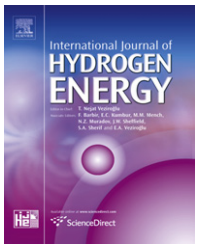
INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 36 (2011) 10443–10454

Available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/he



Iceland's hydrogen energy policy development (1998–2007) from a sociotechnical experiment viewpoint

*Sangook Park**

SPRU, Freeman Centre, University of Sussex, Falmer, Brighton BN1 9QE, United Kingdom

ARTICLE INFO

Article history:
Received 28 March 2011
Received in revised form
6 June 2011
Accepted 7 June 2011
Available online 5 July 2011

Keywords:
Sociotechnical experiment
Strategic niche management
Iceland
Sociotechnical transition
Multi-level perspective

ABSTRACT

From this case study of the Icelandic case, a real-life scale sociotechnical experiment on the hydrogen economy can be observed. The experiment is more generally called a test-bed, which is made possible by Iceland's small society and unique natural environment. Iceland has developed hydrogen energy policies, and corresponding activities have provided researchers with experimental experiences. This paper sheds light on Iceland's challenge from a sociotechnical system viewpoint, which emphasizes the importance of sociotechnical experiments in the early stage, i.e. niche level. Preconditions and conditions of the experiment are analyzed, together with the presentations of observed phenomena, such as articulation of visions and development of networks. A critical review on the Icelandic experiment should provide us with useful lessons and policy implications for improving hydrogen energy activities not only in R&D but also especially in demonstration and deployment.

1. Introduction

Since the Icelandic government issued its statement to pursue the Hydrogen Economy for the first time in the world in 1998 [1], this small, peaceful, and cold country has become a global test-bed for the Hydrogen Economy. It has certainly inspired other counties to think again about the reality and possibility of hydrogen as an energy medium. The Icelandic concept of the Hydrogen Economy clearly suggests that they want to get rid of carbon dioxide emission, and that is thought to be possible, thanks to abundant natural sources of renewable energy in Iceland, such as hydropower and geothermal energy. However, natural advantage is not the only motivation of the Icelandic dream. Icelandic people have been affected by the global development of hydrogen-related technologies, the activities of multinational firms that are preparing the future business, and also the issue of climate change and global policy issues on sustainability. A transition from one energy system to another can be considered as a large change in sociotechnical systems. In this research, it is assumed that Iceland is performing a real-life scale experiment of a sociotechnical transition to the Hydrogen Economy, and it is now in the early stages of this experiment.

Thanks to Iceland's small economic size and population, it is presumably less difficult to realize and manage the necessary sociotechnical transition than in larger and more complex countries. A small system means there are fewer actors to form a relatively simple governance structure. It does not have a high innovation capability but the cutting-edge technologies and resources should be available from outside, because certain leading hydrogen actors in the world want Iceland to be a test-bed for valuable experiments.

With regard to developing the necessary hydrogen-supporting network, Iceland seems to have a small and open

* Present address: Asia Development Institute, Graduate School of Public Administration, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-742, South Korea. Tel.: +82 2 8805622; fax: +82 2 8775622.
E-mail address: sangook.park@gmail.com.

0360-3199/$ – see front matter Copyright © 2011, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ijhydene.2011.06.031

network structure as a consequence of its small society. Moreover, the Icelandic network for the hydrogen economy appears to be flexible, easy to align, efficient and effective, making Iceland an ideal place for a real-life scale experiment. Bigger societies will have a more complex network, which may not be so suitable for this kind of risky sociotechnical experiment.

Unlike scientific experiments, sociotechnical experiments take place in society, which means that they encounter all the real components in sociotechnical regimes, such as various organizations, institutions and the general public. As a result, a sociotechnical experiment cannot be performed in a totally artificial, fully controlled environment. Like scientific ones, an experiment needs to be more controllable, smaller-scale, less-expensive and faster-responding than the real world which the experiment simulates. An energy system transition is a good example of a sociotechnical system transition, which is the reason why transitions are difficult to test in advance, though governments often try to test them locally in a small region.

Iceland offers ideal conditions and an ideal environment for an experiment on the transition to the Hydrogen Economy. Its small population and economy meet the experimental requirement about scale, enabling us to observe the experiment with regard to independent variables, such as demonstrations and prototype infrastructure including technological test-stations. We can also observe the resulting dependent variables such as social influences, the rate and outcomes of the energy system transition, or simply whether the transition took place or not, and the reasons why it succeeded or failed. At present, Iceland may be the only country or society that considers the hydrogen energy transition to be one of major social priorities. It has now been over ten years since most Icelandic people were first acquainted with the concept of the Hydrogen Economy. Because Icelandic people have already experienced a renewable energy transition from oil to geothermal, and because Iceland has also been ambitiously boosting power-intensive manufacturing industries such as aluminum production, Icelandic people are generally positive toward an emerging energy technology and the new industrial opportunities it may deliver. It is possible to say that in Iceland, energy-related issues have priority.

The sociotechnical transition experiment in Iceland is an interactive learning process together with the global community. Whether Iceland ultimately succeeds or fails to accomplish the Hydrogen Economy as planned, the global community will learn numerous lessons from this experiment. On the other hand, Iceland will have to import not only technologies but also technological products such as FCVs and electrolytic cells from overseas, since it does not have its own manufacturing industry and sufficient technological capabilities. Indeed, changes to the global landscape will greatly influence Iceland's experiment. This is the reason why we consider Iceland as a country-size laboratory for the global community, which has sought to provide a test-bed for verifying the feasibility of the Hydrogen Economy.

In this paper, Iceland's hydrogen energy pursuit until 2007 has been reviewed from a sociotechnical experiment viewpoint. The findings contain firstly, the environment, i.e. socio-economic background of hydrogen energy in Iceland; secondly, the way how Icelandic policy makers have reflected public expectations and visions onto hydrogen policy; thirdly, development and alignment of the network of actors; and fourthly, some factors that may limit the outputs of the experiment. Through the findings and related discussions, lessons from the Icelandic case can be identified, from which one may improve the design and management of sociotechnical experiments.

2. Theoretical framework

A growing number of hydrogen energy policy research papers have become involved the issue of sociotechnical transition (e.g. Refs. [2–6]) The concept of the multi-level perspective [7–16] and strategic niche management (SNM)[1] [17,18] is widely applied here. Hoogma et al. first applied SNM to an alternative road transportation system, and its use as a new technology growth policy with a strong social emphasis is gradually increasing [17]. SNM pursues a base expansion strategy of forming a niche space within which new technologies can be tested and cultivated, systematizing various technological attempts and their social realizations in that niche, expanding that system to other areas, and then finally bringing about an entire system change. As the base of this, the niche functions as a platform on which not only the technology suppliers but also the users participate and interact. The platform often takes the form of a public R&D project or local community movement, and the suppliers and the users, through their interaction, accumulate trust and a common knowledge-base, and carry out activities that enhance the social acceptance of new technologies.

The niche for hydrogen energy can be viewed as already partly created. Although several difficult technical problems still exist, hydrogen energy is becoming technically feasible. Economic viability has not yet been achieved but the economic opportunities and potential profitability are well acknowledged. Though not particularly for Iceland, for example, the emerging hydrogen industry [19] possibly contributes to the economic growth and job creation at the national level. In addition, companies that succeed in commercializing hydrogen energy will benefit from the overhaul of the existing industry power hierarchy. For example, commercialization of FCV has the potential to lead to a reorganization of the automotive industry and the creation of new markets [18]. In addition, although there exist various visions over countries that are not necessarily or directly linked to sustainability [20,21], hydrogen energy has both tangible and intangible values as a sustainable technology that can be used to counter the climate change crisis. The establishment of various types of steering organizations that support hydrogen energy is further evidence of the establishment of a niche for hydrogen energy. The involved organizations can be found in academia, business, public research institutes, and government ministries, and they are pursuing hydrogen energy with a certain level of collaboration, drawing on their regional, national and international networks. Organizations and their networks are

[1] The use of abbreviations throughout this paper. SNM – strategic niche management; FCV – fuel cell vehicle; RD&D – research, development and deployment; MNE – multinational enterprise.