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Overcoming barriers to the implementation of alternative fuels for road transport in Europe

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Abstract

The success of implementing alternative fuels for road transport depends on their cost, performance and reliability. This paper focuses on the use of natural gas and LPG, hydrogen and biofuels in Europe. A brief presentation is given of their technical development status, their market potential, and barriers to their implementation in various market segments. Some market barriers are common to many new technologies, and can be overcome through adequate policy measures at European level. Generally, a combination of policies is required, and a number of supporting measures increase their effectiveness. The following policies affecting energy use in transport are discussed: market incentives, policies targeting technology and vehicle efficiency, and overall system improvement.

Keywords: Market incentives; Barriers to implementation; Alternative fuels; Transport; Energy policy

1. Introduction

Security of energy supply, environmental sustainability and competitiveness are three main objectives of the European Union (EU) Energy policy [1,2]. To reconcile these highly interrelated objectives, integrated strategies are needed to invest in cleaner and more sustainable energy. These require strong support and guidance from the EU and national governments to take advantage of the synergies and deal with the inevitable trade-offs between the aforementioned objectives [3].

Transport has become the largest consumer of energy at the EU level, accounting for over 30% or final energy consumption in the EU-25 [3]. The share of this energy imported from third countries is increasing; with continuation of the current trends, by 2030 the EU will be dependent on imports for 90% of its oil requirements and 80% for gas [2]. Given the recent steep increases in oil and gas prices, along with the risk of potential disruptions due to the geopolitical instability of some major exporting countries, this oil dependence constitutes a threat for the Eus' competitiveness.

Recent decades have witnessed an increased concern of the environmental effects of transport, reflected in an upsurge of policy instruments to handle these negative environmental external effects and to monitor their evolution, with mechanisms such as the TERM Reports [4]. It appears that despite the important efforts devoted to environmental abatement policies, the increased transport demand is outstripping the rate of improvement in environmental technology for transport [5]. The result is a significant increase in Green House Gas (GHG) emissions from transport, while emissions from energy production, services and industry sectors all decreased in the same period [3]. This trend threatens European progress towards its international commitments, such as the Kyoto targets and the proposals by the EU Council for further emission reductions for developed countries beyond the Kyoto Protocol period (2008–2012) [6].

Although energy-related emissions from the transport sector have decreased steadily since 1990 [3], largely due to

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increasingly strict emission standards for different transport modes and fuel switching, further emission reductions are required. The proposed Thematic Strategy on Air Pollution (2005) recognises that the air quality in mega cities does not yet meet the limit values set by European regulation and still has a major negative impact on human health [4].

These issues are strong arguments to enhance the use of cleaner and energy effective technologies and alternative fuels. However, when the life cycle assessment (LCA) thinking is taken into account, important trade-offs between emissions, costs and energy efficiency of the different technologies and alternative fuels appear [7,8]. Moreover, some technologies may have opposite effects on different environmental issues [9]. A technical assessment of possible synergies and trade-offs would draw a more realistic picture and may therefore constitute a valuable tool and to support decision-makers [10].

The market penetrations of new technologies and fuels have to tackle serious economic, technological and institutional barriers [11,12]. A clear government leadership is needed to promote the implementation of these innovations, including public policy and collaboration with the private sector, so that energy-efficient solutions become financially attractive both for enterprises and consumers [13].

The potential benefits of introduction of new technologies in transport are significant. The EU could achieve a 20% reduction of its energy consumption compared to the projections for 2020 on a cost-effective basis if today's most advanced technologies were fully integrated in the market [2]. In this line, recent decades have witnessed the upsurge of a wide variety of policy options to overcome barriers for the market penetration of transport-related technology developments [14]. However, the assessment of their effectiveness on final energy consumption constitutes an underdeveloped field for researchers [15]. Models aimed at simulating policies and measures could then be translated into policy recommendations for decision-makers [16].

This paper investigates existing barriers for the implementation of alternative fuels in the transport sector in Europe, and existing policy measures to overcome these barriers. First, an analytical framework of political, socio-economic and technological environments affecting energy use in the transport system is presented. Then leading developments concerning the use of alternative fuels in transport are discussed, along with their market position, their future potential and barriers to implementation. The following section discusses European policy options to overcome these barriers.

2. Political, socio-economic and technological environments affecting the use of energy in the transport sector

In order to understand barriers to the implementation of alternative fuels in the transport sector and policies to overcome these barriers, the relationship between different environments affecting energy use in transport is presented (Fig. 1). Energy use in transport is examined as a separate system, interactions with other energy using systems are not considered.

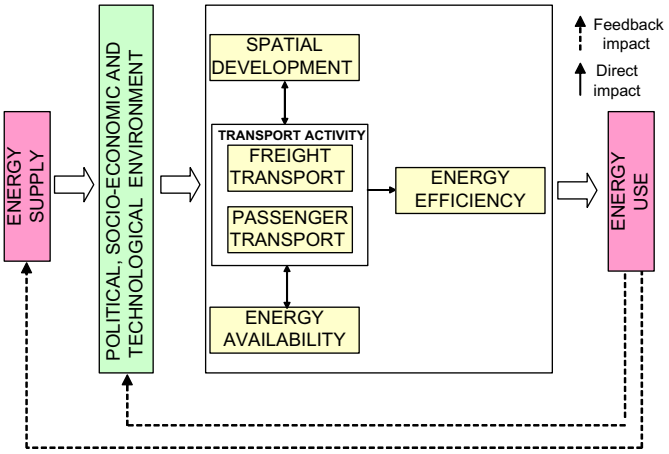

Fig. 1. Conceptual approach and relationships between the different drivers affecting energy use.

The primary drivers of the system are presented at the left side of the diagram. *Energy supply*, defined as the world-level existence of energy resources in varied forms, in sufficient quantities, and at reasonable prices, affects *energy use* in transport through the *political, socio-economic and technological environment*. These environments affect transport activity directly, and indirectly, through complex interactions between spatial development and transport activity; and through their impact on energy availability for transport activities.

Energy use in transport also indirectly affects the energy supply and the political, socio-economic and technological environment, i.e. the increase in transport demand may in the future threaten the security of energy supply and affect international fossil fuel prices, even more with the impending increase of energy demand in highly populated countries, such as China and India.

The political, socio-economic and technological environment affects the volume of *transport activity*, measured in terms of passenger-km (pass-km) and tons-km (t-km) for each mode of transport. For example in Europe, last decades' changes in the 'political environment' with the completion of the internal market reduced the existing barriers in national borders and resulted in increased freight transport, as companies exploited the competitive advantage of different regions [3]. The changed 'socio-economic environment', e.g. the rising personal income in new Member States, created a greater demand for travel and private cars.

Currently transport demand is highly coupled with economic growth, and most authors agree that an efficient transport system is a prerequisite for economic development [17,18]. The challenge for policy-makers is to decouple transport demand from economic growth, i.e. to achieve high levels of economic development without increasing transport demand [19].

The relation between transport and *spatial development* is well documented in the scientific literature [20–22]. In summary, it is the spatial separation between economic activities (e.g. housing, employment, industry, and recreation) which brings the necessity of an efficient transport system to access