Just Transitions to Decarbonisation in the Asia-Pacific

Facilitating a Just, Fair, and Affordable Energy Transition in the Asia-Pacific

June 2022

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About Just Transitions to Decarbonisation in the Asia-Pacific

Working in partnership with teams from the UK Science & Innovation Network, the programme examines how just transitions whilst tackling climate change and biodiversity is key to supporting inclusive economies and societies in the future. Through the programme, the Academy awarded funding to seven research projects exploring the actions required in the Asia-Pacific to tackle climate change and biodiversity loss, to identify opportunities for decarbonising economies and societies, and to recommend options and pathways for communities, workers, businesses, policymakers and the wider public. The programme was funded by the UK's Department for Business, Energy and Industrial Strategy.

Contents

Highlights: challenges and opportunities

Opportunities

Community driven energy access programs

Partnerships across public sector, private companies, and NGOs

Local authorities buy-in and imbedded participation

Challenges

Justice frameworks missing or top-down driven

Variances in perceptions of energy access and justice

Continuous monitoring of success and failures over 5–10-years

- Academic notions of energy justice are being realised in different ways within local Asia-Pacific communities, largely dependent on their level and quality of energy access and types of support programs in communities.
- Justice framings are largely missing from community narratives in case study locations and appear largely as a top-down, academic-driven processes.
- Perceptions of wellbeing, quality of life, and choices with regards to electricity access differ across case studies but also differ from academic notions of justice, with largely positive views in our case studies regardless of access level.
- Community driven energy access programs are being realised in a variety of technical forms, with similar public, NGO and private sector support in Indonesia, Malaysia, the Philippines, and Vietnam.
- We have found that there is a marriage between publicly funded NGO and state-driven management of distributed energy systems, suggesting an optimal partnership between state and civil society actors that utilises the complementary skills sets of each actor depending on the local context.
- The role of local authorities is essential to the success of distributed energy systems after their initial funding and development, as is the local economic development impacts of these systems for long-term success.
- Areas for further research include examination of the long-term success of business models, past the 5- and 10-year marks of projects and examination of new markets as private sector actors are introduced in state driven systems.

Executive summary

This study reviewed four case studies of micro-grids for off grid rural electrification in four ASEAN countries: Indonesia, Malaysia, the Philippines, and Vietnam. Using a mixed methods investigation, researchers identified the techno-economic properties of these systems, the nature of the business models used to deliver them, and how these business models implicate the realisation of fair and equal access to energy in rural communities.

At the national level we have observed opportunities for the examination of new markets should they develop in these largely state driven economies. At the moment, electricity and energy are predominantly controlled by the government, with little if any private sector involvement in Indonesia, Malaysia, and Vietnam, and some involvement in the Philippines. Liberalisation of these systems may influence private sector access and therefor funding, which has implications for the development of more distributed energy systems in the future.

In the context of energy justice, the regional energy transition is not just good for the environment but will also benefit the region's individual and collective economies. In this regard, the clean energy transition has co-benefits for local populations by creating jobs and providing electricity to rural community areas, all while reducing the negative health and environmental effects of regional and global climate change.

1.0 Overview

This research seeks to understand how alternative business models and governance approaches affect rural electricity access in the Asia-Pacific. The research also provides context to the challenges associated with a just regional energy transition, highlighting the dual benefits of increasing regional energy access and agency while also addressing shared climate and decarbonisation challenges.

1.1 Context: rural electrification in ASEAN

Affordable and clean electricity access is a fundamental enabler of many of the United Nations' 17 Sustainable Development Goals (SDG) (Figure 1). Furthermore, the COVID-19 outbreak highlights the importance of electricity and internet access for public health, epidemiology, and treatment in remote locations.[1] However, mains electricity access in rural and island locations remains patchy due to high infrastructure costs, network maintenance, and administration challenges.[2] In the Asia-Pacific region the opportunities created from the unique geographical constraints (i.e., unconnected islands, archipelagos, and vast areas of coverage) are magnified by development challenges associated with rapid growth and growing urban-rural divides. This is particularly true in the subregion of Southeast Asia, where the members of ASEAN (the Association of Southeast Asian Nations) are working towards reaching 100% electrification, but with geographical and resource constraints that apply addition pressure to national and subregional targets.

Figure 1. How affordable and clean energy support the other SDGs.

Affordable and clean energy

Human development	Environmental sustainability	Sustainable growth
1. No poverty 2. Zero hunger 3. Good health and well-being 4. Quality education 5. Gender equality 6. Clean water and sanitation 10. Reduced inequalities 17. Partnership for the goals	1. No poverty 2. Zero hunger 3. Good health and well-being 11. Sustainable cities and communities 12. Responsible consumption and production 13. Climate action 14. Life below water 15. Life on land 16. Peace, justice and strong institutions 17. Partnership for the goals	1. No poverty 4. Quality education 5. Gender equality 8. Decent work and economic growth 9. Industry, innovation and infrastructure 10. Reduced inequalities 11. Sustainable cities and communities 12. Responsible consumption and production 13. Climate action 16. Peace, justice and strong institutions

Source: IRENA[3]

1 REN21 & ADB (2021), Asia-Pacific Renewable Status Report, REN21.
2 Purwanto, W., Afifah, N. (2016), 'Assessing the Impact of Techno Socioeconomic Factors on Sustainability Indicators of Microhydro Power Projects in Indonesia: A Comparative Study', *Renewable Energy,* 93, pp. 312–322. https://doi.org/10.1016 /j.renene.2016.02.071.
3 IRENA (2019), Off-Grid RE Access, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Off-grid_RE_Access_2019.pdf

Significantly more investments are needed to achieve SDG-7 to “ensure access to affordable, reliable, sustainable and modern energy for all,” as well as SDG-13 to “take urgent action to combat climate change and its impacts.”[4] While many developing nations have made great strides in SDG-7 in recent decades, the remaining challenge is by no means trivial. The Alliance for Rural Electrification estimate almost 1 billion people are still without access to modern forms of electricity. The bulk of the people without access to energy in South-East Asia live in four countries: Myanmar (16 million), Philippines (11 million), Indonesia (5 million) and Cambodia (2 million).[5] However, there are also substantial numbers in both Malaysia and Vietnam. The Energy Sector Management Assistance Program (ESMAP)[6] estimates that falling technology costs and increasingly favourable policy environments mean “micro-grids” – islanded electricity systems not connected to the main electricity grid- can economically connect 490 million people globally by 2030. This will require more than 210,000 micro-grids and almost USD 220 billion in investment, and 1,700 mini-grids per month coming online in the next 10 years. If realised, this would create an annual profit for private micro-grid developers of USD 3.3 billion between 2019-2030 and a net profit of USD 4.7 billion across all mini-grid component and service suppliers in 2030.[7] Developing business models which help rural communities capture a share of these revenues, is therefore of huge development importance.

Consequently, access to reliable, affordable electricity for industrial, commercial, and household uses remains a policy priority with the potential for poverty reduction and to mitigate environmental impacts. The challenge of developing electricity access for rural communities while ensuring that electricity generation is consistent with regional and global climate targets and a transition from hydrocarbon dominated energy systems, also carries great opportunity. Harnessing the private sector and local communities to participate in this transition while also providing the necessary sustainable rural electrification services through commercially viable renewable energy technologies are key challenges this research seeks to unpack.

Distributed renewable energy systems (DES) are increasingly fundamental in achieving these SDGs objectives. Governments of the Asia-Pacific are therefore developing rural electrification programs including renewable micro-grids to increase energy access and facilitate the national and regional energy transition away from fossil fuels.[8] These microgrids tend to be sited in remote locations where access to the main power grid is too complex or expensive.[9] The Asia-Pacific is the largest growing market for micro-grids, with regional governments in Southeast Asia developing over 1000 projects in recent years.[10] Although many of these projects include photovoltaics (PV) micro-hydro and battery storage in remote locations, most off-grid systems are still powered by high carbon diesel generators, whilst many locations remain with limited or no access to power.

These projects are therefore often the first form of electricity brought to these communities, although occasionally they displace an existing off-grid electricity system based on diesel generators. Consequently, these projects are likely to create both winners and losers in local and national supply chains, and therefore

4 ARE and GIZ (2020), Position Paper. Off-Grid Renewable Energies to acgueve SDG-7 and SDG-13: Cheaper, Cleaner and Smarter, pp. 1–8.

5 Alliance for Rural Electrification (2020), Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learnt from South and South-East-Asia, Brussels, www.ruralelec.org

6 ESMAP (2019), Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, Executive Summary, pp. 2-7

7 Alliance for Rural Electrification (2020), Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learnt from South and South-East-Asia, Brussels, www.ruralelec.org

8 REN21 & ADB (2021), *Asia-Pacific Renewable Status Report,* REN21.

9 IRENA (2019), Off-Grid RE Access, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Off-grid_RE_Access_2019.pdf

10 REN21 & ADB (2021), *Asia-Pacific Renewable Status Report*, REN21.

have important implications for a "just transition". Recent research also indicates these renewable micro-grids often face challenges in their financial sustainability, maintenance, and governance[11]–suggesting a lack of local engagement in the current delivery model and that new business and governance models are needed. This includes reliability issues with some systems experiencing premature deterioration, in part due to flawed institution and governance relationships, lack of ongoing operation and maintenance, and a lack of engagement and capacity with host communities.[12] **Electricity access is measured based on the combination of seven attributes of energy across six tiers of access with minimum requirements by tier of electricity access.**

The multi-tier framework (MTF) for measuring access to electricity starts with the lowest level of access (Tier 1), referring to limited access to small quantities of electricity for a few hours per day, enabling the household to use electric lighting and phone charging (see table below). This level of access can be provided by any technology, even a small solar lighting system. Higher tiers of access are defined by higher capacity and longer duration of supply, enabling the use of medium and high load appliances (such as refrigerator, washing machine and air conditioning).

A grid is the most likely source for delivering high access tiers, although a diesel generator or a large mini-grid may do so as well. Nonetheless, additional attributes - beyond capacity and duration – are accounted for in higher tiers of access, such as reliability, quality, affordability, legality and safety.

Each attribute is assessed separately, and the overall tier for the household's access to electricity is calculated by applying the lowest tier obtained in any of the attributes.

11 M. Derks, H. Romijn (2019), Sustainable Performance Challenges of Rural Microgrids: Analysis of Incentives and Policy Framework in Indonesia, *Energy for Sustainable Development,* 53, pp. 57–70, https://doi.org/10.1016/j.esd.2019.08.003.

12 Ibid.
McCauley, D , Heffron , R , Stephan , H & Jenkins , K E H. (2013), Advancing Energy Justice: The Triumvirate of Tenets and Systems Thinking. *International Energy Law Review,* 32(3), pp. 107-116.

Figure 2. Multi-tier framework for measuring access to electricity

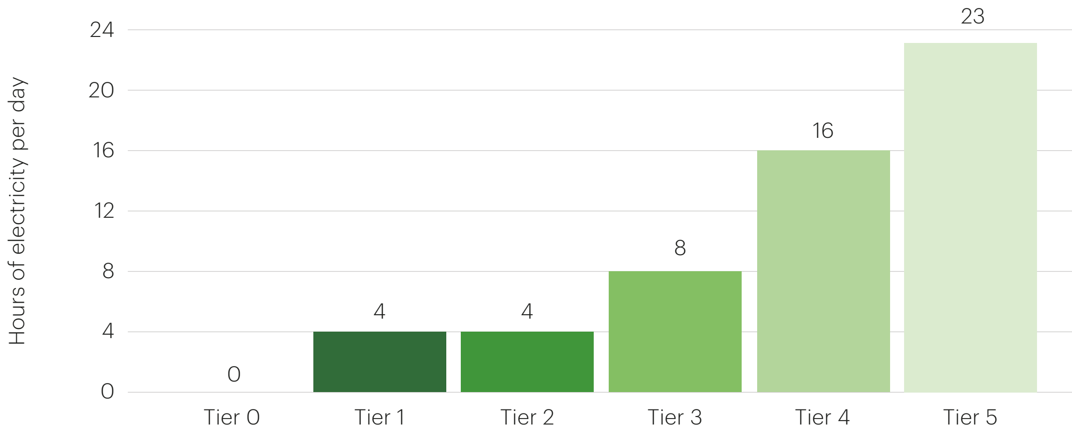
Attributes		**Tier 0**	**Tier 1**	**Tier 2**	**Tier 3**	**Tier 4**	**Tier 5**
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 W
		Less than 12 Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting, air circulation, television, and phone charging are possible			
Availability†	Daily Availability	Less than 4 hours	At least 4 hours		At least 8 hours	At least 16 hours	At least 23 hours
	Evening Availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week or at most 3 disruptions per week with a total duration of more than 2 hours	(>3 to 14 disruptions / week) or ≤ 3 disruptions / week with > 2 hours of outage	At most 3 disruptions per week with total duration of less than 2 hours
Quality						Voltage problems do not affect the use of desired appliances	
Affordability		Cost of a standard consumption package of 356 kWh per year is more than 5% of household income			Cost of a standard consumption package of 365 kWh per year is less than 5% of household income		
Formality		No bill payments made for the use of electricity				Bill is paid to the utility, pre-paid card seller, or authorised representative	
Health and safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

† Previously referred to as "Duration" in the 2015 Beyond Connections report, this MTF attribute is now referred to as "Availability," examining access to electricity through levels of "Duration" (day and evening). Aggregate tier is based on lowest tier value across all attributes* Colour signifies tier categorisation.

Source: Bhatia and Angelou.[13]

13 Bhatia, M., Angelou, N. (2015), Beyond Connections: Energy Access Redefined. ESMAP Technical Report, 008/15, World Bank, https://openknowledge.worldbank.org/handle/10986/24368 License: CC BY 3.0 IGO.

Figure 3. Minimum requirements by tier of electricity



Tier 0	Tier 1	Tier 2
Electricity is not available or is available for less than 4 hours per day or less than 1 hour per evening. Households cope with the situation by using candles, kerosene lamps, or dry-cell-battery-powered devices (flashlight or radio).	At least 4 hours of electricity per day is available (including at least 1 hour per evening, and capacity is sufficient to power task lighting and phone charging or a radio. Sources that can be used to meet these requirements include a SLS, a solar home system (SHS), a minigrid (a small-scale and isolated distribution network that provides electricity to local communities or a group of households), and the national grid.	At least 4 hours of electricity per day is available (including at least 2 hours per evening, and capacity is sufficient to power low-load appliances—such as multiple lights, a television, or a fan—as needed during that time. Sources that can be used to meet these requirements include rechargeable batteries, an SHS, a mini-grid and the national grid.

Tier 3	Tier 4	Tier 5
At least 8 hours of electricity per day is available (including at least 3 hours per evening) and capacity is sufficient to power medium-load appliances–such as a refrigerator, freezer, food processor, water pump, rice cooker, or air cooler—as needed during that time. In addition, the household can afford a basic consumption package of 356kWh per year. Sources that can be used to meet these requirements include an SHS, a generator, a mini-grid, and the national grid.	At least 16 hours of electricity per day is available (including 4 hours per evening) and capacity is sufficient to power high-load appliances—such as a washing machine, iron, hair dryer, toaster, and microwave—as needed during that time. There are no frequent or long unscheduled interruptions and the supply is safe. The grid connection is legal and there are no voltage issues. Sources that can be used to meet thee requirements included diesel-based mini-grids and the national grid	At least 23 hours of electricity per day is available (including 4 hours per evening) and capacity is sufficient to power very high-load appliances—such as an air conditioner, space heater, vacuum cleaner, or electricity cooker—as needed during that time. The most

Source: Bhatia and Angelou.[14]

This project therefore explores how emerging local energy business models, and intermediate technology may be combined with community governance and political will to deliver more just and beneficial outcomes. These findings can therefore be used to develop scalable models for the Asia-Pacific and the wider world.

14 Ibid.

1.2 Business models and microgrids

Business models describe the social and economic “value proposition” produced by economic actors; how this value is created, and how revenues are captured from these activities. Business models are therefore used as both a tool by business practitioners, and as a framing device for academic study. Whilst this thinking originated in the business and management field, the business model framework is increasingly adopted by social science and sustainability researchers.[15] The power of the concept lies in its ability to bridge both social and economic dimensions to allow comparative study and analysis between different models or approaches to economic life in similar fields or sectors.

Researchers are increasingly adopting business models as a lens to study the relationships between energy providers, energy users and energy technologies.[16] This field is particularly useful in understanding the novel commercial, technological and social configurations which accompany DES.[17] Because DES involve a much more decentralised form of electricity provision, the also necessitate more localised transactions between producers and consumers, whose boundaries may be blurred – known as the “prosumer” phenomenon.[18] These emerging business models are, therefore, likely to create new forms of social and economic value as well as potentially create new winners and losers in this transition.[19]

Brown formalises the study of energy business models into five core components. The value proposition which refers to the value or utility from goods and services that a supplier or network provides to the customer.[20] The supply chain which describes the upstream relationships between an organisation and its suppliers. This comprises the logistical and technical elements that enable delivery of the value proposition. The customer interface covers all downstream, consumer-related interactions. This includes the relationship the consumer has with the supplier organisations in terms of marketing, sales and distribution channels and the ongoing relationship with the product or service. The financial model constitutes the combination of an organisation’s capital and operational expenditures with its means of revenue generation. This is linked to the value proposition, in terms of what products and services customers pay for and how revenues are collected and distributed. Business model governance involves the co-ordination and management of the other components and the organisational form of the business model. Thus, may involve a single organisation or a network of interdependent firms that interact to provide a service or product.

While there is a growing research focus on the importance of DES business models, this literature is heavily biased towards the global north.[21] These studies have attempted to create typologies of both DES business models[22] and those which focus specifically on the prosumer phenomenon,[23] drawing on emerging examples, often

15 Bocken, N. M., Short, S. W., Rana, P., & Evans, S. (2014), A literature and practice review to develop sustainable business model archetypes, *Journal of cleaner production*, 65, pp. 42-56.

16 Richter, M. (2012), Utilities’ business models for renewable energy: A review. *Renewable and Sustainable Energy Reviews*, 16(5), pp. 2483-2493.

17 Hall, S., & Roelich, K. (2016), Business model innovation in electricity supply markets: The role of complex value in the United Kingdom, *Energy Policy*, 92, pp. 286-298.

18 Parag, Y., & Sovacool, B. K. (2016), Electricity market design for the prosumer era. Nature energy, 1(4), 1-6

19 Adams, S., Brown, D., Cárdenas Álvarez, J. P., Chitchyan, R., Fell, M. J., Hahnel, U. J., & Watson, N. (2021), Social and economic value in emerging decentralized energy business models: A critical review, *Energies*, 14(23), p. 7864

20 Brown, D. (2018), Business models for residential retrofit in the UK: a critical assessment of five key archetypes, *Energy Efficiency*, 11(6), pp. 1–26. doi: 10.1007/s12053-018-9629-5.

21 Hostettler, S. (2015), ‘Energy challenges in the Global South’, In *Sustainable Access to Energy in the Global South*, Springer, pp. 3-9.

22 Hall, S., & Roelich, K. (2016), ‘Business model innovation in electricity supply markets: The role of complex value in the United Kingdom’, *Energy Policy*, 92, pp. 286-298.

23 Brown, D., Hall, S., & Davis, M. E. (2019), ‘Prosumers in the post subsidy era: an exploration of new prosumer business models in the UK’, *Energy Policy*, 135, 110984.

made viable through heavily subsidised field trials. These studies have tended to focus on how the technical and economic characteristics of these business models implicate their commercial potential and viability in the liberalised electricity markets of Europe and North America.[24] Consequently, much of this thinking is rooted in the context of full electricity access and a competitive retail electricity market framework. Much less consideration has been given to the utility of the business models framework, in the global south and where mains electricity access is patchy or non-existent, or where utilities are state owned. Despite the lack of focus of the DES business models literature on the global south, a considerable body of literature is focussed on the microgrid phenomena itself.[25]

Microgrids or mini-grids[26] describe a form of electricity network that is either partly or wholly isolated from the main electricity network. These systems are commonly delineated by their grid connected and off grid variants.[27] Grid connected microgrids usually aim to maximise the self-consumption of DES generated electricity within a privately owned or local network (Figure 2). These models are predicated on the fact that in most contexts, it is better to self-consume this electricity than sell it back to the grid. This self-consumed power does not usually include the network and other system charges associated with the grid electricity, particularly when installed "behind the meter".

By contrast off-grid systems are completely isolated from the main electricity grid, and therefore often represent the only form of electricity available to their users. These systems have become increasingly common in the global south, in remote and rural locations, too complex or costly to connect to the main grid, which may have very limited coverage in places.[28] Such models involve a very different set of drivers and challenges, to their grid connected counterparts in the global north. Consequently, much of the literature on these systems has either come from the development studies[29] or power systems engineering fields,[30] with a respective focus on the political and social challenges and the technoeconomic parameters of such models.

Few studies, however, have examined the characteristics of these systems from a business models perspective. Arguably, the business model approach can be an important bridge from the technoeconomic dimensions of these systems and the social value they can create or destroy. Consequently, Table 1 operationalises the business models framework in the context of rural microgrids, thus providing important insights as to the social and technical attributes of these systems as well as providing a structured means of comparing them. In Section 4 we utilise this analytical framework to evaluating the different business models, found in our case studies.

24 Parag, Y., & Sovacool, B. K. (2016), 'Electricity market design for the prosumer era', *Nature Energy,* 1(4), 1-6.
25 Parhizi, S., Lotfi, H., Khodaei, A., & Bahramirad, S. (2015), 'State of the art in research on microgrids: A review', *IEEE Access, 3,* pp. 890-925.
26 We use "Microgrids" in this report but consider these terms interchangeable.
27 Borghese, F., Cunic, K., & Barton, P. (2017), 'Microgrid Business Models and Value Chains', *Schneider Electric.*
28 Mandelli, S., Barbieri, J., Mereu, R., & Colombo, E. (2016), 'Off-grid systems for rural electrification in developing countries: Definitions, classification and a comprehensive literature review', *Renewable and Sustainable Energy Reviews,* 58, pp. 1621-164.
29 Palit, D. and Chaurey, A. (2011), 'Off-grid rural electrification experiences from South Asia: Status and best practices', *Energy for Sustainable Development,* 15(3), pp. 266–276, doi: 10.1016/j.esd.2011.07.004.
30 Azimoh, C. L. et al. (2017), 'Replicability and scalability of mini-grid solution to rural electrification programs in sub-Saharan Africa', *Renewable Energy,* 106, pp. 222–231, doi: 10.1016/j.renene.2017.01.017.

Table 1. Business model components for rural micro-grid

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 who?
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?

1.3 Rural electrification, energy justice and Just Transitions

Globalisation and cultural assimilation influenced by development programmes can undermine culture. Finding the balance between globalisation and cultural preservation is imperative, especially for minority communities. Integration into mainstream culture and society increases connectivity by encouraging economic growth. However, both integration and globalisation threaten cultural sustainability, with the culture of the majority being dominant at the expense of the minority. This is known as acculturation. – Lotus Project

To examine this picture, we have adopted a theoretical approach based on the three components of energy justice identified first by McCauley et al. and further popularised by Sovacool & Dworkin and Jenkins et al., namely: distributional, recognition based and procedural justice.[31] These dimensions, combined with McCauley & Heffron's later addition of restorative justice frame the research team's approach to an inclusive energy justice that is not driven only by Western

31 McCauley, D , Heffron , R , Stephan , H & Jenkins , K E H. (2013), 'Advancing Energy Justice: The Triumvirate of Tenets and Systems Thinking', *International Energy Law Review,* 32(3), pp. 107-116 .
Sovacool, B. K., & Dworkin, M. H. (2015), 'Energy Justice: Conceptual Insights and Practical Applications', *Applied Energy,* 142, pp. 435-444. https://doi.org/10.1016/j.apenergy.2015.01.002.
Jenkins , K E H , McCauley , D , Heffron , R , Stephan , H & Rehner , R W M. (2016), 'Energy Justice: A Conceptual Review', *Energy Research & Social Science,* 11 , pp. 174-182 . https://doi.org/10.1016/j.erss.2015.10.004

ideas of justice, but also justice within a variety of political and economic systems and developing country contexts.[32] In addition, this research approach offers the opportunity to expand on the energy justice literature by exploring the relationship between DES and justice in new, previously underexplored international contexts.[33] These tenets of energy justice which form the projects overarching analytical framework are shown in Table 2.

Table 2. Evaluative and normative dimensions of energy justice

Tenets	Evaluative	Normative
Distributional	Where are the injustices?	How should we solve them?
Recognition	Who is ignored?	How should we recognise them?
Procedural	Is there fair process?	How do we make these processes fair?
Restorative	Where has damage occurred?	How should we restore the damage?

Source: adapted from Jenkins et al. (2016) and McCauley and Heffron (2018)

The combination of the theoretical, energy justice framework with analysis of the DES business models will be included following analysis in early to mid-February. This is one of the unique values of this research, as the two have not been combined previously for application in ASEAN's remote communities.

32 McCauley, D., Heffron, R. (2018), 'Just Transition: Integrating Climate, Energy and Environmental Justice', *Energy Policy,* 119, pp. 1-7. https://doi.org/10.1016/j.enpol.2018.04.014.
Sovacool, B.K., Burke, M., Baker, L., Kotikalapudi, C.K. and Wlokas, H. (2017), 'New Frontiers and Conceptual Frameworks for Energy Justice', Energy Policy, 105, pp.677–691.
Lacey-Barnacle, M., Robison, R. and Foulds, C. (2020), 'Energy Justice in the Developing World: A Review of Theoretical Frameworks, Key Research Themes and Policy Implications', *Energy for Sustainable Development,* 55, pp.122–138.

33 Heffron, R., Halbrügge, S., K rner, M.-F., Obeng-Darko, N.A., Sumarno, T., Wagner, J. and Weibelzahl, M. (2021), 'Justice in Solar Energy Development', *Solar Energy,* 218, pp.68–75.

2.0 Aims, objectives, and research questions

The aim of this research is to understand how the 'just transition' is manifested in remote and rural locations without access to mains electricity; to inform recommendations for the design of rural electrification policies in the ASEAN region. The objective is to identify the barriers and solutions to increasing both the number and long-term sustainability of renewable energy micro-grids in the region while also supporting local-community engagement in the energy transition. This research compares the status quo with a range of alternative business models and governance approaches in four brief case studies, including examples of current practice as well as alternative examples that prioritise community engagement and local economic benefits.

This research explores the local challenges of off-grid energy systems through a partnership between UK researchers and research partners at the Solar Energy Research Institute (SRI) at Malaysia's Universiti Teknologi MARA (UiTM), identifying models which enable just and equitable electricity access among the Asia-Pacific's remote and island communities. UK specialists in energy transitions, Asia-Pacific energy policy, and sustainable business models have, with regional energy experts, identified four case studies across the Asia-Pacific (Indonesia, Malaysia, Vietnam and the Philippines), to evaluate the current status of four projects from an energy justice and business models perspective, before workshopping and testing a series of business and policy alternatives that will support public-private engagement in rural electricity access programs.

Our guiding research question for the project is as follows:

How can rural electrification programs be designed to ensure a Just, Fair, and Affordable Energy Transition in the Asia-Pacific?

To address our main research question, we utilised the following research sub questions:

1. How do different techno-economic variables affect the design and viability of rural electrification programs in the Asia-Pacific?

2. How do different business models and modes of governance for Asia-Pacific rural electrification affect the dimensions of energy justice?

3. How should "Just Transitions" be understood in the context of rural electrification programs in the Asia-Pacific?

3.0 Summary of case study analysis

To deliver our aims we undertook a mixed method, comparative case study approach, over the period of December – March 2022. The included basic techno-economic modelling for each project (£/kWh, subsidies, operational costs, distributional impacts), supported by a qualitative analysis of governance and institutional arrangements – via semi structured interviews and small workshops. This qualitative analysis evaluated the socio-cultural and energy justice dimensions of low carbon electrification which may vary between and among the case study communities. The International research team subsequently led policymaker engagement workshops with local, national, and international policymakers and NGOs to discuss the findings and how to scale up rural electrification through equitable and sustainable business models.

The international research team also worked concurrently to address three components of this research— (1) social science research into the energy justice dimensions of rural electrification, (2) the techno-economic analysis of rural electrification business models and (3) the policy implications of these combined findings through stakeholder workshops. These are conceptualised as follows:

1. **Socio-cultural analysis of energy justice in rural electrification:** Qualitative analysis led by the Leeds and Sussex team, focussed on how the ownership, governance, and institutional, and broader cultural and contextual dimensions of the four electrification case studies implicate the key elements of the energy justice framework. This consists of ~15 interviews with 5 in each case study (based on time limitations), focussed on project developers, technology providers, local policymakers, and community leaders. These socio-cultural variables are especially important in determining the suitability of alternatives and varies between Indonesia, Malaysia, the Philippines, and Vietnam's ethnically diverse regions and were therefore used as a factor in case selection.

2. **Techno-economic analysis** led by the UiTM team to compare the economic features of alternative business models in each case study location, including several key variables such as system cost, public grants & subsidies, user tariffs, and financing (cost & source of capital, loan term), among potential others.

3. **Policy workshops:** The findings from the previous two phases were explored in policy stakeholder workshops. The workshops were used to disseminate the findings from the research, understand how just transitions are understood at the regional, national, and local level and as a forum to discuss the potential of different business models and their policy implications. This involved key stakeholders including representatives from ACE, NGOs such as IBEKA as well as local, national, and regional government agencies and development banks. Two workshops, as opposed to one, offered a variety of options for convening, for attendees, and to maximise reach.

Integration of the three phases outlined above contributes to evaluation of the winners and losers in regional electricity access projects, but also identification of impact. Impact is evaluated through a mix of quantitative and qualitative methods, local partnerships, and a combined evaluation of replicable business models for sustainable electricity provision.

4.0 Summary of findings: case study locations

Case studies were selected by shared characteristics relevant to an exploration of energy access, energy justice, and energy transitions in the Asia-Pacific. In addition to their location in the Asia-Pacific and membership in the oldest regional organisation (ASEAN), Indonesia, Malaysia, the Philippines, and Vietnam have similar energy and electrification access goals, diversified energy systems, the potential for increases in renewable energy utilisation, and experience the geographical energy challenges associated with remote and island communities. Further, these four countries also represent a variety of cultural, economic, and political systems that share commonalities with neighbours across the Asia-Pacific, including other countries in the subregions of Southeast and Northeast Asia as well as the Pacific. Finally, while these four may represent a microcosm of the broader region, their relevance in the fastest growing subregion in the Asia-Pacific and their involvement in regional and global climate and energy initiatives make them a vital and logical place for this study to take place.

The project team therefore identified four case study groups: Indonesia, Malaysia, the Philippines, and Vietnam. Our aim was to explore examples of off-grid locations that had been electrified through renewables, were about to, or where these systems were being used in conjunction or as a replacement for diesel generators. The four illustrative case studies therefore have the following characteristics:

1. Microgrid with diesel generators
2. Microgrid with renewables and centralised governance
3. Microgrid with renewables and de-centralised governance
4. Without electricity access, about to have microgrid installed

Additional analysis of data from each energy system was conducted. A summary can be seen below for each case study location. However, the full report draft does show empirical details and expands upon this analysis.

4.1 Indonesia: Ulu-Danau micro hydro power plant

Overview

- Ulu-Danau micro hydro power plant is an on-grid system that has been integrated with the state electricity company since 2007. Prior to this, from 2001-2004 the power plant was off grid. The construction of the project was completed by IBEKA. The grid directly sells to the state company based on metered power output. From 2012 the hydro power plant has been powering 750 households, down from 1500 households from 2005-2012 due to higher loads.

Regional implications

- This project, while community driven, benefited from IBEKA funds and management.
- IBEKA provides funding and support for project development, but it has also fostered the creation of village-based organisations to own, maintain and operate the systems, including full involvement of women within the local community.
- NGO-partnerships like IBEKA's at the Ulu-Danau micro hydro power plant provides a successful, medium-term project that has continued past initial development stages and developed into an important value add for the local community and thus economy.

4.2 Malaysia: Sarawak alternative rural electrification scheme

Overview

- Sarawak Alternative Rural Electrification Scheme (SARES) is an off-grid initiative funded by Sarawak Government and implemented by Sarawak Energy to provide remote households with standalone solar or micro hydro systems in partnership with the community.
- The off-grid system in the case study at Rumah Panjang Tungan Batang Rajang, Kapit, Sarawak is a solar photovoltaic and battery with capacity of 28.12 kW to supply electricity to 28 households of the Iban community.
- The scheme also inludes indoor wiring complete with light bulbs, power socket and individual smart meter.
- The system is designed to power each household with 3kWh allocation of energy every 24 hours renewed at 6pm every day. If weather conditions continue to be bad or cloudy for consecutive days, the battery storage is enough to operate for up to 3 days on regular consumption patterns.
- The community are trained to operate, monitor, and maintain the system, and manage the allocated daily consumption after SARES completion and handover. Contractor Defect Liability Period is for 12 months. After that the maintenance support will be managed by Sarawak Energy with funding from the Sarawak Government. Under the SARES communities do not pay for electricity once commissioned.
- In Sarawak, the SEB together with Ministry of Utilities are implementing the Accelerated Rural Electrification Masterplan for Sarawak. Under this Masterplan, the Sarawak Rural Electrification Strategies highlights two initiatives: 1) grid connectivity and 2) off-grid solution.

Regional implications

- Peninsular Malaysia currently enjoys near 100% electrification. A limited number of homes without electricity are usually represented by highly inaccessible rural locations, specifically in states of Sabah and Sarawak.
- In Sarawak, the Sarawak Rural Electrification Strategies has been designed to achieve electrification rate of 99% by 2020 and towards full electrification by 2025.

4.3 Philippines: Timodos micro hydro plant

Overview

- The Timodos Micro Hydro Plant (MHP) is a community driven off-grid system for rural electrification. Through this project, 87 households belonging to the Manobo tribe had access to electricity in 2016 when it was first commissioned. In 2022, the system continues providing electricity to 115 households. The system has a capacity of 23kW with the head of 15m and flow rate of 350 cubic meter per second.
- The project was developed by a an NGO called Yamog Renewable Energy Inc. and funded through MISEREOR (NGO from Germany) and KZE-Germany (German Government).
- The management of the Timodos MHP is through the creation of Timodos Tribal Micro Hydro Power Association (TTriMPA). The association is registered with the Department of Labour and Employment (DOLE) to do management, tariff collection, reporting and operation & maintenance of the MHP equipment.

Regional implications

- The Philippine government has designed a program-matching criteria and roll-out of schemes to strategically identify appropriate electrification program per specific setup of un-electrified/underserved area/households. The strategies these programmes are subdivided into are: household electrification, grid electrification and off-grid electrification programs.
- In line with the national government's Power Development Plan (PDP) 2016-2040, the Department of Energy (DOE) has targeted a 100% household electrification level by 2022 based on 2015 Census. Under the DOE's Electrification Roadmap toward total Energy Access in 2040 roadmap, the examined micro hydropower plants will be tapped to support the government's rural electrification program targeting 100 percent barangay (or village) electrification.

4.4 Vietnam: Lotus

Overview

- Lotus is a UK/Vietnam NGO with a Rural Development Model (RDM) focussed on renewable electrification . Lotus exclusively focuses on remote communities that have modest initial energy demands and are currently not well serviced by grid connections.

- Lotus is currently in the phase 1 “Pre-electrification” stage of the two projects, having completed a feasibility study, specified the scope of work and budget, and researched the target community needs. Lotus aims to undertake installations in the first half of 2022, followed by a 5-year programme of capacity building, economic development and training under their RDM.

- Lotus is in the advanced planning stages for two small off grid PV & battery microgrids in the of Chi Lang District: Pa Mi (3.5kW) and Lung Thoc Village (4.8kW).

- The systems will be the first electricity for the Lung Thoc Village, replacing a small micro hydro system in Pa Mi village – achieving Multi-Tier Framework (MTF) level 2-3 following the connection.

- The projects use a hybrid donation funding model and ownership will be shared between the community and the local government. The extensive RDM aspect of the project will consume 68% of the project’s capital costs.

Regional implications

- By 2016, 99% of Vietnam used electricity for lighting, up from 14 % in 1993.

- However, Lotus estimates hundreds of communities are still without access to reliable power - most populated by ethnic minority groups.

- Vietnam is targeting 10.7% renewable electricity by 2030, although renewables currently comprise only 5% of all power generation.

5.0 Summary of findings: variations in business models and justice

5.1 Regional findings

The clean energy transition was already becoming the focus of the policymakers and investors in the ASEAN before the Covid-19 hit the world. Renewable energy infrastructure investment in the region had been strong as results of policy imposed by the government to reduce carbon emission in meeting the Nationally Determined Contributions (NDC). Furthermore, the declining costs of RE in these few years specifically solar, given cheaper technology and economies of scale. Two major initiatives were developed to facilitate the energy transition in the region, specifically 1) ASEAN Plan of Action on Energy Cooperation (APAEC)[34] Phase II and 2) ASEAN Interconnection Masterplan Study (AIMS) III.[35]

In ASEAN, 43% of electricity is from coal-fired generation. A study by Friedrich-Ebert-Stiftung reported that to achieve the goals of the Paris Agreement, the countries across the region must reduce their coal-powered generation to 5-10% by 2030 and completely phase out the coal by 2040. We could see a growing commitment from the private sector to producing sustainable products and clean energy services which can be seen is happening in Vietnam through implementation of direct power purchase agreements (DPPAs), in Malaysia through Solar Power Purchase Agreement (SPPA) and Indonesia.

Within our case study locations, we have found a number of unique findings. From a justice framework perspective, we have found that notions of justice are largely top-down in each case study location. Participants in these DES projects are happy with their access level and engagement and justice, equity and fairness are largely unconsidered. However, procedural justice is absolutely a precondition of these systems working. This is underscored by the business model and governance findings that follow. We also expect that additional research into restorative justice in authoritarian states, such as other states in the Asia-Pacific but outside of our case study locations, would be beneficial for further understanding justice frameworks across the region.

34 ASEAN (2021), APAEC, https://aseanenergy.org/asean-plan-of-action-and-energy-cooperation-apaec-phase-ii-2021-2025/
35 ASEAN (2018), AIMS III, https://asean.org/wp-content/uploads/2018/02/ACE_RfP_AIMS-III_February-2018_rev.pdf

5.2 National-findings

Equally important, at the national level we see opportunities for the examination of new markets should they develop in these largely state driven economies, such as Indonesia and Vietnam. At the moment, electricity and energy are predominantly controlled by the government, with little if any private sector involvement in Indonesia, Malaysia and Vietnam, and some involvement in the Philippines. Liberalisation of these systems may influence private sector access and therefor funding, which has implications for the development of more DES projects in the future.

5.3 Local findings

In all four systems examined we have found that local authorities are essential to the long-term management and delivery of the energy systems after they have been funded and sourced. We have found this to be essential to the sustainability of these projects. In addition, the sustainability of these projects relies on local economic development being built into these systems. However, data on the long-term development of these business models is not yet fully understood as all the projects examined are less than 10 years old. One area we see opportunities for further study is the ongoing operation, maintenance, and local economic development support past the 5- and 10-year marks of these projects, particularly where state-civil society partnerships have been so vital to the building and establishments of these systems.

5.4 Local-national complementarities

From a financial systems and funding perspective, the DES examined in Indonesia and Vietnam have similar models—the system is funded by an NGO that provides financial stability and has, as a result, increased electricity access in the surrounding area. However, in both cases there is a limit to what the NGO model can accomplish. For example, IBEKA, which is the largest NGO of its kind in Indonesia and has an enviable level of financial sustainability in its projects, cannot bring electricity access to the millions of people still lacking electricity access. Vietnam and the role of LOTUS is similar in this regard. In Malaysia and the Philippines, it appears that DES projects are primarily state funded (as is the case in Malaysia; the Philippines project is still taking place as of the time of writing).

In the case of both Indonesia and Vietnam, while IBEKA and LOTUS provide a lot of funding for these projects, scalability of larger electricity access is state funded. Both locations show a mix of state-NGO engagement to both reach rural communities and scale larger, sub-nation-wide access. Based on interviews with experts and officials in both Indonesia and Vietnam it is clear that the state-NGO model is serving communities quite well—NGOs are building community-based DES projects, incorporating communities in the process and sustainment of these projects as well as building economic development benefits into the projects themselves. The state, on the other hand, is bringing power and access to larger communities, providing infrastructure, and leading the general delivery model that incorporates local authorities for long-term sustainability of energy systems. We have found that there is a marriage between publicly funded NGO and state-driven management of these DES projects, resulting in a partnership between state and civil society actors that utilises the complementary skill sets of each actor.

6.0 Conclusions and policy recommendations

This study has reviewed four case studies of micro-grids for off grid rural electrification in four ASEAN countries: Indonesia, Malaysia, the Philippines, and Vietnam. Our mixed methods investigation has identified the techno-economic properties of these systems, the nature of the business models used to deliver them and how these business models implicate four key tenants of energy justice. Here we provide conclusions to answer the project's central research question, whilst acknowledging the implications and limitations of our study in addressing regional and national policy considerations:

How can rural electrification programs be designed to ensure a Just, Fair, and Affordable Energy Transition in the Asia-Pacific?

6.1 How do different techno-economic variables affect the design and viability of rural electrification programs in the Asia-Pacific?

Based on our techno-economic analysis we have observed a few unique impacts and emerging themes.

- Firstly, due to their low marginal costs off-grid DES microgrid systems do not require a traditional metered tariff ($/kWh) to make these systems financially viable. We instead observed variety of fixed charge and donation-based models to cover O&M costs. These models therefore have a distinct financial advantage for low-income communities over higher marginal cost diesel generators aside from their climate impacts.

- Second, as the example of the Ulu Danau micro hydro plant shows, grid connected microgrids can enable additional revenues to be generated through net metering or feed in tariff arrangements once and if a grid connection is brought to them.

- Thirdly, many of our case studies demonstrated a levelised cost of energy ($/kWh) that is cost competitive and, in some cases, lower than grid power prices. These findings suggest that DES microgrids present a financially viable route to full electrification of remote communities.

6.2 How do different business models and modes of governance for Asia-Pacific rural electrification affect the dimensions of energy justice?

Distributional justice

- Off-grid micro-grids, like those studied here are unlikely to, with the current funding available, provide equivalent access to grid-connected systems. This value proposition for consumers is therefore inferior when compared to the quality and power quantity of grid-connected systems. This has important implications for distributional justice.

- However, the business models used to deliver the systems, particularly those supported by NGOs, have involved services for capacity building beyond, productive uses for electricity and social development beyond electrification alone. These softer factors are essential in ensuring the viability and longevity of these systems and achieving the distributional aims of the SDGs.

- We also observed a host of wider benefits being created from these systems including, healthcare, educational, economic, and beneficial social outcomes. However, these factors are often difficult to measure and disbenefits of project failures are likely to be underreported.

- Effective business models need to include resources for these softer and ongoing costs. A significant challenge then exists in how policy makers look at spending and affordability and allocate funds for rural systems. Traditionally capital funding is based on maximising the kWp installed and the ‘number of communities electrified’ and doesn’t usually include an additional budget for other factors.

- Further, developing symbiosis between productive uses of energy and the commercial opportunities created by energy access and DES projects creates a co-dependency that can ensure long term engagement, and sustainable funding. Identifying productive uses of electricity, for example, via the involvement of community members, should be centred around existing livelihoods to ensure that needs are met, and livelihoods are actually supported.

- In a similar vein, job creation and local supply-chains also relate to elements of justice. For example, solar PV and batteries have fewer opportunities for local job creation, based on the fact they are “plug and play systems” with components from other high-tech economies. These systems have less labour value-add for the communities they are installed in. On the other hand, micro-hydro for example, has a greater potential for local labour contributions.

Procedural justice

- Repeatedly it was conveyed to the project researchers the importance of community engagement and, more specifically, local champions of projects. Identifying champions and involving local communities in the establishment and management of these systems early on ensures supporting the recipient communities and the principles of procedural justice.

- We also observed a key challenge for rural DES projects is supply chain oriented. Access to the right equipment at the right price is necessary for these projects to get off the ground. In several cases we found more could be done with trade policies and developing domestic supply chains, adding to local job creation via political processes while also reducing costs.

- With regards to procedural justice, harnessing collective responsibility and management via a formal legal organisation to manage the microgrid appears to be another necessary factor. Here an accessible and representative custodial group of DES systems has more likelihood of effective management than individuals and elites within local communities. Without these types of governance structure, there is a danger that the benefits and proceeds of DES systems are co-opted by existing powerful and potentially corrupt interests.

- Additional factors that impact the procedural justice include balancing the benefits and challenges that exist between remote monitoring and digital engagement, versus lack of digital literacy and internet access. Here the cost benefits of digital systems may be part of a virtual circle that can complicate and improves quality of life in local communities.

Recognitional justice

- In general, we found DES microgrids to have positive outcomes for marginalised voices and communities. Women, children and ethnic minorities and lower social classes were all seen to benefit from electricity provision, and these outcomes were mostly likely to occur through inclusive governance processes as outlined above.

- Recognitional justice is also impacted via supply chain challenges. Indigenous supply chains that utilise local labour, engage women in the labour force and in administrative/management side, and engagement with collective community labour, all contribute to the inclusion of multiple groups in energy access and development of DES in rural communities.

- We found that these outcomes were best achieved when they were targeted purposively within the projects, but in a manner that reflected local circumstances, traditions and the practical realities of working in these remote locations. We therefore caution against overly prescriptive diversity metrics in project formation, in favour of a more qualitative and context specific approach to diversity and inclusion in these projects.

- Care should also be taken to ensure that traditional cultural practices are preserved and respected during electrification programmes, through a process of consultation with the host communities. We found that electrification and internet access could have major impacts on cultural traditions and the rhythms of life in the host communities.

Restorative justice

- DES microgrids using renewables have the potential to be a significant contributor to mitigating the climate impacts of ASEANs rapid development, addressing both SDG7 and SDG 13. Indeed, up to 44% of the remaining 339 million people in South and South-East Asia without electricity access may receive their power through these systems.

- While we found limited evidence of past harms caused by fossil fuel energy systems – due to the remote location of these systems – our research suggests that these small- systems are inherently less damaging to local ecosystems and livelihoods than large power projects.

- We also found some evidence that rural electrification can be a catalyst of improving environmental health outcomes for other energy streams. This is particularly the case with clean cooking systems, where electric stoves or increased disposable income for gas stoves can massively reduce the internal air pollution cases by traditional biomass cooking.

6.3 How should "Just Transitions" be understood in the context of rural electrification programs in the Asia-Pacific?

While the research team found our justice framings to be relevant, we also recognise that we brought this academic framing in to the stakeholder interactions, rather than this framing being present already. That said, DES project developers often used 'best practice' participation techniques from project beginning, demonstrating strong procedural justice elements. In this regard the approach to justice in energy transitions is top down, and although the issues are there and can be seen through this justice lens, they are not embedded in the region. Based on examples provided by our case studies, we believe there is a need to broaden out the research approach to understanding the potential for injustice at multiple scales—moving beyond just the community level to examine the supplier and NGO level as well.

We also recognise that as researchers we need to be flexible with our approach to energy justice. Further, based on observation, stakeholder engagement, and data analysis, we also believe that the predominantly western, rule-of-law viewpoint about justice needs to be more flexible to accommodate unique cultural, political and natural contexts in the region. These flexible approaches to justice must also incorporate local values, and, similar to the challenge of a one-size-fits all business model, can be quite different from place to place.

Rural electrification through micro grids is on balance a great way of improving distributional outcomes. Overall, energy in-access is an injustice, and increased energy access addresses that injustice—particularly in "last mile" locations where traditional grid-connected models break down. Further, feedback and analysis demonstrate that electrification is not the end in and of itself, but an enabler with different long-term outcomes depending on project and life cycle. However, to what extent these places are electrified constitutes the same level of power development as those with grid-connected access is a key challenge. However, there are obviously limits to rural areas and what systems can be implemented, wherever "access" is increased.

To manage some of these justice challenges, NGOs and suppliers are already considering needs for projects, with particular focus on distributional justice. IBEKA, for example, focuses on distribution within communities and prioritise equal access across groups by beginning with the poorest, “let behind” groups first. Additional NGO efforts include incorporating people, proper decision-making processes, engaging communities early on, coproducing solutions, and using both a top down and bottom-up way of developing systems. Restorative justice, on the other hand, is being managed via support for displaced people, watershed management, efforts to avoid environmental catastrophe long-term, and projects that create economic and health co-benefits.

Amid these efforts to encourage energy justice regionally and sub regionally, there is also the negative side effect of acculturation, the negative cultural impacts of electricity access. These acculturation impacts depend on the community, country, and project, but seems to be obvious in rural locations. The challenges of mediating acculturation are not significantly addressed in current westernised justice frameworks.

Funding models and governance of DES projects are also limited under current scenarios. While the role of NGOs is quite obviously dominant in case study locations, there are limits to how much of the Asia-Pacific’s infrastructure can be funded using this NGO model. Instead, a hybrid model that utilises either the state or a liberalised market alongside private sector investment, will need to play a role. Traditional connections are quite expensive, but these models show a cost-effective way of funding using a financial model that relies on both government and NGO support. Stakeholders encourage this model, saying national and local governments need to lean into mixed models and embrace NGO engagement. For example, consider the following varieties in engagement:

- Hybrid models, that incorporate private sector as small local businesses and the individuals who are employed by these businesses or work in this area; but the commercial private sector has limited role at the moment.

- Involving recipients in delivery, communities do need to own systems so there is buy-in and management.

- Legal incorporation of local companies and/or federations of local companies.

The challenge of developing these systems within Southeast Asia lies with ASEAN’s greatest benefit and biggest weakness—diversity. What works in one place might be different compared to a nearby neighbour or subregional partner—culture, geography, political system, sub-national political economy, and even religion all impact how rural electrification systems are managed and incorporated into local communities. In ASEAN, and our case studies, no one size fits all solution exists.

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Published June 2022

To cite this report: British Academy (2022), *Facilitating a Just, Fair, and Affordable Energy Transition in the Asia-Pacific*, The British Academy, London

doi.org/10.5871/just-transitions-a-p/C-R-B

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