Proceedings of the 3rd Asia Pacific International Conference on Industrial Engineering and Operations Management, Johor Bahru, Malaysia, September 13-15, 2022

A Review of Energy Community Innovation and Local Resources Utilization in Indonesia

Dana Prianjani
Industrial Engineering Department, Faculty of Industrial Technology
Universitas Islam Sultan Agung, Semarang, Indonesia
danaprianjani@unissula.ac.id

Ardhy Yuliawan Norma Sakti
National Research and Innovation Agency, Tangerang Selatan, Indonesia
Sirindhorn International Institute of Technology, Thammasat University, Rangsit, Thailand
ardh007@brin.go.id

Wahyudi Sutopo
University Centre of Excellence for Electrical Energy Storage Technology
Research Group Industrial Engineering and Techno-Economic
Industrial Engineering Department, Faculty of Engineering
Universitas Sebelas Maret
Surakarta, Indonesia
wahyudisutopo@staff.uns.ac.id

Abstract

Various efforts have been carried out to achieve national electrification targets in Indonesia. However, electrification in remote areas encounters several obstacles related to the high investment costs, lack of infrastructure and demand volatility. The local stakeholders are actively conducting energy projects through the energy community. This paper gathers the latest articles regarding energy community innovation and resource utilization in Indonesia. The review process is focused on the study that highlighted the rural and the remote area. We mapped out the research and innovation carried out by the energy community. We review the report and latest articles indexed by Scopus and SINTA. Based on our review, the energy community in Indonesia optimizes local resources and utilizes waste. Energy innovations are not only related to electrification but also to food storage and processing. The energy Community also actively making continuous improvement to solve local problems.

Keywords
Review, Energy Community, Innovation, Resources, Indonesia

1. Introduction

Global energy demand is heading a growth due to economic and population growth (IEA, 2021). Energy becomes a commodity to satisfy human needs, welfare, and economic development (Owusu & Asumadu-Sarkodie, 2016). The high demand for energy causes the potential for energy scarcity. The impact of energy scarcity in the world is also spreading to Indonesia. Researchers have conducted modelling of energy demand in Indonesia. Lefaan and Dalimi (2018) modelled a significant increase in the household electricity demand of Papua Province Indonesia in 2050 using a system-dynamic approach. Developing regions have higher energy needs to catch up with regions that have good infrastructure. For instance, the condition is related to the need for electrification. Various efforts have been carried out to achieve national electrification targets in Indonesia. On average, the Electrification Ratio in Indonesia is around 99.20% in 2020 (Direktorat Jenderal Ketenagalistrikan, 2021). However, several areas have not received electrification coverage, especially in the remote area. There is an imbalance in the electrification ratio in remote areas such as the provinces of Papua and Maluku which is still below 95%. Even the islands of East Nusa Tenggara only reached 87.62%. The data shows a fairly wide disparity between several regions. Geographical conditions are the main

© IEOM Society International

reason for inequality. If the problem of energy needs can be resolved, it gives a positive multiplier effect on economic growth, improving the quality of education, decreasing crime rates, and increasing the quality of life of local communities. This statement is supported by Wahono et al. (2017) study, electrification acceleration in a rural area in Indonesia boosts employment-creation potential and increases economic empowerment.

The geographical condition of an archipelagic country is the main obstacle. Furthermore, electrification in remote areas encounters several obstacles related to the high investment costs, lack of infrastructure and demand volatility. UN.ESCAP (2012) offers the concept of expanding the energy through a decentralized off-grid energy system while the centralized grid is limited. A decentralized energy system is suitable to be applied in archipelagic countries such as Indonesia.The conditions that must be met are that each island or rural area has independence in supplying its energy. Energy independence can be achieved if each region has its own reliable energy potential. Furthermore, decentralized energy systems require the participation of multiple stakeholders (Van der Schoor & Scholtens, 2015). Community participation is also needed to solve grassroots problems related to energy for addressing societal issues (Budiman, 2018). Collaboration of multiple participants can encourage the establishment of energy communities (Van der Schoor & Scholtens, 2015). The energy community is a group of citizens who have the same goal of for aiming energy independence.

Rahmani, Murayama, and Nishikizawa (2020) reviewed the indicator for driving the sustainability program in nine Countries. They found several indicators including partnership, support and network become the important driver to upscale the energy community project. Thomas et al. (2018) stated energy community project is a transdisciplinary work that needs methodological principles to encounter various problems. Koirala et al. (2016) have reviewed the current energy trends and issues related to relationships with local community engagement. They found energy storage, off-grid options, and lowering energy cost become the current energy community trends. They indicate socio-economic, institutional, technological and environmental aspects as issues when engaging the local communities. From the socio-economic perspective, Syafii, Wati, and Fahreza (2021) study on pumped hydro storage in Remote Area Mentawai Island and Setiawan et al (2021) study on fishery cold storage development using photovoltaic technology in Fisherman Rural Area are agree to implement Techno-Economic Analysis when tackling the Energy Related Technology Development. However, before doing a Techno-Economic Analysis, we need to map an Energy Potential in remote and rural areas (Baghta, Aprilianti, Aryani, Jufri, & Utomo, 2020). To encounter environmental pollution and energy issues, Huang et al. (2015) reviewed the methods and tools for demand forecasting, renewable energy assessment and energy community optimization. Most of the tools and methods reviewed are computer-based programs.

From the state of the art of paper reviewed, most of the emphasis on energy best practices is carried out outside Indonesia. While research related to the energy community in Indonesia was carried out at the initiation stage only. Currently, there is no research that reveals the potential of the resources used, the innovations carried out and how to ensure the sustainability of the program. The energy community has been formed in the scope of Indonesian society. Its existence is also able to make the driving force in energy independence both in rural areas and remote areas. In this review paper, we will collect the best practice energy community in Indonesia and conduct a comparative analysis with the energy community tools and methods that have been applied both inside and outside Indonesia. We limit the scope for potential resources, innovations and program sustainability due to priority indicators. Our review study aims to contribute to best practice literature of energy community innovation and local resources utilization in a decentralized off-grid system.

2. Conceptual and Theoretical Framework

2.1 Definition

An energy community refers to a group of energy storage units with community ownership and governance that operate as a unit to generate collective benefits such as self-consumption of renewable energy, reduced dependence on fossil fuels, reduced energy bills and increased income from various energy services (B. Koirala, Hakvoort, Oost, & Windt, 2019).

© IEOM Society International

2.2 Actors in Energy Community

Actors in the energy community can be individuals (households), universities or schools, public utility companies, non-governmental organizations, local authorities, municipalities, and others. The roles these actors take depend on local conditions and the goals of the energy community (Gjorgievski, Cundeva, & Georghiou, 2021)

Individual reasons for joining an energy community vary widely, usually in the form of achieving certain economic, environmental, or social goals. Although actors in society can pursue each of these goals independently, the literature suggests there are a number of benefits in doing so collectively. For example, when grouped into the energy community, as opposed to acting individually, actors in the community can reap the benefits by gaining more bargaining power or taking the opportunity to derive revenue from markets they otherwise would not qualify for (Gjorgievski et al., 2021).

3. Methods

The researcher has conducted research in several scattered locations and published his work through reputable publications. However, currently, no one has summarized and synthesized the research work to obtain general findings. General findings are important for the exploratory study to investigate the current situation and future challenge that is not defined clearly. Various quantitative and qualitative techniques have been used to understand and organize previous studies (Aria & Cuccurullo, 2017). However, According to Snyder (2019), Literature review techniques are a better way to summarize research and highlight research areas to obtain findings.(Figure 1)

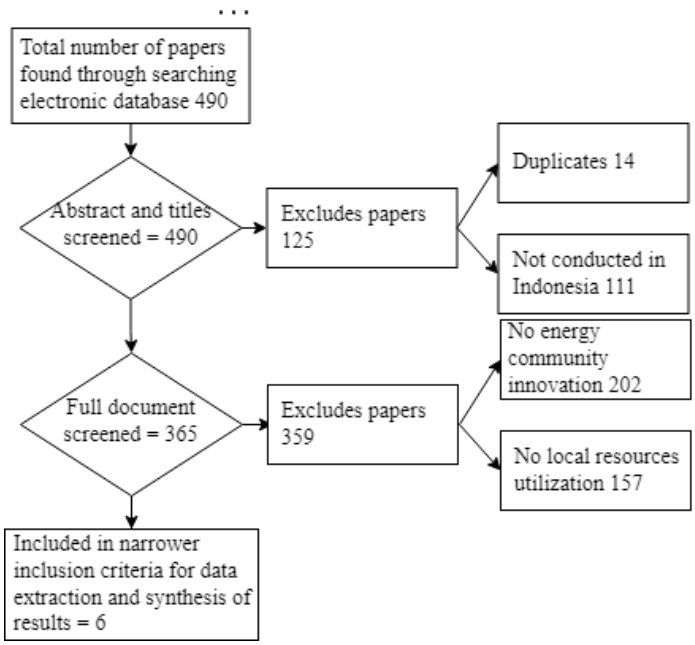

Figure 1 Preferred Reporting Items for Systematic Review and Meta-Analyzes (PRISMA)

This study aims to provide an overview of energy community innovation and utilization of local resources in Indonesia. Through this review, we can map the current situation for the learning process as well as the problem-solving reference. We mapping the keyword strategy TITLE-ABS-KEY (energy AND community AND Indonesia) AND (LIMIT-TO (PUBYEAR, 2002 – 2022) on Report, Paper Indexed by Scopus and SINTA. We found 490 document results and apply inclusion criteria and filter them into four documents. We summarize the papers collected through the keyword technique in the results step. While in the discussion stage, we analyze the adapted Social Sustainability Indicators (SSIs) Energy Framework including (1) Macro Social Performance; (2) External Population; and (3) Internal Human Resources.

© IEOM Society International

We apply inclusion criteria by evaluating all titles and abstracts of the remaining papers. From inclusion criteria, we eliminate 125 excludes papers which duplicate and not conducted in Indonesia. We eliminate 359 excludes papers that do not encompass energy community innovation and local resources utilization. Finally, we obtained 6 papers after applying several inclusion criteria. The final 6 papers obtained were summarized into Microsoft Excel spreadsheet to manage the descriptive statistics. We also use VOSviewer to identify the keyword linkage and co-occurrence.

4. Results

Indonesia has various energy communities at the micro-level, meso-level and macro-level. Several stakeholders are involved in the community who are united in one common interest energy security. From the aspect of the involvement, community energy in Indonesia has different approaches ranging from policy approaches, scientific approaches and community empowerment approaches. The energy community records its activities in various media.

A keyword-based Network Visualization Techniques were performed on initial 490 papers for better understanding related to occurrences and relationships (see Figure 3). A quantitative literature analysis of the initial sample shows a high concentration of keywords related to the energy community model, energy resources, energy utilization, and local factors that influence it.

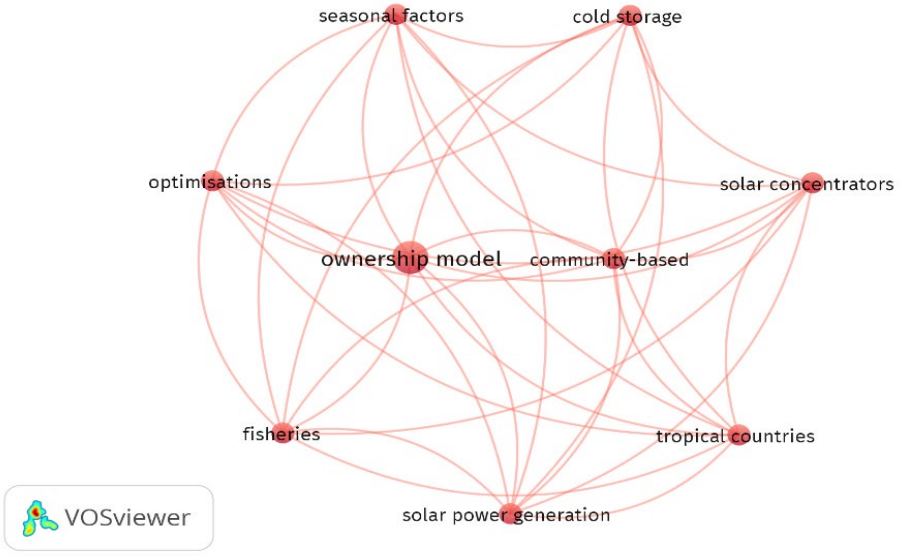

Figure 3 Network Visualization Analysis

Most of the research conducted focuses on solar-powered fishery cold storage. The reasoning is based on the most dominant profession for residents in remote areas. In this study, we limit our review activities to authentic evidence such as responsible research reports and publications. Various research databases Scopus and Google Scholar are useful tools for storing and retrieving information (Khatibi & Montazer, 2012). We collect recorded activities through a research database that belongs to trusted reports and reputable publications. Even though solar energy dominates the keyword occurrence, the use of solar energy is still at the initiation and survey stage. Based on the paper we reviewed, only the Micro-hydroelectric Power Plant, Biogas Dissemination Program, Wind Energy and Biogas Program have successfully formed an energy community model. We have mapped the energy community resource in Table 1. and categorized each energy below.

Table 1. Energy Community Resource Mapping

No	Energy Community	Program	Funding Source	Partnering Agencies
1	Komunitas Energi Pulau Sumba	Micro hydroelectric power plant	Operational funding obtained	Wide range of stakeholders (The Local Community, The State-

© IEOM Society International

			from the community	Owned Electricity Company and Private Sector)
2	Komunitas Energi Ogan Komering Ilir	Biogas Dissemination Program	Government Grant	Government and Private Sector
3	Lentera Bumi	Wind Energy	Self-funded	Private Sector
4	Yayasan Rumah Energi	Biogas Program	Government Grants, Co-financing and Loan Scheme	Government and Private Sector

a. Micro Hydro

Residents of Lukuwingir Village and Waimbidi Village in East Sumba Island, Indonesia utilize energy from the waterfall which produces up to 22 KW/hour of electrical energy to illuminate 135 households (Prilandita, Sagala, Azhari, & Habib, 2022). The management of the micro-hydroelectric power plant (MHPP) in Waimbidi village has not faced any significant financial issues. They have formed a public-private partnership that is accompanied by a wide range of stakeholders (The Local Community, The State Owned Electricity Company and the Private Sector). Funding is obtained from the community as users. However, they are still having problems with maintenance. As consequence, a private energy company in Indonesia helps villages to perform maintenance and technical repairs. There are several factors that affect the sustainability of the program including Community Belonging, Commitment, Ability to Solve the Problem and Access to Resources.

b. Bioenergi

Suheryanto et al. (2012) establish the formation of micro-level energy community in Kabupaten Ogan Komering Ilir, Indonesia. The micro-level energy community was developed through Community Empowerment. The establishment of the micro-level energy community aims the energy independence for the local community. The strategy is carried out by utilizing the local potential such as palm oil waste to be used as bioethanol. Biofuel training is carried out through training obtained from an Energy Company in Indonesia. The formed energy community is able to produce energy independently and disseminate its expertise to the surrounding community. Funding for training and technology dissemination is obtained through grants from the government. However, the program's sustainability strategy is not stated in the report.

Yayasan Rumah Energi (2020) empower livestock and dairy farmer in rural area through biogas technology dissemination. Biogas implementation in the rural area able to reduce fossil fuel and firewood consumption. In the implementation of the program in 2019, around 52% of residents received grants from the government for development. Meanwhile, 36% received a co-funding scheme and 3% financed independently with a credit scheme. To meet the community's need for access to renewable energy through the use of organic waste, the Indonesia Domestic Biogas Program (IDBP) team designed a technological innovation in biogas from polyethylene (PE). This technology is called BioMiRu (Biogas Mini Rumahan / Mini Internal Biogas) offers cheaper construction costs and requires a smaller building area in square meters. By using polyethylene (PE) material, BioMiRu can contain all organic waste, especially food waste. Moreover, BioMiRu is suitable for local communities in need to convert their local waste/household waste into gas and organic fertilizer to support urban agriculture. To improve the quality of BioMiRu, Indonesia Domestic Biogas Program (IDBP) and National Standardization Authority (Badan Standardisasi Nasional / BSN) have carried out a series of studies since the end of 2019 to establish a national standard for (Standar Nasional Indonesia / Indonesian National Standard) (SNI) to be recognized by the end of 2021. There are several factors that affect the sustainability of the program including Community Management and Financial Action Learning for Sustainability, or FALS Methodology.

c. Wind Energy

Based on the ”Lentera Bumi” energy community study, the wind speed in Tasikmalaya ranges from 7-12 m/s. An efficient blade is needed to optimize the energy conversion process. Sari and Laksamana (2019) develop a taperless blade for wind turbines to increase mechanical power. Comparative research conducted by Alfaridzi and Setiawan (2020) applied airfoil NACA to maximize the coefficient lift (Cl) for energy conversion rate. Simulation testing was conducted by Simatupang and Supriatna (2021) to analyze the power and efficiency of testing using Qblade Software.

© IEOM Society International

6. Discussion

Based on the results of our review, program sustainability is an aspect that is mentioned in each literature. To assess the sustainability of an energy program, we adapted the Social Sustainability Indicators (SSIs) Energy Framework from Shiau and Chuen-Yu (2016) namely (1) Macro Social Performance; (2) External Population; and (3) Internal Human Resources.

a. Macro Social Performance

At the initiation stage, Komunitas Energi Ogan Komering Ilir and Rumah Energi Energy Community use funds from donor agencies. Once independent, operational management will be released to the surrounding community like Komunitas Energi Pulau Sumba. In order to aim for a sustainable project, management operation needs to cover self-financing to cover operations and maintenance. Increasing the amount paid by the community is important considering the operational needs of maintenance are quite high. However, a direct increase will certainly burden the surrounding community. One way is to increase the value generation of electricity to become more valuable.

Rahmani, Murayama, and Nishikizawa (2022) offered best practices by assessing the socio-economic impact of existing solar-based water pumping projects that have been conducted by Community Renewable Energy in remote rural areas of Indonesia. Solar-based water pumping projects are able to provide direct benefits to the local community. The study reveals Meso-level community as the main key to project success. The study also suggests that Community Renewable Energy maintain a relationship with existing local power and pays attention to socio-economic inequalities in local communities.

By increasing value, the amount paid collected, the management operation can pay workers, purchase the equipment for maintenance and conduct research to find new energy resources. Based on quantitative research conducted by Pandyaswargo, Wibowo, and Onoda (2022) in Indonesia, summarizing that the main challenge for developing countries is the sustainable use of resources. Resources are important to maintain sustainability.

b. External Population

On the results of the energy community review of Lukuwingir Village and Waimbidi Village in East Sumba Island, Indonesia. Learning the rules and getting to know the leadership structure at a certain location is important. Regulations are important to know what can and cannot be done from the perspective of the local community. Setiyono et al. (2019) and Pambudi et al. (2022) collect feedback from the local community in Indonesia about the perception of Geothermal Power Generation. The responses were analyzed as the basis for the formulation strategy.

Understanding the leadership structure is also important and it is recommended to involve the leader in the management structure. The role of existing leadership becomes a bridge between the internal community and the external energy community itself (Guerreiro & Botetzagias, 2018).

c. Internal Human Resources

Energy conversion technology is a combination of mechanical and electrical, so it requires maintenance. Damage occurs when continuous maintenance is not carried out. Solar PV in West Timor, in Indonesia, is damaged due to environmental conditions such as salinity level, humidity, and extreme temperature in the region (Tanesab, Amheka, Sinaga, Mauta, & Hattu, 2020). This condition causes the energy produced to be inefficient. Rumbayan, Sompie, and Nakanishi (2019) Recommend the need for the transfer of skills and knowledge related to the maintenance and operation of technologies. Novitasari et al. (2019) develop the concept of the Green School Education Model in Rural Area Indonesia to tackle the maintenance problem. In addition to maintenance skills, it is necessary to develop problem-solving skills in the research aspect of potential energy resources and continuous improvement. Bioenergy yields are varies depending on local ecology (Owusu & Asumadu-Sarkodie, 2016). Advanced research is needed to maximize the yields to optimize energy production.

The surrounding community can also learn through access to literacy. This is important as a benchmark between regions. The use of tools and methodologies is also important for the identification of potential energy. Potential mapping techniques of solar irradiation potential were performed by Rumbayan, Sompie, and Nakanishi (2019) using the NASA database through longitude and latitude data. The Preliminary study was conducted on Talaud Island near North Sulawesi Province Indonesia. Through this technique, the average solar energy potential in KWh/m2 /day can be mapped monthly. While, Novitasari, Salis, and Budiarto (2020) generate using GIS Data that can be accessed freely

© IEOM Society International

through Global Solar Atlas (https://globalsolaratlas.info/). Through this data, the irradiation time can be simulated to obtain optimal solar energy.

7. Limitation

More publications are obtained from researchers who review the real work of existing work from the energy community that has made improvements.

8. Conclusion

Indonesia is an archipelago country; the outer island is difficult to transmit electricity through the on-grid. Small islands must be able to supply their own energy needs independently through the off-grid decentralized concept. We followed a literature review methodology aimed at answering a series of questions that helped us understand how the main aspects of the study were addressed to contribute to best practice literature of energy community innovation and local resources utilization in a decentralized off-grid system.

Based on the results of the study, there are four energy communities that have electrical energy fulfillment programs in Indonesia. Electrical energy is fulfilled using micro hydroelectric power plants, biogas dissemination program and wind energy. For further research, it is necessary to add suplementary research on the solar energy community. From our finding, research related to solar energy is still at the survey and initiation stage with the main focus on developing solar-powered fishery cold storage.

Various efforts were made to meet the electricity demand. We found that the selection of the energy program was based on the existing potential in the region. So, it is important to carry out the initial mapping and survey stages before starting the program. For the smooth running of the program, it is necessary to hold deliberations and specifically involve the community and regional leaders. Understanding the leadership structure also important. On the technical aspect, training in operations management and financial management needs to be carried out for program sustainability. Most of the energy communities are grant projects that only cover surveys, initial investment, and operational costs for a limited period of time. Then maintenance and procurement training is also important, thus the energy community can independently solve the technical problem and optimize the energy production.

References

Alfaridzi, M. A. and Setiawan, R., Analisis Performa Bilah Taperless Dengan Airfoil NACA 4412 Pada Horizontal Axis Wind TurbineTSD 500 Di PT Lentera Bumi Nusantara, *Jurnal Teknik Mesin Dan Pembelajaran*, vol. 3, no. 2, pp. 64–73, 2020.

Aria, M. and Cuccurullo, C., Bibliometrix: An R-tool for comprehensive science mapping analysis, *Journal of Informetrics*, vol. 11, no. 4, pp. 959–975, 2017.

Baghta, N. A., Aprilianti, K. P., Aryani, D. R., Jufri, F. H. and Utomo, A. R., Optimization of Battery Energy Storage System (BESS) sizing for solar power plant at remote area. *Proceedings of IOP Conference Series: Earth and Environmental Science*, vol. 599, no. 1, Indonesia, October 8, 2020.

Budiman, I., Enabling Community Participation for Social Innovation in the Energy Sector, *Indonesian Journal of Energy*, *1*(2 SE-Articles), 2018.

Direktorat Jenderal Ketenagalistrikan, Statistik Ketenagalistrikan Tahun 2020. In *Kementerian ESDM* , (Vol. 34), 2019

Energi, Y. R., *Indonesia Domestic Biogas Program Annual Report,* 2020.

Gjorgievski, V. Z., Cundeva, S. and Georghiou, G. E., Social arrangements, technical designs and impacts of energy communities: A review, *Renewable Energy*, vol. 169, pp. 1138–1156, 2021.

Guerreiro, S. and Botetzagias, I., Empowering communities–the role of intermediary organisations in community renewable energy projects in Indonesia, *Local Environment*, vol. 23, no. 2, pp. 158–177, 2018.

Huang, Z., Yu, H., Peng, Z. and Zhao, M., Methods and tools for community energy planning: A review, *Renewable and Sustainable Energy Reviews*, vol. 42, pp. 1335–1348, 2015.

IEA. *Global Energy Review*. Paris. Retrieved from https://www.iea.org/reports/global-energy-review-2021. 2021

Khatibi, V. and Montazer, G. A., E-Research Methodology. In *Collaborative and Distributed E-Research: Innovations in Technologies, Strategies and Applications*, pp. 62–81, 2012

Koirala, B., Hakvoort, R., Oost, E. and Windt, H., *Community Energy Storage: Governance and Business Models*, 2019.

Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A. and Herder, P. M., Energetic communities for community

© IEOM Society International

energy: A review of key issues and trends shaping integrated community energy systems, *Renewable and Sustainable Energy Reviews*, vol. 56, pp. 722–744, 2016.

Lefaan, Y. and Dalimi, R., Electricity Demand Forecasting of Household Sector in Papua Province 2050, *Proceedings of International Conference on Electrical Engineering and Computer Science (ICECOS)*, pp. 291–296. Indonesia, October 2-4, 2018.

Novitasari, D., Hidayat, S., Puruhito, D. D., Arruzi, R. K., Aliyah, F. and Mahfud, A., An Efforts to Maintain the Sustainability of Renewable Energy System in Rural Area through Green School Education Model, *Proceedings of IOP Conference Series: Earth and Environmental Science*, vol. 353, no. 1. France, July 24-26, 2019.

Novitasari, D., Salis, F. R. and Budiarto, R., Challenges in Using Renewable Energy for Islands in Indonesia: A Case Study of Karimunjawa, *Proceedings of the 2020 International Conference and Utility Exhibition on Energy, Environment and Climate Change,* Thailand, October 20-22, 2020.

Owusu, P. A. and Asumadu-Sarkodie, S, A review of renewable energy sources, sustainability issues and climate change mitigation, *Cogent Engineering*, vol. 3, no. 1, 2016.

Pambudi, N. A., Pramudita, V. S., Biddinika, M. K. and Jalilinasrabady, S., So Close Yet so Far - How People in the Vicinity of Potential Sites Respond to Geothermal Energy Power Generation: An Evidence from Indonesia, *Evergreen*, vol. 9, no. 1, pp. 1–9, 2022.

Pandyaswargo, A. H., Wibowo, A. D. and Onoda, H., Socio-techno-economic assessment to design an appropriate renewable energy system for remote agricultural communities in developing countries, *Sustainable Production and Consumption*, vol. 31, pp. 492–511, 2022.

Prilandita, N., Sagala, S., Azhari, D. and Habib, A. H., Rural renewable energy development: Lessons learned from community-based renewable energy business model in East Sumba, Indonesia, *Proceedings of IOP Conference Series: Earth and Environmental Science*, vol. 1015, no. 1, Indonesia, October 20-21, 2021.

Rahmani, S., Murayama, T. and Nishikizawa, S., Review of community renewable energy projects: the driving factors and their continuation in the upscaling process, *Proceedings of IOP Conference Series: Earth and Environmental Science*, vol. 592, Indonesia, October 20-21, 2020.

Rahmani, S., Murayama, T. and Nishikizawa, S., Socio-economic Impact of a Solar Water Pumping System in a Rural Community in Indonesia, *Journal of Sustainable Development of Energy, Water and Environment Systems*, vol. 10, no. 3, 2022.

Rumbayan, M., Sompie, S. and Nakanishi, Y., Empowering remote island communities with renewable energy: A preliminary study of Talaud Island, *Proceedings of IOP Conference Series: Earth and Environmental Science*, vol. 257, no. 1, Japan, January 9-11, 2019.

Sari, N. and Laksamana, W., Perancangan bilah tipe taperless pada kincir angin: Studi kasus di PT. Lentera Bumi Nusantara Tasikmalaya, *Dinamika Teknik Mesin*, vol. 9, no. 2, pp. 104–109, 2019.

Setiawan, E. A., Thalib, H. and Maarif, S.,Techno-economic analysis of solar photovoltaic system for fishery cold storage based on ownership models and regulatory boundaries in indonesia, *Processes*, vol. 9, no. 11, 2021.

Setiyono, B., Setyawan, A., Susanto, H., Punto, E., Abdulrahman, W., Susangkiyono, A. E., … and Delfa, Z., Considering Social Aspects of Geothermal Project: The Case of Social Mapping of Geothermal Project on Mount Ungaran. *E3S Web of Conferences*, vol. 125, Indonesia, August 7-8, 2019.

Shiau, T.-A. and Chuen-Yu, J.-K., Developing an Indicator System for Measuring the Social Sustainability of Offshore Wind Power Farms, *Sustainability* , vol. 8, 2016.

Simatupang, R. and Supriatna, D., Designing a Tapperless Blade with an S-4320 Airfoil on a Micro-Scale Horizontal Axis Wind Turbine (Case Studies at PT Lentera Bumi Nusantara), *MOTIVECTION : Journal of Mechanical, Electrical and Industrial Engineering*, vol. 3, no. 1, pp. 27–34, 2021.

Snyder, H., Literature review as a research methodology: An overview and guidelines, *Journal of Business Research*, vol. 104, pp. 333–339, 2019.

Suheryanto, K., Mara, A., A, M. and A, W., Pemberdayaan Komunitas (Community Empowerment) Petani Kelapa Sawit Ogan Komering Ilir (OKI) Secara Berkelanjutan Melalui Keluarga Mandiri Energi (KME) Berbasis Energi Baru Dan Terbarukan (EBT). *Dharmakarya*, vol. 1, no. 2, 2012.

Syafii, Wati. and Fahreza, R., Techno-economic-enviro optimization analysis of diesel/pv/wind with pumped hydro storage for mentawai island microgrid, *Bulletin of Electrical Engineering and Informatics*, vol. 10. no. 5, pp. 2396–2404, 2021.

Tanesab, J. A., Amheka, A., Sinaga, R., Mauta, J. J. and Hattu, E., A preliminary study of common defects of photovoltaic modules in West Timor, Indonesia. *Procedings of IOP Conference Series: Earth and Environmental Science*, vol. 542, no. 1. Indonesia, October 14-15, 2019.

Thomas, S., Richter, M., Lestari, W., Prabawaningtyas, S., Anggoro, Y. and Kuntoadji, I., Transdisciplinary

© IEOM Society International

research methods in community energy development and governance in Indonesia: Insights for sustainability science, *Energy Research & Social Science*, vol. 45,pp. 184–194, 2018.

UN.ESCAP., *Low carbon green growth roadmap for Asia and the Pacific : turning resource constraints and the climate crisis into economic growth opportunities*. Retrieved from https://hdl.handle.net/20.500.12870/301, 2012.

Van der Schoor, T. and Scholtens, B., Power to the people: Local community initiatives and the transition to sustainable energy, *Renewable and Sustainable Energy Reviews*, vol. 43, pp. 666–675, 2015.

Wahono, J., Djamari, D. W., Nurhadiyanto, A., Batara Surya, B., Rizal, I., Luky, A., … and Murbini, A., Powering The Archipelago: Accelerating Rural Electrification in Indonesia with Community-based Renewable Energy, *ITB Journal Publisher*, vol. 27, pp. 53–65, 2017.

Biographies

Dana Prianjani is a lecture of Department of Industrial Engineering, Universitas Islam Sultan Agung, (UNISSULA). She obtained her Master and Bachelor of Engineering in Industrial Engineering from Universitas Sebelas Maret (UNS). She is also a doctoral student of Industrial and Systems Engineering Department of Institut Teknologi Sepuluh Nopember (ITS). Her research interest are in electricity storage, electric vehicle and renewable energy.

Ardhy Yuliawan Norma Sakti is an early researcher at Research Center for Sustainable Production System and Life Cycle Assessment, Energy and Manufacturing Research Organization, National Research and Innovation Agency, Indonesia. He is involved in several strategic projects in energy and manufacturing. He has completed the project with PT Perkebunan Nusantara Holding, Indonesia Aerospace Industry, PT PINDAD, State Electricity Company (PLN), PT Krakatau Posco, PT Bio Farma, PT Garuda Food Putra Putri Jaya, and PT DAHANA. He obtained his bachelor's degree in Industrial Engineering, from Universitas Sebelas Maret (UNS). Recently, he is currently studying at Sustainable Energy and Resources Engineering, Thammasat University, Thailand.

Wahyudi Sutopo is a professor in industrial engineering and coordinator for the research group of industrial engineering and techno-economy (RG-RITE) of Faculty Engineering, Universitas Sebelas Maret (UNS), Indonesia. He earned his Ph.D. in Industrial Engineering & Management from Institut Teknologi Bandung in 2011. He has done projects with Indonesia endowment fund for education (LPDP), sustainable higher education research alliances (SHERA), MIT-Indonesia research alliance (MIRA), PT Pertamina (Persero), PT Toyota Motor Manufacturing Indonesia, and various other companies. He has published more than 165 articles indexed Scopus, and his research interests include logistics & supply chain management, engineering economy, cost analysis & estimation, and technology commercialization. He is a member of the board of industrial engineering chapter - the institute of Indonesian engineers (BKTI-PII), Indonesian Supply Chain & Logistics Institute (ISLI), Society of Industrial Engineering, and Operations Management (IEOM), and Institute of Industrial & Systems Engineers (IISE).

© IEOM Society International