Technological Forecasting & Social Change 99 (2015) 197–210

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

The construction of a new technological innovation system in a follower country: Wind energy in Portugal

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ARTICLE INFO

Article history:
Received 26 February 2014
Received in revised form 22 June 2015
Accepted 28 June 2015
Available online 18 July 2015

JEL classification:
L2
O33
O38
Q42
Q55
R11

Keywords:
Technological innovation systems
Spatial diffusion
Absorptive capacity
Wind energy

ABSTRACT

This article analyzes the process of construction of a new innovation system based on wind energy in a "follower" context. The technological innovation systems framework is used to analyze the process of technology diffusion as well as the emergence of a new wind sector in Portugal, where this renewable energy technology showed a spectacular development in the past decade. This framework highlights the main processes or functions that occur in the diffusion of a new technology. The evidence obtained demonstrates that the fulfillment of these functions, which were mostly studied in the context of pioneer countries, is still pertinent to explain the formation of a wind energy system in this follower country. Yet the type of resources and the nature of the activities needed to adopt the technology in the latter often differ. This case provides new insights into the importance of functions that enhance the follower's capacity to assimilate the new technology (e.g. local knowledge development, experimentation), thus creating the conditions for a fast move as soon as innovations become sufficiently mature in the core.

1. Introduction

The diffusion of mature low carbon technologies, like wind power, and their adoption in regions where energy demand is expected to rise the most in the next decades is an important issue for global sustainability (BP, 2014; IPCC, 2013; IEA, 2013a). In this matter, the transfer of wind energy technology from "core" markets to fast followers, such as Portugal, provides an interesting case study.

Portugal has no oil or natural gas resources and a historical dependence on energy imports. However, in 2014, nearly 60% of electricity was generated out of endogenous renewable energy sources (RES) (DGEG, 2014). This was only possible due to the spectacular progress of wind energy, which has become the second most important RES after hydropower within a decade. It produced 22.2% of total electricity consumption in 2012, the second highest share among OECD countries, which was only surpassed by Denmark (Eurostat, 2015). The development of wind power benefited from the implementation of a mix of "demand pull" and "supply push" policies. A very generous feed-in tariff was introduced in the early 2000s, resulting in a strong increase in the demand for wind farm connections. Thus, in 2005 the government decided to organize public tenders and to tie the attribution of capacity rights to local production of core technologies (e.g. turbines and blades) (Martins et al., 2011). This triggered the formation of an industrial cluster, which harnessed local engineering and industrial competences. The result was an increase in the share of national inputs from 20% to 100%, and also in exports that reached more than 60% of the output in 2011 (ENEOP, 2013; Público, 2011). Lessons can therefore be derived for countries that are considering the adoption of renewable energy technologies (e.g. wind power) with the objective of reducing emissions and boosting their economy.

This paper draws on the literature that addresses the emergence and growth of new technologies. It combines contributions from the technological innovation systems theory (Bergek et al., 2008a; Hekkert et al., 2007) with those from the empirical historical scaling dynamics analysis (Wilson, 2009; Grubler, 2012). The Technological Innovation Systems (TIS) approach focuses on the emergence of novel technologies and the institutional and organizational changes that are needed for technology development (Markard et al., 2012), thus providing the conceptual instruments to understand how these processes unfold. The empirical research on the spatial diffusion of several energy

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http://dx.doi.org/10.1016/j.techfore.2015.06.037
0040-1625/