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Systematic Literature Review on the Effectiveness of LDPE and PET Waste in Piezoelectric Paving with a DC Coupling System

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ABSTRACT: This paper analyzes the effectiveness of utilizing waste materials consisting of LDPE and PET compounds for pavement, integrating piezoelectric technology with a DC coupling control system. This pavement may function as a sustainable renewable energy solution for the global energy crisis. Paving systems including these materials can effectively convert mechanical stress into electrical energy, hence improving sustainable urban energy infrastructure. This study aims to evaluate a Systematic Literature Review (SLR) of 100 relevant international and national journal publications. The SLR method systematically identifies, assesses, and synthesizes current research, ensuring the relevance and contextual specificity of the chosen studies. The author provides a realistic framework for testing, emphasizing the significance of quality control to ensure accurate results.

KEYWORDS: DC Coupling System, LDPE, PET, Piezoelectric, Systematic Literature Review.

INTRODUCTION

The World Population Review projects that the global population will reach 8.16 billion people in 2025. This significantly increases the global demand for energy to support daily activities. Meanwhile, dependence on fossil fuels still dominates as the primary energy source. This reliance has led to an energy crisis as fossil fuel reserves continue to deplete. In addition, carbon emissions from fuel combustion are on the rise (Baz & Zhu, 2025; Szczygielski *et al*., 2025). To address these issues, a transition toward the utilization of renewable energy is necessary to ensure long-term energy sustainability. Renewable energy sources, such as solar power, wind power, and alternative piezoelectric technology, have the potential to provide clean and relatively unlimited energy (Luo *et al*., 2025; Zidani *et al*., 2025). One promising form of renewable energy that is yet to be developed is piezoelectric energy.

A piezoelectric sensor works by using materials with piezoelectric properties to change mechanical energy into electrical energy (Muhsinin *et al*., 2022; Silalahi, 2025; Pradistia & Prasetyo, 2022). When the material is subjected to pressure, its crystal structure undergoes deformation, generating an electrical charge in response to the applied mechanical force (Aziz & Arifin, 2024; Setiawan *et al*., 2024). Piezoelectric sensors can harness the pressure from footsteps on sidewalks or streets to produce electricity in daily life. The implementation of this technology requires piezoelectric materials, which can be found in certain types of plastic, such as polypropylene from bottlecap waste.

On the other hand, the accumulation of plastic waste, such as bottle caps, continues to increase due to the surge in human population. It is estimated that more than 60% of plastic solid waste accumulates in the environment, leading to the release of toxic gases (Hasan *et al*., 2025; K C *et al*., 2023; Nafiu *et al*., 2025). This buildup is caused by the non-biodegradable nature of plastics, such as LDPE (low-density polyethylene) and PET (polyethylene terephthalate) (Mehdar, 2024; Zhou *et al*., 2023; Pilapitiya & Ratnayake, 2024). The accumulation of plastic waste increasingly worsens environmental pollution, endangers human health, and disrupts the balance of natural ecosystems.

To address this issue, various efforts have been made to utilize plastic waste as an alternative construction material through the production of paving blocks. Plastic waste, such as bottle caps and plastic bags, can be shredded and melted using Appropriate Technology (TTG) machines. The shredded material is then molded into strong and water-resistant paving blocks (Rohimatus Shofiyah *et al*., 2024; Sari *et al*., 2023). This innovative utilization helps minimize plastic waste generation while transforming previously worthless materials into valuable, eco-friendly resources.

The utilization of waste in paving blocks integrated with piezoelectric technology represents an innovative, environmentally friendly solution. With this study, mechanical energy from footsteps can be converted into electrical energy while simultaneously reducing plastic waste. Thus, piezoelectric paving becomes a multifunctional solution, serving as an eco-friendly alternative energy source

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while addressing environmental problems caused by plastic waste. This technology is relevant for implementation in urban areas with high mobility as a source of renewable energy (Kinan *et al*., 2024; Jati, 2024; Marasoki, 2024).

This study aims to evaluate research about the effectiveness of LDPE and PET waste in a piezoelectric pavement system integrated with a DC coupling circuit alongside piezoelectric materials in the realm of renewable energy. Through this paper, the author hopes to make a valuable contribution to a more profound understanding of the role of integration between LDPE and PET as a piezoelectric supporting material in energy transformation toward a more sustainable future. It cannot be denied that our energy future must be based on more sustainable and environmentally friendly sources. LDPE and PET, as real-world examples of how waste can be converted into supporting materials for sustainable energy sources, are becoming relevant and intriguing topics for further research. In this context, this research is the first step toward understanding the potential of LDPE and PET as piezoelectric support materials in providing renewable energy solutions and contributing to the preservation of vulnerable Earth, limiting the articles from 2020 to 2025.

METHOD

This study aims to review research trends and the effectiveness of LDPE and PET waste in a piezoelectric pavement system integrated with a DC coupling circuit. The research method used is a literature review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were used, along with qualitative methods. A stepwise and systematic approach to literature selection was taken using the PRISMA method. The qualitative method employed in this study involved the use of descriptive data. The database used in this study is secondary data, which refers to information obtained from existing sources. This data was collected from Google Scholar, ResearchGate, ScienceDirect, and IEEE.

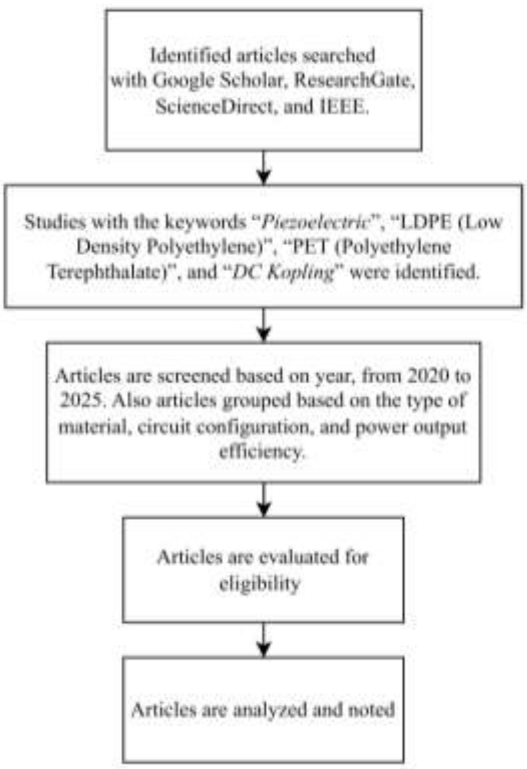

Figure 1. Research Methodology Flowchart
Source: Author's processed data (2025)

This study uses qualitative data collection techniques, with a specific focus on the collection and analysis of descriptive data. Data was collected through a literature review, specifically by examining various scientific articles and papers as references. The articles

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were analyzed thematically based on the type of material, circuit configuration, and power output efficiency. Data processing in this study was carried out based on graphs obtained from secondary data. Data obtained from secondary sources will be presented by compiling important information in the form of descriptive narratives and tables, making analysis easier.

Through a Systematic Literature Review (SLR) of relevant international and national journal publications from 2020 to 2025. The SLR method is used to systematically identify, assess, and synthesize existing research, ensuring that the selected studies are relevant and context-specific. Data collection was conducted through a comprehensive search of the Google Scholar and IEEE Xplore databases. From an initial 100 journal articles, a strict screening process based on article type and number of citations resulted in the selection of 75 articles that met the minimum criteria of 25 citations. The screening process began with a search for journals based on the keywords "piezoelectric," "LDPE (low-density polyethylene)," "PET (polyethylene terephthalate) polymers," and "DC coupling." In addition, the author also filtered the paper references in Indonesian and English. Furthermore, the author grouped the articles from the years 2020, 2021, 2022, 2023, 2024, and 2025.

The framework adopted in this literature review was used to answer the following questions: (1) what factors are related to power outpu t?; (2) how has research on the quality of piezoelectric technology control systems been conducted ?; (3) in what direction should further research on material durability be conducted ?; and (4) how is the frequency stability of the system generated?

RESULT AND DISCUSSION

This study aims to analyze the effectiveness of LDPE and PET waste in a piezoelectric pavement system integrated with a DC coupling circuit. The author performed a grouping on several collected papers to facilitate our analysis. The articles are grouped by year of publication: from 2020 to 2025. Furthermore, the articles were grouped according to several key elements that focused on the research topics. Additionally, the author grouped the articles based on predetermined topics.

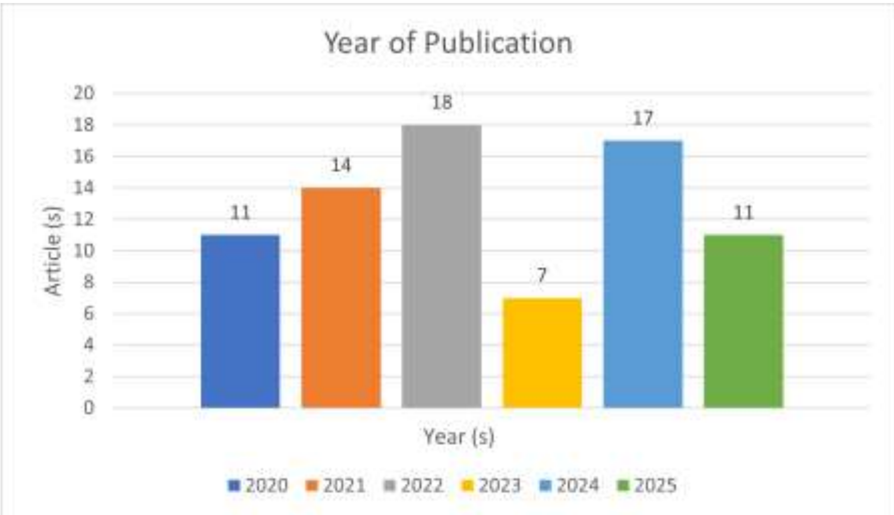

Figure 2. Year of Publication
Source: Author's processed data (2025)

From the graph above, it was found that in 2020 there were 11 articles (14.1%); in 2021 the number increased to 14 articles (17.9%); and in 2022 it reached the highest point with 18 articles (23.1%). In 2023, the number of publications declined significantly to only 7 articles (9.0%), before rising again in 2024 with 17 articles (21.8%), and finally recording 11 articles (14.1%) in 2025. These fluctuations indicate changing research intensity across the observed years, with a noticeable drop in 2023 that may be influenced by shifting interests or limited supporting references. Overall, this pattern highlights the importance of sustaining interest in the studied topic and encouraging researchers to continue producing high-quality publications supported by credible sources. Next, the results of this grouping are presented in the following table to facilitate analysis and comparison of the research:

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Table 1. Research Articles

No	Author	Title	Year
1	Ade, R. H.	Prototipe Pemanfaatan Piezoelektrik Pada Pijakan Kaki Manusia Sebagai Sumber Energi Listrik Alternatif	2020
2	Endri Stiawan & Arif Johar Taufiq	Rancang Bangun Alat Pemanen Energi Listrik Dari Tekanan Mekanik Berbasis Piezoelektrik	2020
3	Gamayel, A., Mulyana, F., & Sunardi, A.	Pengaruh ketinggian bola jatuh terhadap tegangan listrik yang dihasilkan trampolin sebagai pemanen energi dengan pemasangan piezoelektrik.	2020
4	Kallawa, A. F., Fikri, A., & Mujirudin, M.	Pengaruh Rangkaian Seri Dan Paralel Terhadap Tegangan Pada Piezoelektrik.	2020
5	M. Edla, Y. Y. Lim, M. Deguchi, R. V. Padilla and I. Izadgoshasb	An Improved Self-Powered H-Bridge Circuit for Voltage Rectification of Piezoelectric Energy Harvesting System	2020
6	Hajiar Yuliana, Rady Yusaniar, & Yuda Bakti Zainal	Rancang Bangun Sistem Energy Harvesting di Ruang Bising Menggunakan Piezoelektrik Array	2020
7	Ratih, R. M., Yasyak, M. I., Nugroha, H., & Fadlilah, U.	Powerbank Piezoelektrik menggunakan Tekanan Tangan.	2020
8	Sun R, Wang L, Zhang Y, & Zhong C.	Characterization of 1-3 Piezoelectric Composite with a 3-Tier Polymer Structure. Materials	2020
9	Susanti, E., & Bistama, I.	Perancangan Sistem Penerangan Lampu Berbasis Piezoelektrik PZT Di Fakultas Teknik Universitas Riau Kepulauan	2020
10	Wedian Hadi Abd Al Ameer, Mustafa A. Fadel Al-Qaisi, & Ammar Al-Gizi	Comparison between piezoelectric transformer and electromagnetic transformer used in electronic circuits	2020
11	Yoonjung Lee 1, Sohee Kim 1, Daeyeong Kim, Cheoljae Lee, Hyojin Park, & Ju-Hyuck Lee	Direct-current flexible piezoelectric nanogenerators based on two-dimensional ZnO nanosheet	2020
12	Dauda Sh. Ibrahim,Sun Beibei, Orelaja Adewale Oluseyi, Zhao Peng & Umer Sharif	Nonlinear dynamic analysis of a reciprocative magnetic coupling on performance of piezoelectric energy harvester interfaced with DC circuit	2021
13	Diana Rahmawati, Miftachul Ulum, Muhammad Farisal, & Koko Joni	Lantai Pembangkit Listrik Menggunakan Piezoelektrik dengan Buck Converter LM2596	2021
14	Gupta, R., Badel, B., Gupta, P., Bucknall, D. G., Flynn, D., Pancholi, K.	Flexible low-density polyethylene–BaTiO3 nanoparticle composites for monitoring leakage current in high-tension equipment.	2021
15	Hou, W., Zheng, Y., Guo, W., & Pengcheng, G.	Piezoelectric vibration energy harvesting for rail transit bridge with steel-spring floating slab track system	2021
16	J. J. Piel, J. D. Boles, J. H. Lang and D. J. Perreault	Feedback Control for a Piezoelectric-Resonator-Based DC-DC Power Converter	2021

17	Juan Aldo Hasibuan, Cahyantari Ekaputri, Sudarmono Sasmono	Perancangan Prototipe Konversi Energi Suara Menjadi Energi Listrik Dengan Bahan Piezoelektrik Memanfaatkan Energi Tekanan Tambahan Yang Berasal Dari Angin Untuk Kawasan Industri	2021
18	Kusnandar, Ni Ketut Hariyawati Dharmi, & Aisyah Nurul Khairiyah	Rancang Bangun Purwarupa Energy Harvesting menggunakan Piezoelektrik sebagai Pembangkit Energi Listrik	2021
19	Kyungrim Kim, Jinwook Kim, Xiaoning Jiang, and Taeyang Kim	Static force measurement using piezoelectric sensors	2021
20	Magerramov, A. M., Dzhafarov, V. D., Musaev, G. K.	Electrophysical properties of low-density polyethylene and zeolite composites.	2021
21	Muhammad Rifki Ramadhan, Sudarmono Sasmono, & Cahyantari Ekaputri	Perancangan Prototipe Konversi Hybrid Energi Suara, Energi Tekanan Dan Energi Angin Menjadi Energi Listrik Menggunakan Komponen Piezoelektrik	2021
22	Mulyana, F., & Gamayel, A.	Pengaruh Pantulan Bola Terhadap Tegangan Listrik yang Dihasilkan Oleh Piezoelektrik pada Trampolin Sebagai Pemanen Energi.	2021
23	Naveet Kaur a, Shweta Goyal b, Kamal Anand b, Ganesh Kumar Sahu a	A cost-effective approach for assessment of pre-stressing force in bridges using piezoelectric transducers	2021
24	Riska Ekawita, Rahmat Awaludin Salam, Nolla Kusumawardani, & Yuliza Elfi.	Pengujian konfigurasi piezoelektrik penghasil tegangan listrik dari energi mekanik	2021
25	Zulkarnain A. Hasan , Asri Arbie , Abdul Haris Odja , & Abdul Wahidin Nuayi	Pengaruh Jumlah Piezoelektrik pada Rancang Bangun Sistem Penghasil Listrik Berbasis Piezoelektrik dengan Memanfaatkan Gelombang Laut	2021
26	Ansari, M. A., Somdee, P.	Piezoelectric polymeric foams as flexible energy harvesters: a review.	2022
27	Ayi Muhsinin, Hilman Badruzzaman, & Agi Rivi Hendard	Sistem Pemanen Energi Berbasis Piezoelektrik Sebagai Sumber Energi Terbarukan Pada Konstruksi Jalan	2022
28	CAHRUDIN, C.	Rancang Bangun Prototipe Pembangkit Listrik Piezoelektrik Menggunakan Metode Cantilever Beam	2022
29	Hanifah, L. Z., Kurniawan, B. P., Arista, Y., & Rahayu, L. P.	Analisis Daya Piezoelektrik Pada Alat Pencegahan Penyebaran Coronavirus Terintegrasi IoT.	2022
30	Haonan Jin , Xiangyu Gao , Kaile Ren, Jinfeng Liu, Liao Qiao , Mingzi Liu, Wei Chen, Yuhang He, Shuxiang Dong , Zhuo Xu, and Fei Li	Review on piezoelectric actuators based on high-performance piezoelectric materials	2022

31	Im, S., Cho, S. Y., Cho, J. H., Hwang, G. T… Jeong, C. K.	Study on relaxor polymer interface matrix for piezoelectric nanocomposite generators.	2022
32	Islami, M., & Aulia, R.	Pemanfaatan sensor piezoelektrik sebagai generator listrik pada sepatu untuk pengisian baterai peralatan elektronik berdaya rendah.	2022
33	Kumar, R.	Functionalities of ZnO reinforced thermoplastics composite materials: A state of the art review	2022
34	Michael Smith & Sohini Kar-Narayan	Piezoelectric polymers: theory, challenges and opportunities.	2022
35	Mohamad Safiddin Mohd Tahir, Noor Hazrin Hany, Mohamad Hanif, & Azni Nabela Wahid	Maximizing Output Voltage Of A Piezoelectric Energy Harvester Via Beam Deflection Method For Low-Frequency Inputs	2022
36	Ni Ketut H.D, & Septia Rifaldi	Analisis Potensi Energi Listrik yang Dihasilkan dari Rancang Bangun Prototipe Alat Pembangkit Listrik Menggunakan Piezoelektrik Memanfaatkan Energi Kinetik dari Keset Kaki dengan Metode Energy Harvesting	2022
37	Ningsi, A. A.	Pengaruh Penambahan Serbuk Plastik pada Campuran Bata Ringan Jenis Cellular Lightweight Concrete (CLC) terhadap Kuat Tekan	2022
38	Prasetyawati, F. Y., Yusuf, M. M., Ridho, A. I., Harwanti, A., Rezeki, Y. A., Sarwanto, S., ... & Rahardjo, D. T.	Kajian Pustaka Komposit Limbah Plastik sebagai Paving Blok Penghasil Energi Berkelanjutan Terintegrasi Piezoelektrik dan Photovoltaic (VIZO)	2022
39	Relingga Frendy Pradistia & Dedi Ary Prasetya	Pemanfaatan Sensor Piezoelektrik Sebagai Penghasil Sumber Energi Dengan Tekanan Anak Tangga	2022
40	Sadewo, L. F., Gamayel, A., Sarwuna, S. J., & Ujiburrohman, R. A.	Pengaruh Variasi Ukuran Penampang Bluff Body BelahKetupat Terhadap Tegangan Listrik Yang Dihasilkan Piezoelektrik	2022
41	Sidiq, A., Syahrillah, G. R. F., & Isra, M.	Studi Experimental Pemanfaatan Speed Bamper (Polisi Tidur) Menjadi Energi Listrik Menggunakan Piezoelektrik.	2022
42	Smith, M., Narayan, S. K.	Piezoelectric polymers: theory, challenges and opportunities	2022
43	Youssef El Hmamsy a, Chouaib Ennawaoui a, El Mehdi Laadissi a, El Mehdi Loualid a, Abdelowahed Hajjaji a b	Optimized piezoelectric energy harvesting circuit using DC/DC converter	2022
44	Afandi, S., and Afriandini, B	Inovasi Pemanfaatan Limbah Plastik Jenis LDPE (Low Density Polyethylene) dan Limbah Batu Bata Sebagai Bahan Campuran Pembuatan Batu Bata	2023
45	Ashara, S. M.	Rancang Bangun Prototype Karpet Penghasil Energi Listrik Berbasis Piezoelektrik.	2023
46	Dewangga, T., Izzuddin, T. A., & Al-Hazza, F. D	Studi Eksperimental Performa Sound Energy Harvesting Device Menggunakan Variasi Rangkaian Piezoelektrik.	2023

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47	Moonik, A., Rantung, J., & Maluegha, B.	Pemanen Energi Listrik dari Curah Hujan Melalui Transduser Piezoelektrik Secara Seri dan Paralel	2023
48	Ravi Shekhar & Deep Mala	A review on design and analysis of piezoelectric energy harvesting systems	2023
49	Suwandono, D., Sarasanty, D., & Asmorowati, E. T.	Pemanfaatan Limbah Plastik LDPE (Low Density Polyethylene) Sebagai Pengganti Sebagian Agregat Halus Pada Beton Ringan	2023
50	Trido Hardani Putra, Mohammad Fatkhurrokhman & Ilham Akbar Darmawan	Miniatur Jembatan Penyebrangan Menggunakan Sensor Piezoelektrik sebagai Penghasil Listrik	2023
51	Agus Kiswantono, & Adi Irwan	Inovasi Energi Hijau: Piezoelektrik Untuk Mengubah Getaran Kendaraan Menjadi Listrik	2024
52	Benabid, F. Z., Benaceur, H., Al-Oqla, F. M., Mallem, O. K., Zouai, F.	ZnO/LDPE Nano-composites: Effects of Particle Size and Electrical Resistivity on Mechanical, Electrical, and Thermal Properties: A Review.	2024
53	Erny Listijorini, Sidik Susilo, Akhmad Adhiwindoro, Ilham Febrianto, Muhammad Alwi Shihab, Muhammad Ashari Dwiyoga & Rafi Rizqi Ananda	Rancang Bangun ALPENLIBE (Alat Pemanen Energi Listrik Berbasis Piezoelektrik) Sebagai Upaya Mewujudkan Energi Terbarukan	2024
54	Khairunnisa, K.	Pengaruh LDPE (Low Density Polyethylene) Sebagai Aditif Aspal Dengan Agregat Kasar Limbah Beton Terhadap Parameter Marshall	2024
55	Kim, J. H., Hong, I. G., Shin, H. Y., Ahn, H. J., & Im, J. I.	Hydrostatic piezoelectric properties of 1-3 type piezo-composite with a porous polymer matrix	2024
56	Li, S., Shan, Y., Chen, J., Chen, X., Shi, Z., Zhao, L., He, R., Li, Y.	3D printing and biomedical applications of piezoelectric composites: A critical review	2024
57	Lumintang, J., Rantung, J., & Maluegha, B.	Pemodelan Konversi Energi Listrik dari Curah Hujan Melalui Transduser Piezoelektrik Berbasis ANSYS	2024
58	Ma, G., Zhang, M., Gao, F.… Ba, K., Han, Z., Ren, L.	Bioinspired, fiber-based, flexible self-powered sensor for wearable applications.	2024
59	Marasoki, D.	Teknik Piezoelectric Footstep pada Pembangkit Listrik untuk Pengisian Daya dengan Rfid	2024
60	Muhammad Kamal Azizi, Yulianto, & Mila Fauziyah	Meningkatkan Elektrifikasi Lokasi Remote Area dengan Konversi Getaran Menjadi Lampu Penerangan Berbasis Piezoelektrik	2024
61	Rajasekaran, N., Muniraj, C.	Analysis of electrical behavior in LDPE/BaTiO3 ceramic filler nanocomposites for electrical cable insulation applications.	2024
62	Ratna Komala Dewi, Widyaningrum Indrasari, dan Heri Firmansyah	Karakterisasi Sensor Piezoelektrik LDT0-028K untuk Perancangan Sistem Pengukuran Getaran pada Mesin	2024

63	Rostami, M., Daryadel, M., Azdast, T., Moradian, M., Feizlou, N.	Multi-objective optimization of coaxial cables with foamed LDPE/HDPE dielectric layers: Correlating process parameters with foam structure and impact on piezoelectric and electrical properties	2024
64	Stepancikova, R., Olejnik, R., Matyas, J., Masar, M., Hausnerova, B., and Slobodian, P.	Pressure-Driven Piezoelectric Sensors and Energy Harvesting in Biaxially Oriented Polyethylene Terephthalate Film.	2024
65	Wahyu Cahyo Widodo, Windarta, Ratna Dewi Nur'aini, & Fadwah Maghfurah	Pengaruh Variasi Curah Hujan dan Sudut Kemiringan terhadap Daya Keluaran pada Alat Uji Piezoelektrik	2024
66	Xu M, Wen Y, Shi Z, Xiong C, Zhu F, Yang Q	Piezoelectric Biopolymers: Advancements in Energy Harvesting and Biomedical Application.	2024
67	Zahra, A. P., Alam, M. I. B., Wardani, R. B., Sholeh, M., Nuryadin, A., & Subagiyo, L.	Bangkitan Tegangan Listrik pada Rekayasa Piezoelektrik Berbasis Bahan Dapur.	2024
68	Abdallah Al Ghazi * , Achour Ouslimani and Abed-Elhak Kasbari	Advances in Interface Circuits for Self-Powered Piezoelectric Energy Harvesting Systems: A Comprehensive Review	2025
69	Adnan Zaman1, UgurGuneroglu2 1 , Abdulrahman Alsolami 1,* , Liguan Li 2 andJingWang2,	Interface Material Modification to Enhance the Performance of a Thin-Film Piezoelectric-on-Silicon (TPoS) MEMS Resonator by Localized Annealing Through Joule Heating	2025
70	Algimantas Rotmanas, Regimantas Bareikis, Irmantas Gedzeviˇcius and Audrius ˇ Cereška *	Touch Piezoelectric Sensor for Vibration Intensity Testing	2025
71	Fajri, B. N., Maulana, Y. Z., & Syifa, F. T.	Rancang Bangun Prototipe Pemanen Energi Getaran Pada Tangga Menggunakan Transduser Piezoelektrik.	2025
72	Gamayel, A.	Studi Performa Pemanen Energi Piezoelektrik Dengan Metode Vortex Induced Vibration	2025
73	Kaixuan Wang 1, Hao Long 1,*, Di Song 2,3,* and Hasan Shariar 4	Energy Harvesting Microelectromechanical System for Condition Monitoring Based on Piezoelectric Transducer Ring	2025
74	Khosroshahi, F. H., Kordi, F., Tohidian, M.	Preparation of Cross-Linked Sponge With Piezoelectric Properties Based on Low Density Polyethylene/Poly(Ethylene- Co- Vinyl Acetate) and Barium Titanate: Relationship Between Mechanical Properties, and Cell Structure With Piezoelectric Coefficients	2025
75	Lin Zhou 1 ,HaimingChen1,WuBao2,XuehuiChen1,TingGao1 andDaliGe2,*	Theoretical Modeling of Light-Fueled Self-Harvesting in Piezoelectric Beams Actuated by Liquid Crystal Elastomer Fibers	2025
76	Mila Anggreni Valemtina1, Eva Magdalena Silalahi2*, Bambang Widodo3	Perancangan Prototype Pembangkit Listrik Piezoelektrik Lantai Untuk Suplai Energi Listrik Lampu Penerangan Pintu Masuk Rumah	2025

77	Muhammad Eko Saputro, Mohd. Ilyas Hadikusuma, & Rianda	Generator Listrik Tenaga Gelombang Air Menggunakan Kristal Piezoelektrik	2025
78	Samuel E. Osheidu1, Chigozie Israel-Cookey2, Arobo R. C. Amakiri3, Friday B. Sigalo4, Onengiyeofori A. Davies5*	Analytical Modelling of Resistive Load Effect on Transient Voltage and Power Output from $d33$-mode Piezoelectric Vibration Energy Harvester	2025

Integrated waste management not only focuses on reducing waste but also has the potential to be reused as construction material. The collected waste will be managed first through sorting and processing, in accordance with the findings of the study by Suwandono *et al.,* 2023. The processing results were then used as a mixture for the production of environmentally friendly paving integrated with piezoelectric components embedded in the substrate layer to convert energy from mechanical pressure caused by pedestrian traffic (Afandi *et al.,* 2023). The mechanical energy generated will directly touch the paving surface and hit the surface of the piezoelectric sensor, thus producing electrical energy. Thru a series of amplifiers to increase and stabilize electrical energy. Additionally, optimal electrical energy can be directed to the battery for storage in the form of direct current. Meanwhile, other flows are converted into alternating current used to supply specific loads. This conversion process demonstrates the integration of waste to produce piezoelectric materials that not only function as construction structures but are also capable of generating electrical energy (Prasetyawati *et al.,* 2022). Using a multidisciplinary approach examined through resilience and stability studies, power management control, system optimization, and output frequency stability are required.

After the processed waste-based materials are combined to make bricks, the resulting structure's resistance and stability properties must be studied in more detail. The use of LDPE (Low-Density Polyethylene) plastic in lightweight brick mixtures affects the material's resistance properties (Ningsih *et al.,* 2022). Where an increase in the LDPE polymer content reduces compressive strength due to decreased density and reduced bonding between constituent particles. Additionally, adding barium titanate ($BaTiO_3$) ceramic to the piezoelectric material can enhance its response (Rajasekaran *et al.,* 2024). However, using flexible polymers in this material increases the conversion of mechanical energy into electricity without reducing structural stability (Ansari *et al.,* 2022). Therefore, the role of LDPE and PET polymers influences the durability of paving, while $BaTiO_3$ acts as a piezoelectric polymer that enhances the conversion of electrical energy.

Meanwhile, in terms of long-term durability, the stability of dimensions and structure was tested through a literature review across a temperature range of 25-80 degrees. With the pressure parameter showing the most significant influence on the piezoelectric stability of the structural foam, contributing 83% (Khosroshahi *et al*., 2025). This is also consistent with a humidity level of 69%, which plays a role in determining the durability and shrinkage of bricks during their service life (Rostami *et al*., 2024). The study results indicate that the influence of pressure and humidity on material selection needs to be analyzed in greater depth. This is because both aspects determine the piezoelectric material's ability to maintain mechanical performance and functional stability during long-term use.

Power control and management in a piezoelectric paving system with a DC coupling system aim to optimize electrical energy output. By utilizing the piezoelectric elements caused by mechanical pressure from loads on the paving surface, power control and management in a piezoelectric paving system with a DC coupling system are designed to optimize electrical energy output. Because piezoelectric materials generate electrical energy in the form of AC current, a full bridge rectifier is needed as a wave rectifier or to convert AC current to DC current (Hasan *et al*., 2021; Hmamsy *et al*., 2022; Ameer *et al*., 2020; Putra *et al*., 2023; Edla *et al*., 2020). Additionally, piezoelectric energy has low and fluctuating voltage characteristics, requiring capacitors to stabilize or filter the output voltage (Ade, 2020; Zulkarnain *et al*, 2021; Stiawan & Taufiq, 2020; Fajri *et al*, 2025; Wang *et al*, 2025). Therefore, power management control thru the full bridge rectifier component acts as a wave rectifier, while adding a capacitor helps filter the voltage to make it more stable.

Piezoelectric materials can be connected in series when a higher output voltage is required than the input voltage (Agus & Adi, 2024; Kiswanto & Irwan, 2024; Moonik *et al*., 2023; Sidiq *et al*., 2022). Parallel circuits in piezoelectric devices can be used when a higher output current is needed than the input current (Zulkarnain *et al*., 2021; Marasoki, 2024; Ratih *et al*., 2020; Dewangga *et* *al*., 2023). The choice of piezoelectric circuit configuration depends on the load to which it is connected. The load used in this journal is a lamp, which requires a large voltage. Therefore, to produce an efficient output voltage, the circuit will be arranged in parallel (Mila *et al*., 2025). To increase the output voltage to meet the load requirements, a boost converter is used, which functions to step up the DC voltage resulting from the rectifier. The use of a boost converter also helps stabilize the power output when there are pressure variations on the piezoelectric element (Kusnandar *et al*., 2021; Azizi *et al*., 2024). Therefore, power management control through the full-bridge rectifier component acts as a wave rectifier, while adding a capacitor helps filter the voltage to make it more stable.

In a piezoelectric circuit, there are several factors that can affect the output power, such as components, the circuit, and the load. The use of a converter can increase the power generated by approximately 365% compared to the condition when a DC-DC converter is not used (Ravi & Deep, 2023). In piezoelectric circuits, the heavier the load applied, the greater the voltage generated (Susanti & Bistama, 2020; Kallawa *et al*., 2020; Islami & Aulia, 2022). A 49% increase in footstep load can result in a voltage increase of up to 39% (Relingga & Dedi, 2022). Other factors such as method, materials, and design also influence the energy, voltage, and current produced. The use of amplification methods enhances the piezoelectric ability to convert mechanical energy into electricity. This method produces significantly greater power compared to conditions without amplification (Eyi *et al*., 2022). So, the more weight on the paving is linear with the output voltage.

Some studies have used testing to determine the influence of rainfall and angle of inclination on piezoelectric output. When rainfall is high and the angle of inclination is 0°, the power and efficiency of the piezoelectric device increase (Lumintang *et al*., 2024; Wahyu *et al*., 2022). In another study, the use of a cantilever as an effective energy harvesting method was found to produce optimal pressing frequencies against the piezoelectric material (Erny *et al*., 2024). Meanwhile, the use of a bluff body on a piezoelectric energy harvester (PEH) increases voltage because it amplifies the compressive force due to increased wind speed (Gamayel, 2025; Sadewo *et al*., 2022). The higher an object falls onto a piezoelectric material, the greater the voltage generated (Gamayel *et al*., 2020; Mulyana & Gamayel, 2021). The cantilever beam method is less effective and efficient because the stress generated is greater when using ordinary boards (Cahrudin, 2022). Therefore, the placement of piezoelectric sensors affects the output voltage results. Meanwhile, adding energy harvesting methods is more effective when integrated with the right paving to maximize energy conversion. So, this combination allows for optimal output voltage generation.

Overall, these articles demonstrate the development of a reliable and efficient system for integrating the utilization of compounds from waste and renewable energy. The system integrates various technological approaches to optimize the output of electrical energy. This approach connects resilience- and stability-based power management, power management control, system optimization, and innovative output frequency stability to address future global energy challenges.

CONCLUSION

This paper examines the effectiveness of utilizing piezoelectric LDPE and PET polymers with a DC coupling system for energy conversion. Integrated waste management has the potential to be reused as construction material. The properly treated waste products are then used as a mixture for the production of environmentally friendly paving stones integrated with piezoelectric components. With the mechanical pressure from pedestrians, mechanical energy will be converted into electrical energy using piezoelectric sensors. Through a series of amplifiers to increase and stabilize electrical energy. Additionally, optimal electrical energy can be channeled to the battery for storage in the form of direct current. Meanwhile, the other current is converted into alternating current used to supply specific loads.

Material integration affects the electrical response, although the reduction in compressive strength due to decreased composite density requires further evaluation regarding long-term structural reliability. The stability of piezoelectric performance is influenced by variations in pressure, temperature, and humidity, which determine the dimensional deformation, output stability, and physical resistance of the material. Just like in the power conversion aspect, applying the correct circuit configuration by adding a full-bridge rectifier can improve output efficiency. Overall, this review paper emphasizes that material engineering-based approaches, optimization of energy conversion systems, and control of environmental variables are crucial. Thus, the author hopes that through this paper, they can contribute to reducing plastic waste. Additionally, through this paper, the author can contribute to the sustainability of renewable energy.

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REFERENCES

1. Abd Al Ameer, W. H., Al-Qaisi, M. A. F., & Al-Gizi, A. (2020). Comparison between piezoelectric transformer and electromagnetic transformer used in electronic circuits.
2. Abdallah Al Ghazi, A., Ouslimani, A., & Kasbari, A.-E. (2025). Advances in interface circuits for self-powered piezoelectric energy harvesting systems: A comprehensive review.
3. Ade, R. H. (2020). Prototipe pemanfaatan piezoelektrik pada pijakan kaki manusia sebagai sumber energi listrik alternatif.
4. Afandi, S., & Afriandini, B. (2023). Inovasi pemanfaatan limbah plastik jenis LDPE (Low Density Polyethylene) dan limbah batu bata sebagai bahan campuran pembuatan batu bata.
5. Agus Kiswantono, & Irwan, A. (2024). Inovasi energi hijau: Piezoelektrik untuk mengubah getaran kendaraan menjadi listrik.
6. Ansari, M. A., & Somdee, P. (2022). Piezoelectric polymeric foams as flexible energy harvesters: A review.
7. Ashara, S. M. (2023). Rancang bangun prototype karpet penghasil energi listrik berbasis piezoelektrik.
8. Ayi Muhsinin, Badruzzaman, H., & Hendard, A. R. (2022). Sistem pemanen energi berbasis piezoelektrik sebagai sumber energi terbarukan pada konstruksi jalan.
9. Aziz, M. R. A., & Arifin, F. I. (2024). Desain dan Simulasi Teknologi Energy Harvesting dari Air Hujan Menggunakan Material Piezoelectric. CASTLE Proceedings, 4, 166-170.
10. Baz, K., & Zhu, Z. (2025). Life cycle analysis of green technologies: Assessing the impact of environmental policies on carbon emissions and energy efficiency. Geoscience Frontiers, 16(2), 102004. https://doi.org/10.1016/J.GSF.2025.102004
11. Benabid, F. Z., Benaceur, H., Al-Oqla, F. M., Mallem, O. K., & Zouai, F. (2024). ZnO/LDPE nano-composites: Effects of particle size and electrical resistivity on mechanical, electrical, and thermal properties: A review.
12. CAHRUDIN, C. (2022). Rancang bangun prototipe pembangkit listrik piezoelektrik menggunakan metode cantilever beam.
13. Dauda, S. I., Beibei, S., Oluseyi, O. A., Peng, Z., & Sharif, U. (2021). Nonlinear dynamic analysis of a reciprocative magnetic coupling on performance of piezoelectric energy harvester interfaced with DC circuit.
14. Dewangga, T., Izzuddin, T. A., & Al-Hazza, F. D. (2023). Studi eksperimental performa sound energy harvesting device menggunakan variasi rangkaian piezoelektrik.
15. Edla, M., Lim, Y. Y., Deguchi, M., Padilla, R. V., & Izadgoshasb, I. (2020). An improved self-powered H-bridge circuit for voltage rectification of piezoelectric energy harvesting system.
16. Ekawita, R., Salam, R. A., Kusumawardani, N., & Elfi, Y. (2021). Pengujian konfigurasi piezoelektrik penghasil tegangan listrik dari energi mekanik.
17. Endri Stiawan, & Arif Johar Taufiq. (2020). Rancang bangun alat pemanen energi listrik dari tekanan mekanik berbasis piezoelektrik.
18. Erny Listijorini, Susilo, S., Adhiwindoro, A., Febrianto, I., Shihab, M. A., Dwiyoga, M. A., & Ananda, R. R. (2024). Rancang bangun ALPENLIBE (Alat Pemanen Energi Listrik Berbasis Piezoelektrik) sebagai upaya mewujudkan energi terbarukan.
19. Fajri, B. N., Maulana, Y. Z., & Syifa, F. T. (2025). Rancang bangun prototipe pemanen energi getaran pada tangga menggunakan transduser piezoelektrik.
20. Gamayel, A. (2025). Studi performa pemanen energi piezoelektrik dengan metode vortex induced vibration.
21. Gamayel, A., Mulyana, F., & Sunardi, A. (2020). Pengaruh ketinggian bola jatuh terhadap tegangan listrik yang dihasilkan trampolin sebagai pemanen energi dengan pemasangan piezoelektrik.
22. Gupta, R., Badel, B., Gupta, P., Bucknall, D. G., Flynn, D., & Pancholi, K. (2021). Flexible low-density polyethylene–$BaTiO_3$ nanoparticle composites for monitoring leakage current in high-tension equipment.
23. Hanifah, L. Z., Kurniawan, B. P., Arista, Y., & Rahayu, L. P. (2022). Analisis daya piezoelektrik pada alat pencegahan penyebaran coronavirus terintegrasi IoT.
24. Hasan, M. M., Haque, R., Jahirul, M. I., & Rasul, M. G. (2025). Pyrolysis of plastic waste for sustainable energy Recovery: Technological advancements and environmental impacts. Energy Conversion and Management, 326, 119511. https://doi.org/10.1016/J.ENCONMAN.2025.119511
25. Hasan, Z. A., Arbie, A., Odja, A. H., & Nuayi, A. W. (2021). Pengaruh jumlah piezoelektrik pada rancang bangun sistem penghasil listrik berbasis piezoelektrik dengan memanfaatkan gelombang laut.

26. Hasibuan, J. A., Ekaputri, C., & Sasmono, S. (2021). Perancangan prototipe konversi energi suara menjadi energi listrik dengan bahan piezoelektrik memanfaatkan energi tekanan tambahan yang berasal dari angin untuk kawasan industri.
27. Hou, W., Zheng, Y., Guo, W., & Pengcheng, G. (2021). Piezoelectric vibration energy harvesting for rail transit bridge with steel-spring floating slab track system.
28. Ibrahim, D. S., Beibei, S., Oluseyi, O. A., Peng, Z., & Sharif, U. (2021). Nonlinear dynamic analysis of a reciprocative magnetic coupling on performance of piezoelectric energy harvester interfaced with DC circuit.
29. Im, S., Cho, S. Y., Cho, J. H., Hwang, G. T., & Jeong, C. K. (2022). Study on relaxor polymer interface matrix for piezoelectric nanocomposite generators.
30. Islami, M., & Aulia, R. (2022). Pemanfaatan sensor piezoelektrik sebagai generator listrik pada sepatu untuk pengisian baterai peralatan elektronik berdaya rendah.
31. Jati, Fajar Sanintan. (2024). Esai Konservasi 2024, Universitas Negeri Semarang. https://unnes.ac.id/konservasi/wp-content/uploads/sites/29/2025/03/Buku-Esai-Konservasi-2024.pdf
32. K C, P. B., Maharjan, A., Acharya, M., Lee, D. E., Kusma, S., Gautam, R., Kwon, J. T., Kim, C. Y., Kim, K. S., Kim, H. A., & Heo, Y. (2023). Polytetrafluorethylene microplastic particles mediated oxidative stress, inflammation, and intracellular signaling pathway alteration in human derived cell lines. Science of the Total Environment, 897. https://doi.org/10.1016/J.SCITOTENV.2023.165295
33. Kallawa, A. F., Fikri, A., & Mujirudin, M. (2020). Pengaruh rangkaian seri dan paralel terhadap tegangan pada piezoelektrik.
34. Kaur, N., Goyal, S., Anand, K., & Sahu, G. K. (2021). A cost-effective approach for assessment of pre-stressing force in bridges using piezoelectric transducers.
35. Khairunnisa, K. (2024). Pengaruh LDPE (Low Density Polyethylene) sebagai aditif aspal dengan agregat kasar limbah beton terhadap parameter Marshall.
36. Khosroshahi, F. H., Kordi, F., & Tohidian, M. (2025). Preparation of cross-linked sponge with piezoelectric properties based on low density polyethylene/poly(ethylene-co-vinyl acetate) and barium titanate: Relationship between mechanical properties, and cell structure with piezoelectric coefficients.
37. Kim, J. H., Hong, I. G., Shin, H. Y., Ahn, H. J., & Im, J. I. (2024). Hydrostatic piezoelectric properties of 1-3 type piezo-composite with a porous polymer matrix.
38. Kinan, K. A., Zenitha, W., & Saragih, I. S. (2024). Sistem Smart Door bell Touchless Berbasis Arduino Uno.
39. Kumar, R. (2022). Functionalities of ZnO reinforced thermoplastics composite materials: A state of the art review.
40. Kusnandar, Hariyawati Dharmi, N. K., & Khairiyah, A. N. (2021). Rancang bangun purwarupa energy harvesting menggunakan piezoelektrik sebagai pembangkit energi listrik.
41. Lee, Y., Kim, S., Kim, D., Lee, C., Park, H., & Lee, J.-H. (2020). Direct-current flexible piezoelectric nanogenerators based on two-dimensional ZnO nanosheet.
42. Li, S., Shan, Y., Chen, J., Chen, X., Shi, Z., Zhao, L., He, R., & Li, Y. (2024). 3D printing and biomedical applications of piezoelectric composites: A critical review.
43. Lumintang, J., Rantung, J., & Maluegha, B. (2024). Pemodelan konversi energi listrik dari curah hujan melalui transduser piezoelektrik berbasis ANSYS.
44. Luo, Y., Wang, J., Li, H., Sun, Y., Zhao, Q., & Ma, T. (2025). Dual Piezoelectric Catalytic System for Efficient CO2 Reduction. Green Carbon. https://doi.org/10.1016/J.GREENCA.2025.01.005
45. Ma, G., Zhang, M., Gao, F., Ba, K., Han, Z., & Ren, L. (2024). Bioinspired, fiber-based, flexible self-powered sensor for wearable applications.
46. Magerramov, A. M., Dzhafarov, V. D., & Musaev, G. K. (2021). Electrophysical properties of low-density polyethylene and zeolite composites.
47. Marasoki, D. (2024). Teknik piezoelectric footstep pada pembangkit listrik untuk pengisian daya dengan RFID.
48. Mehdar, Y. T. H. (2024). Investigating the Impact of temperature and storage time on antimony release from polyethylene terephthalate (PET) plastic used for bottled drinking water. Desalination and Water Treatment, 319, 100474. https://doi.org/10.1016/J.DWT.2024.100474
49. Michael Smith, & Kar-Narayan, S. (2022). Piezoelectric polymers: Theory, challenges and opportunities.

50. Mohamad Safiddin Mohd Tahir, Noor Hazrin Hany, Mohamad Hanif, & Azni Nabela Wahid. (2022). Maximizing output voltage of a piezoelectric energy harvester via beam deflection method for low-frequency inputs.
51. Moonik, A., Rantung, J., & Maluegha, B. (2023). Pemanen energi listrik dari curah hujan melalui transduser piezoelektrik secara seri dan paralel.
52. Muhammad Kamal Azizi, Yulianto, & Fauziyah, M. (2024). Meningkatkan elektrifikasi lokasi remote area dengan konversi getaran menjadi lampu penerangan berbasis piezoelektrik.
53. Muhsinin, A., Badruzzaman, H., & Hendardi, A. R. (2022). Sistem Pemanen Energi Berbasis Piezoelektrik Sebagai Sumber Energi Terbarukan Pada Konstruksi Jalan. Proceedings of Life and Applied Sciences, 2.
54. Mulyana, F., & Gamayel, A. (2021). Pengaruh pantulan bola terhadap tegangan listrik yang dihasilkan oleh piezoelektrik pada trampolin sebagai pemanen energi.
55. Nafiu, S. A., Azeez, M. O., AlAqad, K. M., Olarewaju, T. A., Yerima, E. A., & Tanimu, A. (2025). Waste plastic management: Recycling and the environmental health nexus. Cleaner Materials, 15, 100291. https://doi.org/10.1016/J.CLEMA.2024.100291
56. Nayanathara Thathsarani Pilapitiya, P. G. C., & Ratnayake, A. S. (2024). The world of plastic waste: A review. Cleaner Materials, 11, 100220. https://doi.org/10.1016/J.CLEMA.2024.100220
57. Ni Ketut, H. D., & Rifaldi, S. (2022). Analisis potensi energi listrik yang dihasilkan dari rancang bangun prototipe alat pembangkit listrik menggunakan piezoelektrik memanfaatkan energi kinetik dari keset kaki dengan metode energy harvesting.
58. Ningsi, A. A. (2022). Pengaruh penambahan serbuk plastik pada campuran bata ringan jenis cellular lightweight concrete (CLC) terhadap kuat tekan.
59. Osheidu, S. E., Israel-Cookey, C., Amakiri, A. R. C., Sigalo, F. B., & Davies, O. A. (2025). Analytical modelling of resistive load effect on transient voltage and power output from d33-mode piezoelectric vibration energy harvester.
60. Piel, J. J., Boles, J. D., Lang, J. H., & Perreault, D. J. (2021). Feedback control for a piezoelectric-resonator-based DC-DC power converter.
61. Pradistia, R. F., & Prasetya, D. A. (2022). Pemanfaatan sensor piezoelektrik sebagai penghasil sumber energi dengan tekanan anak tangga.
62. Prasetyawati, F. Y., Yusuf, M. M., Ridho, A. I., Harwanti, A., Rezeki, Y. A., Sarwanto, S., & Rahardjo, D. T. (2022). Kajian pustaka komposit limbah plastik sebagai paving blok penghasil energi berkelanjutan terintegrasi piezoelektrik dan photovoltaic (VIZO).
63. Putra, T. H., Fatkhurrokhman, M., & Darmawan, I. A. (2023). Miniatur jembatan penyebrangan menggunakan sensor piezoelektrik sebagai penghasil listrik.
64. Rahmawati, D., Ulum, M., Farisal, M., & Joni, K. (2021). Lantai pembangkit listrik menggunakan piezoelektrik dengan buck converter LM2596.
65. Rajasekaran, N., & Muniraj, C. (2024). Analysis of electrical behavior in LDPE/$BaTiO_3$ ceramic filler nanocomposites for electrical cable insulation applications.
66. Ramadhan, M. R., Sasmono, S., & Ekaputri, C. (2021). Perancangan prototipe konversi hybrid energi suara, energi tekanan dan energi angin menjadi energi listrik menggunakan komponen piezoelektrik.
67. Ratih, R. M., Yasyak, M. I., Nugroha, H., & Fadlilah, U. (2020). Powerbank piezoelektrik menggunakan tekanan tangan.
68. Ratna Komala Dewi, Indrasari, W., & Firmansyah, H. (2024). Karakterisasi sensor piezoelektrik LDT0-028K untuk perancangan sistem pengukuran getaran pada mesin.
69. Ravi Shekhar, & Deep, M. (2023). A review on design and analysis of piezoelectric energy harvesting systems.
70. Relingga Frendy Pradistia, & Prasetya, D. A. (2022). Pemanfaatan sensor piezoelektrik sebagai penghasil sumber energi dengan tekanan anak tangga.
71. Rohimatush Shofiyah, et al. (2024). Pengolahan Sampah Polimer Termoplastik dan Termoset di Lingkungan Bank Sampah Induk Kabupaten Jember. Jurnal Komunitas, Vol. 6, No. 2.

72. Rostami, M., Daryadel, M., Azdast, T., Moradian, M., & Feizlou, N. (2024). Multi-objective optimization of coaxial cables with foamed LDPE/HDPE dielectric layers: Correlating process parameters with foam structure and impact on piezoelectric and electrical properties.
73. Rotmanas, A., Bareikis, R., Gedzevičius, I., & Čereška, A. (2025). Touch piezoelectric sensor for vibration intensity testing.
74. Sadewo, L. F., Gamayel, A., Sarwuna, S. J., & Ujiburrohman, R. A. (2022). Pengaruh variasi ukuran penampang bluff body belah ketupat terhadap tegangan listrik yang dihasilkan piezoelektrik.
75. Saputro, M. E., Hadikusuma, M. I., & Rianda. (2025). Generator listrik tenaga gelombang air menggunakan kristal piezoelektrik.
76. Sari, M. M., Afifah, A. S., & Suryawan, I. W. K. (2023). Pengelolaan Sampah Plastik Melalui Teknologi Pirolisis di TPST Manding, Kabupaten Sragen: Analisis Efektivitas dan Potensi Keberlanjutan. Jurnal Energi Baru dan Terbarukan, 4(3), 246-256. https://doi.org/10.14710/jebt.2023.20092
77. Setiawan, I., Siregar, M. F., Satria, H., Maizana, D., Mungkin, M., & Dayana, I. (2024). Design of Piezoelectric Based Energy Saving Public Street Lighting (PJU) Control System. CASTLE Proceedings, 4, 779-783.
78. Sidiq, A., Syahrillah, G. R. F., & Isra, M. (2022). Studi eksperimental pemanfaatan speed bumper (polisi tidur) menjadi energi listrik menggunakan piezoelektrik.
79. Silalahi, E. M. (2025). PERANCANGAN PROTOTYPE PEMBANGKIT PIEZOELEKTRIK LANTAI UNTUK SUPLAI ENERGI LISTRIK LAMPU PENERANGAN PINTU MASUK RUMAH. Jurnal Informatika dan Teknik Elektro Terapan, 13(1).
80. Smith, M., & Narayan, S. K. (2022). Piezoelectric polymers: Theory, challenges and opportunities.
81. Stepancikova, R., Olejnik, R., Matyas, J., Masar, M., Hausnerova, B., & Slobodian, P. (2024). Pressure-driven piezoelectric sensors and energy harvesting in biaxially oriented polyethylene terephthalate film.
82. Sun, R., Wang, L., Zhang, Y., & Zhong, C. (2020). Characterization of 1–3 piezoelectric composite with a 3-tier polymer structure. Materials.
83. Susanti, E., & Bistama, I. (2020). Perancangan sistem penerangan lampu berbasis piezoelektrik PZT di Fakultas Teknik Universitas Riau Kepulauan.
84. Suwandono, D., Sarasanty, D., & Asmorowati, E. T. (2023). Pemanfaatan limbah plastik LDPE (Low Density Polyethylene) sebagai pengganti sebagian agregat halus pada beton ringan.
85. Szczygielski, J. J., Charteris, A., Obojska, L., & Brzeszczyński, J. (2025). Energy in turmoil: Industry resilience to uncertainty during the global energy crisis. Applied Energy, 389, 125351. https://doi.org/10.1016/J.APENERGY.2025.125351
86. Valemtina, M. A., Silalahi, E. M., & Widodo, B. (2025). Perancangan prototype pembangkit listrik piezoelektrik lantai untuk suplai energi listrik lampu penerangan pintu masuk rumah.
87. Wahyu Cahyo Widodo, Windarta, Nur'aini, R. D., & Maghfurah, F. (2024). Pengaruh variasi curah hujan dan sudut kemiringan terhadap daya keluaran pada alat uji piezoelektrik.
88. Wang, K., Long, H., Song, D., & Shariar, H. (2025). Energy harvesting microelectromechanical system for condition monitoring based on piezoelectric transducer ring.
89. World Population Review. (2025). Total population by country 2025.
90. Xu, M., Wen, Y., Shi, Z., Xiong, C., Zhu, F., & Yang, Q. (2024). Piezoelectric biopolymers: Advancements in energy harvesting and biomedical application.
91. Youssef El Hmamsy, C. E., Laadissi, E. M., Loualid, E. M., & Hajjaji, A. (2022). Optimized piezoelectric energy harvesting circuit using DC/DC converter.
92. Yuliana, H., Yusaniar, R., & Zainal, Y. B. (2020). Rancang bangun sistem energy harvesting di ruang bising menggunakan piezoelektrik array.
93. Zahra, A. P., Alam, M. I. B., Wardani, R. B., Sholeh, M., Nuryadin, A., & Subagiyo, L. (2024). Bangkitan tegangan listrik pada rekayasa piezoelektrik berbasis bahan dapur.
94. Zaman, A., Guneroglu, U., Alsolami, A., Li, L., & Wang, J. (2025). Interface material modification to enhance the performance of a thin-film piezoelectric-on-silicon (TPoS) MEMS resonator by localized annealing through Joule heating.

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95. Zhou, L., Chen, H., Bao, W., Chen, X., Gao, T., & Ge, D. (2025). Theoretical modeling of light-fueled self-harvesting in piezoelectric beams actuated by liquid crystal elastomer fibers.
96. Zhou, X., Wang, Q., Feng, S., Deng, J., Zhu, K., Xing, Y., Meng, X., Wang, X., & Li, L. (2023). Recycling Carbon Resources from Waste PET to Reduce Carbon Dioxide Emission: Carbonization Technology Review and Perspective. Journal of Renewable Materials, 11(5), 2085–2108. https://doi.org/10.32604/JRM.2023.025032
97. Zidani, J., Tajounte, L., Benzaouak, A., Touach, N., Duong, A., Zannen, M., & Lahmar, A. (2025). Advances in lead-free flexible piezoelectric materials for energy and evolving applications. Advanced Industrial and Engineering Polymer Research. https://doi.org/10.1016/J.AIEPR.2025.04.001