



Creating the innovation ecosystem for renewable energy via social entrepreneurship: Insights from India



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ARTICLE INFO

Article history:

Received 22 February 2016

Received in revised form 7 November 2016

Accepted 6 March 2017

Available online 21 March 2017

Keywords:

National innovation systems

Social entrepreneurship

Ecosystem creation

Renewable energy

Developing economies

Bottom of the pyramid

ABSTRACT

This paper examines how social entrepreneurship, at both the firm and institutional levels, fosters innovation and economic development. It draws on concepts from national innovation systems (NIS), complexity, ecosystems, and social entrepreneurship research to develop a framework for forming innovation ecosystems via social entrepreneurship. The framework is especially relevant for new market creation in renewable energy for rural and bottom of the pyramid (BOP) populations. Case studies from the renewable energy sector in India support the framework. The paper suggests that creating a robust innovation ecosystem requires the following mechanisms at the national level to provide the supporting infrastructure: (1) creation of new institutions; (2) policies to generate demand; (3) institutional support for linkages to build capabilities. Key mechanisms at the micro-level include: (1) facilitating the entry of social entrepreneurs to serve the needs of rural populations; (2) use of new technology platforms to diffuse entrepreneurial skills and enhance community interactions; and (3) establishing linkages with external organizations to enable resource acquisition.

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1. Introduction

National innovation systems (NIS) have gained in significance as innovation, particularly technological innovation is increasingly regarded as the key to a country's competitive advantage (Lo et al., 2013; Samara et al., 2012). That entrepreneurship helps to diffuse capabilities and facilitates market formation, important for NISs, is well recognized (Newbert, Gopalakrishnan and Kirchhoff, 2008). *Social entrepreneurship*, a form of entrepreneurship directed towards solving social problems such as providing access to energy (Swanson and Zhang, 2011; Dacin et al., 2010; Zahra et al., 2009; Goldstein et al., 2008), is of critical importance in rural India and other “base of the pyramid” clusters (Prahalad, 2007).

Lack of access to energy is a widespread problem as 1.2 billion people in developing economies do not have access to electricity (OECD/IEA, 2015) and 2.9 billion people lack access to energy for lighting, cooking and other purposes affecting livelihood generation (REN21, 2013). Providing modern energy services through innovative technologies is crucial to alleviate this problem. Hence, this paper focuses on renewable energy in India where the government has recently enacted new policies to catalyze this sector.

However, social entrepreneurship is required for diffusing renewable energy technologies for BOP populations and is more relevant than mainstream commercial entrepreneurship (Austin et al., 2006)

for two reasons. First, social entrepreneurship addresses the problem of alleviating lack of access to energy by focusing on the socio-economic environment of the BOP user rather than solely on the technology. Second, social entrepreneurship is more relevant because the poor commercialization environment for innovation in renewable energy in China, India, Mexico and Turkey (characterized by Walsh (2012) as an “Innovation Wasteland”), calls for different mechanisms for the diffusion of knowledge, capabilities and innovation and the development of an ecosystem.

Renewable energy is an attractive option for developing economies as it relies on locally available energy resources, alleviates environmental concerns and keeps petroleum import costs in line while satisfying the rising demand for energy to fuel economic growth. Developing economies as a group (including China, Brazil and India) increased renewable energy investments in 2014 by 36% to USD 131.3 billion, increasing the share of developing economies to 49% in 2014 (REN21, 2013). However, the diffusion and commercialization of renewable energy technologies requires building capabilities, facilitating information exchange and forming new markets to stimulate economic development, key functions of national innovation systems (Johnson, 2001; Nelson, 1993; Lundvall, 1992, 2007).

Research on renewable energy has examined the adoption of specific technologies such as bio-digestion (Tigabu et al., 2015), wind energy (Bronstein, 2011; Lee and Shih, 2011), photovoltaics (Lo et al., 2013), and biomass and biofuels (Kajikawa and Takeda, 2008). Research also focuses on renewable energy adoption and diffusion; themes include improving adoption (Yun and Lee, 2015), policies (van den Bergh,

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2013), evaluation methodologies such as technology roadmaps (Jeffrey et al., 2013) and modeling transitions to a green economy (Musango et al., 2014). However, additional guidance is needed on what trajectories might be appropriate for developing economies like India where pathways for the diffusion of renewable energy to rural areas are not established.

Hence, this paper draws on the national innovation systems (NIS) literature to examine the creation of a renewable energy innovation ecosystem in India. It aims to augment understanding of emerging economy contexts, where conditions are starkly different from those in industrialized economies, as exhorted by Lundvall (2007), and to examine social entrepreneurship in the context of NISs. While national culture may be important for innovation (Harms and Groen, 2017) and entrepreneurship (Gupta et al., 2004), this paper focuses on other dimensions of NISs such as complexity. NISs are complex systems (Samara et al., 2012; Holland, 1998; Arthur, 1989) or ecosystems (Iansiti and Levien, 2004; Gómez-Uranga et al., 2014; Samara et al., 2012). Consequently, attention must be directed to the characteristics of complex systems such as interactions, linkages, non-linear processes, emergence and self-organization (Lundvall, 2007). Additionally, NISs consist of sub-systems spanning multiple levels. For example, sub-systems at the micro-level include firms and industries while sub-systems at the macro level include institutions that frame the context and build the infrastructure in which innovation occurs (Lundvall, 2007; Kaiser and Prange, 2004; Dodgson et al., 2008). Elements of the system can inhibit or accelerate innovation and economic development. Likewise, change can be introduced at the micro-level or at the macro-level.

The paper examines the following research question: (1) How does social entrepreneurship impact the NIS¹ at micro and macro levels to enable the creation of an innovation ecosystem in renewable energy? The question is examined using the lens of NIS, social entrepreneurship and complex ecosystems to build a conceptual framework. The framework is supported by case studies.

This paper draws on concepts from the NIS, social entrepreneurship, complex systems and ecosystems literatures to suggest that diffusing innovations for the rural poor in developing economies requires mechanisms that allow new markets and industries or an ecosystem to emerge, evolve and integrate with the national and global systems. The paper makes two key contributions. First, it develops a framework outlining mechanisms for forming an ecosystem and new markets via social entrepreneurship. Second, it provides case examples in the renewable energy sector in rural India to support the framework.

2. Literature review

Themes from past research relevant to the paper are summarized drawing from the following streams of literature: (1) NISs, specifically related to renewable energy, (2) social entrepreneurship, and, (3) complex systems and ecosystems theories.

This paper extends research on national and technological innovation systems by dealing with the creation of innovation ecosystems. The paper also attempts to link research on innovation systems with research on entrepreneurship and social entrepreneurship, a link not hitherto emphasized. This is important as the link between systems at the macro level and the efforts of entrepreneurs and social entrepreneurs at the micro level can yield insights on ecosystem creation. Additionally, complex systems and ecosystems theories highlight the innovation system as a complex system in which social entrepreneurs play a key role and are endogenous rather than exogenous to the system.

2.1. National innovation systems

Research on national innovation systems (NIS) spans various levels of analysis, ranging from institutions to firms. The national innovation systems concept has been extended to regions (regional systems), technologies (technological innovation systems; Miyazaki and Islam, 2007; Islam and Miyazaki, 2009), and industrial sectors (sectorial innovation systems; Walsh, 2012). Broadly defined, an NIS includes all interrelated institutional actors that create, diffuse and exploit innovations. In contrast, the narrow definition includes only organizations and institutions directly related to technological innovation such as R&D departments, universities and public institutes. Moreover, NISs are composed of sub-systems including regional and sectoral systems of innovation (Chung, 2002). Understanding the linkages among actors involved in innovation is critical for improving national innovative performance (Lundvall, 1992; Nelson, 1993; Samara et al., 2012).

Other researchers focus on the dynamics of the innovation process (Hekkart et al., 2007; Samara et al., 2012). For example, Johnson (2001) suggests that national innovation systems must: (1) Supply incentives for companies to engage in innovative work; (2) supply resources; (3) guide the direction of search; (4) recognize the potential for growth; (5) facilitate information and knowledge exchange; (6) stimulate/create markets; (7) reduce social uncertainty; and, (8) counteract the resistance to change and provide legitimacy for the innovation.

Literature on NISs in industrialized economies has yielded insights on topics such as the impact of government policy on technological innovation, the propensity to engage in entrepreneurship in the U.S., and comparisons with other industrialized economies (Mowery, 2001; Dolfma and Seo, 2013; Aldridge and Audretsch, 2011; Molero and Garcia, 2008). In contrast, studies on NISs in developing economies have focused on topics such as the imperative to imitate other economies, methods of diffusing knowledge, catch-up and leapfrog developed economies in specific areas. Recent studies include Chang and Shih's (2004) study of the comparative strength of Taiwanese and Chinese innovation systems, and Binz et al.'s (2012) study of leapfrogging methods in the area of wastewater treatment in China. Other similar studies on Brazil include those by Silvestre and Dalcol (2009) and Silvestre and Silva Neto (2013).

However, past studies have not examined the role of social entrepreneurship or how social entrepreneurship can be leveraged to create an ecosystem and form new markets. Studies on innovation systems for renewables such as biofuels (Patil et al., 2008; Romijn and Caniels, 2011; Rajagopal and Zilberman, 2007; Suurs and Hekkert, 2009) focus on factors (such as incentives and government intervention) that facilitate adoption and diffusion. van den Burgh (2013) argues that technological innovation must be supplemented with behavioral changes, related efficiency and substitution mechanisms in production, consumption and transport as well as regulation to contribute to emissions reduction. Yun and Lee (2015) note the importance of fostering societal demand and societal readiness for the adoption of sustainable energy innovation. Likewise, Shi and Lai's (2013) review of the literature on green and low carbon technology innovation highlights that: (1) more research on this topic is required, particularly in developing economies; (2) the major themes include innovation adoption and diffusion; (3) the promotion of these technologies cannot be separated from the policy or regulation regime and, (4) local governments and NGOs play a key role, especially in developing economies such as China.

These studies indicate a need to address behavioral changes or increase societal readiness to facilitate renewable energy adoption. However, the role and impact of social entrepreneurship in forming ecosystems and new markets is not examined.

2.2. Social entrepreneurship

Research on entrepreneurship highlights its importance in economic growth and development (Kirchhoff et al., 2013; Headd and Kirchhoff,

¹ In this paper, the term innovation system is used to denote both the national innovation system and its sub-systems including sectoral innovation systems and technological innovation systems.

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