Energy Policy 48 (2012) 687–697

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

An integrated framework for rural electrification: Adopting a user-centric approach to business model development

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HIGHLIGHTS

- Review of two decades of rural electrification research.
- Content analysis of 232 scholarly articles.
- Literature is categorized into four focal lenses: technology, institutional, viability and user-centric.
- We develop a business model framework for rural electrification strategies.

ARTICLE INFO

Article history:
Received 8 March 2012
Accepted 30 May 2012
Available online 22 June 2012

Keywords:
Rural electrification
Business model
Customer

ABSTRACT

Rural electrification (RE) has gained prominence over the past two decades as an effective means for improving living conditions. This growth has largely been driven by socio-economic and political imperatives to improve rural livelihood and by technological innovation. Based on a content analysis of 232 scholarly articles, the literature is categorized into four focal lenses: technology, institutional, viability and user-centric. We find that the first two dominate the RE debate. The viability lens has been used less frequently, whilst the user-centric lens began to engage scholars as late as 2007. We provide an overview of the technological, institutional and viability lenses, and elaborate upon the user-centric lens in greater detail. For energy policy and practice, we combine the four lenses to develop a business model framework that policy makers, practitioners and investors could use to assess RE projects or to design future rural electrification strategies.

1. Introduction

Rural electrification (RE) – the creation of electricity services in rural areas – has grown rapidly over the past two decades, both as a practice and as a field of academic research. Creating a better understanding of why RE projects are successful is important because electrification improves social, environmental and economic parameters of rural livelihood (World Bank, 2008c). For example, rural electrification is instrumental in achieving the Millennium Development Goals (Modi et al., 2005; Mustonen, 2010). Experience shows that on the social level, RE positively impacts: (a) the quality of lighting (World Bank, 2008c), (b) health by diminishing indoor exposure to particulate matter (Howells et al., 2005) and by extending clinic hours and strengthening the cold chain (ADB, 2010; World Bank, 2008c), (c) education outcomes, thanks to extended hours for study (ADB, 2010), (d) connectivity to the outside world via increased access to television, radio and mobile phones (Deichmann et al., 2011; Yadoo et al., 2011) and even (e) social status (Chaieb and Ounalli, 2001). In terms of its effects on the environment, RE's effect on deforestation – via wood as fuel for cooking – is contested (Balachandra, 2011; Lachman, 2011). However, the surge of renewable energy technologies (RETs) as valuable alternatives for conventional fossil fuel solutions reduces carbon emissions (Kaufman et al., 1999), making an overall positive impact on the environment more likely.

Despite RE's beneficial social and environmental impact, the economic case remains somewhat uncertain. Deichman and colleagues state that the connection between rural electrification and local revenue growth remains "largely anecdotal" (2011), which suggests that specific programs to promote productive uses should be incorporated in RE project design to stimulate economic growth (World Bank, 2008c). RE's effect on poverty alleviation is doubtful as only "7 percent of dedicated RE projects and energy sector projects have an explicit poverty-reduction objective" (World Bank, 2008c). Over 1.5 billion people lack access to electricity (IEA, 2010; World Bank, 2008a), the vast majority of them are living in sub-Saharan Africa, India and other

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http://dx.doi.org/10.1016/j.enpol.2012.05.078

developing countries whose population growth rates exceed electrification rates (Barnes and Foley, 2001; IEA, 2010). Consequently, future RE policies, technologies, and strategies could potentially affect a significant base of the pyramid market.

The academic literature on rural electrification is largely populated with country-based approaches which focus on the implementation, problems and outcomes of a project (e.g., Gaunt, 2005; Ghosh et al., 2004; Langevine, 1996) or address the local potential for electrification (e.g., Gulberg et al., 2005; Rabah, 2005; Stutenbäumer et al., 1999). Various studies exclusively discuss aspects of certain technologies (e.g., Krauter and Ochs, 2004; Lubis and Udin, 1991; Munro and Blaesser, 1994) while others focus chiefly on policy and institutional issues (Bond et al., 2007; Ketlogetswe et al., 2006). Comparative studies that analyze different technologies (ARE, 2010), investigate the impact of policy reforms across different countries (Moonga Haanyika, 2006) or try to unpack the drivers of success in the context of particular case studies (Miller and Hope, 2000; Zerriffi, 2007), prove very insightful, but remain rather rare. Although in-depth technological and country-specific research have great value, multifocal research across technological, institutional and financial boundaries is more likely to overcome the general failure to capitalize on past success and generate "a replicable model for rural electrification" (Zerriffi, 2007).

This article attempts to build such an integrated 'replicable model' by linking four focal lenses – technology, institutional, viability and user-centric – that are generally used separately to discuss RE projects. Interlinking these four lenses provides a powerful way of thinking about the building blocks of project or organizational success, as demonstrated by the literature on business models (Afuah, 2001; Amit and Zott, 2001; George and Bock, 2011). Our goal is not to provide a single recipe for RE. Instead, we highlight the building blocks of an integrated framework for design and/or assessment of RE projects. By using the business model logic to analyze RE projects, we build on a young tradition that applies business model thinking to address social and environmental issues (George et al., 2012; Jenkins, 2009; Schillebeeckx, 2011; Seelos and Mair, 2005).

In the following sections, we describe the methodology used to assess the literature and report our findings. We deduce and discuss four focal lenses: technology, institutional, viability and user-centric. The user-centric lens is developed in greater detail than the other three because we believe a better understanding of the underlying 'user' needs is fundamental to increasing the economic success rate of RE projects. Yet, such an approach has, until recently, been largely absent from the literature on RE. Finally, we develop a generic business model checklist that could act as a framework for practitioners to develop a toolkit that can help turn this sustainability challenge into a business opportunity.

2. Methodology

We build on prior work by Zerriffi (2007) and Biswas et al. (2001) to classify the RE literature into four different lenses. Zerriffi (2007) states the important elements of RE business models are "organizational form, technology choice, target customers and financial structure" while Biswas et al. (2001) question whether the RE technology is "technically feasible, affordable, socially acceptable, institutionally sustainable and replicable". From these works and other studies, we develop an a priori categorization of technology, institutional, viability and user-centric lenses. We then use content analysis to examine the relevance and trends underlying the use of each lens to study RE. This methodology involves counting and/or classifying text into subgroups used to analyze which subject area is dominant within a field of interest. Such analyses have proven insightful in fields such as psychology (Nilsson et al., 2007), medicine (Cromer and Stager, 2000) and also business (George and Bock, 2011). Following Stemler (2001), three distinct choices must be made: discourse content identification, unit(s) of analysis selection, and the nature of the categorization (emergent or a priori).

On 16 November 2011, we selected a sample of papers using a "title and abstract and keywords" search for "rural electrification" in the Science Direct database. After a few indicative searches, we excluded the journals 'Fuel and Energy Abstracts', 'Refocus' and 'Photovoltaic Bulletin' because they are not academic in nature, although they are categorized as such. We selected scholarly articles to ensure the use of authentic, credible and meaningful sources, representative of work carried out in the field, thereby following good practise guidelines (Gilbert, 2001). Of the 237 hits, 3 articles were excluded because they did not cover rural electrification and the 2 articles from 2012 were excluded. The resulting sample of 232 articles comes from 25 different journals listed in Appendix A and forms the identified discourse content. We then used two complementary units of analysis: (1) individual abstract to which we apply our a priori categorization; and (2) the individual word-unit which facilitates the discovery of key concepts and emerging categories (Pilbeam et al., 2008) and allows for the identification of first and second order concepts that in turn leads to a "construction of larger narratives and more generalizable theory" (Rousseau et al., 2008).

Using the abstract, we built on our a priori categorization to initially classify 50 randomly selected papers, coding for the various lenses used in each study. We allowed for multiple interpretations and co-constructed the meaning of the four focal lenses in an iterative process between the authors. Each article was classified with exactly one dominant, and between zero and three secondary lenses. The lead author 'coded' the remaining 182 papers individually while the others assessed additional random samples of 25 papers as a control. The correlation between the authors' coding was high as the same dominant lens was found in all but one of the cases and only in five cases was there discussion about whether or not to include a second or third lens, which suggested the categorization was robust. We solved differences by inclusion, to avoid overestimation of the dominance of a single perspective.

On the individual word-level, we extracted important, meaningful words in the context of RE using count frequency data. We grouped specific words (e.g., solar, wind, hydro, jatropha) into more general first-order concepts with a unified meaning (renewables) to increase the clarity of results and to facilitate interpretation. We used Boolean operators to search for groups of words, quotation marks (" ") to search for specific strings, the star symbol *) to allow for multiple endings of words and the question mark (?) to allow for a single unknown letter. After the first order categorization, we searched for relationships between the first order words. This stepwise process then allowed categorization into second order concepts that fitted into the overarching dimensions provided by the four a priori lenses (as shown in Table 2). These second order concepts then formed the basis of our further description of the various lenses. Some technical details are provided in Appendix B, together with a list of the exact words we used to determine the first order words (numbers 1 to 9 in Fig. 3).

3. Findings

Fig. 1 depicts a growing interest in "rural electrification" overall. From the phrase's first appearance in 1990 and through