Centre for International
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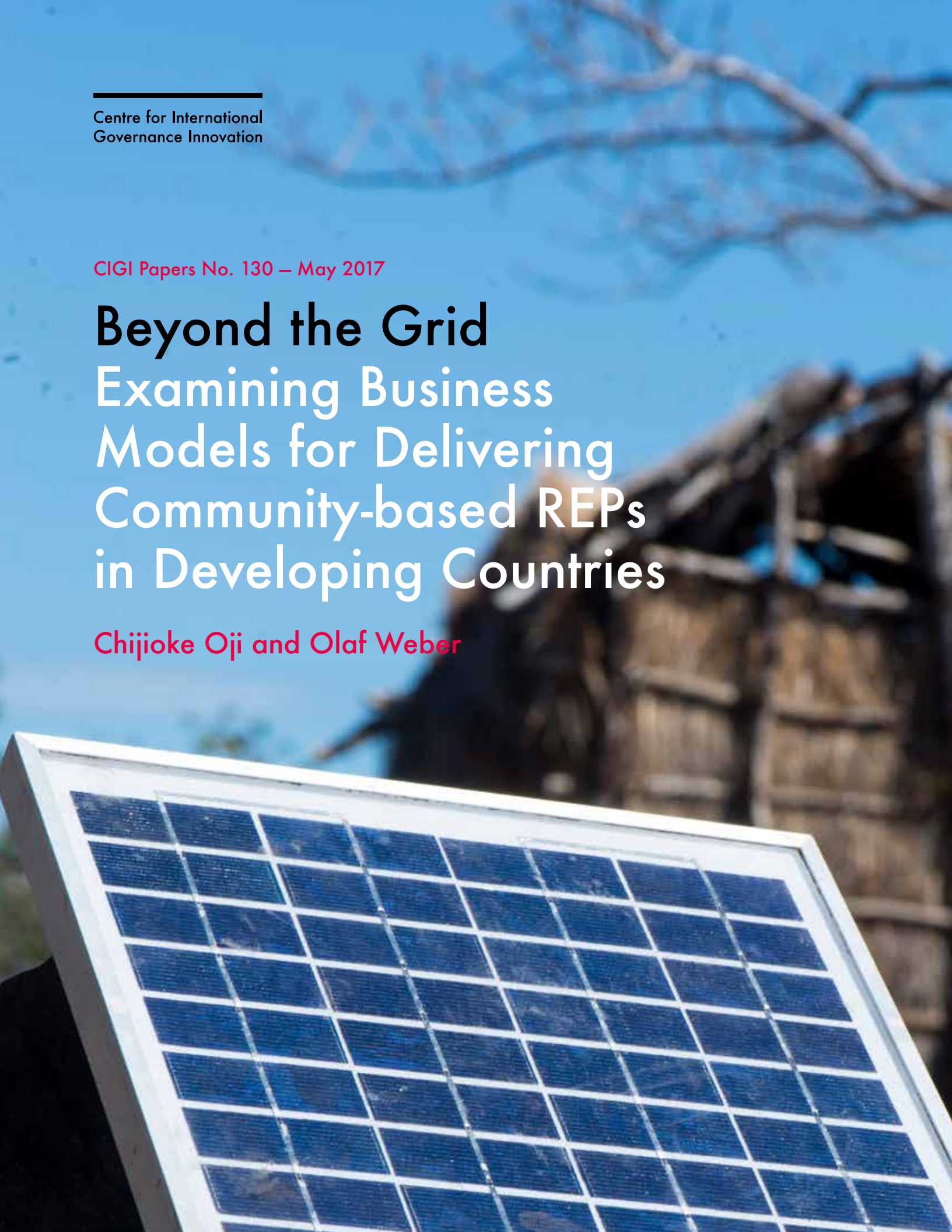
CIGI Papers No. 130 – May 2017

Beyond the Grid
Examining Business Models for Delivering Community-based REPs in Developing Countries

Chijioke Oji and Olaf Weber



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Chijioke Oji is a post-doctoral fellow at the School of Environment, Enterprise and Development at the University of Waterloo. His current research focuses on developing innovative financing models for small and medium-scale renewable energy projects to alleviate the energy access challenge in developing countries and foster decentralized renewable energy production in developed and emerging economies. Previously, Chijioke worked as an associate on numerous consulting projects in the private sector on different continents and as a researcher in the economic diplomacy unit of a leading think tank in Africa. He has an M.B.A. in strategic management and a Ph.D. in international business, both from Wits Business School, Johannesburg, South Africa.

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Acronyms and Abbreviations

ADB	Asian Development Bank
DRC	Democratic Republic of Congo
GMGs	green mini-grids
IDCOL	Infrastructure Development Company Limited
IRENA	International Renewable Energy Agency
MFIs	microfinance institutions
REPs	renewable energy projects
RETs	renewable energy technologies
SDGs	Sustainable Development Goals
SHS	solar home systems
SOEs	state-owned enterprises
USAID	United States Agency for International Development

Executive Summary

Energy is a critical resource that links the factors of production and influences socioeconomic development in communities, and its importance in driving development within social and economic systems cannot be underestimated. It is, however, critical that energy development initiatives are linked to economic activity to stimulate socioeconomic development. Access to clean, reliable energy is a major challenge in developing countries. For the rural population, in particular, the lack of access to modern energy results in a reduced ability to perform economic activities that collectively advance local communities. Ultimately, this phenomenon leads to a cycle of poverty and an ongoing system of substandard development in rural communities. From a social perspective, lack of access to modern energy generally results in poor living standards[1] and low quality of life[2] for rural dwellers (Ray et al. 2016; Lambert et al. 2014). Decentralized renewable energy technologies (RETs) have the potential to eliminate the energy-poverty dynamic in developing countries by delivering the benefits of socio-economic development to rural communities through energy provision (Mboumboue and Njomo 2016). However, appropriate business models and delivery strategies must be put in place to ensure that the benefits of access to stable supplies of affordable energy are obtained. This paper contributes to the discourse on global development through rural electrification by presenting cases on energy delivery for rural development in three developing countries on different continents. Specifically, this paper addresses the challenges around innovation in designing, financing and implementing sustainable business models necessary for delivering energy to rural communities in developing countries. The paper also highlights the importance of business models in attracting finance for rural renewable energy projects (REPs), establishes the importance of adapting business models to local conditions and specifies the role of innovation in scaling up sustainable business models to accelerate progress toward alleviating the energy access challenge in developing countries.

1 See www.wame2015.org/issue.

2 See www.worldenergyoutlook.org/resources/energydevelopment/modernenergyforallwhyitmatters/.

Introduction

The lack of access to stable modern energy is a critical global problem (Kim 2015). While developed countries enjoy a reliable supply of energy provided through multiple channels in well-advanced energy systems, developing countries suffer from an inadequate energy supply. In many developing countries in Africa and Asia — such as Ethiopia, Nigeria, Bangladesh and Pakistan — energy is mainly provided through access to the national grid, which the majority of rural communities are isolated from. In addition, the generation, transmission and distribution of electricity is centrally controlled by state-owned enterprises (SOEs) that, as the sole electricity utilities in these countries, monopolize the electricity production process. In countries where adequate management capacity is lacking in the national electricity utilities, energy planning processes that should incorporate grid extension to rural communities suffer. In specific localities in some developing countries, such as the Democratic Republic of Congo (DRC) and the Philippines, plans for urban electrification are prioritized over plans for rural electrification in the government's standard long-term plans for energy development, for reasons linked to economic activity and the overall perceived contribution to the national growth of these countries.

The rationale for providing electricity to rural communities has been to improve social standards and quality of life. Hence, dialogues on energy provision for the rural poor have revolved around concepts such as "energy poverty" as a means to foster social development. While this issue is certainly important, it excludes the possibility of developing energy systems to drive economic activity in rural settlements, which is necessary for socio-economic development in any given community. Also, the cost of extending the national grid to every rural community is often cited as a factor hindering planned or proposed national rural electrification projects (Szabo et al. 2011).

Moreover, there is huge competition for governments' scarce resources, which must be deployed judiciously for the broader benefit of communities in countries such as Ethiopia, Nigeria, Bangladesh and Pakistan, as well as in other countries with similar socio-economic characteristics. Adopting a cost-benefit model to

analyze the cost of extending the national grid to rural settlements in relation to the potential benefits is not an attempt to price human development; however, it shows that extending the national grid to all rural communities appears to be an impractical approach to rural electrification. The cost is prohibitively expensive and the process is cumbersome.

Decentralized RETs operating in a system that thrives on the inflow of public and private capital have the potential to address the energy access challenges in developing countries around the world. However, the lack of access to finance and low earning potential of rural settlers directly impact their ability to afford modern electricity. Private sector financiers and other groups of financing intermediaries with capital can play an important role in addressing the energy access challenge prevalent in developing countries. Providing finance for small or community-scale REPs and investing in the expansion of rural electrification projects could resolve the energy access problem. However, appropriate business and financing models must be developed to establish the economic viability of smaller REPs in developing countries.

This paper seeks to highlight some of the business models adopted for small-scale REP development in developing countries. Broadly, the paper aims to illuminate the possibility of establishing appropriate business models to support the widespread expansion of modern energy in efforts to address the socio-economic challenges that lack of access presents in some developing countries, specifically those in Sub-Saharan Africa. Emerging and established business models developed and implemented for the dissemination of small-scale REPs in developing countries are described and briefly analyzed. Synopses of these models are presented as short case studies to highlight the efforts made to increase finance and business activities for rural electrification in a bid to address the energy access challenge.

Financing Rural REPs in Developing Countries

Access to energy for rural populations in developing countries such as Nigeria and the DRC is currently a major challenge. Approximately 1.3 billion people, mainly located in rural areas of developing countries, lack access to electricity (Kochtcheeva 2016). According to the International Energy Agency's "World Economic Outlook 2016," the number of individuals without access to electricity in some developing African countries surpasses those with access to electricity (International Energy Agency 2016). Studies show that 600 million people in Sub-Saharan Africa do not have access to any form of modern electricity — this number equates to 57 percent of the population of the subcontinent. In South Asia, India, which has a population of approximately 1.25 billion people, stands out as prime evidence of the challenge of energy access: 300 million people in the country do not have access to electricity (Lindeman 2015). Of the 214.8 million people in the Middle East, 17.7 million people do not have access to electricity (ibid.). Over 80 percent of those without electricity in the Middle East reside in Yemen. Finally, in Latin America, with a population of 466.1 million people, 23.2 million people are without access to electricity (ibid.).

In some developing countries, the population of people living in rural areas is often larger than the population of urban dwellers, due to social and economic factors such as a lack of formal education, low wages and language barriers, among other issues. The individuals affected by the challenge of poor access to electricity are predominantly found in rural locations (United Nations Environment Programme Finance Initiative 2012). The challenge of poor or inadequate access to modern electricity has persisted over the years and efforts to address the problem have been largely fragmented, given the various approaches to the differing energy situations in developing countries. Those who study rural electrification have suggested the application of multiple financing and business models to foster rapid development of community-scale REPs in rural areas. However, an understanding of the typology of models and the energy situation of the community is necessary if the global objective for advancing increased development of small-scale REPs in rural communities in developing countries is to be realized.

The Rural Electrification Landscape and Financing Challenges

The electrification of rural areas in developing countries is a major challenge for development. Ensuring access to affordable, reliable and sustainable modern energy for all is stated as goal 7 of the Sustainable Development Goals (SDGs) in the United Nations' framework for global development. Achieving many of the stated goals for development will not be possible without focusing on the electrification of rural communities. While policy proposals to advance development through the electrification of rural populations have been presented, the challenge remains rooted in the complexity of financing rural electrification (International Renewable Energy Agency [IRENA] 2014). In addition to standard energy financing challenges such as high costs of capital, low access to capital, fluctuating exchange rates and unstable interest rates, the process of financing rural electrification projects is compounded by distinct factors that largely contribute to increase the impact of associated investment risks. These factors include low and unstable income, undocumented financial behaviour (receiving and repaying loans) and the lack of data on household expenditure on energy (IRENA 2016a).

Scholars have argued that the situation with financing rural electrification is unconventional, and for this reason, conventional financing methods and risk assessment procedures used in financing standard REPs would not be applicable (Steurer, Manatsgruber and Jouégo 2016). Since government resources are limited in most developing countries, in particular in Africa and Asia, and understandably highly prioritized, the potential contribution of capital from the private sector in financing rural electrification projects cannot be ignored. However, private sector financiers with large pools of capital do not see small-scale REPs as worthy investments, based on the level of financial risks smaller rural electrification projects carry (Escalante, Abramskiehn and Falzon 2016). In weighing the risk and return profile of potential REP investment cases, private financiers tend to focus on projects that offer high profit margins, and small-scale rural electrification projects are unattractive due to the low financial returns they provide in relation to the capital and labour invested in developing a project (Das et al. 2015). The financial risk is compounded by the risk of policy uncertainty or the absolute lack of policy frameworks to secure investments and guarantee returns.

Importantly, the perception of value from the private financiers' perspective is mainly transactional, as value for most lenders is primarily measured in terms of monetary profits (Lubber 2012). However, in particular with environmentally conscious investors, value in financing REPs is also measured in terms of social impact (Chronias 2016). Essentially, financing models that integrate financial returns and social impact in the analysis of value could contribute largely to unlocking capital for financing rural electrification projects in developing countries. In the past few decades, developing countries have relied on donor funding either directly from developed countries or from the representative agencies of developed countries to obtain capital for rural electrification projects. While donor funding is a useful tool in providing development assistance and a commendable factor that contributes to strengthening diplomatic ties between developed and developing countries, considering the broad agenda for accelerated development through rural electrification, in itself, the donor funding model is insufficient and possibly unsustainable. In order to unlock capital to finance the accelerated electrification of rural communities in developing countries, viable alternative business models for financing RETs must be implemented.

Business Models for REP Delivery in Developing Countries

Business models are essential for the delivery of decentralized energy through RETs in developing countries. For private sector financing, they play a critical role in describing the revenue generation process using specific technologies, thereby helping to satisfy financiers' criteria for investment, which, primarily, is the return on investment. Through analyses of the business model and evaluations of economic value, the potential for extracting profits as returns on investment are weighed and

financing decisions on whether or not to invest in businesses focused on providing renewable energy are reached (Srinivasaraghavan 2012). Business models are also important to the governments of developing countries involved in financing rural electrification through renewable energy development. This is based on the role business models play in the delivery of energy services in electrification projects coordinated mainly by central electricity utilities, and the impact of electricity provision in rural communities (African, Caribbean and Pacific — European Union Energy Facility, n.d.). However, in evaluating business models for delivering renewable energy, these governments do not focus entirely on financial profits. Rather, as impact investors focused on social development, they mainly evaluate business models on specific criteria, which include effectiveness of delivery, practicality and replicability of the model, potential for scaling up, projected societal impact and cost efficiency. Regardless of the criteria for evaluation, business models are important to both government and private sector investors in financing decentralized renewable energy development (Rai et al. 2015).

There are two main approaches from which a host of business models for financing and delivering decentralized renewable energy are derived: the donor-driven and the private-sector-driven approaches. The donor-driven approach is derived from a philanthropic model, where funding for specific REPs is provided to developing countries by developed countries, and government departments or agencies within the receiving countries oversee the allocation of funds for the project. Ibrahim Hafeezur Rehman et al. (2017) suggested that this financing model does not provide a basis for establishing a viable market, as the model is entirely unsustainable. Therefore, although this model plays an important role by catering to the poorest of the poor, a transition to other models that emphasize balance between societal development and return on investment is critical. In direct contrast to the traditional donor model, the private-sector-driven model is commercially led and is based on cash sales for renewable electricity services without subsidies. This model has been described by Cle-Anne Gabriel and Jodyanne Kirkwood (2016) as a classic market-based model, in which private firms with private capital own, lease or sell the electricity-generating system and supply renewable electricity to individuals as final consumers who pay for electricity services provided. These private firms install and maintain the renewable electricity-generating system as a service to their customers (Kolk and van den Buuse 2013).

In between the two extremes of the traditional donor-driven model and the commercial private-sector-led model, a number of business models exist. These include multi-stakeholder approaches with varying concessions and agreements. A popular variation of this model is one in which a private firm owns the renewable electricity-generating asset and financing for end-users is provided by a donor, a government financial institution or a dealer through low and medium-sized investments in the entire project. In some cases, especially with green mini-grids (GMGs), the donor finances the installation of the renewable electricity-generating asset through a low-interest loan, and a private firm is contracted to maintain the asset and billing process. Upon successful repayment of the loan, the asset is transferred to the national electricity utility in the country. Local microfinance institutions (MFIs) within close proximity of communities may also single-handedly finance and install renewable electricity-generating products or partner with specialized energy services providers to finance and install products. In this model, the MFI focuses on its core business of financing, while the energy services provider focuses on its core business of providing electricity; the two businesses are linked by a contractual agreement.

Variations of fee-for-service models, in which the national electricity utility or an energy service company owns, finances and maintains the renewable electricity-generating asset while charging households and businesses a fee based on their respective consumption, may also exist. This may be combined with an affordable payment scheme to increase technology adoption. Examples of businesses that are implementing this model include Grameen Shakti in Bangladesh and SELCO in Sri Lanka (Emili, Ceschin and Harrison 2016). In some other models, subsidies are integrated to complement tariffs paid by consumers or fund producers of renewable electricity for the number of connections established. Typically, this model is promoted as a regulated purchase tariff as implemented by NuRa in South Africa (Lemaire 2007) and for businesses in the solar consumer product sector in Uganda, through the country's Energy for Rural Transformation program led by the

Ugandan Rural Electrification Agency in partnership with a network of local MFIs and non-governmental organizations. Finally, business models based on small power-purchase agreements that guarantee renewable electricity producers a specific price on electricity and minimum purchase as a means to stimulate investment in off-grid renewable electricity development also exist (Alliance for Rural Electrification 2011). The following paragraphs highlight cases of business model innovations for financing the development of decentralized renewable energy in developing countries.

There are various classifications of business models; however, models are mainly categorized based on ownership and service. On the one hand, ownership models such as public-private partnerships, multi-party ownership, lease or hire purchase model, consumer credit and dealer credit focus on financing and mitigating risks associated with project development. On the other hand, service models such as the user cooperative and the energy service company model focus on providing specific services through varying processes of operation. Business models are also classified based on ownership and financial flows into projects: these are public-private partnerships, community-owned and operated, and private-sector-based models. Since the reality of financing decentralized renewable energy is such that business models are typically a hybrid of approaches, for the purpose of this study, business models are categorized as government-led, multi-party-led and private-sector-led approaches (Asian Development Bank [ADB] 2015).

Government-led Models

In this approach, governments or selected agencies of government are channel leaders, controlling the allocation of resources and the broad implementation of strategies to realize maximum value from investments. Using this model, financing is typically obtained through loans from multilateral development banks or grants from foreign development institutions. Some governments may set up private entities to manage the operational processes for renewable energy delivery, while others coordinate operations through the energy and infrastructure ministry. Variations of this approach may also be structured as electrification programs, in which the government initiates renewable energy development projects as a means to increase access to electricity for its citizens. The case study below presents an overview of a government-led approach to off-grid REP financing and development successfully implemented in Bangladesh.

Infrastructure Development Company Limited

The Infrastructure Development Company Limited (IDCOL) in Bangladesh was established as a sub-division of the Ministry of Finance in May 1997 and licensed shortly thereafter as a non-banking, government-owned financing institution to manage and oversee investments in infrastructure and renewable energy. Among others, initiatives of the IDCOL focused on developing off-grid energy, including programs on solar home systems (SHS), solar irrigation pumps, solar mini-grids and biogas-electricity-based production. However, the SHS program that the IDCOL embarked on in 2003 is recognized as the IDCOL's flagship program, due to its success in expanding access to energy in Bangladesh.[3] The IDCOL delivery model for its SHS program engages partner organizations, which include overseas development finance institutions, suppliers of the SHS, local small and medium-sized enterprises and MFIs.

The IDCOL's SHS program was first funded by the World Bank and the Global Environmental Facility. Additional financiers from international development banks and agencies such as the ADB, Department for International Development, Gesellschaft fur Internationale Zusammenarbeit and United States Agency for International Development (USAID) have contributed to finance the expansion of the program. Grants and loans obtained at low interest rates are channelled into financing the purchase of SHS at retail level. The IDCOL's delivery model involves selecting and training representatives from MFIs to conduct assessments of energy needs at the household level. MFIs are also responsible for estimating affordability, installing the SHS and providing after-sale services and maintenance.

The IDCOL provides its partner organizations with grants to subsidize the costs associated with purchasing the SHS, thereby reducing the cost of the SHS for final purchasers. A combination of partial subsidy and refinancing is used in the IDCOL's financing model, where households receive grants in the form of reduced costs for the SHS. Households seeking to purchase SHS make

3 See http://idcol.org/home/solar.

a down payment comprising 10 percent of the system cost, and the outstanding 90 percent is made available at 15–20 percent through micro-credit from MFIs (Khandker et al. 2014). The IDCOL provides a grant to the partner organization, also refinancing 70–80 percent of the loan provided to households, and then reclaims the loan funds used in refinancing from its financial partners. Upon successfully paying off loans, households become owners of the SHS (ibid.).

Multiparty-led Models

In this approach, government departments and relevant agencies enter into agreements with international development agencies and private sector firms to develop REPs. Depending on how the model is implemented, guided by the government's policy for REP development, governments, international organizations or private sector firms enter into partnerships and initiate a project. In some cases, projects are developed from a broad renewable energy program established by governments in partnerships with international organizations — governments establish policy guidelines, international organizations fund and co-ordinate the program and private sector firms finance and construct the REPs. Some examples of this model in Sub-Saharan Africa include Power Africa, the United States' clean energy plan for Africa led by USAID, and the Electrification Financing Initiative, led by the European Commission in partnership with governments of African countries and private sector investors. Variations of this model exist and it is not uncommon for governments to work in partnership with either international development institutions or firms in the private sector to deliver REPs. Public-private partnerships for renewable energy development are mostly used to finance mini-grid projects, as these projects require high levels of specialized skills. However, the model has also been used to finance SHS programs. Common arrangements in public-private partnerships are usually structured such that skills and capital from the private sector, which governments lack, are channelled into developing REPs. In some variations of this model, specifically with GMGs, governments give concessions to private firms to operate the mini-grid and transfer the asset to the government at an agreed date. The case study presented below highlights the interaction between a social enterprise with a combination of government and private sector financing in delivering REPs to remote areas in Mexico.

Iluméxico

In 2009, Iluméxico was established as a social enterprise with the aim of improving access to energy for the rural poor in Mexico. The initiative started as a pilot project to provide electricity through the SHS in the rural areas across Mexico and became a project for implementation across the country in 2010, operating independently of the government as a firm. Through a combination of government grants, subsidies and private sector funding, Iluméxico operates as an institution overseeing the purchasing, financing, installation and maintenance of SHS. Typically, households sign up to purchase SHS with Iluméxico and sign an agreement for the repayment of the loan used to purchase the SHS. Consumer finance for the SHS is provided in the form of a loan through Telecomm-Telegrafos, a government telecommunications agency, which, in addition to basic communication services, provides remittance services in Mexico. Telecomm-Telegrafos oversees the loan administration process through its nationwide network of branches, which are normally within close proximity to Iluméxico's customers.

Iluméxico operates through a chain of local branches known as ILU Centros. These branches operate as rural service centres offering customer service, distribution, support and maintenance to the rural customers. ILU Centros also function as hubs for community development, offering workshops in schools on sustainability and community development, helping to educate Iluméxico's customers. The SHS that Iluméxico installs are locally produced, based on the outcome of assessments on technology and the electricity needs of the rural poor in Mexico. Iluméxico currently has five ILU Centros and serves approximately 18,500 rural dwellers in Mexico.[4]

4 See http://ilumexico.mx/home/how-we-do-it/.

Private-sector-led Models

In this approach, either governments or private sector firms initiate the renewable energy project development process. It has been suggested that this model is preferred by firms in the private sector, as it holds high prospects for establishing a local market for the consumption of renewable electricity (IRENA 2016b, 16; European Bank for Reconstruction and Development 2013). The standard variation of this model involves private sector firms financing and developing the renewable electricity-generating asset, connecting households and managing the daily operations and the electricity-billing process. Variations of the billing process, which forms the primary revenue stream, also exist in this model — customers may choose how much electricity they require and pay a flat rate when issued a bill reflecting their electricity consumption at regular intervals, or customers pay for electricity consumed using a flexible pay-as-you-go billing structure. The case study below highlights the challenges for private sector firms in entering off-grid energy markets in some developing countries. The case study establishes the importance of adapting business models to local conditions and innovating across internal firm operations to deliver services in an energy market considered by conventional finance and energy development standards to be highly risky.

Powerhive East Africa

Powerhive is a private micro-grid solutions provider with a focus on developing off-grid renewable electricity for developing and emerging market countries. Through the development of proprietary technology and streamlined customer service operations, Powerhive devised a business model to provide electricity to the rural poor in developing countries, while making a profit. The East African operation of Powerhive was established in 2012 as a pilot project to test the effectiveness of Powerhive's variant of the fee-for-service business model initiated by a private firm. In Powerhive's business model, communities are connected to microgrids that provide renewable electricity for use. Since Powerhive operates as a private utility, it absorbs the costs associated with developing the microgrid infrastructure, which serves as the point of entry into the local market. Powerhive's business model allows customers to purchase electricity using mobile money payment applications on their mobile phones. Payments trigger automatic electricity production for households and businesses for a period of time, based on the amount of electricity purchased.

In 2012, Powerhive first tested the compatibility of its business model and its target market with a small cluster of residential customers in Mokomoni, a rural village in the Nyamira county located within the Nyanza province in Kenya, where a 1.5 kW microgrid was commissioned. These customers mainly used the electricity provided for power appliances in their households. In 2013, three other pilot sites with capacities of 10 kW, 20 kW and 50 kW were developed in the villages of Nyamondo, Matangamano and Bara Nne, respectively. These microgrids served approximately 1,500 rural customers (Powerhive 2015a), supporting a larger cluster of users involved in commercial activities such as welding, carpentry and milling. Understanding the importance of scale to the success of the business model, in 2014, Powerhive began seeking concessions with the Kenyan government to supply electricity within specific remote areas of the country for a number of years. Early in 2015, the Energy Regulatory Commission of Kenya granted Powerhive concessions to supply electricity to hundreds of rural communities in the country beyond the national grid, beginning in the Kisii and Nyamira counties located in western Kenya (ibid.).

Analysis of Selected Business Models

In the cases selected for this study, the established business models have contributed to the rural energy development agenda by successfully delivering renewable electricity to remote communities served by the implementing institutions. However, some approaches have been more successful than others. By May 2013, IDCOL had installed two million SHS units across Bangladesh;[5] by January 2017, Illuméxico had completed 7,700 solar installations (Sustainable Energy for All 2017); and in 2015, Powerhive Kenya outlined its strategy to connect 200,000 homes (Powerhive 2015b). IDCOL thrives on capital contributions made by the Government of

5 See http://idcol.org/home/milestones.

Bangladesh and a number of development finance institutions, which offer loans to the institution at low interest rates. Although this type of financing is necessary to spur energy development, IDCOL's business model may be difficult for other local financial institutions to adopt, as IDCOL's partnering financial institutions receive grants from the pool of funds, allowing them to offer financing to the poor at low rates. Due to this, other capable financial institutions unable to offer similar interest rates are crowded out, reducing the potential for accelerating rural electrification using capital from the private sector. Additionally, IDCOL has reduced the subsidy it provides its partner financial institutions from US$90 to US$25 per SHS (Sharif 2013). This can impact the agenda for rural electrification as fewer people may be able to afford the SHS without the subsidy. Although IDCOL expects affordability to increase due to forecasted reductions in the cost of SHS, a dilemma may, however, arise in the event that IDCOL withdraws the subsidy entirely, as this could impact the institution's entire business model.

In the first years of its development, Iluméxico depended heavily on government funding to operate its business model. This, in itself, poses a risk to the agenda for energy development by a private social organization, based on the changing priorities of governments. Reduced funding and budget cuts severely impact the operations of these firms. Ultimately, in this type of arrangement, critical external factors such as government funding and alignment of government priorities, which the firm is unable to control, contribute to increased risks, highlighting the impracticality of operating a private business delivering a social good such as energy and heavily reliant on government funding. Additionally, for Iluméxico, the agenda for delivering on its objectives for rural electrification were vetted by the Government of Mexico. As a firm grows, operational strategy evolves and navigating the firm innovatively may become cumbersome when relying on government funding. Illuméxico hedged against this long-term risk in 2015 by entering into a partnership with a social impact investor, Engie, which provided investment capital for the firm, rendering its business model sustainable.

The pay-as-you-go model for electricity bill payments adopted by Powerhive exists in various forms across rural communities in developing countries. Powerhive neither invented nor owns this payment system. However, Powerhive owns the underlying technology infrastructure that holds its business model together, giving the firm a competitive advantage over smaller competitors. In a popular variation of the pay-as-you-go model, energy providers operating in rural areas sell scratch cards to customers wishing to top up their electricity. In another variation of this model, customers of off-grid electricity providers purchase electricity using mobile applications, and the telecommunications company that owns the technology serves as a mobile bank, facilitating transactions between energy providers and their customers.

Energy providers that adopt these models tend to grow organically, experiencing difficulty in scaling up the business model. Powerhive's business model highlights the importance of private sector investment in financing access to energy for rural communities in developing countries. By partnering with energy providers, project developers and investors, the firm's model shows high potential for scaling up for rapid expansion. The strategy of actively seeking concessions to exclusively provide electricity to a specific region for an agreed number of years also serves as a form of security for financiers that invested in the firm. Specifically, the success of Powerhive's business model can largely be attributed to the vast development of the mobile payments market and technology infrastructure in Kenya.

Next Steps in Delivering Community-based REPs

Despite the viability of the models described in this paper based on the capacity to deliver REPs to remote communities, numerous challenges for business model development exist and these hamper the agenda for rural electrification using decentralized RETs. Some key challenges for energy access in relation to the development of viable business models for expanding energy access using RETs include high levels of risk intolerance from financiers, limited channels for business model innovation, the scalability of selected models, absence of policy frameworks for off-grid energy development and low capacity of

communities to participate in the market. Some policy suggestions that may contribute toward addressing these challenges are highlighted below.

Lowering risk intolerance: For rural electrification projects in particular, financiers tend to have low levels of tolerance for risks associated with community-based REPs. Additionally, since many private financiers consider this category of REPs to be highly unprofitable, private sector capital contribution to rural electrification projects is limited to financial donations. Through the establishment of appropriate policies to support sustainable business models that are scalable and work to alleviate investment risks while earning financial profits, private financiers may consider investing in project developers. This would work to accelerate the expansion of renewable energy across rural settlements in developing countries.

Increasing innovation: Business models are products of innovative collaborations. Therefore, to foster innovation in business model development, it is important for governments in developing countries to increase innovative interactions among key stakeholders in the off-grid renewable energy development process. Seminars and workshops serve as platforms for engagement to devise cohesive approaches; however, there is a need for daily engagements in shared working spaces. Centralized community centres located within close proximity of villages may serve as energy development innovation hubs for business development as synergies between stakeholder groups can lead to the development of new, locally adaptable business models.

Scaling up models: Expanding platforms for delivering renewable electricity to rural communities is a critical part of the process to alleviate the energy access challenge in developing countries. Governments can provide funding for pilot projects to test the viability of new business models that are developed and provide concessions for electricity supply to specific firms over an agreed number of years, in accordance with their plans for extending the national grid. Impact investors, development financial institutions and private financiers alike tend to readily provide financing to firms with proven business models with the potential to scale up. Concessions would work further to guarantee financing.

Increasing community participation: Local buy-in can advance the project development process, in particular with the development of mini-grids. Rural communities function differently and understanding the underlying drivers of community life can be an essential addition in developing new business models or adapting existing models to different communities. In addition, the community management group holds valuable knowledge on the community, and including this group in the business model development process makes this knowledge accessible to project developers, while providing the community with a sense of ownership in the project.

Establishing energy frameworks: Electricity is largely considered to a public good, hence, governments are responsible for regulating and coordinating issues around electricity. As developing countries seek solutions for rural electrification, governments can encourage off-grid energy development by making information on grid extension plans available to stakeholders in renewable energy development. Plans for further development of business models by project developers may include grid integration and net metering, which, as a component of business models, could be more attractive to financiers in terms of evaluating the sustainability of the model and its capacity to generate revenue in the long term.

Conclusion

Innovative business models are essential for the delivery of energy services to underserved communities in the rural areas of developing countries (primarily due to the unconventional characteristics of rural communities in some developing countries). Before much-needed capital to finance off-grid REPs is invested, financiers require demonstrated capacity of a business to generate revenue and, ultimately, make a profit. The business model serves this purpose as it functions to address financiers' perceptions of risks in relation to the business, fundamentally impacting financiers' decisions on whether or not to invest in a project. While this paper highlights three cases in which locally appropriate business models were used to deliver off-grid renewable energy to rural communities, challenges with developing business models, which are critical for attracting finance, still

exist in developing countries. Business models that cater to the ultra-poor — people suffering extreme income poverty and living in low-income, lower-middle-income and upper-middle-income countries — must be developed to reduce the energy access challenge and improve the living standards of poor rural dwellers. Importantly, business models for rural electrification should link energy provision to enterprise development within communities to have a positive impact on social and economic development in developing countries.

Over the years, however, the cost of the SHS has reduced significantly due to economies of scale experienced in the solar photovoltaic industry (Clover 2016). This lower cost can contribute to alleviating the energy access challenge by increasing affordability for families financing equipment purchase through hire purchase, lease or the fee-for-service model, as highlighted in the cases examined in this paper. Lower SHS costs mean that families can purchase the equipment at potentially lower costs and over shorter periods of time. However, further intervention from governments through policy and regulation is necessary to stimulate private sector participation in the off-grid electricity market in some developing countries (IRENA 2016b). Although this market is still considered to be highly risky by large groups of lenders, there is significant potential for investment in this sector in some developing countries. In order to unlock this potential and effectively address the energy access challenge persistent in some developing countries, in addition to promoting retail solar consumer products such as the SHS, a focus on financing and developing community-scale REPs is necessary. Therefore, de-risking smaller REPs in the form of GMGs is critical. This can be done through the provision of a fund for rural electrification projects, to eliminate the burden of high upfront capital requirements, in order to create an environment where innovative business models can thrive (Quitzow et al. 2016). Additionally, pursuing cost-reduction strategies through competitive equipment procurement and aggregating activities across the small REP value chain can contribute to reduce project development costs, thereby increasing the potential for small REPs to be profitable for lenders and project developers (Agenbroad et al. 2016).

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