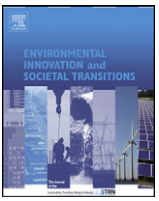
Environmental Innovation and Societal Transitions 3 (2012) 50–66

Contents lists available at SciVerse ScienceDirect

Environmental Innovation and Societal Transitions

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



How do we govern sustainable innovations? Mapping patterns of governance for biofuels and hybrid-electric vehicle technologies

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ARTICLE INFO

Article history:
Received 19 January 2012
Received in revised form 22 April 2012
Accepted 22 April 2012
Available online 18 May 2012

Keywords:
Biofuels
Hybrid-electric vehicles
Innovation
Policy
Sustainability
Sweden
Transport

ABSTRACT

This paper examines patterns of governance aimed at sustainable technological innovation in the transport sector. It makes an overall assessment of governance emerging in the fields of biofuel and hybrid-electric vehicle (HEV) technologies, and makes a classification of its characteristics. It examines the role of different actors and levels of governance as well as preferred mechanisms and targets of governance. The assessment reveals that there are rather differential patterns of governance influencing the two fields. For instance, international-level and market-based governance are much more prevalent in biofuels, whereas industry-led and cognitive governance play comparatively stronger roles in HEV. These patterns can be understood in light of both the different institutional and actor characteristics of the two technologies, and their positions in relation to socio-technical regimes.

1. Introduction

The quest for sustainable transport has emerged as a principal governance challenge. Transport is one of the sectors where environmental and resource pressures keep mounting over and above

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2210-4224/$ – see front matter
http://dx.doi.org/10.1016/j.eist.2012.04.002

already unsustainable levels. Contributing to this is continued growth in freight and personal transport, reliance on private automobiles, and continued use of fossil fuels with conventional internal combustion engine technologies. At the same time, much hope has been placed on the development and rapid uptake of new vehicle technologies such as the hydrogen-based fuel cell, biofuels and hybrid-electric vehicles (HEV). However, up until recently these new technologies have had difficulties to compete on the market, and further innovations are needed. Given the urgency to resolve unsustainable trends in the sector, today both industry and policy makers agree that innovation in these technologies requires more active governance (ACEA, 2010).

There is indeed a range of governance arrangements at different levels that potentially influences these systems. At the *international* level, there are agreements and regimes related to climate change mitigation, energy security, and innovation promotion. In the *EU*, the European Commission has its "Greening Transport Package" including a Communication (CEC, 2008), and a strategy for external cost integration. In 2011, the EU adopted a roadmap for the next decade to reduce its dependence on imported oil and to cut carbon emissions in transport by 60% by 2050 (CEC, 2011). By 2050, key goals include phasing out conventionally fuelled cars in cities, and a 50% shift of medium-distance intercity passenger and freight journeys from road to rail and waterborne transport. The EU has set progressive targets for carbon dioxide (CO_2) emissions from cars, and the current target is to reach an average of 130 g CO_2/km by 2015. The EU has also governed through various projects, for example, the 1990s ZEUS programme (Zero and Low Emission Vehicles in Urban Society); a collaborative effort of eight European cities to facilitate the introduction of cleaner cars. At the *national* level, governments use different instruments to facilitate the deployment of sustainable transport technologies, such as differential taxation/licensing fees of vehicles, differential taxation of fuels, investment subsidies, discharge premiums, and R&D programmes for alternative fuel and high-efficiency vehicles. Vehicle fuel standards and emissions standards have been introduced at both national and EU levels. The Californian Zero Emission Vehicle (ZEV) mandate and the US Corporate Average Fuel Economy standard (CAFE) are well-known examples that have affected the industry not only in America but also internationally. *Local* authorities have deployed measures such as differential parking fees and congestion charges, as well as developing infrastructure and refuelling/charging stations for vehicles.

Despite the wealth of governance to induce sustainable innovation in transport, there is surprisingly little analysis of it. Questions about *who* is best suited to govern sustainable innovation in transport, what are the appropriate *levels* for governance, and what are the most effective *instruments* to use, have not been addressed much at all. This lack of knowledge is not unique to the transport sector but concerns technological innovation much more broadly. Just how governance should be best arranged to achieve both momentum and sustainable direction in technological innovation systems is not well understood, be it in biotechnology, electricity generation and use, or urban infrastructure. Agreeing on governance can be complicated due to lack of agreement on goals, and divergence of interests between the many actors involved across levels. Still, there is, at least in the EU, relatively strong consensus among actors, judging from the plethora of low-carbon road maps and visions for sustainable energy and transport systems (Nilsson et al., 2011).

Existing research on governance for sustainable technologies has usually been national or sometimes regional in scope – even when technological innovation systems rather than regional or national innovation systems are in focus (Jacobsson and Lauber, 2006b). But sustainable transport technologies emerge internationally, are taken up on international markets, and respond to global challenges such as resource use and climate change. Furthermore, the technologies are put to use locally, and constrained or enabled by local rules and infrastructures.

This paper examines patterns of governance across these levels in two low-carbon vehicle technology domains, namely biofuels and hybrid-electric vehicles. The main research question is: in what ways are the characteristics of the governance arrangements different or similar across the two technology domains of biofuels and hybrid-electric vehicles, and how can we explain these similarities and differences? The paper takes a multi-level approach but the entry point for the national level is the country of Sweden. The purpose of the paper is to make an overall comparative assessment of governance patterns over the last two decades and make a classification of their characteristics. Here, we take a particular interest in understanding (1) actor involvement, for instance, the relative involvement of private and public actors; (2) the level of governance, and (3) the mechanism of governance.