Journal of Applied Research in Science and Humanities

Sustainable Development and Its Relationship with Physics

Habiba Salah El-Din Abdallah, Nada Ibrahim Ahmed, Nada Mostafa Kamel, Rana Ashraf Mohamed, Reem Tarek Abd-Elkreem, Toka Nasser Abd El-Rhman, Yasmeen Khaled Shahat

Supervisor: Hany Nazmy Soliman, Assistant Professor of physics, Solid State Physics.

Ain Shams University, Faculty of Education,

Program: Bachelor of Science and Education (Preparatory and Secondary), Physics major (in English)

Abstract

The goal of this project is to create a mechanical energy gadget that will improve students' understanding of sustainable development and how it relates to physics. Researchers are investigating novel approaches to harvesting renewable energy because of the growing demand for sustainable and clean energy sources. The creation of mechanical footstep power generators, which harness the kinetic energy of a person's footfall to generate electricity, is one such strategy. An outline of the idea, design factors, and possible uses for footstep power generators are given in this abstract. The idea behind footstep power generators is to use the generator and springs to transform mechanical energy into electrical energy. Such as Rack & Pinion can produce electricity when under mechanical stress. These materials are frequently placed higher up on the floor so that as people walk or run, their weight will compress them and cause them to produce electricity. The optimization of footstep power generators' practicality and efficiency is largely dependent on design considerations. Footstep power generators have a wide range of potential uses. By placing them in busy places like train stations, airports, and retail centers, they may produce electricity from constant foot traffic and lessen reliance on conventional energy sources. Wearable technology can also incorporate step-by-step power generators, allowing users to produce electricity while moving or exercising. Furthermore, using them in isolated locations or during emergencies might offer a reliable and quick source of electricity. This is being done in the hopes of offering a fresh viewpoint and demonstrating how to approach and accomplish sustainable development. Our goal is to stimulate more study on this subject.

***Keywords*:** Sustainability, Sustainable development, green science, clean energy, green cities and transport,

1. Introduction:

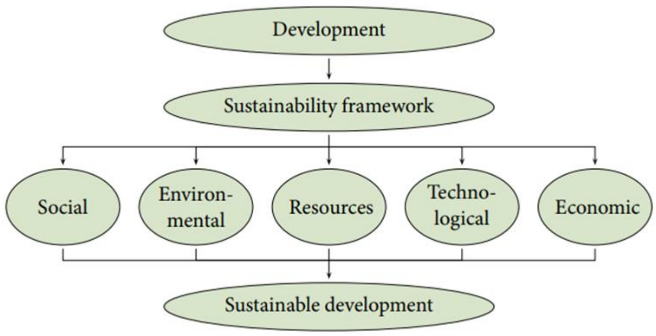
What is sustainable development?

Sustainable development, a widely recognized term in the 21st century, embodies both moral and scientific dimensions. While it pertains to natural sciences, economics, and politics, it also holds cultural significance. This concept entails achieving development that fulfils current needs without jeopardizing the capacity of future generations to fulfil their own requirements **[1]**. It represents a developmental vision that includes populations, animal and plant species, ecosystems, and natural resources like water, air, and energy. This vision integrates various concerns such as poverty alleviation, gender equality, human rights, universal education, healthcare, human security, and intercultural dialogue. In academic discourse, sustainable development is characterized as the enhancement of human life quality while operating within the sustainable capacity of supporting ecosystems **[2]**. The primary aim of the Decade is for sustainable development to transcend mere rhetoric and materialize as a tangible reality in the daily choices and actions of individuals, organizations, and governments. This commitment is essential to ensure a sustainable planet and a safer world for our children, grandchildren, and future generations.

What is the difference between sustainability and sustainable development?

Defining sustainability poses a significant challenge. Existing literature suggests that sustainability encompasses a philosophy, approach, or practice that steers the efficient utilization of current resources to ensure their availability and adequacy in meeting the needs of both present and future generations **[4,5]**. Sustainability is also articulated as the capability to make prudent choices when deploying and distributing resources among economic and non-economic pursuits, with the aim of realizing specific desired social, economic, and environmental results **[5]**.

The two concepts are fundamentally different. Sustainability acts as the motivating factor or agenda that directs a developmental process towards reaching a sustainable level of development **[6,7]**. To coordinate all aspects of development toward the goal of reaching a sustainable level of development, sustainability sets the tone, the strategy, or the guiding principles **[6]**. On the other hand, sustainable development is an objective that is attained through adherence to a set of sustainability standards or principles **[8]**. A straightforward example of how development directed by an appropriate sustainability framework might result in sustainable development is shown in the opposite image.



Conceptual Relationship between Sustainability and Sustainable Development

This figure's representation suggests that sustainability and sustainable development have a positive relationship, which could be linear or non-linear. The framework in this image implies that putting sustainability first on the development path leads to sustainable development. A development outcome is deemed sustainable if it is attained at any level and guided by a sustainability framework. On the other hand, any degree of development attained in the absence of a guiding framework for sustainability is regarded as an unsustainable development outcome. The three pillars of sustainable development or sustainability are social, environmental, and economic **[9,10]**. Thus, it entails striking a balance between social advancement, environmental preservation, and economic development. Accordingly, a dynamic balance of the interrelated and dependent domains of social, economic, and environmental sustainability is what is meant to be understood as sustainable development **[11]**.

Sustainable Development Goals:

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

The importance of sustainable development:

1. **Economic Prosperity**:

It is not possible for sustainability and economic prosperity to coexist. Although economic growth is important, sustainable development stresses that it should be accomplished in a way that is equitable, socially, and environmentally responsible, and friendly to the environment. We can promote innovation, new job possibilities, and sustainable economic growth by implementing sustainable business practices and investing in green technologies.

2. **Environmental Conservation**:

Preserving and conserving biodiversity, ecosystems, and natural resources is a key component of sustainable development. It acknowledges that resources on Earth are limited and need to be managed carefully to avoid running out. We can lessen climate change, preserve ecosystems, cut down on pollution, and preserve the environment for coming generations by implementing sustainable practices.

3. **Social Equity and Well-being**:

The goal of sustainable development is to raise everyone's standard of living and well-being, both individually and collectively. It aims to end poverty, lessen inequality, and guarantee that everyone has access to needs including food, clean water, sanitary conditions, medical care, and education. Sustainable development encourages a more inclusive and just society by placing a high priority on social equity.

4. **Long-term Resilience**:

The main goal of sustainable development is long-term planning and thought. Through considering the interdependencies of social, economic, and environmental elements, we may construct resilient communities and systems that are more capable of withstanding shocks and emergencies. This entails making investments in infrastructure that can be adjusted to meet changing needs, advocating for sustainable agricultural and energy systems, and becoming ready for the effects of climate change.

5. **Global Cooperation**:

Collaborating and working together globally is necessary to achieve sustainability. Numerous issues we confront, such biodiversity loss, climate change, and resource depletion, cut beyond national borders. Countries, organizations, and people are encouraged by sustainable development to collaborate, exchange resources and expertise, and come up with group solutions to these common problems.

2. The Theoretical Framework

Green science:

It is a tool for development that combines economy, business, and education to create a viable future. Therefore, in order to reduce ecological harm and eliminate the use of and age of hazardous compounds, we need now concentrate on advancements in green science. Furthermore, the same ideals and tenets support both green science and sustainable development. They both acknowledge the interdependence of social, economic, and environmental issues and place a higher priority on the health of people and the environment than do temporary financial gains. Through the alignment of these values and principles, we may develop a more unified and efficient strategy for sustainability.

Sustainable development physics point of view:

- **Physics is playing a vital role in helping meet the challenge of climate change**.

The discipline is multidisciplinary and finds application in various areas of economic development, such as health, agriculture, weather, and climate. These areas are influenced by solar radiation absorption and its subsequent re-distribution through processes such as radiative, advective, and hydrological. The equilibrium between radiation emission and absorption controls the Earth's surface temperature. Radiative forcing, which is expressed in Watts per square meter, is the word used to describe a shift in this radiative balance.

The Earth's surface retains its warmth due to the natural greenhouse gases, mostly carbon dioxide and water vapor, which trap heat radiation from the surface. Because of human activity, atmospheric concentrations of greenhouse gases have significantly increased, amplifying the effects of the natural greenhouse effect.

- **The importance of semi-conductors for sustainable development**:

These days, industry, transportation, and the production of electricity account for a sizable portion of the world's greenhouse emissions. The demand for power is predicted to rise by 30% over the next ten years, contributing to a roughly 50% increase in global energy consumption until 2050. Therefore, more effective energy use and improved power and energy management are now essential to ensuring our civilization has a sustainable future. In this regard, one of the main factors facilitating the shift to sustainability is the development of new semiconductor device technologies for power electronics that offer a higher energy efficiency compared to silicon. Wide band gap semiconductors (WBG) are the most promising materials for the next generation of energy-efficient power and high frequency devices because of their exceptional physical and electrical features. In terms of crystalline quality and device technology, silicon carbide (SiC) and gallium nitride (GaN) are the most advanced among them.

- **Renewable energy sources**:

are crucial to sustainable energy since, in general, they improve energy security and produce far less greenhouse gas emissions than fossil fuels. Projects involving renewable energy can occasionally give rise to serious sustainability issues, such as threats to biodiversity when very ecologically valuable areas are turned into bioenergy production facilities or solar and wind energy farms.

- **Energy**:

Energy is the lifeblood of modern society and has made a significant contribution to raising the standard of living for all people. There are significant political and moral ramifications to the controversy around the relationship between energy sources and climate change.

The creation of vast and sustainable energy sources now requires additional convergence and integration between the physics and technology strands. Accordingly, the next several decades will be critical for proving the scientific and technological feasibility of fusion as a source of energy by combining the physics knowledge that has been gained, such as engineering optimization and containment. Enhancing the performance of batteries and fuel cells necessitates a deeper comprehension of the intricate multi-scale phenomena that occur in these devices; an empirical approach alone will not suffice. Computational simulation combined with sophisticated characterization methods can help meet this problem. Consequently, a great deal of work needs to go into validating the model against experiments.

An attitude of caring for the environment is one that is demonstrated in daily actions to avert and prevent environmental harm. The ability to act on environmental issues indicates environmental competence. Four factors: 1) environmental knowledge, including environmental fundamentals; 2) attitudes of environmental care, environmental conditions, and feelings toward the environment, including environmental perspectives; 3) cognitive, including environmental issues, environmental analysis, and planning; skills; and 4) behaviour, including specific behaviour toward the environment-can be used to measure an individual's environmental literacy **[12]**. The references used to ascertain an individual's reading level, particularly among students, are these four variables.

The concept of Education Sustainable Development (ESD) presents a quality education perspective that emphasizes lifetime learning, the development of students' abilities, values, and competences to become change agents, in addition to quantifiable learning outcomes and national standards. ESD uses problem-solving and experiential learning techniques that are active and interactive **[13]**.

Among the Sustainable Development Goals (SDGs), science is one area where learning is important. Numerous items are directly tied to science, which is how science, and the SDGs relate to each other **[14]**. Energy and environmental materials are among the many natural science values that might be applied in opposition to the SDGs. To incorporate sustainable development into learning activities, instructors must be able to analyse science curriculum and learning objectives using the SDGs idea to identify problems that pose a danger to the planet's sustainability.

With a shared understanding and set of solutions, it will be easier to address the issues we currently face and those we will face in the future, including gender inequality, climate change, rising air pollution, declining forest cover, difficulties related to migration and displacement, poverty and inequality, and general poor health and wellbeing. On our path together to a better future – one with a healthy world, improved health and wellbeing, a respectable standard of living, equality, a political paradigm based on our conscious selves, social justice, and improved conflict resolution – self-awareness will make us more cooperative and conscious. We might hope to leave our future generations with a better place to live in by developing and valuing our inner selves.

3. Methods of Research and the tools used

A. Survey:

Firstly, we have documented the research by conducting a survey to measure the students' knowledge across various age groups on the topic of sustainable development and its relationship with physics. The survey was administered in both Arabic and English to facilitate their responses. Subsequently, after applying our research, we will re-conduct the same survey following a thorough explanation of the topic, and interactions were also will be documented.

https://forms.office.com/r/hjsSGGy4H9

https://forms.office.com/r/mjxgSx9csW

B. Materials:

- Springs
- Up and down plates

- Wires
- Pinion

- Generator
- Resistors
- LED light
- Rack.

Mechanism of working:

The mechanical footstep power generator system works by converting the mechanical energy generated by footsteps into electrical energy. The system consists of a base made of plywood or other sturdy material, with springs attached to it. Up and down plates are placed on top of the springs, and when pressure is applied, they move up and down, generating mechanical energy. The mechanical energy is then converted into electrical energy by a generator, which is connected to the up and down plates. The electrical energy is then stored in a capacitor and used to power an LED light.

C. How to construct the prototype:

To construct our prototype, we follow the following steps:

1. Firstly, construct the base out of plywood or another durable material.
2. Use screws or other fasteners to secure the springs to the base.
3. Use screws or other fasteners to secure the up and down plates to the springs.
4. Use cables to connect the generator to the up and down plates.
5. To make sure that the electrical charge flows in the right direction, connect the diodes to the breadboard.
6. Attach the capacitors to the breadboard to store the electrical charge produced by the generator.
7. Connect the resistors to the breadboard to control the amount of electrical current flowing.
8. Finally, connect the LED light to the breadboard to test our system and confirm that power is being generated.

D. Efficiency:

The efficiency of the mechanical footstep power generator system will depend on a variety of factors, including:

- the design of the system,
- the materials used, and
- the amount of pressure applied to the up and down plates.

In general, the efficiency of the system is likely to be relatively low, as there will be some energy lost in the conversion process from mechanical energy to electrical energy. However, with further development and refinement, the efficiency of the system could be improved **[15]**.

4. Results of Research

A. Renewable energy:

A mechanical footstep power generator system is a type of renewable energy technology that converts the mechanical energy generated by footsteps into electrical energy. The system typically consists of a series of plates or pads that are placed on the ground and connected to a generator. As a person steps on the plates, the mechanical energy generated by the movement is converted into electrical energy by the generator. This electrical energy can then be stored in batteries or used to power devices directly. The output of the mechanical footstep power generator system is considered renewable energy because it is generated by a natural and sustainable source – human movement. Unlike fossil fuels, which are finite resources that will eventually run out, the energy generated by a footstep power generator system can be continuously replenished as long as people continue to walk and move. Additionally, footstep power generator systems are environmentally friendly because they do not produce any harmful emissions or pollutants. They are also relatively low-cost and easy to install, making them a practical solution for powering devices in public spaces such as parks, malls, and airports. Electric power generated by a mechanical footstep power generator system is considered a renewable resource of energy because it is generated from a natural and sustainable source – human movement. Unlike fossil fuels, which are finite resources that will eventually run out, the energy generated by a footstep power generator system can be continuously replenished as long as people continue to walk and move. Renewable energy sources are those that are replenished naturally and can be used repeatedly without being depleted. Examples of renewable energy sources include solar, wind, hydro, geothermal, and biomass. These sources of energy are considered renewable because they are replenished naturally and can be used indefinitely. Similarly, the energy generated by a mechanical footstep power generator system is also considered renewable because it is generated from a natural and sustainable source – human movement. As long as people continue to walk and move, the energy generated by the system can be continuously replenished. Renewable energy sources are becoming increasingly important as the world seeks to reduce its dependence on fossil fuels and transition to a more sustainable energy future. By harnessing the power of natural and sustainable sources of energy, we can reduce our carbon footprint, mitigate the impacts of climate change, and ensure a more sustainable future for generations to come.

B. **Energy conservation**:

The mechanical footstep power generator system with plates is an innovative technology that not only generates electricity but also promotes energy conservation. The system works by converting the mechanical energy generated by footsteps into electrical energy, which can be used to power devices or stored in batteries for later use. Here are some ways in which the system promotes energy conservation:

1. **Energy harvesting**:

The mechanical footstep power generator system harvests energy that would otherwise be wasted. When people walk or run on the plates, the energy generated by their movement is captured and converted into electrical energy. This means that the system is able to generate electricity without the need for additional energy inputs, such as fossil fuels **[16,17]**.

2. **Efficient energy use**:

The system is designed to be highly efficient in its energy use. The energy generated by the system can be used to power devices directly, such as streetlights or traffic signals, or stored in batteries for later use. By using the energy generated by the system in an efficient manner, the overall energy consumption of the system is reduced **[18]**.

3. **Reduced carbon footprint**:

The mechanical footstep power generator system with plates has a low carbon footprint compared to traditional energy sources. The system generates electricity without producing any harmful emissions or pollutants, which helps to reduce the overall carbon footprint of the project.

4. **Public awareness**:

The system also promotes energy conservation by raising public awareness about the importance of sustainable energy sources. By showcasing the system in public spaces, such as parks or shopping malls, people are able to see first-hand how energy can be generated from natural and sustainable sources.

C. **Kinetic energy**:

In a footstep power generator system, kinetic energy from footsteps is usually converted into electrical energy using a process called electromagnetic induction **[19]**.

This process involves the use of a generator that consists of a coil of wire and a magnet. When the coil of wire moves relative to the magnet, an electric current is induced in the wire due to the changing magnetic field. The kinetic energy from footsteps is usually used to rotate a shaft that is connected to the generator **[20]**. As the shaft rotates, it causes the magnet to move relative to the coil of wire, inducing an electric current in the wire. This electric current can then be used to power various devices or stored in batteries for later use. The amount of electrical energy that can be generated depends on various factors such as the speed and torque of the shaft, the efficiency of the generator, and the resistance of the load **[21]**. To maximize the electrical energy output, it is important to design the system with efficient components and to optimize the kinetic energy harvesting mechanism to match the local environmental conditions and usage patterns.

*__Generator design__:

The generator used in a footstep power generator system is typically a DC generator that consists of a rotor, a stator, and a commutator **[22]**. The rotor is the rotating part of the generator that is connected to the shaft and contains the magnet. The stator is the stationary part of the generator that contains the oil of the wire. The commutator is a set of contacts that allows the generated electrical energy to be collected as a DC output.

*__Electromagnetic induction__:

As the rotor rotates, it creates a changing magnetic field that passes over the coil of wire in the stator. This changing magnetic field induces an electric current in the wire due to Faraday's law of electromagnetic induction **[19]**.

The induced current flows through the wire and is collected by the commutator.

*__Load resistance__:

The electrical energy generated by the footstep power generator system is dependent on the resistance of the load that it powers **[23]**.

If the load resistance is too high, the electrical energy output will be low, and if the load resistance is too low, the electrical energy output can be dangerously high. Therefore, it is important to design the system with an appropriate load resistance to maximize energy output and ensure safe operation.

* **Efficiency**:

The efficiency of the generator and the kinetic energy harvesting mechanism are critical for maximizing the electrical energy output **[24]**. The generator should be designed with efficient materials and construction to reduce losses due to friction and resistance. The kinetic energy harvesting mechanism should also be optimized for the local environmental conditions and usage patterns to ensure the maximum conversion of kinetic energy into electrical energy.

D. Prototype development:

Prototype development is a critical part of designing and testing a footstep power generator system, involving the translation of the design into a functional system that can be tested for performance and efficiency. The prototype development process involves several steps, including material and component selection **[25]**. Fabrication of the mechanical structure, and design and assembly of the electrical circuit. Testing is an essential aspect of prototype development, requiring rigorous evaluation of the prototype's performance under various loads and stresses to ensure it meets design specifications **[26]**. Careful documentation of the design and testing process, including any modifications made, is crucial for troubleshooting, optimization, and future development of the system **[27]**. Material and component selection involves considering factors such as cost, availability, durability, and efficiency to select high quality options **[5]**. Fabrication of the mechanical structure involves proper alignment and assembly of the structure and secure attachment of components to ensure durability, robustness, and ease of installation **[28]**. Design and assembly of the electrical circuit require careful selection of voltage regulators, inverters, and other components, as well as a circuit layout that maximizes power output and minimizes interference **[29]**. Testing and evaluation involve subjecting the prototype to various loads and measuring power output to evaluate reliability, durability, and performance under different conditions **[26]**. The iterative design process involves creating and testing different versions of the system and making modifications based on testing results until the desired performance is achieved **[30]**. Simulation and modelling can be used to identify potential design flaws and optimize performance before constructing the physical prototype **[3,6]**. Customization may be necessary depending on the intended use of the footstep power generator system, such as adapting the prototype to fit the terrain and environmental conditions of the intended location **[30]**.

Safety considerations, such as grounding the system and using insulation, are essential when working with electrical components to prevent injury or damage to the system. Collaboration between experts in different fields, such as electrical engineering, mechanical engineering, and materials science, can help ensure that the final prototype meets all design specifications and is optimized for performance. Cost considerations are crucial during prototype development, requiring balancing the cost of materials and components with the time and resources required for fabrication, testing, and documentation.

5. Interpretation of Results

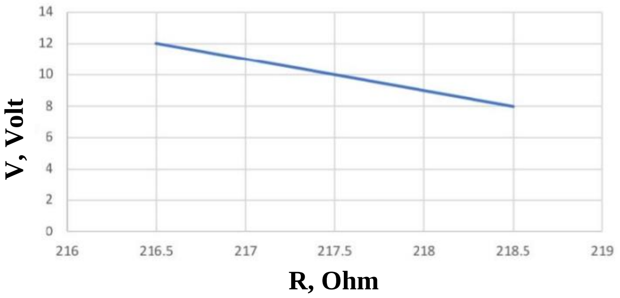


Figure (1)

In Figure (1), A graph explains the relationship between voltage and the value of the internal and external resistance, where the lower the resistance value, the output voltage increases, and vice versa, because the resistance value was very high, reaching 0.5 MΩ, and the internal one was 216 Ω. Firstly, the system is generating from 10 to 12 of power, this suggests that it is functioning effectively and efficiently. The voltage output will depend on factors such as the number and size of the plates used, as well as the force and frequency of footstep impacts and the value of the internal and external resistance. Secondly, it is important to consider how this generated power could be used. Depending on the application, 12 V may be sufficient to power small electronic devices or charge batteries. However, for larger-scale applications such as powering buildings or vehicles, additional generators or energy storage systems would be needed. Finally, it is worth noting that mechanical footstep power generation has potential environmental benefits compared to traditional energy sources such as fossil fuels. By harnessing human motion rather than burning fossil fuels, this technology could help reduce greenhouse gas emissions and promote sustainability. The effectiveness of a specific mechanical footstep power generator system, the fact that it is generating 12 volts suggests that it has promise as a renewable energy source.

Figure (2)

Figure (2) As a result of experimenting with the device and the voltage that came out when we measured it with a voltmeter.

Calculations

Hooke's law is a principle of physics that states that the force required to extend or compress a spring by some distance **X** is proportional to that distance. That $\mathbf{F = KX}$, where **K** is a constant factor characteristic of the spring its fitness and **X** is small compared to the total possible deformation of the spring. The spring constant **K** is measured in newton per meter (N/m or kilogram per sec squared (kg/s^2) Now, to find the force exerted by the weights which you have i.e., for example, if you have a 55 kg block of weight, then $\mathbf{F = mg}$ F = (55 kg) × (9,8 m/s^2) = 539 N. Now use $\mathbf{F = KX}$ where **X** is the displacement produced in the spring when the weight is suspended. In this instance, the displacement **X** for our project task is 0.1524 m.

$$\mathbf{K} = \frac{\mathbf{F}}{\mathbf{X}}$$

K = 539 N/0.1524 m = 3536.745 N/m So, for a minimum weight of a person of 55 kg the stiffness of the spring is given as 3536.745 N/m.

Theoretical Power Output:

It is crucial to ascertain the force exerted on the model to calculate the device's output power. Let the force applied be calculated as, Force = Weight of the body = mg.

Work done =Force × Displacement

Power = Work done / Time. Let the weight applied by the body is 55 kg, then the maximum displacement of the spring can be noted as 0.05 m

$F = (55\ kg) \times (9{,}8\ m/s^2) = 539\ N$

Work done = 539 N × 0.05 m = 26.95 J

Power generated per second = 26.95 W

Practical Power Output:

When the load is imposed on the footsteps, power may be computed in terms of the voltage and current obtained. The multimeter is used to record the readings. **Power = Voltage × Current** Here, when the foot is depressed due to the applied load on the footsteps the calculated power is as follows. For one step of 55 kg of load applied on the footsteps, the generated voltage is 7.15 V and the average current produced is 12 mA.

Power =7.15 × 0.012 =0.0858 W

6. Conclusion

Mechanical footsteps a risk-free method of producing electricity is the power generator. People moving about squander a lot of energy, which can be effectively converted into electrical energy, utilized in educational institutions and other settings. Employing this power-producing technique is economical. In essence, long-term cost efficiency is attained. Places where there is a lot of movement, including shopping centres, colleges, schools, train stations, etc., can apply this type of power generation. This method of producing electricity is considered environmentally conservative since it produces power without causing pollution in the surrounding area. Additionally, this technology uses the energy that people lose while working to generate electricity. Consequently, the method guarantees optimal utilization of energy that is accessible. The energy source is constantly available and renewable. As a result, compared to other power generation techniques, this method is highly convenient. Rural areas can use the power produced by this system. The production process doesn't require fuelling, which emits smoke and other pollutants, making it a very environmentally friendly method. The system is the finest since it offers customers reasonably priced energy alternatives, according to tests conducted thus far. Despite the method's apparent benefits in most cases, locations requiring large amounts of electricity may not be able to utilize the system's power output. This system can be designed to produce 6 kW per hour. As a result, the system can only produce enough energy to light up and run basic electrical devices. But there is still room for improvement to boost production, including finding a way to step up the generated power. To sum up, the footstep power generator system is an exciting new technology that could completely change how we produce electricity. This experiment has shown that it is feasible to capture the kinetic energy produced by walking people and transform it into electrical energy that can be used. The system has multiple uses, including supplying energy to houses, charging mobile devices, and operating streetlights. Some of the difficulties in putting such a system into practice have also been brought to light by the research, such as the requirement for effective energy conversion and storage methods. However, these obstacles can be addressed with additional study and advancement.

Acknowledgement

We would like to thank Dr. Hany Nazmy for his helping and advising through this research, the lab workers for their assisting with information, all participants for their cooperation to participate in this research, and all appreciate to Prof. Dr. Heba El Gharib for being our support in every aspect.

References and Sources

1) Our Common Future, Report of the World Commission on Environment and Development, (1987).
2) Willers, B. (1994, 1146-8). 'Sustainable Development: A New World Deception.' Conservation Biology.
3) Monique Perrot-Lanaud, Sabrina Sidhu, Stéphanie Tang and Marine Samson, (2005). UNESCO and Sustainable Development, Printed at UNESCO.
4) Greenland, D. J. (1997). The Sustainability of Rice Farming. New York: cab International.
5) Grant, L. K. (2010, 7-47). 'Sustainability: From Excess to Aesthetics.' Behavior and Social Issues.
6) Hodge, T. (1997, 5-98). 'Toward a Conceptual Framework for Assessing Progress toward Sustainability.' Social Indicators Research.
7) Jabareen, Y. (2008, 179-92). 'A New Conceptual Framework for Sustainable Development.' Environment, Development and Sustainability.
8) Diesendorf, M. (2000, 19-37). 'Sustainability and Sustainable Development.' In Sustainability: The Corporate Challenge of the 21st Century, edited by D. Dunphy, J. Benveniste, A. Griffiths, and P. Sutton. Crows Nest: Allen & Unwin.
9) Clune, W. H., and A. J. Zehnder. (2020, 1001-6). 'The Evolution of Sustainability Models, from Descriptive, to Strategic, to the Three Pillars Framework for Applied Solutions.' Sustainability Science.
10) Ranjbari, M., Esfandabadi, Z. S., Zanetti, M. C., Scagnelli, S. D., Siebers, P. O., Aghbashlo, Peng, M., Quatraro, W., F., and Tabatabaei, M. (2021, 126660). 'Three Pillars of Sustainability in the Wake of covid-19: A Systematic Review and Future Research Agenda for Sustainable Development.' Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2021 .126660.
11) Bhatnagar, D. and Patra, S. (2024, 149-166). Applied Spirituality and Sustainable Development Policy, A Holistic View to Approach Sustainable Development: Spiritual Roots and Evidence From Quantum Physics, doi:10.1108/978-1-83753-380-020231008
12) Ratna, F. (2018). Integrasi PBL-STEM pada mata kuliah kimia lingkungan untuk meningkatkan literasi lingkungan dan kreativitas mahasiswa calon guru kimia [Universitas Pendidikan Indonesia]. http://repository.upi.edu/34409/
13) Didham, R. J., & Ofei-Manu, P. (2020, 101631). Adaptive capacity as an educational goal to advance policy for integrating drr into quality education for sustainable development. International Journal of Disaster Risk Reduction, https://doi.org/10.1016/j.ijdrr.2020.1 01631
14) Rosana, M. (2018, 148-163). Kebijakan pembangunan berkelanjutan yang berwawasan lingkungan di Indonesia. Kelola: Jurnal Sosial Politik.

15) Patil, S. S., Kadam, S. S., & Patil, S. S. (2018). Design and Development of a Footstep Power Generator for Rural Electrification.
16) Zhang, Y., He, Z., Xing, F., & Wang, Z. (2018). Energy harvesting from footstep-induced deformation of piezoelectric tiles. Journal of Intelligent Material Systems and Structures, 29(1), 33- 43.
17) Ruiz-Cortés, A., Schreiner, C., Garcia, E., & Ferrater-Simón, F. (2019). Smart pedestrian flooring for energy harvesting: A review. Sensors, 19(6), 1399.
18) Halder, A., & Sur, A. (2020). Energy harvesting from footsteps using piezoelectric materials: A review. Journal of Renewable and Sustainable Energy Reviews, 119, 109602.
19) Britannica, The Editors of Encyclopedia. "Kinetic energy". Encyclopedia Britannica, 7 Mar. 2024, https://www.britannica.com/science/kinetic-energy. Accessed 13 April 2024.
20) Beeby, S. P., Torah, R. N., Tudor. M. J. (2008, 44-51). KINETIC ENERGY HARVESTING, Acta Futura, DOI: 10.1007/978-1-4419-7566-9_1
21) Elssaify, R. A. (2022). "Electromechanical Energy Conversion Applications." Faculty of Engineering, Tanta University, Renewable Energy Engineering Dept.
22) DC Generators. (n.d.). Electrical4U.
23) Energy Harvesting. (n.d.). Analog Devices, Inc.
24) Alam, M. M., Alam, N. N., and Ali, M. S. (2017). "Design and Fabrication of Footstep Power Generator," International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering.
25) Roy, S. S., Deb Nath, S. K, Islam, M. A., and Hossain, A. M. A. (2018). "Performance Analysis of Footstep Power Generator System Under Different Load Conditions," International Journal of Renewable Energy Research.
26) Ashraf, N., Rehman, R. U., Din, N. U., and Khan, M. M. (2016). "Development of a Footstep Power Generator: Design, Implementation, and Performance Evaluation," Journal of Sensors.
27) Islam, M. A., Hossain, A. M. A., Roy, S. S., and Deb Nath, S. K. (2017) "Design and Fabrication of a Footstep Power Generator for Rural Areas," Journal of Energy.
28) Ahmed, T., Das, S., and Islam, M. A. (2017). "Simulation and Modelling of Footstep Power Generator for Rural Areas," Journal of Energy.
29) Roy, S. S., Deb Nath, S. K., Islam, M. A., and Hossain, A. M. A., (2016). "Design and Development of a Cost Effective Footstep Power Generator for Rural Areas," Journal of Energy and Power Engineering.
30) Singh, M. and Singh, N. (2016, 3546-3551). "Design and Development of Footstep Power Generator," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering.