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# Review of the small wind turbine sector in Kenya: Status and bottlenecks for growth

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## ABSTRACT

Rural electrification has been a long-standing goal in Kenya, but there is still a long way to go with only 7% rural access to electricity. Therefore, there lies great potential for small wind turbines (SWT) in areas with sufficient wind resources. This paper presents a review of the SWT sector in Kenya. The review consists of a description of the status of the sector and a more in-depth investigation into factors and dynamics that hinder sector growth. This investigation is performed by using a combination of two theoretical approaches: Strategic Niche Management (SNM) and the Multi-Level Perspective (MLP). The main insights from this review are that the SWT sector in Kenya is growing but is characterized by one-time experiments, fragmented learning experiences, lack of focus and low quality products and services. The weakly aligned network with many underperforming actors and unaligned expectations is the main cause of the weak current status of the sector. Despite the low rural electricity access and growing electricity demand, niche upscaling remains cumbersome due to external factors such as corruption, poverty, lack of innovation and an anti-entrepreneurial mind-set. The results of this review serve as inputs for recommendations for all niche actors on what can be done to make the niche grow. In addition, the paper includes ideas on how the SNM and MLP approaches could become better suited for reviewing and analyzing renewable energy technologies in developing countries such as SWTs in the Kenyan context.

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## 1. Introduction

Energy services and appropriate energy technologies are vital for the social and economic development of Kenya. However, only 7% of the 30 million rural inhabitants have access to electricity [1]. Energy needs are met by using polluting and unhealthy energy sources such as traditional biomass and kerosene. Besides that, the grid suffers from power cuts and growing cost [2]. Due to Kenya's rising energy demands and its high dependency on oil imports, there is a strong need to increase non-fossil based domestic energy production. At the same time, Kenya is facing major challenges to increase grid connectivity to the sparsely populated rural areas, which creates an opportunity for decentralized energy generation. Up to now, the prevalent decentralized renewable electricity solution in Kenya is solar photovoltaic (PV) systems. Considering the country's favorable wind resources, small-scale wind turbines also represent a practical option for rural electrification in wind-rich areas [2]. Little research into Kenya's wind turbine sector has been done in the past [4,5], leaving many aspects unexplored.

This paper presents a review of the small wind turbine (SWT) sector in Kenya. The review consists of two parts: (1) a descriptive part that presents an overview of the sector, and (2) an analytical part in which the dynamics within and growth factors within and outside the sector are assessed, based on which bottlenecks for sector growth are identified. The analytical part uses the Strategic Niche Management approach and the Multilevel Perspective for the analysis. Based on the review, the paper ends with some theoretical considerations and recommendations on how growth of the small wind turbine sector in Kenya can be stimulated. The scope of the paper is the development and implementation of small horizontal axis wind turbines in Kenya, with a power rating up to 10 kW, within the context of Kenya's energy sector and Kenya's society, in the period 1999–2014. The paper considers both locally manufactured and imported turbines.

The main question addressed in this paper is: what is the status of the small wind turbine sector in Kenya and what are bottlenecks for growth of this sector?

The case study material described in this paper was collected using the use of three research methods: (1) a literature study, (2) a three month field study in Kenya in 2011 [3] and (3) participatory observation in the SWT sector in Kenya in the period 2011–2014. Literature sources were used to collect qualitative information to analyze the relevant developments external to the SWT sector. The field study primarily consisted of open-ended, semi-structured interviews with 42 actors. The interviews focused on analyzing the status of the SWT sector and the dynamics within it. Based on observations and a questionnaire, additional cultural and social factors that influence the sector were found. Since 2012, the second author of this paper has lived in Kenya and has been active in the Kenyan wind turbine sector. In the period 2012–2014 she updated the insights from the field study in 2011 by way of participatory observation.

This paper is innovative in three respects. Firstly, it is the first paper that provides a recent review of the case of the SWT sector in Kenya based upon primary data sources, mainly interviews. Secondly, it is the first paper that applies a combination of the Strategic Niche Management approach and the Multi-Level Perspective to a case study in a developing country. And thirdly, it proposes additions and improvements to the Strategic Niche Management approach to make it better suited for analyzing case studies in developing countries.

The paper is structured as follows. In Section 2, we discuss the key notions of the analytical framework applied. Section 3 presents the development and current status of the niche. Subsequently, the important factors and dynamics within the SWT niche are investigated in more depth in Section 4 by using Strategic Niche Management. In Section 5 we investigate the important factors and dynamics from

outside the SWT niche in more depth by using the Multi Level Perspective. We present our conclusions and theoretical discussion in Section 6. Section 7 transfers the results of the analysis into practice, by providing recommendations for actors involved.

## 2. Analytical framework

Our theoretical framework is based on two approaches: Strategic Niche Management (SNM) and the Multi-Level Perspective (MLP). SNM is a theoretical framework that can be used to study the sociotechnical dynamics and factors within a niche around a new innovation [6,7] – in this case small wind turbines in Kenya. The MLP adds to the SNM framework by giving insight into the external environment in which the new innovation is developing – in this case the energy sector in Kenya and Kenyan society as a whole. The MLP approach studies how innovation is influenced by factors at three levels: the exogenous 'landscape'; the dominant way of providing a societal function or the 'regime'; and the 'niche', the level where the innovation emerges and develops [8]. Our theoretical approach combines SNM and MLP and adds some elements in order to better suit the particular case of SWTs in the Kenyan context. This framework provides more insight into which factors are relevant, and how they interact. Furthermore, applying this framework to the SWT sector will enable us to reflect on the application of the framework in the context of a developing country.

### 2.1. Strategic Niche Management

Strategic Niche Management (SNM) was developed as an analytical approach that can be used to review and analyze the development of innovative technologies in niches, which can be seen as incubation rooms or protective systems surrounding the new technology [9–11].

In the niche, the innovation can grow and develop to become viable through gradual experimentation and learning by networks of actors. During this period, the emerging technology has to compete with the existing technologies which are technologically and economically superior to the innovation [8]. These established technologies are part of large social networks, the regimes, which have certain rules such as price/performance ratio, engineering practices, user preferences and regulatory requirements [6].

In the initial stages, a niche technology finds itself within a technological niche, which is a space protected from the rules of the regime, e.g. by subsidies or regulatory exemptions. A technological niche can evolve into a market niche, a space where users start to recognize the values of the innovation and where it is able to compete over the established technologies. Market niches can eventually lead to the development of a new regime or become part of it [6,9].

To analyze the development of a niche, researchers have proposed three niche processes which are dynamically interrelated: the voicing and shaping of expectations, network formation and learning processes [6]. We discuss them subsequently.

#### 2.1.1. Shaping and voicing of expectations

Expectations give direction to the technology development, influence design choices, and attract resources as well as new actors. According to Hoogma [12], expectations contribute to successful niche development if they become more robust (shared by more actors), more specific (give guidance) and have a higher quality (the expectations are validated from the on-going experiments). In the early niche stages, participants join the niche by investing effort, money and time because they have expectations of the future success. At that moment, actors have broad and unclear expectations about the technology and different visions of its future [7]. During

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