ACCELERATING MYANMAR'S INVISIBLE PEOPLE POWER

Opportunities for bottom-up decentralized renewable energy in Myanmar

Hivos
people unlimited

INTRODUCTION

Despite multiple ethnic conflicts, Myanmar has a long history of locally developed, low cost renewable energy (RE) solutions, installed and sustained by local social entrepreneurs and rural communities over the past 30 years, without government or donor funding. These local RE entrepreneurs are ready to continue investing in rural areas with high energy demands for household and productive end use. Meanwhile, Myanmar's new local civil society organizations (CSOs) have initiated an ambitious movement calling for environmentally and socially responsible energy plans.

However, the momentum established by local entrepreneurs and CSOs has attracted little attention from the government of Myanmar or the development organizations that have been supporting energy access in Myanmar since 2015. Despite the influx of foreign initiatives and investment in decentralized Renewable Energy (DRE) projects, there have so far been limited efforts to engage and partner with Myanmar's proven entrepreneurs and civil society proponents of renewable energy.

The Hivos Green and Inclusive Energy program expanded its work to Myanmar in 2018 to support the Renewable Energy Association of Myanmar (REAM) and its local private sector partners to engage with Myanmar's government and development partners. Listening to and engaging with local actors, Hivos has gained perspective on how Myanmar's RE entrepreneurs have worked with local communities and enterprises to develop innovative and durable energy access solutions that deliver tangible socio-economic benefits. While the COVID-19 global pandemic impacts international development organizations in Myanmar, the role of local actors in introducing locally shaped-solutions has become ever more important. Hivos is committed to further enabling frontrunner energy access entrepreneurs to scale up and replicate, in partnership with local CSOs.

If Myanmar is to reach its ambitious target for 100% electricity access by 2030, it will be essential to harness this wealth of existing local experience and capacity. As a first step, this report summarizes some of Hivos' findings and lessons based on its engagement with local DRE actors, including the results of a scoping mission in late 2019. It provides a brief contextual background on DRE, describes Myanmar's existing electrification programs and solutions, profiles local DRE initiatives and actors, and highlights key challenges faced by the local DRE sector. It concludes with recommendations for Myanmar's government, development partners and CSOs on how they may engage with and support local entrepreneurs and civil society to scale up the country's proven energy access solutions.

Acknowledgements

Hivos would like to thank the following organizations for their contributions: Renewable Energy of Association of Myanmar (REAM), Hydropower for Community Empowerment in Myanmar (HyCEM), Hydro Empowerment Network (HPNET), Save the Natural Resources (SaNaR), Foundation for Renewable Energy and Ecology (FREE) and Royal Htoo Linn Manufacturing (RHL).

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1. THE CONTEXT FOR DECENTRALIZED RENEWABLE ENERGY IN MYANMAR

1.1 Union, regions and states

Situated at the crossroads between China, India and Southeast Asia, Myanmar is home to numerous ethnicities, religions and political ideas. While the country has recently begun to open up after decades of military rule, it continues to face a legacy of instability and conflict between different groups.

In 2008, Myanmar's new constitution established a system of subnational governance in which authority was to be shared by Myanmar's Union (national) government with its seven State and seven Regional governments. However so far, the country's decentralization remains limited. The Union government, which is under the direct administration of the president, still maintains most control.

Myanmar's Regions are located in the fertile plains that surround the Irrawaddy river, which flows north-south through the country's central core. The inhabitants of these areas are predominantly from the country's majority Bamar ethnicity.

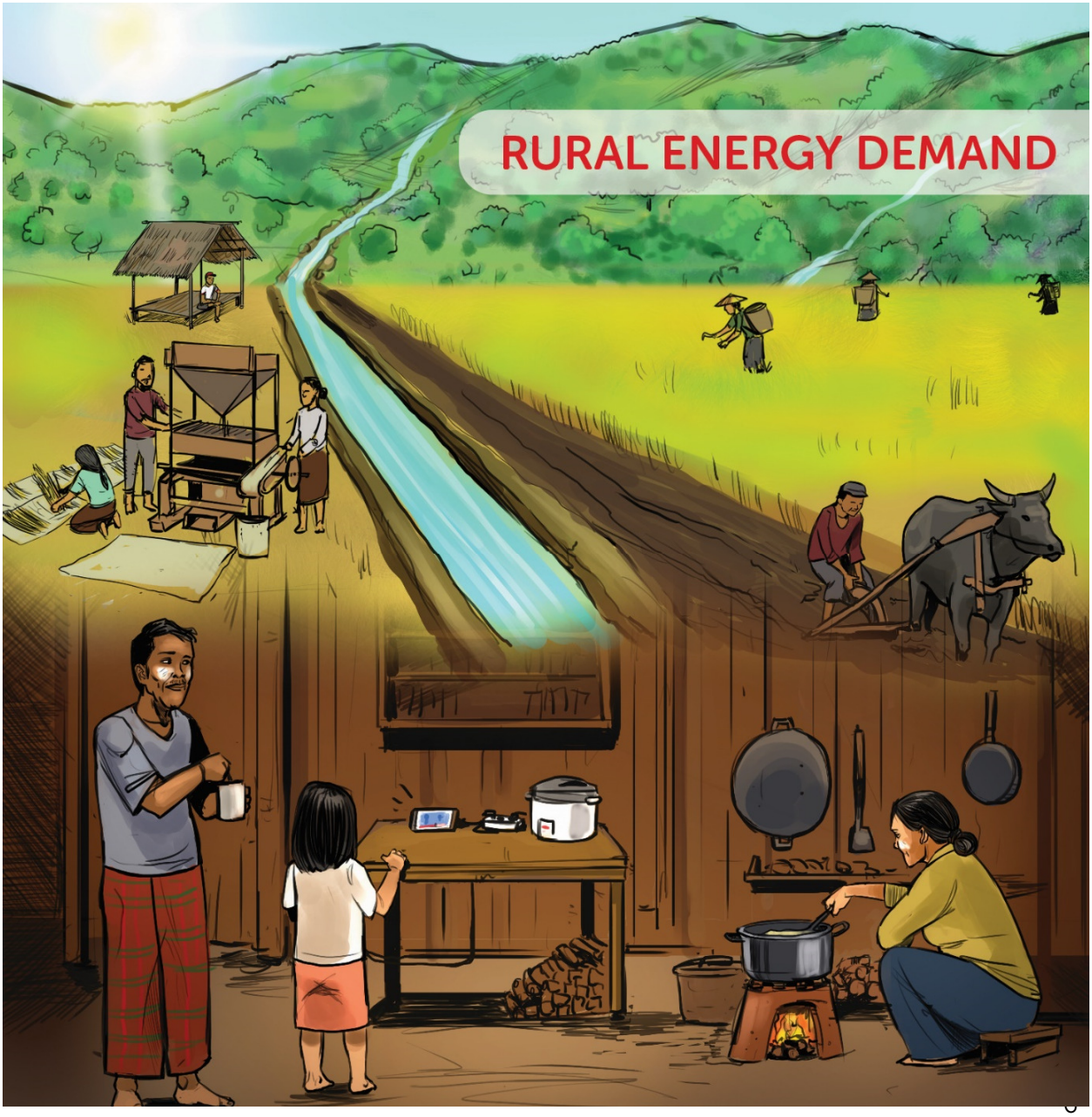
By contrast, Myanmar's States are extensive remote and hilly regions that are mainly populated by ethnic minority populations. These areas have a long history of conflict between the government and Ethnic Armed Organizations (EAOs) that seek power and control over local resources, and most States have witnessed historic atrocities to ethnic populations. While some progress has been made toward negotiating peace between EAOs and the Union military, States with ongoing conflict have vast rural areas known as 'brown zones' where foreigners and foreign agencies are not permitted to go.

1.2 Consequences for electrification

The hierarchy of Myanmar's Union government over the States and Regions has important consequences for electrification. Formed in 2011, the Region and State governments have their own ministers for energy. However, in reality they have little control over energy policies, plans and budgets. The authority of Regions and States only extends to power plants under 30MW. Installations with capacity in excess of 30MW, including large hydro and coal plants, fall under the jurisdiction of the Union.

In addition, regardless of its size, no power plant can feed into the main grid without approval from the Union Ministry of Electricity and Energy (MoEE). States and Regions are also not allowed to build or use high voltage transmission lines without MoEE approval. This means that States such as Kachin, which generate more power than they consume, cannot sell electricity to the main grid. The requirement to seek MoEE approval for interconnection also makes it difficult for mini grid projects to mitigate the risk of the main grid arrival.

Meanwhile, underserved by existing electrification efforts, Myanmar's more remote and conflict-prone States have high demand and abundant resources for renewable energy, including hydropower. Indeed, the so-called 'brown zones' controlled by EOAs sometimes boast their own energy infrastructure under the control of insurgent groups.



2. MYANMAR'S ELECTRIFICATION PROGRAMS

2.1 National electrification programs

Focus on centralized electricity provision

In 2014, the government of Myanmar established two plans to raise the electrification rate from roughly 30 percent to 100 percent by 2030; the National Electrification Plan (NEP) and the National Electricity Master Plan (NEMP). Both plans focus on the extension of the centralized grid powered by coal, large hydro, and gas.

1. The National Electrification Plan

The NEP is supported by the World Bank International Development Association (IDA). The Least-Cost Analysis that shaped the NEP compares Solar Home Lighting Systems, diesel generators, and the national grid. The analysis concludes that least cost rural electrification for 99% of the country would be achieved through national grid extension.[1]

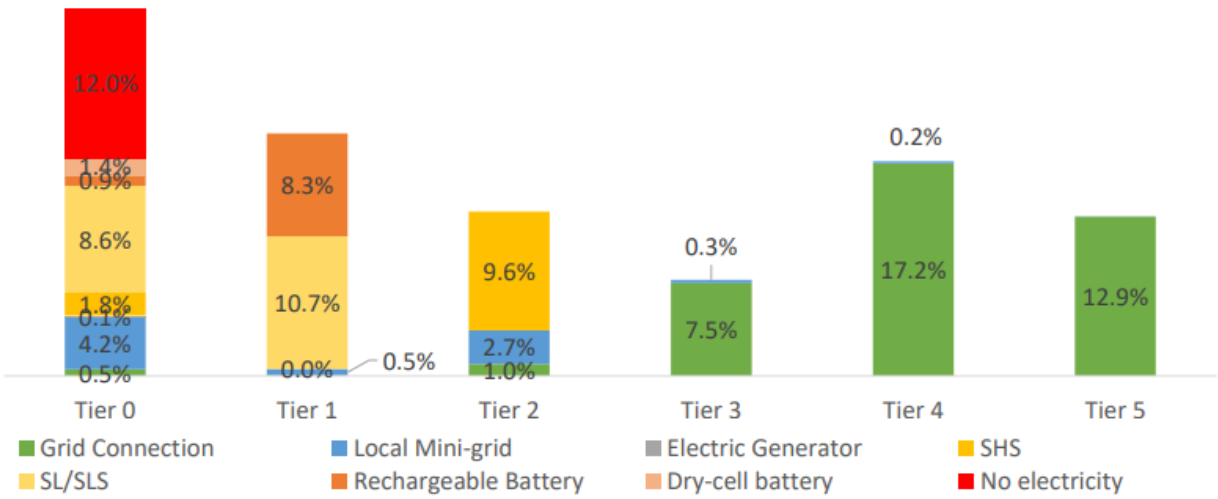
In addition to providing $320 million for grid extension, the World Bank IDA loan for the NEP allocates $80 million for off-grid solutions. The provision for off-grid renewable energy solutions is mainly earmarked for subsidized Solar Home Lighting Systems (SHLS). These provide only Tier 1 access to electrification,[2] and cannot power irrigation, agri-processing, or other productive end uses that play a key role in poverty alleviation.

The NEP off-grid component also includes a 60% subsidy program for community-based renewable energy mini grids that involve the private sector. However, the subsidy is not what local entrepreneurs need to invest in mini grids. . These developers voice a strong preference for interest subsidies or a revolving fund mechanism. However, such instruments are currently precluded by the NEP guidelines, which stipulate that funds may only be used for subsidies to communities and cannot be used for loans to developers. As a result, the subsidy program has faced challenges in establishing financially viable mini grids with sufficient end use. In response, a number of multilateral, bilateral and international development organizations are now

[1] Thuya Aung Bo, MOEE, "National Electrification Plan (NEP) in Chin State: Recent Progress, Future Plans and Challenges" presentation on 28-30 Mar 2017.
[2] As per the World Bank ESMAP Multi-Tier Framework for Measuring Energy Access (2015), Tier 1 refers to and annual consumption below 4 kW-hours and daily consumption of 12 watt-hours.

considering increasing funding for rural electrification. These include the French Development Agency (AFD), which is looking at loan options for mini-grids and rural energy (biomass).[3]

Figure 1. Myanmar's current distribution of access level by technology using multi-tier framework[4]



- Of those with access to the public grid, only one third of them reach Tier 5 level of service
- Off-grid solutions fill the gap for households without grid option
- With adequate policy supports, mini-grid is one of the promising energy solutions shifting households to higher tiers

2. National Electricity Master Plan

The NEMP follows the NEP emphasis on centralized electricity provision, introducing a north-south transmission corridor that is expected to cost the country $5.5 billion by 2030. Funded by the Japan International Cooperation Agency (JICA), the plan focuses extensively on generation from fossil fuels.

[3] Smart Power Myanmar, Decentralised Energy Market Assessment in Myanmar publication May 2019
[4] Source: Moe Myint, World Bank/ESMAP, Myanmar: Energy Access Diagnostic Results based on Multi-Tier Framework, presentation, 2018. Chuenchom S. Greacen, Multi-Actor Meeting to Advance Community-Scale Hydropower for Rural Livelihoods and Re-forestation, presentation, Taunggyi, Shan State, July 2019

Limitations of a top-down approach

National grid extension and upgrading must undoubtedly be a major component of efforts to achieve Myanmar's ambitious universal access target. However, the almost exclusive focus of current electrification planning on centralized provision is ultimately likely to prove self-defeating.

Simply put, Myanmar cannot meet its 2030 targets for universal access without decentralized renewable energy. Even in areas with grid access, decentralized renewable energy systems are still needed to fulfil the needs of rural enterprises and communities that suffer from unreliable power supply or cannot afford existing connection fees and tariffs.

As the following sections describe, Myanmar already has a thriving entrepreneurial sector with decades of experience in providing decentralized renewable energy solutions to rural communities and enterprises. Rather than seeking to harness this experience, however, Myanmar's electrification plans risk undermining its indigenous mini grid sector. Since no provision is made for the integration of mini grids into the network, existing mini grids are likely to be displaced by the arrival of the centralized grid, and financiers are reluctant to risk investing in new projects.

The current top-down approach to electrification also carries significant risks of negative social impacts. Many of Myanmar's existing DRE installations are located in the country's conflict-prone 'brown zones'. Sidelining local entrepreneurs and ignoring the existing energy solutions of local communities risks alienating these actors and complicating Myanmar's ongoing peace process. Meanwhile, the power sources used with the central grid are limited to coal, large hydro and gas, which are prone to displacing populations and negatively impacting climate change.

Left: Civil society protesting large coal and large hydro infrastructure planned by the government. Right: A map of Myanmar showing constructed and planned dams. Credit: U Sein Lin

2.2 People-powered decentralized renewable energy

Myanmar's proven solution

Despite the challenges and conflicts, over the past 30 years an active community of local, small scale energy entrepreneurs has grown up to meet the unserved energy needs of Myanmar's rural communities. Long before the country opened to international aid, these entrepreneurs were developing proven solutions for affordable, reliable, equitable and climate resilient electrification.

Roughly 16,000 small-scale off-grid DRE systems (below 1.5 MW) have so far been developed in Myanmar, achieving scales that far surpass even the most extensively funded DRE programs in South and Southeast Asia. Almost 6,000 communities are estimated to have met their electricity needs using pico, micro, and mini hydropower (less than 1 MW).[5] Meanwhile, an estimated 10,000 local agro-processing industries (e.g. rice mills) are powered by biomass gasifiers (less than 1.5 MW).[6]

These indigenous DRE systems have been developed without foreign technology transfer, international funding or scaled government policy. They have instead been developed by legally registered multi-generational, family-based, home-grown local enterprises that have partnered with village communities to develop and disseminate made-in-Myanmar renewable energy technology.

At the core of this phenomenon is local ingenuity in the form of local entrepreneurs with engineering skills to manufacture cost-effective technology, entrepreneurial skills to identify productive end uses of electricity, and local know-how and relationships that enable them to forge partnerships with rural communities for financially viable projects. They serve as community facilitator, financier, manufacturer, installer, trainer, and operate and maintain services.

An invisible solution

Developed under military rule, most of Myanmar's indigenous mini grids were implemented in the country's conflict-prone 'brown zones' where communities had limited access to government assistance. Since the vast majority of installations were developed without government or international support, there is little or no formal documentation of these mini grids. They therefore exist largely under the radar of Myanmar's government and its development partners (DPs). As a result most projects have not been systematically surveyed and documented, even in baseline reports.

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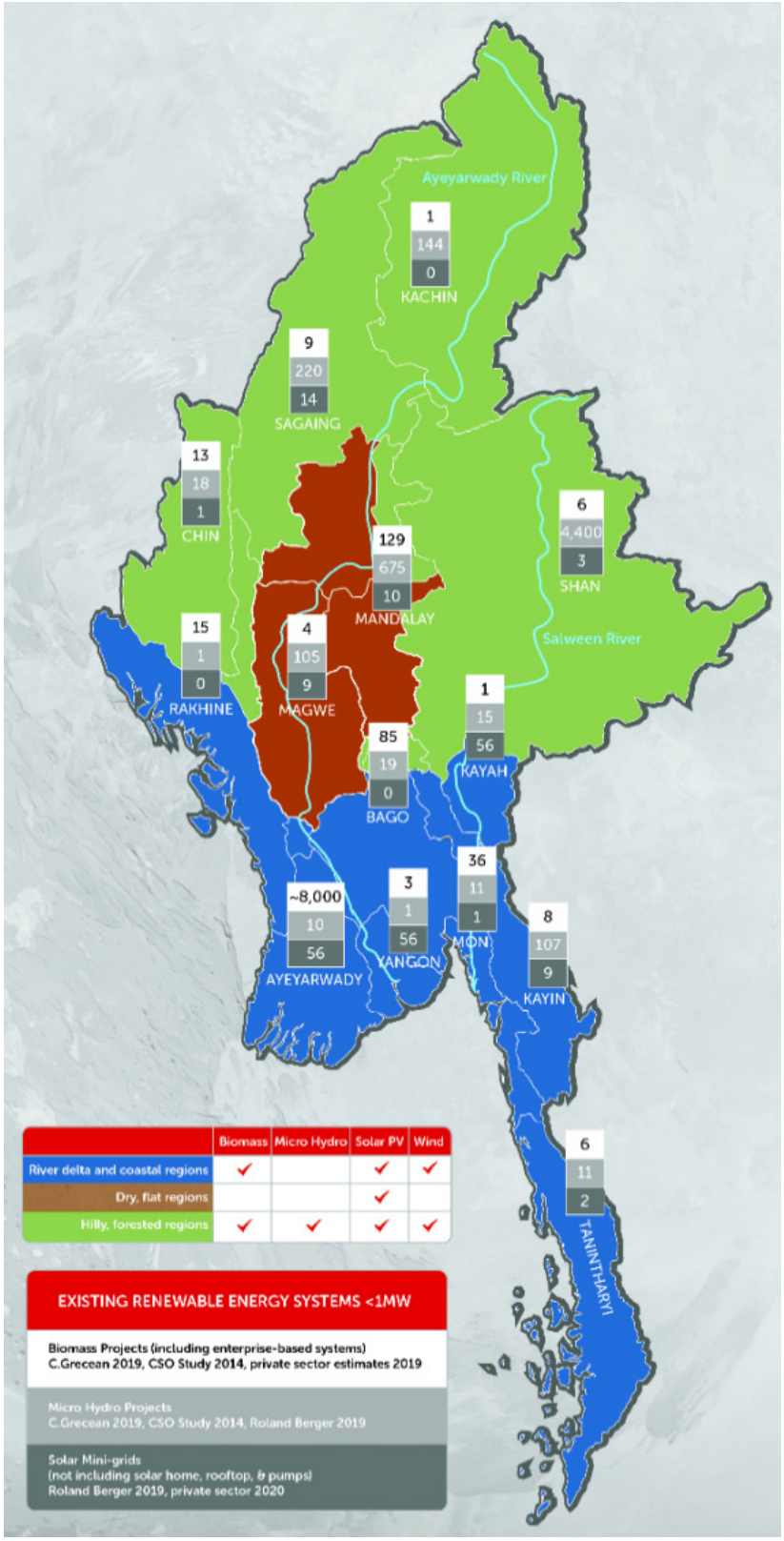
[5] An unpublished 2017 country-wide assessment of secondary data conducted by the Mekong Energy and Ecology Network (MEENet) estimated that there were 5,840 mini grids under 1 MW in Myanmar.
[6] Based on RHL estimates that 70-80% of Myanmar's roughly 15,000 rice mills are powered by biomass gasifiers.

There is substantial learning yet to be captured from these projects and from the communities that maintain them. In the field, many of Myanmar's indigenous mini grids display clear evidence of techno-economic viability, with some operating for up to 20 years. The experience of the local entrepreneurs and communities that have developed and maintained these 'made-in-Myanmar' systems can greatly benefit and enrich the NEP and other DRE programs.

Energy development crossroad

Now in the initial stages of its re-instated political democracy, Myanmar sits at an energy development crossroads to meet its 3GW rural energy demand. It can either continue to focus almost exclusively on extension of the national grid based largely on energy from fossil fuels and large hydropower, or it can seek to incorporate and build on its long experience of locally-driven, reliable, and climate resilient decentralized renewable energy solutions.

Figure 2. Community-based renewable energy map of Myanmar



Biomass waste produced from street vendor's sale. Credit: Jue Khinsandar

3. PEOPLE-POWERED SOLUTIONS

3.1 Clean biomass gasification

Myanmar has about 15,000 rice mills, up to 80% of which are estimated to run on rice husk biomass gasifiers. That is well over 10,000 gasifiers–a number unheard of elsewhere in Southeast or South Asia. Myanmar SMEs have adapted impressively to the complex technical nature of gasifiers. These are typically built by local workshops using locally engineered technology, ensuring long-term technical reliability. Many of the gasifier-powered rice mills are located in the Ayeyarwady River Delta.

Why do so many rice mills prefer gasifiers? One reason is that with its own gasifier, powered by rice husk, a mill pays only a fraction of the cost for electricity than it would using alternative sources. For example, a rice mill typically pays only an estimated MMK 25/unit of electricity produced by a gasifier compared to MMK 170/unit for electricity from the main grid or MMK 200-400/unit from a diesel generator.[7]

In addition to reducing the cost of electricity, gasifiers help to consume the large amount of husk waste produced by rice mills. The bulk of husk waste generated in Myanmar is discarded into rivers systems or burned, stressing the health of river ecology, fish populations, and nearby communities. The same is true for other biomass waste from agri-processing, such as coconut husks, palm branches, peanut shells, and beetle nut husks. Technology that converts biomass waste into clean energy offers a win-win solution for increasing energy access and reducing environmental impacts.

Made-in-Myanmar Technology

Myanmar's leading gasifier engineer and manufacturer, U Soe Tint Aung, built his first gasifier 30 years ago at the age of 26, when none could be easily found in the country. Having successfully demonstrated the technology, he formed an inventors' cooperative to train local fabrication workshops to manufacture gasifiers. Since this time, his own company has built and sold more than 700 gasifiers for various agri-SMEs. He has also electrified villages and townships with biomass mini grids ranging in capacity from 30 kW to 1.5 MW, in some cases leasing distribution lines from the government's diesel mini grids to electrify entire townships. In 2006, he was awarded the ASEAN Energy Award for his biomass gasifier mini-grids.

[7] Figures drawn from a 2017 interview with RHL, prior to recent tariff increases on electricity and diesel.

U Soe Tint Aung is an example of how local entrepreneurs innovate, learn, improve, and work with others to achieve greater social impact using clean energy technology. This is evident in his drive to develop affordable zero-toxic-effluent gasifiers.

Outdated Polluting Gasifiers

Carcinogenic effluent is a byproduct of any gasifier technology. If not safely discarded, the toxic effluent causes severe negative impacts to local water sources. Before 2017, all available gasifier technology in Myanmar relied on the owner to safely dispose the wastewater. Despite being aware of the issue, gasifier owners commonly dispose toxic wastewater and biochar from their gasifier system in nearby waterways.

U Soe Tint Aung realized the immense negative socio-environment impact in the Ayeyarwady Delta from decades of toxic gasifier effluent being dumped into the river system. When he discussed waste water management with millers, he understood that they reluctantly discarded the toxic waste water into river systems, despite understanding the negative consequences for river ecology and the health of nearby communities. He realized that millers had no alternative because they had no solution to deal with the toxic elements.

Raised in a rice milling family, U Soe Tint Aung knew firsthand how central gasifiers had become to the financial sustainability of small-scale rice mills. He knew that as Myanmar opened its doors to foreign aid, millers might be banned from using outdated gasifiers due to their negative impact on the environment. He reasoned that this would devastate small-holder rice production, and concluded that it was urgent to find a technical solution to resolve the situation.

RHL's Zero-Toxic-Effluent Gasifier

Having played a role in popularizing gasifiers in Myanmar, U Soe Tint Aung felt partly responsible for the prolific use of the outdated gasifiers, and therefore in 2009 made the commitment to develop *zero-toxic-effluent* gasifier technology. In order to raise funds for technology research and development, he sold his manufacturing workshop. He spent the next six years developing the next generation of made-in-Myanmar gasifier technology. The technology uses the heat from the gasifier to separate toxic material from the waste water. The toxic solids are incinerated and the remaining waste water is treated before it is released. This results in zero-toxic-effluent. Further, the amount of water released and consumed is less due to greater efficiency of the gasifier.

U Soe Tint Aung's aim is to trigger a scaled transformation, where all rice millers are incentivized to transition from polluting gasifiers to zero-toxic-effluent gasifiers. For this to happen, his new design targets reducing the cost and time rice millers spend on gasifiers, as listed in Table 1. As his efforts advanced, he established Royal Htoo Linn Manufacturing Ltd. Co. (RHL), dedicated to developing clean biomass energy solutions. In 2015 he completed his first model of the zero-toxic-effluent gasifier. After rigorous testing, RHL's zero-toxic-effluent gasifier technology was approved by Department of Research and Innovation (DRI) in 2017, allowing the RHL to take the

technology to rice millers who had been looking for alternatives and un-electrified communities that had ample biomass resource.

Table 1. Differences between old gasifier and RHL's gasifier

	Outdated gasifier technology	RHL zero-toxic-effluent gasifier (2019 model)
Pollution		
Water effluent	Toxic discharge	Zero toxic discharge
Emissions	Strong odor	No odor
Ash byproduct	Ash becomes mixed with waste water	Ash is kept dry and can be reused in the rice farm
Tar release	Tar is released with the water effluent	Collected and re-used to paint boats.
Engine life		
Engine servicing	Every 2,000 hours	Every 6,000 hours
Efficiency	Poor	Much higher such that rice millers see benefits
Labor		
Biomass feeding	Manual feed-in	Automated, sensor-based feed-in
Ash removal	Manual removal	No-touch removal
Resources		
Water usage	2500-3000 gallons per hour	50 gallons per hour

RHL's zero-toxi-effluent gasifier generators in Betut village co-funded by the NEP. Credit: RHL

Enabling Rice Mills with Access-to-Finance

RHL's made-in-Myanmar, zero-toxic-effluent gasifiers are increasingly being adopted by rice millers, especially those who have outdated technology that is in need of being refurbished. In April 2018, the first rice mill transitioned from the outdated gasifier to RHL's zero-affluent gasifier. In April 2019, four rice millers in partnership with RHL applied for the Danish-funded Responsible Business Fund, which incentivized SMEs to upgrade their waste management, energy efficiency, and water efficiency with up to 60% co-funding. The co-funding was awarded, leading to positive feedback from the millers. Based on the results, RHL joined the World Wide Fund (WWF) *Tha Ba Wa* initiative to engage with local banks in order to support rice millers to access finance to transition to clean gasifiers. The Global Green Growth Institute (GGGI), in partnership with local associations of rice producers, has also been exploring options to bring finance for rice millers to use adopt clean gasifier technology.

The key challenge that any access-to-finance initiative must resolve is that there is no financial incentive for millers to invest in new technology when the outdated technology is still functional. Further, with the price of rice strongly influenced by China's purchase of Myanmar rice, millers are not able to consider taking loans when their profit margins in the short and medium term are not clear. Incentives such as *green labels* can be considered for millers that use zero-toxic-effluent technology instead of outdated technology.

In addition to gasifiers, RHL would like to enable rice millers and rice farmers with affordable and effective rice dryers and briquette-making machines, as solutions to further consume husk waste while increasing the quality of their milling and diversifying their business. Rice dryers result in less broken rice, which sells for a higher price; and briquettes can be sold to the many local industries that rely on dirty coal and reused oil to generate power.

Mini-Grids Powered by Clean Gasifiers

RHL also applied for the World Bank financed NEP subsidy to develop biomass energy mini grids to electrify 564 households in Betut Village in the Delta region. The 60% subsidy enabled RHL to significantly upgrade the technology, integrating automated husk feed-in and ash removal. The experience of applying for the subsidy has allowed RHL to understand firsthand the process of applying for foreign finance. Unlike when it mobilized communities to establish their own biomass mini-grids, RHL must be careful in how the NEP is explained to the Village Electrification Committee so there are no false expectations. RHL also made changes to its design and safety procedures in order to meet World Bank safeguards standards.

Overall the experience of engaging with the NEP has been positive, and RHL will encourage other un-electrified and qualifying communities to apply for the NEP subsidy. However, the bottleneck for RHL to facilitate more communities to apply for the subsidy is a lack of finance. Communities are not able to provide upfront their required 20% contribution. Likewise, RHL is also challenged in mobilizing its 20% required contribution. However, in terms of manufacturing and installation capacity, RHL has the ability to commission a biomass mini-grid system every six months (not including the time to develop the NEP proposal documents). This means that access to affordable finance that complements the NEP could greatly enhance the scale up of biomass mini-grids.

All goods store in Betut village using electricity generated by RHL's clean gasifier. Credit: RHL

Owner of milling enterprise powered by a cooperative-owned micro hydro system in Shan State.
Credit: Dipti Vaghela

3.2 Community-scale hydropower

Myanmar has over 5,800 pico (<5 kW), micro (<100 kW) and mini hydropower (<1000 kW) projects, and many small hydro projects (>1000 kW). Most of the pico, micro, and mini hydro systems have been financed, manufactured, and installed by local entrepreneurs. In fact, there is an extensive and diverse local eco-system of practitioners, which can be leveraged to meet the country's 2030 electrification target since there is great untapped natural resource potential in the largely un-electrified ethnic regions of Myanmar. With advanced local manufacturing capacity already in place, and an innate awareness of productive end use, thousands of jobs and livelihoods can be generated while meeting electrification targets. Such local expertise also ensures the long-term sustainability and financial viability of projects, especially in overcoming challenges of post-COVID 19. Further, at the community level there is a keen understanding of the linkage between climate resilience, forest conservation, and community-scale hydropower that has brought increased impact and sustainability, and greater motivation for CSOs who are fighting large hydro and coal.

Pico hydro turbine in Shan State. Credit: U Kyi Phyo

In short, all the ingredients for scaled, sustainable, high impact and inclusive community-based hydropower initiatives are currently present in Myanmar.

Diverse Projects and Motivations

Over the last 50 years, small-scale hydropower has been adapted by diverse stakeholders in a variety of different contexts in Myanmar, each having its specific motivation, as listed in Table 2 (on the next page).

While all of the contexts listed in Table 2 are significant, the analyses below focus on the village plus local entrepreneur developed projects, particularly those developed by members of the association Hydropower for Community Empowerment in Myanmar (HyCEM). HyCEM was established in 2014 to synergize hydro mini-grid local social entrepreneurs, with support from REAM and HPNET.

HyCEM members at micro hydro project in Shan State. Credit: Dipti Vaghela

Table 2. Range of small-scale hydro contexts in Myanmar

Context	Capacity Range	Motivation
1. Union Government	Small Hydro	Tendered projects for meeting township and large industry demand
2. State Government	Micro and Mini Hydro	Tendered projects for meeting rural electrification needs
3. Foreign Developer	Small Hydro	Turnkey project bids awarded by the government
4. Civil Society Organization	Pico and Micro Hydro	Demonstration and skills-building to enter sector
5. Local Entrepreneur	Mini and Small Hydro	Private enterprise development
6. Village Committee	Pico and Micro Hydro	Community-based projects for lighting
7. Village Monastery	Pico and Micro Hydro	Community-based projects for lighting
8. Household	Pico Hydro	Family-based project for lighting
9. Village + Local Entrepreneur	Pico, Micro, and Mini Hydro	Community-enterprise development for lighting, productive end use, and income generation

Made-in-Myanmar Technology

In the 1990s, in Nepal, Sri Lanka and Indonesia, local capacity building for small-scale hydro was avidly supported by international donors and governments, leading to scaled programs in the decades that followed.

During the same time span in Myanmar, family-based, multi-generational, local social entrepreneurs self-developed their capacity to do project design, engineering, community mobilization, and local manufacturing - providing electricity to thousands of communities without international, government, or bank support.

Having lived near or raised in micro hydro communities, these entrepreneurs have long been driven to advance their skills to create greater social benefits for the communities they serve. Because there were no international donors, and

HyCEM member U Zaw Min with Francis turbine housing. Credit: HyCEM

government funding was sparse, the entrepreneurs took it upon themselves to develop and finance community-owned systems. In order to implement projects solely with their own investments and minimal down payments from the communities, the entrepreneurs innovated their design and manufacturing to produce equipment that was both low cost and high quality for long-term reliability. As they gained more experience and positive results, the entrepreneurs invested in modern-day design tools, e.g. 3D printers, fluid analysis software, CAD, Google Earth, and GIS tools. This technological proficiency was self-initiated and self-learned, using academic, online, and peer-to-peer learning resources.

Francis turbine manufacturing in Taunggyi, Shan State. Credit: U Zaw Min

Today all members of HyCEM produce Francis, Pelton, Turgo, Crossflow, and Propeller turbines. They also manufacture the penstock, transformers, transmission/ distribution poles, and flow governor systems. In addition to the electro-mechanical system, they have extensive experience in overall system design, including flow and head measurements, terrain mapping and analyses, and civil structure design.

In each project, HyCEM members have trained VEC members and community-based technicians to operate, troubleshoot, and conduct preventive maintenance, such that systems that were built 20 years ago are still functional.

HyCEM project workmanship. Credit. HPNET

Diverse Ownership Models

Local entrepreneurs tailor their projects to the local contexts in which they operate, helping to ensure long term social, technical, and financial viability. They customize the ownership models for each project, based on the economic and management strengths of the village communities involved. These ownership structures include community-owned, cooperative-owned, developer-owned, developer-leased and hybrid structures. Connection fees and tariff structures are also customized to affordability, willingness to pay, and economic efficiency (e.g. tariffs and fees of commercial consumers may help to offset reduced residential tariffs).

Built-in Financial Viability

Extensive productive end-use is typically designed into HyCEM member's cooperative-owned projects, helping to ensure their financial viability over the long term. To maximize use, profit, and growth, local entrepreneurs ensure higher load factors by developing the capacity of households and enterprises to use electricity for income generation. The systems accommodate organic growth, and power generation capacity is typically increased in phases by re-investing revenues in increasing generation capacity to meet growing demand. End uses in Myanmar hydro mini-grids can be categorized as external enterprises, villager-owned enterprises, social services, and household use. Figure 3 provides a snapshot of productive end use activities in a cooperative-owned micro hydro project.

Twenty-four hour clinic with infant delivery facility powered by HyCEM micro hydro project. Credit: HPNET

Figure 3. Productive end use in locally developed mini-hydro project.[8]

3.3 Solar PV applications

Solar PV is now very widespread worldwide. But unlike hydropower and gasification technologies there is no indigenous solar technology development. All major components for solar applications are imported (primarily from China). Rather than local social enterprises, CSOs such as REAM have been the leading local players involved in the dissemination of imported technologies including Solar Home Lighting Systems and solar PV drip irrigation.

Solar Home Lighting Systems

Long before it opened to foreign donors, Myanmar had developed a strong self-financed indigenous sector for Solar Home Lighting (SHL) based on technology procured from China. REAM pioneered the dissemination of SHL technology in rural areas in Myanmar, and played a significant role in developing the sector, latterly establishing a revolving fund with a local bank to support dissemination. By the 2010s, the sector had reached even the most rural areas of the country with products and after sales services.

[8] Hydro Empowerment Network (HPNET) 2019

The foreign-funded SHL programs that entered Myanmar in the last six years have operated largely independently of these indigenous actors, instead establishing new operations through government offices or private teams. These included the World Bank 90% subsidy program for SHL and UNCDF financing for foreign companies. However, the highly subsidized provision of solar PV systems has shown low sustainability, and most foreign private sector actors have left the SHL sector in Myanmar.[9]

Innovative Applications

Solar PV Drip Irrigation. Over the past five years, REAM has sought to develop innovative PV applications that meet the needs of communities in Myanmar. This includes a self-financed PV drip irrigation initiative in Myanmar's central low-land Dry Zone. REAM's initial work with ten local farming businesses to develop a model for PV drip irrigation has shown very promising results. REAM has recently introduced access to financing for its PV drip irrigation model in order that more farmers can benefit. To support scale up, REAM is looking to interface with international organizations working on climate resilient agriculture in Myanmar and will require guidance on how to grow its revolving fund.

Modern Electric Cooking solutions. REAM has also been collaborating with Loughborough University (LU) to develop locally appropriate e-cooking solutions for low-income households across Myanmar powered by solar PV with used battery. With support from LU's e-cooking market assessment research program, REAM worked with local urban and rural households and innovators to understand what types of e-cooking appliances are most useful and how they could be connected to DRE sources. The action research focused on localized off the shelf cooking appliances that can be modified to meet cooking needs in different parts of Myanmar, e.g. Dry Zone vs Shan State hill regions vs the Ayeyarwady Delta. . The research is currently in a second phase in 2020 which is looking at e-cooking within the mini-grids and grid connected environment in collaboration with Hivos and civil society organisations partners.

[9] See e.g. https://www.sun-connect-news.org/articles/business/details/the-danger-of-subsidized-solar-how-government-and-donors-unwittingly-hobbled-our-business/ for a discussion of how subsidized provision has crowded out independent commercial provision

Beneficiaries of the REAM Revolving Fund for solar PV drip irrigation, supported by EKOenergy Climate Fund.
Credit: Dipti Vaghela

4. UNLEASHING THE HOMEGROWN SECTOR: KEY CHALLENGES

Despite the myriad indigenous off-grid solutions that have been developed in Myanmar over the past 30 years, the local private sector remains largely below the radar of the government and its development partners as they seek to advance rural electrification. Local civil society organizations that work in support of Myanmar's DRE entrepreneurs and communities also experience limited engagement and space for dialogue on energy policies, regulations and planning. This is indeed a missed opportunity, as Myanmar's local DRE solutions have an important role to play if the country is to radically scale up electrification in line with its 2030 goals.

4.1 Neglect of local actors

The Myanmar government and its development partners appear to have a blind spot about the indigenous DRE sector. This is well illustrated by the fact that even World Bank baseline studies on existing DRE do not include the indigenous sector, despite the fact that the local sector has supported more communities and local enterprise activities through DRE than any other source. As a result, policies and programs that aim to promote energy access fail to engage with and factor in the experience and capacity of local actors to contribute to Myanmar's ambitious electrification targets.

A lack of visibility contributes to the neglect of local actors. Much of the work of Myanmar's home-grown renewable energy sector has focused on the country's more remote, underserved, and conflict-prone 'brown zones', away from the gaze of government and donor agencies. In addition, there is little credible information and documentation about the activities and achievements of local RE entrepreneurs available to government or international audiences.

4.2 Linking supply and demand

The capacity of Myanmar's local entrepreneurs to develop locally appropriate technology plays a critical role in ensuring the viability and sustainability of its community-scale hydropower systems. Complex DRE technologies like micro hydro and biomass gasifiers require local providers to ensure that systems are affordable, and to support maintenance and troubleshoot problems. In Myanmar, the same local entrepreneurs who design, manufactured, and supply the technology also mobilize communities for optimal management, support financing, and train

communities in installing and maintaining projects. Rather than relying on external technology, expertise, organizational models and financing, Myanmar's DRE technology providers build on 35 years of local ingenuity, experience and local networks to work within the scope of what is technically, economically and socially feasible in the contexts where they operate. Unfortunately, the funding programs available do not yet cater to the project design and implementation approaches of the homegrown sector.

4.3 Limited access to affordable financing

Local entrepreneurs experience many barriers to access financing from local banks. Challenges include high collateral requirements; high interest rates (currently 13%); short loan periods of three years or less;[10] and limited capacity or willingness of banks to provide loans of $100,000–$1.5 million for hydro and biomass mini grids. While local banks like Ayeyarwady Farmers Development Bank (A-Bank) have shown interest in co-financing loans to local biomass and hydro entrepreneurs with foreign financiers, such loans have yet to eventuate. In addition, local hydro and biomass entrepreneurs lack access to soft loans to upgrade their manufacturing facilities, limiting their capacity to improve and innovate.

Key contributing factors include lack of information around main grid extension and lack of policy on mini grid integration. This makes local and international financiers reluctant to invest in mini grid projects. In addition, DRE entrepreneurs have limited capacity to describe and document their business models, and local banks lack sufficient knowledge and skills to assess them.

4.4 Lack of multi-stakeholder collaboration

Lack of coordination and communication within and between the various stakeholder groups is a major challenge for the development of the DRE sector. While the NEP delegates responsibility for rural electrification to the MoEE and the Ministry of Agriculture Livestock and Irrigation (MoALI), until recently there has been limited coordination between the two Ministries. Meanwhile, coordination between Myanmar's development partners has been limited to quarterly progress updates, with little space for exchange and coordination.

This lack of coordination and communication has resulted in a failure to develop an enabling policy and regulatory framework for local businesses and private investors to participate in efforts to accelerate rural electrification. It has also created risks of multiple overlapping programs without proper documentation or sharing of lessons. Coordination and collaboration among and between international and local CSOs are also quite limited, leading for example to repetition of

[10] Biomass and hydro mini grid developers require eight to ten-year payback period, assuming no subsidy and five to eight-year payback with 60% subsidy.

the same type of event by different CSOs. This reduces the effectiveness of their efforts to strategically influence policy makers.

4.5 Limited local civil society capacities to voice their concern effectively

Advocacy messages from civil society groups largely focus on protests against coal and large dams. Few have the capacity to showcase alternative solutions and most lack understanding of renewable energy and its successful application, including DRE at the community level. Events and field visits are conducted sporadically, with no follow up or space for dialogue with government or other actors. As a result, civil society actors are largely excluded from development consultations and are in a weak position to influence the sector.

CSOs leaders from Shan, Mon, and Kayin states and renewable energy developer committed to advancing renewable energy solutions for sustainable development. Credit: Hivos Southeast Asia

5. CONCLUSION AND RECOMMENDATIONS

Myanmar's aim of achieving 100% access to electricity by 2030 is inspiring, though extremely ambitious, and it will not be achieved through the current almost exclusive focus on expanding grid access. To accelerate access to electricity for communities and enterprises that are poorly served by the grid, Myanmar must also harness and build on the capacity of its indigenous DRE sector. The country's proven entrepreneurs have decades of experience in working with local communities to develop locally appropriate solutions to the energy needs of households and enterprises that are cost-effective, reliable and capable of expanding to serve growing demand.

The following are some identified key recommendations reflecting to the current situation in the efforts of accelerating access to electricity in the country:

1. **Ensure that assessments properly recognize the impacts and potential of the homegrown RE sector.** Energy sector assessments in Myanmar have so far failed to capture the achievements of local social enterprises. As a result, the local RE sector has been sidelined in Myanmar's electrification policies and plans. In future, assessments such as the World Bank baseline must include local RE solutions. Targeted new studies should also be commissioned to assess the impacts, challenges and potential of the local sector, to inform policies and plans on RE development. For such assessments to be accurate and constructive, local entrepreneurs would need to be engaged. International organizations should actively develop dialogue with local actors due to their decades of experiences in advancing DRE in the country.

2. **Support access to affordable financing for local DRE entrepreneurs.** Lack of access to financing at affordable rates and with sufficient loan tenures restricts investment in new projects and in local manufacturing capacity and innovation. Solutions may include working with local or international financial institutions to establish new financial instruments, including low interest and/or subsidized loan packages with longer tenures (up to ten years). Other supporting interventions may include building the knowledge of local banks about the DRE sector and developing their capacity to assess loan applications. Local entrepreneurs also need support to build their capacity to constantly improve their technology solutions and communicate their business models to lenders. Access to affordable finance that complements the NEP could greatly enhance the scale up of decentralized renewable energy mini-grids. Smart Power Myanmar, in partnership with the DRD, has recently launched a credit scheme to support NEP developers to access credit for equipment. With this opportunity, local developers of biomass and hydro mini-grids need to be informed of this great progress and be encouraged to leverage the credit.

3. **Facilitate access to information on grid extension plans.** Incomplete, inconsistent, and inaccurate information about grid extension makes it difficult for local enterprises and financial institutions to make informed decisions and disincentivizes investment and lending for DRE projects. To help unlock local investment in energy access for rural communities and enterprises, the Myanmar government and its development partners should open-up this information and make it easily available for the relevant parties to access, including by making them available in Burmese language.

4. **Improve cross-sectoral cooperation.** Cross-sectoral coordination could help to improve acceleration of rural electrification. It reduces risk of multiple overlapping programs and increases effectiveness both in resource allocation and investment made by others. Coordination should also involve relevant Ministries, private players, development partners including civil society and academic institutions. Initiate a multi-stakeholder approach and establish regular coordination mechanisms will stimulate inclusive participation and transparency of information for stakeholders in making decision, improve collaboration, at the same time allowing documentation and knowledge exchange.

5. **Promote a more conducive policy environment in which the DRE sector can co-exist with the grid, and local decision-makers and communities have more say in resource planning.** Establishing policies on feeding electricity into regional and national grids is critical for the development of Myanmar's indigenous mini-grid sector, as it will help to unlock financing and enhance the financial viability of local mini-grids. Regions and States should also be provided with increased authority and mandates to administer local development plans.

Capacity building for CSO and community leaders on decentralized renewable energy solutions in southern Shan State, facilitated by Hivos Southeast Asia, REAM, Save the Natural Resources (SaNaR), HyCEM, and Energy Action Partners (ENACT). Credit: Hivos Southeast Asia

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