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Energy Access and Justice in the Asia-Pacific

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CONTENTS

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Navigating energy and climate justice in Southeast Asia: perspectives and pathways

Clare Richardson-Barlow and Nofri Yenita Dahlan

Abstract: This research explores the multi-faceted challenges and opportunities of achieving climate and energy justice in Southeast Asia, particularly in ASEAN. By examining three distinct yet interrelated studies, it provides a comprehensive account of energy access development that intertwines regional electrification strategies, localised energy solutions in the Philippines, and an in-depth analysis of just transitions in Indonesia, Malaysia, the Philippines, and Vietnam. The research presented here delves into the complex dynamics of electrification efforts, showcasing the role of diverse stakeholders, the importance of contextually grounded business models, and the implications of socio-political factors on climate justice, energy justice, energy access and sustainability. Emphasis here is on the need for an integrative approach to energy policy that considers not only technological innovation but also the social, economic, and cultural dimen-sions of sustainable development. The findings presented herein offer significant insights into the pursuit of equitable and sustainable energy access in Southeast Asia, highlighting the region's unique challenges and opportunities in the global context of climate change and sustainable development.

Keywords: ASEAN, climate justice, energy justice, just transitions, energy access

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1. Introduction

Global commitment to Net Zero and achieving the United Nations' Sustainable Development Goals (SDGs) has brought the role of energy in driving global development sharply into focus. This special issue zeroes in on Southeast Asia within the broader Asia-Pacific context, a region where the challenges of electrification are as diverse as its geography, comprising unconnected islands, sprawling archipelagos, and extensive rural landscapes. The escalating urgency of addressing climate change and advancing sustainability is underscored by recent global challenges, emphasising the critical role of electricity and internet access in remote areas for enhancing public health and fostering societal resilience. This necessity highlights the interconnectedness of environmental stewardship, technological access, and community well-being, particularly in the context of sustainable development.

The articles that follow collectively explore the complex interplay of energy access, justice, and climate imperatives in Southeast Asia, shedding light on the transformative potential of innovative electrification strategies and new policy solutions being employed in the region. These alternative approaches represent both hope and innovation in a region where traditional grid connections and physical and governance electricity infrastructure have faltered due to high costs, complex geography, and remote locations.

In this special issue, we bring together three papers that explore the multi-faceted challenges and opportunities of achieving climate and energy justice in Southeast Asia. Firstly, 'Rural electrification efforts from the perspective of ASEAN Energy Awards' by Monika Merdekawati, Beni Suryadi, Veronica Ayu Pangestika, and Zahrah Zafira from the ASEAN Centre for Energy, delves into the regional energy landscape, providing a macro-level view of ASEAN's journey towards sustainable electrification. This sets the stage for the second paper, 'Empowering rural electrification in the Philippines: a case study' by Isidro Antonio III Marfori, Alvin B. Culaba, and Aristotle T. Ubando, which offers a micro-level exploration, highlighting the nuances and impacts of rural electrification initiatives in the Philippines. The third paper, 'Research overview and outcomes: just transitions to decarbonisation in the Asia-Pacific' by Clare Richardson-Barlow and Nofri Dahlan, bridges these perspectives, presenting comprehensive research findings that underscore the complexity of just transitions in the region by highlighting four distinct country experiences in Indonesia, Malaysia, the Philippines, and Vietnam. Together, these papers present a narrative that underscores the critical need for inclusive, equitable, and sustainable approaches to energy access and climate action. They collectively emphasise the importance of local contexts, stakeholder engagement, and innovative business models in driving forward the region's energy transition, while

ensuring that this transition is aligned with the global objectives of climate change mitigation and sustainable development.

2. Contextualising the energy challenge in Southeast Asia

Southeast Asia stands at a critical juncture, grappling with the dual challenge of expanding energy access while transitioning to cleaner energy sources. Investments in off-grid rural electrification, particularly through renewable microgrids, are key to achieving SDG 7 and SDG 13, combating climate change (UN 2023). The region's diverse cultural, economic, and political systems add layers of complexity to these efforts. This issue highlights how Distributed Energy Systems (DESs), especially in rural and off-grid settings, are not just about technological innovation but are deeply intertwined with social, economic, and governance dimensions.

The journey towards sustainable energy futures in Southeast Asia is not straightforward. It encompasses the development of viable business models that balance technical efficiency with social equity, the navigation of political and cultural landscapes, and the pursuit of environmental sustainability. This special issue serves as a guide, taking readers through a multi-disciplinary exploration of energy justice, governance, policy implications, and the practical realities of electrification in this diverse and dynamic subregion.

2.1 Bridging climate and energy justice with electrification in the Global South

Climate and energy justice are critical frameworks for understanding the multifaceted challenges of electrification in the Global South. These concepts go beyond mere access to energy; they delve into the equitable distribution of energy resources, the recognition of diverse needs and vulnerabilities, and the procedural fairness in energy decision-making processes (McCauley *et al.* 2013). As the world grapples with escalating climate change, these justice frameworks become instrumental in guiding ethical and equitable responses, especially in regions most acutely affected by climate impacts and energy poverty (Setyowati 2021).

In the Global South, the interplay of climate change and electrification presents a unique set of challenges. Climate change exacerbates existing vulnerabilities, particularly for communities already facing energy poverty. Frequent extreme weather events, such as droughts and floods, disrupt traditional livelihoods, making access to reliable energy sources not just a matter of convenience but of survival. In Southeast Asia these impacts are felt acutely across the subregion (ACE 2023). Electrification, therefore, is not only about lighting homes; it is about powering

sustainable development, enhancing resilience to climate impacts, and enabling communities to adapt to changing environmental conditions (Anantharajah & Setyowati 2022).

2.2 Justice, electrification efforts, and global responsibilities

Energy justice in the Global South calls for a nuanced approach that considers the local socio-economic and cultural contexts. This means acknowledging that energy needs vary significantly across different communities. For example, electrification efforts must be sensitive to the local landscape, ensuring that renewable energy projects do not usurp land needed for agriculture or disrupt local ecosystems. The focus should be on empowering communities, offering them agency in shaping their energy futures.

Climate justice brings to the forefront the responsibilities of developed nations in supporting the Global South's transition to sustainable electrification. Given that developed countries have historically contributed the most to global greenhouse gas emissions, there is a moral imperative to aid less affluent nations in adopting green technologies. This support should not be seen as mere charity but as a crucial step in rectifying historical inequities and mitigating global climate change (Defermos 2023).

The pursuit of climate and energy justice in the context of electrification in the Global South calls for a collaborative approach, engaging local communities, governments, non-governmental organisations (NGOs), and international bodies. Policies and initiatives must be grounded in the principles of fairness, recognising the varying capabilities and needs of different regions. A just transition to a sustainable energy future necessitates not only technological advancements but also socio-economic transformations that uplift and empower the most vulnerable populations.

3. 'Expanding electricity access in ASEAN: an examination of the transition' by Monika Merdekawati, Beni Suryadi, Veronica Ayu Pangestika, and Zahrah Zafira

The insightful piece from the Association of Southeast Asian Nations (ASEAN) Centre for Energy (ACE) provides a comprehensive overview of the electricity access landscape in the ASEAN region. Exploring the ongoing transitions, this article illuminates the endeavours of rural electrification within the context of the ASEAN Energy Awards. It explores the roles of stakeholders, measures the effects,

and facilitates mutual learning among member nations. By examining sixty-two project submissions and winners from 2010 to 2023, the research delves into three principal domains: 1) trend analysis and stakeholder mapping, 2) technologies, and 3) impacts of projects. The analysis is pivotal in understanding the region's progress against the backdrop of Sustainable Development Goals and climate commitments and highlights the role of the ASEAN in supporting this ongoing work.

3.1 Key findings

The findings from this review highlight the shift from traditional government-led initiatives to more diverse actors, including universities, private enterprises, and community groups. The prevalent use of technologies like solar PV (photovoltaics) and micro-hydropower and their cost-effectiveness are noted. This article underscores a dynamic landscape of rural electrification with emerging opportunities for private sector involvement and community-driven solutions, aligning with sustainable development goals and climate commitments in the region.

i. **Rural electrification policies**: This study identifies that rural electrification is supported by specific policy measures in eight ASEAN member states, with Thailand, the Philippines, and Vietnam achieving complete electrification by 2023.
ii. **Role of government:** The authors underline that electrification initiatives, particularly in remote rural areas with considerable distance from urban centres or challenging geography, are typically expensive and labour intensive. As a result, these tasks are commonly assigned to state actors, such as government agencies or state-owned corporations.
iii. **Emergence of non-state actors**: Analysing submissions to the ASEAN Energy Awards, the authors find that, while governments and organisations are active in rural electrification, more grassroots efforts from universities, businesses, non-profits, and communities are becoming important.
iv. **Trends in technologies:** Analysis delves into the prevalence of technologies such as solar PV and micro-hydropower, uncovering patterns in installed capacity and cost-effectiveness, with most projects costing below US$100,000.
v. **Quality of electrification:** By employing the 'Tier 3' standard of 'Multi-Tier Framework for Measuring Household Electricity Access' to evaluate the projects, the authors discover that most projects have the capacity to provide electricity to fewer than one hundred households.

4. 'Empowering rural electrification in the Philippines: a case study' by Isidro Antonio III Marfori, Alvin B. Culaba, and Aristotle T. Ubando

This paper explores the effectiveness of micro-hydropower (MHP) in rural Philippine communities. Marfori *et al.*'s research showcases two case studies, Parina and Timodos, demonstrating the positive impacts of MHP on health, education, income, and environmental conservation. This research highlights the significance of community involvement, the role of women, and the socio-economic benefits from MHP projects, noting the importance of community participation, capacity building, and appropriate technology for the success and sustainability of rural electrification projects.

4.1 Key findings

Marfori *et al.*'s case studies on the Philippines highlight the nuances of rural electrification in the Southeast Asian context. Through an in-depth exploration of local initiatives and policies, this research sheds light on how rural communities are harnessing innovative strategies to overcome electrification challenges. These findings are a testament to the potential of localised solutions in addressing broader energy justice issues, supporting the findings of the subsequent article by Richardson-Barlow and Dahlan.

i. **Community–NGO–state synergy**: The study highlights that the success of rural electrification through micro-hydropower depends not only on technical aspects but also on social, governmental, and community factors. This is evidenced by the case study of the Parina and Timodos MHP project.
ii. **Community participation**: the authors emphasise the importance of community involvement to foster a sense of ownership over an MHP project. Residents participated in identification of the sources of micro-hydropower, identification of the riparian zones and critical areas in the watershed, conduct of site surveys, finalisation of designs, construction of hydropower, preparation and implementation of watershed protection, operation, and maintenance.
iii. **Role of women**: The study identifies that more women are now participating in varying roles in an MHP project. This is demonstrated by the recognition and support of women in various roles, as the majority of members in the Operation and Maintenance Team are women.
iv. **Community benefits**: The findings highlight the ways in which the community gained from the micro-hydropower project in terms of socioeconomics, health, education, and the environment.

5. 'Research overview and outcomes: just transitions to decarbonisation in the Asia-Pacific' by Clare Richardson-Barlow and Nofri Dahlan

The article by Richardson-Barlow and Dahlan offers a comprehensive synthesis of research outcomes concerning just transitions in the Asia-Pacific subregion of Southeast Asia. Their collaborative work, funded by the British Academy, navigates the complex interplay between decarbonisation strategies and energy justice, underscoring the need for equitable approaches in the face of global climate targets. The research revolves around in-depth case studies from Indonesia, Malaysia, the Philippines, and Vietnam. These nations were selected for their shared characteristics, including ASEAN membership, similar energy goals, and unique geographical challenges due to remote and island communities. These case studies offer insights into the diverse cultural, economic, and political systems within the region, making them valuable for understanding broader patterns in Southeast Asia.

This research and its findings are particularly pertinent to the Global South, where the impact of climate change and the necessity for sustainable energy solutions are most pressing. The resulting article makes a compelling case for the need to address electrification and climate change challenges in Southeast Asia through a lens of justice and equity. It argues that understanding and integrating local needs, cultural contexts, and sustainable business models are crucial for a just transition in the region. The insights from this research are critical for policymakers and stakeholders in designing and implementing energy policies that are not only environmentally sustainable but also socially equitable and beneficial for local communities in the Global South.

5.1 Key findings

i. **Energy access and diversified systems:** This research identifies the critical role of diversified energy systems in achieving energy access goals. It notes the potential for renewable energy utilisation in these countries, despite geographical challenges.
ii. **Influence of local and cultural contexts:** The research emphasises how local contexts influence energy justice. The case studies in Indonesia, Malaysia, the Philippines, and Vietnam demonstrate that local community engagement and understanding cultural nuances are vital for the success of DES energy projects.

iii. **Variability in energy justice perception:** The key findings highlight how perceptions of energy justice vary across the region, often differing from Western academic notions. This points to the need for an energy justice framework that is adaptable to local and cultural contexts in Southeast Asia.
iv. **Role of distributed energy systems (DESs):** This research also underlines the importance of DESs in rural electrification, particularly in off-grid areas. These systems are presented as a key solution for enhancing energy access in remote areas of the Global South.
v. **Public–NGO–state synergy:** A significant outcome is the identification of successful partnerships between publicly funded NGOs, state bodies, and civil society. These collaborations are essential for the sustainability and local economic impact of energy projects.
vi. **Just transition framework:** The research integrates a just transition framework, advocating for equitable and inclusive approaches in moving towards renewable energy. This includes consideration of local workforces, community benefits, and cultural sensitivities.

The research of Richardson-Barlow, Dahlan, and their co-investigators Dr Donal Brown and Dr James Van Alstine, contributes significantly to the discourse on sustainable and just energy transitions in Southeast Asia. It provides a nuanced understanding of the complexities involved in rural electrification, energy justice, and the broader implications for climate change mitigation in the region. The findings and recommendations of this study are instrumental in guiding future efforts towards equitable and sustainable energy access in the Global South.

6. Integrating social sciences and humanities perspectives in just transitions

The articles in this special issue not only provide empirical findings and policy analyses but also offer rich insights from the social sciences and humanities, crucial for understanding just transitions in the Asia-Pacific region. These perspectives help us grasp the nuanced human and societal impacts of energy and climate policies, going beyond mere technical and economic considerations.

i. **Understanding local contexts and stakeholder dynamics**: The paper by Merdekawati *et al.* from the ASEAN Centre for Energy delves into the intricate dynamics of stakeholder engagement in rural electrification. This research underscores the importance of understanding local socio-political contexts and the role of various actors—from governments to grassroots communities—in

shaping energy access. It reflects on how energy justice is not just a concept of equitable resource distribution, but also involves recognising and respecting the diverse needs and voices of different communities.

ii. **Community engagement and empowerment**: Marfori *et al.*'s work on micro-hydropower in the Philippines exemplifies the critical role of community engagement and empowerment in rural electrification. It highlights the social dimensions of energy projects, such as the participation and agency of local communities, and especially the evolving role of women. This paper illustrates how energy projects can be more than infrastructure developments; they can be catalysts for social change, community building, and gender equality.

iii. **Navigating the complexities of just transitions**: The paper by Richardson-Barlow and Dahlan bridges these perspectives, offering a comprehensive view of just transitions in Southeast Asia. By examining case studies from four different countries, this research brings to light the complexities of aligning energy access with climate and sustainability goals in diverse political and cultural settings. It shows that just transitions are not merely about technological shifts but involve deep-seated changes in societal structures, economic systems, and cultural norms.

In synthesising these insights, this special issue contributes significantly to the discourse on just transitions, particularly in the context of Southeast Asia. It highlights that achieving sustainable and equitable energy access in the face of climate change is not only a technical challenge but also a deeply social and human endeavour. The papers collectively emphasise the need for policies and interventions that are sensitive to local contexts, inclusive of diverse stakeholders, and aligned with broader societal goals.

By integrating these social science and humanities perspectives, this special issue not only enriches our understanding of just transitions in the Asia-Pacific but also underscores the need for a holistic approach that considers the human dimensions of energy and climate justice. It serves as a vital resource for policymakers, practitioners, and researchers, offering pathways to navigate the complex interplay of technology, society, and environment in the pursuit of a sustainable and just energy future.

7. Conclusion: charting a path forward in climate and energy justice

This special issue, 'Navigating energy and climate justice in Southeast Asia: perspectives and pathways', underscores the urgent need to address climate and energy justice in a region poised at the frontline of climate change. Southeast Asia's unique blend of rapid economic growth, cultural diversity, and environmental vulnerabilities places it at a crucial intersection in the global quest for sustainable energy transitions.

The articles presented herein transcend traditional academic discourse, offering invaluable insights for policymakers, practitioners, and stakeholders. By weaving together empirical research with social sciences and humanities perspectives, this issue illuminates the human and societal dimensions of energy and climate policies. It underscores the necessity of inclusive and just energy strategies that are attuned not only to technological and economic imperatives but also to the social, cultural, and ethical facets of sustainable development.

Key takeaways from this collection include the importance of understanding local contexts and stakeholder dynamics, the empowerment of communities through engagement in energy projects, and the complexity of navigating just transitions in diverse political and cultural landscapes. These insights highlight the imperative of policies and interventions that are sensitive to local nuances, inclusive of diverse voices, and aligned with broader societal goals.

This special issue thus represents a call to action for concerted efforts towards sustainable and just energy futures in Southeast Asia. It invites a critical, collaborative, and forward-looking dialogue on climate and energy justice, urging a holistic approach that integrates technological innovation with social equity and environmental stewardship. As we confront the challenges of climate change and strive to meet global commitments such as the Paris Agreement, the insights from this collection serve as a guiding light, charting a path forward in the pursuit of a sustainable and just energy future for Southeast Asia and beyond.

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Rural electrification efforts from the perspective of ASEAN Energy Awards

Monika Merdekawati, Beni Suryadi, Veronica Ayu Pangestika and Zahrah Zafira

Abstract: Access to reliable and affordable electricity remains a cornerstone of sustainable development and renewable energy in the ASEAN region. While all member states strive for universal electrification, progress varies significantly, influenced by diverse national landscapes and approaches. This research sheds light on rural electrification efforts through the lens of ASEAN Energy Awards, uncovering stakeholder roles, quantifying impacts, and promoting cross-learning among member states. Through analysis of project submissions and winners from 2010 to 2023 (N = 62), the study delves into three key areas. First, there has been a shift beyond traditional government-led initiatives. While state-owned enterprises, government agencies, and international development agencies remain active, the emergence of universities, private enterprises, non-profit organisations, and even communities themselves signals the growing importance of bottom-up approaches. The analysis delves into the prevalence of technologies like solar PV (photovoltaics) and micro-hydropower, revealing trends in installed capacity and cost-effectiveness (the dominance of projects below US$100,000). The study identifies consistent rural electrification efforts across countries like Indonesia, Malaysia, Myanmar, and Thailand, which recorded the most project submissions. Findings reveal a dynamic landscape of rural electrification efforts in ASEAN. The rising presence of non-state actors and community-driven initiatives presents opportunities for increased private sector contributions and bottom-up solutions.

Keywords: ASEAN, rural electrification, energy awards, renewable energy, private sector initiatives

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1. Introduction

Access to reliable and affordable electricity is a cornerstone of sustainable development, serving as a crucial indicator of energy accessibility and a powerful driver of socioeconomic progress. Recognising its importance, rural electrification has been a core focus of the ASEAN Plan of Action for Energy Cooperation (APAEC) since its inception. Each member state of ASEAN shares this focus, striving to achieve 100 per cent universal electricity access. However, progress varies significantly, with each country adopting unique approaches tailored to its specific landscape and challenges.

While national grids form the backbone of electrification efforts in many member states, extending them to remote and isolated rural communities often proves costly and impractical. To bridge this gap, dedicated rural electrification funds have been established in Cambodia (REF 2013), Lao PDR (World Bank 2018), the Philippines (Department of Energy Philippines 2024), and Vietnam (Gencer *et al.* 2011), channelling resources specifically towards off-grid solutions. Meanwhile, other countries like Indonesia (EBTKE 2017), Malaysia (Sabah Energy 2023, Sarawak Energy 2024), and Thailand (Provincial Electricity Authority Thailand, 2019) prioritise enhancing the quality and reliability of existing grid access for rural populations.

Despite these diverse approaches, a common challenge emerges at the regional level: a limited pool of actors willing to venture into the complex and often unprofitable task of electrifying the most vulnerable communities. Traditionally, the burden has fallen on governments, state-owned utilities, and philanthropic foundations. Corporate social responsibility initiatives from private companies also contribute but remain on a smaller scale.

Recognising the invaluable role of the private sector in advancing renewable energy (RE) and promoting sustainable development, the ASEAN Energy Awards were established in 2000 (ASEAN Centre for Energy 2024a). Among its three core categories, the ASEAN Energy Awards dedicate special attention to exemplary rural electrification projects captured under several sub-categories. This category indirectly supports the regional aspiration in RE, which has undergone several iterations. APAEC Phase II: 2021–2025 documented the latest regional target, achieving a 23 per cent RE share of total primary energy supply (TPES) by 2025 (ASEAN Centre for Energy 2024b).

This research delves into the rural electrification efforts recognised by the ASEAN Energy Awards. By analysing trends in submissions and winners over the past two decades, the aim is to illuminate three main areas: (1) uncovering stakeholder roles, (2) quantifying impact and quality of life based on the multi-tier

framework for energy access, and (3) sharing the best practices for cross-learning among member states. The award has showcased a multitude of innovative solutions initiated and driven by private players, shedding light on the potential of their involvement in tackling this critical challenge.

This paper will identify the diverse range of actors involved in rural electrification projects, including private enterprises, community groups, non-profit organisations, and government agencies. In assessing the project's impacts, the research is extended to estimate the number of households reached by exemplary rural electrification projects recognised by the awards. Several effective and innovative rural electrification practices displayed by award-winning projects across ASEAN member states are highlighted to encourage more replication.

2. Literature review: overview of electrification in ASEAN

2.1 Policy

The rural electrification policies in ASEAN vary in approach and implementation, reflecting each country's unique geographical and socio-economic contexts. Some countries, such as Singapore and Brunei Darussalam, with their urbanised and concentrated populations, have achieved nearly universal electricity access (*The ASEAN Post* 2016). Their policies emphasise sustainable and efficient energy use.

Indonesia, in contrast, plans to advance rural electrification through initiatives like the Super Extra Energy Saving (SEHEN) and Solar Home System (SHS) programmes (Sambodo 2015). The country's focus has been on RE in remote areas, particularly under the 2016 ministerial decree targeting underdeveloped areas with small-scale electricity projects like solar energy (*The ASEAN Post* 2018). The Energy Saving Solar Lights (LTSHE) programme, launched in 2017, exemplifies this approach, aiming to illuminate more than 2,500 villages throughout Indonesia with minimal electricity infrastructure (EBTKE 2017).

In Malaysia, the electrification rate in Peninsular Malaysia mirrors the near-100 per cent achievement seen in Singapore and Brunei. However, several initiatives have been made in rural areas in Sabah and Sarawak, such as the Sarawak Alternative Rural Electrification Scheme (SARES), and the Sabah Rural Electrification Renewable Energy (RE2) Roadmap (Sabah Energy 2023, Sarawak Energy 2024). SARES focuses on providing 24-hour electricity to remote communities, while the RE2 Roadmap in Sabah outlines a ten-year plan to deploy 206 mini-grids. Malaysia also has a rural electrification programme called the Bekalan Elektrik Luar Bandar

(BELB) Programme, which operates through grid extension and alternative methods like solar energy in remote areas. This initiative, underpinned by the Electricity Supplies Industry Trust Account, emphasises not only infrastructure development but also improvement in the consistency and availability of supply systems (Ministry of Rural and Regional Development 2010).

Thailand's Accelerated Rural Electrification Project, managed by the Provincial Electricity Authority, stands as a testament to the country's commitment to rural electrification (World Bank 2017). Thailand's strategy involves a Provincial Electricity Authority (PEA) whose objectives include expanding the distribution system to new households, particularly in rural and regional areas, thereby improving quality of life and addressing social inequality (Provincial Electricity Authority Thailand 2019). Similarly, Myanmar has also developed a National Electrification Plan that aims to achieve universal energy access by 2030 through grid extension and decentralised rural electrification via mini-grids and solar home systems (Peralta 2018). Cambodia targets also include the connection of 70 per cent of its households to the national grid by 2030 through mini-grids and renewable energy systems (ERIA 2017). The development of a special Department of Rural Electrification Fund in Cambodia helps to boost rural electrification through several initiatives, such as providing interest-free loans for grid supply, developing a Solar Home System programme, and facilitating private electricity suppliers in rural areas to access funds for investment in the expansion of the electricity supply network (REF 2013).

Lao PDR, Vietnam, and the Philippines have similar types of approaches in most of their rural electrification programmes, where most of their initiatives are funded by dedicated support. For example, Lao PDR has witnessed a rapid increase in rural electrification since 2005, largely fuelled by international support, such as the World Bank's Rural Electrification Project (JICA 2020). Vietnam also received dedicated support from World Bank in 2000, through the Rural Energy Project that helped to increased rural income under the Doi Moi reforms, rehabilitated several large power plants across the country, and enabled rapid progress in rural electrification in the subsequent period (Gencer *et al.* 2011). In the following years, Vietnam developed a comprehensive rural development programme under the state-owned utility called EVN (Vietnam Electricity) that has led to significant gains in electrification (World Bank 2015). Concurrently, the Philippines is implementing a blended grid extension with off-grid solutions as their rural electrification strategy (ITA 2022). Moreover, the Philippines has also developed the Expanded Rural Electrification (ER) Programme, which integrates the rural and missionary electrification efforts of the government in collaboration with the private sector, non-governmental organisations, and several donor-funded projects (Department of

Table 1. Categorisation of rural electrification projects.

Country	*Initiative name*	*Category*
Cambodia	Rural Electrification Fund	Government-led programme
Indonesia	SEHEN	Government-led programme
	SHS	
	LTSHE	
Malaysia	BELB Programme	Government-led programme
	SARES	
	RE2 Roadmap	
Lao PDR	Rural Electrification Project	Dedicated support
Myanmar	National Electrification Plan	Government-led programme
Vietnam	Rural Energy Project	Dedicated support
	EVN-led programmes	Government-led programme
Philippines	Expanded Rural Electrification Programme	Government-led programme
Thailand	Accelerated Rural Electrification Project	Government-led programme

Energy Philippines 2024). These diverse approaches, which are summarised in Table 1, not only demonstrate the region's commitment to rural electrification but also highlight the innovative and adaptive strategies employed to address unique geographical and socio-economic challenges.

2.2 Status of electrification rate

As of 2020, the electrification landscape in ASEAN exhibited varying degrees of success. Based on data from *The ASEAN Energy Outlook 7* (ASEAN Centre for Energy 2022), which are shown in Table 2, Cambodia (81.1 per cent), Indonesia (99.2 per cent), Lao PDR (95 per cent), Myanmar (51.6 per cent), and the Philippines (97.2 per cent) had not yet achieved complete electrification, in contrast with their counterparts like Thailand, Singapore, Vietnam, Brunei Darussalam, and Malaysia, which reported full electrification (ASEAN Centre for Energy 2022). Indonesia was close to its target, aiming to close the gap by 2022. Myanmar, with just over half of its population electrified, faces a significant challenge in bridging this disparity. The focus is not only on achieving universal physical connections but also on ensuring the quality, affordability, and sustainability of electricity supply for inclusive access to energy across the region.

2.3 Non-governmental drivers

The efficacy of rural electrification programmes in the ASEAN region is predominantly influenced by governmental policies and social acceptance from local communities. Vietnam's rural electrification success exemplifies the impact

Table 2. Electrification rate for ASEAN member states.

Country	*Electrification rate (2020)*
Lao PDR	95%
Myanmar	51.6%
Thailand	100%
Cambodia	81.1%
Singapore	100%
Vietnam	100%
Philippines	97.2%
Brunei Darussalam	100%
Malaysia	100%
Indonesia	99.2%

of consistent governmental commitment and effective collaboration across various administrative levels, from central to local authorities (Gencer *et al.* 2011, Hidayah & Rarasati 2020). However, beyond governmental initiatives, the role of the private sector in financing these programmes is crucial.

Some countries in the ASEAN region, such as Indonesia, are still struggling with several barriers in terms of attracting private investors for rural electrification projects, which can be caused by the government's predominant focus on large-scale RE projects, the lack of dedicated rural electrification financing schemes, and centralised energy development with PLN (Perusahaan Listrik Negara) as the main player in electricity off-take, supply, and distribution (UNDP 2018). However, countries like Vietnam and the Philippines have developed several new approaches to attract and promote investment for rural electrification. The existence of EVN allowed Vietnam to overcome the profitability issue that most private investors and private sector operators worried about by providing substantial support for electrification (ADB 2011). In the case of the Philippines, the government launched the Expanded Rural Electrification Programme that allowed the participation of non-governmental and non-utility agencies in electricity provision and resource generation by involving qualified third parties (QTPs) (Bhattacharyya 2013).

An emerging dimension in the financing of rural electrification is the utilisation of Corporate Social Responsibility (CSR) funds. This approach allows private entities to contribute to high-impact socio-economic initiatives, aligned with Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy). The integration of CSR funds into rural electrification projects presents a valuable opportunity for private sector participation, offering a dual benefit of community development and fulfilment of corporate social commitments. Evidence of successful CSR-funded rural electrification initiatives is showcased in the ASEAN Energy Awards, reflecting the private sector's growing role in

advancing rural electrification in the region. The ASEAN Energy Awards also serve as a platform to catalyse private sector involvement in renewable energy by showcasing innovative solutions and commitments, thereby inspiring further investment in rural electrification.

3. Methodology

This study employed a comprehensive methodology to analyse rural electrification efforts through the lens of the ASEAN Energy Awards. The dataset was sourced from the publicly available applicants' database of the ASEAN Energy Awards spanning the years 2010 to 2023. This database provides detailed information about submitted projects, including project descriptions, technology type, investment value, business model, and socio-economic benefits. The procedure involved three main steps: (1) data collection and shortlisting, (2) trend analysis and stakeholder mapping, and (3) impact evaluation.

The shortlisting stage was based on sub-category selection and project objective filtering. Given the research focus on rural electrification, the initial dataset was shortlisted to applications categorised under the on-grid (local) and off-grid (power) sub-categories. These sub-categories specifically target projects aimed at electrifying remote and underserved communities. Further refining the data, the study focused on projects explicitly targeting rural community electrification rather than those targeted on companies' own benefit or commercial use, such as electricity saving or decarbonising their remote facilities. This targeted subset ensures that the analysis directly addresses the core research question.

From the final shortlisted data, the study extracted and analysed key trends to understand the evolving landscape of rural electrification in ASEAN. This included examining the geographical origin of projects, the predominant renewable energy technologies employed, the associated investment costs, and the year of project commissioning. The organisational type of each applicant was carefully assessed to illuminate the diverse actors driving rural electrification initiatives. This analysis categorised applicants into groups, such as private enterprises, community organisations, non-profit organisations, and government agencies.

To gauge the impact of shortlisted projects, the study estimated the electricity generation capacity for each project based on the specified technology and installed capacity. This provided a quantitative measure of the potential energy production associated with each initiative. Assuming tier-3 electricity access as the standard (Myanmar Multi-Tier Framework 2022), the study estimated the number of households benefiting from each project based on the calculated generation capacity and

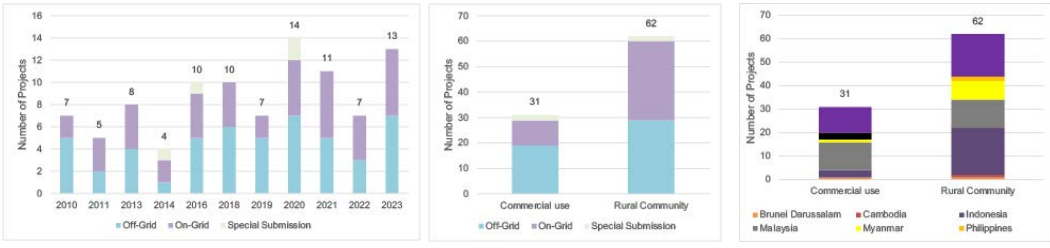
average per-household electricity consumption. This metric allows for a tangible assessment of the impact of these projects on improving the lives of rural communities.

The analysis utilised quantitative methods. These quantitative techniques comprised: (1) descriptive statistics employed to identify trends, and (2) impact assessments involving calculations based on project data and assumptions about household's tier-3 electricity access. This study acknowledges the limitations of relying on self-reported data from project applicants. Potential biases in project descriptions and the possibility of missing projects not submitted for awards were carefully considered. Furthermore, ethical considerations regarding data privacy and confidentiality were strictly adhered to throughout the research process.

4. Trend analysis and discussion

4.1 Data filtering

The general upward trend in the number of submissions over the years suggests that rural electrification efforts are gaining traction in ASEAN countries. Figure 1(a) indicates that the number of submissions in each sub-category fluctuates year-to-year. However, there is a general trend of increasing submissions in the 'off-grid' and 'special submission' categories, while submissions in the 'on-grid' category have remained relatively stable. Figure 1(b) further shows that the number of projects submitted for rural electrification purposes is double the number of



(a) (b) (c)

Figure 1. Submissions of rural electrification projects from 2010 to 2023:
(a) trends over the year by sub-category of the award, (b) filtering criteria by project objectives, (c) country of origin.

applicants for commercial use which are also from the on-grid and off-grid sub-categories. Figure 1(c) points out that most of the rural electrification projects with the objective of serving the community originated from Indonesia, Malaysia, Myanmar, and Thailand. From now on, the data analysis is based on the 62 rural electrification projects with specific objectives to serve local communities.

4.2 Technology

Across the trend of rural electrification in ASEAN reflected in the awards programme, the choice of technologies for powering rural areas is also assessed in Figure 2. These technologies comprise solar PV (photovoltaics), small-scale hydropower projects, biomass, biogas, as well as the combination of two or more of the aforementioned technologies—in addition to other energy sources, such as battery and diesel. Amongst the technologies used for rural electrification in ASEAN, solar PV and micro-hydroelectric plants dominate the submission population against the other types of technologies. Solar PV projects are relatively small in scale, with the installed capacity size ranging up to 0.5 MW. One submission stood out with an enormous installed capacity of around 3 MW, namely the Sarawak Alternative Rural Electrification Scheme (SARES). The popularity of using solar PV in the context of empowering rural areas can be attributed to its affordability due to its relatively low cost compared to other technologies or energy sources (Feron 2016).

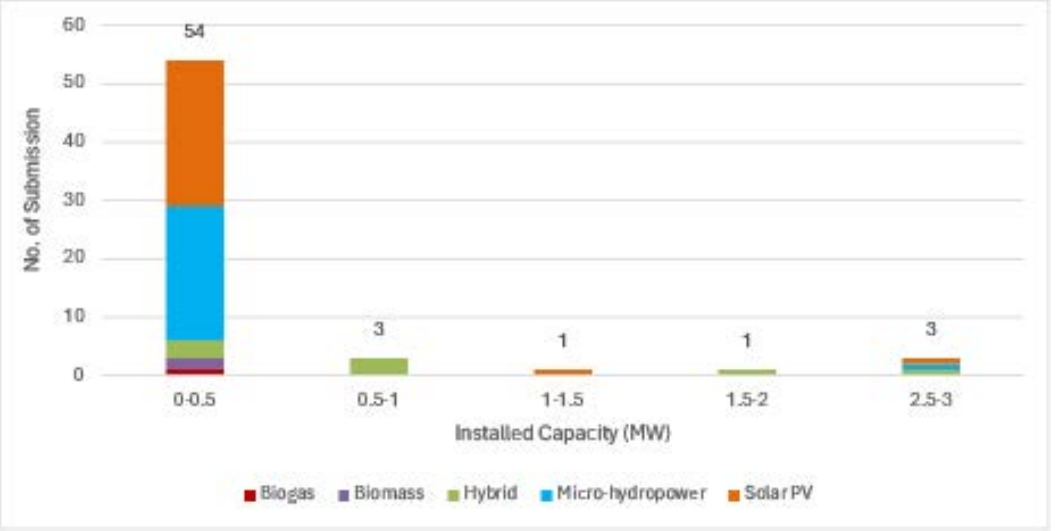


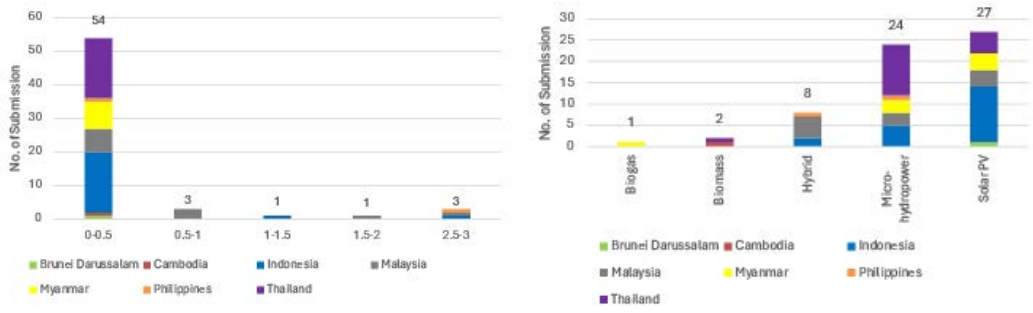
Figure 2. Technology trend of shortlisted rural electrification projects.

4.3 Country

The trend of rural electrification programmes is dominated by small-scale projects, with their installed capacity size in the range of 0.5 MW and under, as reflected in Figure 3. Within the thirteen-year period of the implementation of the ASEAN Energy Awards, submitted projects were compiled from seven out of ten ASEAN member states—Indonesia, Thailand, Malaysia, Myanmar, Brunei Darussalam, Cambodia, and the Philippines. Out of the total of 62 submissions that qualified as rural electrification programmes, Indonesia, Malaysia, Myanmar, and Thailand submitted the greatest number of projects. Malaysia had seven submitted projects and Myanmar had eight programmes, with Brunei Darussalam, Cambodia, and the Philippines each submitting one project. From the overview of technology options, the submissions from Indonesia are dominated by solar PV with the prevalence of micro-hydropower. Malaysia presents a rather balanced option of technologies, with relatively equal submission of projects leveraging mini-hydropower and solar PV, as well as hybrid sources.

4.4 Commissioning date

Commercial Operation Date (COD) signifies the year the project started its operation. Figure 4 shows the ways in which micro-hydropower plants have emerged as the technology of choice for rural electrification in ASEAN, with the earliest recorded COD among the submissions, a project that started operation in 1993. Assessed from the overall submissions with COD across three decades,



(a) (b)

Figure 3. Overview by shortlisted rural electrification projects:
(a) by project size, (b) by technology from different countries.

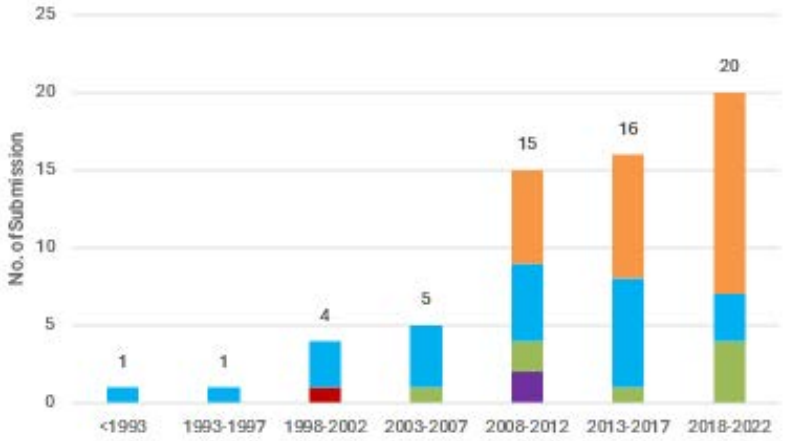
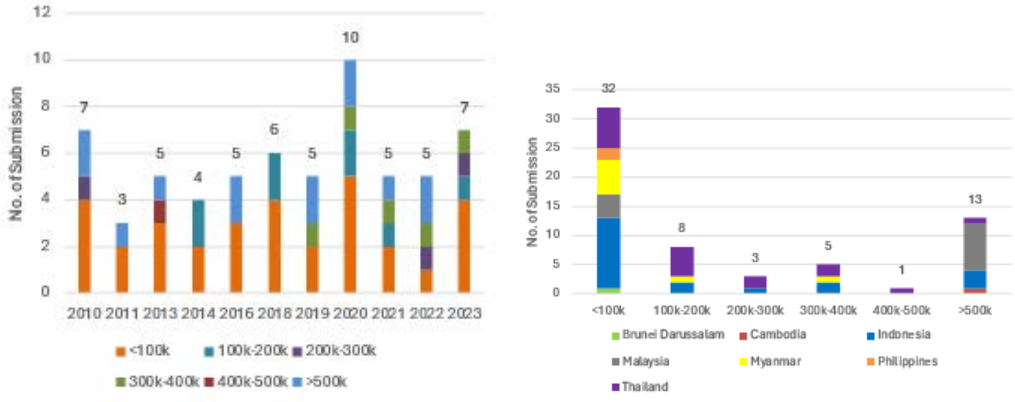


Figure 4. Typical operational age of shortlisted rural electrification projects.

micro-hydropower has enjoyed steady popularity as a technology option for pursuing rural electrification in the region. From the ASEAN Energy Awards submissions, the dominant technology for rural electrification, which is solar PV, only arrived as a technological option to be pursued during the 2008–12 period. Since then, the rate of solar PV deployment has increased over time. The same period also saw the rise of rural electrification programmes in ASEAN that leveraged hybrid technologies, such as a combination of solar PV and/or micro-hydroelectric plants with battery, diesel, and other technologies. For projects that solely deploy biogas as well as biomass, the submissions showed that there have been no recently operationalised facilities powered by those sources in the last ten years.

4.5 Capital expenditure

Capital Expenditure (CAPEX) refers to the expenditure generated in the initial stage of the development of rural electrification projects. The trend of CAPEX shown by the submissions is characterised by the dominance of projects that were constructed with initial expenditure in the range of US$100,000 and under. The prevalence of such a range of CAPEX is fairly steady over the years, and projects with CAPEX under US$100,000 typically occupied half of the submissions per year with the exception of 2022. This trend further shows that rural electrification projects in ASEAN are dominated by small-scale facilities, which correlates with the typically sparse population in rural areas as well as the need to extend energy access in addition to fulfilling the electrification target. From a country perspective, projects with CAPEX of US$100,000 and under were submitted by almost all submitting-ASEAN countries apart from Cambodia. However, for projects with a



(a) (b)

Figure 5. Projects' CAPEX by submission year and country:
(a) by submission year, (b) by country.

CAPEX value of US$500,000 and over, Malaysia dominated the trend with eight submissions.

4.6 Stakeholders/drivers

The direct link between benefits from extending electrification to the rural population and the alleviation of geographical inequality and poverty—as well as the pitfalls associated with the lack thereof—has driven rural electrification into the territory of state intervention policies. While resources and supportive policy measures are instrumental in increasing the rate of electrification, especially in countries where 100 per cent electrification has yet to be reached, non-state actors are increasingly contributing to rural electrification efforts. From the submissions of projects that qualify as rural electrification programme in the ASEAN Energy Awards, stakeholders from state-associated actors, such state-owned enterprises, government, and international development agencies, are identified. However, the submissions also witness the emergence of non-state stakeholders, such as universities, private enterprises, as well as non-profit organisations. Aside from top-down intervention from state actors, communities and cooperatives have also been proactively involved in driving up electrification initiatives within their areas.

Throughout the thirteen-year period of ASEAN Energy Awards submissions, the role of private enterprises has been consistently present in the representation of

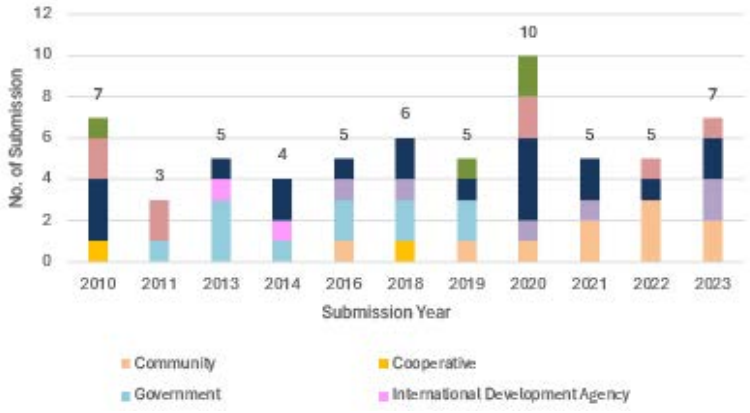


Figure 6. Main stakeholders driving the rural electrification project.

rural electrification projects, except in 2011. Figure 6 also highlights the prominent role of government-initiated projects in driving rural electrification in ASEAN during the period 2011–19. However, the subsequent four years are characterised by the absence of government as the main stakeholder in rural electrification projects. Interestingly, the period 2019 to 2023 is marked by the active roles of community in driving rural electrification in the region, as shown by the data of ASEAN Energy Awards submissions. The prevalence of non-state actors in driving up rural electrification, as shown by the active participation of private enterprises and communities, presents opportunities for drawing a higher contribution from bottom-up initiatives. Despite active participation from non-state stakeholders, the state still has the responsibility for designating a policy environment conducive for expanding rural electrification. Drawing bottom-up initiatives from private enterprises can serve as a broader means to alleviate energy poverty. Meanwhile, encouraging active participation from communities can facilitate better-tailored electrification projects which reflect the needs of the communities themselves.

4.7 Quality of electrification

Electricity is an indispensable aspect in enhancing the positive quality of human lives. This critical feature of electricity is encapsulated within Sustainable Development Goal (SDG) number 7, which asserts the need to 'ensure access to affordable, reliable, sustainable and modern energy for all'. With access to electricity being one of the targets in the SDGs, the provision of modern energy in accelerating development has received universal acknowledgement. Advancing access to electricity towards all populations is instrumental in ensuring just and sustainable

development for all. However, access to the kind of energy possessing the qualities outlined in SDG 7 has not been extended to certain populations. The communities most susceptible to deprivation of electricity access are those living in remote areas, challenged by long distances to city areas or constrained by extreme geographical features. Thus, rural electrification efforts are salient in the trajectory for reaching universal energy access.

With its recognised importance in driving the electrification rate and extending access to populations barred from electricity, rural electrifications programmes also provide room for further scrutiny with regard to the quality of the electrification itself. A study by the World Bank (Tenenbaum *et al.* 2014) brought up an instance of policy error in which the parameter of electrification was defined solely as physical connection to the grid. As a result of this loose parameter, a village can be characterised as electrified if a grid connection is established even if the supply is limited to powering a single appliance (Tenenbaum *et al.* 2014). The application of such a standard in assessing rural electrification can lead to fatal policy ramifications, especially when the qualification as an 'electrified village' restrains further upgrading of poor conditions.

To avoid this problem, this study applied the 'Multi-Tier Framework for Measuring Household Electricity Access' (Tenenbaum *et al.* 2014) to assess the quality of electricity access of the rural electrification projects submitted under the ASEAN Energy Awards. As the current data gathering system under this award has not collected information on the number of supplied households, the application of this framework presents an important opportunity to examine the quality of the electrification from the projects.

Table 3. Appliances used in 'tier-3' and their indicative wattages.

Appliances	*Indicative wattage*
Radio	1
Task lighting	1
Phone charging	1
General lighting	18
Air circulation	15
Television	20
Computing	70
Printing	45
Air cooling	240
Food processing	200
Rice cooking	400
Washing machine	500

(a) (b)

Figure 7. Indicative supplied households:
(a) by submission year, (b) by country.

The framework consisted of five tiers of electricity access, from which its quality was attributed through the household appliances that could be employed as a result of the supply. This study assumed 'tier 3' of the framework as a standard for an ideal electrified quality for a household. Electricity access qualified as 'tier 3' allows members of the household to perform basic domestic activities with electrified appliances, such as cooking and washing, in addition to enjoying television and access to air-cooling. In deriving the results, this study multiplied the indicative wattages of appliances as shown in Table 3 with the assumed hourly usage per day, within a period of a year.

Subsequently, the generated capacity (MWh/year) data for each project that were submitted by the applicants were divided by the annual assumed appliance usage of a 'tier-3' household. However, it is important to note that, due to data limitations, the results of this method are only indicative of the number of households that can potentially be supplied, as opposed to reflecting the real-life conditions. As presented in Figure 7(a), the results lead to the finding that rural electrification project submissions to the ASEAN Energy Awards are dominated by small-scale projects with 'tier-3' electricity provision capacity for 2,000 households or fewer. Projects that can provide 'tier-3' electricity access to fewer than a hundred households make up the majority of the submissions data, with thirty rural electrification projects.

4.8 Situating rural electrification projects within the just transition framework

Rural electrification is a fundamentally transformative process, which through its enactment can bring about significant and holistic improvements to the lives of a population previously made vulnerable by the lack of access to electricity. This paper has attempted to critically examine the provision of rural electrification beyond the question of extending accessibility to electricity to rural communities, by also evaluating the quality of the electricity access provided. Today, ensuring the universal deliverance of electricity is driven by the objective to achieve better living conditions at the critical juncture of the ever-accelerating climate crisis while simultaneously alleviating energy poverty.

Within this context, addressing energy poverty is one among many aspects emanating from the rural electrification process, as it intertwines with questions of sustainability, affordability, and the quality of the electricity service. It is imperative to situate rural electrification efforts not only within the limited framework of electrification, without a meaningful assessment of its quality or the concrete existence of socio-economic empowerment that it provides to community members, but to look at the potential negative ramifications that it causes.

Energy justice as a discourse and framework arises from the critical need to go beyond the narrow technocratic view of energy practice, emphasising the importance of seeing energy from the 'temporal, economic, socio-political, geographic, and its technological aspects' (Sovacool & Dworkin 2015). Just transition, on the other hand, is an emerging framework that focuses on the elements of equity and inclusivity in the search for or transition towards more environmentally sustainable alternative methods of energy practice (Heffron 2021). The catchphrase 'no one is left behind' is at the heart of just transition's operation as a framework (Heffron 2021). This consequently means that just transition implies embracing people from every socio-economic background—race, gender, and income or class (Velicu & Barca 2020).

This work has assessed the ability of the electrification provided by rural electrification efforts to transcend the pragmatism of 'already-electrified' status, which is sometimes devoid of further inquiries into the actual benefits derived from electrification. It has also touched upon the ways in which rural electrification practices have the potential to eradicate inequality and empower communities through the various activities that it enables. Regardless, the assessment has focused solely on the numbers of households enabled to enjoy 'tier-3' electrification quality—without an advanced investigation of the class or economic status, gender, religion, and ethnicity of the receivers themselves. This is a pitfall that needs to be addressed in the next round of the ASEAN Energy Awards through which data on the receiving populations' socioeconomic background also need to also be collected, in order to

meaningfully situate the rural electrification projects from this database in the just transition framework.

5. Conclusions

Access to reliable and affordable electricity for all is instrumental in achieving and actualising sustainable development. Its provision is an indispensable component propelling socio-economic advancement. This study tracked the current electrification progress within the landscape of ASEAN and found that five member states have not reached universal electrification. The unelectrified portion is usually attributed to a rural population to which access to electricity has not been extended. By means of tracking policies that address this challenge of achieving universal electrification, this study finds that rural electrification has dedicated policy measures in eight ASEAN member states—with Thailand, Philippines, and Vietnam achieving 100 per cent electrification as of 2023. Aside from identifying specific policies that tackle rural electrification challenges, this study also aimed to identify the various actors that are involved in driving rural electrification progress in ASEAN. Electrification efforts, especially in rural areas characterised by distance from urban centres or challenging geographical features, tend to be costly and effort-intensive; hence these tasks are considered to be the domain of state actors, such as the government itself or state-owned corporations.

The database of ASEAN Energy Awards through its renewable energy category provides an avenue to map out the main stakeholders involved in driving rural electrification across the ASEAN region. From this study, non-state actors, such as private enterprises, university bodies, cooperatives, and the communities themselves, are identified in galvanising electrification among populations deprived of energy access. The study also finds that the involvement of non-state actors in driving rural electrification is present across the submission years. In addition to the identification of stakeholders, this study also assessed the electrification quality of the submitted rural electrification projects in the ASEAN Energy Awards by the means of 'Multi-Tier Framework for Measuring Household Electricity Access'. Through applying the standard of 'tier-3' in examining the projects, the study found that the majority of the projects were able to power under a hundred households. However, the study also recognises the pitfalls of this method as it does not reflect in-field reality due to data limitations. Therefore, further comprehensive data collection through ASEAN Energy Awards submission that draws information on the quantifiable impact of the projects will be crucial to enriching the contemporary literature landscape on rural electrification in ASEAN.

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Empowering rural electrification in the Philippines: a case study

Isidro Antonio V. Marfori III, Alvin B. Culaba and Aristotle T. Ubando

Abstract: The paper describes the application of micro hydro power to improve the quality of life of people in rural areas. In this paper, two case studies in the Philippines are presented. One case study is a micro hydro power plant located in Parina in the north of the Philippines developed by an academic institution, De La Salle University; it utilises simple technology. In contrast to Parina, another micro hydro case study developed by a non-governmental organisation (NGO), YAMOG, is located in Timodos in the southern region of the Philippines; it implements more sophisticated technology. Even with differences in technology, similarities in terms of community dynamics, preparation, development, and impact on the community are evident in both case studies. The implementation phases for the two case studies were analysed to determine the characteristics for a successful micro hydro project in conjunction with its social impact. It is shown that micro hydro is a potential solution for clean and sustainable energy access for rural areas.

Keywords: Micro hydro, rural electrification, social impact

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1. Background

Micro hydro power or MHP is a clean source of renewable energy that has been utilised for remote communities for electricity generation. The technology of MHP is mature and proven and operates on the same principle as a large hydroelectric power plant but with much lower power capacity. Depending on the country standard, micro hydro plants are mostly hydroelectric power plants with a capacity between 1 kW and 100 kW (Philippine Department of Energy 2011). Most micro hydro systems are run-of-river type systems in which a specific volume of water available all year round is diverted from the river to the MHP system using diversion weirs. Large dams are usually avoided for MHP systems due to their environmental impact. Instead, a natural head brought about by the topographic terrain is used for MHP. MHP requires a continuous supply of water for at least the majority of the months of the year and a significant head; otherwise it is not feasible. Because of the requirements for water and head coupled with grid-unreachable communities, MHP is mostly used in mountainous tropical rural areas. Micro hydropower had already proven itself to be a practical and potentially low-cost option for generating electricity at remote sites. In Indonesia, MHP accounts for 0.1 per cent of the consumed renewable energy power, accounting for 2,600 kW of installed capacity out of a potential 143,845.3 kW (Erinofiardi *et al.* 2017). In west Malaysia, a total of 109 MHP sites have been identified through a reconnaissance study totalling 20,400 kW of potential power (Raman *et al.* 2009). In the Philippines, MHP is tapped to support the government's rural electrification programme targeting 100 per cent *Barangay* (or village) electrification with a potential of 27,000 kW (Philippine Department of Energy 2013). As of 2013, there were a total of 105 operational MHP sites in the Philippines with capacities ranging from 0.03 kW up to 75 kW. Table 1 shows the number of MHP sites as well as the total installed capacity per region in the Philippines. The total MHP installed capacity as seen in Table 1 indicates 1,065 kW while the potential for the Philippines is 27,000 kW. This indicates that there is still a large potential for MHP in the Philippines. Although it is unknown whether the potential is intended for community electrification or commercial use, either way good practices must be observed to achieve the full benefits of MHP. In most cases in the Philippines, the utilisation of MHP is for lighting and for powering small appliances. In some cases, battery charging is chosen, especially for communities with a greater distance between households and the MHP powerplant. Another use of MHP is to power machinery, such as small post-harvest agricultural machinery. In this paper, a Philippine case study on MHP is presented, showing the entire process from planning, to development and then to Utilization. The basic components of the MHP are also discussed with examples from several selected MHP sites.

Table 1. MHP installed capacity in the Philippines.

Region	*Count of MHP plants*	*Total capacity, kW*
CAR	42	370
II	4	3
III	2	2
IV	6	223
V	2	4
VI	23	100
VII	9	110
VIII	2	75
IX	4	1
X	4	11
XI	4	75
XII	3	91
TOTAL	**105**	**1065**

Sources: The majority of the data were provided by the Philippine Department of Energy while some data were taken through a survey of the developer or contractor of the MHP plant.

2. The social dimension of micro hydro power

When dealing with the social impact of an MHP system to a benefiting community, it is first essential to understand the basic principles of MHP. A typical MHP plant is shown in Figure 1. The first step in the operation of an MHP plant happens in the intake weir located at the highest elevation relative to other components of the MHP plant. The function of the intake weir is to divert water from the river unto the canal. The canal is a long channel used to convey water safely from the diversion weir into a silt basin and then to a forebay. In many cases with a relatively short canal, the silt basin is omitted and a combination of silt basin and forebay is used. The forebay is a water settling tank used to filter debris and sand from flowing water before it enters the penstock. Depending on the length of the canal, the forebay is typically just a few metres lower in elevation than the diversion weir. The diversion weir, canal, silt basin, and forebay are all designed based on the water flow rate and topographical features of the MHP system. The penstock is a long, large pipe often made of steel. The penstock is used to maintain a vertical head, H, as seen in Figure 1, which is necessary for the proper operation of the turbine located in the power-house. The power-house also contains the electric generator for the conversion of mechanical to electrical energy and controls to ensure the safe operation of the MHP turbines and generators. The final component of the MHP system is the transmission, which distributes the energy among the households within the community. It is important to understand the basic operation of the MHP plant because it has a significant impact on the community from the

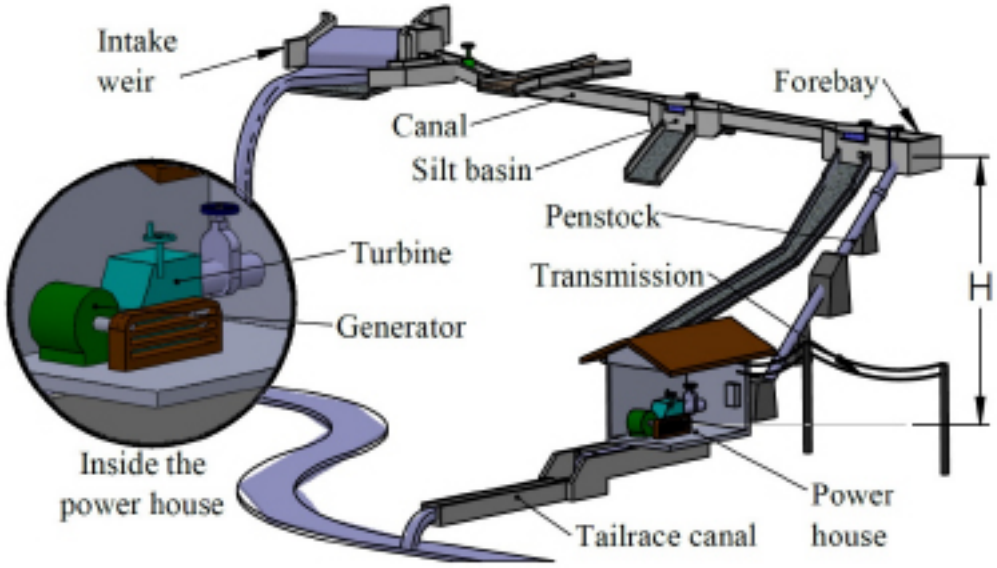

Figure 1. Components of an MHP plant (Culaba & Marfori 2020).

development stage, to the use phase and finally the end-of-life phase of the MHP plant. The complexity of the components plays a significant role as it affects the adaption, acceptance and success of MHP by the community. In the succeeding sections, details on the components of the MHP plant will be discussed and how these affect the social dimension of the MHP system.

One of the greatest features of MHP is its ability to provide access to affordable and clean energy, which is a requirement for achieving sustainable development. The goal of an MHP project is to improve basic quality of life, which could include the areas of health, education, income, and the environment (Culaba & Marfori 2020). It has been demonstrated in the literature that having electricity significantly improves the life of people compared to situations where there is no access to power (Murni *et al.* 2012). However, the success of MHP lies in the dynamics of the community. The typical model for an MHP project as off-grid community electrification is through government or private subsidy. In such cases, the community is often expected to provide free labour as its contribution. In other cases, labour maybe sourced by other financial means. In either case, the operation of MHP in the use phase will still be in the hands of the community. The operation will include technical and managerial activities which all require training or skills development. It is therefore crucial that the community has a good understanding of the technical, financial, economic, and social aspects of the MHP system. It is only then that the community will have a complete appreciation of the benefits of MHP and how it can affect people's lives.

3. Philippine MHP case studies

Two MHP sites are included in this case study: Parina and Timodos MHP sites. Parina MHP is located in the northern part of the Philippines while Timodos is located in the southern part. The two MHP sites were chosen based on the available data and on the difference in geographic location. Figure 2 shows the location of the two MHP sites. Parina MHP was established by De La Salle University (DLSU) in Manila with a partnership between the local government of Calanasan and SN-Aboitiz Power. Timodos MHP was established by a non-governmental organisation, Yamog Renewable Energy Development Group (YAMOG), with funding from Misereor Germany and the Government of the Federal Republic of Germany.

3.1 Parina MHP

Parina MHP is specifically located north of Luzon in the province of Apayao and in the municipality of Calanasan in the Cordillera administrative region (CAR). Parina is a small village, which had 65 households at the time of the development of the MHP system. The main economic activities of the residents are farming and

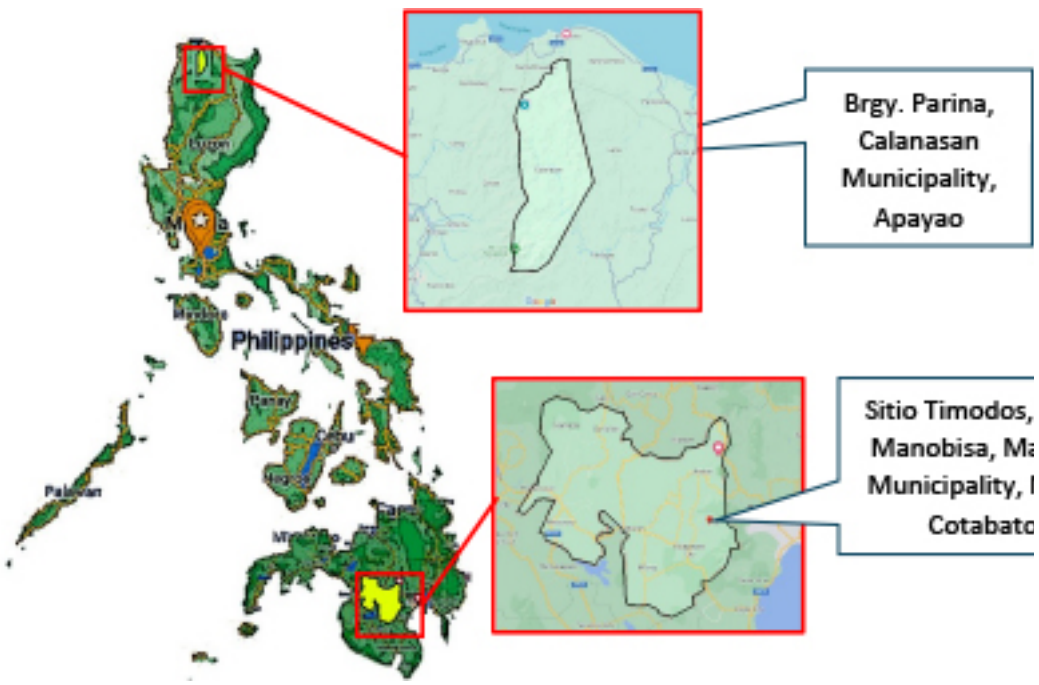

Figure 2. Location of Parina and Timodos MHP plants.

seasonal construction work. The area is characterised by mostly rolling and sloping terrains and is about 30 km from the nearest power grid. A roadway was established from the town of Claveria up to the town of Tanglagan that passes through Parina. At the time of the development of the MHP the road was mostly rough earth. Public access to Parina is through a heavy-duty jeepney with a pick-up point at Claveria with only one trip leaving in the afternoon and returning on the morning of the day after. The jeepney ride typically takes between 2 and 3 hours depending on the road conditions. The fare for each passenger was 100 Philippine Pesos (₱) for a one-way trip.

Environmental conditions in Parina are characterised by dense forestry, hilly terrain, and several creeks that lead to the Calanasan river. The people of Parina had already been practising good watershed practices. Historically, the people of Calanasan including those in Parina had experienced degradation of the forest due to excessive logging. Local regulation was implemented, and this led to good environmental practices, such as fines on illegal logging and dumping of waste in the river, etc. Pre-school and primary school education is offered in Parina up to grade 6, while secondary schooling is offered in the town of Tanglagan 7 km away. Most children are able to finish primary school while others who have relatives in the nearby town are able to finish secondary school as well. Electricity use in Parina is very rare. One household is equipped with a diesel generator and can have lighting and power small appliances. It is interesting to note that this single household usually hosts regular television viewing among the young in Parina through DVDs and sometimes regular shows through satellite pre-paid subscription. This indicates the technical ability of some of the people in Parina.

Prior to MHP implementation, Parina engaged in pico-hydro power through the local government, but this was unsuccessful as it only lasted several months because the turbine broke down. During the pre-implementation phase of the MHP system, it was found that the previous failure of pico-hydro was due to limited technical capacity in hydro systems. It was found that the pico-hydro system was under-capacity and poor turbine selection had been implemented. On the other hand, the previous implementation of pico-hydro had had a positive impact on the community of Parina. During the limited time the pico-hydro was operational, the people of Parina had experienced the benefits of electricity and how it can have the potential to improve their lives. Furthermore, the previous pico-hydro project gave the leaders and key people of Parina insights into the working principle of a hydro-power system. In comparison, in communities that have no prior knowledge of the principles of hydro-power, extensive community preparation is needed to acquaint the people with the concepts, benefits and all things needed for MHP.

3.2 Timodos MHP

Timodos is located in Barangay Manobisa which is one of the 36 Barangays of Magpet Municipality in North Cotabato. Out of a total land area of 1,824 hectares, about 4.35 per cent is forested while the rest is classified as agricultural land. Similar to Parina, the main economic activity of the inhabitants is farming. Timodos is about 6 km from the nearest power grid and it can be reached on foot from the centre of the Barangay or Municipality, or by means of a passenger motorbike locally called a '*habal-habal*'. The access road from the centre of Magpet Municipality to Timodos is in very poor condition and access is usually made possible only through an old, rugged road that is almost impassable during the rainy season.

Timodos can be characterised by an abundance of springs, waterfalls, and river systems. The Timodos MHP system is situated near a 700-hectare watershed. The people of Timodos assign crucial importance to the watershed as it is not only home to diverse flora and fauna, but it is also the major source of drinking water for local inhabitants. The watershed is characterised by biodiversity, with sightings of the endangered Philippine Eagle in the densely forested areas. Historically, the forest cover of Timodos had steadily decreased due to both legal and illegal logging and slash-and-burn farming. As a result, soil erosion, river siltation, flash floods, and landslides emanating from heavy rains became a common occurrence.

Prior to the establishment of the MHP system, there were a total of 119 households in Timodos, but this decreased to 87 households due to armed conflict in the area. Inhabitants of Timodos mostly belong to the Manobo tribe with just a handful of lowland, Christian settler-families. The average family size was five members with incomes ranging from ₱4,000 to ₱5,000 per month, which was below the poverty line. Malnutrition among the children of Timodos was prevalent due to low income. Low income was attributed to a lack of post-harvest facilities for corn, a staple crop of the people of Timodos. Poor road conditions that resulted in high transportation costs also contributed to the low income. Primary school from grade 1 to 4 is available in Timodos, but very few children are able to finish school. Secondary school is said to be almost impossible as the nearest secondary schools are kilometres away. Prior to the MHP system, Timodos residents utilised firewood, and later on kerosene for cooking and household lighting, respectively. At the time of project conceptualisation, the residents were spending ₱150 to ₱200 per month per household on kerosene. Other sources of energy were vehicle batteries and dry-cell batteries.

It is interesting to note the differences between Parina and Timodos. Parina seems to have established good governance as evidenced by their ability to

Table 2. Conditions in Parina and Timodos before the MHP establishment.

	Parina	*Timodos*
Socio-economic	• Mostly from agricultural industry such as farming and post-harvest processing of rice. • Some provide labour work in the construction industry of mostly roads. • Lighting is mostly from kerosene lamps.	• Mostly from agricultural industry such as farming and post-harvest processing of corn. • Broom making for some women. • Lighting is mostly from kerosene lamps.
Education	• Primary education up to grade 6. • Most students can finish with some students continuing secondary education in the nearby town.	• Primary education up to grade 4. • Few students are able to finish. • There is no secondary education available nearby.
Health	• There were no clinics or health centres in the area. • Barangay health workers provide basic health care. • Incidence of respiratory illness was evident.	• There were no clinics or health centres in the area. • Barangay health workers provide basic health care. • Incidence of respiratory illness was evident. • Incidence of gastrointestinal illnesses.
Environment	• Laws and regulation had already been imposed and implemented for watershed protection.	• Activities regarding watershed protection was not evident.

implement and enforce local environmental laws and regulations. In comparison in Timodos, the local government has difficulty providing basic social needs to the community, mainly due to the lack of financial allocation from central government. However, in terms of income and quality of life, Parina and Timodos share the same conditions. Both Parina and Timodos have household incomes lower than the Philippine poverty threshold. Table 2 provides a summary of the conditions of Parina and Timodos in the categories of income, education, health, and the environment prior to the establishment of an MHP system.

4. Community involvement

One of the essential requirements of a successful MHP project is in the interaction and participation of the stakeholders. A study conducted by Sovacool with ten community-based energy project case studies indicated that one key factor for a successful energy system is the active participation of the community (Sovacool

2013). Sovacool stated that, for a successful energy system, community awareness and information on renewable energy are essential. Developers of successful energy systems have strong marketing, promotional, and demonstration activities for the community, not only for the project, but also for renewable energy technologies (Sovacool 2013). In the two case studies of the Parina and Timodos MHP, the developers DLSU and YAMOG both provide marketing activities to promote renewable energy. At that time, DLSU had been engaged in several activities within the Philippines, such as MHP training, seminars, and symposia. DLSU also provided brochures, free plans and drawings, and manuals for other MHP developers. YAMOG on the other hand provides promotional and marketing through their official website and social media platforms.

The Parina MHP first began as a failed pico-hydro project. Initial assessment for rebuilding of the pico-hydro system was conducted by representatives from SN-Aboitiz Power (SNAP). At that time, it was said that SNAP and the local government of Calanasan had a partnership for the development of small hydro in the area as a corporate social responsibility or CRS project by SNAP (Aboitiz 2021). The involvement of DLSU as the developer of the Parina MHP came about through academe–industry linkage, as one of the representatives of SNAP knew that DLSU was engaged in MHP development. The first activity involving DLSU, SNAP, and the community was a stakeholder meeting (Culaba & Marfori 2020). The meeting was only with key people from the community, such as the Municipal Mayor, the Barangay chairman and officers, teachers, and tribal elders. Typically, a kind of townhall meeting is often conducted, but for the case of Parina it was not necessary as the community already had prior knowledge of MHP. Other activities that involved all community members were also conducted, such as basic electricity, use and care of the MHP plant, and watershed protection.

Timodos MHP began as a community effort. The Timodos community with the help of the office of the Barangay made a request to YAMOG for a site assessment. The community of Timodos knew about the benefits of energy from a nearby village in which YAMOG had also developed a scheme. YAMOG first conducted a rapid site survey to determine whether a MHP system was suitable for the community. A meeting with the stakeholders was also conducted. Planning, funding, community contribution, development, and management were discussed at the meeting. Because the project was funded by a German NGO Misereor and KZE-Germany, a project proposal was first created with the assistance of YAMOG. The involvement of the community began at the very start of the project in planning, construction, and management. As a counterpart, the community provided the majority of unskilled labour during the construction phase. Skilled labour also came from the community, while other specialised skilled labour was sourced outside the commu-

nity. The community was also involved in survey and other activities that served as a training component of the project. Basic electricity training was also conducted, participated in by volunteers from the community, which was the foundation for the community-based technicians who would serve the community for operation and maintenance. Finally, operation and maintenance training were conducted three months prior to the completion of the project. It is also vital to note that, aside from providing access to clean energy, the Timodos MHP also aimed to provide other objectives. One of these was the provision of safe drinking water.

4.1 Rapid site survey

With the approval of key stakeholders, a rapid site survey is often the first activity of the developer with the community. One objective of a rapid site survey is to identify the volumetric flow rate of water Q, the elevation head h, and community energy demand. This activity is crucial to the community, as the information will determine whether an MHP is suitable for the site. The MHP developer usually divides the activity into a technical survey to identify Q and h, while another activity is dedicated to identifying the energy demand of the community. The technical survey is often assisted by several members of the community. Typically, the technical survey is assisted by no more than ten able-bodied men composed of Barangay officials and individuals who are familiar with the terrain. The technical survey requires the identification of a suitable location where physical measurement of the condition of the river is possible and safe. The role of the community at this stage is to guide the developers through the mountainous terrain and bring to them to a suitable spot within the river or water source. Community members with the technical site survey team may be required to clear the area or path of vegetation, branches, and bushes to make the location conducive for site measurement. The technical survey utilises simple measuring techniques such as the area–velocity method for Q and an open-piezometer for h. These two techniques are often chosen because of their simplicity, making it easy for community members with the site survey team to understand the concept. At this stage, it is still not known whether there is enough flowing water or enough elevation head for MHP potential and therefore it is important to provide this information right away so as not to arouse false expectations. In many successful MHP projects, the initial rapid site survey is welcomed by several community volunteers and leaders. The community will often undertake prior preparation, such as coffee, snacks, and some meals, which are good indicators of community acceptance of the MHP technology.

In the other part of the rapid site survey, a team from the developer is deployed to assess the community energy demand (Table 3). For both Parina and Timodos,

Table 3. Rapid demand estimation detail for Parina and Timodos.

		Parina Item Detail	*Timodos Demand Detail*	*Item*	*Demand*
Lighting load	Number of households	65		87	
	Number of light bulbs per household	2		2	
	Wattage of light bulbs, W	5	650	5	870
Outlet provision per household	Small appliance wattage, W	100	6,500	100	8,700
Refrigeration load	Number of refrigerators	1		2	
	Wattage of refrigerator, W	1,000	1,000	1,000	2,000
Education	School power needs		1,000		1,000
Other			2,000		2,000
	Total Demand, W		**11,150**		**14,570**

the energy demand survey was conducted by a team composed of social scientists and research assistants. The energy demand survey is composed of interviews with the heads of several household, teachers, health-care workers, and Barangay officials. In both Parina and Timodos, the community had little knowledge of electricity. There were several accounts of the elders saying that they had not seen a lightbulb before. The objective of the energy demand survey is therefore to identify the basic needs of the community and to identify appropriate technology to meet these needs. Other information, such as technical capacity, income, health, and education, is gathered during the rapid site survey. For both Parina and Timodos, energy needs tend towards better lighting and food preservation. There were accounts of electricity usage to provide income, such as welding applications in Parina and post-processing of agricultural products in Timodos.

4.2 Community preparation

Although the Parina and Timodos projects show differences in the implementation for community preparation, they share the same objective. For both Parina and Timodos, the objective of community preparation was to provide information to the community about the development of the MHP system. The Parina MHP project had already established good community organisation through the leadership of the Barangay chairman. In the past, most men in Parina had engaged in construction work, with the Barangay chairman acting as the foreman. The Parina community

seemed to have good trust in the Barangay chairman in many aspects of living, such as in farming, health, income, and laws. The Parina Barangay chairman was the only college graduate among the members of the community. He has good knowledge of physics and natural sciences, and this made MHP easily implementable in Parina. Community preparation in Parina was therefore mostly dissemination of information about the concepts of MHP and electricity, as the organisational structure had already been established. The roles and responsibility for the development of the MHP project in all its phases were absorbed by the existing Barangay organisation. A separate organisation intended for management, operation, and maintenance was established later on.

Timodos, on the other hand, was different, as organisational activities along with information dissemination were necessary. At the pre-implementation stages, organisational activities were conducted. Initially, committees were formed with members from the community, YAMOG, representatives from the local government units, and key stakeholders for water use and energy use. Timodos needed to identify how the water would be divided for potable drinking, agricultural needs, and for energy use. Community organisation activities, including the formation of sub-groups, the preparation of a constitution and by-laws, the election of a board of directors and officers, and identification and agreement of tariff rates, were conducted. Timodos also conducted activities to strengthen the commitment from all members of the community, key stakeholders, and local government units. A community group called the Rural Infrastructure Working Committees or RIWC was formed, as well as other committees for watershed protection.

For both Parina and Timodos, the social preparation resulted in stronger organisation and better appreciation of the benefits of MHP. Aside from the basic requirements for the MHP project, the organisations and groups developed from community preparation also provided the people with an avenue to express their needs, sentiments, and ideas. Members of the community are involved in analytical decision-making, taking into consideration the real needs and aspirations of the community. This ensures that all succeeding stages will have sustained community support. Beneficiaries have a clear grasp of the MHP system and how it affects their lives, thereby enhancing social acceptability and a sense of community ownership.

4.3 Development phase

An MHP system could be built as simply as possible using resources readily available in the area or could be built using state-of-the art technology, requiring materials and expertise from outside to be brought to the area. Table 4 shows a

Table 4. MHP development key differences for Parina and Timodos.

Components	*Parina*	*Timodos*	*Community Involvement*
Intake	• Combination of natural weir and man-made weir. • Build with concrete and stone masonry. • Stones and gravel were sourced at the site. • Cement was brought to the site by foot.	• Steel-reinforced concrete cement. • Sand and gravel were sourced at the site.	• Location identified by community members. • Provided both skilled and non-skilled labour. • Elderly men helped in the hauling of stones. • Some women and children also helped in hauling of sand and gravel.
Headrace canal	• 300-m-long open canal. • Stone masonry for the first 50 m from the intake. • The rest were made from steel-reinforced hollow concrete blocks.	• 306-m long made from steel-reinforced hollow concrete blocks. • Closed with concrete slab throughout the length with several cleaning access points.	• In Parina, it was said to be the most difficult component to build according to locals. • Timodos closed canal was preferred to minimise periodic cleaning as the slab cover prevents falling leaves and branches entering the canal.
Forebay and penstock	• Steel-reinforced concrete. • Located at the previous pico-hydro project. • Size increased significantly. • Constructed near a sloping terrain. • With retaining wall. • 0.3-m-diameter steel penstock. • 36-m-long penstock.	• Steel-reinforced concrete. • Constructed away from sloping terrain. • More excavation requirements due • to the depth and penstock access. • 0.4-m-diameter steel penstock. • 56-m-long penstock.	• For both MHP sites, community provided labour. • Welding needs provided by manpower outside the community. • For Parina, 'bayanihan method' for the hauling of the steel penstock proved to be effective.
Powerhouse and electromechanical equipment	• Philippine-made cross-flow turbine. • Manual controller. • Single-phase generator.	• Indonesian-made cross flow turbine. • Load controller. • Three-phase generator	• For Parina, community members participated in hands-on fabrication of the turbine. • Both MHP sites had the community participate in management, financial, operation, and maintenance capacity building, and training.

comparison of the components of the MHP systems for Parina and Timodos. The majority of the components are made mostly of concrete, stone masonry, and steel reinforcements. So typical construction techniques were utilised in which the community could fully participate. For both case studies, the majority of the men had adequate experience in construction and so the manpower requirements for the entire development phase were provided by the community. Although the involvement of the community is mostly in the provision of labour by able-bodied men, other members of the community, such as the elderly, women, and children, also contributed to the development of the MHP plant. Older men along with male teenagers participated though hauling sand, gravel, or stone. Women and female teenagers participated in the preparation of meals, although there were some instances of women who also hauled materials.

For both case studies, the locations of the forebay and penstock are accessible only on foot and a typical penstock in the case of Parina was 6 m long with a weight of about 800 kg. For a well-organised community, the hauling of heavy materials is accomplished through a traditional activity called in the Filipino language '*bayanihan*'. In the context of MHP, several volunteers from the community carried the penstock on foot from the drop-off point of the jeepney all the way to the forebay area. This was accomplished by wooden poles attached along the length of the penstock while a person on both ends of the wooden pole would carry it, as shown in Figure 3.

Several key members of the community spent days at the DLSU workshop for a hands-on experience in the manufacturing of the MHP turbine. Aside from basic metal working processes and welding, members from Parina also gained knowledge of the working principle of the turbine. Aside from benefits for the operation and maintenance of the MHP system, the training also gave a good sense of ownership. Other capacity building and training were conducted for both case studies. Capacity building training in organisational strengthening, financial management, watershed conservation, basic electricity, leadership and conflict management, operation and maintenance were implemented.

5. Impact of MHP

The impact evaluation is based on interviews between the authors and the developers of the two case studies. Reports and documents from the case studies were also provided to the authors. Parina MHP was inaugurated and began operation in May 2013. A monitoring visit was conducted by the DLSU developer at Parina six years after the inauguration. The monitoring visit consisted of interviews with key

Figure 3. Community volunteers from Parina MHP hauling a steel penstock in '*bayanihan*' fashion. (Photograph courtesy of DLSU.)

community members, including local government officials, schoolteachers, health-care workers, and members of the Parina micro hydro association. Table 5 shows the impact of MHP for the two case studies. In education, children had a reduction in time spent on many manual activities, such as fetching water and fuelwood; instead students now spend more time in school. Interviews with parents claim that children can study better at night with the provision of better lighting. The use of computers, radios, mobile phones, and televisions was now made possible in the school. Interviews with local government officials indicate improvements in livelihoods and savings from reduced kerosine use. An appliance repair service also became common in the community, as well as a welding service and other services that utilise electricity. On health, there was evidence of decreased respiratory illness due to the decreased use of kerosine lamps. A community refrigerator to be shared among the residents of Parina was purchased and it was claimed that it gave better access to food.

The Parina community formed the Parina micro hydro association which is tasked with managing all aspects of the MHP plant in terms of operation, maintenance, collection, and reporting. The association was able to collect tariffs so diligently among the community that it was able to raise funds to purchase a secondary generator to be used as back-up during maintenance. The Parina MHP

Table 5. Impact comparison of before and after Timodos MHP.

	Before MHP	*After MHP*
Socio-economic	• Mostly from agricultural industry, such as farming and post-harvest processing of corn. • Broom making for some women. • Lighting was mostly from kerosene lamps.	• Women and household members can conveniently do household chores at night. • Capacity building formation has increased through project managers, organisational development workers,financial management personnel, operation and maintenance personnel, community electricians, women leaders, youth leaders, and community leaders. • Household savings as much as ₱600 per month as a result of a significant decrease in kerosine use. • The presence of electricity has prompted the Barangay Local Government Unit (BLGU) and Municipal Local Government Unit to improve the access road going to the community which has had a positive impact on farming. • Production of brooms has increased due to longer hours at night. • Women's role has increased to higher management level.
Education	• Primary education up to grade 4. • Few students were able to finish. • There was no secondary education available nearby.	• Improved study environment for children. • Improved access to information from radios and TV.
Health	• There were no clinics or health centres in the area. • Barangay health workers provided basic health care. • Incidence of respiratory illness was evident. • Incidence of gastrointestinal illnesses.	• Records from the Barangay Health Workers of the BLGU reveal a reduction in the incidence of respiratory diseases, and gastrointestinal-related illnesses.
Environment	• Activities regarding watershed protection were not evident.	• TTriMPA with BLGU developed policy watershed protection. • Cutting of hardwood within the watershed has been significantly reduced.

was also able to source additional funds from government subsidies for the replacement of all the wooden transmission poles by more durable steel poles.

The evaluation of the impact of the Timodos MHP system on the community was a combination of quantitative and qualitative approaches, and a simple before-and-after study that was caried out by YAMOG. The methods employed include a review of key project documents, report preparation, and primary data gathering. The sample size of the household surveys consisted of 40 per cent of the 87 households as well as focus group discussions and key informant interviews with project stakeholders. A summary of the results is given in Table 5 with a comparison with the situation before the installation of the MHP system. Significant improvement was evident in the socio-economic aspects. Aside from household savings due to the dramatic decrease in kerosine use, other income-generating activities were improved, with an increase in production in broom making and electricity service-related livelihoods.

6. Key points for a successful MHP system

The following discussion lists the essential elements for a successful MHP project, based on findings from the two case studies.

- *Marketing and awareness*
  As in the study by Sovacool, it was identified that communication is a necessary ingredient for a successful MHP project. For both case studies, community consultation, dialogue, and consensus-building were utilised to enable community participation in all stages of the project.
- *Ownership*
  Community participation is essential to achieve a sense of community ownership for the MHP project. The residents participated in the identification of the sources of micro hydro power, identification of the riparian zones and critical areas in the watershed, conduct of site surveys, finalisation of design, construction of hydropower, preparation and implementation of watershed protection, operation, and maintenance.
- *Capacity building*
  Training in different forms and fields related to MHP itself or more managerial or financial in nature are all necessary. In both case studies, capacity-building strategies were attuned to the uniqueness of the community.
- *Utilisation of appropriate technology*
  In terms of the overall impact, the two case studies share almost the same

characteristics, even though Parina has inferior technology compared to that of Timodos. This can be related to the study by Sovacool, indicating that successful MHP programmes tend to be oriented towards energy service matched with the needs of the end-user, which indicates that even simple technology can have a similar impact to complex technologies (Sovacool 2013).

- *Leadership*
  Successful MHP programmes often receive consistent support from government, an experienced implementing agency, and a clear project champion (Sovacool 2013). Similar findings were made in a case study by Culaba *et al.* (Culaba & Marfori 2020). In Parina, the Barangay leader led the community to accomplish the development of the MHP system with support and financial assistance from the local government, while Timodos had consistent support from the developer YAMOG.

7. Conclusions

MHP has been proven to be an effective approach for providing clean electricity to rural areas, but it is not always successful. In many studies, it has been established that the success of MHP rural electrification depends not only on the technical aspects but more on the social, governmental and community aspects. The Parina and Timodos MHP case studies show a similar trend. Although the Parina MHP system has inferior technological features to those of the Timodos MHP system, the two MHP projects have had similar impacts on the community and similar indicators that led to their success. Unity and a positive outlook among the members of the community have been evident since the start of the MHP projects. This can be seen in the formation of the Timodos Tribal Micro Hydro Power Association (TTriMPA) and the Parina Micro Hydro Association. Through these endeavours, the recognition and acceptance of women in varying roles became possible as women are managerial members of these groups. The participation of stakeholders, such as local government, developers, and the community, has provided a voice for the community.

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Research overview and outcomes: just transitions to decarbonisation in the Asia-Pacific

Clare Richardson-Barlow and Nofri Yenita Dahlan

Abstract: This paper presents a comprehensive overview of a study examining microgrids for off-grid rural electrification in Indonesia, Malaysia, the Philippines, and Vietnam within the ASEAN context. Utilising mixed methods, this study delved into the techno-economic aspects of these systems and explored varied business models and governance strategies. It assessed how these models and strategies impact rural electricity access and contribute to a just regional energy transition. The study highlights the dual benefits of enhancing regional energy access and community empowerment while addressing shared challenges in climate change and decarbonisation. It identified potential market opportunities at the national level, with an expectation of increased private sector involvement amid prospective system liberalisations. Viewed through the lens of energy justice, the regional energy transition is presented not only as an environmental imperative but also as a catalyst for economic growth. This involves creating jobs, expanding electricity access, and mitigating climate impacts for local communities and the broader region. This study also sheds light on workforce and labour support and industry transformation, suggesting avenues for future research.

Keywords: ASEAN, energy justice, microgrids, electricity access, energy transition, labour

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1. Introduction: the urgency of addressing climate change and quality of life

The research presented in this paper is situated at a critical juncture where the global challenges of climate change intersect with local and regional imperatives to improve electricity access. Addressing climate change is an urgent global priority, highlighted by the Intergovernmental Panel on Climate Change (IPCC) as requiring immediate and substantial action to reduce emissions. Concurrently, enhancing electricity access is pivotal in improving the quality of life, particularly in off-grid rural areas of the Asia-Pacific region and the subregion of Southeast Asia. This dual focus frames the following research, acknowledging that balancing carefully against the environmental imperatives of climate change mitigation while expanding electricity access is crucial for development, and vice versa. It is urgent to recognise that approaches to climate change mitigation vary significantly across different global contexts. In Western or G7 nations, the primary emphasis often lies on the climate aspect, driven by a need to rapidly reduce carbon emissions. However, in the Global South, including many of Southeast Asia's economies, the approach is necessarily different. Here, the priority is to first address the immediate quality of life improvements that come with increased electricity access. Ensuring reliable and sustainable energy access is seen as a precursor to and enabler of effective climate action. This underscores the importance of developing tailored strategies that reflect the socio-economic realities of these regions, ensuring that climate change mitigation does not overshadow the critical need for development and improved living standards.

The quest for affordable and clean electricity access is pivotal to achieving many of the United Nations' 17 Sustainable Development Goals (SDGs) (UN 2023). This need has been further accentuated by the COVID-19 pandemic, which highlighted the critical importance of electricity and internet access for public health, especially in remote areas (REN21 & ADB 2021). However, in the Asia-Pacific region, particularly within the Southeast Asian subregion and among ASEAN (Association of Southeast Asian Nations) members, achieving universal electricity access presents unique challenges. Geographical constraints like unconnected islands and remote locations, compounded by rapid development and growing urban–rural divides, make rural and island electrification particularly challenging (Purwanto & Afifah 2016). Despite significant strides in recent years, the Alliance for Rural Electrification (2020) estimates nearly 1 billion people globally, with a substantial number in Southeast Asia, still lack access to modern electricity.

The Energy Sector Management Assistance Program (ESMAP) forecasts that falling technology costs and improving policy environments will enable microgrids to economically connect 490 million people globally by 2030 (ESMAP 2019). This scale of electrification necessitates substantial investment but also offers considerable economic potential, both in terms of profit for microgrid developers and in fostering local community revenues.

Access to reliable and affordable electricity is a key policy priority for ASEAN, with implications for poverty reduction and environmental sustainability (ACE 2023). The challenge lies in harmonising rural electrification with regional and global climate goals, transitioning from traditional energy systems to more sustainable models. This involves leveraging private sector participation and community engagement, employing commercially viable renewable energy technologies.

Distributed Renewable Energy Systems (DESs) have emerged as a crucial component in achieving SDG objectives. Governments across the Asia-Pacific are increasingly focusing on renewable microgrids to enhance energy access and drive the energy transition away from fossil fuels (REN21 & ADB 2019). These microgrids, often situated in remote areas where grid connection is impractical, represent the first electricity source for many communities. Yet, they also face challenges in financial sustainability, maintenance, governance, and local community engagement, indicating a need for new business and governance models (IRENA 2019).

Realising this ambitious goal of rural electrification will necessitate the deployment of over 210,000 microgrids, requiring an investment close to US$220 billion. The next decade is expected to see the establishment of approximately 1,700 mini-grids every month. Achieving this scale of development could generate significant economic returns, with projections estimating an annual profit of US$3.3 billion for private microgrid developers from 2019 to 2030, and a collective net profit of US$4.7 billion for all mini-grid component and service providers by 2030 (Alliance for Rural Electrification 2020). Therefore, developing effective business models that enable rural communities to tap into these revenue streams is of paramount importance, ensuring that the benefits of these investments are equitably shared and contribute meaningfully to local development.

This project aims to explore how local energy business models and intermediate technologies can be integrated with community governance to create equitable and sustainable energy solutions. It seeks to develop scalable models for rural electrification in the Asia-Pacific, enhancing energy access and contributing to a just and beneficial energy transition.

1.1 Defining just transitions

At the centre of this research is the concept of 'just transitions', which has become increasingly relevant in the discourse on sustainable development and climate action. Defined in the COP26 Just Transitions Declaration (UN Climate Change Conference 2021) and the International Labour Organization (ILO) Guidelines (ILO 2015), just transitions refer to the spectrum of social interventions necessary to secure workers' rights and livelihoods as economies transition towards sustainable practices. This concept is particularly pertinent to the Asia-Pacific region's efforts towards decarbonisation, which must harmonise the need for increased electricity access with sustainable environmental practices that are in line with national and subregional climate targets (ACE 2023).

Following these issues, this article provides an in-depth overview of a study into the use of microgrids for off-grid rural electrification in Indonesia, Malaysia, the Philippines, and Vietnam, within the broader ASEAN context. Employing mixed methods, this research investigates the techno-economic aspects of these microgrid systems, examining the associated business models and their role in promoting equitable energy access.

An integral component of this study is the exploration of potential market opportunities at a national level, particularly considering an expected increase in private sector participation and potential system liberalisation. This exploration is crucial for understanding the changing market dynamics in the region and their implications for rural electrification initiatives.

From the perspective of energy justice, the regional energy transition is viewed not only as an environmental necessity but also as a driver of comprehensive regional development. This transition presents opportunities for economic growth, job creation, broader electricity access, and significant reduction in climate change impacts. The consequences of such a transition for local populations and the broader region are substantial, highlighting the importance of a well-rounded approach to energy policy and planning in the Asia-Pacific.

The following article provides a comprehensive exploration into the complex interplay between climate change mitigation, electricity access, and just transitions in the Asia-Pacific region. The subsequent sections of this paper will delve deeper into the nuances of these interrelated themes. We will explore how the unique geographical, political, economic, and cultural contexts of Indonesia, Malaysia, the Philippines, and Vietnam shape their approaches to just transitions. The importance of language in framing positive narratives, the critical role of consultation and collaboration with diverse stakeholders, and the imperative of workforce transitions for sustainable employment will be examined in detail. These discussions

will not only contextualise the concept of just transitions within the Asia-Pacific region but also highlight lessons learned and potential strategies for policymakers. By synthesising these insights, this paper aims to contribute significantly to the discourse on sustainable development, energy justice, and the broader implications of decarbonisation efforts in this dynamic and evolving region.

2. Methodology and research approach

This study employed a mixed-method, comparative case study approach, conducted between December 2021 and March 2022, to investigate rural electrification in the Asia-Pacific region. Our methodological framework was multi-faceted, incorporating both quantitative and qualitative elements to provide a comprehensive understanding of the subject matter.

i. **Techno-economic modelling:** We conducted basic techno-economic modelling for each project, encompassing factors such as cost per kilowatt-hour, subsidies, investment, and operational costs, expected load consumption, energy generation as well as distributional impacts. This quantitative analysis provided a solid foundation for understanding the financial and technical aspects of the microgrid systems in our case studies.
ii. **Qualitative analysis of governance and institutional arrangements:** Through semi-structured interviews and small workshops, we engaged with project developers, technology providers, local policymakers, and community leaders. Approximately fifteen interviews were conducted across the case study locations—Indonesia, Malaysia, the Philippines, and Vietnam. This qualitative component allowed us to delve into the socio-cultural dimensions and energy justice aspects of low-carbon electrification, acknowledging the regional diversity and varying contexts.
iii. **Policy workshops for stakeholder engagement**: We organised policymaker engagement workshops, involving local, national, and international stakeholders, including NGOs (nongovernmental organisations). These workshops facilitated discussions on the research findings and explored avenues to upscale rural electrification through equitable and sustainable business models.

2.1 Rationale for case study selection

This study strategically selected Indonesia, Malaysia, the Philippines, and Vietnam as case studies due to shared characteristics that are significant for exploring energy

access, energy justice, and energy transitions within the Asia-Pacific. These countries, members of ASEAN, not only share geographical locations in the Asia-Pacific and Southeast Asian subregion, but also have parallel objectives regarding energy and electrification access, diverse energy systems, and potential for enhanced renewable energy use (ACE 2023). Moreover, they face unique geographical challenges pertinent to remote and island communities.

These nations represent a broad spectrum of cultural, economic, and political systems, reflecting the diversity of the Asia-Pacific region. This includes similarities with other countries in Southeast and Northeast Asia, as well as the Pacific subregions. Given their role in the rapidly developing Southeast Asian subregion and their active participation in regional and global climate and energy initiatives, these countries offer a critical microcosm for the study.

The chosen case studies also encompass diverse types of micro-grid configuration, including systems with diesel generators, microgrids combining renewables and battery energy storage systems (BESSs) with centralised and decentralised governance, and communities on the verge of acquiring microgrid facilities. The intent was to explore a variety of off-grid situations, ranging from those already using renewable energy to areas preparing for transition away from diesel generators. Each case study represented a unique approach to rural electrification:

i. Indonesia's Ulu-Danau Micro Hydro Power Plant, illustrating a community-driven on-grid system integrated with state electricity.
ii. Malaysia's Sarawak Alternative Rural Electrification Scheme, showcasing an off-grid innovative state government–community partnership with standalone solar or micro hydro systems.
iii. The Philippines' Timodos Micro Hydro Plant, a community-driven off-grid system focusing on rural electrification.
iv. Vietnam's Lotus projects, which represent pre-electrification stages in remote communities underserved by grid connections.

The choice of these locations was driven by their representativeness of different energy systems, governance models, and the diverse socio-economic contexts within the Asia-Pacific region. This selection enables a comprehensive understanding of the dynamics at play in rural electrification and the pursuit of energy justice, offering valuable insights for policymakers and stakeholders.

2.2 Business models for rural electrification

The concept of business models encompasses the creation and capture of social and economic value by various economic entities. Historically rooted in business and management studies, this conceptual framework has gained traction among social science and sustainability researchers (Bocken *et al.* 2014). It offers a powerful tool for bridging the gap between social and economic aspects, enabling comparative analyses of different economic approaches within similar sectors.

In the realm of energy research, particularly concerning Distributed Energy Systems (DESs), business models have become a focal point for examining the interplay between energy providers, consumers, and technological infrastructures (Richter 2012). DES, characterised by their decentralised nature, necessitate closer and more localised interactions between energy producers and consumers, often leading to the blurring of traditional roles in what is known as the 'prosumer' phenomenon (Parag & Sovacool 2016). Emerging business models in this field have the potential to forge new socio-economic pathways, creating opportunities and challenges alike.

According to Brown's (2018) formulation, energy business models can be dissected into five key components: the value proposition, supply chain, customer interface, financial model, and governance. The value proposition relates to the benefits offered to consumers, while the supply chain encompasses upstream relationships and logistics. The customer interface deals with downstream interactions, marketing, and service relationships. Financial models represent the blend of capital and operational expenses with revenue strategies, and governance encapsulates the coordination and organisational structure of the model. Hence, Table 1 applies the framework of business models specifically to rural microgrids. This application offers critical insights into both the social and technical characteristics of these systems, presenting a methodical approach for their comparison. In Section 4, this analytical framework is employed to assess and compare the diverse business models identified in our case studies.

While research in DES business models has been prominent in the Global North, focusing on liberalised electricity markets and full electricity access, there is a notable gap in studies addressing the Global South, where electricity access is often limited, and utility models are typically state-owned (Hostettler 2015). This gap highlights the need for further exploration of DES business models in diverse socio-economic and political contexts.

Microgrids, a subset of DES, illustrate this point well. These can be grid-connected, maximising on-site consumption of generated electricity, or off-grid, serving as the sole electricity source in remote areas; the latter of which is

Table 1. Business model components for rural microgrids.

Business model component	*Considerations for rural microgrids*
Value proposition	• What level of electrification is offered?—are there limits on daily consumption? Is power available at certain hours of the day? • What tariff (if any) is there for power consumption? • What other services are included—support in power utilisation, infrastructure works, training programmes?
Supply chain	• What are the systems technical features? • Who are the system designers? • Who are the equipment suppliers? • Who are the system installers? • Who undertakes maintenance?
Customer interface	• How is the community engaged during the planning process? • How is the ongoing relationship managed and by whom?
Financial model	• How is the capital cost of the system funded? • How are the operational costs of the system funded? • What is the tariff structure (if any) for the system? • Are there additional revenues: e.g., from exported power?
Governance	• Who owns the system? • How are key decisions taken? • What is the relationship between the funder/installer/owner and the host community?

increasingly prevalent in the Global South, posing unique technical, economic, and social challenges (Borghese *et al.* 2017). The business model framework provides a valuable lens to understand these systems, bridging technical aspects with the social value they generate or impact. This comprehensive approach is crucial for evaluating and comparing various business models in rural microgrid applications, as explored in this study.

The integration of these methodological components enabled a thorough examination of the winners and losers in regional electricity access projects, while also identifying impactful and replicable business models for sustainable electricity provision. This research approach culminated in a comprehensive understanding of DES within the Asia-Pacific context, illuminating effective business models for sustainable electricity provision. By examining various DES configurations and governance models, our study offers critical insights into the economic and social dynamics of rural electrification. The exploration into diverse business models, from community-based initiatives to state-driven projects, highlights the intricate balance between technological feasibility, economic viability, and social acceptability. The findings underscore the importance of adaptable and inclusive business models in achieving energy justice and access, particularly in geographically challenging regions. These models not only address the immediate need for electricity

but also pave the way for sustainable and equitable energy solutions that can be replicated across the Asia-Pacific region and the Southeast Asian subregion, contributing significantly to the global discourse on sustainable energy transitions.

2.3 Energy justice: intersecting local, national, and regional considerations

Our methodological approach incorporated a theoretical framework of energy justice, integrating the concepts developed by McCauley *et al.* (2013), Sovacool and Dworkin (2015), and Jenkins *et al.* (2016). This framework encompasses four key dimensions: distributional, recognition-based, procedural, and restorative justice. Each dimension addresses different aspects of energy justice: 'distributional' focuses on identifying and resolving injustices; 'recognition' emphasises acknowledging overlooked communities; 'procedural' seeks fairness in processes; and 'restorative' aims to repair past damages. This multi-faceted approach provides a comprehensive lens for examining energy justice, ensuring that our analysis is not solely based on Western paradigms but also reflects the diverse political, economic, and social realities of developing countries (McCauley & Heffron 2018). Crucially, this research intertwines the theoretical underpinnings of energy justice with the practical examination of Distributed Energy System (DES) business models. This novel combination, applied specifically to ASEAN's remote communities, offers fresh insights, and contributes to expanding the energy justice literature in new, international contexts (Heffron *et al.* 2021).

3. Contextualising just transitions in the Asia-Pacific

The Asia-Pacific region's approach to just transitions is deeply shaped by its diverse geographical, political, economic, and cultural landscapes. This diversity brings forth varying perceptions and strategies towards achieving sustainable energy access and climate change mitigation. Countries like Indonesia, Malaysia, the Philippines, and Vietnam face unique challenges due to their geographical features, from dense forests and high mountains to sprawling archipelagos, which complicate the electrification process. Rapid growth and an expanding urban–rural divide further magnify these challenges (Setyowati 2021). Geographically, this diversity significantly impacts the implementation of just transitions, particularly in rural and island locations where infrastructure costs and maintenance are challenging; Politically, the region is also host to a variety of governance styles, which affects policy formulation and implementation; Economically, there is a juxtaposition of rapidly growing economies alongside others with more modest growth, creating

varied priorities and capacities for the global climate and energy transition; Culturally, the variation of traditions and values across the region influences public perception and acceptance of new technologies and reforms.

3.1 Acknowledging regional diversity

The diversity within the ASEAN member states necessitates tailored approaches to electrification and decarbonisation. Efforts towards achieving 100% electrification are ongoing, with each nation grappling with its own set of geographical and resource constraints. These constraints pose additional pressures on meeting national and subregional targets and require innovative solutions that cater to the specific needs of each locale.

In the pursuit of sustainable energy goals, acknowledging the regional diversity is paramount. For instance, Indonesia's archipelagic nature poses unique challenges in electrification compared to the more mainland-centric challenges of Vietnam. Malaysia and the Philippines, too, present their own set of challenges and opportunities, shaped by their specific socio-economic and geographical contexts. Recognising these nuances is crucial for developing strategies that are not only efficient but also equitable and culturally sensitive.

3.2 Emphasising the role of context-specific timescales

The journey towards a just transition in Southeast Asia must also consider the context-specific timescales unique to each country. The pace of progress in one nation may not be feasible in another due to varying political, economic, and infrastructural realities. Recognising these differences is essential for setting realistic goals and creating effective strategies for energy access and climate change mitigation. For example, the pace at which Vietnam can implement renewable energy projects may differ significantly from that of the Philippines, due to differences in regulatory environments, economic structures, and resource availability. It is important to set realistic and achievable goals within these individual contexts to ensure the success and sustainability of just transitions.

3.3 Lessons learned

i. **Specific and sensitive definitions**: Understanding the unique challenges and opportunities in the Asia-Pacific requires definitions of just transitions that are specific and sensitive to the regional context. This specificity ensures that pol-

icies and initiatives are relevant and effective. The definition of just transitions in the Asia-Pacific region must be rooted in the specific realities of each country. For instance, what constitutes a just transition in Malaysia might look different in Indonesia, owing to their distinct economic statuses and energy infrastructures.

ii. **Promoting mutual learning between regions**: The diversity within the region offers an opportunity for mutual learning and there is much to be gained from a collaborative approach. Sharing experiences and best practices among countries can lead to more innovative and effective approaches to just transitions. Countries within the region can learn from each other's successes and challenges. For example, Vietnam's and the Philippines' successes in gaining international NGO funding for projects could offer valuable insights to their ASEAN counterparts.

iii. **Engaging policymakers in all regions**: Effective implementation of just transitions strategies requires the active engagement of policymakers across the region. This engagement is crucial, irrespective of the current stage of industry development in their respective countries, as it fosters a collaborative approach to addressing common challenges. Engagement should not be limited to countries with advanced energy sectors but should also include those at different stages of energy development to foster a more inclusive and comprehensive approach.

A just transition in Southeast Asia is inherently complex, influenced by a variety of geographical, political, economic, and cultural factors. The lessons learned from addressing these complexities are invaluable for shaping future strategies. Section 4 takes this diversity further, exploring how the use of language and the creation of positive narratives play a pivotal role in the success of these transitions. Our research highlighted this challenge, underscoring that understanding and harnessing the power of language can be instrumental in aligning diverse understandings and expectations, ultimately contributing to the achievement of just transitions across this dynamic and varied region.

4. Positive narratives and diverse understandings

The adoption of positive narratives in the discourse surrounding rural electrification and energy transitions in Southeast Asia is crucial for their success. Language plays a pivotal role in shaping perceptions and aligning community-driven energy access programmes with local values and aspirations. This research indicates that justice

frameworks, as currently articulated, often come across as top-down, academic-driven constructs, highlighting the need for a language and conversation that resonate naturally with local communities, integrating their perspectives and cultural context into the narrative.

4.1 Considering issues of inequalities and historical injustices

The narrative around energy transitions should also consciously incorporate considerations of historical injustices and current inequalities. In the context of Southeast Asia's rural electrification, it is essential to address language in a way that reflects the region's complex history and diverse socio-economic landscape. Many communities in this region have experienced historical injustices and disparities, which are often intertwined with rural electrification efforts. Acknowledging these inequalities is vital in framing the narrative around energy transitions:

i. **Acknowledging past inequities**: In Southeast Asia, many rural communities have historically been marginalised in terms of infrastructure development, including energy access. This is true for the experience of the Ulu-Danau Micro Hydro Power Plant in Indonesia, where road access was limited and highly susceptible to weather conditions. Recognising this history in communication strategies is crucial for building trust and demonstrating a commitment to equitable development.
ii. **Reflecting cultural sensitivities**: The region is home to a rich history of cultures and languages. Communication strategies must be culturally sensitive and inclusive, respecting local customs and traditions. This is particularly important in areas where minority groups may have faced historical disadvantages.
iii. **Addressing socio-economic disparities**: Southeast Asia's rural areas often exhibit significant socio-economic disparities compared to urban centres. Language used in the context of energy projects should be mindful of these disparities, ensuring that the narratives do not inadvertently reinforce existing inequalities.
iv. **Empowering local voices**: Encouraging and facilitating local communities to express their needs and concerns in their own words can be empowering. They allow for a more authentic and respectful dialogue about energy access and justice.
v. **Creating inclusive narratives**: The language used in the discourse on rural electrification should aim to create narratives that are inclusive of all community members, regardless of their socio-economic status, ethnicity, or gender.

This inclusivity is key to ensuring that the benefits of energy transitions are shared equitably.

By considering these aspects, the narrative surrounding rural electrification in Southeast Asia can become more inclusive and attuned to the historical and current context of the communities involved. This approach not only fosters a sense of fairness and respect but also helps in building more sustainable and effective energy solutions. The use of language and the creation of positive narratives play a significant role in the success of energy transitions not just in Southeast Asia, but potentially across other regions of the Global South. Effective communication—acknowledging and integrating local perspectives and historical contexts—is vital in aligning community-driven energy access programmes with the principles of energy justice.

4.2 Lessons learned

Engaging in broad, open conversations that include diverse local perspectives is key to fostering a comprehensive understanding of energy justice. This approach ensures that the dialogue around energy transitions is inclusive and reflects the multi-faceted nature of local communities. These discussions must also transcend technical and economic aspects, considering social, cultural, and ethical dimensions of energy access and sustainability.

Addressing and reframing any negative associations with energy access initiatives are also crucial. In conversations with local communities, researchers noted that these can be achieved by highlighting the tangible benefits of these initiatives and aligning them with local priorities and values. Varied understandings of energy access across communities necessitate a nuanced approach in communication, and one that is sensitive to the local socio-cultural frameworks.

5. Fostering success through consultation and collaboration in DES projects

The success of DES in rural localities of Southeast Asia is deeply rooted in the active consultation and collaboration among diverse stakeholders. Engaging a wide range of participants—from local authorities and NGOs to private sector players and community members—is crucial for the effective implementation and sustainability of DES projects and was pivotal in the success of the case studies explored. Such broad-based engagement ensures that these energy initiatives are not only

technically sound but also socially and culturally attuned to the communities they serve.

5.1 Broad engagement for just transitions

Local knowledge is an invaluable asset in designing and implementing energy projects, particularly in the case of DES in Indonesia and Malaysia. Engaging with communities provides insights into their unique challenges, aspirations, and cultural nuances. This local understanding is crucial in developing solutions that are not only technically viable but also socially and culturally acceptable, garnering buy-in from the communities that are benefiting from these systems, as well as offering opportunities for the continued success and utilisation in these systems in the medium and long term. In Indonesia, the Ulu-Danau Micro Hydro Power Plant exemplifies the power of community engagement. Managed by IBEKA, a local NGO, the project not only secured funding but also fostered the creation of village-based organisations, including the active participation of women, to ensure the project's sustainability. This local involvement was crucial in addressing the unique challenges and aspirations of the community.

Consultation with a diverse array of stakeholders, including local authorities and NGOs, also provides a multi-dimensional perspective for comprehensive project planning and execution. This collaborative approach ensures that various viewpoints are considered, leading to more robust and sustainable energy solutions while also incorporating aspects of justice that may otherwise be overlooked. In Malaysia, the Sarawak Alternative Rural Electrification Scheme (SARES) demonstrates the effectiveness of collaboration between government and community. This off-grid initiative, implemented by Sarawak Energy and funded by the Sarawak Government, provided remote households with solar or micro-hydro systems. Community training for operation and maintenance was integral to the project's success, ensuring long-term viability and local ownership.

5.2 Key lessons for effective collaboration

i. **Community-centric approaches:** Ultimately, the four case studies highlight the importance of placing communities at the heart of DES projects. By engaging them in planning and decision-making, projects become more sustainable and culturally sensitive.
ii. **Building trust through transparency and engagement:** In Vietnam, the Lotus project, focusing on renewable electrification, demonstrates the

importance of trust-building. By engaging communities in the planning stages and considering their future needs, Lotus ensures long-term project success and community buy-in.

Emphasising the need for a community-focused participatory approach, transparent communication, and the engagement of young people in sustainable energy initiatives, these case studies underscore the essence of consultation and collaboration in DES projects within the Asia-Pacific. By involving diverse stakeholders, respecting local cultures and needs, and ensuring community participation, these projects have not only achieved technical success but have also contributed to local economic development and energy justice. As we move forward, the path to sustainable energy solutions in rural areas lies through a collaborative, inclusive approach that values and integrates the voices of all stakeholders.

6. Workforce transitions and decent employment

In Southeast Asia's journey towards sustainable energy systems, the entwinement of economic and environmental goals is critical. Workforce changes are necessary for achieving these intertwined objectives, particularly in the context of rural electrification through renewable energy sources. The transition presents both challenges and opportunities, especially in terms of employment and workforce development in rural communities. This research highlighted some of these issues, but further analysis, over a longer period of time, would benefit both the research and the long-term outcomes of programmes in these spaces.

In the context of rural electrification in Southeast Asia, the interconnectedness of economic and environmental vulnerabilities is particularly pronounced. This entwinement highlights the fact that environmental changes, such as those necessitated by the shift to renewable energy sources, have direct and profound economic implications, especially for rural communities. These populations often face dual vulnerabilities: economic instability due to changing labour markets and environmental risks exacerbated by climate change and unsustainable energy practices. Recognising this interconnectedness is crucial in ensuring that the transition to renewable energy systems not only addresses environmental concerns but also supports and enhances economic stability and growth for these communities. This approach underlines the need for energy policies and initiatives that are holistic, considering both environmental sustainability and economic vitality as inseparable and equally important objectives.

6.1 Recognising interconnected vulnerabilities

The shift to renewable energy systems is not just an environmental imperative; it has significant socio-economic implications, particularly for local workforces. Many rural communities in Southeast Asia, dependent on traditional forms of livelihood, face vulnerabilities that are both economic and environmental. The transition to renewable energy offers an opportunity to address these vulnerabilities by creating new jobs and promoting sustainable economic growth.

The move towards increased renewable energy use in Southeast Asia's rural areas offers a paradigm shift in how local communities interact with their environment and economy. Historically, many communities have relied on agricultural or traditional industries, which are often susceptible to environmental changes and economic fluctuations. Renewable energy projects, such as solar and micro-hydro power installations found in Indonesia, Malaysia, and the Philippines, not only reduce environmental degradation but also introduce new forms of livelihood that are more resilient to climate change. This shift has the potential to rejuvenate local economies by diversifying income sources. Moreover, it empowers these communities to participate in energy projects and their continued utilisation and management (particularly those in remote or underserved areas) by fostering local entrepreneurship and skill development. In this way, the move to greener energy sources and the distributed energy systems studied is a path to economic resilience, helping communities withstand and adapt to both current and future economic and environmental challenges.

6.2 Prioritising workers' benefits in just transitions

The concept of just transitions is pivotal in the discourse on transitioning to more sustainable energy systems, underscoring the imperative to prioritise the well-being and advancement of workers. Central to this approach is the commitment not to overlook the workforce implications, especially for those traditionally employed in non-renewable energy sectors. The global shift in energy systems presents unique opportunities and challenges, often at the crossroads of traditional and modern energy practices. As the energy landscape undergoes changes to achieve climate and energy goals, it becomes essential to implement strategies that encompass retraining programmes, fair compensation, and the development of new job opportunities within burgeoning energy sectors. These measures are fundamental in ensuring an equitable and inclusive shift towards sustainable energy practices. This transition presents a unique opportunity not only to redefine the energy landscape but also to reshape workforce dynamics in a way that benefits and empowers workers:

i. **Transitioning rural workforces:** The move towards DES involves transitioning rural workforces towards new forms of employment. This includes providing training and development opportunities focused on skills relevant to DES, such as installation, maintenance, and management of renewable energy technologies. Tailoring these programmes to local contexts is vital for ensuring that they are both accessible and beneficial to rural populations.
ii. **Incorporating traditional energy sector skills:** Many skills from traditional energy sectors are transferable to DES. For example, mechanical and electrical skills used in conventional energy can be adapted to renewable technologies. Recognising and harnessing these existing skills can facilitate smoother transitions for workers and enhance the efficiency of DES projects.
iii. **Local economic development through DES:** DES projects offer more than just energy solutions; they can stimulate local economies by creating jobs and supporting ancillary services. Engaging local workers in these projects not only provides employment but also helps in building a sense of ownership and community involvement in the energy transition.
iv. **Community-centric approach to workforce development:** A community-centric approach is essential in DES projects. This involves understanding the unique socio-economic dynamics of rural communities and designing workforce development initiatives that are aligned with these nuances. By doing so, the transition to DES can contribute to broader community development goals, including poverty alleviation and social empowerment.
v. **Policy support for just transitions in rural areas:** Government policies and support mechanisms play a critical role in facilitating just transitions in rural areas. This includes creating incentives for renewable energy companies to hire locally, providing funding for workforce training programmes, and ensuring that rural communities are actively involved in planning and decision-making processes related to DES.

Aligning workforce transitions with the adoption of DES in rural communities is not just about technological change, but also about nurturing human capital and supporting local economies. This approach ensures that the benefits of renewable energy extend beyond environmental impact, fostering sustainable development and enhancing the quality of life in rural areas.

Prioritising workers' benefits in the transition to renewable energy is not just a matter of equity or fairness; it is a strategic approach to ensure the long-term success and sustainability of this transition, and the projects that power it. By focusing on retraining, fair compensation, job creation, local economic development, and community involvement, just transitions can deliver tangible benefits to workers

and communities, thus supporting the development of a more equitable and sustainable energy future.

6.3 Identifying net-zero job opportunities and initiating retraining programmes

The renewable energy sector is expected to generate a multitude of job opportunities, marking a significant shift in the employment landscape. Identifying these opportunities, particularly in off-grid rural electrification, and aligning them with the skills and capacities of the local workforce are crucial. This alignment requires targeted skill development programmes and educational initiatives to prepare the workforce for new roles in renewable energy projects.

In line with the findings of our research, the transition to renewable energy in rural Asia-Pacific regions, especially through off-grid electrification, is not just an infrastructural change but a catalyst for socio-economic transformation. Our case studies in Indonesia, Malaysia, the Philippines, and Vietnam reveal that localised renewable energy projects, such as microgrids, have the potential to create a variety of jobs that go beyond the traditional energy sector roles. These range from technical positions like system installation and maintenance to community-oriented roles such as project coordination and user education. To harness this potential, it is imperative to establish retraining programmes tailored to the unique contexts of these communities. These programmes should focus on equipping the local workforce with necessary technical skills, while also fostering an understanding of sustainable energy management and its broader socio-economic benefits. Moreover, educational initiatives should be designed to not only transfer knowledge but also to empower communities to become active participants in their energy systems. This approach aligns with the broader goals of energy justice and inclusivity, ensuring that the shift to renewable energy contributes to a holistic development of rural areas, as observed in our case studies.

6.4 Collaborating across sectors for holistic impact

The effective transition of the workforce in the context of rural electrification projects in Southeast Asia demands a concerted effort from a variety of stakeholders. Our research findings emphasise the importance of such collaboration, particularly in the diverse socio-economic landscapes of Indonesia, Malaysia, the Philippines, and Vietnam. Engaging trade unions, local communities, non-governmental organisations, and academic institutions is crucial in ensuring that the transition to renewable energy is both inclusive and beneficial to all sections of society. Engagement across these groups would provide the following:

i. **Role of trade unions and NGOs**: In the context of Southeast Asia's rural electrification, trade unions and NGOs can play pivotal roles in advocating for workers' rights and ensuring fair labour practices. These organisations can also be instrumental in facilitating dialogue between the community and associated energy companies, ensuring that local voices are heard and considered in decision-making processes.
ii. **Community engagement**: Our case studies highlight the importance of deeply involving local communities in renewable energy projects. This involvement goes beyond mere consultation; it encompasses active participation in planning, implementation, and management. This type of engagement ensures that projects are tailored to meet the specific needs of the community, thereby enhancing the social acceptability and sustainability of these initiatives.
iii. **Academic contributions**: Academics can contribute significantly through research and analysis, providing data-driven insights into the most effective strategies for workforce transition in the renewable sector. Researchers, like those at UiTM (Universiti Teknologi MARA) in Malaysia, have already contributed significantly to the evaluation and monitoring of these programmes. By studying the impacts of various renewable energy initiatives, academic research can guide policy development and programme design, ensuring they are based on sound evidence and best practices.
iv. **Policy development and programme design**: The collaboration between these diverse stakeholders is essential in developing policies and programmes that address the multi-faceted aspects of workforce transition in rural electrification. Policies need to be sensitive to the unique economic and cultural contexts of rural communities in Southeast Asia, ensuring that they support sustainable development and social equity.
v. **Integrating local and regional perspectives**: Our research underscores the necessity of integrating both local and regional perspectives in the transition to renewable energy. The varied cultural, economic, and political systems in the case study countries require a nuanced approach to workforce transition, one that aligns with broader regional goals while respecting local specificities.

In essence, this multi-stakeholder collaboration, as evidenced in our research, is key to a holistic and impactful transition to renewable energy in rural areas of Southeast Asia. It not only supports the economic and social aspects of the transition but also ensures that the benefits are equitably distributed, contributing to the overall resilience and sustainability of these communities.

6.5 Towards sustainable employment

The transition to renewable energy in Southeast Asia's rural areas presents a unique opportunity to drive economic growth and create sustainable employment. However, this transition must be managed inclusively and justly to ensure that the benefits are equitably distributed and that local workforces are adequately prepared and supported. As the region moves towards a greener future, it is imperative that these transitions are not only environmentally sustainable but also socially equitable and economically beneficial for all.

The transition to renewable energy within the rural locales of Southeast Asia stands as a critical juncture for economic evolution and the creation of sustainable employment. Our research has highlighted the workforce opportunities embedded within this transition, including upskilling and retraining initiatives, essential for realigning the workforce from traditional energy roles to burgeoning opportunities in the green energy sector. The pivotal role of collaborative efforts across various sectors has also been underscored, emphasising the need for integrated approaches to ensure inclusive growth and equitable benefit distribution.

Through the examination of four of Southeast Asia's rural DES projects, it is evident that these initiatives offer more than environmental solutions; they are instrumental in driving socio-economic development. These projects contribute to diversifying rural economies and enhancing the resilience of local communities. As the region progresses towards increased renewable energy adoption, the intertwined goals of environmental sustainability, economic vitality, and social equity remain at the forefront, guiding the path towards a balanced and sustainable future.

5. Conclusions: summarising the critical insights for policymakers

This study rigorously examined four case studies—Indonesia, Malaysia, the Philippines, and Vietnam—to unravel the complexities of energy justice and rural electricity access in the Southeast Asian sub-region. This analysis revealed distinct realisations of academic energy justice concepts, influenced by local variations in energy access and interactions with support programmes. Notably, community narratives exhibited a conspicuous absence of justice considerations, often perceived as externally imposed rather than intrinsic principles. Varied perspectives on well-being, quality of life, and choices related to electricity access challenged established academic notions of justice across the case studies. The ensuing key findings present a synthesis that holds significant implications for policymakers navigating the intersection of energy access, justice, and sustainable development in the region:

i. Academic concepts of energy justice manifest diversely in Asia-Pacific communities, shaped by energy access levels and support programmes.
ii. Justice framings are notably absent from local narratives, often perceived as top-down, academic-driven processes.
iii. Well-being, quality of life, and choices related to electricity access vary across case studies, sometimes deviating from academic notions of justice.
iv. Community-driven energy access programmes take various technical forms, garnering support from public, NGO, and private sectors across Indonesia, Malaysia, the Philippines, and Vietnam.
v. Successful distributed energy systems often result from a partnership between publicly funded NGOs, the state, and civil society, leveraging their complementary skills.
vi. Local authorities play a crucial role post-funding, ensuring sustained success and emphasising the local economic impact for long-term viability.
vii. Future research avenues include assessing the long-term viability of business models beyond initial project phases and exploring new markets in state-driven systems with increased private sector involvement.

In consolidating the salient findings of this research, we have identified several key insights with substantive implications for policymakers that are navigating the intricate terrain of energy justice in Southeast Asia. Academic conceptualisations of energy justice exhibit distinctive realisations within local communities, contingent upon their specific energy access levels and participatory engagement with support programmes. Notably, justice considerations exhibit a marked absence within community narratives, often manifesting as imposed, top-down constructs rather than intrinsic principles. Divergent perceptions regarding well-being, quality of life, and choices pertaining to electricity access challenge established academic paradigms of justice, presenting a nuanced outlook across the diverse case studies. The emergence of community-driven energy access initiatives, supported by public, NGO, and private sectors, underscores a promising trend in Indonesia, Malaysia, the Philippines, and Vietnam. The symbiosis between publicly funded NGOs, state entities, and civil society emerges as pivotal, while the indispensable role of local authorities post-funding becomes evident in ensuring sustained success. These findings prompt further exploration into the enduring viability of business models and the intricacies of nascent markets in state-driven systems undergoing evolving private sector involvement.

7.1 Implications for future research

The findings from this study not only illuminate the current landscape of rural electrification in Southeast Asia, but also highlight critical areas for future research. A significant aspect that warrants deeper investigation is the impact of these energy transitions on local labour markets and workplace dynamics. Future studies could explore how shifts towards renewable energy systems affect employment patterns, especially in communities transitioning from traditional energy sources to distributed energy systems. This includes examining the potential for job creation in new energy sectors, the need for skills training and workforce development, and the socio-economic implications of such transitions on local labour markets.

Moreover, there is opportunity to delve into the potential for distributed energy systems to create decentralised, community-based employment opportunities. This could involve studying the viability of local entrepreneurship models in the maintenance, operation, and management of these systems. Another crucial area is understanding how these transitions affect gender dynamics in the workforce, exploring how increased access to electricity might empower women and provide them with new economic opportunities.

In addition, investigating the long-term sustainability of business models in post-funding phases remains a key area of focus. This research should aim to comprehend how these models adapt and sustain themselves amidst changing economic, environmental, and political contexts. The role of private sector involvement in traditionally state-driven systems, and the interplay between public and private entities, also present an interesting area for exploration, especially in terms of funding and governance structures. Understanding these dynamics is essential for developing resilient, adaptable, and inclusive rural electrification strategies that not only address energy needs but also contribute to the broader socio-economic development of the region.

7.2 A holistic and collaborative approach for a just transition

This study's insights into the multi-faceted nature of rural electrification in Southeast Asia call for a concerted, action-oriented response from various stakeholders. The research underscores the need for an integrated approach that marries the technical and socio-economic aspects of energy transitions, particularly in the context of achieving energy justice in rural communities. Policymakers, practitioners, and the private sector must collectively prioritise the development of energy systems that are not only efficient and sustainable but also equitable and inclusive.

The absence of justice frameworks in local narratives, as highlighted by our findings, suggests an urgent need for more grassroots-oriented and culturally sensitive approaches to energy policy and implementation. Efforts should be directed towards demystifying the concept of energy justice and embedding it into the fabric of community engagement and participation. This involves moving beyond top-down, academic-driven processes to more inclusive, locally driven initiatives that resonate with the everyday experiences and aspirations of rural communities.

Moreover, the potential of community-driven energy access programmes, supported by a mix of public, NGO, and private sector involvement, highlights the importance of collaborative models that leverage the strengths of diverse stakeholders. Such partnerships can lead to more resilient and adaptive energy solutions that address not only the technical aspects of electrification but also the socio-economic needs of the communities.

Addressing the gap in labour and workplace dynamics within these energy transitions is also crucial. Future strategies should focus on creating sustainable employment opportunities, enhancing workforce capabilities, and ensuring that the benefits of energy transitions are distributed fairly across all sections of society. This includes special attention to vulnerable groups, such as women and ethnic minorities, to ensure that these transitions do not perpetuate existing inequalities but rather contribute to broader social and economic development.

The path to rural electrification Southeast Asia, grounded in the principles of justice and sustainability, requires a holistic, multi-stakeholder approach. It is a call to action for all involved to foster energy systems that are not only environmentally sound and economically viable but also socially just and empowering for the communities they serve.

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