

Protecting the environment and utilizing affordable and clean energy (point 7) is one of the goals of SDGs/TPB. The energy crisis that occurs in the world is a serious matter that needs to be addressed immediately (Rudiany, n.d.). Using fossil fuels and non-renewable energy sources impacts the continuity of human life in the future (Kaslam, 2020). The depletion of natural resources such as oil and gas results in efforts to use renewable energy, use energy-efficient devices, and regulate the management of energy resources (Afriyanti et al., 2020). Taking swift action to address climate change and its impacts is one of the goals of the Sustainable Development Goals by taking steps to use resources efficiently and effectively (Wardani & Putra, 2022). Utilizing resources better through energy conservation measures in every institution and sector, one of which is the school institution under the auspices of the Regency/City Government, which is also mandated to be able to carry out the goals in the Sustainable Development Goals program (Putra et al., 2015). Related to the Sustainable Development Goals, the Indonesian government has issued a policy in the form of a government regulation on energy audit and energy conservation contained in Government Regulation No. 70 of 2009. The government states that energy utilization by energy sources and users must be done efficiently (Government of the Republic of Indonesia, 2009).

Facilities and infrastructure in schools have a significant role in education (Megasari, 2020). Providing facilities and infrastructure to support learning will improve the quality of education

(Alfianto et al., 2017). Conversely, inadequate facilities and infrastructure will make it challenging to achieve optimal educational outcomes. Facilities are tools or equipment directly used in an educational activity, such as rooms, libraries, laboratories, etc. Meanwhile, infrastructure is tools or equipment indirectly used to achieve educational activity objectives, such as location or place, school buildings, and sports fields ((Ya'cub & Ga'a, 2021)). School facilities and infrastructure that meet the standards will undoubtedly correlate with the costs incurred to achieve them. The higher the facilities and infrastructure quality available, the greater the cost. High-quality facilities and infrastructure have a long service life. Unlike facilities and infrastructure made with low quality, besides having a shorter usage than the quality ones, it will undoubtedly affect the running of an educational activity. It is caused by frequently replacing devices or tools; besides increasing financing, it also disrupts educational activities. Schools with large buildings and many rooms equipped with electronic devices require a lot of electrical energy (Handayani, 2010). Some examples of school devices that use electrical energy include lights, air conditioners, fans, water heaters, projectors, network devices (wifi hotspots, servers), water pumps, audio devices, CCTV, etc.

The more devices there are, the more energy will be used (Almanda et al., 2017). It significantly impacts the money schools must spend to pay for the electricity they use. Every electrical device in the school must be appropriately managed (Indrawan, 2015). Schools need to plan for the use of these electrical devices (Rawis et al., 2016). Starting from determining the type of tool, the power usage required, service life, brand, and type of maintenance to be carried out. High-quality devices require low power but with optimal results.

Conversely, low-quality electrical devices will potentially require enormous power (Rumimper et al., 2016). In this case, there will be a waste of electricity usage. Of course, this will affect the electricity costs.

Many schools have not concentrated on energy management issues, especially electricity (Prihanta et al., 2021). Schools generally do not pay attention to managing existing energy resources better. Many of the devices provided are not up to standards and are of low quality. For this reason, it results in using energy sources in schools (Damanik, 2015). The impact is that some of the energy sources in schools have not been utilized optimally, which ultimately results in losses on the school's financial value and the effectiveness of the school's activities. The uniqueness of this research is that it was conducted at Islamic schools in Bandung City, precisely at SMP Cendekia Muda Bandung and SMP Muhammadiyah 8 Bandung. Researchers saw the two schools as the right location for research. Currently, no research raises the theme of energy management in schools to improve the quality of facilities and infrastructure. Schools with the best school level do not yet have a unique program

related to energy management. So far, educational management activities have been limited to facilities and infrastructure management, finance, and students, and there is no discussion related to energy management.

Researchers are interested in conducting this study because energy issues are part of the Sustainable Development Goals - SDG's program, which contains 17 study components, one of which is related to the goal of clean and renewable energy. Researchers want to know how the use of energy in the school environment, especially schools with an Islamic basis, is analyzed from a management perspective.

## **Method**

This study utilizes a descriptive qualitative approach (Maxwell & Reybold, 2015) to investigate social realities and phenomena related to school energy management. The research focuses on two renowned Islamic schools in Bandung: SMP Cendekia Muda Bandung and SMP Muhammadiyah 8 Bandung, both recognized for effectively implementing energy management in school activities. Primary data were collected through interviews with key stakeholders, including principals, vice principals of facilities and infrastructure, vice principals of finance, teachers, and staff. Secondary data were derived from relevant documents. This research aims to provide a comprehensive account of school energy management, focusing on enhancing the quality of facilities and infrastructure in Islamic schools.

The research employs Miles & Huberman's (2010) interactive model, comprising four stages: data collection, data reduction, data display, and conclusion drawing. In the initial stage, data were collected through interviews and document procurement. Subsequently, interview and documentation data were reduced based on predetermined research indicators. The findings are presented as qualitative descriptive narratives accompanied by analytical insights. The analysis concludes by drawing insights contributing to a comprehensive understanding of the research subject.

On Fig 1 Based on the data analysis conducted on the School Energy Management in efforts to improve the quality of facilities and infrastructure at SMP Cendekia Muda and SMP Muhammadiyah 8 Bandung, several significant findings were discovered in each stage, namely Planning, Implementation, Evaluation, and Follow-up of School Energy Management (Mujahida & SE, 2018)

**Result and Discussion**

**RESULTS**



Fig 1: School Energy Management Diagram

The stages of energy management planning in schools that shown on fig 2 are as follows: (1) Commitment to religious values in practicing devotion to Allah SWT. (2) The presence of policies that embody effective leadership from both the foundation and the school head. (3) Awareness followed by planning to comprehend the proportion of renewable energy. (4) School energy efficiency. (5) The presence of awareness and participation among the community members. (6) Collaboration with external parties related to school energy management. The analysis of school energy management data reveals that planning is a crucial aspect that must be undertaken in any program or activity (Akilah et al., 2019).

**Energy Management Planning:**

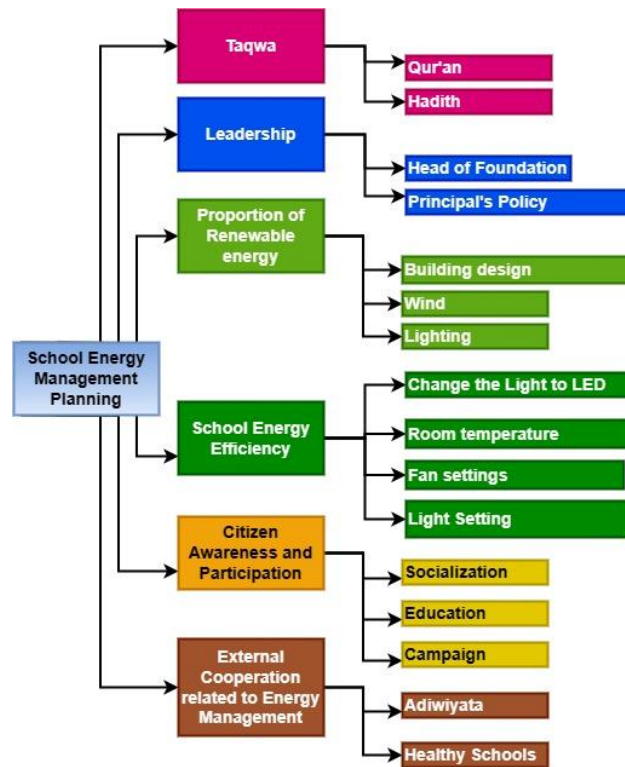


Fig 2: Energy Management Planning

Management planning should be systematically composed and documented for successful implementation. While formulating plans, reference is made to religious values associated with energy management. Islam teaches that planning for goodness is an obligation. In the Quran, one of the verses discussing energy management is Surah al-A'raf [7]: 54 and 56. These verses elucidate that Allah SWT is the Creator of the heavens and the earth, the sun and the moon, day and night, and everything in between. Allah SWT also governs the rotation and balance of the universe with wisdom and justice. Therefore, gratitude should be expressed for Allah SWT's blessings and resources without damaging or wasting the bestowed energy sources. Humans should use energy wisely, efficiently, and responsibly, uphold environmental preservation, and prevent pollution and damage.

In the Sunnah, one of the hadiths addressing energy management is found in Bukhari nos. 5624 and 6296. This hadith narrates that the Prophet Muhammad (peace be upon him) advised, "Turn off the lights at night when you retire, close the doors, seal the containers of water, cover the food and

drinks.” This hadith illustrates that the Prophet encouraged his followers to conserve energy, even in small matters like household lighting. It also demonstrates the Prophet’s concern for the safety and well-being of his community, as turning off lights, sealing containers, and closing doors can prevent fires, disturbances from wild animals, or diseases that may arise from these sources.

Effective leadership from foundation leaders and school principals significantly influences school planning. Measuring the proportion of energy owned by educational institutions, including how to design and construct schools with energy management standards, is crucial. One approach is utilizing renewable energy, such as maximizing solar energy for room illumination and optimizing indoor air circulation through large windows and doors. Using energy-efficient bulbs is also instrumental in optimizing electricity consumption for optimal lighting.

Replacing all bulbs with LED (Light Emitting Diode), lights is a step toward electric energy efficiency, as is proper temperature regulation in rooms using appropriate Air Conditioner usage regarding temperature settings and required quantities. Timely utilization scheduling is a vital planning component to maximize energy utilization. Energy management planning can be effectively carried out with the participation of all stakeholders within the school community.

Energy usage awareness can be propagated in schools through various means, including social media information dissemination, flyers, or posters. Educational stages involving all parties engaged in the school are critical and should be meticulously planned. Education can be administered in written formats, through videos distributed through active school channels, and during school activities conducted by subject teachers in class or during workshops.

Energy management campaigns should not only be limited to the school environment but also extend to the local community through slogans encapsulating energy management values. Building relationships with external parties engaged in energy utilization-related programs can enhance energy management planning.

The Adiwiyata or Green School Program, administered by the Ministry of Environment and Forestry (KLHK), aims to foster knowledge and awareness of environmental conservation among school communities. The program aspires to shape environmentally conscious schools with tangible initiatives integrated into the teaching and learning processes. To participate, schools must fulfill four primary indicators: environmentally conscious policies, environmentally-based curriculum implementation, eco-friendly school infrastructure management, and school participation in environmental preservation.

The Healthy Schools Program, sponsored by the Ministry of Health (Kemenkes), endeavors to establish physically, mentally, socially, and spiritually healthy schools. The program aims to form School Energy Management in Efforts ...(Kurnia, Y.. et al)

schools capable of providing essential healthcare services to the school community and instill clean and healthy living behaviors in daily activities. To enroll in the program, schools must fulfill eight core indicators: healthy school policies, primary healthcare services in schools, mental health guidance and counseling at school, reproductive health education for adolescents, balanced nutrition guidance in schools, physical education, and bodily health promotion at school, environmental cleanliness fostering at school, and stakeholder empowerment in support of the healthy school program.

In the planning stage, several key aspects were revealed. Firstly, the commitment to religious values was acknowledged as the foundation for practicing piety towards Allah SWT. The presence of policies originating from the school's leadership, both from the foundation and the principal, also proved to play a significant role in directing the energy school plan. Consciousness and well-planned use of renewable energy and energy efficiency demonstrated the adoption of holistic policies.

Furthermore, the implementation of religious values and perspectives on energy policies is also present in the teachings of Islam. Surah al-A'raf [7]: 54 and 56 provide a spiritual foundation for preserving energy resources and using them wisely and responsibly. The teachings of Prophet Muhammad SAW to save energy in daily activities also offer concrete guidance for schools in implementing efficiency efforts.

### **Energy Management Implementation:**

There are four activities in the implementation of energy management in schools that shown on fig 3, namely: (1) utilization of renewable energy, (2) replacement and adjustment of inefficient devices, (3) activities that enhance energy-saving awareness, and (4) activities that promote participation and build relationships. The initial phase of energy management implementation involves utilizing renewable energy sources available in the school's nearby environment. Sunlight is harnessed for natural room illumination. Throughout the year, the entire Indonesian region receives ample sunlight. This significant advantage allows for optimal utilization of renewable energy in sunlight, reducing the need for artificial lighting during learning activities.

Constructing school buildings with large windows is an effort to maximize the natural potential for benefit and energy conservation, be it lighting or electricity. Adequate air circulation through easily operable windows and large doors optimizes the inflow of fresh air into the rooms, minimizing the need for air conditioning.



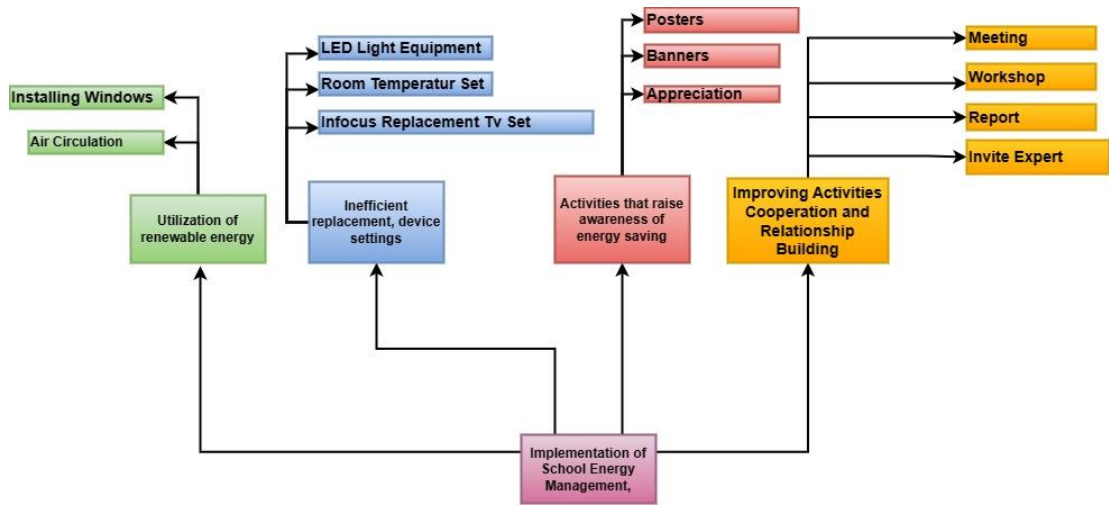


Fig 3: Energy Management Implementation

Old electronic devices consume more electrical energy, particularly those using outdated technology. Replacing obsolete devices with new ones that are environmentally friendly and energy-efficient is crucial to energy management implementation. Additionally, replacing traditional room lighting with energy-efficient LED lights enhances lighting potential while minimizing wasted energy.

The use of air conditioning (AC) should be carefully regulated, encompassing optimal temperature settings for comfort, duration of use, and activation timing. Replacing traditional projectors in classrooms with Smart TVs featuring LED technology effectively reduces electricity consumption. Projector screens require more energy than Smart TVs when used in classrooms.

Installing posters, flyers, and energy-saving slogans is essential in public and private areas such as restrooms. Large banners highlighting the institution’s dedication to energy management should be created as part of campaign efforts.

To raise awareness of energy management, recognition and awards should be granted to individuals, whether within the school or specific classes, who have demonstrated effective energy management practices, particularly in school energy-saving programs. Energy management programs cannot succeed in isolation; schools must collaborate with external entities to foster a larger community.

Organizing training sessions with experts and specialists in energy management will enhance continuous awareness and improvement. Schools should participate in programs like Adiwiyata or healthy school initiatives. It accelerates the school’s commitment to optimal energy management. Naturally, schools will be required to provide reports on how they have implemented the Adiwiyata

and healthy school programs, especially concerning energy management within the institution. Inviting speakers well-versed in successful energy management practices is a means to ensure adequate energy management in schools.

The implementation stage highlights activities that have a tangible impact on school energy management. The utilization of renewable energy, such as sunlight, is an intelligent solution for natural room lighting. Building designs that harness sunlight and natural air circulation and replacing old electronic devices with new energy-efficient ones demonstrate a commitment to efficiency.

Moreover, installing posters, flyers, and slogans that educate about energy conservation serves as internal and external campaigns. Training involving experts in energy management helps raise awareness and improve practices. The school's initiatives to participate in the Adiwiyata and Healthy School programs demonstrate broader environmental preservation and health involvement.

In the energy management evaluation phase on fig 4, the following actions should be taken: (1) recording and calculating energy consumption; (2) measuring and recording savings; (3) assessing the strengths and weaknesses of action plans; and (4) reporting and presenting the results. Electricity use in schools must be monitored effectively to ensure efficient and effective activities. There are at least two electricity usage systems: using prepaid electric tokens and electricity usage with monthly billing. The token-based electricity measurement system allows users to purchase a certain kWh based on the corresponding value in Indonesian Rupiah. The current price per kWh is around 1,500 Rupiah for a power capacity of 1,300 kVA. Kilowatt-hour (kWh) indicates the amount of electricity consumed per watt-hour. An evaluation can determine whether the school's electricity-consuming activities align with the action plan by recording electricity consumption.

Recording and calculating energy consumption is the first step in energy management evaluation. The aim is to determine the amount of energy the school uses during a specific period—per day, week, or month. It can be done using measurement tools like electric meters or keeping track of token purchases. By understanding energy consumption, the school can set energy-saving targets.

Measuring and recording savings is the second step in energy management evaluation. It aims to determine how much energy the school has saved after implementing the action plan. Energy savings can be measured by comparing energy consumption before and after implementing the plan (Tanod et al., 2015). Energy savings can also be calculated using the following formula:

### School Energy Management Evaluation:

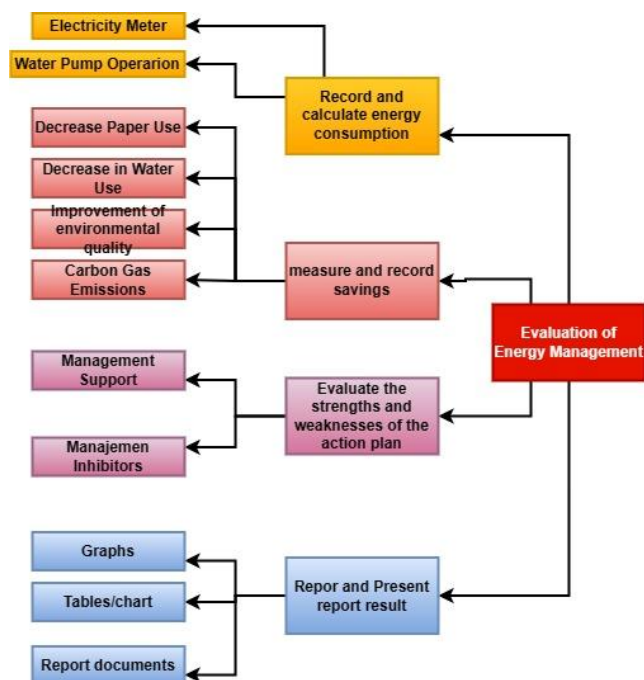


Fig 4: Energy Management Evaluation

Energy Savings (%) = (Initial Consumption - Final Consumption) / Initial Consumption x 100%

By measuring and recording savings, the school can evaluate the effectiveness of the action plan.

Assessing the strengths and weaknesses of the action plan is the third step in energy management evaluation—the aim is to identify factors that support or hinder the implementation of the action plan. Strengths of the action plan include positive impact factors on energy savings support from the school head, teachers, students, parents, or other parties. Weaknesses of the action plan include negative impact factors on energy savings and technical, financial, social, or cultural constraints. By assessing the strengths and weaknesses of the action plan, the school can make improvements or adjustments as needed.

Reporting and presenting the results is the fourth step in energy management evaluation. The aim is to communicate the achievements made by the school regarding energy savings to relevant stakeholders, including the education department, environmental agency, school committee, or the local community. The energy management evaluation report should be systematically and informatively prepared, including supporting data such as tables, graphs, diagrams, or photos. The report should also be visually appealing and easily understandable to the audience, using suitable media like presentation slides, posters, videos, or websites. By reporting and presenting the results,

the school can demonstrate its achievements and responsibilities in energy management and inspire others to do the same.

In the evaluation stage, concrete actions are taken to measure the success of the energy management program. Recording and calculating energy consumption, measuring savings, and evaluating action plans are crucial. Applying energy measurement methods, such as comparing consumption before and after actions, provides a clear picture of the program’s effectiveness.

Furthermore, evaluating the strengths and weaknesses of action plans allows the school to identify supporting and inhibiting factors. It enables continuous improvement and appropriate adjustments. Structured reporting of evaluation results helps the school share achievements and knowledge with relevant parties.

**Follow-up of School Energy Management:**

Follow-up actions in energy management that shown on fig 5 must be carried out in the energy management process to ensure that set objectives and goals are achieved effectively and efficiently. Several forms of follow-up actions that schools can undertake include:

Implementing recommendations from energy auditors: This involves acting on the recommendations provided by energy auditors who hold certificates by the Minister of Energy and Mineral Resources Regulation No. 14 of 2012 regarding Energy Audits. If the school’s report stage has not fully implemented the ministerial regulations, various actions can be taken. Examples include switching to LED lights, replacing energy-consuming projectors with LED TVs, enhancing awareness and participation of students, teachers, and staff, expanding collaborations with relevant stakeholders such as the Adiwiyata program, Ministry of Energy and Mineral Resources, SDGs program, healthy schools, and more.

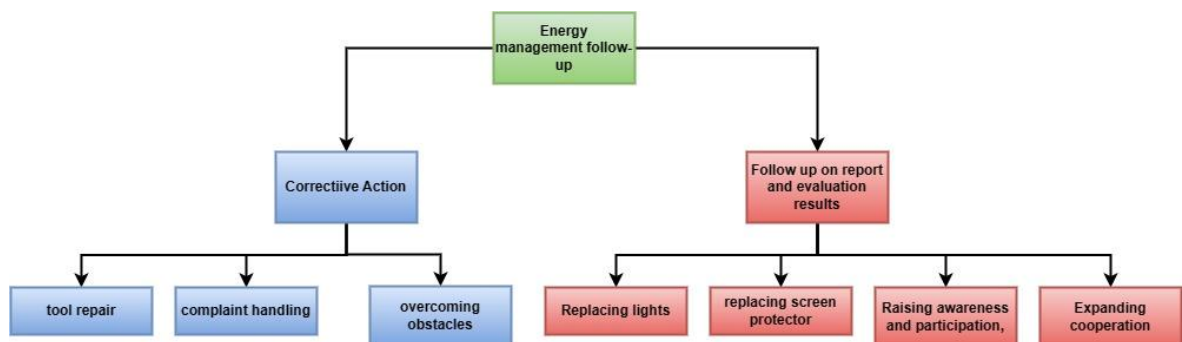


Fig 5: Follow-up of School Energy Management

Carrying out corrective actions involves repairing malfunctioning or underperforming equipment, addressing energy user complaints, and addressing obstacles encountered in energy management implementation. These actions aim to sustainably improve energy performance by applying an energy management system by ISO 50001:2018 standards. They also facilitate energy management enhancement related to greenhouse gas emission reduction.

Implementing preventive actions: This involves continuous planning, recording, monitoring, and evaluation of energy usage without compromising the quality of the teaching and learning process. These actions aim to prevent energy wastage and improve energy efficiency across all utilization pathways within the school. They also relate to environmental management, education management, logistics, and functions associated with school operations.

The latest findings from this research indicate that schools have unknowingly engaged in activities related to energy management to enhance the quality of school facilities. Researchers discovered that for the successful implementation of energy management activities, schools should refer to the diagram below:

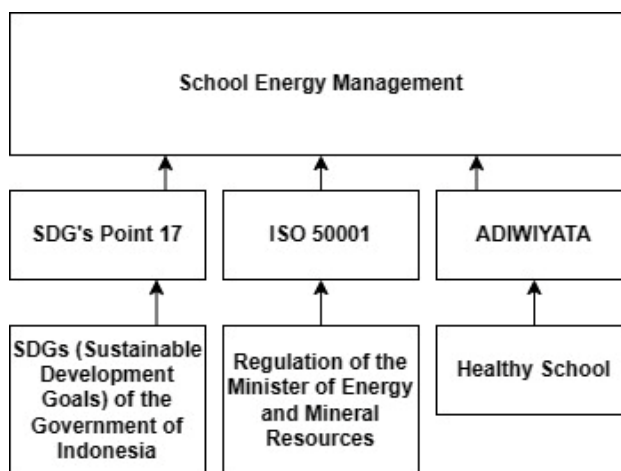


Fig 6: School Energy Management

Energy management in schools can be effectively carried out by embracing the spirit of implementing Sustainable Development Goal 17 (SDG 17), as outlined by UNESCO and other related bodies worldwide (Parpairi, 2017). Implementing ISO 50001 as the energy management standard and adhering to the Minister of Energy and Mineral Resources regulations provide schools with a solid foundation to execute effective energy management programs (Ridwan, 2020). The progressive implementation of Adiwiyata (Hanifah, 2023), from the local to national levels, closely aligns with the school's culture and energy management practices. Additionally, the Healthy Schools

program can be applied to enhance the quality of facilities from a health perspective.

The school's efforts to maintain sustainability and program effectiveness are revealed in the follow-up stage. Following up on report and evaluation results, such as replacing old devices with more efficient ones, raising awareness, and building cooperation, demonstrates a commitment to continuous improvement.

Taking corrective and preventive actions also reaffirms the school's readiness to respond to changes and ensure ongoing energy efficiency. Involving energy auditors and implementing the ISO 50001:2018 standard provides a clear framework for sustainable energy management.

The importance of school energy management in improving the quality of facilities and infrastructure is evident from the findings of this research. The success of the energy management stages provides strong evidence that this approach is effective in achieving the goals of energy conservation and responsible resource use.

An approach that combines religious values, Islamic principles, and hadith practices as guidance in energy management provides a moral and ethical foundation for energy efficiency efforts. Additionally, the involvement of school leadership and participation from all parties within the school is a critical factor in successful energy management implementation.

The effectiveness of internal campaigns, training, and programs like Adiwiyata and Healthy School highlights the importance of cross-sector approaches in school energy management. Furthermore, meticulous measurements, structured evaluations, and continuous actions reaffirm the school's social and environmental responsibility commitment.

Therefore, the results of this research significantly contribute to the development of energy management practices in schools. Wise and efficient energy use forms the basis for implementing sustainable and responsible educational programs for the future environment and generations.

## **Conclusion**

Energy management is a crucial aspect in efforts to enhance the quality of school facilities and infrastructure. Schools can optimize energy usage and achieve higher efficiency through careful planning, effective implementation, regular evaluation, and continuous follow-up. All school stakeholders play an active role in maintaining an environmentally friendly and resource-efficient school environment. Schools can serve as positive examples of responsible energy management through collaborative efforts and shared awareness.

The findings concluded that schools have not fully implemented the SDGs, the ESDM Regulations,

and ISO 50001. However, some activities have unknowingly been categorized as part of school energy management efforts—evidenced by the awards received by schools through the Adiwiyata and Healthy School programs. Through efforts to conserve electricity, water, and paper, schools have benefited by reallocating funds for infrastructure improvements and enhanced school programs.

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