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# The impact of behavioural factors in the renewable energy investment decision making process: Conceptual framework and empirical findings

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## ABSTRACT

Investments in renewable energy (RE) technologies are regarded with increasing interest as an effective means to stimulate growth and accelerate the recovery from the recent financial crisis. Yet, despite their appeal, and the numerous policies implemented to promote these technologies, the diffusion of RE projects remains somehow below expectations. This limited penetration is also due to a lack of appropriate financing and to a certain reluctance to invest in these technologies. In order to shed light on this phenomenon, in this paper we examine the decision making process underlying investments in RE technologies. We propose and test a conceptual model that examines the structural and behavioural factors affecting the investors decisions as well as the relationship between RE investments and portfolio performance. Applying econometric techniques on primary data collected from a sample of European investors, we study how the investors' a-priori beliefs, their preferences over policy instruments and their attitude toward technological risk affect the likelihood of investing in RE projects. We also demonstrate that portfolio performance increases with an increase of the RE share in the portfolio. Implications for scholars, investors, technology managers and policy makers are derived and discussed.

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## 1. Introduction

In the World Energy Outlook 2009 (IEA, 2009a), the International Energy Agency launches an extremely clear and compelling message: current energy policies cannot be maintained if we want to avoid catastrophic consequences for the climate. An “energy technology revolution” is called for, in order to meet the challenging objective of halving CO<sub>2</sub> emissions by 2050 compared with 2005 levels (IEA, 2008a). “The task is urgent; we must ensure that investment decisions taken now do not leave us with inefficient, high-emitting technologies in the long term” (IEA, 2009b, page 1). It seems that a new era is about to start, where renewable energy technologies are no longer considered a “Cinderella option” (Grubb, 1990) but are increasingly seen as “survival technologies” (Leggett, 2009).

To increase the share of renewables in the global energy mix, significant innovations are needed not only in the technical field, but also in the social and institutional context (Krewitt et al., 2007). Improved policy frameworks for renewable energies are required, which correct externalities and ensure a more level playing field. Furthermore, cooperation between public and

private actors needs to be strengthened. Both groups play a key role. Policy makers should create incentives to ensure that the necessary investments are undertaken (IEA, 2007). In turn, the private sector can play a crucial role in raising the required financial resources to facilitate the transition towards a low-carbon economy.

Energy analysts estimate that huge additional investments are needed to realize this transition to a low carbon economy. Needless to say, this is particularly challenging in the current economic context, as investors are reluctant to do so unless dedicated policies are implemented to stimulate renewable energy investments. Recently, a group of 181 investment institutions which collectively represent assets for 13 trillion US dollars has stated that clear and appropriate long-term policy signals are essential to help investors integrate climate change considerations into decision-making processes and reallocate capital to low-carbon technologies (UNEP FI, 2009). Indeed, it seems that the main barrier to investments in greenhouse gas mitigation technologies is not the lack of capital, but rather the lack of appropriate policy packages to attract it (Usher, 2008a). As a matter of fact, many policies implemented so far have attained only partial results, because they have been unable to leverage the true drivers of the investment decision process.

An emerging body of literature has started investigating how policies should be designed to mobilize investments in the renewable energy sector. Several studies at the EU level have

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provided a measure for policy effectiveness (EC SEC, 2008; OPTRES, 2007; PROGRESS, 2008). Yet, although distinguished, these studies provide only limited insights into the investors' perspective.

The lack of emphasis on investors' preferences is an important shortcoming in the extant research, which is acknowledged in the management and the finance literature (Bürer and Wüstenhagen, 2009; Russo, 2003; Shleifer, 2000). This paper intends to fill this knowledge gap by shedding new light on the process through which investors allocate capital to renewable energy projects. To this end, we develop and empirically test a model that takes explicitly into account behavioural factors to analyse investors' decisions. The model examines how a priori beliefs vis-à-vis renewable energy technologies, policy preferences and technological risk attitudes influence the agents' willingness to invest in renewables, and how this, in turn, affects the investment performance. The model is empirically tested using primary data collected from a sample of European investors. Europe is an appropriate context for our empirical analysis, both for its leading role on climate change and energy policies and because it is the world region that attracted the largest share of new renewable energy investments in 2008 (UNEP and NEF, 2009).

The paper makes several contributions. First, by providing a better understanding of the investors' decision making process, the study will help policy makers design more effective policy instruments to support the market deployment of renewable energy technologies. Second, by extending the empirical analysis to a wide range of institutional investors, the paper makes a methodological contribution too. So far, the few studies in this field have focused on a restricted group of investors, namely venture capitalists. By expanding the scope of the analysis to a broader set of financial actors, this work will contribute to extend the validity of previous findings to a broader and more general context.

The remainder of the paper is structured as follows: the next section reviews the most relevant literature and the theoretical foundations of our work. Section 3 presents a conceptual model linking investors' beliefs, investment decisions and performance. Section 4 describes the research design and the empirical methods employed to test the model. Section 5 illustrates the main findings. Finally, Section 6 highlights the main conclusions and discusses implications for theory and practice.

## 2. Literature review and theoretical background

### 2.1. Renewable energy investments and financial performance

Investments in renewable energy technologies have increased steadily over the last years. Analysts estimate that from 2002 until the end of 2009, the green energy market has attracted more than USD 650 billion cumulatively (NEF, 2009a; UNEP and NEF, 2009). The years 2006 and 2007 have experienced double-digit growth, whilst 2008 and 2009 have been affected by the consequences of the global financial crisis, which has impacted the clean energy market both directly (through a liquidity squeeze) and indirectly (via a general fall in global energy demand associated with lower oil and gas prices). Even though the economic downturn has hit the renewable energy market quite severely, experts believe that in the long term the clean energy sector should recover better and faster than others. Many governments have launched green fiscal measures that have contributed to moderate the fall of investments in this industry. Furthermore, the IEA recently called for a "Clean Energy New Deal" to exploit the financial and economic crisis as an opportunity to induce a permanent shift in investments to low-carbon technologies (IEA, 2009c).

Some experts recognize that low carbon technologies can offer tremendous opportunities to overcome the current crisis thanks to the numerous environmental, economic and societal benefits they incorporate (IEA, 2009c; Ragwitz et al., 2009; Deutsche Bank, 2008). Fulton (Deutsche Bank, 2008) identifies a "safety net effect" for clean energy investments determined by government regulations, which ensure a built-in advantage over most other sectors in the long term.

As scientific evidence on human-induced climate change becomes more robust and consensus over the urgency and the necessity of taking action is reached, practitioners and policy makers are provided with a number of dedicated tools for financial analysis and decision making. Comparative studies on the performance of renewable energy investments versus traditional assets are also becoming common. These studies show that, in recent years, investments in renewable energy technologies have led to superior performance compared to more traditional investments (Deutsche Bank, 2009; NEF, 2009b).

Providing an explanation for this phenomenon, by clarifying the underlying relations between renewable energy investments and financial performance would represent a useful theoretical contribution and it would also help policy makers design more effective policies to attract further investments in this area. Unfortunately, management scholars have somewhat overlooked this topic so far. Given the lack of studies specifically addressing the link between renewable energy investments and financial performance, some useful insights can be obtained from studies in related fields, such as those examining the relationship between environmental performance and financial performance. Scholars seem to suggest that there is a positive relationship between the companies' involvement in environmental and social activities and their financial performance (Cohen et al., 1995; Dowell et al., 2000; Hart and Ahuja, 1996; Porter and van der Linde, 1995; Reinhardt, 1999; Russo and Fouts, 1997). However as King and Lenox (2001) point out, correlative studies offer only a partial picture to corporate managers and policy makers, because they do not indicate the direction of causality. These authors therefore call for additional research in this area, to explore how underlying firm characteristics affect the relationship between environmental performance and financial performance. This view is shared by Weber et al. (2005) who state that while the positive correlation between environmental performance and financial performance is widely accepted, the strength of the correlation and its genesis are still often unclear.

Although the relationship between renewable energy investments and financial performance remains underexamined and somehow uncertain, there is increasing evidence that policy targets and the accompanying policy instruments deployed at the national, regional and global level have a strong influence on the investors' decision to allocate capital to renewable energy projects.

### 2.2. Policy preferences and effectiveness

Policy targets and measures have been set by several countries worldwide to support the deployment of renewable energy technologies. According to REN21 (2010) more than 80 countries have already established renewable energy policies. Policies can play a crucial role in reducing the risk associated to an investment decision, by providing a stable framework and decreasing market uncertainty.

As pointed out by Ecofys (2008) "commitment, stability, reliability and predictability are all elements that increase confidence of market actors, reduce regulatory risks, and hence significantly reduce the cost of capital". However, the relationship

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