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Business models for mini-grid electricity in base of the pyramid markets

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ABSTRACT

This research project develops a business model framework based on the robust management literature on business models and uses the framework to analyze 24 mini-grid business models that serve "base of the pyramid" markets. The framework is based on the four dimensions of a business model that strategy scholars have identified, and is tailored to the unique circumstances of mini-grids that serve BOP customers. The study identifies 29 configurations of elements within mini-grid business models that supply a large—and growing—unmet demand for electricity in these markets. Analyzing these configurations results in a series of observations that pave the way for future research on mini-grid business models, as well as a number of trends within the off-grid electrification sector. The implications of these findings, and areas for further research, are also discussed.

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Nearly one in five people around the world—1.26 billion to be precise, living primarily in Sub-Saharan Africa and Southeast Asia—lack access to a reliable source of electricity (International Energy Agency, 2013). The vast majority—85%—of these individuals live in rural areas (International Energy Agency (IEA) and World Bank, 2014). To reach these rural off-grid customers, two approaches are possible: a top-down approach based on extending the main grid, and a bottom-up approach based on household- and village-scale electricity generation. Most countries attempt to implement both, yet main grid extension often remains untenable in the near term for two reasons. First, extending the main grid to remote areas requires a large capital investment that many governments, or utility companies, cannot afford without funding from international donors and lenders (IEA and World Bank, 2014). Second, these investments, even if they were made, would likely not be recuperated financially for decades because utilities in these countries are usually required to charge new rural customers the uniform national tariff, which is hardly ever high enough to allow the utility to recover operating costs, leaving aside capital costs. In the most recent and complete survey of African utility companies to date, the World Bank found that 15 of 21 national utilities in Sub-Sahara Africa operate at a loss because they are required to sell electricity at rates that are below cost-recovery levels (Camos et al., 2008).

Consequently, the World Bank and the International Energy Agency have calculated that only 40% of the electricity required to supply off-grid individuals can feasibly come from extensions of main grids. The remaining 60% of the required electricity must come from "mini-grid and stand-alone off-grid solutions" (IEA and World Bank, 2014, p. 115). These statistics represent not just an international development issue, as lack of electricity access hinders economic growth potential, but also a considerable market opportunity for the private sector to provide solutions in the rural, off-grid electrification sector.

We should not be surprised, therefore, that in rural areas throughout Sub-Saharan Africa and developing Asia, mini-grids are emerging as a solution to provide electricity to off-grid communities. In fact, they are often the preferred method of bottom-up, off-grid electrification because they enable higher levels of electricity-based services at lower costs than solar home systems (Chaurey and Kandpal, 2010; Palit and Chaurey, 2011). In addition, as Ulsrud et al. (2011, p. 294)) assert, "the variety in electricity's uses is potentially higher for mini-grids compared to solar home systems" and "mini-grid systems may also facilitate the set-up of commercial organizations with incentives to keep the system in good working order," both of which make mini-grids important drivers of economic development.

Two important clarification are necessary before moving forward. First, the off-grid areas of low-income countries are not the only places where mini-grids operate. In fact, the most recent and complete assessment of the global mini-grid market to date, conducted by Navigant Research, a research and consulting firm that closely tracks the deployment of mini-grids, highlights that 66% of the total mini-grid installed capacity around the world exists in North America. Applications for these mini-grids include commercial and industrial

Abbreviations: BOP, Base of the Pyramid; GTF, Global Tracking Framework; MGD, Mini-grid Developer.

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complexes, remote communities, and military installations, among others (Asmus et al., 2014). This research project, however, will focus on mini-grids that operate in low-income countries, where 99.92% of the 1.26 billion people without access to electricity live (International Energy Agency, 2013).

Second, mini-grids themselves are not businesses. They are the distribution network that connects an electricity generation source to end users. As we will see in the Prototypical mini-grid business model section, they also can be built, owned, operated, and maintained by different entities. However, we can refer to the business model of a mini-grid because a business model is not tied to a single firm, as we will see in the Business models section, and because the activities surrounding a mini-grid include the elements needed to describe its business model: it has customers, a value chain, and some monetization mechanism. Therefore, in this project I will study mini-grid business models, using data collected from organizations involved in their development, management, and operation.

Mini-grids in low-income countries exhibit a diversity of business models, and there has been a lively discussion, primarily within the investor, practitioner, and international development community, about these business models (e.g., Bardouille and Muench, 2014). However, the many discussions on mini-grid business models in the literature tend to use the term business model loosely, and as a consequence, the business model-specific results and recommendations from these studies are not comparable from one study to the next. In essence, current research on many aspects of mini-grid business models lacks a common understanding of what actually is a business model, and what business models actually exist for mini-grids that serve low-income customers in off-grid areas.

This research project, therefore, sets out to create a foundation for future research on mini-grids and their business models by identifying what the business models are (the building blocks) and what they are made of (the more detailed elements within business models). This project is an exploration of existing mini-grid business models, which leverages academic research on business models in order to identify and understand how different models provide electricity to off-grid consumers in low-income countries. Importantly, the framework that this project develops can be used in future research on any set of mini-grids to determine which business models work best.

In this paper, I first synthesize our current understanding of business models, with a particular emphasis on those models within the Bottom of the Pyramid (BOP) market context where most off-grid customers exist, and mini-grids, with a focus on what has been written about their business models. Next, I construct a business model framework relevant to mini-grids, and use this framework to analyze 24 mini-grid business models that operate in low-income countries. The results identify 29 configurations of elements within mini-grid business models, and build a foundation for further research into the viability of different mini-grid business models that provide electricity to off-grid customers—a market that is estimated to be worth up to $150 billion per year (Bardouille and Muench, 2014), and in which companies and investors have taken a keen interest.

Literature

The aim of this literature review is twofold. First, it contextualizes the research project within recent scholarly work on both business models and mini-grid-based solutions to off-grid electrification. Second, the literature provides the building blocks for the business model framework that I develop in order to analyze the mini-grid business models in the study. This second aim is key: the goal of the paper is to identify what the existing business models are of mini-grids serving the BOP, so I first present and then draw from the robust literature in management on business models in order to develop a robust business model framework that can be applied specifically to mini-grids.

I therefore examine two streams of literature: business models, particularly those in BOP markets; and, mini-grids in off-grid areas of BOP markets. A large and growing body of academic literature on business models exists, and I will leverage the key take-aways from this literature in order to develop the business model framework in the Data and methods section. Scholars have also studied business models within the context of BOP markets, which is of particular relevance to this project since most people without access to electricity reside in these markets. The literature on mini-grids usually addresses the technical aspects of the mini-grid and generator systems, or best practices and ways to ensure long-term success of the mini-grid. Very little academic literature on business models for mini-grids exists, however practitioners and international development agencies have written much on this topic. These reports and studies are sparsely populated by scientifically rigorous analysis, but they do provide insights into the elements contained within the four dimensions of mini-grid business models.

Business models

While the concept of a business model gained traction in academic and popular usage around the early 1990s (as reported by Osterwalder and Pigneur, 2005), no theory of—or one that incorporates—business models yet exists. Early research was characterized by variety in the definitions of business models, and what they are made of—that is, what their dimensions are. As DaSilva and Trkman (2013, p. 4) note, "dozens of definitions and component breakdowns of the business model have been proposed over the last decade."

As the definitions and dimensions of business models have evolved over the past 15 years, they have begun to coalesce around the definition put forward by Baden-Fuller and Haefliger (2013, p. 419): a business model is "a system that solves the problem of identifying who is (or are) the customer(s), engaging with their needs, delivering satisfaction, and monetizing the value." Importantly, a business model is a standalone model for understanding these elements, and is not the sum total of all the activities of a firm—so a single company can actually have multiple business models (Baden-Fuller and Morgan, 2010). For example, Amazon operates a business model for its retail marketplace, and a separate business model for its cloud computing, which it sells to tech companies around the world.

Operationalizing this definition first requires a set of clear business model dimensions, each comprised of measurable elements that accurately and completely describe the organization's key value creation, value capture, and profit generating activities (Teece, 2010). The dimensions put forward by Baden-Fuller and Haefliger (2013) represent not only some of the latest thinking in business model research in terms of how to operationalize the concept, but also the most concise and yet still complete description of the firm's business model. These dimensions are:

- *Customer Identification*: Who is the customer? Who is the end user?
- *Customer Engagement*: What is the firm's value proposition? (i.e., What product and/or service does the firm sell?)
- *Value Chain Linkages*: How is customer satisfaction delivered? Is the value chain hierarchical, networked, or integrated?
- *Monetization*: From whom, how, and when is money made?

These four dimensions form the structure of the business model framework I develop in the Literature section.

Business models in BOP markets

Now that we have identified the four dimensions of the business model, let us turn to extant research on business models in the BOP.

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