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Pioneer countries in the transition to alternative transport fuels: Comparison of ethanol programmes and policies in Brazil, Malawi and Sweden



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ABSTRACT

Efforts to develop alternative transport fuels and vehicles are found in countries varying tremendously in their level of economic development. In this paper, we compare the alternative fuels transition, focusing on ethanol, in three countries: Brazil, Malawi and Sweden. Each can be described as a pioneer in developing the physical and institutional infrastructure and stimulating innovation towards alternative transport fuels. We assess the transition in these pioneer countries based on niche formation and interaction with regime and landscape levels. Particular reference is made to spatial and temporal path dependencies and to the significance of cross-scale and cross-sector effects that impact the innovation process. As other countries and regions develop programmes to address the twin challenges of energy security and climate change, they can benefit from a better understanding of linkages between techno-economic and socio-technical factors in transition paths of pioneer countries, across different scales and different stages of economic development.

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1. Introduction

The use of alternative transport fuels, particularly alcohol fuels, was widespread in Europe and the Americas before World War II but fell out of favour with the low oil prices of the 1950s and 1960s (Kovarík, 1998; Knothe, 2001). The oil price shocks of the 1970s spurred renewed interest in the U.S. and worldwide in stimulating a transition to alternative fuels. Some developing countries, Brazil foremost among them, recognised that biofuels could improve energy security, save foreign exchange and contribute to agricultural development. In addition to the U.S. and Brazil, several other countries committed themselves to biofuels (only alcohol fuels at that time), including Argentina, Costa Rica, Malawi, Swaziland, Sweden and Zimbabwe (Gowen, 1989).

Yet after a century of experimentation, alternative fuels provide less than 2% of global road transport fuels, and are heavily concentrated in just three regions—Brazil, the European Union (EU) and USA. Alternatives to liquid biofuels such as biogas, electric vehicles and fuel cell vehicles have barely moved beyond pilot stages. The transition away from fossil fuels has proven much more difficult in the transport sector than in other end-use sectors; oil dependency reveals the classic features of *path dependence* and technology *lock-in* that create barriers in the energy transition (Grübler, 2004).

More recently, a new tripartite rationale—energy security, climate change and rural development—has been driving biofuels programmes in developed and developing countries alike (Sorda et al., 2010). In addition to the EU, other regional bodies have been developing biofuels policies, such as the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) (Lerner et al., 2010; Jumbe and Madjera, 2012). Biofuels markets and policies have become a multi-scale phenomenon playing out at national, regional and global levels. Consequently, significant new interdependencies have arisen across these scales: the EU Renewable Energy Directive (EU-RED) in particular has had significant repercussions for global biofuels markets and policies (Johnson, 2011).

Only a few countries, however, have pursued consistent biofuels policies over several decades: Brazil, Malawi and Sweden are noteworthy for their efforts to maintain the newly established markets even after the oil price collapse of 1986. They are also noteworthy in terms of environmental impacts compared to the large biofuels programmes in the U.S. and Germany, where the key options (maize ethanol and rapeseed biodiesel, respectively) have poor energy balances and are not environmentally innovative. In contrast, sugarcane ethanol as used in Brazil and Malawi (and imported in significant amounts in Sweden) is noted in both EU and U.S. legislation as having the best energy and GHG balance among first generation biofuels (EC, 2009; US-EPA, 2010).

The environmental sustainability of different biofuels is not, however, the focus of this paper. Nor is the focus here on the overall sustainability transition in the transport sector, since this would require a much broader assessment covering both demand and supply sides and addressing systemic transitions (Geels, 2012). We are interested instead in analysing transition pathways across different levels of economic development for countries that engaged purposefully in stimulating the shift away from fossil fuels in the transport sector: How does the nature and scope of transition pathways vary with differing economic development realities and priorities? We therefore choose three countries—Brazil, Malawi and Sweden—spanning three different world regions and three different levels of economic development. Given that transition studies have been concentrated in a few European countries, this paper offers new geographical breadth. These countries have been regional “pioneers” or market leaders (global leader in the case of Brazil) in establishing ethanol as a transport fuel. The paper aims to place this role of market leader in a comparative developmental/institutional context in which temporal and geographical linkages are considered through a socio-technical lens.

The rationale and approach are outlined in the next section, followed by a review of fuel ethanol market development in the three countries and a comparison of key drivers, actors, policies/programmes, infrastructure requirements and institutional foundations. The paper draws on several different conceptual frameworks and thus none of these can be explored and/or applied on its own in great detail; the paper emphasises instead the overall biofuel-development pathways pursued by the three countries. The paper adds a socio-technical lens in analysing the evolution of the fuel-vehicle (and ethanol) systems so as to complement conventional analyses on techno-economic changes and/or political-economic drivers.

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