Transitioning Towards a Low-Carbon Hydrogen Economy in the United States: Role of Transition Management

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ABSTRACT

This paper describes the process of transitioning to a low-carbon hydrogen economy in the United States and the role of transition management (TM) in this process. Focusing on the transition process for hydrogen-based energy and transport systems in the United States, especially California, this study outlines the key characteristics of TM that have been employed in managing the transition. Several characteristics of TM have been noted in the United States’ hydrogen transition, including: (a) the complementarity of the long-term vision with incremental targets, (b) the integration of top-down and bottom-up planning, (c) system innovations and gradualism, (d) multi-level approaches and interconnectedness, and (e) reflexivity by learning and experimenting. These characteristics are instrumental in bringing about the development and initial commercialization of hydrogen fuel cell vehicles and related energy infrastructure in the United States.

Keywords: California Fuel Cell Partnership, Energy, Fuel Cell Vehicles, Hydrogen Economy, Low-Carbon, Transition Management, Transport

INTRODUCTION

In recent years, countries such as Denmark have begun shifting towards a low-carbon pathway in response to the challenge of climate change, with large efforts directed towards the development or adoption of low-carbon energy and transport technologies (Energi Styrelsen, 2009). To bring about the low-carbon transition, technological environmental innovation (TEI) is essential (Murphy & Gouldson, 2000). TEIs, such as hydrogen energy, and cleaner transport technologies, offer the potential to significantly reduce greenhouse gas (GHG) emissions, enhance resource use efficiently, and increase productivity and long-term competitiveness. However, due to the high complexity and the low compatibility of these technologies with existing technological, institutional, social and political institutions, the transition to low-carbon energy
and transport technologies has proved to be a major challenge to these countries, developed or developing alike (Gouldson & Murphy, 1998).

In European countries, such as the Netherlands (Kemp & Loorbach, 2005) and the United Kingdom (Foxon et al., 2009), transition management (TM) has been taken as an approach in managing socio-technological transitions towards the goal of sustainability. This approach has been applied to harness sustainable low-carbon mobility and energy. TM assumes that a systems approach is needed for technological innovation. Hence, in managing transitions to a low-carbon technological system, coevolutions in socio- and political- systems are needed. Transition management utilizes both top-down and bottom-up approaches, and employs both forecasting and back-casting techniques in identifying short-term, intermediate and long-term sustainability goals, and possible pathways to realizing these goals. Different groups of stakeholders, including political stakeholders, are engaged in each small step of socio-technological transitions so that the barriers associated with system incompatibility and complexity are addressed incrementally and plausible pathways to reaching sub-goals are explored before any of the pathways is fixed and selected. The involvement of political stakeholders in parallel with the engagement process ensures that the policy and political plans developed synchronize with the workable plans developed by relevant technological and societal stakeholders (Kemp & Loorbach, 2005).

To understand how TM is used to steer low-carbon energy and transport technologies, the case of the United States’ transition to a low-carbon hydrogen economy is selected. It is a vivid demonstration of how, by means of TM, political, public and private stakeholders coordinate their efforts and jointly push forward the development and commercialization of hydrogen fuel cell vehicles (HFCVs) and hydrogen fuel in the United States, through stakeholder participation, cooperation in technology development, financing, and technology demonstration in incremental steps. Given the technological immaturity of hydrogen technologies and the institutional and systemic complexity associated with the development and commercialization of the technology, co-evolutions at the niche, regime and landscape levels; interactions among social, institutional and technological systems; and collaboration among a wide array of public and private stakeholders, have been conducted resulting in the emergence of alternative zero-emission hydrogen energy and fuel cell (FC) transport systems in the United States, especially in California. The complex zero-emission energy and transport systems also requires that multi-dimensionality of knowledge, expertise and resources have to be sought from the stakeholders involved. As observed in the United States and California’s transition to a hydrogen economy, stakeholder participation and learning serve as the essential elements to ensure that the wide range of perspectives can be attended to carefully, that consensus can be reached, and that the knowledge and expertise in support of the changes can be drawn from a wide ranging group of stakeholders at the technological, social and institutional levels, including investors, energy companies, car manufacturers, transit operators, consultant companies, public citizens and political leaders (USDOE, 2002a, 2002b; CaFCP, 2008, 2009; ITS-UC Davis, 2009).

TRANSITION MANAGEMENT: ROLE, DEFINING FEATURES AND EXPERIENCES

Why is Transition Management Necessary for Low-Carbon Energy and Transport Development?

In the transition to low-carbon energy and transport, a new set of technological configurations involving systemic change is required at several different levels, including: technological, societal, institutional and political. To facilitate necessary structural change, many challenges have to be tackled. Some examples include high system complexity, risk and uncertainty concerning the long-term impacts of systemic change; technological lock-in; the unstructured
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