How Micro-hydro power plant fit in support of SDG 7?

Putri Lintang Utami[1], *Siti Nur* Aisah[1], *Nadi* Suprapto[1*], *Hasan Nuurul* Hidaayatullaah[2] and *Beken* Arymbekov[3]

[1]Physics Education Program, Universitas Negeri Surabaya, 60231, Surabaya, Indonesia
[2]Postgraduate Science Education Program, Universitas Negeri Surabaya, 60231, Surabaya, Indonesia
[3]Faculty of Physics and Technology, Al-Farabi Kazakh National University, Kazakhstan

Abstract. SDGs establish an evidence-based structure for sustainable development planning and implementation. A micro-hydro power plant (MHPP) is a compact hydroelectric using a non-variable system and engine-driven control for active power generation. Bibliometric research related to Micro-hydro Power Plants to achieve SDG7 needs to be studied more. This study conducted a bibliometric analysis of Micro-hydro Power Plants to investigate their contribution to achieving SDG7. This study aims to (1) analyze the distribution of Micro-hydro Power Plants research to achieving SDG7, (2) analyze countries' contribution to Micro-hydro Power Plants research, (3) network analysis of Micro-hydro Power Plants research and contribution to achieving SDG7. This bibliometric analysis using VOS viewer and R-Studio Biblioshiny with Scopus database (2014-2024). Research on Micro-hydropower plants increased rapidly in 2018, with Indonesia being the most published document. Micro-hydropower plants contribute to sustainable development goal 7 by providing adequate, sustainable energy. It is environmentally friendly and fulfills energy demands in small communities.

1 Introduction

Sustainable Development Goals (SDGs) is an international strategy consisting of 17 interconnected goals and 169 targets that received unanimous support from 193 UN member states. The SDGs set guidelines for public policy in development and international cooperation until 2030 [1]. The 2030 Agenda also supports industrialization involvement and partnerships to support nations utilizing all available resources to put into action and realize transformation [2]. Fulfilling the SDGs is a global responsibility that must be carried out [3]. The new SDG framework includes 17 bolder goals, including sustainable and clean energy, as SDG7 [4]. These goals strive to eradicate poverty, defend the environment, and ensure peace and prosperity [5]. Development that fulfills current needs while preserving resources for future generations [6]. This development includes economic, social, and environmental

* Corresponding author: nadisuprapto@unesa.ac.id

aspects [7]. The SDGs are designed to be interconnected and support each other to achieve sustainable growth in various aspects of global life [8]. SDGs ensure a better and more sustainable future for everyone [9].

An essential step is to move the energy transition towards sustainable sources that do not cause pollution and increase effectiveness. Keeping this in view, the carbon-based fuel problem that is the priority of SDG 7 includes the notion of an energy transition paradigm, transitioning from fossil fuel energy generation to a different state based on the future. Seeking a better natural environment and ecological balance [10]. Achieving SDG7 is critical to the overall sustainable development agenda, as energy is a crucial driver for many other SDGs [11]. Sustainable Development Goal 7 ensures the availability of inexpensive, reliable, sustainable, and advanced energy [12]. This is underpinned by providing universal energy access, Enhancing the ratio of renewable energy in collaboration, and increasing performance [13]. Using renewable resources is essential because it is an ideal solution to prevent greenhouse gas pollutants and minimize environmental consequences [14]. Renewable energy supports reducing greenhouse gas emissions and meets global energy needs while focusing on modern technology and creative solutions [15]. Intelligent technologies and energy storage systems are crucial in facilitating the transition to the dominance of renewable energy within the global energy framework [16]. Renewable energies can help attain net-zero carbon emissions by minimizing greenhouse gas emissions and reducing CO2 levels [17].

Access to sufficient amounts of energy is a prerequisite for the development of human welfare [18]. The treatment of electricity as a right in developing countries results in unequal and sporadic access, thereby reducing growth potential [19]. The total of people without reliable electric energy access is about 3.5. This provides a more detailed picture of the global energy access gap for future investment and policymaking [20]. Low access to electricity is a human rights issue affecting millions worldwide, and efforts are underway to develop clean and sustainable energy systems in energy-limited communities [21].

Micro-hydro Power Plants are compact power plants harnessing water energy from sources like irrigation canals, rivers, or waterfalls, using the height of the waterfall (head) and water flow rates [22]. Micro-hydropower plants can produce electricity efficiently from non-conventional sources such as water, thereby reducing demand for conventional grid-based energy [23]. Optimizing the design of micro-hydro power plants reduces weight while maintaining usage properties and durability, thus producing a mini energy source for remote locations [24]. Integrating Micro-hydropower plants in water distribution systems can reduce costs, increase economic profits, and reduce environmental impacts by an average of 282 tons per year [25].

Bibliometrics is a qualitative and quantitative method that has widely investigated knowledge and the development of specific research fields using mathematical and statistical methods [26]. In recent years, developments in bibliometrics have steadily explored trends in scientific publications [27]. This approach describes the influence of research, information transfer, and knowledge networks [28]. This bibliometric analysis allows a comprehensive analysis of academic articles and citation patterns to examine the literature [29].

In pursuing Sustainable Development Goal 7 (SDG7) bibliometric studies have become a handy tool in understanding recent developments in renewable energy. In this context, bibliometric analysis of Micro-hydro Power Plants offers valuable insights into trends, developments, and future directions in this technology, which has excellent potential. However, the bibliometric research related to Micro-hydro Power Plants to achieve SDG7 needs to be studied more. This study conducted a bibliometric analysis of Micro-hydro Power Plants to investigate their contribution to achieving SDG7. Through this approach, we identify key works, collaborative networks among researchers, as well as emerging research focuses in this domain. This research discusses research problems there are

1. How the distribution of Micro-hydro Power Plants research to achieving SDG7?

2. How countries contribution of Micro-hydro Power Plants research?
3. How network analysis of Micro-hydro Power Plants research and contribute to achieving SDG7?

2 Methods

The research utilizes a descriptive methodology alongside a bibliometric analysis. Bibliometrics comes from the words "biblio" or bibliography and "metrics." Bibliometric analysis is a robust technique for exploring and analyzing scientific information. This approach enables us to reveal the evolutionary intricacies of a particular discipline and up-and-coming areas [30]. Bibliometric analysis measures the growth of scientific publications [31]. It is also essential to know the pattern and frequency of citations to published articles [32]. Analyzing trends often involves bibliometric indicators, such as research fields, country and institution distribution, citations, and keywords [33]. Bibliometric studies are typically employed in scientific fields and concentrate on quantitative analysis on publication [34].

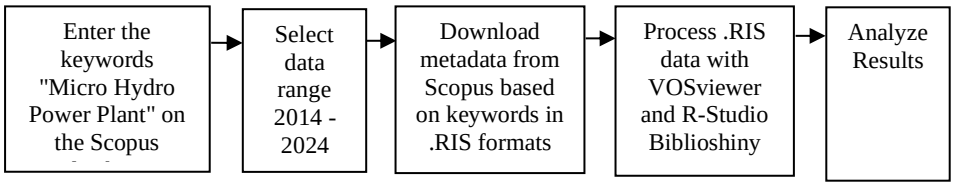

Fig. 1. Bibliometric Analysis Research Stages.

3 Result and Discussion

3.1 The distribution of Micro-hydro Power Plants research to achieving SDG7

A descriptive analysis was obtained where in the last 10 years (2014-2024) the growth rate was -13.64%, where there were 243 documents, 146 sources, and 792 authors.

Table 1. Descriptive Analysis

Description	Results
Timespan	2014-2024
Sources (Journals, Books, etc)	146
Documents	243
Annual Growth Rate %	-13.64
Document Average Age	4.69
Average citations per doc	4.383
References	4269
Authors	792

Based on 243 documents found, 62.96% of the documents were conference papers and 31.28% were articles. This shows that researchers are more interested in publishing their papers at conferences.

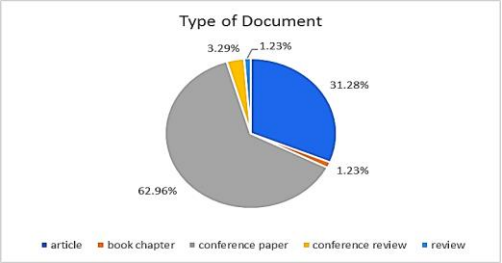

Fig. 2. Type of Documents.

Research related to Micro-hydro Power Plants increased rapidly in 2018 with a total of 40 papers. The most cited paper was written by Apichonnabutr W. and Tiwary A. related to the economic performance and environmental impact of existing micro-hydro energy systems to increase efficiency and overcome various reliability for future life to reduce dependence on Diesel Generators.

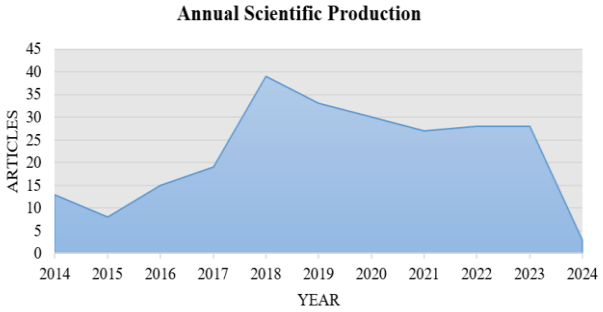

Fig. 3. Annual Scientific Production.

Based on citation analysis, papers in 2014 related to Micro-hydropower plants had an average total citation per year of 1.25 with an average total citation per article of 13.77 articles. Bilal Abdullah Nasir wrote the most cited article regarding the design of a micro-hydro power plant.

Table 2. Citation Analysis

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2014	13.77	13	1.25	11
2015	6.12	8	0.61	10
2016	9.27	15	1.03	9
2017	9.95	19	1.24	8
2018	4.64	39	0.66	7
2019	2.48	33	0.41	6
2020	4.6	30	0.92	5
2021	2.52	27	0.63	4
2022	1.14	28	0.38	3
2023	0.29	28	0.14	2

Based on source analysis, these are the leading five sources for papers on Micro-hydropower plants over ten years, where the IOP Conf. Ser. Earth Environ. Sci. is the top-

producing source, with the most popular paper written by H Didik regarding sustainable development and Micro-hydropower plants in Indonesia.

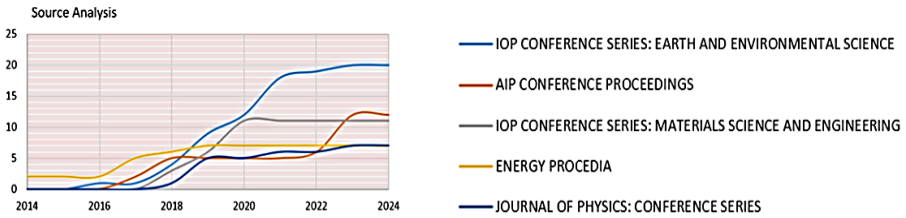

Fig. 4. Source Analysis.

3.2 Countries' Contribution to Micro-hydro Power Plants research

Based on co-authorship with a unit of analysis countries there are 50 countries. The density visualization shows 50 meeting thresholds, at least one document in each country.

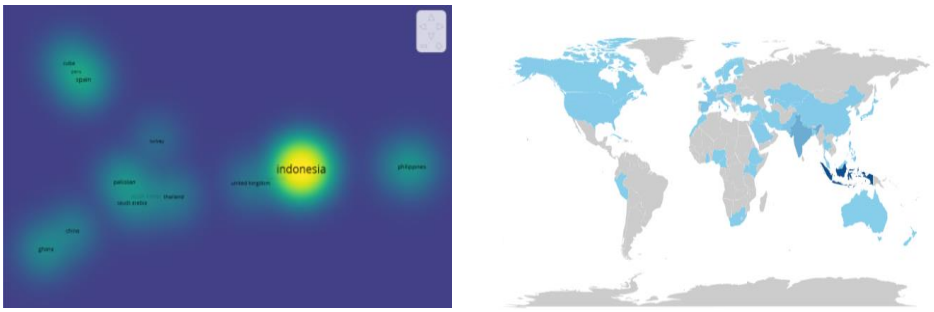

Fig. 5. Countries Overlay Visualization and Scientific Production.

Based on the analysis of countries' scientific production, it was found that Indonesia is the country that publishes the most on Micro-hydropower plants. Indonesia has large natural resource potential to develop renewable energy which can meet local energy needs sustainably [35]. Micro-hydro power plants have been developed in Indonesia since the 1970s [36]. Micro-hydro power plants have great potential to be developed in Indonesia because of the abundance of small rivers and high rainfall due to their location on the equator [37]. Micro-hydro power plants are environmentally friendly, easy to operate, and have low operation costs, contributing to Indonesia's energy sustainability [38]. Investment in micro-hydro power plants in Indonesia would increase GDP and promote employment [39].

Micro-hydro systems in Central Java, Indonesia, meet villages' electrical energy needs [40]. The study in Yogyakarta, Indonesia, optimizes the hydroelectric system capacity based on the cost of capital investment, grid revenue, energy costs, and net present value [41]. Micro-hydro power plants in Jambi Province, Indonesia, benefit considerably and contribute to electrical energy independence and forest conservation [42]. Optimizing the water drop point in Micro-hydro power plants can increase the electric power generated by using smaller pipes in Indonesia [43].

3.3 Network analysis of Micro-hydro Power Plants research and contribution to achieving SDG7

Based on Networking Analysis using VOS Wiever, the results obtained are that research related to Micro-hydro Power Plants is divided into 1704 keywords with a minimum number of occurrences of 5, and Network Visualization is divided into 5 Clusters.

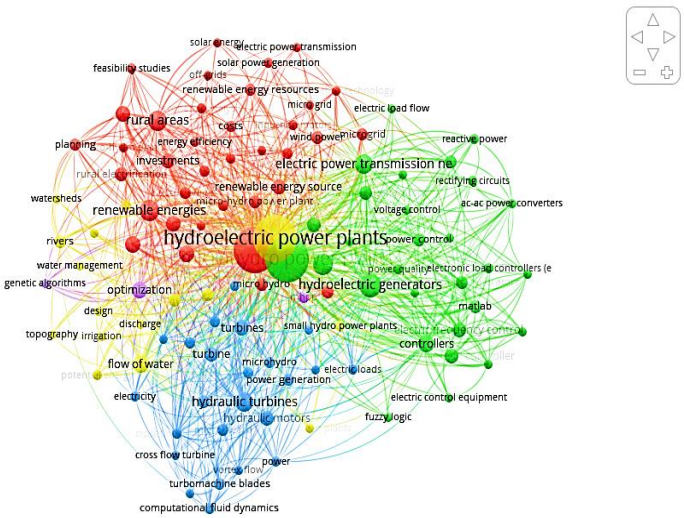

Fig. 6. Network Analysis.

If we describe the supporting elements of Micro-hydropower plants to capture the latest trends and research, we find several supporting elements, including renewable energy sources. Micro-hydro-electric power is an efficient, reliable, and clean renewable energy source with minimal environmental impact on local ecosystems [44]. Micro-hydro power plants are becoming a significant renewable energy resource without population displacement and environmental problems [45]. Micro-hydropower plants offer better performance, decreased greenhouse gas emissions, and better grid operation than conventional fossil fuels [46]. Micro-hydro power plants (MHPPs) are a major source of renewable energy, reducing CO2 emissions and offering financial benefits through fuel-free operation [47].

Micro-hydro power plants provide clean, affordable, and sustainable renewable energy to remote areas, reducing dependence on traditional sources [48]. In contrast to fossil fuels which are limited and Emit greenhouse gases that exacerbate climate change, renewable energy sources are sustainable and have a lower environmental impact [49]. Micro-hydro energy is an essential contributor to the energy mix of the future, providing cost-effective and efficient electricity generation in isolated and disaster-affected areas [50]. Micro-hydro power plants in remote areas provide reliable, affordable electricity, positively changing rural livelihoods, such as abandoning traditional kerosene lamps and firewood consumption [51]. Micro-hydro power systems offer an alternative energy source for off-grid rural communities, resulting in social, environmental, and economic impacts [52].

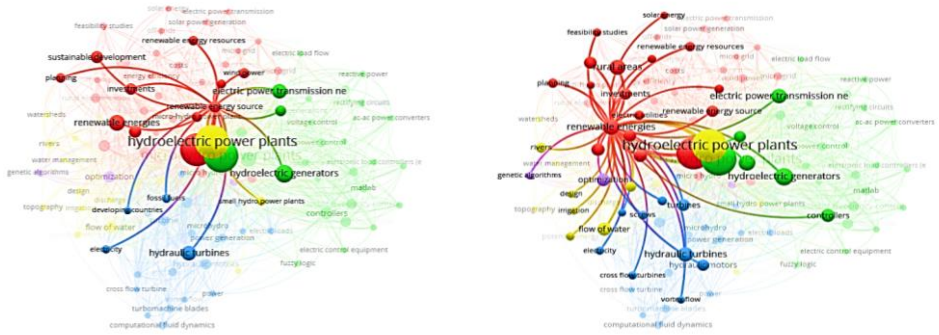

Fig. 7. Network Analysis Renewable Energies Sources Terms.

Micro-hydro power plants are closely related to energy efficiency. Micro-hydro power plants tend to convert water potential energy into electrical energy efficiently. Micro-hydropower has considerable potential to develop, reducing dependency on fossil fuel and contributing to energy efficiency and renewable energy production capabilities [53]. Micro-hydropower systems can generate power at high flow, resulting in optimized utilization of flow and head [54]. Generating electricity from water through turbines and generators is usually more efficient than using fossil fuels such as coal or oil. This allows more efficient use of resources to produce electrical energy.

Micro-hydroelectric power in the water industry reduces global warming and fossil resources [55]. Micro-hydro storage with a pump functioning as a turbine can reduce electricity grid demand and enable cost-effective, efficient use of generated energy with a levelized cost of energy [56]. Micro-hydropower contributes to impacts on global warming with potential benefits from using alternative materials [57].

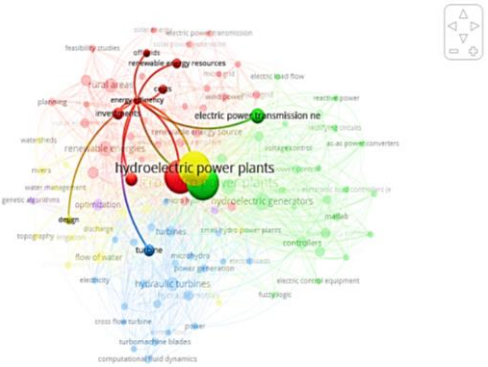

Fig. 8. Network Analysis Energy Efficiency Terms.

Micro-hydro-electric power plants have high efficiency, high capacity factor, and slow rate of change, making them a suitable renewable energy source for SDG7 [58]. Reducing power losses in renewable energy systems supports increased energy efficiency, which is one of the main targets of SDG7 [59]. Micro-hydro power plants provide affordable, clean energy with climate change mitigation potential [60]. Integrating renewable energy enables the creation of more sustainable energy, diminishes fossil fuel dependency, and lowers greenhouse gas emissions [61]. Micro-hydro power plants are environmentally friendly, easy to operate, and have low operation costs.

Micro-hydro power plants contribute to sustainable development goal 7 by providing rural electrification through green energy sources [50]. Micro-hydro provides rural electrification through local participation and close collaboration of private and financial sector firms [62]. Micro-hydro power plants fulfill energy demand in small communities, support sustainable development, and generate jobs and revenue [63]. Micro-hydro power plants strengthen community commitment to renewable energy use and improve economic conditions through community innovation and microcredit availability [64].

Micro-hydro power plants contribute to sustainable development goal 7 by providing adequate energy generation, avoiding population movement and environmental effects pertaining to hydro power plants [66]. Micro-hydro power plants can be optimized for weight reduction and improved use properties, contributing to SDG7 [67]. Micro-hydro power plants can contribute to sustainable development by providing an alternative to diesel generators, reducing environmental costs, and improving renewable penetration [68].

4 Conclusion

Based on research and discussion research related to Micro-hydro Power Plants increased rapidly in 2018 with the most type of document being a conference paper and IOP Conf. Ser. Earth Environ. Sci. being the top published source. Indonesia is the most published Micro-hydro Power Plants document. Network Visualization of Micro-hydro Power Plant research divided into 5 Clusters. Micro-hydroelectric power is an optimal, reliable, and clean renewable energy source. Micro-hydropower plants tend to efficiently convert water potential energy into electrical energy. Micro-hydro power plants contribute to sustainable development goal 7 by providing adequate sustainable energy. Environmentally friendly and fulfills energy demands in small communities

References

1. A. E. López-Carrión & M. Martí-Sánchez, Revista Latina de Com. Soc. **82**, (2024)
2. S. Nahar, Tech. Forecasting and Soc. Change **201**, (2024)
3. P. L. Utami, N. Suprapto, H. N. Hidaayatullaah & T. H. Cheng, E3S Web of Conferences **513**, (2024)
4. United Nations, THE 17 GOALS | sustainable development (United Nations, 2022)
5. H. N. Hidaayatullaah, E. Hariyono, D. Hadiana, H. Fujii & M. Satriawan, E3S Web of Conferences **513**, (2024)
6. A. Ambariyanto & Y. J. Utama, E3S Web of Conferences **202**, (2020)
7. R. Abazov, E3S Web of Conferences **307**, (2021)
8. H, V, Saphira, B. K. Prahani, E. Hariyono, F. C. Wibowo, M. A. H. Bunyamin & S. Wahono, E3S Web of Conferences **450**, (2023)
9. R. F. Sari, Y. A. Sidiyanto & J. H. Windiatmaja, E3S Web of Conferences **450**, (2023)
10. A. N. K. Lup, V. Soni, B. Keenan, J. Son, M. R. Taghartapeh, Environmental Sci. **2**, 4 (2023)
11. I. Vakulenko, L. Saher, O. Lyulyov & T. Pimonenko, E3S Web of Conferences **250**, (2021)
12. G. T. Tucho & D. M. Kumsa, Frontiers in Energy Research **8**, 564104 (2020)
13. World Health Organization. Tracking SDG 7: The Energy Progress Report (2021)
14. S. E. Hosseini, Future Energy **1**, 2022

15. D. Gielen, F. Boshell, D. Saygin, M. D. Bazilian, N. Wagner & R. Gorini, Energy strategy reviews **24**, (2019)
16. L. M. Pastore, G. Lo Basso, M. Sforzini & L. De Santoli. E3S Web of Conferences **197**, (2020)
17. X. Yuan, C. W. Su, M. Umar, X. Shao & T. O. R. J. Lobon, Environmental Management **308**, 114648 (2022)
18. R. Brecha, European J. Sustainable Development **8**, 4 (2019)
19. R. Burgess, M. Greenstone, N. Ryan & A. J. Sudarshan, Eco. Perspectives, **34**, 1 (2020)
20. J. Ayaburi, M. Bazilian, J. Kincer & T. Moss, The Electricity J. **33**, 7 (2020).
21. C. Cañizares, J. Nathwani & D. Kammen, Proceedings of the IEEE **107**, 9 (2019)
22. E. Desfitri, C. Salsabilla, & B. A. Putri, Teknosia **17** 2 (2023).
23. D. Raveendra, Mini Hydro Power Plant. Inter. J. Scientific Research In Eng. And Management. **7**, (2022)
24. P. Srb & M. Petrů, Proceedings of the ICMD 2018 (2020).
25. A. Berrada, Z. Bouhssine & A. J. Arechkik, Cleaner production **232**, (2019)
26. B. Jiang, N. Hong, F. Zhao & F. Dong, International Ophthalmology **44**, 1 (2024)
27. D. Zhao & A. Strotmann, Analysis and Visualization of Citation Networks (Springer, 2015)
28. N. J. Van Eck & L. Waltman, Scientometrics **84**, 2 (2010)
29. S. B. Nielsen, S. Lemire, I. Bourgeois, & L. A. Fierro, Eval. and Program Plan. **6**, (2023)
30. A. Parmar, R. Ganesh, & A. K. Mishra, Asian journal of psychiatry **42**, (2019)
31. I. Setyaningsih, N. Indarti, & F. Jie, Inter. J. Management Concepts and Philosophy 11 3 (2018)
32. L. Hakim, Procuratio: J. Ilmiah Manajemen **8**, 2 (2020).
33. L. Jinyao, E. Bhattacharyya, Asia Pacific J. of Business, Hum. And Edu. **7**, 2 (2022)
34. N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, & W. M. Lim, J. business research 133 (2021)
35. H. Hariyanto, D. Parenden, Z. Vincēviča-Gaile, & P. G. Adinurani, E3S Web of Conferences **190**, (2020)
36. Y. Haroen, 3rd International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE) (2016)
37. P. Gokhale, A. Date, A. Akbarzadeh, P. Bismantolo, A. F. Suryono, A. K. Mainil, & A. Nuramal, Energy Procedia **110**, 1(2017)
38. Y. Pasalli & A. Rehiara, Procedia environmental sciences **20**, (2014)
39. D. Hartono, S. Hastuti, A. Halimatussadiah, A. Saraswati, A. Mita & V. Indriani, Heliyon **6**, (2020)
40. R. Syahputra & I. Soesanti, J. Electr. Comput. Eng. **5**, 3 (2020)
41. R. Syahputra & I. Soesanti, Energy Reports **7**, 1 (2021)
42. R. Bahtiar, A. Falatehan, D. Sari & S. Thamrin, Proceedings of The 2nd International Conference On Advance And Scientific Innovation, ICASI 2019 (2019)
43. H. Hermawan & S. Sunardi, Buletin Ilmiah Sarjana Teknik Elektro **3**, 1 (2021)
44. B. Nasir, Energy Procedia **50**, (2014)

45. M. Hanmandlu, H. Goyal & D. Kothari, International Conference on Power Electronic, Drives and Energy Systems (2006)
46. C. Jawahar & P. Michael, Renewable & Sustainable Energy Reviews **72**, (2017)
47. W. Ali, H. Farooq, A. Rehman, M. Jamil, Q. Awais & M. Ali, International Symposium on Recent Advances in Electrical Engineering (RAEE) (2018)
48. T. Demissie & G. Somano, Inter. J. eng. research and tech. **5**, (2016)
49. K. Abdullah, A. S. Uyun, R. Soegeng, E. Suherman, H. Susanto, R. H. Setyobudi, & Z. Vincēviča-Gaile, E3S Web of Conferences **188**, (2020)
50. C. Purece, P. Vasile & C. Lilica, Technium: Romanian J. App. Sci. and Tech. **2**, 4 (2020)
51. A. Gurung, I. Bryceson, J. Joo & S. Oh, Scientific Research and Essays, **6**, (2011)
52. A. Culaba & I. Marfori, Micro-hydro Power System (Springer, 2020)
53. K. Chae, I. Kim, X. Ren & K. Cheon, Energy Conversion and Management **101**, (2015)
54. J. Gallagher, D. Styles, A. McNabola & A. J. Williams, Cleaner Production **99**, 1 (2015)
55. F. Lugauer, J. Kainz & M. Gaderer, Energies **14**, 2 (2021)
56. T. Ueda, E. Roberts, A. Norton, D. Styles, A. Williams, H. Ramos & J. Gallagher, J. Cleaner Production **218,** (2019)
57. B. Nasir, Advances in Energy and Power **2**, 1 (2014)
58. W. Awandu, R. Ruff, J. U. Wiesemann & B. Lehmann, Energies **15**, (2022)
59. O. Toirov, M. Taniev, M. Hamdamov & A. Sotiboldiev, E3S Web of Conferences **434** (2023)
60. E. Nyeche & E. J. Diemuodeke, Cleaner Production **250**, 1 (2020)
61. B. Novianto, K. Abdullah, A. S. Uyun, E. Yandri, S. M. Nur, H. Susanto & Y. Nurdiansyah, E3S Web of Conferences **188**, 2 (2020)
62. H. Didik, P. Bambang, S. Asep & Y. Purwanto, IOP Conf. Ser. Earth Environ. Sci. **147**, 1 (2018)
63. M. Pigaht & R. Plas, Energy Policy **37**, 1 (2009)
64. C. Blanco, Y. Secretan & A. Mesquita, Energy for Sustainable Development **12**, 1 (2008)
65. M. Isa, P. Sudjono, T. Sato, N. Onda, I. Endo, A. Takada, B. Muntalif & J. Ide, Energies (2021)
66. M. Adhau, R. Moharil & P. Adhau, Estimation of Micro-hydro power plant capacity from potential sites, *in IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, pp. 1-5, (2012)
67. P. Srb & M. Petrů, Design Optimization of Micro-hydro Power Plant (Springer, 2019)
68. W. Apichonnabutr & A. Tiwary, Applied Energy **7**, 1 (2018)