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Technological change in niches: Auxiliary Power Units and the hydrogen economy

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Abstract

In studies of large scale systems innovations or technological transitions, niches have been given a prominent role as incubators for the seeds of future technological systems. It is often argued that immature technologies rely on niches for their development, before they are able to compete in mainstream markets. This paper combines insights from economic theory and from technology studies to formulate a framework for understanding the dynamics of technological change in niches, and applies this framework to the case of fuel cell Auxiliary Power Units (APUs). We conclude that the choice of technology for APUs will be of critical importance in determining the role this market could have in shaping future developments in hydrogen and fuel cells. However, a number of factors are not strictly dependent on the technology used in fuel cell APUs. These comprise factors influencing external economies of scale, network effects, the behaviour of users and expectations.

Keywords: Niches; Technological transitions; Auxiliary Power Units (APUs); Hydrogen economy; Fuel cells

1. Introduction

Any attempt to understand and plan for a future transition to a hydrogen energy system must rely on some understanding of the processes of technological change. Although our knowledge of such processes remains incomplete, the concept of 'niche' has provided a fertile area for discussion in studies of innovation in recent years. In studies of large scale 'systems innovations' or 'technological transitions', e.g. [1], niches have been given a prominent role as incubators for the seeds of future technological systems. In essence, it

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is argued that immature technologies rely on niches for their development before they are able to compete in mainstream markets. This is well reflected in discussions relating to hydrogen, with niche markets and products often seen as important in the development of a hydrogen energy system, e.g. [2,3].

The focus on niches in technology studies has given rise to both analytical recommendations (the call to characterise and understand 'promising niches' in scenario analyses [4]), and policy prescriptions (in the form of "strategic niche management" [5]). However, the technological change literature demonstrates a variety of understandings of what constitutes a niche, and there have been few attempts to characterise the processes likely to occur when technologies become established in niches. This paper combines insights from economics and from technology studies to formulate a framework for understanding the dynamics of technological change in niches. This framework is applied to the case of fuel cell Auxiliary Power Units (henceforth APU).

The paper is structured as follows. The next section describes and clarifies two concepts of the 'niche' in studies of technological change. In Section 3, a framework is presented for understanding the processes that occur in established niches. In the fourth section, this framework is applied to a niche market for auxiliary power aboard vehicles. Finally, in Section 5, we draw conclusions about the approach, and comment on the role of the fuel cell APU, and similar niches, for fostering developments towards a hydrogen energy system.

2. Conceptions of the 'niche' in studies of technological change

In the literature there are two dominant conceptions of niches: the 'market' niche and the 'technological' niche. By providing a brief description of the salient features of market and technological niches, this section seeks to bring some clarity to these different concepts of the niche. As we will see, the key distinction between market and technological niches is related to the time horizon on which the technologies are evaluated. In the technological niches, actors promote technologies thought to offer potential *future* benefits while in the niche markets consumers with particular and specialist needs value technologies for their *present* performance characteristics.

2.1. Technological niches

By the time a technology enters its first markets, it has already undergone a process of development involving networks of scientists, engineers, developers, entrepreneurs, financiers, and frequently activists. This pre-market stage is characterised by the development of the technology in 'protected spaces' [4] created by social networks in the belief that the technology may be important in achieving future goals, be they commercial, social, or military. Technologies at this stage need protection from the market as they are currently 'hopeful monstrosities' [6] whose performance is poor, but that show future promise. Schot and Geels [7] describe these protected spaces, or 'technological niches' as "*proto-markets created by actors to test and develop new technologies in order to develop larger market niches*".

Technological niches are frequently manifested through the formation of associations, partnerships and lobby groups (such as the London Hydrogen Partnership), which develop demonstration and deployment activities, seek resources for the technology, and build advocacy networks. In physical terms, technological niches exist through large demonstration projects (or "bounded socio-technical experiments", [8]) that focus on learning about the technology in its social and real-world context. Technological niches can also be thought of in terms of networks of actors embedded in particular local