

Research Article

Empowering Through Energy: A Renewable Energy-Based Model of Community Empowerment in Agrarian Villages of Aceh Tamiang

Rahmad Purnama*, Zulfahmi, Firmansyah, Rini Febrianti, Maya Maria, Heriani

Faculty of Economics and Business, Universitas Terbuka, Tangerang Selatan, Indonesia, 15417

*Corresponding Author: rahmad.purnama@ecampus.ut.ac.id | Phone: +6282210123483

ABSTRACT

Inequality in access to renewable energy presents a significant challenge to achieving sustainable development in agrarian villages throughout Indonesia. This research investigates the dynamics of community empowerment in the uptake of renewable energy within rural agricultural contexts, specifically focusing on Aceh Tamiang Regency. Utilizing a grounded theory methodology, the study operates within the framework of critical constructivism, positing that energy is not solely a technological instrument, but a socio-cultural construct influenced by local knowledge, governance, and collaborative institutional frameworks. The research methodology encompasses a range of qualitative approaches, including in-depth interviews, focus group discussions, participatory observations, and document analysis, engaging various stakeholders such as farmers, village officials, extension workers, and institutions. The analysis employed open coding, axial coding, and selective coding techniques, resulting in a conceptual model reflecting three interconnected pillars: (1) energy literacy and community empowerment, (2) adaptive village governance aligned with the Sustainable Development Goals (SDGs), and (3) multi-stakeholder institutional synergy. Key findings indicate that the effectiveness of renewable energy initiatives hinges not only on technological advancements and financial resources but also on essential collective values such as cooperation, social learning, and trust within the community. In extending Zimmerman's empowerment framework, this study incorporates local cultural dimensions, enriching Geels' socio-technical systems theory by emphasizing moral and spiritual influences and enhancing Rhodes' network governance theory through the integration of trust and social capital. This research contributes to the discourse on energy transition by offering a bottom-up, socially grounded theoretical model that reconceptualizes renewable energy as both a catalyst for rural empowerment and a mechanism for socio-institutional transformation. It highlights that the path towards sustainable energy development in rural areas necessitates a harmonious interplay of community engagement, inclusive governance, and cooperative institutions. Consequently, energy emerges not merely as an economic asset but as a vital social force promoting justice, dignity, and resilience in agrarian lifestyles.

Keywords: Renewable Energy Access; Community Empowerment; Sustainable Development; Agrarian Villages; Multi-Stakeholder Governance

1. INTRODUCTION

Inequality of access to renewable energy in Indonesia's agricultural villages is still a fundamental challenge in efforts to realize sustainable and equitable development. Most rural areas, especially those whose economic base rests on the agricultural sector, are still heavily reliant on fossil energy sources such as kerosene, gasoline, and diesel to power agricultural equipment and lighting (Sumarsono et al., 2018). This condition shows a structural gap in the distribution of energy technology and knowledge (Marianti et al., 2023). Villages as the base of national food production are ironically still the weakest entities in the clean energy access chain. This inequality reflects not only technical problems, but also complex social and institutional problems. When people's energy literacy is low, resistance to new innovations becomes high, and participation in the adoption of renewable technologies is slow (Hermawati & Rosaira, 2017). In fact, the potential of solar, biogas, and biomass energy in rural areas is huge and can be used to support more efficient, productive, and environmentally friendly agriculture (Nugraha et al., 2021).

In addition to technical and infrastructure issues, low energy literacy and lack of participation of farmers in the adoption of clean technology show that energy problems in rural areas are social problems related to knowledge structures and governance (Pratiwi & Juerges, 2022). Many farmers do not yet understand how renewable energy can help their activities, while village officials often do not have the technical capacity and policies to support them. The asynchrony between village

policies, extension institutions, and external support from universities or the private sector adds to the complexity of this problem (Meslin, 2019). On the other hand, the social capital of rural communities such as mutual cooperation, deliberation, and collective trust is a strength that can be a strong foundation for the acceptance and management of renewable energy if processed appropriately (Wahono et al., 2021). The complexity of the relationship between village policies, social capital, and institutional actors is an important entry point in understanding how renewable energy an instrument of community empowerment can be as well as a means of socio-economic transformation in rural areas (Wirawan & Gultom, 2021).

Based on this background, this study seeks to answer two main questions: how the process of community empowerment in the use of renewable energy takes place in agrarian villages, and what factors are obstacles and reinforcements in creating renewable energy synergy at the village level. This question arises from the desire to understand that energy is not only a technological issue, but also a social phenomenon that is tied to cultural contexts, economic structures, and local governance (Blum et al., 2013). Understanding the social processes behind the application of renewable energy is important to avoid the pitfalls of top-down and short-term projects. Thus, the focus of this research is not only on the result, but also on the dynamics of the process, the interaction between actors, and the formation of collective meaning within it.

The main purpose of this study is to explain the pattern of empowerment of village communities in the use of renewable energy and formulate a conceptual model based on a grounded theory approach. Through this approach, the research seeks to build a substantive theory from the bottom up based on the empirical experience of society (Kimani, 2018). In this way, the resulting theories are not only descriptive, but also reflective of local and contextual values that live in the community. In addition, this research also aims to map the interaction between social, institutional, and policy dimensions in the context of village energy to produce a more adaptive and sustainable synergy model (Giwangkara & Campen, 2018).

Theoretically, this research is expected to contribute to the development of energy-based empowerment theories in rural areas. So far, empowerment theories tend to focus on social and economic aspects without looking at the strategic role of energy as the main lever for social transformation (Rachmawatie et al., 2020). By placing renewable energy as a medium of empowerment, this study seeks to expand the horizons of local resource-based development theory (Trapsila, 2018a). Practically, the results of this research are expected to provide policy direction and collaborative strategies for village governments, agricultural extension workers, CSR institutions, and universities in strengthening community capacity (Hermawati & Rosaira, 2017). This research also has the potential to be the basis for the formulation of village-based energy policies that are more contextual and in favor of the needs of small communities. Furthermore, this research opens up space for an equal partnership model between villages and external actors through knowledge transfer, technology, and institutional capacity building (Meslin, 2019).

The benefits of this research can be felt from various sides. For the village community, the results of this research are expected to increase awareness of the importance of renewable energy and foster collective initiatives in the management of local energy resources (Wahono et al., 2021). For local governments and policy-making institutions, this research can be a reference in designing more participatory and empirical data-based programs. For the academic world, this research enriches the literature on sustainable development by presenting a new perspective that combines social, energy, and institutional dimensions (Sumarsono et al., 2018). As for private institutions and CSR partners, the findings of this study provide an overview of patterns of effective and ethical collaboration with local communities in supporting a sustainable clean energy transition (Kimani, 2018).

Conceptually, this research also departs from the awareness that there is still a gap in the study of renewable energy in Indonesia. Most previous research has been technocratic in nature and highlighted aspects of technological efficiency or economic viability, while its social and cultural dimensions tend to be overlooked (Ratriyana et al., 2021). The lack of a qualitative approach that explores the meaning, interaction, and social construction behind renewable energy practices has created a significant knowledge gap (Hermawati et al., 2023). Therefore, this study seeks to fill this gap by exploring how renewable energy is understood, adopted, and interpreted by rural communities. The grounded theory approach is used to capture social realities in depth and find patterns of relationships that form a synergy process between communities, village governments, and supporting institutions. Thus, this study contributes not only to the development of theories, but also to the formation of a new paradigm in seeing energy as an integral part of the ever-evolving social dynamics of rural areas (Agusta, 2009a).

2. RESEARCH METHOD

This research is based on a critical constructivism paradigm that places social reality not as a fixed and singular entity, but as the result of a dynamic social construction. In this paradigm, reality is considered to be born from the process of social interaction, conversation, and negotiation of meaning between the individual and his environment (Agusta, 2009b). This view departs from the belief that each social actor has his own experience and interpretation of the phenomena they face, so that knowledge is not neutral or completely objective, but is built through a reciprocal relationship between researchers and participants. Epistemologically, this research is dialogical and reflective; The researcher does not stand as an observer far from reality, but rather as a reflective partner who engages in a process with participants to understand the context, experience, and meaning inherent in the practice of utilizing renewable energy in rural areas (Ratriyana et al., 2021). From

an ontological perspective, this research is based on the belief that reality is plural and contextual, meaning that the understanding of renewable energy, community empowerment, and village governance is always shaped by different social, cultural, economic, and political situations in each community (Hermawati et al., 2023).

The approach used is qualitative exploration with a grounded theory design developed by Strauss and Corbin. This approach was chosen because it is in line with the research objective of finding substantive theories that depart from empirical data, not just test existing theories (Rachmawatie et al., 2020). Grounded theory provides a space for researchers to dive into the meaning, process, and relationships between actors in a real context, so that the resulting theory really grows from the roots of people's social experiences (Hermawati & Rosaira, 2017). The research process is conducted in an open and reflective manner, where data is collected, coded, and analyzed continuously to find the strong conceptual relationships behind social phenomena. Through this approach, the research seeks to formulate a pattern of synergy between community empowerment, village governance, and institutions in the use of renewable energy that is relevant to real conditions on the ground.

This research was conducted in several agricultural villages in Aceh Tamiang Regency, an area that has great renewable energy potential while facing serious challenges in terms of its utilization. The selection of this location is based on the consideration that Aceh Tamiang is a representation of agrarian villages in Indonesia that are striving to transform towards sustainable development (Sumarsono et al., 2018). The research participants included various actors who are directly and indirectly involved in village energy initiatives, such as farmers who are the main users of energy, women involved in biogas activities and organic fertilizer processing, village officials who play a role in policy and governance, agricultural extension workers who function as agents of social change, as well as representatives of CSR institutions and universities who contribute to technology transfer and training (Trapsila, 2018b). The diversity of participants is expected to be able to present a multi-stakeholder perspective that enriches the analysis process (Wahono et al., 2021).

Data was collected through several complementary techniques and were carried out in a triangulative manner. Semi-structured in-depth interviews were used to explore participants' experiences and perceptions of renewable energy utilization practices and their impact on their social and economic lives (Halimatussadiah et al., 2024). The Focus Group Discussion (FGD) was conducted by involving various actors in one forum to understand the dynamics of collaboration, conflicts of interest, and potential synergies between actors in the context of village energy (Gregory & Yudarwati, 2024). Participatory observation is carried out to capture social interactions and people's daily behaviors that cannot always be expressed through interviews (Utami et al., 2022). In addition, the researcher also examined important documents such as the Village Medium-Term Development Plan (RPJMDes), Village Regulations (Perdes) on energy, and reports on the activities of CSR partners and universities involved in renewable energy programs. The incorporation of these various data sources allows researchers to gain an in-depth, comprehensive, and contextual understanding (Izad & Saadi, 2024).

The data analysis process follows the classic stages of grounded theory which starts with open coding, where raw data from interviews and observations are broken down into smaller units of meaning and categorized based on the initial theme (Khumairoh & Nukyanto, 2024). The next stage is axial coding, where the categories are linked to each other to find conceptual relationships that explain phenomena more systematically. The final stage is selective coding, in which the main themes are synthesized into core categories that represent the overall structure of the substantive theory. From this process, a conceptual model was born that describes the relationship between energy literacy, village governance, and institutional collaboration as the core of synergy towards sustainable agriculture based on renewable energy. The development of this model is iterative, where each stage of analysis is linked back to empirical data to ensure the validity and depth of interpretation (Noordin et al., 2024).

The validity of the research is maintained through a combination of source triangulation, method triangulation, and member-checking. Source triangulation was carried out by comparing information from different participants with different backgrounds to see consistency and variation of views (Puspita et al., 2023). The triangulation method is carried out by combining interviews, observations, and document analysis to ensure that the research results are not biased by one particular type of data. The member-checking process is carried out by involving participants again to verify the results of the researcher's interpretation so that it remains in accordance with the meaning they understand. Meanwhile, the validity of the research process is guaranteed through a trail audit that records all stages of analysis in a transparent and systematic manner. In the ethical aspect, this study upholds the principles of voluntary participation, anonymity, and data confidentiality. Each informant is given complete freedom to express their views without pressure, and all identities are disguised to maintain privacy. Thus, this research is not only methodologically valid, but also morally and ethically and socially (Sa'diyah et al., 2017).

The philosophical approach used in this study is not just a methodological choice, but a reflection of the view that social knowledge should be constructed through a dialogue between empirical experience and reflective consciousness. By understanding renewable energy as a meaningful social construction, this research places the village community as a subject that has agency, not as an object of development (Rana, 2019). The interaction process between researchers and participants becomes a forum for the birth of a common understanding of the meaning of energy in social life, as well as the basis for the formation of substantive theories based on local values and real practices in the field. Thus, this methodology not only

produces empirical findings, but also presents philosophical reflections that affirm that sustainable development is actually a humanitarian process rooted in knowledge, participation, and social awareness.

3. RESULTS AND DISCUSSION

3.1 Results

This study found that the process of using renewable energy in the agricultural area of Aceh Tamiang is the result of interrelated social, institutional, and policy interactions. Based on the results of interviews with agricultural extension workers (informant codes P1–P3), farmers (T1–T5), and village officials (D1–D3), it is understood that renewable energy is not only seen as a technology, but as part of a social system that includes the value of mutual cooperation, social learning, and collaboration between sectors. These empirical findings are processed through three stages of grounded theory analysis: open coding, axial coding, and selective coding, which then produce a substantive grand theory.

3.1.1 Open Coding

At the open coding stage, there are 15 main categories that describe the reality of society in interpreting and adopting renewable energy. T1 and T2 informants explained that the community "does not fully understand how solar panels work and benefits," and some even consider it "only for villages that have a lot of funds." This shows low energy literacy. Meanwhile, P1 revealed that "there are still many farmers who do not believe in the effectiveness of biogas," due to the limitations of tools and technical assistance. Capital barriers and dependence on fuel also emerged strongly from interviews with T3 and T5, who stated that start-up costs are still a heavy burden for smallholders. On the other hand, there are signs of increasing social participation, especially from young farmers (T4) and women's groups (T2) who are starting to be active in energy training and processing of biogas-based organic fertilizers. Other categories such as cooperation with universities (D2) and the role of CSR (D3) also show external support in expanding access to technology. The results of this open coding reflect the initial dynamics between awareness, barriers, and social opportunities that accompany the adoption of clean energy in rural areas.

Table 1. Open Coding

Informant Sources & Interview Quotes	Meaning or Context of the Statement	Initial Code (Open Code)
"We know solar power can be used for water pumps, but we don't know how to install it and how it will cost." (Petani 01)	Farmers have basic knowledge, but do not yet understand the technical and economic aspects of solar energy.	Limited understanding of renewable energy
"If the price of diesel increases, the cost of harvesting will also increase. So the net result is getting smaller." (Farmer 02)	High dependence on fossil energy has an impact on the efficiency of agricultural economies.	Fossil energy dependency / high energy costs
"We have made counseling on green energy, but not all farmers are present." (Extension 03)	Socialization of clean energy is not evenly distributed; low participation rate.	Green energy counseling has not been effective
"Our village already has a Regulation on biogas, but it has not been implemented because of a limited budget." (Village Apparatus 01)	There is an energy policy at the village level, but its implementation is not optimal.	Energy policy is not implemented
"Young farmers are more daring to try new technologies, they want to participate in solar panel training." (Extension 02)	The younger generation shows an open attitude towards energy innovation.	The innovative attitude of young farmers
"If there is capital assistance, we want to install solar pumps, so that we don't waste diesel." (Peasant 03)	Farmers are interested in renewable energy if there is financial support.	The need for energy capital assistance
"We are working with companies for CSR of solar street lights." (Village Apparatus 03)	Collaboration between villages and the private sector has occurred through CSR programs.	Institutional collaboration/CSR partnerships
"We want to have local technician training so that the equipment can be maintained on its own." (Peasant 04)	The community wants independence in the management of energy technology.	The need for technical capacity building
"Women in farmer groups participate in making organic fertilizers and using biogas from livestock waste." (Extension 01)	Women are active in environmentally friendly energy activities and household economics.	Gender participation in clean energy
"We only know the SDGs after training from village assistants, but actually we have implemented the principles." (Village Apparatus 02)	The village does not yet understand the term SDGs formally, but the practice is already running.	Implementation of SDGs values without formal labels
"If there is cooperation with the university, we can learn how to treat the panel." (Farmer 05)	Collaboration between academics and society is important for technology transfer.	Academic involvement/technical mentoring
"Our main obstacle is not willpower, but tools and cost." (Petani 06)	The obstacle to clean energy adoption is more about the economic aspect, not the intention.	Economic barriers / limitations of facilities
"We are budgeting village funds for renewable energy demonstration plots next year." (Village Apparatus 04)	There is a commitment of the village government to allocate a budget for energy.	Village policy support for energy

"Farmers are often hesitant because they haven't seen examples of success from other villages." (Extension 05)	Farmers need social proof (a model of success) to believe in new technologies.	Need examples of local success
"If the power goes out, the solar street lights will still be on. That's good for village security." (Village Apparatus 05)	Renewable energy provides social benefits in addition to the economy.	Social benefits of renewable energy

3.1.2 Axial coding

At the axial coding stage, the fifteen categories are grouped into seven main clusters: (1) energy literacy and awareness, (2) socio-economic barriers, (3) the role of energy extension and education, (4) village governance and policies, (5) multi-stakeholder and institutional collaboration, (6) local socio-cultural factors, and (7) the impact of renewable energy. The first cluster emphasized that energy literacy is the main prerequisite for the success of the village energy program. The P2 extension worker said, "the public only understands the benefits if they have seen the direct results, for example streetlights that are lit from solar panels." The second cluster, socio-economic barriers, emerged from the T3 and T5 narratives that cited "limited capital and difficulty of maintenance" as the cause of the energy program stopping halfway. The third cluster, the role of extension workers, was strengthened by P1 who explained that mentoring "is not only technical but also builds collective spirit and awareness."

Meanwhile, the fourth cluster, village governance and SDGs policies, was strengthened by interviews with D1 and D2. They said that "energy is included in the RPJMDes, but it has not been much outlined in the special Regulation," indicating that the village policy is still in the initial adoption stage. The fifth cluster, multi-stakeholder collaboration, is seen as a strong CSR collaboration with universities (D3) which "provides tools and training, but its sustainability depends on citizen initiatives." The sixth cluster, local socio-cultural factors, emerged from the T4 and P3 statements which said that "the spirit of mutual cooperation and the successful example of neighboring villages are the motivation for adoption." Finally, the seventh cluster, the impact of renewable energy, is represented by T1 which says that "solar lights make villages safer at night and reduce electricity costs." All of these clusters form a network of causal relationships that show that the use of renewable energy relies on social capital, institutional support, and community awareness.

Table 2. Axial Coding

Category Utama	Subcategories / Derivative Codes	Causal Relationships and Explanations	Field Data Sources (Quotes)
Community Energy Literacy and Awareness	a. Basic knowledge of solar energy and biogas. b. Young farmers' interest in new technologies. c. Women's participation in household energy management.	Energy literacy is an initial factor in the process of adopting renewable energy technology. A society that understands the benefits of clean energy is better prepared to accept behavioral changes and technology investments.	"We know solar power can be used for water pumps, but we don't know how yet." (Petani 01)
Social and Economic Barriers	a. The initial cost is high. b. Limited capital and access to financing. c. Fear of the risk of technological failure.	Economic and social barriers hinder the application of renewable energy. Farmers have an interest but are constrained by financial capacity and lack of financing support.	"If there is capital assistance, we want to install a solar pump." (Peasant 03)
The Role of Extension Workers and Energy Education	a. The socialization of green energy is not evenly distributed. b. The need for local technical training. c. Lack of technicians at the village level.	Agricultural extension workers function as change agents to build energy awareness and skills. This role is important in bridging technological knowledge to society.	"We have done green energy training, but not all farmers are present." (Extension 02)
SDGs-Based Village Governance and Policy	a. Energy Regulation and Energy Independent RPJMDes. b. Practical implementation of SDGs values. c. Energy budget allocation in the APBDes.	The village government is the main institution in directing renewable energy policies at the local level. Clear policies strengthen the legitimacy and sustainability of clean energy programs.	"Our village already has an energy regulation, but it has not been implemented because of limited funds." (Village Apparatus 01)
Multistakeholder and Institutional Collaboration	a. CSR energy companies. b. University assistance. c. Technical partnerships between villages and the private sector.	Collaboration between actors results in synergy between technical resources, knowledge, and funding. Institutional synergy accelerates the adoption of renewable energy technology.	"We are working with companies for CSR of solar street lights." (Village Apparatus 03)
Local Social and Cultural Factors	a. The need for examples of local success. b. The influence of community leaders on collective decisions.	Rural communities are more responsive to change if they see concrete successes. Collective decisions are influenced by social beliefs and the role of local figures.	"If the neighbors succeed, then we want to come." (Farmer 05)
The Impact of Renewable Energy on Village Life	a. Energy cost savings. b. Improved security and public lighting. c. Increased environmental awareness.	The use of renewable energy has a real socio-economic impact: cost efficiency, village security increases, and environmental awareness grows.	"If the power goes out, the solar lights stay on, good for safety." (Village Apparatus 05)

3.1.3 Selective coding

The selective coding stage then unites these seven clusters into three core themes: (1) Community empowerment and energy literacy, (2) Village governance and SDGs policies, and (3) Multistakeholder and institutional synergy. The first theme is rooted in the statements of P1 and T2 which show that social change starts from people's knowledge and confidence to use new technologies. The second theme highlights the importance of adaptive village governance, as conveyed by D2, that "villages must have clear regulations and allocation of funds for energy, not just temporary projects." The third theme emphasizes the importance of cross-actor collaboration. In this case, P3 emphasized that "synergy between village governments, CSR, and universities accelerates technology transfer, but must be accompanied by citizens' responsibility." These three themes do not stand alone, but are intertwined to form a social system that supports energy sustainability.

Table 3. Selective Coding

Main Components	Functions in the System	Output Produced
Community Empowerment & Energy Literacy	Increase public awareness and technical ability to manage renewable energy.	Active participation and local energy independence.
Village Governance & SDGs Policy	Provide regulation, planning, and financing for renewable energy programs.	The formation of a clean energy policy system at the village level.
Multi-stakeholder & institutional synergy	Uniting support across sectors (government, academia, the private sector, NGOs).	Knowledge transfer, innovative financing, and program sustainability.

3.1.4 Concept Findings

Based on the results of the analysis, a final conceptual model was formed that showed the synergistic relationship between the three main themes. At the bottom layer, energy literacy is the foundation that fosters public awareness of the importance of clean energy. The middle layer, village governance, serves as a bridge between community knowledge and village development policies. Meanwhile, the top layer, institutional synergy, is the binder that ensures cross-sector collaboration runs continuously. This model illustrates that the shift towards sustainable agriculture based on renewable energy is the result of multi-level interactions: communities as the main actors, village governments as policy setters, and external institutions as facilitators of knowledge and resources.

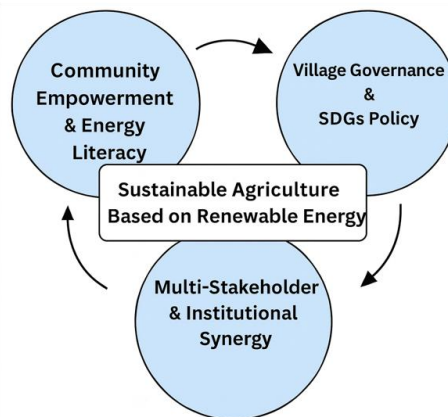


Figure 1. Concept

Through the comparison of the four theories, it can be concluded that the Three Pillars Synergy model found in this study includes community empowerment, village governance, and institutional synergy expanding the range of existing theories by integrating social, institutional, and policy dimensions into a single mutually reinforcing framework. If polycentric governance describes governance structures, CBRE emphasizes community participation, Capability Approach describes the empowerment dimension, and MLP describes the dynamics of technology transition, then this study combines all four in one sustainable synergy system. This model shows that the rural energy transition is not just a technological change, but also a social and institutional transformation that takes place in a circular and mutually reinforcing manner.

From this entire analysis process, a substantive grand theory can be formulated that "the empowerment of agrarian communities in the use of renewable energy occurs through the synergy of energy literacy, adaptive village governance, and multi-sector institutional collaboration based on local social values." This theory expands on Zimmerman, (2000) empowerment theory by adding a collective-social dimension and reinforcing Geels' social-technical system theory with the cultural and moral perspective of agrarian society. In the context of energy governance, this theory also affirms Rhodes' view of network governance, but with an emphasis on the importance of social trust and the value of cooperation as a binding network of collaboration.

3.2 Discussion

The results of this study show that the use of renewable energy in agricultural villages in Aceh Tamiang is not just a technological process, but a complex social process that involves the construction of meaning, power relations, and institutional dynamics. When people engage in clean energy initiatives, they are not only dealing with machines or solar panels, but also with the transformation of the values and mindsets that underlie their social lives. In this context, research findings can be linked and critically compared with several major relevant theories, such as Zimmerman's empowerment theory, Geels' socio-technical systems theory, and governance network theory of Rhodes. All three provide a conceptual framework for understanding social change, but the results of this study show that each theory has limitations when faced with the empirical realities of typical rural communities such as in Aceh Tamiang. In Zimmerman's view, empowerment is a multidimensional process that includes psychological, social, and political dimensions, in which an individual or community gains control over decisions that affect his or her life (Geels, 2002; Messman et al., 2022; Zimmerman, 2000). If associated with the results of this research, the process of community empowerment in renewable energy management is indeed in line with this idea.

The community is not only a beneficiary, but also an active actor that determines the direction of change through participation in the planning, management, and maintenance of the village energy system. Extension workers and village officials act as facilitators who bridge technical knowledge with the social experience of the community, so that a dialogue space is formed that strengthens collective capacity. However, Zimmerman's theory, which was born out of the context of urban societies in developed countries, pays less attention to the cultural and spiritual factors that often form the foundation of participation in rural communities (Zimmerman, 2000). In the context of Aceh Tamiang, empowerment does not only mean improving technical capabilities or control over resources, but also related to social values such as cooperation, sincerity, and a sense of responsibility towards others. Thus, this study expands the theory of empowerment by adding cultural-local dimensions that are often overlooked in rational and individualistic western approaches.

Meanwhile, the social-technical systems theory developed by Geels explains that technological transitions cannot be understood only from a technical perspective, but are the result of complex interactions between social, economic, political, and cultural factors (Geels, 2002). This theory is very relevant in explaining how the renewable energy system in the villages of Aceh Tamiang developed. For example, the success of solar energy implementation in some regions is determined not only by its technological efficiency, but also by the level of social acceptance, support for village policies, and the participation of external institutions such as universities and CSR. However, in the context of this research, Geels' theory seems to need to be expanded to include the moral and spiritual aspects of agrarian society which have a great influence on the process of technology adoption. Many farmers judge the success of the energy program not only from economic efficiency, but from how much the technology brings benefits to the common social welfare. This means that the sustainability of technology here cannot be separated from social sustainability, where harmony and solidarity between citizens are the basis for the acceptance of innovation. Thus, the results of this study contribute by affirming that the socio-technical system in agrarian societies is holistic connecting technology, culture, and spirituality simultaneously.

On the other hand, Rhodes' governance network theory views that the success of public policy no longer depends only on formal government, but also on the ability to build networks between interdependent and cooperative actors. In the context of village energy, this theory is very relevant to explain how multistakeholder synergy between village governments, communities, extension workers, universities, and CSR are the key to success. In Aceh Tamiang, this kind of collaboration can be seen from the formation of a village energy forum that involves various parties in the planning and evaluation process. However, the results of this study also show that governance networks at the local level are not always stable; It depends on moral commitments, beliefs, and social values that are the glue of inter-stakeholder relationships. In other words, governance at the village level is not just an administrative system, but a system of trust and social responsibility. Therefore, the findings of this study enrich Rhodes' theory by adding dimensions of morality and trust as important variables in the network of sustainable energy governance.

The main strength of the findings of this study lies in its ability to capture local dynamics in a contextual and participatory way. The synergy model between community empowerment, village governance, and institutions found in this study shows that social change does not come from outside the community but grows from within through sustainable social learning. This process confirms that village communities have a reflective capacity to adapt to change without losing their socio-cultural identity. In addition, the grounded theory approach allows the resulting theories to be truly rooted in real experience, rather than from normative or technocratic assumptions. This makes the resulting model more responsive to local social structures, more realistic to implement, and more potential to strengthen community autonomy in managing energy resources.

Theoretically, the results of this study make an important contribution to the development of the concept of bottom-up governance in the context of community-based energy development. While many energy studies have emphasized a top-down approach that is structural, these findings confirm that energy sustainability can only be achieved through a bottom-up process that combines participation, social dialogue, and local values. The conceptual model born from this research shows the synergistic relationship between three main domains: community empowerment, village governance, and

institutional collaboration. The three are not stand-alone entities but reinforce each other in one dynamic social system. It is in this context that the resulting theory can be called a substantive theory of social synergy in the rural energy transition. This theory contributes to expanding the discourse on sustainable development by affirming that energy is not only an economic instrument, but also a social medium to build solidarity, independence, and dignity of rural communities. Thus, this discussion shows that research in Aceh Tamiang not only describes local phenomena but also offers a new theoretical framework that repositions renewable energy as a social process that lives in the context of cultural and institutional society. This is where the strength and novelty of this research it does not stop at descriptions but gives birth to theoretical reflections on how energy development can be a space of social learning that fosters collective awareness and strengthens the capacity of agrarian communities towards a more sustainable and just future.

4. CONCLUSION

This study concludes that the adoption of renewable energy in Aceh Tamiang's agricultural villages is not only a technological process, but a social transformation driven by three interrelated pillars: community empowerment, adaptive village governance, and institutional collaboration. First, community empowerment and energy literacy strengthen public awareness and participation, encouraging self-reliance and innovation based on local values of cooperation and solidarity. Second, village governance and SDGs-based policies provide the regulatory and financial foundation that connects community initiatives with long-term energy planning. Third, multi-stakeholder collaboration among government, universities, and the private sector ensures knowledge transfer, technical support, and sustainability. These three pillars form the Three Pillars Synergy Model, illustrating that sustainable rural energy transition arises from the interaction of social, institutional, and policy dimensions. The resulting substantive theory states that Empowerment of agrarian communities in renewable energy adoption occurs through the synergy of energy literacy, adaptive village governance, and institutional collaboration rooted in local social values. Thus, renewable energy development in Aceh Tamiang reflects a bottom-up process of collective learning and social innovation that strengthens community independence and supports sustainable rural development.

RECOMMENDATIONS

Future researchers are encouraged to explore the quantitative and comparative impacts of renewable energy adoption across different rural contexts.

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AUTHOR'S CONTRIBUTIONS

All authors discussed the results and contributed to the start to final manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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