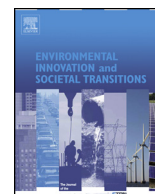




Contents lists available at ScienceDirect

Environmental Innovation and Societal Transitions

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



Analyzing sectoral niche formation: The case of net-zero energy buildings in India

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ARTICLE INFO

Article history:

Received 26 February 2016

Received in revised form

19 November 2016

Accepted 28 November 2016

Available online xxx

Keywords:

Net zero energy building

Energy transition

Niche development

Strategic niche development

Sectoral innovation system

ABSTRACT

Large scale development of Net Zero Energy Buildings (NZEBS) is seen as a potential solution to deal with future energy challenges in the building sector. This article aims to assess the current status of NZEB development in India by using an integrated framework named Sectoral System Innovation Assessment framework (SSIAf). The article addresses the research question: “What does the SSIA framework tell about NZEB niche formation in India?” The SSIAf is developed using insights from the theoretical frameworks of Strategic Niche Management (SNM) and Sectoral Innovation Systems (SIS) with five key components: shaping of expectations, social network formation, institutions, learning process and market demand. A case study research design was used to analyze seven NZEB demonstration projects in India. The results show that the NZEB innovation niche has yet to develop into a mature niche, and is growing only slowly.

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1. Introduction

Both in construction and in operation, buildings consume vast amounts of energy. This energy is mainly derived from fossil fuels (UNEP-SBCI, 2009). It poses a major challenge since these conventional sources of energy are limited and cause serious environmental damage including greenhouse gas (GHG) emissions. A transition towards low energy, low carbon and energy efficient buildings has gained much attention in recent decades but has seen mixed success (IEA and WEO, 2013). Many developed countries are currently preparing to transform their building sector (both new and existing) by deploying more Net Zero Energy Buildings (NZEBS)¹ (EU-Commission, 2013). NZEBs are buildings that are self-sufficient in meeting their energy needs, first by reducing energy demand and then by using on-site renewable energy sources to meet the remaining needs (Hermelink et al., 2013). Torcellini et al. (2006) define NZEB as ‘a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies.’

The large-scale uptake of NZEBs is expected to enable many countries to reduce their energy and carbon footprints and move towards using renewable sources of energy for their building sector (Iqbal, 2003). To achieve this, policies and innovative approaches are being developed and implemented (Jain et al., 2014). As such, governmental actors are one of the

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¹ Net Zero Energy Buildings is also interchangeably termed as Near-Zero Energy Buildings.

main facilitators of the introduction and diffusion of new sustainable technologies. In addition, actors from both the public and private sectors are expected to participate in creating an enabling environment for this socio-technical transformation (Schot and Geels, 2008). The large-scale adoption of NZEBs is not straightforward as building-sector stakeholders still view it as a complex concept, to an extent because it can be described in a wide range of terms and expressions without a standardized holistic approach. Its definition can vary depending on the project goals, the intentions of the investor, concerns about climate change and energy costs (Marszal and Heiselberg, 2009).

Many developed countries have demonstrated the NZEB concept as a practical option. They are now in the process of expanding the niche towards wider adoption through societal acceptance (Voss and Musall, 2011). In doing so, governments have also set ambitious targets to decarbonize their building sector (for example, the European Union (EU)) Directive on Energy Performance of Buildings (EPBD) specifies that, by the end of 2020, all new buildings should be “Net Zero Energy Buildings” (EPBD Recast, 2010). However, ambitious targets and innovative approaches are missing in most developing countries where sustainable transitions are still needed (Lachman, 2013). A good example is India in which only a handful of NZEB demonstration buildings have been constructed in recent years.

In India, the building sector is growing rapidly, with an estimate that 70% of the 2030 building stock had yet to be constructed (NRDC and ASCI, 2012). In terms of energy consumption, this poses a large challenge as buildings are responsible for nearly 33% of India's total energy consumption, which is mostly derived from fossil fuels (NRDC and ASCI, 2012). A growing population, stable economic growth and rapid urbanization further increase the challenge of meeting the growing energy demand (Ofori, 2002). From this perspective, buildings which meet their energy demand through self-generation can become a favourable solution to deal with the energy challenges (demand–supply shortage, energy security, fossil fuel dependence) facing the country, especially in growing urban settings. To achieve this, a major systemic transformation will be required to fundamentally change the way in which buildings are designed, constructed, operated and refurbished throughout their life. This will be a formidable task since, despite efforts towards sustainable building solutions; the mainstreaming of energy efficiency in the building sector in India still encounters substantial economic, technical and implementation challenges (WEC, 2013). In recent years, a few NZEB demonstration projects have gained attention, showing early signs of the formation of a new niche. These NZEBs will require radical transformations or structural change on the societal scale once they are able to demonstrate the benefits. Such socio-technical transitions imply changes in structure, user practice, regulations, networks, infrastructure, culture and new technologies (Loorbach and Rotmans, 2005).

Theoretical frameworks such as Strategic Niche Management (SNM: Kemp et al., 1998; Hoogma, 2002; Raven, 2005; Schot and Geels, 2008) and Sectoral Innovation Systems (SIS: Malerba, 2004; Geels, 2004; Faber and Hoppe, 2013) provide insight into fostering technological and social change to initiate sustainable innovations at the niche and sector levels respectively. SNM is an analytical framework designed to facilitate and study the introduction and diffusion of new sustainable technologies through societal experiments (Schot and Geels, 2008). It is also argued that, to understand innovation activities at the niche level, it is important to understand sector-level innovations through a lens that highlights sectoral innovation systems (Weber and Hoogma, 1998). The latter is a more holistic approach than focusing on a single technological niche and provides a more comprehensive understanding of learning and innovation processes that are specific to a given industrial sector. In this paper, a new heuristic tool is proposed that combines insights from the conceptual SNM framework and SIS framework: the *Sectoral Systems Innovation Assessment* framework (SSIAf) and can be used to analyse the innovation system surrounding a given technological niche in a given economic sector (the conceptual details are addressed in Section 2).

The aim of this article is to assess the status of NZEB niche innovation in India. The main research question is: “*What does the SSIAf framework tell about NZEB niche formation in India?*” The question will be answered by assessing NZEB demonstration projects in India. In this, SSIAf is used as the primary theoretical framework to assess the niche formation process at the sectoral level.

The article is structured as follows. Section 2 presents the theoretical underpinnings of SSIAf with origins in SNM and SIS. Next, Section 3 addresses the research design and methodology adopted in this study. Section 4 presents the results which then, in Section 5, are discussed and positioned in on-going academic debates. Finally, the main conclusions are presented in Section 6.

2. Background to the sectoral system innovation assessment framework

This article uses an assessment framework (SSIAf) that draws on insights from two distinct theoretical frameworks (and the research traditions they stem from): (i) Strategic Niche Management (SNM) and (ii) Sectoral Innovation Systems (SIS). Before presenting the SSIAf, the main conceptual notions of SNM and SIS will be presented, as well as their shortcomings and previous conceptual endeavours to combine insights from the two frameworks. Finally, based on these insights the SSIAf will be presented as an integrated framework that allows for analysing niche formation in a particular given economic sector.

2.1. Theoretical frameworks

2.1.1. Strategic niche management

The concept of SNM was introduced by the late 1990s as a theoretical framework and a policy tool to manage technological innovations and to facilitate the market introduction of sustainable technologies (Schot and Geels, 2008). The

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