Energy justice and inclusive transitions: Lessons from community renewable energy in Southeast Asia

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Abstract

Southeast Asia occupies a critical position in the global renewable energy transition, yet the region faces persistent contradictions. Despite vast solar, hydro, and biomass resources, energy systems remain dominated by coal and natural gas, with subsidies reinforcing fossil dependence. At the same time, more than 45 million people still lack reliable electricity access, highlighting the urgency of inclusive approaches. Community renewable energy (CRE) projects, such as micro-hydro, solar mini-grids, and biomass cooperatives, offer decentralised pathways that expand access, empower communities, and build resilience. However, outcomes across ASEAN have been uneven. This article applies the energy justice framework to explain these divergent outcomes, conceptualising CRE barriers as justice deficits: distributional (high costs, financing gaps, and subsidy bias toward fossil fuels), procedural (governance and participation limitations), and recognition (overlooked cultural values and community knowledge). These injustices are compounded by cross-cutting risks such as climate variability and fragile infrastructure. By synthesising comparative evidence, the study highlights that financial innovation alone cannot ensure sustainability, regulatory reforms fail without community trust, and technological solutions remain vulnerable without resilience planning. The findings underscore that CRE is not only a technical or economic issue but fundamentally a matter of fairness, legitimacy, and empowerment in Southeast Asia's energy transitions.

Keywords: community renewable energy (CRE); energy justice; Southeast Asia; inclusive energy transition; decentralised energy systems

1. Introduction

The global transition toward renewable energy has become a central component of contemporary strategies for mitigating climate change and achieving sustainable development. Southeast Asia occupies a critical position in this global shift, as its primary energy demand is projected to increase by nearly 60% by 2040, driven by rapid economic growth, industrialisation, and

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urbanisation [1]. Despite being richly endowed with renewable energy resources ranging from solar and hydropower to biomass and geothermal, the region continues to rely heavily on fossil fuels. Coal and natural gas remain the backbone of electricity generation, while long-standing fossil fuel subsidies have reinforced carbon-intensive energy systems [2–5]. This dual reality of substantial renewable potential but entrenched fossil dependence underscores both the urgency and complexity of achieving a sustainable energy transition in Southeast Asia.

Community renewable energy (CRE) has emerged as a promising pathway to address these intertwined challenges. CRE refers to decentralised, small-scale energy systems such as micro-hydro schemes, solar mini-grids, and biomass cooperatives that are owned or managed by local communities [6]. Unlike large-scale projects, CRE initiatives extend electricity access to remote and underserved areas while promoting community ownership, economic empowerment, and social resilience. According to the International Energy Agency, approximately 45 million people in Southeast Asia, mainly in Cambodia, Myanmar, and Indonesia, still lack access to reliable electricity [2,7]. In this context, CRE models not only help bridge the energy access gap but also embody the broader principles of a just transition, one that links decarbonization with inclusivity, participation, and fairness [8,9].

Yet, the implementation of CRE across ASEAN has been uneven. Vietnam's remarkable solar expansion, driven by well-calibrated feed-in tariffs and investment incentives, illustrates how supportive policy frameworks can catalyze large-scale adoption [10,11]. In contrast, countries such as Indonesia and the Philippines continue to face persistent financial, regulatory, and socio-cultural barriers that have slowed or hindered community-based projects [6,12,13]. Laos and Thailand provide alternative experiences: micro-hydro cooperatives in rural Laos and community solar initiatives in Thailand reveal the importance of culturally embedded practices and institutional support in shaping successful CRE models [14]. These divergent trajectories suggest that the challenges confronting CRE cannot be fully explained by technology or finance alone but must also be understood through questions of justice, who benefits, who participates, and whose voices are recognized.

While the energy justice framework has been widely applied in Europe and North America, its conceptual development and empirical grounding remain largely shaped by Western institutional contexts. Many existing studies implicitly assume stable governance structures, mature energy markets, and formalized participation mechanisms that do not always reflect conditions in developing regions. Recent scholarship has begun to address this limitation by examining justice and transition dynamics in Asian contexts, particularly in China, where state–society relations, development priorities, and energy governance differ markedly from Western settings [15,16]. However, beyond these emerging contributions, energy justice remains underexplored in Southeast Asia, a region characterized by fragmented governance, persistent energy access gaps, and strong reliance on community-based and hybrid energy arrangements.

This article addresses these issues by applying the energy justice framework to the study of CRE in Southeast Asia. It argues that barriers to CRE are best conceptualized as justice deficits: distributional (financial inequities and uneven allocation of benefits), procedural (gaps in governance and community participation), and recognition (cultural and identity misalignments that marginalize local knowledge), all of which are compounded by environmental and technical risks [3,8,9,17]. By synthesizing empirical evidence across the region, the article identifies practical lessons on financing, governance, community ownership, and resilience that can inform the design of more inclusive and equitable energy transitions. The next section develops the theoretical framework of energy justice, which serves as the foundation for the subsequent analysis of CRE initiatives across ASEAN.

2. Energy justice framework

Energy justice has become an important way to study whether energy systems and transitions are fair and inclusive. Instead of seeing energy change as only a technical or economic issue, this approach stresses that it is also about justice, who gets the benefits, who carries the costs, and whose voices are included or ignored [8,17]. The framework has gained wide attention because it provides policymakers with ethical guidance and offers researchers a tool to analyze how access to energy is shaped.

At the center of the framework are three connected ideas: distributive, procedural, and recognition justice. Jenkins et al. describe distributive justice as fairness in outcomes, procedural justice as fairness in decision-making, and recognition justice as respect for diverse identities and experiences [17]. These are not just abstract concepts; they are practical tools for identifying injustice in energy systems. However, as Sovacool et al. point out, research has often focused more on distribution than on procedure or recognition, which creates an incomplete picture [8]. This gap shows why all three need to be considered together.

Distributive justice has received the most attention because questions of affordability, access, and energy poverty are the clearest signs of inequality. Sovacool et al. see distribution as the first step in most analyzes, while Fan et al. show that unfair cost-sharing can make households more vulnerable, especially the poor [8,18]. Bouzarovski and Simcock add that geography matters; where people live affects whether they can access energy fairly [19]. Together, these studies show that distribution is not just about dividing costs and benefits but also about wider social and spatial structures that shape inequality.

However, distributive justice is not limited to material outcomes such as income, energy prices, or physical access to electricity. It also encompasses non-material impacts that shape people's relationships with work, place, and community. Zhu and Lo show that energy and environmental restructuring can reconfigure workplace attachment and social relations, producing distributive effects that are experienced socially and emotionally rather than monetarily [20]. In the context of community renewable energy, such non-material dimensions include changes in community cohesion, perceived autonomy, dignity associated with local energy production, and the redistribution of responsibilities and risks within communities. Recognizing these non-material impacts is essential for understanding why some community energy projects persist while others fail despite similar financial or technical conditions.

But distributive fairness cannot be separated from the processes that lead to decisions. Scholars stress that without fair and inclusive decision-making, good distributional outcomes are unlikely to last. This makes procedural justice central. Radtke shows that many participatory processes in energy remain superficial, while Stojilovska notes that even institutions set up to protect citizens can fail, reproducing unfairness [21,22]. Sovacool et al. also argue that fair outcomes cannot be achieved if procedures exclude people [8]. Thus, procedural justice is the political and institutional side of distributive justice.

Even when procedures are more open, they may still fail if they ignore culture, local knowledge, and the lived realities of communities. This is the role of recognition justice, which stresses respect, identity, and acknowledgment. Jenkins et al. introduced this dimension into energy debates, and later scholars developed it further [17]. Van Uffelen identifies forms of misrecognition, such as invisibility or disrespect, while Tarasova argues that recognition should mean not only acknowledgment but also empowerment [23,24]. Recognition justice connects back to distribution and procedure: unfair outcomes and exclusive processes often persist because communities are not seen or valued as legitimate actors. To conceptualize how fairness operates within energy systems, the study refers to the established energy justice framework, which is summarized in

Figure 1.

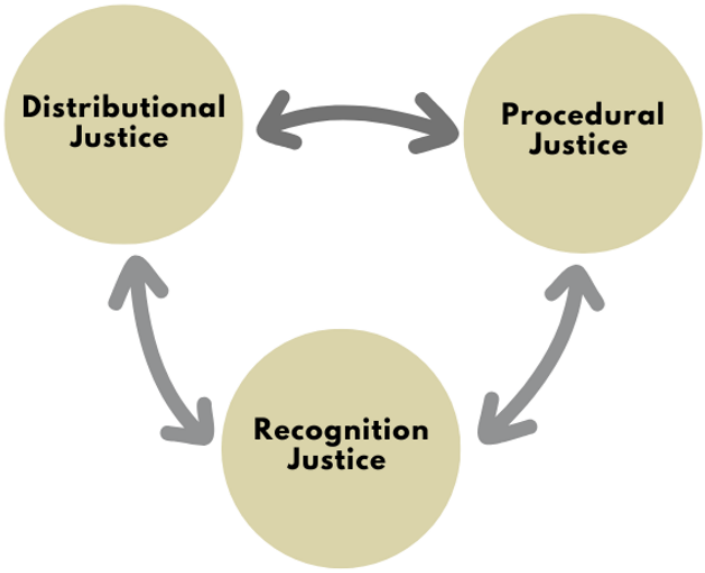

Figure 1: *Energy justice dimensions (source: author's personal illustration)*

As shown in Figure 1, distributive, procedural, and recognition justice are three interrelated dimensions of energy justice. In the wider literature, these principles are often linked to barriers studied in renewable energy research: distributive justice to financial issues, procedural justice to policy and regulatory challenges, and recognition justice to socio-cultural barriers. The figure is kept simple to highlight the justice principles themselves, but treating barriers as forms of justice deficits allows the framework to go beyond technical problems and underline the ethical and political sides of energy transitions. It also prepares the ground for the findings section that follows.

Finally, these three dimensions should not be seen as separate. Astola et al. show that distributive, procedural, and recognition justice are closely connected, and focusing on one while ignoring the others can distort analysis [25]. For instance, unfair outcomes often arise from weak procedures, and both are exacerbated by misrecognition. Sovacool et al. therefore call for an "integrative justice" approach, where all three are addressed together [8]. In this way, energy justice is not three pillars standing apart but a connected system where problems in one area spill into the others. This interlinked view strengthens the lens used in the next section to explore how justice challenges appear in CRE projects in Southeast Asia.

3. Data generation

This study uses a qualitative research design to review and interpret existing evidence on community renewable energy (CRE) in Southeast Asia. As Creswell explains, qualitative approaches are suitable for exploring processes and meanings rather than testing fixed hypotheses [26]. Data were gathered from two main sources: academic studies and policy reports. Academic sources were drawn from Scopus using keywords such as "community renewable energy," "solar mini-grid," and "energy justice." From more than 100 studies, 55 were chosen for their relevance and detail.

To complement these, reports from international agencies such as IRENA, IEA, ASEAN Centre for Energy, and ERIA were used to provide statistical data and policy context. Together, these sources give both depth (from case studies) and breadth (from regional statistics).

Country cases were then selected to show the diversity of energy systems and governance across the region. Indonesia, the Philippines, Vietnam, Laos, and Thailand were included because they represent different pathways of CRE adoption, from Vietnam's policy-driven solar boom to Laos' micro-hydro cooperatives. Following Yin, these cases were chosen not to be statistically representative but because they help illustrate how justice issues appear in different contexts [27]. The use of multiple countries also helps reduce bias by allowing comparison across varied institutional and cultural settings.

The analysis used a two-step process. First, evidence from the literature was coded into common barriers such as financial, policy, technical, and social. Second, these themes were reinterpreted through the lens of energy justice distributional, procedural, and recognition dimensions [8,17]. Environmental and technical risks were treated as cross-cutting factors. This abductive approach [28] moved back and forth between theory and evidence, ensuring that concepts were grounded in real cases. Triangulation of academic and policy sources increased reliability, while acknowledging limits in data coverage, especially for countries like Cambodia and Myanmar. Still, the framework provides a useful way to compare experiences and highlight lessons for more inclusive and just energy transitions in Southeast Asia.

4. Findings and analysis

This section examines how community renewable energy (CRE) in Southeast Asia has developed and why its outcomes remain uneven, using the energy justice framework as a lens for interpretation. The analysis aims to move beyond descriptive accounts of technologies or policies by showing how distributive, procedural, and recognition injustices intersect with technical and environmental risks to shape success or failure. The section proceeds in three parts. First, it outlines the regional renewable energy landscape to situate CRE within broader trends in installed capacity and energy mixes. Second, it discusses practices and innovations in CRE, ranging from village-scale micro-hydro and solar mini-grids to hybrid systems and cooperative ownership models, highlighting their contributions to access, empowerment, and resilience. Third, it maps common barriers to CRE onto the three justice dimensions, demonstrating how financial inequities, governance gaps, and misrecognition of local culture constrain progress. By linking empirical cases with theoretical arguments, the section underscores that CRE is not merely a technical or economic challenge, but fundamentally a question of fairness and legitimacy in Southeast Asia's energy transitions.

4.1. Regional renewable energy landscape

Southeast Asia possesses vast renewable energy (RE) resources, including high solar irradiation, abundant hydropower reserves, rich biomass potential, and some of the world's largest geothermal fields. However, the utilization of these resources remains uneven across ASEAN member states due to disparities in policy implementation, regulatory capacity, and financial accessibility. Although the region has made notable progress in expanding renewable energy deployment over the past decade, fossil fuels continue to dominate energy systems, demonstrating that Southeast Asia's transition is ongoing but uneven [29,30].

According to IRENA, the total installed renewable energy capacity in ASEAN reached approximately 97 GW by 2021, accounting for slightly more than one-third of total electricity generation

capacity [29]. The ASEAN Plan of Action for Energy Cooperation (APAEC) aims to raise this share to 35% by 2025, underscoring a region-wide commitment to accelerating energy diversification [30]. To situate CRE within the broader regional context, Figure 2 illustrates the evolution of renewable energy capacity in ASEAN between 2015 and 2024.

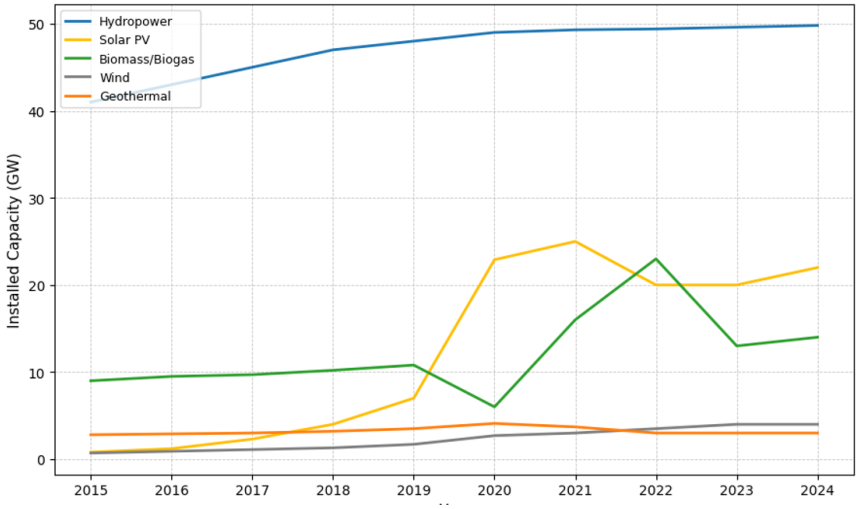

Figure 2: *Renewable energy capacity in ASEAN, 2015-2024 (GW) [29,31,32]*

As shown in Figure 2, renewable energy deployment in ASEAN has expanded consistently from 2015 to 2024. Hydropower remains the dominant source, representing roughly half of ASEAN's total renewable capacity, around 48-50 GW in 2021. Solar PV has emerged as the region's most dynamic growth sector, increasing from minimal levels before 2015 to nearly 20 GW by 2023, driven primarily by large-scale installations in Vietnam and Thailand [31]. Biomass, geothermal, and wind energy have also expanded, but at a slower pace, together contributing approximately 20-25% of the total renewable mix. The composition of ASEAN's renewable energy portfolio in 2023 highlights the growing diversification of technologies. To further contextualize the composition of the region's renewable portfolio, Figure 3 presents the share of installed renewable energy capacity across ASEAN in 2023.

As illustrated in Figure 3, hydropower constituted the largest share of ASEAN's renewable capacity in 2023 at about 55%, followed by solar PV at 22%, biomass/biogas at approximately 15%, wind at around 4-5%, and geothermal at about 3%. These proportions indicate that hydropower remains the structural backbone of renewable electricity in the region, while solar PV has become the most dynamic source of new capacity additions [31,32].

At the national level, significant differences exist among ASEAN members. Vietnam leads the regional solar market, reaching approximately 18.6 GW of installed capacity by the end of 2023, enabled by strong feed-in tariff policies and rapid private investment [10,31]. Thailand has maintained steady growth in solar and biomass utilization, while Indonesia recorded around 0.94 GW of solar PV and 2.6 GW of geothermal capacity by 2024, well below its estimated geothermal potential of 14 GW [33,34]. The Philippines also remains a leader in geothermal energy, with nearly 2 GW of installed geothermal capacity and an overall renewable capacity of approximately 7.7 GW as of 2023 [29]. Meanwhile, Laos generates over 80% of its electricity from hydropower, with an installed capacity of about 9.7 GW, reinforcing its role as a regional electricity exporter [32]. Singapore, by contrast, relies heavily on imported natural gas, which supplied about 94.5% of

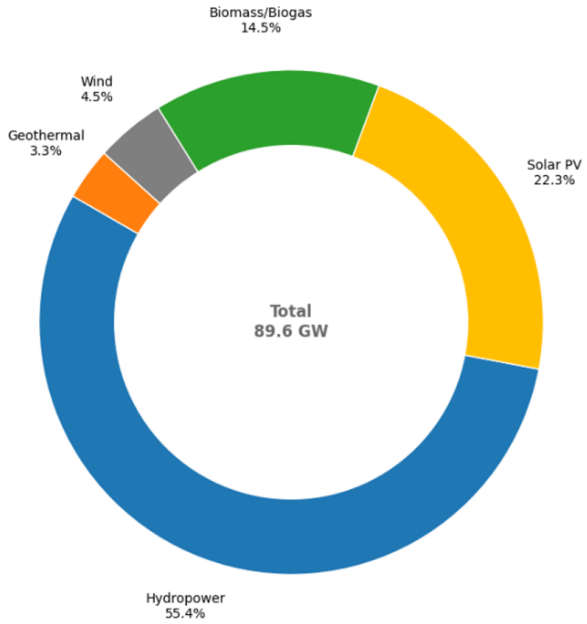

Figure 3: *ASEAN renewable energy capacity share 2023 [29,31,32]*

its electricity generation in 2023, with solar and waste-to-energy systems contributing less than 5% [35].

Despite these advances, fossil fuels continue to underpin Southeast Asia's energy systems. Coal still supplies over 40% of ASEAN's electricity, particularly in Indonesia and Vietnam, while Malaysia and Brunei Darussalam maintain high reliance on oil and gas [1]. These patterns reflect enduring subsidy regimes, fossil fuel lock-ins, and infrastructural constraints that slow renewable integration. Institutional and policy disparities further compound these barriers: Singapore's transition strategy focuses on net-zero targets and floating solar innovation, whereas Vietnam faces grid instability amid rapid solar expansion. Meanwhile, Cambodia and Myanmar remain below a 10% renewable share due to limited governance and investment environments [29].

The evidence presented in Figures 2 and 3 demonstrates a dual reality. Hydropower continues to dominate the renewable mix, providing the stable foundation of regional generation, while solar PV has emerged as the most transformative source of new capacity. However, fossil fuels still shape the overall energy structure, illustrating the challenges of integration, financing, and equitable access. Understanding this dynamic is crucial to framing renewable energy not only as a technological transition but also as a matter of justice and inclusivity. The following section, therefore, examines Community Renewable Energy (CRE) as a decentralized, socially embedded approach that can address access inequalities and enhance local participation in the region's transition.

4.2. Community renewable energy practices and innovations

Community Renewable Energy (CRE) has become an increasingly important component of Southeast Asia's energy transition, offering decentralized and socially grounded alternatives to large-scale power projects. CRE initiatives emphasize local participation, cooperative management,

and flexible hybrid technologies that are well-suited to the region's dispersed geography and diverse socioeconomic conditions. In contrast to top-down electrification efforts, community-based systems aim to strengthen energy access, local ownership, and long-term sustainability [36].

Across ASEAN, CRE initiatives take diverse forms, including micro-hydropower, rooftop and village-scale solar PV, biomass-solar hybrids, and cooperative grid-connected systems. Their scales vary widely from a few kilowatts in isolated villages to several hundred kilowatts in cooperative or demonstration projects. Most operate below 1 MW and are designed to match the energy needs of rural households, small enterprises, and community facilities. Although the technical and economic viability of these systems continues to improve, their expansion remains uneven across countries due to gaps in policy support, financing mechanisms, and maintenance capacity [1].

In Laos, community-scale micro-hydropower remains the dominant CRE technology. Most systems range between 10-50 kW and supply entire rural villages, often serving 50-200 households. Seasonal hydrological variability significantly affects their performance. Generation can fall by as much as 40-60% during the dry season, leading some systems to integrate solar or storage units to stabilize output [32]. In Vietnam, CRE development has primarily focused on small-scale solar PV for rural schools, health centers, and cooperative farms, typically in the 5-30 kW range, often funded through government-NGO partnerships [31].

In Indonesia, several CRE projects have become national showcases for community-driven electrification [37]. The Mata Redi hybrid solar mini-grid in Nusa Tenggara Timur operates at around 95 kWp, serving approximately 220 households through a cooperative model that ensures local management and tariff collection [38]. Other projects in Sumba and Sumbawa, such as those supported by Hivos and the Asian Development Bank, combine micro-hydro and solar technologies in the 30-80 kW range to support both domestic and productive uses, including agriculture and small industries [39]. These projects demonstrate that localized ownership and participatory operation can substantially improve energy reliability and social acceptance.

In the Philippines, large-scale solar development has advanced in Mindanao, where a new 99-megawatt solar power project is expected to generate over 150,000 megawatt-hours of clean electricity annually and supply power to more than 80,000 households. The initiative forms part of the national effort to increase the renewable energy share in the country's power mix to 35% by 2030 and 50% by 2040 [40]. In Thailand, rooftop solar development has been supported through self-consumption and net-billing programs that allow residential consumers with systems up to 10 kW to sell excess electricity to the grid at a buyback rate of 2.2 THB/kWh. The Energy Regulatory Commission (ERC) has introduced a regulatory sandbox to test innovative energy concepts, including peer-to-peer (P2P) energy trading, enabling prosumers with rooftop solar PV to directly share or trade electricity with nearby users. The Department of Alternative Energy Development and Efficiency (DEDE) also promotes off-grid solar programs in remote communities, while the Board of Investment (BOI) provides tax incentives for cooperatives and investors in solar PV projects. These initiatives aim to expand rooftop solar deployment, attract private investment, and enhance renewable energy participation across consumer groups [41].

Despite these innovations, the diffusion of CRE projects across ASEAN is still constrained by technical, financial, and institutional barriers. Many systems rely on donor or pilot funding, and maintenance challenges often arise from limited local technical expertise and inconsistent quality of imported equipment. Furthermore, access to affordable credit remains a key obstacle for community groups seeking to expand or replicate successful pilot models. In Indonesia, for example, most rural cooperatives are unable to secure commercial financing without government or donor guarantees [38, 42].

Nevertheless, CRE offers an important complement to centralized renewable expansion by directly addressing energy access and social equity gaps. It embodies a bottom-up approach

aligned with the principles of energy justice, emphasizing procedural inclusion, distributive fairness, and recognition of local needs. In regions where national energy infrastructure remains fossil-heavy or grid coverage is incomplete, community-scale renewable systems demonstrate the potential for inclusive and context-sensitive energy transitions. The next section further explores how CRE initiatives intersect with energy justice dimensions in practice, highlighting the implications for equitable transition policies in Southeast Asia.

4.3. Justice dimensions in community renewable energy barriers

The development of community renewable energy (CRE) in Southeast Asia is closely intertwined with questions of justice. Although the region has seen rapid renewable expansion, reaching nearly 97 GW of total installed capacity by 2024 [43], the social and spatial distribution of these gains remains highly uneven. Persistent inequalities in access, financing, and participation reveal that renewable growth does not automatically translate into energy equity. These justice deficits can be understood through three interrelated dimensions: distributional, procedural, and recognition justice, each shaped by environmental and technical vulnerabilities.

Distributional challenges are most visible in the economic and structural barriers that prevent equitable access to renewable technologies. Investment remains concentrated in a handful of countries, with Vietnam alone accounting for roughly 19 GW of solar and wind capacity, about twice the combined total of other ASEAN members [44]. Meanwhile, fossil fuel subsidies persist as a major distortion: the International Energy Agency reports that Southeast Asia's fossil consumption subsidies reached USD 105 billion in 2022, with the richest 10 percent consuming six times more energy than the poorest 10 percent [1]. These subsidies, combined with limited financial access, undermine the competitiveness of community-scale renewable energy sources. Around 8 million households in the region still lack electricity, and about 200 million people remain without access to clean cooking fuels [45]. Financing patterns exacerbate inequality; commercial loans make up nearly 60 percent of energy investment, while equity financing remains below 30 percent in most countries [46]. Such dependence on debt limits local ownership and forces communities to rely on external capital, producing a form of distributional injustice where benefits are captured by capital-rich actors while risks fall on poorer households.

In CRE initiatives, distributional outcomes extend beyond the allocation of financial benefits or electricity access. Several cases reviewed in this study indicate that community-managed systems also redistribute non-material outcomes, including social recognition, collective pride, and attachment to shared energy infrastructure. Conversely, externally driven or donor-led projects often shift operational responsibilities and risks to local communities without equivalent social empowerment or recognition. These non-material distributive effects help explain why technically similar CRE projects generate divergent social outcomes across Southeast Asia.

Procedural barriers reflect the limited participation of communities and cooperatives in decision-making processes. Across ASEAN, energy governance remains centralized, with frequent regulatory changes that create uncertainty for small-scale investors. Thailand's 2022 Feed-in Tariff (FiT) policy sets new targets through 2030; yet, similar schemes in the Philippines and Vietnam have faced abrupt revisions that have disrupted investment confidence [47,48]. Vietnam's once-generous FiT up to 9.35 US cents per kWh was retroactively reduced by 25-46 percent for 173 projects, leaving many installations stranded [48]. Meanwhile, the Direct Power Purchase Agreement (DPPA) mechanism, intended to enable corporate RE procurement, was only approved in 2024 after years of delay [49]. Bureaucratic hurdles also stall project operation: Yong reports that many of Vietnam's new solar and wind plants remain idle due to grid integration problems and regulatory bottlenecks [50]. These patterns show how procedural injustice arises when communities and

smaller actors have little influence over unstable, top-down regulatory systems that determine project viability.

Recognition-related barriers concern how local identities, cultures, and knowledge systems are valued or ignored in energy planning. Surveys and field observations suggest that social acceptance of new technologies remains fragile. Many rural communities continue to prefer diesel generators over solar systems due to reliability concerns and limited technical familiarity [51]. Gender inequality compounds this issue: women constitute only about 8 percent of the ASEAN energy-sector workforce [52], limiting their input in household-level energy decisions and community leadership. Successful projects often hinge on strong cultural integration, as seen in Flores, Indonesia, where a church-led micro-hydro cooperative fostered collective ownership and maintenance, strengthening trust and sustainability [51]. In contrast, externally managed or donor-driven projects that disregard local traditions often face a rapid decline once external funding ends. Recognition injustice, therefore, manifests when local agency, gender perspectives, and cultural legitimacy are marginalized within the broader transition agenda.

Beyond social and institutional barriers, environmental and technical vulnerabilities reinforce inequities across all three justice dimensions. Seasonal variability sharply reduces micro-hydro generation in Laos during dry months, while the IEA estimates that nearly half of ASEAN's renewable capacity lies in cyclone-prone zones, more than three times the global average [1]. Extreme weather regularly damages solar panels, wind turbines, and transmission lines, worsening power insecurity for isolated communities. Climate projections suggest that regional hydropower output could fall by 5-9 percent by 2100, further stressing local systems [53]. Technical weaknesses such as substandard inverters, poor installation, and the lack of trained operators often lead to premature system failure, eroding community confidence and deepening the recognition of injustice [50].

These interlinked barriers—economic, procedural, cultural, environmental, and technical—form a complex web that constrains CRE sustainability in Southeast Asia. To synthesize how the identified barriers correspond to the core dimensions of energy justice, Table 1 categorizes the distributional, procedural, and recognition-related challenges shaping the development of Community Renewable Energy (CRE) in Southeast Asia.

Table 1 demonstrates that CRE barriers in Southeast Asia emerge not as isolated technical or financial constraints, but as interconnected justice deficits that reinforce one another. Distributional issues, such as uneven access to financing, concentrated investment patterns, and fossil fuel subsidy distortions, limit the ability of communities to participate equitably in the transition. Procedural barriers arise from centralised governance, unstable regulatory frameworks, and limited community involvement in decision-making processes, all of which undermine long-term project viability. Recognition-related challenges further complicate implementation when local knowledge, cultural contexts, and gender dynamics are insufficiently acknowledged. These justice dimensions are magnified by cross-cutting environmental and technical risks, highlighting that addressing CRE constraints requires integrated policies combining equitable financing, participatory governance, and socio-cultural alignment. This holistic perspective is essential for ensuring that CRE models advance not only technological progress but also fairness and long-term sustainability across diverse Southeast Asian contexts.

5. Conclusion and implications

This study has examined the growth and barriers of community renewable energy (CRE) in Southeast Asia through the lens of energy justice. By moving beyond technical or economic explanations, the analysis highlights how distributional, procedural, and recognition injustices

Table 1: *Justice dimensions and barriers in community renewable energy (CRE) in Southeast Asia*

Justice Dimension	Key Barriers	Evidence / Examples	Implications
Distributional justice	Fossil fuel subsidies; unequal financing access; concentration of investment in a few countries; high reliance on commercial debt	Fossil consumption subsidies in ASEAN reached USD 105 billion [1]; the richest 10% consume 6x more energy than the poorest 10%; Vietnam alone holds ∼19 GW solar and wind—twice other ASEAN combined [44]; loans form ∼60% of energy investment, equity <30% [46]	Benefits captured by capital-rich actors; poor and rural households remain excluded; community projects rely on external capital and face high financial risk
Procedural justice	Centralised governance; unstable Feed-in Tariff (FiT) and delayed regulations; bureaucratic barriers	Vietnam's FiT (9.35¢/kWh) retroactively cut by 25–46%, stranding 173 projects [48]; Direct Power Purchase Agreement (DPPA) delayed until 2024 [49]; Thailand's 2022 FiT updated, while Philippine and Vietnam revisions caused uncertainty [47]; grid bottlenecks stall projects [50]	Communities and cooperatives have little influence; investment confidence erodes; procedural exclusion reproduces inequity and discourages participation
Recognition justice	Cultural and gender neglect; preference for diesel; low technical familiarity; externally driven projects	Many rural areas still prefer diesel for reliability [51]; women only 8% of ASEAN energy workforce [52]; local success in Flores church-led micro-hydro cooperative [51]	Ignoring cultural identity and gender roles undermines trust; local ownership and social integration improve sustainability and acceptance
Cross-cutting risks	Climate vulnerability; seasonal instability; low-quality equipment; limited technical expertise	Nearly 50% of ASEAN RE capacity in cyclone-prone zones [53]; hydropower output may drop 5–9% by 2100; micro-hydro generation in Laos drops 40–60% in dry months [32]; poor inverters and maintenance issues [50]	Climate and technical fragility intensify justice deficits; unreliable systems reduce community trust and threaten long-term viability

shape the uneven adoption of renewable technologies across the region. Distributional deficits were evident in high upfront costs, limited access to credit, and subsidy regimes that continue to favor fossil fuels. Procedural injustices were visible in unstable tariff schemes, centralized governance, and bureaucratic hurdles that limit community influence. Recognition injustices surfaced where local culture and knowledge were overlooked, reducing trust and long-term viability. Overlaying these dimensions, cross-cutting environmental and technical risks, such as typhoons, seasonal variability, and fragile infrastructure, magnified inequities and further tested governance and community trust.

The findings suggest that CRE cannot be sustained through isolated solutions. Financial support without predictable governance risks collapses; regulatory reform without cultural legitimacy fails to build trust; and even well-designed projects falter without climate-proof and reliable technologies. Instead, success depends on integrated approaches that combine fair and accessible financing, stable and transparent regulation, community-driven design, and resilience against environmental shocks. Table 1 underscores how barriers align with justice deficits, reinforcing that CRE is as much a question of fairness as it is of technology or economics. Addressing these challenges requires shifting from donor-dependent pilots toward institutionalized, community-owned, and justice-oriented models of renewable energy.

Looking ahead, the implications extend beyond Southeast Asia. As global debates on energy transitions intensify, CRE offers lessons on how decentralized systems can promote not only sustainability but also equity and empowerment. Policymakers should treat distributive, procedural, and recognition justice as guiding principles for design and implementation, ensuring that energy transitions are both fair and inclusive. For scholars, future research should further examine how justice deficits interact in practice, especially under conditions of climate change

and geopolitical uncertainty. For practitioners, the findings highlight the importance of linking financial innovation, participatory governance, cultural legitimacy, and resilience planning. Only by weaving these dimensions together can CRE become a cornerstone of a just and sustainable transition in Southeast Asia.

Declaration of interest: The authors declare no conflicts of interest.

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