

The influence of perceived uncertainty on entrepreneurial action in emerging renewable energy technology; biomass gasification projects in the Netherlands

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Abstract

Emerging renewable energy technologies cannot break through without the involvement of entrepreneurs who dare to take action amidst uncertainty. The uncertainties that the entrepreneurs involved perceive will greatly affect their innovation decisions and can prevent them from engaging in innovation projects aimed at developing and implementing emerging renewable energy technologies. This article analyzes how perceived uncertainties and motivation influence an entrepreneur's decision to act, using empirical data on biomass gasification projects in the Netherlands. Our empirical results show that technological, political and resource uncertainty are the most dominant sources of perceived uncertainty influencing entrepreneurial decision-making. By performing a dynamic analysis, we furthermore demonstrate that perceived uncertainties and motivation are not stable, but evolve over time. We identify critical factors in the project's internal and external environment which influence these changes in perceived uncertainties and motivation, and describe how various interactions between the different variables in the conceptual model (internal and external factors, perceived uncertainty, motivation and previous actions of the entrepreneurs) positively or negatively influence the decision of entrepreneurs to continue entrepreneurial action. We discuss how policymakers can use these insights for stimulating the development and diffusion of emerging renewable energy technologies.

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1. Introduction

The ever-growing body of literature on innovation and entrepreneurial decision-making reveals that there is a large and diverse set of factors influencing the decision of entrepreneurs whether or not to engage in innovation activities. These numerous factors range from characteristics of the innovation itself (e.g. the distinction between radical versus incremental innovations or the relative

advantage of an innovation compared with established technologies (Dewar and Dutton, 1986; Henderson and Clark, 1990; Rogers, 1995)) to characteristics of the decision-making actor (such as personal or cultural characteristics that distinguish entrepreneurs from non-entrepreneurs or innovators from laggards (Brockhaus, 1980; Rogers, 1995; Shane, 1995)), characteristics of the environment in which the entrepreneur is operating (e.g. the stability of the market demand or the degree of competition (Porter, 1980; Teece et al., 1997)) and so on. However, independent of the type of actor, the type of innovation or the type of environment, all innovation decisions inherently involve uncertainty (Nelson and Winter, 1977; Dosi, 1982; Rosenberg, 1996; Edquist,

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1997). Therefore, uncertainty is considered a very important factor to focus on in order to gain a better understanding of innovation decisions.

The intrinsically uncertain character of innovation decisions is particularly true for innovation decisions concerning emerging technologies, i.e. technologies that are still in an early phase of development (van Merkerk and van Lente, 2005). On the one hand, the high degree of uncertainty surrounding emerging technologies signifies the large variety of opportunities that a new technology has to offer. On the other hand, though, this uncertainty poses a threat of not knowing what comes next and not being able to *ex ante* determine the success or failure of a technological path (Garud and Rappa, 1994). To phrase it differently, uncertainty can both create opportunities for entrepreneurs to engage in emerging technologies, as well as hamper entrepreneurs in undertaking action. Thus, the relation between uncertainty and the decision of entrepreneurs to engage in emerging technologies is very complex.

While the emergence of new technologies in general is a long and uncertain process, this appears to be particularly true for the development and diffusion of emerging renewable energy technologies (Jacobsson and Johnson, 2000). Due to the urgent problem of climate change, there is a growing need for the application of renewable energy technologies. However, despite their large environmental benefits, large-scale implementation of emerging renewable energy technologies has proven to be difficult (Jacobsson and Bergek, 2004; Raven, 2005; Negro, 2007). In 2004, the share of renewables in western countries accounted for only 5.7% of the total primary energy supply (IEA, 2007). Several authors have argued that uncertainty is one of the major barriers for the breakthrough of emerging renewable energy technologies (Kemp et al., 1998; Rotmans, 2003; Jacobsson and Bergek, 2004; Foxon et al., 2005). More specifically, Jacobsson and Bergek (2004) argue that uncertainty is blocking the development and implementation of renewable energy technologies, since it hinders the fulfilment of entrepreneurial activities (Jacobsson and Bergek, 2004). This is problematic, since the emergence of a new technology cannot take place without the involvement of entrepreneurs who dare to take action under uncertainty, in pursuit of a possible opportunity arising from the new technology (Hekkert et al., 2007). In order to contribute to a better understanding of the underlying mechanisms that determine the emergence of renewable energy technologies, this article therefore aims to provide insight into the influence of uncertainty on entrepreneurial action in emerging renewable energy technologies.

In traditional entrepreneurship literature, the success or failure of entrepreneurial action is often attributed to specific individuals who have the vision, skills and risk-taking mentality needed to discover, create and exploit opportunities that lie beyond the reach of most (see Gartner (1990) for an overview). However, there is a growing awareness that the development of emerging

technologies cannot be attributed to any one individual actor, but is best understood as “both an individual and a collective act” (Van de Ven, 1993; Edquist, 2001; Garud and Karnøe, 2003; Jacobsson and Bergek, 2004; Hekkert et al., 2007). As Garud and Karnøe (2003) argue, “technology entrepreneurship is a larger process that builds upon the efforts of many”. According to this stream of research, entrepreneurs are not only technology-developers who produce new technologies, but, for instance, also adopters (buyers and users) who offer critical inputs for the commercialization of emerging technologies (Van de Ven, 1993; Garud and Karnøe, 2001, 2003). In this article, we subscribe to the idea that the development of emerging renewable energy technologies is the result of actions from multiple entrepreneurs. However, in contrast to the above scholars, we do not analyze the emerging technology from a macro- or system-level perspective but focus on specific innovation projects from the perspective of the various entrepreneurs involved. In this article, we focus on the development of biomass gasification technology by studying various innovation projects aimed at developing and implementing this emerging renewable energy technology. This focus on innovation projects is useful for providing more insight into the relation between entrepreneurial action and the perception of uncertainties.

This study builds on the work of McMullen and Shepherd (2006) who argue that, in order to understand the influence of perceived uncertainty on entrepreneurial action, we are required to examine not only perceived uncertainty but also the entrepreneur’s motivation. They explain that whether an entrepreneur will engage in a particular action is a decision that depends on whether the entrepreneur is motivated enough to act, given the uncertainty he or she expects to encounter in pursuit of an opportunity (McMullen and Shepherd, 2006). Thus, motivation needs to outweigh perceived uncertainty in order for entrepreneurs to act. This implies that we need to analyse both perceived uncertainty as well as the balance between perceived uncertainty and motivation if we want to understand why some entrepreneurs decide to act whereas others do not.

We will make three contributions to the conceptual framework of McMullen and Shepherd (2006). First, we will break down uncertainty perceptions in different sources of uncertainty. Whereas McMullen and Shepherd (2006) analyse perceived uncertainty by looking at whether or not an entrepreneur possesses enough knowledge in order to recognize an opportunity worth pursuing, we try to specify in what domains knowledge is lacking by distinguishing between different uncertainty sources. The entrepreneurs involved in emerging technologies are confronted not only with high uncertainty about the technology itself but also with uncertainty about other elements in the socio-institutional environment in which the new technology will be embedded, such as uncertainty about unclear user requirements or the actions of competitors (Rosenberg, 1996; Afuah and Utterback,

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