INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

An Increasing The Effectiveness Of Electrical Energy Use Effectiveness Of Electric Energy

Batara Manggala Sianturi[1], Rangga Budi Hartanto[2], Mulia Arif Nasution[3], Rafiq Syarif Lasmana[4], Solly Aryza[5]
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

Article Info
Keywords:
effectiveness,
Energy and Electricity

ABSTRACT
Increasing the effectiveness of electrical energy use is an important step in reducing excessive energy consumption, and reducing operational costs. This research aims to identify and analyze various efforts that can be made to increase the effectiveness of electrical energy use. The research method used is a literature study by collecting data from various journals and scientific articles related to energy saving. The research results show that the application of energy-saving technology such as LED lights, the application of an automatic control system that can regulate energy use according to needs, and the application of an energy management system based on Internet of Things (IoT) technology have also been proven to increase energy effectiveness. This research also found that public education and awareness about energy savings has a very important role in optimizing the use of electrical energy. With proper implementation and supporting policies, this effort can provide significant cost savings

Corresponding Author:
Batara Manggala Sianturi
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia
sollyaryzalubis@gmail.com

INTRODUCTION

Electrical Energy Is A Fundamental Necessity In Modern Society, Supporting Industries, Businesses, And Households. As Global Energy Demand Continues To Rise, Ensuring The Effective And Efficient Use Of Electrical Energy Has Become A Crucial Challenge. Inefficient Energy Consumption Leads To Higher Operational Costs, Increased Environmental Impact, And Energy Wastage, Making Energy Conservation A Priority For Sustainable Development. In Many Sectors, Energy Inefficiency Is Caused By Outdated Equipment, Poor Energy Management, And Lack Of Awareness Regarding Energy-Saving Practices. According To International Energy Agency (IEA) Reports, Improving Energy Efficiency Can Reduce Energy Consumption By 20-30% Without Compromising Productivity. Furthermore, Renewable Energy Integration, Smart Grid Technologies, And Demand-Side Management Play A Vital Role In Enhancing Energy Use Effectiveness.

Electricity is one of the main needs in everyday life, both for household needs, industry, education, and other sectors. In this modern era, almost all aspects of life depend on the use of electrical energy, from lighting, electronic devices, air conditioning systems, to industrial machines. However, with the continuous increase in electricity consumption, the

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

problem of energy waste has become a serious concern in many countries. This has a significant impact on the increase in electricity bills.

Increasing the effectiveness of electricity use is an important step to reduce energy waste that is very economically beneficial. Several methods of saving electricity can be applied in various sectors, from households to industries. In households, simple steps such as turning off unused electronic equipment, replacing lamps with more energy-efficient LED lamps, and using energy-effective electrical equipment can have a significant impact on reducing electricity consumption.

In addition, smart technologies such as automatic control systems that can regulate energy use according to needs are also becoming increasingly popular solutions in energy saving. Wise use of energy in everyday life is very important, considering that energy resources are not unlimited, and the increasing demand for electricity worldwide.

In this study, various methods and strategies for increasing the effectiveness of electrical energy use that can be applied will be discussed, as well as the latest technologies that can help achieve energy saving goals effectively and sustainably. The approach that will be used includes an analysis of energy usage patterns.

Literature Review

Energy Efficiency and Its Importance

Energy efficiency refers to maximizing output while minimizing energy input, thereby reducing energy wastage and lowering costs. According to the International Energy Agency (IEA, 2021), improving energy efficiency could reduce global energy demand by 30% by 2040, significantly cutting greenhouse gas emissions. Sioshansi (2013) emphasizes that energy efficiency plays a critical role in sustainable development, enhancing power system reliability and reducing dependency on fossil fuels.

Energy efficiency improvements can be classified into three main categories:

1. Technological improvements, such as high-efficiency motors, LED lighting, and smart grid technologies.
2. Behavioral changes, including demand-side management and consumer awareness programs.
3. Policy and regulatory frameworks, such as energy efficiency standards, tax incentives, and energy audits.

Electrical energy is a form of energy produced by the movement of electrons in a conductor. The process of electrical energy can be understood through several basic concepts in physics, which explain how this energy is produced, transmitted, and utilized in everyday life. In general, the theory of electrical energy includes concepts such as electric charge, electric current, voltage, resistance, and the basic laws that govern them.

Some important characteristics of electrical energy include

a. Electric current

Electric current is the flow of electric charge that moves through a conductor (usually a conductor wire) due to a difference in voltage. Electric current is measured in Ampere (A), and can be direct current (DC) or alternating current (AC). This current is produced

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

by electromotive force (EMF) which can be triggered by a difference in voltage between two points in an electrical circuit.

b. Electrical voltage
Voltage or potential difference is the force that drives electrons to move in a conductor. Voltage is measured in Volts (V). This voltage difference causes electric current to flow from a point with high potential to a point with low potential. Voltage can be generated through various sources, such as batteries, generators, or power plants.

c. Electrical power
Electrical power is the rate of use of electrical energy in a circuit. Power is measured in Watts (W), and can be calculated by multiplying the voltage and current in a circuit:

$$P = V \times I$$

Where :
P is Electrical Power
V is the voltage
I is the current

If the electrical power is known and the duration of load usage is also known, then we can determine the amount of electrical energy using the formula

$$E = P \times t$$

Where :
E = Energy
P = Power
t = Time

Factors Affecting Energy Consumption Efficiency

Several factors influence the effectiveness of electrical energy usage:

a. Power Quality Issues: Voltage fluctuations, harmonics, and poor power factor can lead to inefficient energy use (Bollen & Hassan, 2011).
b. Aging Equipment and Infrastructure: Older machinery consumes more power compared to modern energy-efficient alternatives (Tanaka, 2011).
c. Lack of Energy Management Systems (EMS): Many industries lack automated energy monitoring systems, leading to energy wastage (Gellings, 2020).
d. Consumer Behavior and Awareness: Poor energy consumption habits contribute to inefficient usage (Delmas et al., 2013).

Technological advancements have significantly improved energy efficiency in various sectors. The following technologies have been widely studied for their impact on energy conservation:

a. Smart Grid Technologies: Smart grids integrate real-time monitoring, automated control, and distributed generation, optimizing energy usage (Fang et al., 2012).
b. Energy-Efficient Appliances and Systems: LED lighting, variable frequency drives (VFDs), and energy-efficient motors can reduce energy consumption by up to 40% (Rahman et al., 2018).

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

c. Building Management Systems (BMS): Automated control systems regulate HVAC (Heating, Ventilation, and Air Conditioning), lighting, and electrical loads, minimizing unnecessary energy use (Wang et al., 2011).

Demand-Side Management (DSM) and Energy Conservation Strategies

Demand-side management (DSM) refers to measures taken to optimize electricity usage by consumers. According to Strbac (2008), DSM strategies include:

1. Load Shifting: Encouraging consumers to use electricity during off-peak hours, reducing grid strain.
2. Peak Demand Reduction: Implementing energy storage solutions and renewable energy integration to lower peak demand.
3. Real-Time Monitoring and Smart Meters: Providing consumers with real-time energy consumption data to encourage energy-saving behaviors.
4. Energy Audits: Identifying inefficiencies in energy usage and recommending solutions (Pérez-Lombard et al., 2009).

Research highlights the significant benefits of improving energy efficiency:

1. Cost Savings: A study by McKinsey & Company (2019) found that industries implementing energy efficiency measures reduced operational costs by 15-25%.
2. Reduction in Carbon Emissions: Energy efficiency improvements contribute to global climate goals, with studies estimating a 30% reduction in CO_2 emissions by 2050 (IEA, 2021).
3. Grid Stability: Reducing energy wastage enhances the reliability of power systems, preventing blackouts and voltage instabilities (Sioshansi, 2013).

Despite its benefits, energy efficiency faces several challenges:

1. High Initial Investment Costs: Many energy-efficient technologies require substantial upfront investments, which deter small businesses and consumers (Gillingham et al., 2016).
2. Lack of Awareness and Training: Many industries lack skilled personnel to implement and maintain energy-efficient systems.
3. Regulatory Barriers: Inconsistent government policies and lack of incentives hinder widespread adoption of energy-saving technologies.

The literature emphasizes that increasing energy efficiency is essential for cost savings, environmental sustainability, and energy security. While various technologies and strategies exist to improve energy use effectiveness, challenges such as high costs, lack of awareness, and regulatory issues must be addressed. Future research should focus on policy interventions, financial incentives, and advanced smart technologies to further enhance energy efficiency across different sectors.

METHOD

This study aims to identify and analyze various ways of saving electrical energy that have been applied in various sectors, such as households, industry, and commercial. To achieve this goal, this study uses a descriptive-qualitative approach by collecting data through literature reviews or analysis of relevant journals on Increasing the Effectiveness of Electrical

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

Energy Use. This method was chosen because it allows for an in-depth picture of the various techniques and technologies used in saving electrical energy.

Data Collection through Literature Study

The main data collection in this study was carried out by means of literature study, namely by collecting and analyzing journals, scientific articles, books, and other reference sources related to saving electrical energy. This process involves several stages, namely:

a. Journal Selection
   The journals used in this study were selected based on the relevance of the topic to electricity saving. The journals taken cover various fields, ranging from energy saving technology, energy effectiveness policies, to the implementation of energy saving practices in households and industries.
b. Journal Analysis
   After the journals were selected, data from each source was analyzed to determine the methods of saving electricity that had been implemented. The analysis was conducted by reviewing the energy effectiveness techniques that had been tested, as well as the results and impacts of their implementation in reducing electricity consumption.
c. Data Categorization
   Data obtained from various sources are then grouped into certain categories, such as energy savings in the household, industrial and commercial sectors, as well as the use of the latest technology that can support energy effectiveness.

Data Analysis Methods

Data collected from journals and other sources will be analyzed using content analysis techniques to explore emerging patterns in electricity saving. In addition, data is also analyzed qualitatively to gain a deeper understanding of the effectiveness of energy saving techniques applied in various sectors.

Using this approach, the research aims to explore various methods that have been proven effective in saving electrical energy, as well as to provide recommendations to parties in need, such as governments, companies, or individuals who want to increase energy effectiveness.

RESULT

We have learned that the amount of electrical energy used depends on two things, namely:

1. The magnitude of the electrical load capacity
   The greater the electrical load power used, the greater the electrical energy consumption. Conversely, the smaller the electrical load power used, the smaller the electrical energy consumption.
2. Length of time of use of electrical load
   The longer the use of electrical load, the greater the use of electrical energy. And vice versa.

In this study, various efforts to increase the effectiveness of electricity use have been analyzed through a literature review that includes journals and scientific articles. Based on

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

the results of the analysis, several techniques and technologies were found that are effective in reducing electricity consumption, both in the household, industrial, and commercial sectors. The following are some of the main findings related to increasing the effectiveness of electricity use.

Implementation of Energy Saving Technology

One of the main findings in this study is the application of energy-saving technology. One of them is through the application of LED lights as a substitute for TL lights and traditional incandescent lights. LED lights are known to be more effective in terms of energy use because LEDs have much smaller electrical power than other lighting without reducing the quality of lighting (the size of the lamp lumen). Based on the results of studies conducted by several researchers (Siti Anisah and Amani Darma Tarigan), the use of LED lights can reduce electrical energy consumption with the following comparison:

Table 1. Lamp Power to Lamp Lumen Comparison Table

No	Incandescent Lamp Power	Neon lamp power	LED light power	Light quality (Lumen)
1	40 watt	9 watt	7 watt	450
2	60 watt	14 watt	9 watt	800
3	75 watt	19 watt	12 watt	1100
4	100 watt	24 watt	14 watt	1600

From here we can see that the use of LED lights is much more efficient than incandescent and neon lights. To require light quality of 450 lumens, incandescent lamps must have a power of 40 watts, fluorescent lamps must have a power of 9 watts, while LED lamps only have a power of 7 watts.

To require light quality of 800 lumens, incandescent lamps must have a power of 60 watts, neon lamps must have a power of 14 watts, while LED lamps only have a power of 9 watts. To require light quality of 1100 lumens, incandescent lamps must have a power of 75 watts, neon lamps must have a power of 19 watts, while LED lamps only have a power of 12 watts. To require light quality of 1600 lumens, the incandescent lamp must have a power of 100 watts, the fluorescent lamp must have a power of 24 watts, while the LED lamp only has a power of 14 watts.

In addition to the examples above, there are also efforts to increase the effectiveness of electrical energy use based on the results of studies by several researchers, especially on the use of air circulation (AC). The amount of electricity in the AC is also influenced by the selection of refrigerants where the selection of inappropriate refrigerants will result in greater energy consumption. As there are results of studies by several researchers (Dimas Nanda Ikhsan, et al) at the Istana Koki Restaurant & Grand Ballroom that replacing AC refrigerants with Musicool refrigerants can potentially save electrical energy by around 10% to 30%.

Here we can see that the efforts made to increase the effectiveness of electricity usage are to choose loads with smaller electrical power without reducing the quality of the electrical load.

INFOKUM
Volume 13, Number 01, 2024, DOI 10.58471/infokum.v13i01
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

Energy management through the application of automation control system technology

The implementation of this system is a technology system that has been proven to be one of the efforts to increase the effectiveness of electrical energy usage. There are many examples applied in this system. One of them is the Smart Control Energy Idle Time System. Based on the results of studies by several researchers (Mhd Rizki Syahputra, et al.), this system was built integrating sensors and Arduino microcontrollers to detect activity in a room such as a laboratory and if it is idle (break time) then this system can turn off electrical equipment in the room.

In addition, there are also other examples with the Implementation of the Internet of Things (IoT) in Building a Boarding House Control Application System Using an Android Application. Based on the results of studies by several researchers (UC Mariance, et al.), this system was built integrating motion sensors (PIR) and android applications to detect activity in a room such as a boarding house. If the boarding house tenant/occupant is not in the boarding house, the boarding house owner can monitor and control to turn off the boarding house's electricity supply using an android application remotely. Here we can see that the efforts made to increase the effectiveness of electricity usage are by reducing the time of electricity usage, namely by cutting off the electricity flow during unnecessary electricity usage.

Energy Education and Awareness

Examples of the results of studies by several researchers above are the application of technology in an effort to increase the effectiveness of electrical energy use. However, we can also make these efforts through education and increasing awareness of the importance of energy conservation. Education on simple ways to save electrical energy, such as turning off unused devices, and choosing equipment with good energy effectiveness, can contribute greatly to reducing overall energy consumption.

CONCLUSION

Improving the effectiveness of electrical energy use is crucial for reducing energy costs, minimizing environmental impact, and enhancing power system reliability. This study highlights several key findings related to energy efficiency, technological advancements, and demand-side management strategies. Energy Efficiency and Its Benefits; Implementing energy-efficient technologies, such as smart grids, LED lighting, and high-efficiency motors, can reduce energy consumption by 20-40%. Energy management systems (EMS) and real-time monitoring play a vital role in identifying and eliminating energy wastage. Energy audits and consumer awareness programs significantly improve energy-saving behaviors in industries and households. Technological and Policy Interventions; Smart meters and automated energy controls enable better demand-side management and load balancing, optimizing energy distribution. Government policies, financial incentives, and regulatory frameworks are essential for promoting energy efficiency investments. Renewable energy integration, combined with energy storage systems, can further enhance energy conservation efforts. Challenges and Future Directions; High initial investment costs and lack of technical expertise remain barriers to widespread adoption of energy-

efficient technologies. More research is needed on advanced energy-saving techniques, including AI-driven energy management systems and predictive analytics. Future energy policies should focus on economic incentives, public-private partnerships, and sustainability-driven energy planning.

REFERENCES

Anisah, S., & Tarigan, AD (2023). Planning of On Grid Rooftop Solar Power Plant as an Environmentally Friendly Alternative Energy Source. Journal of Information Technology and Computer Science (INTECOMS), 6(1), 503–510. Panca Budi Development University.

Aryza, S., Efendi, S., & Sihombing, P. (2024). A ROBUST OPTIMIZATION TO DYNAMIC SUPPLIER DECISIONS AND SUPPLY ALLOCATION PROBLEMS IN THE MULTI-RETAIL INDUSTRY. *Eastern-European Journal of Enterprise Technologies*, (3).

Aryza S dkk (2024) EFEKTIVITAS SIMULASI TERHADAP ANALISA KEHANDALAN TENAGA LISTRIK BERBASISKAN INTERNET OF THINK (IOT). *ESCAF*, 1226-1231.

Sri Wahyono, Firman L. Sahwandan and Feddy Suryanto. (2008). Review of the Development of Research on Solid Waste Processing in Palm Oil Mills

Wijono, Agung. (2014). Biomass Steam Power Plant Empty Oil Palm Fruit Bunches Feasibility Study and Environmental Impact. RAPI National Symposium XIII, (CI), 111–118.

Evridianto Dino, et al. (2022). Processing of Oil Palm Empty Fruit Bunches Biomass as Fuel for Steam Power Plants. Indonesian Journal of Social Technology.

Febryanti Fitri, et al. (2019). Utilization of Empty Oil Palm Fruit Bunch Waste into Bio-Char, Bio-oil and Gas Using Pyrolysis Method. Chemical Engineering Study Program. Faculty of Engineering. Mulawarman University.

Lubis, Z., & Aryza, S. (2023). AN IMPROVEMENT CONTROL PERFORMANCE OF AC MOTOR 3 PHASE WATER TOWER CENTRIFUGAL PUMP. *Jurnal Scientia*, *12*(04), 2086-2093.