

## THE IMPORTANT ROLE OF KINETIC ENERGY IN SUPPORTING SUSTAINABLE TECHNOLOGICAL DEVELOPMENT

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### Abstract

*Energy is a basic need that plays an important role in meeting the demands of rapid growth in various sectors in Indonesia. Currently, the majority of energy used is sourced from conventional energy, which is not only limited, but also has a negative impact on the environment. Therefore, this article aims to explore the basic concepts of kinetic energy, understand its technological utilization in Indonesia, and identify its advantages and limitations. In the face of global challenges related to energy sustainability, an understanding of kinetic energy is important in an effort to find more efficient and sustainable energy solutions. Through an analysis of the basic concepts of kinetic energy, this article also tries to analyze the potential of kinetic energy in the scope of technology in Indonesia. It is hoped that this understanding can motivate a wider adoption of kinetic energy, contribute positively to energy sustainability, and advance Indonesia towards a brighter future.*

**Keywords:** Efficiency, Energy, Kinetic, Sustainability, Technology

### INTRODUCTION

Energy is a basic need of every individual. As time goes by, the level of growth in various fields in Indonesia is increasing rapidly, causing the level of energy use to increase from time to time. Currently, the majority of energy used is conventional energy, such as natural gas, coal, and petroleum. This type of energy can run out at any time, so energy renewal is needed for the future. Kinetic energy is a form of energy that is inherent in objects in motion. This concept is the basis for our understanding of dynamics and movement in various aspects of everyday life. Kinetic energy is not only limited to macroscopic objects such as vehicles or moving balls, but also permeates the microscopic level, affecting particles within atoms and molecules. Kinetic energy is one of the most common forms of energy encountered in everyday life. Kinetic energy is the energy possessed by an object due to its motion. The faster an object moves, the greater its kinetic energy. In the ever-evolving modern world, understanding kinetic energy plays a crucial role in finding energy sources to create more efficient and sustainable technologies. This article aims to further review the basic concepts of kinetic energy, the utilization of kinetic energy-based technology, and its impact in facing global challenges related to energy sustainability.

### METHODS

The research methods used include literature review, data analysis, and case studies to obtain a comprehensive overview of this topic. With an in-depth understanding of kinetic energy, it is expected that effective solutions and recommendations can be found to overcome challenges and capitalize on opportunities in the future. A literature study will be conducted to gather information on the basic concepts of kinetic energy, kinetic energy utilization in Indonesia, and the environmental and sustainability impacts of kinetic energy use. In addition, data analysis will be used to analyze the potential of kinetic energy in Indonesia and identify obstacles in the development of kinetic energy. Finally, case studies will be conducted to gain a deeper understanding of the implementation of kinetic energy in Indonesia's development.

### RESULTS AND DISCUSSION

#### A. Kinetic Energy

Energy is defined as a unit of ability to do effort so that the term energy in everyday life is synonymous with the term effort. Energy is not a substance because energy does not occupy space has no mass and the

amount of energy cannot be measured but can only be seen from the impact it causes. Kinetic energy is a form of energy associated with the movement of objects. As an object moves, its kinetic energy will increase as its speed and mass increase. Kinetic energy can be converted into other forms of energy or used to do work. An understanding of kinetic energy is essential in sustainable energy development as it can help in designing efficient energy storage systems and making optimal use of sustainable resources.

### 1. Definition of Kinetic Energy

Kinetic energy can be defined as the energy possessed by an object due to their motion. This energy depends on the mass of the object and its speed. The greater the mass of the object and the higher the speed, the greater the kinetic energy it has. This definition explains that kinetic energy is a form of energy produced by the motion of an object and can be measured based on the size of the mass and speed of the object.

### 2. Kinetic Energy Formula

The kinetic energy formula can be expressed by the mathematical equation as  $E = 1/2 * m * v^2$ , where E is the kinetic energy, m is the mass of the object, and v is the velocity of the object. This formula shows that kinetic energy is directly proportional to the mass of the object and its speed of motion. For example, if the mass of an object doubles, then its kinetic energy will also double if the speed remains the same. In addition, if the velocity of an object doubles, its kinetic energy will quadruple if its mass remains the same.

### 3. Unit of Kinetic Energy

The unit of kinetic energy in the international system (SI) is joule (J). Joule is the unit used to measure energy. Although, in practice, other units such as kilojoules (kJ) or megaliters (ML) are often used depending on the scale of energy being measured. The use of consistent units is essential for communication and calculations in sustainable energy development, so that data and information can be compared accurately and effectively.

## B. The Role of Kinetic Energy in Sustainable Energy Development

Energy is one of the basic human needs that is important to support life. The world's energy needs continue to increase along with population growth and technological development. However, the excessive use of fossil energy sources can cause various environmental problems, such as climate change and air pollution. Kinetic energy is one of the potential forms of energy to be developed as an energy source for sustainable technology. Kinetic energy comes from the motion of objects, such as wind, water and geothermal energy.

### 1. Utilization of Kinetic Energy in Power Generation

Kinetic energy has a very important role in the development of sustainable energy. The use of kinetic energy derived from natural sources such as water, wind, ocean waves, and human movement can reduce dependence on fossil energy sources that are limited and not environmentally friendly. By utilizing kinetic energy, we can generate clean and renewable electrical energy. In addition, the development of kinetic energy can also create new jobs and improve the regional economy. Thus, the role of kinetic energy is very important in supporting sustainable energy development and reducing negative impacts on the environment.

### 2. Kinetic Energy as an Alternative Energy Source

Kinetic energy, apart from being the basis of the concept of movement in the world of physics, also has great potential as an environmentally friendly alternative energy source. When moving objects, their kinetic energy can be converted into other forms of energy that can be used to meet the needs of modern society.

Kinetic energy from the motion of objects can be captured and converted into electrical energy through a technology called kinetic energy harvesting. One example of the application of this technology is wind turbines, where the kinetic energy of the wind that rotates the turbine blades is converted into electrical energy. Similarly, hydroelectric power generation technology, where the kinetic energy of flowing water is used to drive turbines and generate electricity. However, challenges in the development of kinetic energy as an alternative energy source still need to be overcome. Factors such as energy conversion efficiency, initial investment costs, and environmental impact need to be considered in widely applying this technology. Through continuous research and innovation efforts, it is hoped that kinetic energy can become a major contributor in achieving renewable and sustainable energy goals.

### 3. Positive Impact of Kinetic Energy Development

The utilization of kinetic energy as an alternative energy source provides several advantages. First, kinetic energy can be obtained from various natural sources, such as water, wind, and even human movement. Second, the use of kinetic energy can reduce dependence on fossil energy sources which are increasingly limited and have a negative impact on the environment.

### **1) Kinetic energy can be extracted from a variety of natural sources**

- a) Wind, Kinetic energy can be drawn from the movement of the wind. Wind power plants use wind turbines to convert wind kinetic energy into electrical energy.
- b) Water, Hydroelectric power plants utilize the kinetic energy of flowing water to drive turbines, which then generate electricity.
- c) Ocean Currents, Ocean waves and currents can also generate kinetic energy. Technologies such as wave power plants or ocean current turbines are utilized to convert this energy into electricity.
- d) Human Movement, Human activity, such as walking or running, can also generate kinetic energy. Several innovative technologies are being developed to convert human movement into electrical energy, such as smart footwear or smart clothing devices.
- e) Vehicle Motion, Moving vehicles, such as cars, trains or planes, contain kinetic energy. Regenerative braking systems in electric vehicles can convert the kinetic energy during braking back into electrical energy that can be reused.

Utilizing these various natural sources to generate kinetic energy is part of a global effort to diversify energy sources and shift to cleaner, more sustainable energy sources. These technologies reflect a commitment to meeting the challenges related to climate change and the limitations of conventional energy sources.

### **2) Reducing dependence on fossil energy sources**

Kinetic energy utilization plays a crucial role in reducing dependence on fossil energy sources. Fossil energy sources, such as oil, coal and natural gas, have long been a key driver of the global economy, but their use also has a negative impact on the environment and contributes greatly to climate change.

Here's how the use of kinetic energy can help reduce dependence on fossil energy sources:

#### **a) Renewable Energy**

Kinetic energy sources, such as wind energy and water energy, fall under the category of renewable energy. By replacing fossil energy sources with renewable energy, we can reduce greenhouse gas emissions and other negative impacts on the environment.

#### **b) Reduction of Carbon Emissions**

One of the immediate advantages of using kinetic energy is the reduction in carbon emissions. Wind and hydropower plants, for example, do not produce significant amounts of greenhouse gas emissions during their operation, unlike fossil fuel power plants.

#### **c) Diversification of Energy Sources**

The utilization of kinetic energy helps in the diversification of energy sources. By having a variety of energy sources, society becomes less dependent on a single type of energy, which in turn improves energy security and reduces the risks associated with fossil fuel price fluctuations.

#### **d) Increased Energy Sustainability**

Kinetic energy can be generated sustainably as it relies on renewable natural resources such as wind, water and human movement. This contributes to the construction of a more sustainable and environmentally friendly energy system.

By continuing to develop and adopt kinetic energy technologies, we can accelerate the transition to a more sustainable society and reduce the negative impacts of utilizing fossil energy sources.

### **C. Current Technologies in Kinetic Energy Utilization**

One of the latest technologies related to kinetic energy utilization is the development of "kinetic harvesting". Here are some recent innovations regarding the latest technology in kinetic energy utilization.

#### **1. Wind Turbines**

Wind energy is one of the most widely developed kinetic energy sources. Wind energy can be utilized to generate electricity through wind turbines. Wind turbines convert wind kinetic energy into electrical energy. The use of wind turbines utilizes wind energy that can be obtained freely throughout the year. Currently, wind turbines have become an important source of electrical energy in various

countries around the world. In Indonesia, wind energy development has also begun, especially in coastal areas that have great wind potential.

## 2. Ocean Wave Power Plant

Sea Wave Power Plant (PLTGL) is a power plant that utilizes the kinetic energy of ocean waves to generate electricity. Ocean wave kinetic energy is one form of renewable energy that is abundantly available, especially in Indonesia, where most of the territory is water. The working principle of PLTGL is to utilize the up and down movement of ocean waves to drive a device that produces electrical energy. The tool used to generate electrical energy from ocean waves is called a converter. There are several types of converters used in PLTGL, namely:

### a) OWC (Oscillating Water Column) Converter.

The OWC converter utilizes the air pressure generated by the up and down motion of ocean waves to drive the turbine generator.

### b) OWC (Oscillating Water Column) Converter.

Attenuator Converter. The Attenuator Converter utilizes the up and down motion of ocean waves to drive a device that absorbs ocean wave energy. The absorbed energy is then used to drive the generator turbine.

### c) Attenuator Converter

Buoy Converter. The Buoy Converter utilizes the up and down motion of ocean waves to drive a buoy. The motion of the buoy is then used to drive the generator turbine.

### d) Buoy Converter

The development of PLTGL in Indonesia has started since 2012. By 2023, there will be 10 PLTGLs operating in Indonesia with a total installed capacity of 1.2 MW.

In addition to ocean waves, electricity can also be generated from river water currents through water turbines. The greater the water discharge, the efficiency of the kinetic turbine will increase because the high speed of the water hitting the turbine affects the turbine torque, power, and kinetic turbine efficiency. The Indonesian government targets an installed capacity of 100 MW of PLTGL by 2030. To achieve this target, the government needs to encourage the development of more efficient and affordable PLTGL technology.

## 3. Use of Kinetic Energy for Transportation

Kinetic energy has been used in transportation for centuries. One of the earliest examples is the use of wind to power sailing ships. Sailing ships utilize the kinetic energy of the wind to move their sails, which in turn moves the ship. The use of kinetic energy in transportation makes a significant contribution towards a more sustainable and environmentally friendly transportation system in Indonesia.

## 4. Innovation in Kinetic Energy Technology

Innovations in kinetic energy technology can bring significant changes in resource use and reduce impacts on the environment. One example is the development of technologies to harness energy from human and vehicle movement. Examples include doors that can generate energy every time they open and close, or highways that can convert energy from pedestrian footsteps and vehicle vibrations into electricity.

There is also a focus on improving the efficiency of wind turbine technology and the use of innovative materials in the construction of structures that can capture and convert kinetic energy. By continuing to explore creativity and advanced technologies, we can find new ways to optimize the use of kinetic energy in various situations.

## D. Challenges and Obstacles in the Development of Kinetic Energy

Although the potential of kinetic energy is very attractive, there are several challenges and obstacles in the development of this technology. The following are the challenges and obstacles that we need to face in developing the potential of kinetic energy.

### a. Limited Natural Resources

The development of kinetic energy technology is also limited by the availability of natural resources. For example, the location required for the development of kinetic energy technology is still lacking, some kinetic energy technologies, such as wind turbines or ocean

waves, are highly dependent on the right geographical location. Not all regions have sufficient potential to utilize kinetic energy effectively.

b. Technical and Technological Issues

Some kinetic energy technologies may be less efficient in converting motion into electrical energy. Improving efficiency is a challenge that must be overcome to make these technologies more sustainable and practical. Energy storage, as we know ourselves, the success of kinetic energy also depends on efficient energy storage capabilities. Currently, energy storage technologies may not be sufficient to support such energy sources in a sustainable manner.

c. Economic Factors in Kinetic Energy Development

The development and application of kinetic energy technologies are often costly, especially in the early stages, which can be a barrier to widespread application, as well as in resource-constrained regions.

**E. Strategies for Sustainable Development of Kinetic Energy**

To develop kinetic energy in a sustainable manner, several strategies are needed to be implemented in order to support the development process.

a) Research and Development of New Technologies

Conduct continuous research to improve the efficiency and reduce the cost of kinetic energy technology. Such as innovating in design, this can be a creative step towards creating solutions that are more efficient, aesthetically pleasing, and often more sustainable. Materials, and conversion technologies must also be considered, material selection in kinetic technology development depends on the specific application, environment, and performance requirements. Innovation continues to create materials that are more efficient, environmentally friendly, and reliable in utilizing kinetic energy.

b) Public Awareness and Education

Educating the public about the benefits of kinetic energy and its positive impact on the environment can increase public support. Increased awareness is likely to create demand for sustainable solutions. Such as overcoming ignorance, many people may not be familiar with the concept of kinetic energy and how electricity is generated from motion and vibration.

Education can help overcome such ignorance and provide a deeper understanding of the potential of these energy sources. Public education is an important step in creating a transition to a more sustainable society and utilizing the potential of kinetic energy for energy sustainability.

**F. Case Study: Kinetic Energy Implementation in Developed Countries**

This case study shows how developed countries are integrating kinetic energy in various aspects of their daily lives, from transportation to renewable energy infrastructure. These implementations not only create additional energy sources, but also make a positive contribution to sustainability and carbon footprint reduction.

**1. Netherlands**

The Netherlands is one of the countries actively working to introduce kinetic energy utilization technologies. Some examples of its implementation are

a) Offshore Wind Turbine Applications In the Netherlands, there are a number of offshore wind turbine power plants in the North Sea. These wind turbines utilize the kinetic energy of the wind to generate electricity. Given the strong wind conditions in the region, this is an important source of renewable energy.

b) Energy Utilization Technology in Road Infrastructure The Netherlands is developing projects to use kinetic energy harvesting technology on roads. For example, the use of technology that can convert the vibrations of vehicular traffic into electrical energy. The energy generated can be used for street lighting and other equipment.

c) Offshore wave power generation The Netherlands is also researching wave power technology on the coast. Equipment such as boats and other equipment that move with the ocean waves produce kinetic energy that is converted into electricity.

d) Use of pneumatic water pumps, Some cities in the Netherlands use pneumatic water pump systems that use the kinetic energy of water to drive water pumps. This allows water to flow

from a lower place to a higher place using the kinetic energy of water, so that water can benefit from changes in water level in geographically flat areas.

- e) Application of energy production technologies in buildings, The concept of smart buildings, i.e. buildings capable of producing energy, is being used in several cities in the Netherlands.

Some innovations, such as the use of bicycle lanes and electric bicycle charging stations in the Netherlands that can generate kinetic energy from the movement of bicycles, are a step towards more environmentally friendly transportation options.

The innovation and application of kinetic energy technology in the Netherlands is an effort to achieve sustainability goals and reduce dependence on conventional energy sources. This reflects the company's commitment to environmentally friendly solutions to the challenge of climate change.

## 2. Germany

Germany is one of the countries actively using and applying technologies that utilize kinetic energy in various situations. Examples of the application of this technology in Germany include:

- a) Wind energy production Germany has a strong wind energy industry. They have built various onshore and offshore wind turbines. These turbines convert the kinetic energy of the wind into electrical energy, contributing to Germany's renewable energy goals.
- b) Kinetic energy from traffic vibrations, Some German cities use technology to convert vibrations from public transportation such as subways and trams into electrical energy. This reduces energy consumption and provides an additional source of energy.
- c) Smart pavement technology, Germany has tested and introduced smart pavement technology on its roads. When vehicles pass over these surfaces, kinetic energy is generated. One example is the use of piezoelectric speakers on highways that can convert traffic vibrations into electrical energy.
- d) Waterwheel technology innovation (hydraulic turbines), Several river projects in Germany involve the use of waterwheels that can convert the kinetic energy of flowing water into electricity. This is mainly used on rivers where the kinetic energy potential is very large.
- e) Energy from stairs (piezoelectric floors), Some public buildings in Germany have adopted piezoelectric floor technology that can convert the pressure and vibration from stairs into electrical energy. This can be applied in areas with heavy pedestrian traffic, such as stations and shopping centers.
- f) Projects utilizing ocean wave energy, Germany is also researching the potential of ocean wave kinetic energy. Several experimental projects are underway to convert ocean wave energy into electrical energy. Electric bicycle lanes: Some bike paths in Germany are equipped with technology that allows cyclists to convert the kinetic energy of cycling into electrical energy. This energy can be used for street lighting or fed into the electricity grid.

These applications demonstrate Germany's commitment to reducing dependence on fossil energy sources and increasing the use of renewable energy through the use of kinetic energy in various aspects of daily life.

## CONCLUSION

Energy is a vital basic need for every individual, and with the rapid growth in various sectors in Indonesia, the level of energy consumption continues to increase. Currently, the majority of energy used is sourced from conventional energy, which is not only limited, but also has a negative impact on the environment. Therefore, there is a need for energy renewal to face a sustainable future. One form of energy that attracts attention is kinetic energy, which is inherent in objects in motion.

The importance of understanding kinetic energy is increasing in the context of ever-evolving modern development. This is a crucial step in finding more efficient and sustainable energy solutions. However, Indonesia still faces challenges in widely adopting kinetic energy. The purpose of this research is to explore the basic concepts of kinetic energy, understand its utilization in Indonesia, and identify the advantages and limitations of its use. Through the analysis of the basic concepts of kinetic energy, it is expected to find the potential that can be optimized in Indonesia.

With these steps, it is hoped that the public will become more aware of the important role kinetic energy plays in achieving energy sustainability. Along with this awareness, it is expected that the adoption of kinetic energy

will increase, making a positive contribution to the search for environmentally friendly and sustainable energy sources in the future.

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With all warmth and appreciation, we would like to express our gratitude to the loyal readers who have taken the time to explore this article. Hopefully, the discussion on kinetic energy can provide valuable insights and motivate us all to care more about energy sustainability.

Thank you for your interest and support in understanding the role of kinetic energy in facing global challenges. Let's together contribute to efforts to find energy solutions that are more efficient, environmentally friendly and sustainable. May we be part of the positive change towards a brighter future. Once again, thank you very much for your attention and enthusiasm.

See you in the next articles that will cover more interesting issues. Stay connected and stay passionate about creating a better world.

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