OFF-GRID RENEWABLE ENERGY SOLUTIONS TO IMPROVE LIVELIHOODS

Insights from Southeast Asia

Off-grid renewable energy solutions can have a transformative impact on peoples' lives, well-being and livelihoods. Backed by supportive policies, innovative delivery and financing models and tailored technology solutions, stand-alone systems and mini-grids are being rapidly deployed to expand modern energy access across a wide range of contexts. The pace of deployment has accelerated over the past five years globally and off-grid solutions offer a strong promise for bolstering national energy access plans and advancing the 2030 Agenda for Sustainable Development (IRENA, 2018a). Regional and country perspectives on sector development offer valuable insights on the advancements being made and the socio-economic and environmental benefits being realised.

In this context, this brief offers insights into selected projects from Southeast Asia – a region that has made significant progress over the past decades across a wide range of socio-economic development objectives. The poverty rate (based on the threshold of USD 1.25 per day in purchasing power parity) has fallen considerably in the region, from 47% in 1990 to 14% in 2015, ranging from 9% in Indonesia to nearly 30% in Lao People's Democratic Republic (ASEAN, 2017). Advancements also have been made in lowering malnutrition, increasing life expectancy and improving access to education, clean water and sanitation. Access to affordable and reliable energy has contributed to these efforts and will play a key role in meeting the Sustainable Development Goals (SDGs) (Figure 1).

Figure 1: **Access to affordable, reliable, sustainable energy supports all other Sustainable Development Goals**

Source: IRENA, 2017.

Yet, in 2016, nearly 65 million people in Southeast Asia continued to live without electricity access, and 250 million people relied on traditional use of biomass energy (IEA, 2017). The majority of the unelectrified populations is concentrated in emerging economies of the region, including Cambodia and Myanmar, and in archipelago countries such as Indonesia and the Philippines. Large parts of the region also face high electricity prices and unreliable supply. Reliance on the traditional use of biomass is especially high in Indonesia, Myanmar, the Philippines and Viet Nam.

Off-grid renewable energy solutions, including stand-alone systems and mini-grids, offer a unique opportunity to expand modern energy access services to rural areas as well as in island and urban settings. The distributed nature of these systems allows them to be tailored to local conditions, tap into available renewable resources, deliver diverse energy services and utilise local capacity to ensure long-term sustainability. Recent technology advancements and cost reductions have strengthened the socio-economic and environmental case for adoption. The region hosts several examples of off-grid renewable energy infrastructure development. Applying a wide range of delivery and financing models, these have led to benefits across multiple indicators, including economic, social, health and environmental, contributing to several SDGs as illustrated in Figure 1. Economic benefits include reduced fuel spending and increased energy affordability, income generation and poverty alleviation, and job creation. Social benefits include increased gender equality, improved education and inclusive growth, while health benefits include reduced indoor air pollution, reliable provision of healthcare services, and improvements in food security and access to clean water. The environmental benefits are widespread and cross-cutting and include reducing deforestation and emissions, and advancing climate action. Off-grid energy infrastructure, when well-integrated into rural economies, can facilitate community cohesion through delivery models focusing on community ownership and engagement in the development and operation of systems.

To capture these impacts, IRENA, with support from stakeholders in the region, has developed a set of project/programme-level case studies as part of its *Renewable Energy Market Analysis: Southeast Asia* (IRENA, 2018b). These case studies, while not representative of all initiatives in the region on off-grid renewables, cover a wide range of technologies, countries and applications, offering examples of the transformative potential of renewables in advancing sustainable development objectives. It also provides insights on the enabling ecosystem needed to scale-up deployment, including policies and regulations, delivery and financing models, technology, capacity building and cross-sector applications.

Some key messages emerging from the case studies are summarised below, with references to the individual cases. These include an enumeration of the diversity of off-grid renewable energy applications present in the region and the wide range of socio-economic and environmental benefits being realised. The brief further discusses the importance of tailored delivery models with a focus on engaging local communities to enhance sustainability and benefits of the projects. The role of policies and regulations in influencing the delivery models and outcomes of energy access initiatives is discussed with an emphasis on adopting an inclusive approach to design and implementation, including from a gender perspective. Finally, the brief concludes with some key messages to support a scale-up in the deployment of off-grid renewable energy solutions towards multiple SDGs.

EXAMPLES EXIST OF OFF-GRID RENEWABLE ENERGY SOLUTIONS SUPPORTING LOCAL SOCIO-ECONOMIC DEVELOPMENT

Across the region, several programmes and projects illustrate how off-grid renewable energy solutions are being deployed to provide a wide range of energy services to support sustainable livelihoods and to enhance access to affordable and reliable energy. Viet Nam, for example, hosts one of the largest domestic biogas digester programmes in the world. Since its inception in 2003 the programme has facilitated the construction of nearly 250 000 domestic biogas digesters, resulting in access to clean, renewable and reliable energy for lighting and cooking while addressing waste management in the animal husbandry sector and improving living conditions for over 1.2 million people [case study 1].

Beyond the provision of energy services, off-grid solutions are being deployed to improve access to drinking water services in rural communities. In Cambodia, over 164 kiosks have been deployed by the non-governmental organisation (NGO) 1001fontaines to provide drinking water using solar photovoltaic (PV)-based purification systems. These kiosks are managed as social enterprises by local villagers providing safe water to nearly 400 000 people [case study 5].

Recognising the important role for energy in stimulating socio-economic development, off-grid solutions are increasingly integrated into the development agenda. At the project level, this has led to the adoption of a bottom-up approach to system design, development and operation. In the cases analysed from the region, such an approach has often led to the development of a variety of productive end-uses, including brick making, cash crop farming, fruit processing, fabrication workshops and silkworm breeding. In the coastal area of Roxas in Green Island in the Philippines, a biomass-wind-solar-battery hybrid mini-grid, besides catering to the electricity requirements, also powered water pumps to tackle freshwater access issues, as well as ice machines to support the local economy based on fishing [case study 6].

On a larger-scale, Sumba Island in Indonesia, home to 700 000 people, is at the centre of the Iconic Island initiative to showcase the potential for local development facilitated by a supply of 100% renewable energy. A renewable energy blueprint and roadmap was jointly drafted and developed by all stakeholders, including the district, provincial and national governments, the state electricity company PLN, local NGOs and the corporate social responsibility units of several companies [case study 4].

TAILORED DELIVERY MODELS INVOLVING THE PUBLIC, PRIVATE SECTOR AND COMMUNITIES ARE DRIVING GROWTH

The region exhibits a wide range of delivery models to support the development and operation of off-grid energy infrastructure. Innovative models engaging the public and private sectors and communities have emerged to enhance long-term sustainability of the energy system. For example, for years local private micro-utilities have developed and operated micro-hydro and biomass gasifier projects in countries such as Myanmar (Vaghela, 2018). Several types of equipment are now manufactured locally (*e.g.,* the pelton turbine, mechanical governor and mild steel penstock), allowing them to be tailored to the contexts and localising the maintenance of the systems.

International and regional development finance institutions, such as the World Bank, Asian Development Bank and SNV, are also active in the region. Their engagement in the sector has taken various forms, including public-private partnerships. Viet Nam's biogas programme was initiated by the Dutch government and the Vietnamese Ministry of Agricultural and Rural Development and implemented by the Department of Livestock Production supported by SNV. This institutional approach ensured that the programme was nationally owned and managed [case study 1].

Although different models of public and private sector participation can be seen, communities have played a strong role across the case studies analysed. They are involved in the ownership, design (Box 1), financing, development, operation and maintenance of energy infrastructure, whether through newly created community organisations (*e.g.,* co-operatives in Sumba Island in Indonesia [case study 4] or through existing organisations such as village development committees (Cullinen and Harrison, 2018)).

In Indonesia, in Sumba Island, a micro-hydro facility is owned, operated and maintained by the Kamanggih Community Cooperative. The system supplies electricity to over 100 households and exports excess power to the national grid. The co-operative has grown its assets from nearly USD 300 000 to over USD 624 000, allowing it to support its members with a wider range of financial services [case study 4].

Tailored financing solutions are also playing a crucial role in accelerating off-grid renewable energy development. Covering both small and medium enterprises and end-users, different models of financing are being tried and tested. In Cambodia, for instance, a clean energy revolving fund offers access to affordable finance, ranging from USD 10 000 to USD 100 000) to small enterprises in the agrifood sector to invest in off-grid renewable energy technologies. The fund acts as a de-riksing mechanism for the local financial market for financiers to crowd in once the viability has been demonstrated. Fifteen loans have been disbursed, majority for solar-powered pumping equipment (REEEP, 2018).

Box 1: Enabling active local participation in mini-grid planning and management: an example from Malaysia

Strong community consultation and adept local management could address challenges to long-term operations of rural mini-grids, such as the mismatch of supply and demand, electricity theft, conflicts over load curtailment and insufficient savings for repairs. Unique energy system planning tools are being developed and deployed to support enhanced community engagement and local capacity building. One such example is the Minigrid Game developed by Energy Action Partners.

Designed as a co-operative simulation, the Minigrid Game enables community members to negotiate and build consensus around key management decisions of a rural mini-grid. Using tablets or notebooks connected through a local network, members simultaneously role play their behaviour as electricity consumers: purchasing and operating appliances, paying their electricity bills (or not), and responding to unexpected challenges such as storm damage or economic shocks. Once members see the consequences that their individual decisions have on the economic viability of the mini-grid, they collectively discuss and decide on parameters such as system capacity, tariffs, demand-management mechanisms and other "rules" of the system. In this way, they apply existing village practices for resource management and conflict resolution to the new technology of a renewable energy mini-grid.

The game is currently being used to improve the sustainability of micro-hydro systems in two rural and mountainous villages in Sabah, Malaysia. In both cases, members from the village energy committee and a broad representation of households (women and men, young and old) joined the simulation to explore options for increasing mini-grid revenue and better co-ordinating load curtailment during the dry season. Outcomes included recommendations for tariff adjustments and the installation of new demand-management devices. Based on the positive results of the initial deployment, use of the Minigrid Game is being expanded to work with other community-based organisations and mini-grid developers throughout Southeast Asia.

Off-grid renewable energy solutions are increasingly attractive for meeting captive energy needs. In the tourism sector, which contributes immensely to local economies in the region, island resorts are shifting towards solar energy to reduce fuel costs and local environmental impacts, increase reliability of supply and reduce the tourism footprint. In Nikoi Island in Indonesia, the displacement of diesel generators and a decrease in energy consumption resulted in a reduction in harmful gas emissions of over 42%. The Qi Palawan Resort, which supplies almost 100% of its annual energy needs with solar PV panels, saves nearly 34 tonnes of carbon dioxide per year [case study 3].

POLICY AND PROGRAMME DESIGN INFLUENCES SOCIO-ECONOMIC IMPACTS AND LONG-TERM SUSTAINABILITY

Different approaches exist to scale up the deployment of off-grid renewable energy solutions, and they need to be tailored to the local context. Nevertheless, integrating a long-term sustainability view in policy and programme design can ensure the longevity of infrastructure as well as ensuring socio-economic impacts. Of the cases analysed, several have embedded this consideration in technology selection and design; in selection of the delivery model, financing schemes and ownership structures; as well as in the introduction of additional measures needed to support long-term sustainability.

Viet Nam's biogas programme, for example, was designed with a long-term view and a focus on local ownership and capacity building. More than 1 000 technicians have been trained on biogas technologies, and more than 1 700 masons have been trained in construction of the various designs of the brick, dome-shaped, domestic biogas digester. Furthermore, 355 biogas construction team leaders have been supported in establishing biogas businesses [case study 1].

The Sumba Island initiative in Indonesia also has been designed to engage local communities and entrepreneurs, enhance the capacity of local institutions and empower communities by transferring ownership and responsibility for operation and maintenance of the systems. The owners of the solar kiosks installed under the initiative, for instance, are responsible for daily operation and maintenance of the equipment and for monitoring the charging system, including interactions with customers [case study 4].

GENDER CONSIDERATIONS ARE KEY FOR SUSTAINABILITY AS WELL AS FOR DRIVING DEPLOYMENT

The case studies have demonstrated that the active engagement of women in the design and development of off-grid energy infrastructure is key to ensure long-term sustainability. The Wonder Women programme in Indonesia [case study 2], for example, focuses on empowering women to expand energy access to last-mile communities through clean technologies. Since 2013, the programme has trained more than 561 "wonder women" as social entrepreneurs, who have sold more than 22 000 clean energy technologies.

Women are playing an equally important role in the Indonesian Domestic Biogas Programme or Biogas Rumah (BIRU). Under the programme over 1 000 digesters have been deployed, and nearly a third of the bio-slurry operations are managed by women [case study 4]. Women also are beneficiaries of improved access to modern energy services. The manual tasks for cooking and delivering water typically shouldered by women decreased as a result of access to electricity. Meanwhile, women also have reported improved family relationships and greater access to telecommunications and entertainment through televisions and DVD players.

SCALING UP DEPLOYMENT TOWARDS UNIVERSAL ENERGY ACCESS AND SDGS

The cases analysed provide a glimpse of how off-grid renewable energy solutions can be designed and implemented to support livelihood development and to contribute to rural development and poverty alleviation efforts in diverse settings. To tap into the full potential of these solutions, a holistic approach is needed that reconciles both deployment and development aspects, while being people-centric, participatory, tailored and well-integrated into the local economy. This would create an ecosystem where energy serves its purpose as an enabler of long-term socio-economic development.

Based on the analysis presented here, the following measures are identified as key to accelerating the adoption of off-grid renewable energy solutions towards the achievement of SDG 7 in Southeast Asia, while reinforcing several other SDGs:

1. With decreasing costs, improving technology and a demonstrated track record in the region, off-grid renewable energy solutions should be considered a mainstream solution in national energy access strategies, together with on-grid options. Such strategies should identify areas to be served through each solution and should leverage on the successes (and failures) of existing practices and projects.

2. Successful energy access programmes should adopt a holistic and tailored approach in the design of technology solutions, delivery models, ownership structures and system management. This involves considering the entire spectrum of energy services needed, including for cooking, delivery of public services, and existing or potential productive end-uses, as well as utilising community-based structures for system design, installation and management. Energy access strategies should enable, and even facilitate, the adaptation of deployment approaches to local contexts to increase benefits and long-term sustainability.

3. Participation of the local private sector, including entrepreneurs, and communities should be encouraged through dedicated and stable policy and regulatory frameworks, financial incentives and capacity building programmes focusing on, for example, entrepreneur incubation and skills training. Adequate standards and quality control measures also should be implemented to avoid the proliferation of low-quality products.

4. Tailored financial support (*e.g.,* concessional local financing, high-risk innovation funds) and fiscal incentives (*e.g.,* import duty and value-added tax exemption) can help address the challenge of access to finance for both end-users and suppliers. International development finance programmes should be designed to bolster the capacity of local financial institutions in the long term and should be accessible to the diversity of practitioners in the sector in terms of magnitude and type of funding available and the process for accessing it. The case studies also have showcased financing models that include community financing through village-based entities (*e.g.,* co-operatives), leading to stronger ownership of off-grid energy infrastructure.

IRENA's work on the socio-economic benefits of off-grid renewable energy

In recent years, IRENA has published several reports documenting the socio-economic benefits off-grid renewable solutions. These include: Renewable Energy Jobs & Access (2012), Renewable Energy and Jobs (2013), Renewable Energy and Jobs: Annual Review (2014, 2015, 2016, 2017 and 2018) and Renewable Energy Benefits: Decentralised Solutions in the Agri-food Chain (2016). In addition, the third edition of Rethinking Energy (2017) analysed the linkages between renewable energy and the Sustainable Development Goals set out by the United Nations. These reports can be downloaded from www.irena.org/Publications.

IRENA also provides platforms for convening diverse stakeholders from the off-grid sector and facilitate dialogue and exchange of best practices and lessons learnt. IRENA's International Off-grid Renewable Energy Conference (IOREC) is a key platform that brings together practitioners, the public and private sector, financing institutions and development agencies to discuss pathways to scale-up energy access through off-grid solutions and maximise the socio-economic benefits. The outcomes from the first three editions of IOREC have been published and available online, with IOREC 2018 scheduled to take place from 31st October to 1st November 2018 in Singapore (details available at iorec.irena.org).

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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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References

ASEAN (Association of Southeast Asian Nations) (2017), "Celebrating ASEAN: 50 Years of Evolution and Progress", ASEAN, Jakarta.

IEA (International Energy Agency) (2017), *Energy Access Outlook 2017,* OECD/IEA, Paris.

Cullinen, M. and Harrison, R. (2018), "The next phase of Rural Electrification in Myanmar", www.pactworld.org/blog/next-phase-rural-electrification-myanmar.

IRENA (International Renewable Energy Agency) (2018a), *Off-grid Renewable Energy Solutions: Global and Regional Status and Trends,* IRENA, Abu Dhabi.

IRENA (2018b), *Renewable Energy Market Analysis: Southeast Asia,* IRENA, Abu Dhabi.

IRENA (2017), *Rethinking Energy 2017: Accelerating the global energy transformation,* IRENA, Abu Dhabi.

REEEP (Renewable Energy and Energy Efficiency Partnership) (2018), *Powering Prosperity Beyond the Grid*, REEEP, Vienna.

Vaghela, D. (2018), "Financing Economically Viable Decentralised Renewable Energy", Presentation at the Annual Conference of the Low Carbon Energy for Development Network, https://energypedia.info/images/9/9b/Financing_Viable_Mini_Grids_Dipti_Vaghela.pdf.

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