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De-centralized Electricity in Africa and Southeast Asia: Issues and Solutions

A study by Accenture Development Partnerships

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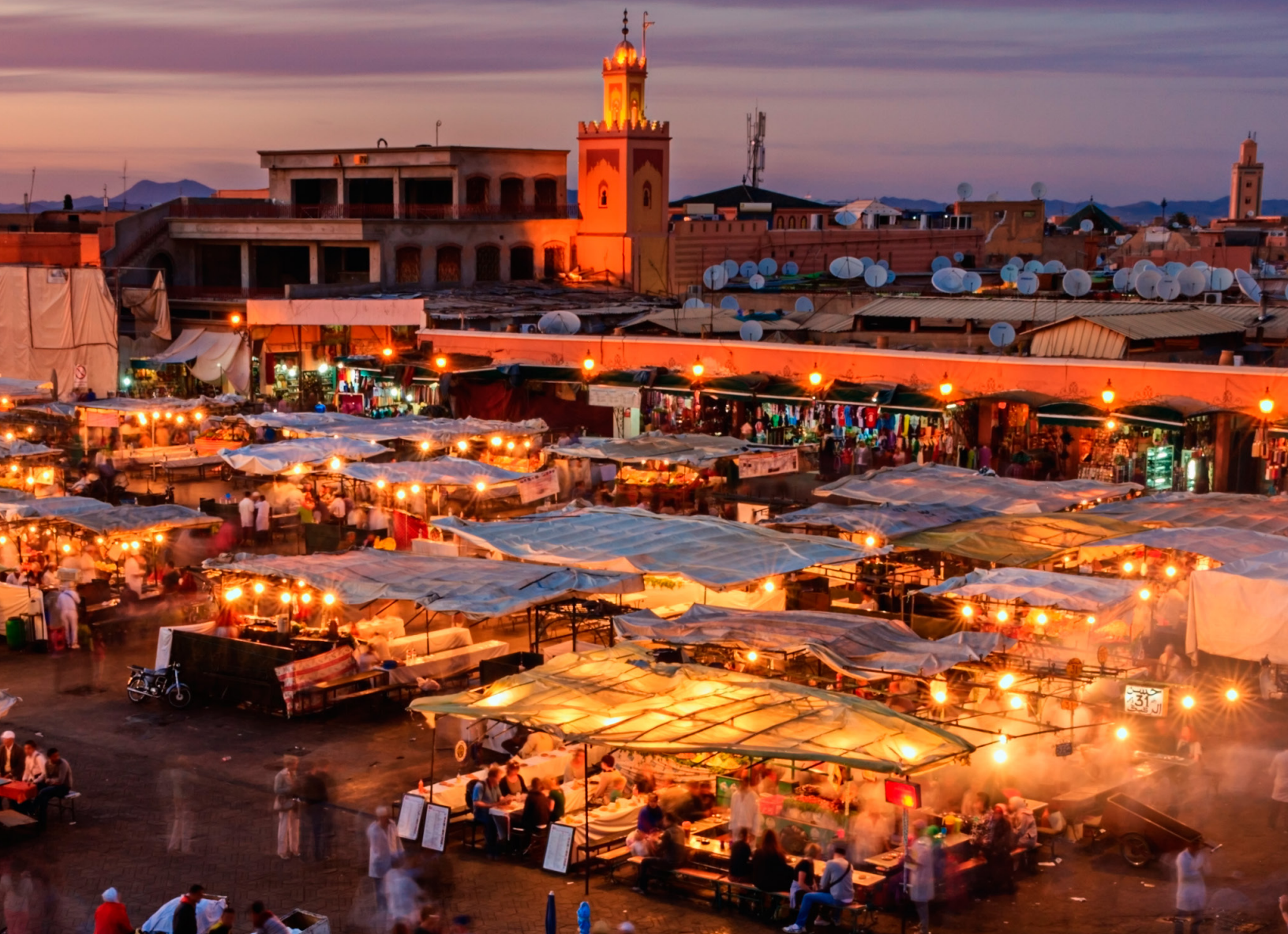

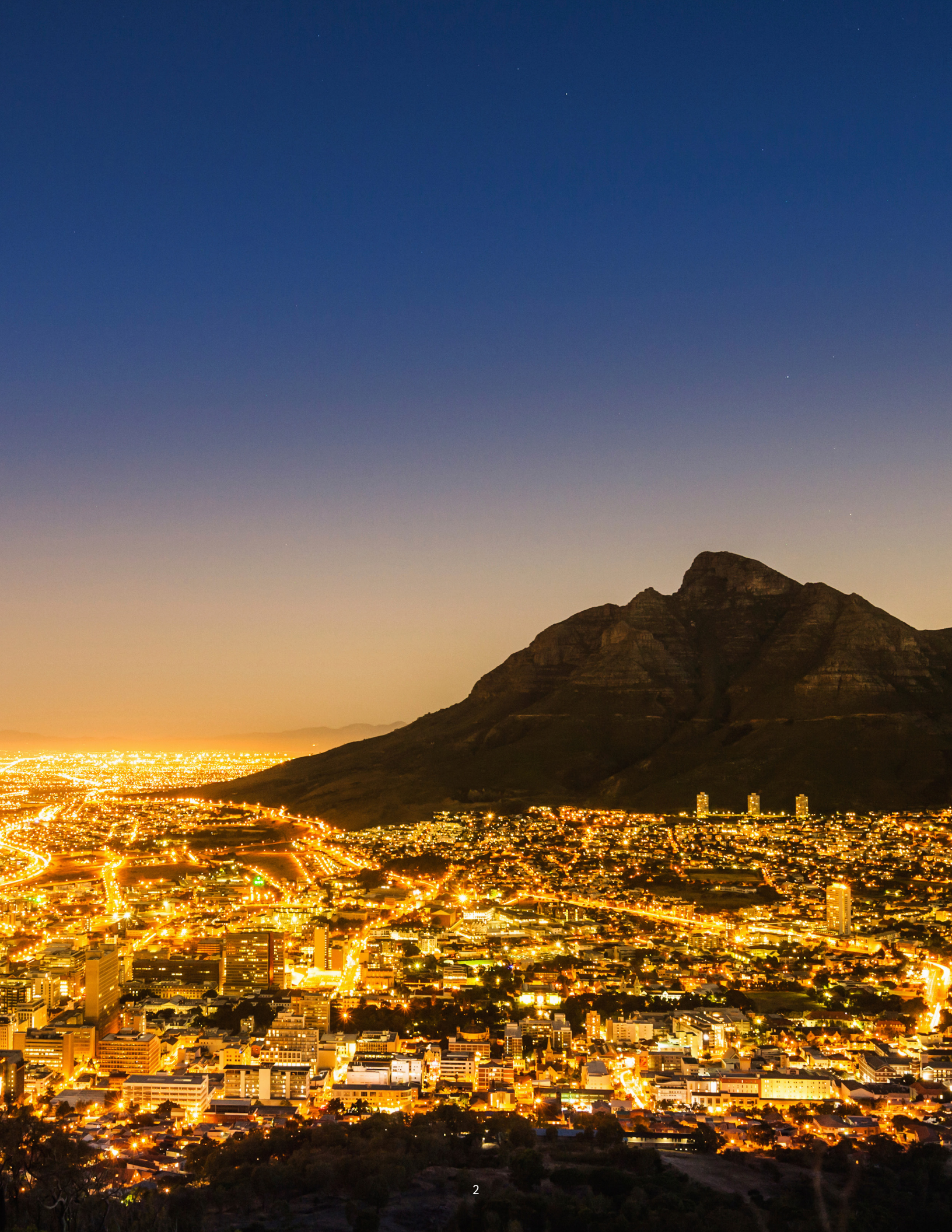

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Foreword

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Around the world, almost a quarter of the world's population or 1.3 billion people lack access to electricity. Of these, close to 85 percent of those without electricity live in rural areas and 87% are geographically concentrated in Sub-Saharan Africa and South Asia. These statistics only provide a brief insight into the problem as many of those who do have access to electricity still experience frequent and unplanned outage periods. The lack of access to reliable electricity unfortunately is a great hindrance of development, limiting people's ability to enhance their incomes, improve food security, educate their children, access key information services. It especially burdens women with physically taxing activities and reduces their safety within communities. Lack of access to electricity is a major barrier to achieving a more inclusive economy and to building the resilience of poor or vulnerable communities.

Due to the high consumer interest in off-grid electricity, many have drawn parallels between the explosive growth of the telecommunication sector in the past decade with that of a nascent off-grid energy market. According to IFC, the number of African telecommunications subscribers has grown at a rate of approximately 30 percent annually for the past 10 years. The growth in the telecommunications sector has shown how technological advancements can allow a leapfrog effect in emerging markets and it also demonstrates that even low and middle-income consumers have purchasing power that should be recognized. This telecommunication growth also provides a unique opportunity as they continue to expand their infrastructure investment in rural areas, thereby improving both coverage and reliability. This continued growth provides a unique opportunity to meet the current demand for power from off-grid telecom sites.

The Rockefeller Foundation saw an opportunity to catalyze the telecommunications and off-grid energy sectors. Currently cell phone towers in rural areas are often powered by expensive diesel generators and companies are looking for cheaper alternatives, thereby creating the possibility for a strong "anchor" demand for off-grid power in rural areas. Entrepreneurs can take advantage of this demand by setting up power plants which provide electricity to cell phone towers as well as surrounding communities and other local enterprises. With a total commitment of $75 million, The Rockefeller Foundation has launched Smart Power for Rural Development to promote sustainable business models that deliver renewable electricity and spur economic development among poor, underserved rural populations. The initiative will focus on India, where the Foundation is establishing a new organization that will partner with energy service companies (ESCOs), telecom tower operators, investors, non-governmental organizations (NGOs), and government agencies to electrify 1,000 villages in the next three years (2014-2017).

The following study was in support of The Rockefeller Foundation, building off the lessons learned in India over the past four years, to explore the feasibility of the expansion of the model to new countries. The Rockefeller Foundation and Accenture Development Partnerships partnered to assess the viability of the Smart Power for Rural Development model in seven countries throughout Africa and Asia, where the approach was determined to have substantial potential for adaptation and scale. The goal of this report is to share the information and encourage greater collaboration with practitioners who are interested in in de-centralized renewable energy mini-grids market. In this light, we hope this report will contribute to global dialogue and innovation on solutions addressing energy poverty.

Executive Summary

Introduction

A lack of access to electricity is one of the key development issues of our time, with a majority of the world's underserved communities living in rural areas far removed from grid connections.

This issue is not new to governments, with extension of national grids a key part of most developing countries' energy development plans. However, the remoteness of afflicted locations and the high capital costs required for large-scale grid connection make grid extension too long-term a solution for rural communities. This leaves a large hole in the socio-economic development of those most in need.

Into this gap step de-centralized renewable energy solutions focused on productive power mini-grids that provide access to rural communities. The de-centralized model reviewed in this assessment is comprised of an Energy Service Company (ESCO) business model that develops partnerships with aggregated anchor tenants—specifically telecommunications or telecoms companies. These tenants sign long-term power purchasing agreements and the ESCO also sells power to rural households and micro-enterprises that, as they develop, demand more power and ultimately drive profitability, scalability and socio-economic gains for the community.

Supported by The Rockefeller Foundation, Accenture Development Partnerships assessed the suitability of de-centralized mini-grid solutions in seven countries across Asia and Africa. The assessment led to the development of this detailed report on the current conditions for mini-grids in each country, the relative viability of entry into each country, and an overview of the key learnings taken across the assessment. The countries selected were Cambodia, Indonesia, Myanmar, Kenya, Tanzania, Nigeria and Ghana.

This executive summary provides an overview of this assessment and the subsequent report, focusing on the key learnings and recommendations identified.

About the Assessment

The assessment focused on answering the following critical question across all seven geographies:

How suitable is the market environment for de-centralized mini-grids to operate and scale?

At the highest level, each country was assessed across five business critical environmental dimensions:

- **Policy**—suitability of the regulatory environment
- **ESCO—**viable companies and business models
- **Anchor**—potential anchor load tenants
- **Social**—available skills / capacity and consumer demand
- **Financial**—availability of financial support

The assessment across these five areas was combined and analyzed, allowing comparative conclusions to be drawn regarding the suitability of each country for de-centralized mini-grid power.

High-level Recommendations

The assessment revealed both supportive and inhibitive characteristics affecting the viability of de-centralized mini-grid solutions. There are a number of considerations that rural electrification initiatives aiming to supply productive load and harness telecoms towers as anchor clients should consider prior to developing de-centralized mini-grid solutions:

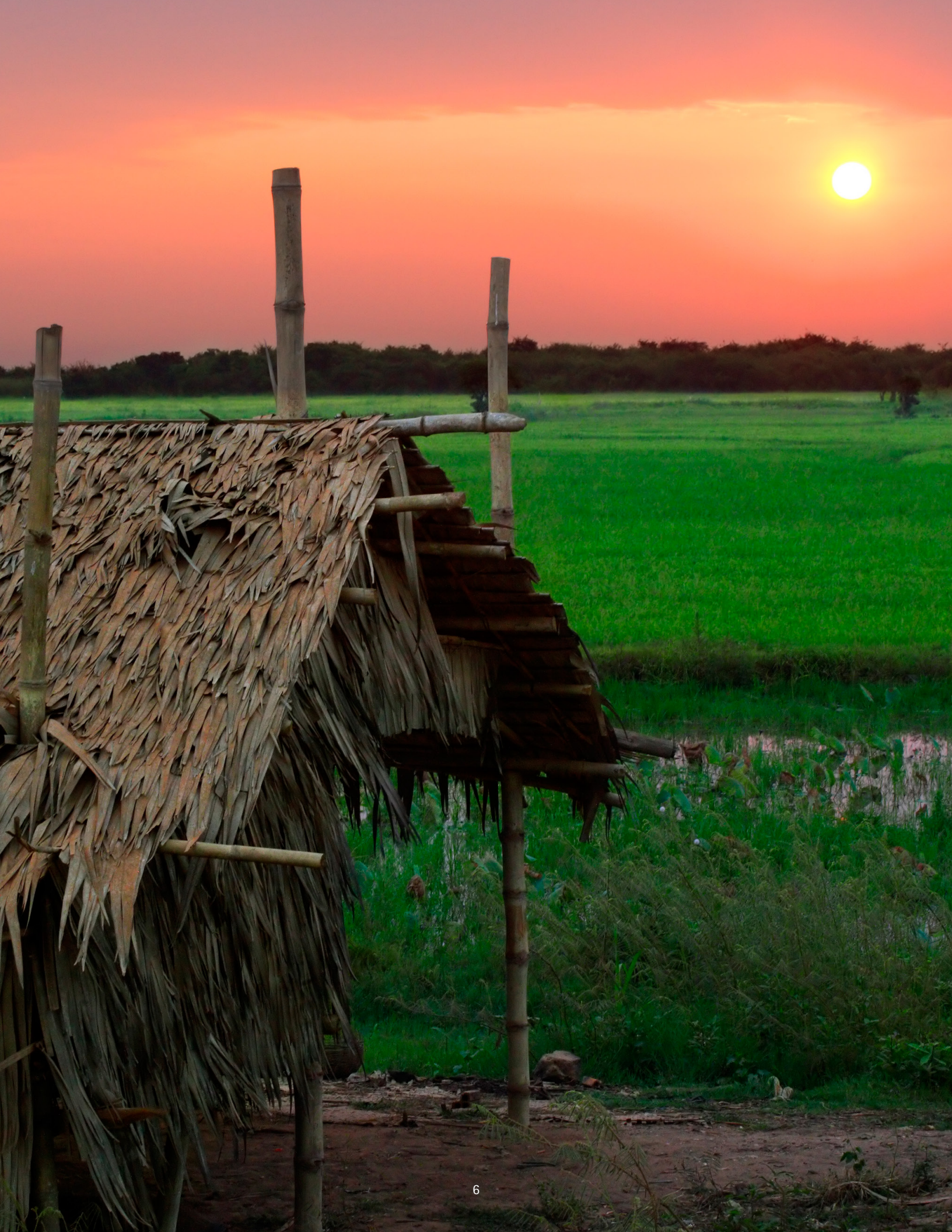
- From a **policy perspective,** focus on countries (and regions) that have a history of supporting de-centralized power with clear frameworks and commercial tariff rates.
- From an **ESCO perspective,** focus on reducing barriers to entry by providing project development and load ramp-up support as well as access to versatile financing.
- From a **telecoms perspective,** focus on Mobile Network Operators (MNOs) and tower operators who have switched from a primary focus on growth (revenue) to portfolio optimization (cost).

Conclusion

With the right environmental conditions and business model, de-centralized power can play a role in helping communities overcome the issue of energy access in all seven countries—although scalability is questionable in some.

This assessment and comparative analysis found three levels of suitability across the seven countries:

- **Current Potential** countries with strong de-centralized electricity environments that are suitable for entry today—**Cambodia** and **Tanzania**.
- **Future Potential** countries undergoing a high amount of change but likely to be suitable in the medium term—**Nigeria** and **Myanmar**.
- **Limited Potential** countries that are relatively poor matches for the anchor tenant de-centralized solution model due to currently unfavorable regulatory conditions or other inhibiting factors— **Indonesia, Kenya** and **Ghana.**



Introduction

Electricity access is one of the great development issues facing the world today, with millions of lives deprived of the social and economic opportunities that are commonplace to those with access. As grid extension is slow and may not always be the best solution, alternative de-centralized scalable solutions are required.

This publication provides an overview of the key learnings from an assessment of the viability of de-centralized renewable energy mini-grids in seven Asian and African geographies.

Overview of the Issue

Almost one quarter of the world's population (1.3 billion people) lack access to electricity, with 2.6 billion still reliant on traditional fuels for cooking. They are ostensibly locked out of the huge developmental gains that access makes possible. This lack of access to modern energy services has staggering consequences for human health, economic development and political stability, and is a major inhibitor to achieving equitable growth and building greater resilience in poor and vulnerable communities.[1] This issue of electricity access and its corresponding social ills is particularly apparent in Asia and Africa, where 620 million, and 590 million people, respectively, lack access.

The issue of access is not unknown to national governments and there are many programs in place to extend grids to rural areas where access to electricity is at its lowest. However, with so many people to connect, a single focus on nationally-led grid extension may not be feasible, particularly in remote or low population density areas that are costly to reach. To fill this gap, governments need economical, commercially viable and scalable de-centralized electricity solutions that are able to provide productive electricity to those lacking access and will, ultimately, drive economic and social development.

The mobile industry's concurrent exponential growth in developing countries, even in disconnected remote areas, offers latent potential. Its explosive growth has been supported by the build out of infrastructure, primarily cellular towers. These towers provide mobile services to remote areas and are frequently powered by captive diesel-based generators. For example, in India alone, 400,000 cell phone towers use an estimated two billion liters of diesel fuel each year. This assessment investigates the potential of developing commercially scalable productive power for rural communities by harnessing the electricity needs of these cellular towers as anchor tenants for small (less than 250kW) de-centralized energy systems.

Since 2010, The Rockefeller Foundation has been working to address energy poverty through the *Smart Power for Environmentally-Sound Economic Development* (SPEED) model in India. This report takes a broader perspective to identify which other geographies may be most receptive to similar de-centralized mini-grid models, with a particular focus on supplying electricity to anchor clients such as telecoms towers.

Potential for Mini-grids in New Geographies

To support the potential future expansion of de-centralized power to new geographies, the Rockefeller Foundation and Accenture Development Partnerships have partnered to assess the applicability of the de-centralized mini-grid model in new geographies. The proposed model is that of a small de-centralized energy service company generating 30kW to 250kW of capacity that sells electricity to an anchor customer such as a telecoms tower, while also creating electricity for productive community uses such as running equipment for agriculture processing.

The countries selected for the study were Cambodia, Indonesia, Myanmar, Kenya, Tanzania, Ghana and Nigeria.

About the Assessment

The assessment focused on answering the following critical question across all seven geographies:

How suitable is the market environment for de-centralized mini-grids to operate and scale?

Each country was assessed across five business critical areas:

- Policy
- ESCO
- Anchor
- Social
- Financial

The assessment across these five areas was combined and analyzed, allowing comparative conclusions to be drawn regarding the suitability of each country for de-centralized mini-grid power.

The following sections highlight the findings related to three of the key areas—Policy, ESCO, Anchor—and then look more closely at the suitability of de-centralized power in each of the seven geographies.

Key Learnings

Policy

Increasing energy access is one of the most pressing issues facing developing world governments today, with many having committed to de-centralized power as part of the solution. Political commitment, enabling policy environment, regulations, subsidies, tariff arrangements, awareness, and promotion of renewable de-centralized mini-grids are key drivers and accelerators of these grid systems.

Political Commitment

Increasing access to electricity is of critical importance to the governments assessed, with most setting aggressive targets to improve electricity access. This commitment to electrification is unsurprising with improvements in access seen as central to development plans, and electricity itself often seen as a universal right for citizens, as in Indonesia and Ghana.[2] As part of this commitment, most governments are loud advocates for de-centralized power as part of the solution. However, very few have put in place the policies required to support this commitment.

To truly understand the level of commitment for de-centralized power across the seven geographies, this section will look at the types of approaches, regulations and tariffs that have been put in place.

Government Policy

A recent World Bank paper[3] sets out two distinct policy approaches for increasing electricity access:

- **Centralized:** In the centralized model, electrification is led by the government through organizations such as state utilities, electrification agencies or energy ministries, with the extension of the national grid as the main route for increasing access.
- **De-centralized:** In the de-centralized model, electrification is led by non-governmental groups such as private entities, NGOs and communities, with de-centralized mini-grids being the preferred method for increasing electrification.

When mapping these options to the geographies assessed, three countries can be seen to focus on centralized solutions, and two on de-centralized solutions. The remaining two countries have policy environments that are changing and have yet to be fully defined and implemented. The countries focused on centrally-managed grid expansion and connection are **Indonesia**, which is investing in large generation to meet the demand of its urban population; **Kenya**, which is aiming to connect over 250,000 households a year; and **Ghana**, which is aiming to be at 100 percent grid coverage by 2016. Those whose policies are focused more on de-centralized private sector solutions[i] are **Cambodia**, with over 170 rural license holders; and **Tanzania**, which is deregulating its energy sector due to a lack of financing to develop its grid. The third category of those in a state of flux have new laws either being drafted or just implemented, such as **Nigeria** with recently passed legislation, and **Myanmar** with legislation due to be passed in 2014.

Regulatory Set-up

The regulatory framework is the simplest way to understand the true level of commitment to de-centralized solutions with regulations set, managed and enforced by a combination of energy and industrial ministries, regulatory bodies and rural electrification agencies.

The approach that best encourages the development of commercial mini-grids is **deregulation**. Removing the regulations governing small ESCOs, as seen in Tanzania, provides developers with the flexibility to develop new projects and experiment with new business models, driving industry innovation.[4]

If deregulation is not possible, a **clear, supportive framework** outlining what actions are needed to generate and distribute power to rural communities is necessary. Clear frameworks allow ESCOs to make the long-term investment decisions required to build scalable mini-grids. However, these need to be carried through in implementation. Cambodia's clear framework has been somewhat undermined during implementation by non-competitive ESCOs, and protected by monopolistic licenses. This has not encouraged ESCO competition to the extent preferred.

At the other end of the spectrum are countries with **unclear, unsupportive frameworks**. These frameworks force ESCOs to either operate in regulatory grey areas or to not operate at all. In Indonesia, despite a professed understanding from the state utility Perusahaan Listrik Negara (PLN) that a de-centralized approach is the best way to overcome geographic issues, regulations ensure that PLN has primacy on distribution to consumers, with many ESCOs believing that mini-grid activities are illegal.[5]

Tariff Environment

Central to the commerciality, and therefore scalability, of rural mini-grids are tariffs. Set too low, they make mini-grids unattractive. Set too high and they discourage customers from using electricity for productive uses. A balance is needed. Unfortunately tariffs are often deeply political and very rarely designed around commercial realities.

The two main examples of politicised tariffs are: **universal tariffs**, which are the same for every person in the country, be they urban or rural; and **life-line tariffs**, which are fixed particularly low for those who consume little power. Both of these tariff models undermine the business case for de-centralized ESCOs, unless a subsidy is provided to create an attractive return on investment for ESCOs. The issue is that **universal tariffs** (seen in Indonesia and Kenya[6]) and **life-line tariffs** (seen in Ghana and Nigeria[7]) are logical policies when applied to national grids where the high costs and low margins associated with poor rural customers can be covered by the low cost and high margins related to serving urban customers. For ESCOs whose residential (retail) customers are always likely to be rural low-energy-usage customers, fixed low tariffs (~US$0.05 to US$0.08 per kWh) fundamentally undermine not just profitability but operability.

There are, however, examples of commercially designed tariffs, such as **variable tariffs**—tariffs that are set by regulators to take into account costs, such as those in place in Cambodia and Myanmar where tariffs fluctuate in line with changes in set-up and running costs.[8] In Tanzania, de-regulation also extends to tariffs, with the government only stepping in if the community lodges an official complaint.

[i] It is important to note that both have grid targets, but de-centralized policies are seen as more likely to be effective in the medium term.

Defining Key Terms

A recent World Bank paper[3] sets out two distinct government policy approaches for increasing electricity access:

Centralized: In the centralized model, electrification is led by the government through organizations such as state utilities, electrification agencies or energy ministries, with the extension of the national grid as the main route for increasing access.

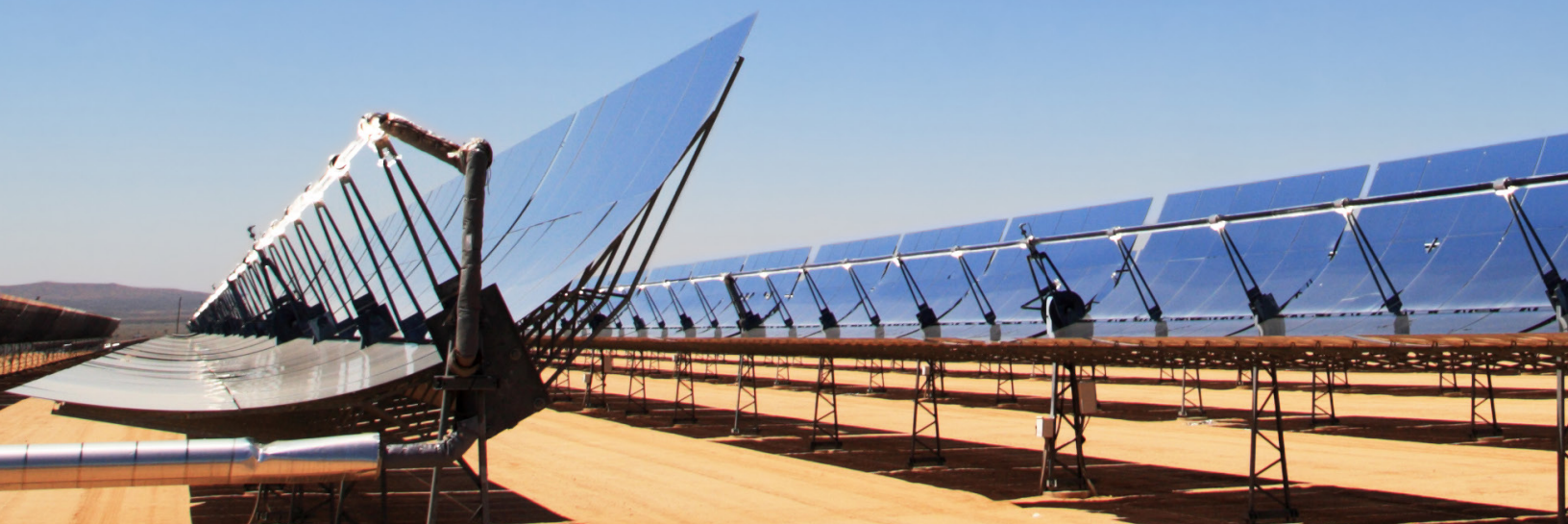
De-centralized: In the de-centralized model, electrification is led by non-governmental groups such as private entities, NGOs and communities, with de-centralized mini-grids as the preferred method for increasing electrification.

For the purpose of this assessment, an **Energy Service Company (ESCO)** is a commercial business providing a varied range of energy solutions often including energy infrastructure, power generation, energy supply, and distribution. Most importantly, an ESCO is a commercially sustainable business that can generate and distribute electricity to an anchor tenant, productive community operations, and underserved community households.

The focus of this assessment is on:

ESCOs: Independently operated electricity providers that generate and sell electricity to retail customers on a mini-grid, to the national utility on the grid or on an isolated mini-grid, or to a combination of the three.

ESCOs are typically differentiated by their size—usually producing less than 10 megawatts [MW]—and by the technology they use, such as solar photovoltaic. ESCOs are also referred to as mini-grids, distributed generators, or community-level mini-utilities.



Overall Commitment

Political commitment is clearly highly variable, with many countries outwardly supportive of de-centralized power but not acting to support commercial solutions. Of the countries assessed, Tanzania and Cambodia display true commitment to the solution of de-centralized power, whereas Myanmar and Nigeria's commitment is yet to be clarified as their new laws are passed and implemented.

Other Challenges

Outside of the challenges seen with commitment, regulations and tariffs, a number of additional political challenges are important to consider, particularly:

- **Risk of changing political priorities** on investment, especially due to the nature of the long payback, low-return mini-grid business model.
- **Uncertainty regarding the impact of new energy laws**, which make entry and investment decisions difficult, as seen in Myanmar and Nigeria.
- **Complexity of working with multiple levels of jurisdiction** both in terms of agreeing terms at national, regional and local levels, and managing the multiple agencies involved in the process.

Recommendations

To overcome these issues, rural electrification initiatives that aim to supply productive load and harness telecoms towers as anchor clients should:

- **Understand the true political environment** influencing mini-grid regulations and tariff restrictions.
- **Focus on countries with clear frameworks** that support, and are open to commercial decentralized power.
- **Support networks and coalitions to influence governments to provide financial incentives to ESCOs** that will unlock capital, attract private sectors players and de-risk investment in decentralized power initiatives.
- **Influence implementation of new laws,** working with governments to ensure favorable outcomes for de-centralized business models.

Energy Service Company (ESCO)

Today there are a number of companies looking to develop the sustainable business models needed to serve the 1.3 billion who lack access to electricity. Although there are examples of successful pilots, truly scalable business models are yet to be proven, in part due to the large variety of issues faced in each country, region and even village, and the difficulties in building the ecosystems needed to support these business models.

ESCO Business Models

The challenge of developing a viable and scalable productive power mini-grid business model to serve the underserved is one of the key questions facing the international development community today. With a large amount written on the topic, this section will not look to rehash existing theories or debates but share the insights gained from the seven geographies assessed.

To develop a strong understanding of the business models at play across the geographies it is worth outlining the core components of an effective business model.[9]

- **Customer value proposition (CVP):** The added value from the job; helping customers by adding value or solving a problem. In this case, the job refers to energy-related activities either for wholesalers or end users.
- **Distribution model:** The model used to charge customers—traditionally part of the CVP. In the case of de-centralized mini-grids, this is how ESCOs sell power to retail customers.
- **Profit formula[ii]:** How the model generates value for the ESCO.
- **Key resources:** The technology, products, people, equipment and brand required to deliver the value proposition. In this case, we will focus on the generation system preferred.

The specifics of each component vary across different models, and although no single model dominates, particular aspects are more prevalent than others.

Customer Value Proposition (CVP)

The most common CVP across the seven geographies is the **integrated** proposition where the ESCO takes on the responsibility of generating, distributing and selling power or services directly to consumers. While the CVP of direct power sales may not be the most desirable proposition due to its complexity, the high risk of partnering with, or relying on a generation or distribution company in an already intricate environment, favours an integrated solution. There are examples of integrated business models in Tanzania.

There are a few cases where ESCOs operate as a **generator-wholesaler,** generally in partnership with the government or with charities where trust already exists (examples can be seen in Indonesia and Myanmar) or when distribution licenses are difficult to obtain.[10]

Privately run **distribution-only** ESCOs are also rare, with high barriers to entry in distribution driving the split between generation and distribution, or when an integrated ESCO's generation capacity becomes redundant in cases of grid entry—a risk of varying degree across the assessed countries. It is, however, worth noting that in some cases, particularly in Cambodia, separation between generation and distribution has often been temporary, with both sides looking to move along the value chain to maximise profits.[11]

Rural Energy Business Models—Components

Customer Value Proposition (CVP)	Distribution Model—Distribution Customers	Key Resources—Generation System
• Integrated (micro-utility): Generate and distribute to customers • Generator: Generate and wholesale to distributor • Distributor: Purchase and distribute to customers	• Monthly pre-pay: Pre-Payment of energy with usage monitored by meters • Monthly post-pay: Pre-Payment of energy with usage monitored by meters • Energy as a service: Rental of energy services (Lights, TVs) rather than electricity • Energy pay as you go: Sale of units of electrified time (days) rather than volume	• Diesel-gen 100 to 200 kW—Hybrid 20 to 30% diesel • Solar 10 to 150 kW—Modular AS/DC 2 kW+ • Bio-mass 30 to 750 kW • Micro-hydro 20 to 150 kW

Distribution Model

Mirroring established distribution models, the most common payment systems are **monthly** (or weekly) **pre-pay/post-pay plans** in which the customers are charged either in advance of consumption or after the event. Of the two, **pre-pay** is becoming increasingly common as it helps overcome the issue of ensuring on-time payment from low-income customers. Pre-pay models are specifically used in Cambodia and Tanzania.

Although these distribution models are prevalent, there are a number of emerging payment models of potential interest, such as energy-as-a-service and energy pay-as-you-go.

The **energy-as-a-service** model designs the value proposition and pricing around energy services (e.g., lighting, charging of devices and powering a radio) with these services rented to customers at a price that includes electricity.[12] The **energy pay-as-you-go** model lets customers buy a set amount of power/time via, in this case, their mobile phones. Once they have spent what they have paid for, they need to top up again.[13] It is worth noting that both these models are used in areas with low tariffs or strict distribution regulations as a method of bypassing regulations that limit the sales price of kWh units.

Key Resources—Generation System

Although this study focused on renewable technology-agnostic resources, a preference for similar power generation systems emerged across the assessed geographies. The most prevalent system for rural mini-grids is diesel, which has historically been the cheapest and most efficient way of generating electricity for isolated communities. However, the rising price of diesel means these fundamentals are no longer sustainable.[14] In response to a new economic reality, renewable technologies have begun stepping in.

Solar is the most popular generation technology, with solar potential ranging upwards of 4kWh/m2/day across all geographies. It is also the simplest to install with modules easily added and removed depending on demand. Various off-grid ESCOs in Kenya and Tanzania can scale up and down power generation units for this reason. This scalability, coupled with continued reduction of costs for solar products, is driving this preference.[15]

Biomass gasification is the second most common power generation technology with use most prominent in Southeast Asia where the supply of rice husk fuel is great. Innovative ESCOs in Cambodia and Tanzania are working with local farmers and rice-cooperatives to develop sustainable sourcing models for the rice husks required to run their generation equipment.[16]

Micro-hydro is the least popular form of renewable power generation among the countries assessed, with the exception of Myanmar, which had military-led micro-hydro installations. Examples of unsuccessful micro-hydro pilots, as seen in a World Bank project in Cambodia, undermine the potential of these systems. The challenges these systems include large drop-offs in generating capacity during the dry season and reliance on specific locations.[17]

Challenges

There are many challenges facing ESCOs in each country. However, at a high level, the following pose the greatest risk to de-centralized mini-grid entry:

- **Undeveloped and unaligned eco-systems where key players**[iii] either lack the ability to design and operate mini-grids— as in Myanmar and Ghana—or there are competing priorities and incentives that stop players working together to realize their potential, as in Cambodia, Indonesia and Kenya.
- **Strength of competitor business models,** particularly solar home systems, undermines the value proposition of mini-grid power that does not provide productive load, especially in countries with strong grid extension policies such as in Kenya and Ghana.
- **Lack of clear grid extension plans** with utilities acting as competitors, expanding their grid into communities where mini-grids have just been established. This was seen in Kenya and Indonesia.
- **Finding funding for capital-intensive, long-term, and often low-return** business models such as de-centralized ESCOs is difficult as investors prefer the high-returns given by large-scale generation and feed-in-tariffs.
- **Difficulty in finding capable operators** to manage the business, keep accounts, and operate sites curtails ESCOs' ability to scale, as seen in Cambodia.
- **Difficulties in providing 24-hour power** due to intermittent nature of renewables and high costs of battery storage that undermine the potential offer to anchors such as telecoms companies.

Recommendations

To overcome these challenges, rural electrification initiatives that aim to supply a productive load and harness telecoms towers as anchor clients should:

- **Build key partnerships** with anchor load clients, financial institutions and technology suppliers, and collaborate with agencies and organizations doing community engagement.
- **Test the effectiveness of distribution models** across pilot sites to understand the right fit for regional cultures.
- **Understand the penetration of competitor models** and customer willingness to move up the energy ladder to reduce the risk of entry failure.
- **Work with government agencies** and utilities when selecting regions and communities for entry to limit grid competition.
- **Develop a robust employee value proposition** and assess capability requirements to attract and retain top talent.
- **Provide debt, guarantees, bridge financing, and other concessionary support** needed to catalyze this emerging commercial model.
- **Engage community leaders and members** to develop collaborative vested interest, ultimately helping to understand the full landscape, identify resource capacity, support load development, and deter theft.

[ii] Financial details on ESCOs operating are not included in this report due to the requirement of contractual agreements before ESCOs will share critical business data

[iii] Key players in the mini-grid eco-system include other ESCOs, energy technology companies, utilities, energy NGOs, financers, and government agencies

Telecoms

With an ever-growing global telecoms market, mobile network operators (MNOs) are expanding their geographic footprints to serve even the most remote communities, including rural areas where grid electricity is unavailable and alternate power solutions are costly and difficult to maintain. The following assessment analyzes the telecoms industry across the seven target countries as a potential ESCO customer. Telecoms were assessed primarily on their rural footprints and their business incentives to partner with a de-centralized mini-grid ESCO as an energy customer.

Telecoms Industry Landscape

	Mobile Subscribers	Market Penetration	Signal Coverage	Off-grid Towers	Ownership Model	Life Cycle Stage	Anchor Suitability
Cambodia	18.4m	40%	85%	~2,300 (24%)	MNO	Brownfield Development	Supportive
Indonesia	90.3m	44%	87%	8,000 (8%)	Mixed	Brownfield Development	Supportive
Myanmar	~5m	8-10%	TBD	TBD	Outsourced	Greenfield Expansion	Limiting
Kenya	29.2m	74%	89%	577 (10%)	MNO	Grid Connected	Limiting
Tanzania	26.8m	62%	76%	1,442 (31%)	Mixed	Brownfield Development	Assisting
Ghana	24.9m	99%	80%	638 (11%)	Outsourced	Grid Connected	Neutral
Nigeria	107m	85%	85%	12,560 (52%)	Mixed	Brownfield Development	Supportive

Customer Analysis

The team took many characteristics into consideration in its evaluation of the telecoms industry and potential customers in each of the seven target countries. These characteristics included the value proposition of de-centralized electricity for MNOs, the business priorities of potential ESCO telecoms anchor customers, the size of the markets, and stages of the Base Transceiver Station (BTS) power lifecycle (i.e., whether it is greenfield expansion, brownfield development, or established in a grid-connected environment).

The market assessment team also investigated other non-telecoms anchor load clients in each country. While some other anchor clients exist, like rice cooperatives in Southeast Asia or the Tanzania Agriculture Partnership in Tanzania, there are limited nationally scalable anchor tenants available to partner with. Additional assessment is required to identify state-level partners.

Value Proposition

Interviews indicate that the value proposition of a de-centralized ESCO is of interest to MNOs and BTS operators, with each particularly interested in:

- **Reduced operating costs** for off-grid mobile base stations through replacement of costly diesel fuel and accompanied maintenance. The GSM Association (GSMA) analyses and market assessment interviews confirm that MNOs allocate 30 percent to 50 percent of their OpEx budget towards tower operations.[18]
- **Outsourced energy needs,** to allow MNOs to focus on core business priorities.
- **Improved OpEx budget forecast ability** through introduction of long-term power purchase agreements and agreed electricity tariffs.
- **Improved brand awareness** through community engagement and partnerships.

Telecoms Customers

Each of the assessed countries typically had three to five primary MNOs operating competitively with occasional small-scale players seeking niche markets. A growing trend in the industry is for MNOs to outsource their tower ownership, operation and maintenance to tower companies in an effort to strictly focus on core business needs. This industry shift creates two primary telecoms anchor customers for de-centralized power:

- **MNOs** owning and operating their own BTS towers.
- **Tower companies** contracted to manage a large portfolio of BTS towers.

In the scenario of MNO tower ownership and operation, the primary business priorities include expanding market coverage, reducing operational costs and outsourcing tower operations where appropriate. Regardless of the tower ownership model, however, MNOs continue to dictate market expansion into new areas where they see the greatest revenue potential and impact. MNOs are keen to reduce their OpEx budget through the procurement of more cost-efficient electricity, as specifically seen in Cambodia and Indonesia.

Tower companies that have been contracted by MNOs to own, operate, and maintain BTS towers, are primarily focused on portfolio expansion as directed by client MNOs, site optimization through antenna co-location, and operational cost reduction.

Although there are nuances in operational priorities between MNOs and tower companies, the main driver, namely cost reduction, is consistent, establishing both MNOs and tower companies as potential energy customers.

Market Size

All seven countries have relatively strong telecoms infrastructure or, as in the case of Myanmar, are rapidly expanding BTS tower volume and national coverage. Off-grid site installations are often required to cover target markets beyond urban networks or improve network stability, establishing BTS footprints in areas that are attractive for de-centralized power. Some countries have significantly more off-grid sites than others, primarily due to the maturity and reach of the country's national electricity grid.

Attractive markets are characterised by a large volume of off-grid sites in areas with productive uses for electricity. Example markets include Cambodia, Indonesia, Tanzania and Nigeria where off-grid tower volumes range from 2,300 to 12,500. Indonesia and Nigeria have the highest number of mobile subscribers along with the largest quantity of off-grid towers, which number in the thousands, creating a highly scalable environment.[19] Similarly, countries like Tanzania do not have an extensive national grid and therefore require off-grid energy solutions for further coverage, creating demand for de-centralized energy solutions.

The least attractive telecoms partner markets from a sizing perspective are those with fewer off-grid towers. Kenya and Ghana, both with 25-30 million mobile subscribers and a far-reaching national grid, are limited in scale-up potential with only around 500 off-grid sites or less, which are expected to be further reduced as grid expansion continues. Furthermore, although plans for rapid tower expansion are in progress in Myanmar, MNOs are focused on meeting rollout targets with already identified energy models.[19]

BTS Power Lifecycle

The maturity of the environment's energy supply is also a critical component to consider prior to market entry. The seven target countries are in various stages of the BTS energy lifecycle, promoting or hindering their viability as anchor tenants for de-centralized power. Three distinct energy lifecycle stages were observed to influence the suitability of anchor tenant supported mini-grids. These are:

Greenfield expansion: This is typically the focus of new and expanding markets where MNOs are striving to rollout towers and increase mobile coverage at aggressive rates, as in Myanmar. Due to the overwhelming focus required on Greenfield rollouts, Myanmar's MNOs are utilizing proven energy models such as diesel and are prioritizing urban and peri-urban markets.

Brownfield development: This is the most attractive stage for de-centralized models. It is typically seen in countries with a vast tower footprint but a weak accompanying national grid, as in Tanzania and Nigeria. A lack of grid connectivity creates an environment with partners interested in more economical power solutions. Focus continues to increase on solutions that utilize supplemental renewable energy technology such as solar and wind. Most commonly, solar and wind technologies are combined with battery storage or back-up diesel generators to provide 24-hour up-time.[20] At its most advanced, MNOs provide excess power from their towers' hybrid generation systems to power local communities, as is seen in some parts of Indonesia.[20]

Grid connected environments limit the potential of de-centralized mini-grids, where a majority of the telecom tower portfolio is connected to the national grid. Kenya and Ghana both have environments in which there is interest in more economical off-grid power solutions, but the scale-up potential is significantly capped by the reduced off-grid portfolio.[21]

Challenges

Consistent challenges arise globally when considering BTS tower operators as customers of de-centralized mini-grid ESCOs. Key challenges identified across the seven target countries include:

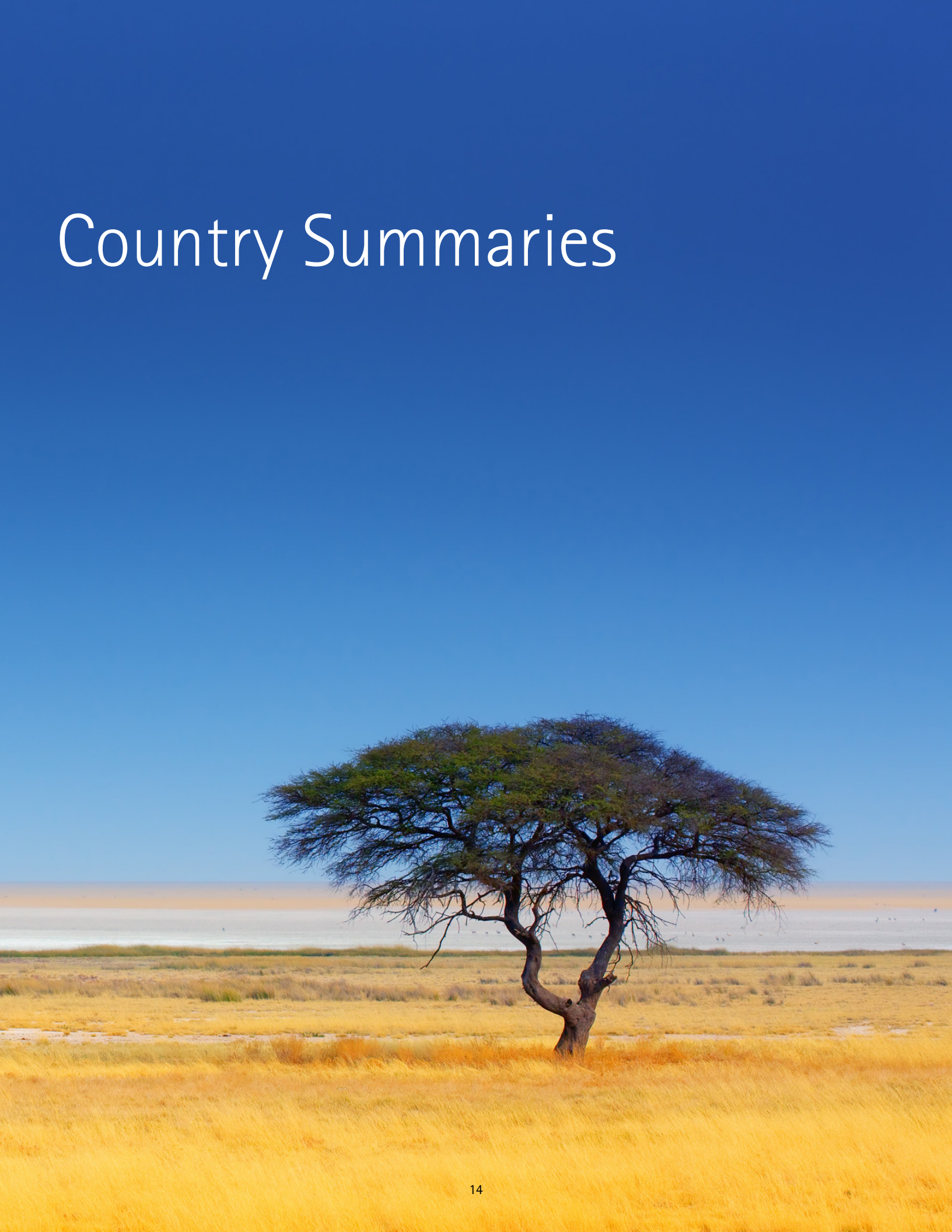
- **Identifying MNOs and tower companies willing to risk** outsourcing their energy needs to unfamiliar models.
- **The competitive landscape of diesel suppliers and green energy technology companies** creates uncertainty, especially with regard to the response mounted by diesel suppliers and stakeholders with vested interests in diesel generation solutions. Progressive markets such as Indonesia have however already established strong relationships with renewable energy vendors.[21]
- **Telecoms' 24-hour electricity supply requirement** is a costly prerequisite to meet with renewable energy technology, often requiring battery storage or supplemental diesel. Interviews confirm that MNOs demand tower uptime upwards of 99%.
- **Large distances from tower to village,** created when sites are installed on hills or strategic geographic locations that cover the largest area without being economically close to a village or community. Lengthy distribution lines also increase the risk of theft of power cables and power loss.

Recommendations

To overcome these challenges, any rural electrification initiatives that aim to supply productive load and harness telecoms towers as anchor clients should:

- **Focus on large off-grid portfolio countries** motivated to address costly energy needs. Larger markets increase the potential availability of suitable sites in regard to geographic tower location.
- **Focus on countries developing their brownfield portfolio** as these markets are the most motivated to optimize operations and reduce energy costs, as in Cambodia, Indonesia, Tanzania and Nigeria.
- **Understand nuances between MNO and tower company operators** to develop flexible offerings specific to their varying interests.
- **Build key partnerships** with appropriate MNOs and/or tower companies to fully understand their needs, identify priorities and determine solutions to mitigate risk; and consider alternative anchors such as agricultural cooperatives to diversify revenue streams.

Country Summaries



Cambodia

Cambodia has a high potential for de-centralized energy solutions with experienced ESCOs and energy technology companies, interested telecoms companies, and a population accustomed to paying high prices for electricity from already de-centralized generators and distributors. Unfortunately the regulatory framework, although designed to support rural electrification, discourages new entrants and removes competition from the rural electricity market.

Country Context

The Kingdom of Cambodia has a prime location in Southeast Asia between Thailand, Vietnam and Laos, with access to the Gulf of Thailand. Prime Minister Hun Sen of Cambodia's People Party has been in power since 1985, providing stability to the country after coming into power during the civil war that ravaged Cambodia for decades. This civil war, which officially ended in 1991, left Cambodia lacking much of the infrastructure needed to drive its development.

Cambodia has an export-oriented free market economy which grew by 7.2 percent in 2012. The service sector contributes the largest amount of GDP but agriculture employs the largest number of people, with 80 percent of the country's approximately 15 million people living in rural areas. The electricity generation mix consists of 96 percent oil (diesel) generation, 4 percent hydropower, and less than 1 percent solar power. The country's annual power consumption of about 125 million kWh is the lowest in Southeast Asia and among the lowest in the world. A majority of Cambodia's power is imported from neighbouring countries, which in part explains the focus on diesel generation.

Cambodia has one of the lowest electrification rates in Asia, at 26 percent, and some of the most expensive electricity tariffs for grid-connect customers. It also has the most expensive electricity with prices ranging widely from US$0.18 per kWh to US$0.40 per kWh for grid electricity. Demand, however, continues to grow at approximately 20 percent per year with rural households' access targeted to increase to 70 percent by 2030.

De-centralized Environment

Policy

The government, with The World Bank support, is focused on de-centralized solutions to drive rural electrification. This focus prompted the government to develop a license-based framework for rural electrification which allows strong profits for rural ESCOs, driving private sector involvement. Although this is positive, in practice the regulations focus too heavily on supporting high profits (through high tariffs) within the monopolistic license framework, leading to low investment and non-competitive electricity pricing. The lack of competition in license areas and the supra-normal profits available for licensees makes obtaining licenses in viable areas increasingly difficult, limiting innovation and slowing the march of electricity access.

ESCO

Government focus on private sector solutions for rural electrification means there are a large number of mini-grid operators and multiple energy technology companies developing solutions to harness the high potential of solar and bio-mass micro-generation technology. However, the regulatory incentive system has encouraged private players to focus on diesel mini-grids which can be run at a profit, with high-tariff rates supressing demand and dis-incentivizing rural ESCOs to use alternative energy sources, or to rapidly connect rural communities. There is high-potential in the country but rural monopolies are holding it back.

Anchor (Telecoms)

Cambodia has a high number of rural base stations using diesel systems, creating high potential for partnerships between MNOs and rural ESCOs. The maturity of telecoms in Cambodia increasing and moving away from greenfield expansion to focus on site optimization is encouraging. Additionally, rice milling operations have the potential to be scalable anchors for de-centralized power mini-grids as the sustainability of rice milling operations is undermined by diesel prices. A number of cooperatives exist that can aggregate demand and spread adoption.[22]

Social

Rural Cambodia can be said to have high demand for electricity with rural households paying close to the highest rates seen globally, and multiple households using alternative technology, such as home solar systems or car batteries, to provide the electricity they need. However, the level of technical expertise in the workforce is considerably lower than in neighbouring countries, leading to issues in site operation and maintenance that have severely reduced the attractiveness of rural mini-grid operators. This undermines their ability to scale.

Financial

A large gap in finance exists with regard to the type of investment that commercial mini-grid operators require to set-up, prove the concept, and scale. Though strong economic growth has piqued investors' interest, commercial banks are conservative and require substantial land-based collateral. Private equity is looking to invest, but is primarily interested in large-scale generation plays, meaning the major investors, for now, remain the government, donors, and development banks. There is, however, an increasingly vibrant microfinance industry that acts as a reliable lending partner for micro-enterprise but is not yet of the scale required to support commercial mini-grid operations.

Conclusion

With experienced ESCOs and multiple prospective anchors, Cambodia's potential is only limited by an energy regulatory framework that supports high profits while discouraging new entries. If these issues can be overcome, then Cambodia has the right pieces in place to successfully solve its pressing electricity needs with commercially-driven renewable energy mini-grids. However, to achieve this, more government support is required.

Indonesia

Indonesia has a vibrant energy environment and a number of telecoms companies interested in alternative energy solutions; however, current regulations prevent de-centralized ESCOs from being commercially sustainable. These government regulations also discourage investors, further undermining the potential of de-centralized mini-grids in Indonesia.

Country Context

The Republic of Indonesia is situated in Southeast Asia and Oceania, with the capital Jakarta located on the most populous island of Java. Socio-politically, Indonesia is a secular democratic country. It has a presidential form of government, with both presidential and legislative elections held in 2014. Indonesia is the 16th largest economy globally by nominal GDP, and the fourth most populous country globally. Out of a population of 246 million, 80 percent live on the islands of Java and Bali. More than 32 million Indonesians, or 13 percent, currently live below the poverty line.

The country is home to 40 percent of the world's known geothermal resources. Yet, 70 percent of the country's electricity is generated from oil and coal-fired power plants. Of the population, 53 percent use traditional biomass for cooking.

The government is focused on rapidly increasing electricity supply across Indonesia to achieve 90 of the population electrification by 2020. However, the main focus is on rapid economic growth rather than cleaner de-centralized energy.

De-centralized Environment

Policy

Indonesia has a strong and well-functioning democracy and a government focused on economic development through rapid electrification. Indonesia has targets to reach 90 percent electrification by 2020,[23] and has an increased preference for renewables. A target of 15 percent of generation from renewables has been set for 2025.[24] However, the government's low fixed tariffs (about US$0.08/kWh[25]), strict foreign investment laws, preference for electricity distributed by the state utility (PLN), and limited support for de-centralized electricity, weakens mini-grid potential.

ESCO

Indonesia has a vibrant energy environment with a highly capable private sector that is able to harness the country's vast renewable potential in rural areas. Regulations and the primacy afforded to the state electricity company (PLN) do however pose challenges to harnessing the country's full renewable potential. Indonesia's renewable energy potential sits with around 0.5 GW of mini/micro hydro, 50 GW of bio-mass, and 4.8kWh/m2/day of solar.[26] The country has a well-developed eco-system saturated by energy technology companies able to provide ready supply and maintenance for off-grid power. However, liberalisation of transmission and distribution has been slow. There is also uncertainty regarding where and when ESCOs can distribute, and how closely ESCOs must align with PLN entrants.

Anchor (Telecoms)

Although most of the country's MNOs focus on securing data subscribers in urban areas and not expanding their rural footprint, those that do operate in rural areas are interested in decreasing power costs through managed service power solutions for their rural base stations. Using these MNOs as anchor clients, de-centralized mini-grids have the potential to leverage rural MNO coverage and demand for electricity to scale in Indonesia.

Social

With 60 million Indonesians lacking access to electricity, the potential market for de-centralized solutions is vast and varied. A large industry presence—specifically oil and gas, mining, fishing and agriculture—increases the rural community's ability to pay. Most rural customers can afford between US$2 a month and US$15 a month for electricity.[27] However, the viability of mini-grids is dampened by a perception that renewable energy and electricity is free or low cost,[28] and a shortage of technical education and skills available to ESCOs (especially in the east).[29] Low population density in eastern areas also weakens the sustainability of the model by making the cost of distribution prohibitive for ESCOs.[30] While Indonesia's social sector has supportive characteristics for mini-grids, there are significant challenges requiring attention prior to market entry.

Financial

Indonesia's economy is growing. It has grown by over 6 percent for the past three years,[31] with investment flooding into the country. There are large numbers of micro-finance initiatives attracted by Indonesia's 50 million micro, small, and medium sized enterprises. Mandatory corporate social responsibility (CSR) spending by large state-owned institutions is expected to largely be spent on promoting rural electrification.[32] However, with multiple alternative investment options, high interest rates, discouragement of foreign investments, high collateral requirements, and long payback periods, small-scale de-centralized energy companies will struggle to find the non-donor financing needed to drive rapid expansion.

Conclusion

Components of the de-centralized model do exist, including experienced energy technology companies that are attracted by Indonesia's high renewable energy potential and could become ESCOs. Rural areas in the western islands with industry presence have high willingness to pay, and the combination of an entrepreneurial culture and micro financing can accelerate economic development.

However, Indonesia's potential for de-centralized mini-grids is ultimately hampered by a regulatory environment that limits the commercial viability for small-scale ESCOs. Any solution will be closer to supporting the government's rural electrification efforts, rather than creating a commercially-driven solution for Indonesia.

Myanmar

With the lowest energy access and GDP per capita in Asia-Pacific, Myanmar presents an opportunity for rural electrification. Rural electrification has become a top priority for the central government, and key regulatory changes to support it will likely fall into place with the new 2014 Electricity Law. However, both the financial and telecoms sectors are currently undergoing major reforms that will undermine anchored mini-grid potential. These issues, coupled with the lack of a strong supportive ESCO ecosystem, limit the viability of entry into Myanmar at this stage.

Country Context

Myanmar is emerging from two decades of isolation and poverty (GDP per capita is US$900[33]), and moving from an authoritarian regime to a democracy. Its centrally directed economy is also transitioning to a market-oriented model. Last year, the economy grew at a rate of 6.5 percent.[34]

Myanmar's electrification rate is 13 to 26 percent, the lowest in Asia-Pacific.[35] Nearly 65 percent of its 60 million inhabitants live in rural areas which lack basic infrastructure and are prone to extremes of climate.

Hydropower accounts for 70 percent of energy generation, and approximately two-thirds of the country's primary energy needs are fulfilled by biomass sources.[36]

The synergies between energy access, economic development and social mobility are perhaps nowhere more overt than in Myanmar with President H.E. U Thein Sein promoting rural development and rural electrification as a way to transform the country.

De-centralized Environment

Policy

Myanmar is in the beginning stages of transitioning to an energy framework that promotes off-grid and renewables, and could support de-centralized power solutions. Myanmar's power sector is based on a state-owned single buyer model with the state utility (MEPE) as the sole purchaser, leading to a heavily regulated system.[37] In contrast, there are regulations in place for off-grid generation with a newly formed ministry tasked with consolidating law-making and overseeing the implementation of the 2014 Electricity Law. Off-grid private enterprise is encouraged through the availability of permits to electricity generators under 30MW, and low license fees for distribution initiatives below 1MW.[38] While there is a theoretically supportive framework in development, future implementation and the viability of de-centralized models is currently unclear.

ESCO

Myanmar has considerable renewable energy potential (including solar, biomass, wind, hydro-power, and geothermal[39]) and already-proven imported mini-grid systems that charge weekly fees for use. Small patchworks of mini-hydro systems that are unregulated and unlicensed also exist. To further successful mini-grid operations at scale, considerable resources would need to be spent training communities on the maintenance and repair of equipment.[40] Ultimately, Myanmar's underdeveloped ESCO ecosystem[41] would present a critical barrier for de-centralized mini-grid entry and expansion.

Anchor (Telecoms)

Myanmar's current 8 percent to 10 percent mobile penetration rate is the lowest in the region. The government's target rate is 82 percent within five years, more than 50 percent of which is expected to be off-grid.[42] To meet this goal and reach the required expansion into greenfield sites,[43] newly licensed MNOs Telenor and Ooredoo[44] have already developed power supply scenarios based around diesel.[45] Alternative electricity anchors exist, such as rice-milling cooperatives with four million metric tons of rice husks available for use, and a number of larger associations able to act as aggregators.[46] Ultimately, de-centralized mini-grid entry may be more optimal after MNO site rollouts have concluded and they shift their focus to optimization.[47]

Social

Although also going through changes as the country moves out of decades of isolation, Myanmar's social environment is broadly positive for mini-grid solutions. A strong entrepreneurial drive,[48] comparatively high levels of technical capability,[49] and demand for solar technology products[50] make operating ESCOs and driving rural development through small and medium sized enterprises more likely to succeed. However, a lack of disposable income[51, 52] and poor infrastructure connecting remote villages may harm the commerciality of mini-grids in some areas.

Financial

Myanmar's financial sector is small and underdeveloped.[53] However, as part of the country's market-oriented reform process, the 2011 Microfinance Law allowed local and foreign investors to establish privately owned micro finance institutions (MFIs).[54] Today, financial products for new enterprises have difficult payback schedules and low loan-to-value ratios. However, increased donor interest in building an SME client base could support productive enterprises in mini-grid powered communities. As with most sectors in Myanmar, success will hinge on how the financial sector evolves over the next few years.

Conclusion

Myanmar is committed to using electricity to help drive its development, and has a telecoms sector looking to rapidly expand. These factors encourage intervention, and intervention at pace. An emerging political agenda focused on rural electrification could lead to a strongly positive environment for mini-grids in Myanmar. However, a limited ESCO eco-system, a financial system that discourages new entrants, and a weak support structure—all of which are needed to make mini-grids a reality—severely limit potential for success at this time.

Kenya

There is a substantial need for rural electrification in Kenya and a strong interest in off-grid electrification in rural populations. There are proven cooperative business models and finance options from international donors that will support de-centralized mini-grid models. However, government policies primarily support national grid electrification, which ultimately hinders the scale of de-centralized solutions.

Country Context

The Republic of Kenya, located in Eastern Africa, is a presidential representative democratic republic. Uhuru Muigai Kenyatta, the fourth and current President of Kenya, has been in office since April 2013.

Of Kenya's 43 million inhabitants, 75 percent live in rural areas. Although Kenya has the largest GDP in East and Central Africa, the average per capita income is US$400 under the Sub Saharan Africa average. Agriculture employs nearly 75 percent of the population, but accounts for less than 25 percent of GDP. Tourism is the largest contributor to the economy.

Of Kenya's population, 25 percent has access to electricity, while rural grid access is only 5 percent. The country produces 6.573 billion kWh (2009 estimate) and consumes 5.516 billion kWh (2009 estimate) of electricity. Of total installed capacity, 43.8 percent is from hydroelectric plants and 12.9 percent is other renewables.

Vision 2030, the government's national development strategy, lists higher electrification and reliable electricity supply as key to future development. While the recent discovery of oil in Turkana in the northwest, and the possible gas deposits off the Lamu coast gives Vision 2030 additional momentum, the discovery also adds a factor of uncertainty to changes in future development strategies.

De-centralized Environment

Policy

National grid extension is the Government's primary method for increasing energy access and lowering energy prices. On the other hand, the regulatory structure does allow for private mini-grid operation. The 2006 Energy Act[55] liberalized the sector and gives private sector participants flexibility in tariff pricing, incentivizing off-grid players. Smaller stakeholders cannot, however, replicate at a scale that would allow them to offer electricity at rates competitive with those of the subsidised national grid. Thus, national utilities usually offer better rates in rural areas. Furthermore, a recent repeal of the solar product tax holiday on value-added taxes (VAT) has increased prices and deterred investment in solar initiatives.

ESCO

New energy developers and ESCOs with an interest in Kenya's strong solar and wind potential are beginning to prove mini-grid models successful. Some companies use a fixed and movable asset business model to compete with the expanding and unpredictable national grid. Also, co-ops run by communities have been running successfully for decades. Still, return on investment is uncertain due to the rapidly expanding national grid which targets creation of 250,000 new connections each year. Furthermore, limited demand research has been completed to confirm a rural consumer ability, or willingness to pay for mini-grid electricity. Overall, however, Kenya's ESCO sector maturity supports de-centralized mini-grid solutions.

Anchor (Telecoms)

The mobile telecoms market penetration rate is 74 percent, and mobile services cover 95 percent of the population. Over 90 percent of Kenya's 5,565 BTS are connected to the national grid and primarily owned by four MNOs: Safaricom, Bharti Airtel, Orange, and Yu. Future BTS placements are likely to parallel grid extension, providing little incentive for MNOs to partner with de-centralized mini-grid ESCOs despite their focus on reducing operational costs.

Social

Of Kenya's population, 76 percent live in rural areas. People in the sparsely populated arid and semi-arid Northern regions may be drawn to purchasing mini-grid power. However, there is a possibility that the national grid could extend to even these remote areas. In Nairobi, a hub of development, there is a vibrant ecosystem of NGOs and CSOs interested in partnering to implement de-centralized mini-grid power solutions along with educational programs. Many education programs began in December 2013 to support renewable energy technical courses.

Financial

An absence of government funding and limited private finance for off-grid electrification demands that foreign private investment and donor funding be generated if de-centralized mini-grid ESCOs are to find financing. While potential funding for project ramp-up is reportedly available from private investors (pending proven models) a majority of rural electrification initiatives are donor or grant-funded. Limited seed funding is also a bottleneck for project development, feasibility studies and proof of concepts. Organizations such as the Energy and Environment Partnership are trying to fill the gap but for the moment financing remains an issue.

Conclusion

Kenya's de-centralized mini-grid potential is limited by a rapidly expanding national grid and a lack of project seed funding. In the favour of de-centralized models, however, Kenya has a strong entrepreneurial spirit: it is growing licensed technical skills, is interested in ESCOs, and has proven mini-grid business models.

Essentially, while there is demand for rural electrification and entry of mini-grid models, market entry is not quite sustainable.

Tanzania

There is great market potential to support de-centralized mini-grid models in Tanzania. A growing number of energy sector participants and strong potential anchor customers are interested in de-centralized power solutions. However, gaps in project finance, a lack of local operating partners, and uncertainty about future regulations could slow progress.

Country Context

Situated in East Africa, The United Republic of Tanzania is a multi-party democracy. The President, Jakaya Ki kWete, assumed office in 2005.

Tanzania has a population of 47.78 million, more than 70 percent of whom live in rural areas. Tanzania is sparsely populated country, with density of 51 persons per km^2.

Tanzania's economy grew at close to 7 percent in 2012, and is a liberalized market economy, though the government retains a presence in sectors such as telecoms, banking, energy and mining. Agriculture is the major sector, providing about 80 percent of jobs but contributing only 27 percent of GDP.

Tanzania produces 4.489 billion kWh and consumes 3.589 billion kWh (the difference is lost in transmission and distribution). Of the installed capacity, about 40 percent is from fossil fuels while 60 percent is sourced from hydroelectricity. The country generates very little electricity from renewable energy sources.

Only 18.6 percent of the population is connected to the grid, and the rural electrification rate is only 3 percent. The key government bodies involved in electrification are the Ministry of Energy and Minerals (MEM), which is responsible for energy matters; the Energy and Water Utilities Regulatory Authority (EWURA), the key government regulatory body; and the Rural Electrification Agency (REA), an autonomous body established under the Rural Energy Act of 2005, which is tasked with the promotion of rural electrification.

De-centralized Environment

Policy

To encourage rural electrification innovation and project execution, the Government of Tanzania has relaxed the regulatory environment and simultaneously provided financial incentives for project developers. More specifically, there are exemptions given by Tanzania's Energy and Water Regulatory Authority (EWURA) on registration and regulation for ESCOs who develop projects of less than 1MW, as well as exemption from regulation or even licensure for Very Small Power Producers (VSPP) doing projects under 100kW.[56] However, a reported lack of enforcement, uncertainty about future tariff regulations and the instability of a major government utility may jeopardise the usefulness of the government's policies. Overall, the regulatory environment in Tanzania strongly supports de-centralized models for increasing electricity access.

ESCO

There are strong potential ESCOs that can support de-centralized mini-grid solutions in Tanzania, particularly if they can attract financing and operations support. These companies perceive a substantial business opportunity, particularly in the areas of solar power and biomass gasification, but also in micro-hydro and wind power generation systems. A consistent challenge, however, to the energy and ESCO environment will be the lack of financial and human capital. With the addition of sustainable financing, capacity, and a proven model, the ESCO sector will be poised to scale de-centralized mini-grid solutions to combat the inhibiting issue of electricity access in Tanzania.

Anchor (Telecoms)

The mobile phone market has a penetration rate of 62 percent in Tanzania, with three main MNOs, Vodacom, Bharti Airtel, and MIC Tanzania Limited, occupying 92 percent of the market. The independent telecoms tower operator structure lends itself to power purchase agreements (PPAs) from ESCOS. They can provide a consistent load for rural ESCOs and have substantial off-grid reach. Of telecoms towers, 30 percent are currently off-grid but, of those, only 4 percent are powered by green energy. Tower operating companies are positioned to be motivated and far-reaching customers of de-centralized ESCO power.

Social

In some ways, the social environment is primed for mini-generation options. There is a strong customer value proposition, a vast market lacking electricity, and communities with customers willing to pay. However, volatile community incomes and a lack of available technical capabilities may slow growth. Ultimately, Tanzania's social sector poses challenges that make it difficult for ESCOs to act on the desired move to scale.[57]

Financial

Project financing is one of the most challenging areas for mini-grid implementation in Tanzania. The financial sector does not offer the funding options that are generally required for off-grid electrification efforts. Instead of domestic private capital, project developers and ESCOs would have to seek foreign private investment, donor funding and government funding. Where domestic private debt is available, it comes with a prohibitively high interest rate. International donor funding could alleviate these obstacles, although currently Tanzania's financial environment does not provide the sustainable means to scale de-centralized models.

Conclusion

Tanzania's potential for de-centralized solutions is strong with favorable mini-grid regulations, a broad network of increasingly capable ESCOs specifically focused on mini-grid business models, and interested telecoms anchors. Tanzania's potential for de-centralized mini-grids is only hindered by a lack of technical capacity, business acumen and locally available finance, with only donor or government funding available. With the noted challenges overcome, Tanzania could see large growth in de-centralized mini-grids.

Ghana

Ghana's impressive efforts to connect the country to the national grid have created an underdeveloped off-grid ESCO sector. The high percentage of grid-connected telecoms towers reduces the overall anchor scale-up opportunity. Furthermore, there is a shortage of funding for mini-grid model scale-up. Funding is only available through donors for seed funding and prohibitively high interest commercial funding for scale-up.

Country Context

The Republic of Ghana is one the largest economies in West Africa and the 12th largest in Africa. At 7.9 percent, Ghana's economy has grown faster than the overall African economy. Ghana is rich in diamonds, gold, cocoa and crude oil. A unitary presidential constitutional republic with a parliamentary multi-party system, Ghana has evolved into a stable and mature democracy over the last two decades. The current president, John Dramani Mahama, began a four-year term in 2013.

While Ghana's national electrification rate is about 77 percent, only 35 percent of the rural households are grid-connected. The government has a target rate of 100 percent electricity access by 2016 under the National Electrification Scheme (NES).

As of October 2013, Ghana's installed electricity generation capacity was 2,546.5MW (51.9 percent hydro, 48 percent thermal, and 0.1 percent solar).[58] The Ministry of Energy (MoE) is responsible for formulating, monitoring and evaluating policies, programs and projects in the energy sector.

De-centralized Environment

Policy

In its efforts to reach 100 percent electricity access, the Government of Ghana is investigating mini-grid models as a solution to reach isolated off-grid communities. With an off-grid mini-grid proof of concept underway, the MoE, World Bank, and African Development bank (AfDB) are jointly supporting four island mini-grids expected to be operational by the end of 2014.[59] Ghana also has import duty and VAT exemptions on complete renewable energy products, and government mandates to source 10 percent of the country's electricity generation from renewables. However, the government currently offers no financial incentive to develop off-grid capacity, and the existing regulatory framework does not allow for private ESCOs to charge rates exceeding the urban subsidized uniform tariff, although mechanisms to subsidize decentralized mini-grid tariffs are being considered by the MoE.

ESCO

Ghana's far-reaching national grid provides electricity to over 77 percent of the population, creating market entry challenges that are costly and difficult to prove. Renewable energy companies are instead focused on the distribution of home energy products on one end of the spectrum, and the installation of large-scale generation to supply the national grid on the other. Although there is great potential for renewable energy technologies, there are few ESCOs with the experience to develop productive power mini-grids, or interested operators as is suggested by the fact that there are no operational mini-grids licensed or registered with the Energy Commission.[60]

Anchor (Telecoms)

Nearly 90 percent of Ghana's telecoms towers are already connected to the national grid, with the few off-grid towers being powered by diesel generators and expected to ultimately be connected to the main grid as expansion continues.[61] MNOs are not currently focused on expanding their portfolio into off-grid areas as they do not currently see large enough revenue opportunities in remote off-grid areas. This limits telecoms anchor potential for de-centralized models.

Social

Ghana's stable and mature democracy continues to show good performance on democratic governance and strong civil society activism. With a World Bank Doing Business ranking of 67 (out of 189 economies), Ghana's civil society stakeholders continue to establish a stable environment that would support mini-grid development via a demand for electricity, an ability to pay and successful training programs. Social potential supporting de-centralized mini-grid solutions is only limited by the available scope of off-grid communities and seasonal influences on income.

Financial

Ghana's renewable energy and mini-grid financial environment is relatively immature and in its early stages of focus and growth. With little to no local private or government funding available, international donor organisations are beginning to foster the mini-grid sector through funded feasibility studies and soon-to-be-implemented pilot models. Local banks are keen to invest in clean energy initiatives, although they require proven case studies and an increased awareness in the industry.

Conclusion

Ghana's population and telecoms tower portfolio are mostly connected to the national grid, ultimately limiting the demand for de-centralized mini-grid solutions. Energy technology companies are in the early stages of investigating mini-grid models; however, home energy providers are mainly attracted to Ghana by the plentiful small communities willing and eager to purchase pico-solar products. Mini-grid regulations are in flux; though currently deter sustainable off-grid models due to the nation's low subsidised tariff. Despite unfavorable conditions in most sectors, Ghana's strong and stable social sector provides a welcoming environment with strong supply chain networks, available capacity, and a rural willingness to pay.

Nigeria

The market for de-centralized mini-grids in Nigeria is attractive despite an electricity supply landscape in flux and possible difficulty finding project financing. Government policies and incentives support private-sector-led electrification targets, and a thriving telecoms sector is eager to cut operating costs. There are also residential and commercial communities willing to pay. However, ESCOs would find local financing and technological expertise inadequate and would have to focus on overcoming these operational challenges in order to implement mini-grid models.

Country Context

The Federal Republic of Nigeria is Africa's largest and most populous country, accounting for 47 percent of West Africa's population. After years of military rule and political instability, Nigeria enacted a new constitution in 1999 and brought to power a civilian government. The Democratic Party (PDP) has dominated the political scene since then.

Nigeria is Africa's largest oil exporter and boasts the largest natural gas reserves in the continent. The country is the sixth largest producer of petroleum in the world; it is the eighth largest exporter and has the tenth largest proven reserves.

Almost 50 percent of the population does not have access to grid electricity, though the government has ambitious plans to improve the power sector, targeting 20,000MW capacity and 75 percent rural electrification by 2020. The first of these plans include the appropriation of US$100 million for the Rural Electrification Agency (REA) to implement electrification projects across rural communities and the privatisation the power sector, handing over legal control of 15 state-owned electricity companies to new owners.

De-centralized Environment

Policy

The Government of Nigeria has ambitious targets for private sector-led rural electrification and renewable energy—15,903MW produced by renewable energy sources by 2015, and 75 percent rural energy access by 2020.[62] To further promote private sector-led electrification, no license is required for ESCOs producing less than 1MW of electricity. While the national government is largely supportive, many challenges still remain in creating a support structure to incentivize off-grid electrification programs. With the national utility, the Power Holding Company of Nigeria (PHCN), recently unbundling and transferring its assets to 17 private-sector companies (a mix of generation and distribution entities), many believe that the political landscape may focus more attention on off-grid programs and others in the supply-side industry. Further inhibiting mini-grid models is the cap on electricity tariffs regulated by the Multi-Year Tariff Order (MYTO). It ensures reasonable prices to predefined consumer classes but may be low enough to eliminate the business case for investment in some rural communities.

ESCO

Although there have been a number of new entrants pursuing Nigerian off-grid electrification programs with clear regulations and licensing frameworks, high-equipment costs and a shortage of local technology expertise has restricted the growth of this environment. Renewable sources are available with hydropower currently providing 20.9 percent of Nigeria's energy, and with solar and wind as high-potential sources. Rural generation and distribution companies are rushing to take advantage of high demand, but the Nigerian electricity supply industry currently relies heavily on offshore resources for equipment and technical expertise in set-up, management, and technical maintenance. These technical limitations and supply chain challenges will impede scaling.

Anchor (Telecoms)

MNOs and independent tower operators in Nigeria are eager to cut operating costs for both on and off-grid towers, and have begun exploring renewable energy solutions, specifically solar generation. Telecoms companies in Nigeria have a broad mobile footprint with 27,000 base stations. Due to unreliable national grid supply, nearly all of these towers are diesel-generator-powered, though only 52 percent are off-grid. All four major network operators are seeking to expand in remaining rural markets, although this expansion may not align with areas lacking power, renewable energy potential, and an ability to pay.

Social

Of Nigerians, 70 percent live below the poverty line, and 60 million of the country's 168 million people are without electricity access. Those who do have access are subject to unreliable supply in most areas. Communities are eager for electrification but the absence of technical skills, the inability to pay, or volatility of income, would prevent mini-grids from being implemented in a number of geographies. Efforts to develop skills are under way, led by the National Power Training Institute of Nigeria, which was established to build technical capabilities for power sector personnel.

Financial

Despite increasing interest in the Nigerian Electricity Supply Industry and government funding via the Renewable Electricity Policy Guidelines, ESCOs still face a number of challenges with respect to financing. Viable sources, which include government funding, CSR, domestic private capital, local banks and foreign financial institutions, all pose differing difficulties which limit funding options. Particularly, investor wariness exists due to limited knowledge of renewable energy technology and delays in implementation of drafted policies to reform the power sector.

Conclusion

Nigeria has great potential for de-centralized mini-grid models, with a growing interest in, and political support for off-grid electrification programs. The political environment, however, could quickly change as national and local government support systems are established to bolster renewable energy.

Conclusion

Electricity access is a major issue in the seven countries assessed, with de-centralized solutions gaining attention and prominence. The assessment provides a distinct overview of each country's relative potential to support the establishment of de-centralized mini-grids, along with the key considerations in terms of the policy, ESCO, and telecoms environments in which mini-grids would operate.

Electricity Access

At present, over 250 million people across the seven geographies assessed do not have access to electricity, with 150 million of these in Indonesia and Nigeria alone. Progress in terms of providing access is particularly undermined in Tanzania, Kenya and Cambodia, with two-thirds of these countries' populations lacking basic access to electricity and the development opportunities it brings. In each country, the issues driving these low levels of electrification are different but the results are often the same: a lack of electricity has staggering consequences for human health, economic development, political stability, equitable growth, and the development of resilient communities.

The Assessment

This report is concentrated on helping to understand which assessed geographies would be most receptive to decentralized renewable energy mini-grid models, with a particular focus on supplying electricity to anchor clients such as telecoms towers, households and micro-enterprises.

The research project that has resulted in this report did this by looking to answer one key question across all seven geographies. That question was:

How suitable is the market environment for de-centralized mini-grids to operate and scale?

Additional Considerations

During the assessment, the team uncovered a number of key considerations and recommendations that rural electrification initiatives should consider when selecting a market to enter focused on the policy, ESCO and telecoms environments. At a high-level these considerations are:

- From a **policy perspective,** focus on countries that have a history of supporting de-centralized power with clear frameworks and commercial tariff rates.
- From an **ESCO perspective,** focus on reducing barriers to entry by providing project development and load ramp-up support, as well as access to versatile financing.
- From a **telecoms perspective,** focus on MNOs that have switched from growth to portfolio optimization and cost reduction.

These environmental considerations should feed heavily into any future portfolio choices.

Conclusion

Electricity access is an issue holding back development across all of the seven countries assessed, and de-centralized productive power could play an important role in helping communities overcome this issue across all seven countries.

Various factors come into play when considering the applicability of de-centralized mini-grids as a solution to the issue of electricity access. These include the landscapes of policy, ESCOs, anchor tenants, and social and financial environments. This assessment and comparative analysis found three levels of de-centralized mini-grid suitability:

- Current Potential—the countries with strong decentralized electricity environments suitable for entry today are **Cambodia** and **Tanzania**.
- Future Potential—the countries undergoing a high amount of change but likely to be suitable in the medium term are **Nigeria and Myanmar**.
- Limited Potential— countries that are relatively poor matches for de- centralized solutions due to currently unfavorable regulatory conditions or other inhibiting factors are **Indonesia, Kenya and Ghana**.

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