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Renewable energy investors in Sweden: A cross-subsector analysis of dynamic capabilities

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ABSTRACT

Tradable Green Certificates (TGC) schemes are among the prevalent policy frameworks to promote investments in Electricity from Renewable Energy Sources (RES-E). However, a technology-neutral design of the TGC system is coupled with uneven competition across renewable energy subsectors. The cost of RES-E technologies is often identified as the primary cause for this unevenness. This paper sheds light on additional explanatory factors for uneven competition, illustrating that investment paths vary across subsectors. Such paths can influence investor dynamic capabilities to explore new market opportunities and reinforce future investment behavior in each subsector. Empirical data from the Swedish TGC system for wind power, biopower, and hydropower are used for this analysis. The results indicate that investor dynamic capabilities related to cumulative experience and industrial diversification vary significantly across renewable energy subsectors. The findings are relevant to TGC program design.

1. Introduction

Policy-support schemes have been proposed to accelerate investments in Electricity Generation from Renewable Energy Sources (RES-E). Accordingly, widely cited contemporary literature examines the effectiveness of different policy schemes (e.g., Bergek and Jacobsson, 2010; Del Río and Tarancón, 2012; Fais et al., 2014; Rowlands, 2005; Verbruggen, 2009). Most studies are concentrated on economy of investment (e.g., Faúndez, 2008; Koo et al., 2011; Reuter et al., 2012) and overlook the dynamics of investment processes (cf. Menanteau et al., 2003). This paper aims to fill this gap by highlighting the importance of investor's dynamic capabilities through a focused study on varied investment paths within a Tradable Green Certificate (TGC) system. TGCs are a favored framework within European energy policy (Bergek and Jacobsson, 2010).

The TGC framework is the dominant support system for RES-E investment in Europe (ETSO, 2003; Verhaegen et al., 2009), and has even been considered as a harmonized policy option for the European power system (Del Río, 2005; Nielsen and Jeppesen, 2003). The TGC system is a technology-neutral, market-based and cost-efficient support system (Menanteau et al., 2003; Nielsen and Jeppesen, 2000). Thus, decisions of RES-E investors performing under the TGC system are based on similar values for electricity and certificates regardless of production costs (Verhaegen et al., 2009). The TGC system therefore favors investments in the most mature renewable technologies, such as wind or biomass-based combined heat and power plants (CHP), while hindering investments in less mature technologies, such as solar photovoltaics (PV) (Bergek and Jacobsson, 2010; Meyer, 2003). These cost and investment variations are among the main drivers for the uneven competition across renewable energy subsectors within the TGC system (Meyer and Koefoed, 2003; Midttun and Gautesen, 2007; Ringel, 2006). This study examines the prevalence of additional explanatory factors.

The analysis here is based on the premise that RES-E investment follows different paths in different subsectors; those paths *per se* can create conditions for potential technical changes and adaptation. Therefore, certain investment paths taken by investors in terms of accumulating experience and diversifying their industrial profile, can build up their dynamic capabilities for adapting to market changes. Dynamic capabilities enable firms to explore,

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realize, and exploit new opportunities (Hamel and Prahalad, 1994; Teece et al., 1997; Zahra et al., 2006). Exploring varied historical investment paths as a proxy for RES-E investors' dynamic capabilities can indicate which investors are more inclined to capitalize on current changes in the power market and to benefit from support policies. Earlier studies indicate the importance of both cumulative experience and industrial background[1] on RES-E investors' evaluation of investment opportunities (Masini and Menichetti, 2013) and their performance (see, Worch et al., 2013). How key organizational characteristics affect RES-E investment capabilities and behavior remains a topic of little exploration, which this paper aims to tackle.

This paper contributes to the academic literature in several ways. First, the paper provides a better theoretical and empirical understanding of dynamics of RES-E investment process by shedding light on the role of varied investment paths in different renewable energy subsectors. The research further underlines the importance of RES-E investment processes using dynamic capabilities theories, which have seldom been incorporated in the contemporary energy policy literature (see also, Darmani et al., 2014b; Lieberherr and Truffer, 2015). Through a cross-subsector analysis, the research further illustrates differences among investors' investment paths and thereby dynamic capabilities in different subsectors. Second, the research contributes methodologically and empirically to the energy-policy literature by analyzing a broad set of investors (see also, Masini and Menichetti, 2012). Moreover, as the paper interprets and measures a group of variables, the study makes one of the first attempts to measure RES-E investors' dynamic capabilities. It does so through an investor-oriented perspective, which is not generally considered in energy-policy studies. Finally, the findings have implications for policymakers, pointing to the need of understanding dynamics of investment processes in the renewable energy industry. This understanding will aid policymakers to design policies that effectively target and stimulate certain types of technologies and investors.

The empirical data for this study is based on 836 Swedish windpower, biopower[2], and hydropower producers[3] that received certificates for their electricity production from the plants commissioned or expanded between 1996 and 2013 in Sweden. The Swedish electricity market has been deregulated since 1996 and the Swedish government enforced its TGC framework to encourage a larger share of renewable power production in May 2003.

Section 2 provides an overview of literature on categories of energy policies and RES-E investors, followed by a discussion of theories on dynamic capabilities and an introduction of propositions of this paper. Section 3 is dedicated to a description of empirical data and measures for the variables in the case study. A discussion of the empirical results is provided in Section 4. Section 5 concludes with a discussion of policy implications and recommendations.

2. Literature review

2.1. RES-E investors and energy policy

In this paper, investors are defined as actors

> "… who invest in renewable electricity production rather than as actors who finance such investments, e.g. banks, funds. […]. The former initiate the idea for a new plant, mobilize resources to realize it and take ownership of the plant once it is in place. Electricity production then becomes a part of their business"
>
> (Bergek et al., 2013: 573).

Energy policy scholars have dedicated significant effort to studying the interaction between investors (often in terms of utilities and other energy producers) and policies in developing and deploying new technologies, including renewable energy technologies (e.g., Buen, 2006; Darmani et al., 2016; Fagiani et al., 2013; Raven, 2007; Requate, 2005; Toke, 2005; van der Vleuten and Raven, 2006; Verbruggen and Lauber, 2012; Wang, 2006; Wüstenhagen and Menichetti, 2012).

In several scholarly research, the RES-E investment process is assessed using financial theories considering economic factors as the main motive (Bode and Michaelowa, 2003; Faúndez, 2008; Fleten et al., 2007; Koo et al., 2011; Söderholm et al., 2007). Such studies suggest that energy policies offer the most rigorous tools to promote RES-E by enhancing the economic motives behind investments (e.g., Awerbuch, 2006; Fabrizio and Hawn, 2013; Söderholm and Klaassen, 2007).

Public policies and regulations are regarded as an influential driver for development of any RES-E technology (Darmani et al., 2014a; Del Río and Gual, 2007; Geels and Raven, 2006; Jacobsson, 2008; Picciariello et al., 2015). In order to enhance the economic efficiency of investments in renewable technologies and in turn stimulate investments in RES-E, two types of instruments have been introduced into the electricity industry thus far: price-based policies and quantity-based policies (Fagiani et al., 2014). For price-based mechanisms, a fixed price is determined for each technology; in order to reach that price, supplementary subsidies or taxes are also introduced into the market (Karakaya et al., 2015; Karakaya and Sriwannawit, 2015). Germany and Spain are frontrunners in the implementation of price-based mechanisms with the introduction of feed-in tariff support schemes (Del Río and Gual, 2007; Sühlsen and Hisschemöller, 2014).

Differently, quantity-based policies oblige investors to meet a set market target for renewable energy generation. The TGC framework is a known example enacted in, for example, France, Sweden and the United Kingdom (UK). In the TGC framework, investors receive a certificate for every kilowatt-hour (kWh) of RES-E. Investors can trade those certificates in a market that is particularly designed for green certificates (Bergek and Jacobsson, 2010). When buying and selling certificates, RES-E investors receive an additional revenue for their electricity production (Toke, 2007). A TGC framework is technology-neutral, meaning that such a mechanism supports cost-efficient renewable energy technologies (See Fig. 1) and less efficient technologies will demand further support (Menanteau et al., 2003).

Recent studies have shown that economic factors are only one reason behind the investment decisions of RES-E investors (Masini and Menichetti, 2012, 2013; Wüstenhagen and Menichetti, 2012). Bergek et al. (2013) point out that researchers often are too focused on power utilities and neglect that RES-E investors are heterogeneous and different factors affect their investment processes and decisions. If the aim of policy is to promote RES-E investments among all potential investors, understanding the dynamics of investment process through which investors allocate capital to RES-E is essential (Masini and Menichetti, 2013). This paper takes a step in this research area by examining the dynamic capabilities reflected in investment paths of the wind power, biopower and hydropower subsectors.

[1] Industrial background refers to the industrial focus of a firm, which is the main industry the firm's business is dedicated to.

[2] Biopower means producing electric power from biomass, such as peat or wood (Jacobsson, 2008).

[3] In this paper, the terms "entity," "firm," and "investor" are used interchangeably. An officially registered firm is the unit of analysis in this study.