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Impact of Social Movements on Renewable Energy Policy in Indonesia: Study of Solar Power Plants

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Abstract

Anthropogenic-induced warming has altered the climate of the Earth, causing significant impacts on urban areas such as compromised water supplies and detrimental health effects. This paper employs a case study approach to analyse the causal relationship between energy consumption and social activities. Such an approach is well-suited to unraveling complex cause-and-effect relationships or pathways. System mapping is a method used in case study research to analyse cause-and-effect relationships in complex systems, such as energy systems. The primary literature was searched utilising the reverse snowball technique, with a focus on renewable energy, particularly solar power. Its importance is highlighted in global efforts to reduce dependence on fossil fuels and mitigate the effects of climate change. Indonesia has extensive solar potential and is preparing to utilise solar energy as a clean power source. Nonetheless, effective policy implementation necessitates more than governmental intention; active participation from social movements is required. Two prominent movements - the Solar Electricity Initiative Movement and the Million Solar Roof National Movement - are significant driving forces in this pursuit. The Role of Social Movements in Environmental Policy Transition to Renewable Energy Sources. Social Movements are instrumental in promoting renewable energy policies through public awareness campaigns, advocacy, and concrete actions. They are essential in accelerating policy changes and facilitating a transition towards clean energy. In light of the challenges posed by climate change, the hard work of social movements has become increasingly significant in achieving Indonesia's goal of becoming a sustainable country that does not rely on fossil fuels.

Keywords: Climate Change, Indonesia Energy Potential, Renewable Energy, Social Movements, Solar PV

INTRODUCTION

There is scientific consensus that human activity has caused a change in the Earth's climate. The Intergovernmental Panel on Climate Change (IPCC, 2018) indicates a high probability that temperatures will rise to 1.5◦C above pre-industrial levels between 2030 and 2050 (Tollefson, J. 2018). The United Nations Environment Program (UNEP) predicts that by 2100 temperatures will increase by 3.5◦C. In recent years, there has been a growing recognition of the impacts of climate change worldwide, which has raised concerns about the urgency to limit further warming and adapt to inevitable changes (Neale et al., 2020). Failure to address the factors driving these changes will result in serious and far-reaching impacts for urban areas. The anticipated consequences of climate change include the rise of specific risks such as insecurity of urban water supplies (Te Linde et al., 2012), bushfire risk (Stambaugh et al., 2018), increased intensity and frequency of storm events (Trenberth et al., 2018), and adverse impacts on human health (Watts et al., 2017).

Failing to achieve this target may exacerbate extinction rates (Barnosky et al., 2011) and cause significant suffering (Moser at al., 2020), leading to increased implementation of mitigation and adaptation actions in select areas. The Paris Agreement (United Nations, 2015), signed by 189 parties, aims to limit warming to 1.5◦C by 2100. However, worldwide greenhouse gas (GHG) emissions are not decreasing at the necessary rate to limit warming to 1.5◦C. The decarbonisation and reformation of the energy, transport, and construction sectors are necessary,

but they are improbable to attain under present climate change policies of nations (United Nations Environment Program, 2020; United Nations). Framework Convention on Climate Change (UNFCCC, 2021). Many climate change actions have been taken, but they have fallen short. Some reasons for this include the limited scope of action, sector-specific focus, and narrow emphasis on either adaptation or mitigation (Reckien et al., 2018; United).

(Nations Framework Convention on Climate Change, 2021). As the severity of climate change is already set in motion, merely focusing on mitigation without adaptation would result in significant harm to both the natural and human ecosystems. As the severity of climate change is already set in motion, merely focusing on mitigation without adaptation would result in significant harm to both the natural and human ecosystems. Similarly, a reliance on adaptation solely is unsustainable; given that climate continues to vary, adaptation endeavours should continuously adapt to new environmental benchmarks. The integration of climate change is necessary in response to the existential threat posed by climate change.

In response, solar power plants (PLTS) are an option worth considering. While many of the components and devices used to convert the sun's rays into electrical energy (photovoltaic modules) have been manufactured, the cost of solar power plants is higher than that of conventional power plants (Zhang et al., 2020), Mini-grid solar panels are often used in homes and are sometimes referred to as Solar Home Systems (SHS), although they are not the best option. Because solar energy does not produce pollutants, it is less environmentally hazardous than fossil fuel plants (Maggi et al., 2020). The development and utilisation of solar energy in the future is crucial to achieving energy sustainability and reducing the negative impacts of climate change.

Renewable energy has become an important pillar in global efforts to mitigate the negative impacts of climate change and reduce dependence on fossil energy resources (Bustamante et al., 2019). Indonesia, as one of the countries with abundant solar potential throughout the year, has a great opportunity to adopt and utilise solar energy as a clean energy source (Islami, M.S., Urmee, T., & Kumara, I.N.S., 2021). However, the implementation of policies that support renewable energy, particularly solar power generation, requires more than just good intentions from the government. Social movements play an important role in driving positive policy change.

RESEARCH METHODS

In analysing the causal relationships of energy projects with social activities this paper follows a case study approach, which is suitable for analysing complex causal relationships or pathways (Temper., et al 2020; S. Crowe., et al 2011). In case study research, system mapping is one of various related methods for analysing causal relationships in complex systems, including energy systems (Barbrook-Johnson, P., & Penn, A., 2021).

Figure 1. presents an outline of the literature review. Primary literature was searched using the reverse snowball technique and limited to a maximum of two repetitions. Studies were excluded if their main message could not be clearly reconstructed from the publications reviewed. If a study was eliminated during the abstract scan, it was still read in full if it contributed to the storyline of this paper.

Thus, the following section is based on 38 studies extracted from Figure 1. Of these studies, four studies were sourced from the Ministry of Energy and Mineral Resources (ESDM), five studies from industry, and 29 studies from academic literature. Of the 38 studies, 22 studies concentrated solely on the national level, six studies focused on the global level, while five studies pertained to the provincial, inter-provincial, and regional levels, respectively. In terms

of technology, seven studies each focused on a combination of RE and solar PV, while another six centred on biomass. Five studies each were dedicated to wave energy and tidal currents, while only two studies were conducted on hydropower, OTEC, offshore wind and geothermal. Of all the studies, 34 were conducted in English and only four were conducted in Bahasa Indonesia. Figure 1 illustrates that 182 studies were removed because they were secondary literature or had too narrow a regional scope. The exclusion of local case studies is due to the potential lack of scalability, especially for locally sensitive technologies such as wind power. However, it is recognised that local research on renewable energy technologies is essential and should not be ignored, as decentralised RE can be a stepping stone towards community empowerment and socio-economic development at the local level (Chaurey, A., Ranganathan, N., & Mohanty, P., 2004).

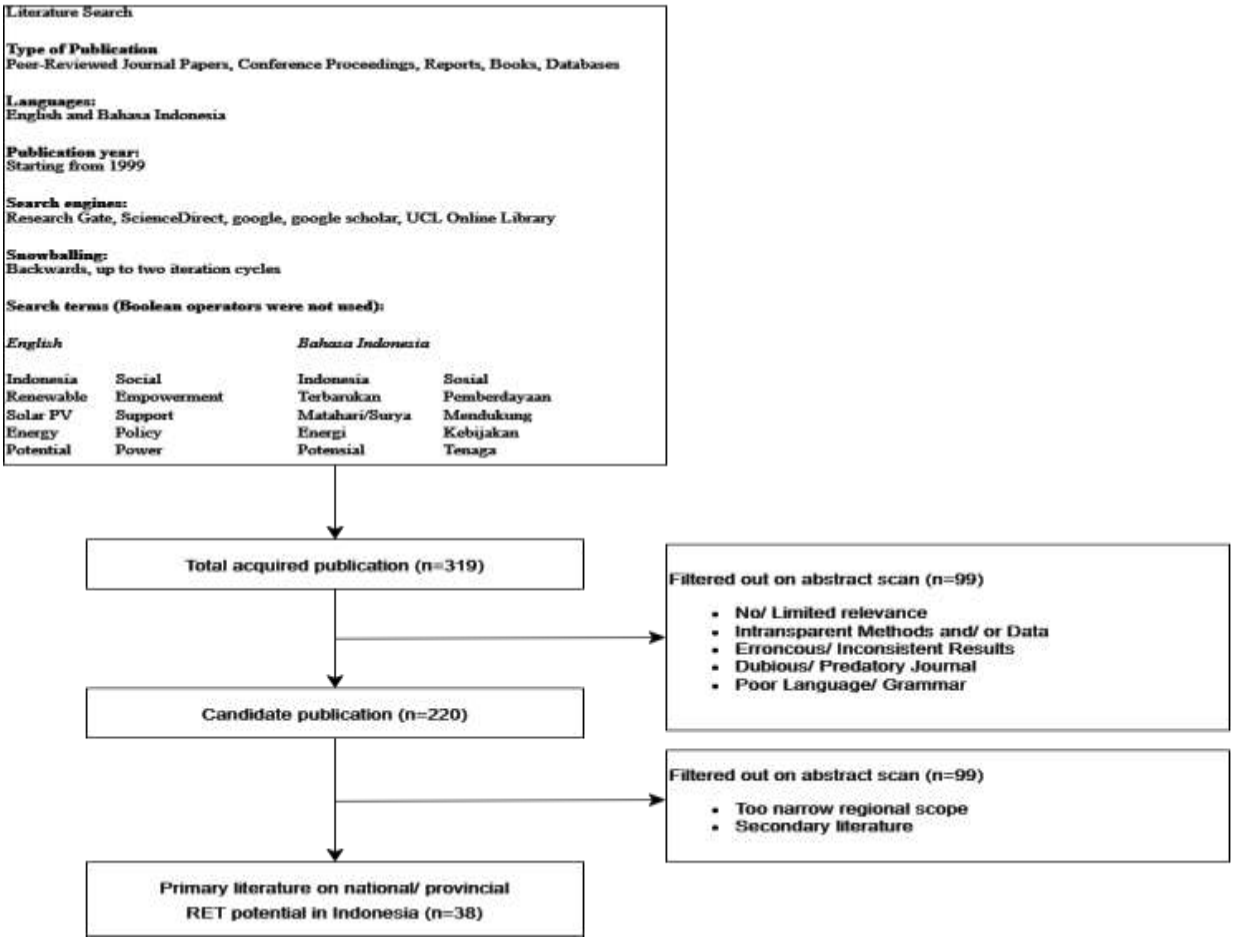

Figure 1. Methods used for the systematic literature review on RET potential in Indonesia.

The nine technologies reviewed include geothermal, large and small hydropower, biomass, solar photovoltaic cells, wind power, tidal power, wave energy. Various definitions have been used to study the potential of these technologies as shown in Table 1. To ensure consistency, this study adopts definitions sourced from academic and industry literature, which provide greater detail than the ESDM definitions. The technical and practical potential of ESDM has been summarised as technical potential, with acceptable potential as practical potential. Ministerial potential in Energy 2021, 14, 7033, section 3 of 21 has been adjusted where necessary for comparison purposes. The theoretical potential and economic potential of ESDM are assumed to remain unchanged. Values obtained from the Global Energy Resource Database by Royal Dutch Shell are based on estimates of technically feasible potential that have been realistically

constrained. This article recognises the existence of technical and non-technical limitations (Deng et al., 2015). Therefore, this paper categorises the potential benefits listed in the database as practical potentials.

Table 1. Different definitions of potentials found in literature

	Academic and Industrial Literature (Terminology Used in This Study)	Reports by ESDM
Theoretical Potential	Potential restricted by physical limits (e.g., Carnot efficiency for Solar PV, etc.)	Potential based on field data via a modelling system
Technical Potential	Potential restricted by technical limits (e.g., geo- and oceanographic restrictions, electrical and mechanical, etc)	Identified potential that can be implemented at a certain location based on long-term data
Practical Potential	Potential restricted by non-technical limits (e.g., protection zones and tourist areas)	Identified potential that can be implemented at a certain location based on long-term data
Acceptable Potential	-	Potential that considers demand, infrastructure, and communal approval
Economic Potential	Potential with unit costs equal to or lower than benchmark (e.g., wholsale electricity price)	Potential that can be actually utilized

In this paper, we present the potential identified in the literature in its original physical units, which are then converted to GWe for comparison purposes. If energy units are used, we convert the potential to GWe by using the average generation efficiency (electricity output divided by primary energy input) and capacity factor (electricity generated divided by theoretical maximum). The installed capacity and annual operating hours (8760 hours) of power plants in Indonesia were sourced from statistical data provided by ESDM. This literature review exclusively focuses on renewable energy (RE) technologies for electricity production, excluding other applications such as heating, cooling, and transportation.

The current status of technologies and power generation is not assessed as there are already existing works as indicated in the respective sub-sections. The assessment of energy statistics is limited to the context of Renewable Energy Technologies (RETs) as the overall data for Indonesia's entire energy system has only recently been discussed (Burke et al., 2019; Maulidia et al., 2019).

RESULT AND DISCUSSION

The Role of Social Movements in Environmental Policy

Conceptually, (Simon, B., & Klandermans, B. 2001) defines the environmental social movement as a triangulation of social and political movements that aim to preserve and improve the natural environment through public education, advocacy for better lifestyle choices, improved community planning, increased financial investment, and government regulation. The environmental movement actually encompasses and includes many different and sometimes separate organisations, ranging from financially powerful organisations at the national and international level to thousands of voluntary environmental organisations operating at the

grassroots level and even including individuals fighting only at the local level. So it can be said that, initially, concern for the preservation of the natural environment was the main driving force that gave birth to the environmental movement.

Concern for the preservation of nature and awareness of the dangers of natural destruction that threaten human life were first raised by Malthus in the XVIII century. Then Gidden who said that among the global dangers that could threaten human existence on earth are 'ecological calamity and uncontainable population explosion' (Yearley, 1999). As a result of industrialisation and the mechanisation of transportation, the first problem captured by environmental activists was the problem of pollution that occurred especially in the 1950s, 1960s and 1970s. Various environmental movements emerged to protect air and water from pollution. Subsequently, environmental activists did not only limit themselves to the environment, but also other unique things such as unique wild plants and animals, protection of rare creatures. This movement has been quite fruitful in the US with the passage of the Clean Water Act, the Clean Air Act, the Endangered Species Act, the National Environmental Policy Act, etc., laying the foundation for the creation of environmental standards. In addition, these developments have also raised new awareness about various environmental changes that are very worrying for humanity such as ozone depletion, climate change, and biogenetic pollution (Langhelle, 1999).

Indonesia's Energy in Transition to Renewable Energy Sources

The electricity sector plays a key role in reducing greenhouse gas emissions from the energy sector in Indonesia. Data shows that power generation, mainly using coal, is expected to be the main source of emissions in the energy sector by 2021. More than 4,600 MW of new coal-fired power plants will come online by the end of 2022. However, the environmental impact of these new power plants is a serious concern, as they are expected to generate at least 27-32 million tonnes of CO2-eq (CO2 equivalent) per year over their lifetime.

In-depth studies on decarbonisation show that emissions from the energy sector will peak in 2025 if Indonesia adheres to the commitments laid out in the Paris Agreement. To achieve this target, greater efforts need to be made to reduce emissions from power generation.

It is important to find more efficient solutions to reduce emissions from power generation. For example, Supercritical power plants (SC) produce about 8% less emissions than subcritical coal plants. Although there are more advanced technologies such as ultra-supercritical CFPP (AUSC) that are considered "most efficient", they still produce much higher emissions compared to gas-fired power plants, with emissions reductions of only about 16.5% compared to subcritical power plants. Therefore, phasing out old and inefficient power plants may be a more effective measure.

Climate change mitigation efforts in the energy sector rely heavily on the success of the country's renewable energy and energy efficiency programmes. Both programmes contribute significantly to reducing emissions. Renewable energy and energy efficiency programmes contributed about 53% and 20% of the total 64.36 million tonnes of emissions reduced by CO2 equivalent in 2020. Therefore, developing more programmes like this might be one of the keys in reducing greenhouse gas emissions in Indonesia's power sector.

Social Movements in Support of Renewable Energy Policy

In the Indonesian environment, social movements play a pivotal part in driving the development and relinquishment of renewable energy. There's a growing trend towards espousing aneco-friendly life across Indonesia. People are decreasingly apprehensive of the impact of global warming. For illustration, there's growing interest in installing solar panels for ménage power generation. There are two social movements that play an important part in the trouble to increase the utilisation of solar energy in Indonesia. The first is the Solar Electricity Initiative Movement, which aims to engage the youngish generation in the part of clean energy activists and accelerate the relinquishment of renewable energy, particularly solar energy. The

alternate movement is the One Million Rooftop Solar Electricity National Movement, which promotes the installation of solar panels on rooftops as a step to increase access to sustainable electricity. On 13 September 2017, the protestation of the" One Million Solar Rooftop National Movement" was made and ratified.

The intention of this National Movement is to support the National Energy Policy, which is to achieve 23 use of new and renewable energy by 2025. The protestation was attended and inked by representatives of the Directorate General of Renewable Energy and Energy Conservation of the Ministry of Energy and Mineral coffers (EBTKE KESDM), the Ministry of Industry, the Agency for the Assessment and Application of Technology (B2TKE BPPT), the Indonesian Renewable Energy Society (METI), the Indonesian Photovoltaic Industry Independence Consortium, the Indonesian Solar Energy Association (AESI), the Indonesian Solar Module Manufacturers Association (APAMSI), and the Association of Rooftop Solar Electricity druggies (PPLSA), among others. The explanation for this movement is that there are 30 million ménage guests in Java, of which1/3 are middle to upper class homes, or 10 millionhomes.However, this would be 4, 000 MWp, If 10 million homes installed a 4 KW solar power factory on eachroof.

However, this is still 1 Gigawatt, If only ¼ of them. 1 Gigawatt on the islet of Java won't have a big effect on the electricity system, because the use of electricity during the day is formerly above 10,000MW.However, rooftop solar power shops could be a pillar in reaching 5000 MWp, If given the right programs and stimulants. This would be a huge eventuality. With this high request eventuality, the development of the PV assiduity in Indonesia will be a necessity. The objects of the One Million Rooftop Solar Electricity National Movement are

1. Encourage and accelerate the development of rooftop solar photovoltaic power shops in casing, public installations, government services, marketable structures, and artificial complexes, to reach the order of gigawatts before 2020;
2. Encourage the growth of a public assiduity of photovoltaic systems that's competitive and creates green jobs;
3. Encourage the provision of dependable, sustainable and competitive electricity;
4. Encourage and mobilise community participation to reduce hothouse gas emigrations and the trouble of climate change, and support the perpetration of Indonesia's commitment to the Paris Agreement and sweats to achieve the Sustainable Development Goals (SDGs).
5. In the 3 times since GNSSA was launched, the number of PLN guests using rooftop solar power has increased from 268 in 2017 to further than 2,300 bymid-2020, with a total capacity of11.5 MW.

Another social movement programme that has surfaced to help transition from fossil energies to more environmentally friendly energy is the Solar Electricity Initiative Movement (GERILYA). The Ministry of Energy and Mineral coffers (ESDM) together with Society Renewable Energy (SRE) invites the youngish generation to come clean energy activists in order to accelerate the utilisation of New Renewable Energy (EBT), especially solar energy. This movement invites the youngish generation to take part and be active in taking a part in the transition to the use of renewable energy, especially solar energy. The thing of the Solar Electricity Initiative Movement Programme is the development of indispensable energy through massive rooftop solar power shops. Socially, the thing of the Solar Electricity Initiative Movement programme is to train acceptable mortal coffers (HR) who can understand how to apply volition energy technology in the country. In addition, the Solar Electricity Initiative Movement programme is also a form of collaboration to encourage the achievement of

Indonesia's net zero emigration target, and in this case, the participation of youthful people as the nation's successor acts as the main actor.

A study of social movement programmes in Indonesia that concentrate on solar power generation, videlicet the Solar Electricity Initiative Movement (GERILYA) and the National Movement for One Million Rooftop Solar Electricity, reveals the significant impact of the part of social movements in driving change towards clean and sustainable energy. These two programmes are clear substantiation that collaborative action and community advocacy can be a driving force in energy policy change and raising mindfulness of the significance of renewable energy. The Solar Electricity Initiative Movement (GERILYA) is an trouble that aims to get the youngish generation laboriously involved in sustainability conduct, especially in the use of solar energy. By involving the youngish generation as agents of change, GERILYA has succeeded in creating mindfulness about the significance of renewable energy and encouraging community participation in the transition to clean energy.

The impact isn't only felt at the mindfulness position, but also in changing public views and supporting programs for the use of solar energy. Meanwhile, the National Movement for One Million Rooftop Solar Electricity emphasised the significance of installing solar panels on rooftops as a step towards sustainable energy access. The movement successfully mobilised communities to take concrete action by installing solar systems on their homes. In this process, communities come part of the result in reducing dependence on conventional energy sources. The programme also demonstrated how community participation can significantly contribute to the achievement of renewable energy targets in Indonesia. The impact of these two movements also extends to impacting renewable energy policy. Through collaborative action and strong advocacy, social movements have successfully told communities and companies to support programs that promote the use of solar energy.

In the environment of this study, social movements fastening on solar power generation end to produce public mindfulness about the significance of renewable energy, mobilise public participation in the transition to clean energy, and support programs for solar energy utilisation. These social movements come agents of change in the trouble to achieve renewable energy pretensions in Indonesia. Through combined sweats and strong advocacy, social movements have successfully told governments, companies, and communities to support the use of solar energy. They've also stressed the negative impacts of conventional energy sources and encouraged the use of more effective and environmentally friendly technologies. In this way, the social movement on solar power generation has had a significant impact in supporting programs and the shift towards clean energy in Indonesia. The government has actually designated the energy generation assiduity as a precedence assiduity, this is stated in the National Industrial Development Master Plan (RIPIN) 2016- 2035 which is the elaboration of Law no.3/2014 on Assiduity. The development of the Photovoltaic assiduity in Indonesia has been the focus of the Ministry of Industry. The presence of these two programmes has been part of the donation to help optimise the use of rooftop solar power shops (PLTS) in the community and achieve the target of 23 renewable energy blend by 2025. The perpetration of the Gerilya and GNSSA programmes is one part of the process towards a clean energy transition where the eventuality of PLTS has a great occasion to be enforced.

The Gerilya and GNSSA programmes seek an energy transition towards the use of cleaner energy. presently, 86 per cent of electricity comes from fossil energies, which will one day run out. With the energy transition, it's anticipated that the quality of public energy security and independence will increase, no longer dependent on reactionary energy. Indonesia has renewable energy sources, and they're abundant, especially solar energy. This means that if we want to transition from reactionary tonon-fossil, the source is formerly there. The alternate issue is the global pressure that presently climate change and rainfall are delicate to prognosticate,

indeed in tropical countries like Indonesia. This is because of global warming, due to the large quantum of GHGs that rise and also make the earth's temperature rise, not only the ocean position rises, but the rainfall is also changeable, and it has been felt.

These movements are in line with the Government of Indonesia's commitment to pursue an energy transition by reducing hothouse gas (GHG) emigrations in agreement with the Nationally Determined donation (NDC) by 29 by 2030 with its own capabilities or 41 with transnational backing. Social movements that watch about the terrain have a significant positive impact in driving the relinquishment of renewable energy, particularly in the solar power sector in Indonesia. Through public mindfulness, advocacy and concrete conduct, social movements have been necessary in accelerating policy change and the shift towards clean energy. As the challenges of climate change escalate, the hard work of social movements becomes indeed more applicable in realising Indonesia as a sustainable and unborn- looking country in terms of energy.

CONCLUSION

The electricity sector plays an important part in reducing hothouse gas emigrations from the energy sector in Indonesia. The success of renewable energy and energy effectiveness programmes in Indonesia is pivotal in mollifying climate change in the energy sector. Social Movements to Support Renewable Energy programs. In the Indonesian environment, social movements have an important part in promoting the development and perpetration of renewable energy programs. One illustration is the Solar Electricity Initiative Movement. This movement aims to encourage the youngish generation to come clean energy lawyers and accelerate the relinquishment of renewable energy, particularly solar energy.

The One Million Solar Rooftops National Movement advocates the installation of solar panels on rooftops to increase access to sustainable electricity. The end is to support the National Energy Policy, which aims to achieve a 23 increase in the use of new and renewable energy by 2025. In addition, the Solar Electricity Initiative Movement has also surfaced as another programme that supports this transition. The Ministry of Energy and Mineral coffers and the Society for Renewable Energy are calling on the youngish generation to come clean energy lawyers to accelerate the relinquishment of New Renewable Energy, particularly solar energy. This means encouraging youthful people to share and play an active part in the transition to renewable energy, especially solar energy. The thing of the Solar Electricity Initiative Movement Programme is to develop essential energy through rooftop solar installations. A study of social movement programmes in Indonesia that prioritise solar power generation, specifically the Solar Electricity Initiative Movement (GERILYA) and the National Movement for One Million Solar Roofs, highlights the significant impact of social movements in driving the relinquishment of clean and sustainable energy. Meanwhile, the National Movement for One Million Solar Roofs emphasises the significance of rooftop solar panel installations to promote sustainable energy access.

In the environment of this exploration, social movements centred on solar power generation end to raise public mindfulness of the significance of renewable energy, encourage community involvement in the transition to clean energy, and support programmes that promote the use of solar energy. As a result, solar social movements have had a significant impact in supporting programmes and the shift towards clean energy in Indonesia. Indonesia has abundant renewable energy sources, especially solar energy. Social movements that concentrate on environmental issues play an important part in promoting the use of renewable energy, especially in the solar power sector in Indonesia.

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