Chapter 24
Use of Hydrogen and Fuel Cells for Refrigerated Transport

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ABSTRACT

Benchmark refrigeration systems in the road transportation sector are powered by diesel, having operation costs of up to 6,000 €/y with the consequent increase of the goods cost. This chapter presents an alternative refrigeration system based on fuel cells (FC) and hydrogen as fuel, with higher efficiency, reduced costs and independent of diesel price fluctuations. Examples of the energy load profiles impact on the FC sizing, H2 consumption and system autonomy are presented as well as a description of the FC model and performance simulation results. The economical feasibility of this new refrigeration system linked to renewable energies is also analyzed and an economical assessment for different scenarios is presented.

INTRODUCTION

The use of hydrogen and Fuel Cell based refrigeration systems for road transport sector instead of present diesel based ones has different overall objectives.

First, the reduction in diesel consumption to meet this demand as current systems operation is based on fossil fuels. This reduction in diesel consumption is associated with a reduction in energy dependence from fossil fuels producing countries and therefore the import of these fuels with the consequent financial savings on a global level and of course on a system user’s level.

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The use of hydrogen and FCs also completely eliminates greenhouse gas emissions and noise so that the product to be developed has significant direct environmental benefits in the transport sector and indirect benefits as hydrogen can be produced from renewable energies thereby increasing the RES share in the national energy mix since it helps their integration in a more appropriate manner.

This chapter describes in a first step, the analysis of load profiles for different scenarios and CO2 emissions savings. Secondly, a model of the FC for this application has been developed with Matlab/Simulink and some simulation results are discussed in the chapter. Finally, a simple economic availability analysis of the hydrogen chain for this application is also presented.

BACKGROUND

The road freight market in the EU is currently recovering from the deep economic crisis of 2008/09 which greatly reduced transport activity. In 2010, road freight transport activity in the EU, measured in tonne-km, was roughly 3% higher than in 2009. However, this followed a fall of 2% in 2008 and another 10% drop in 2009 which leaves road freight transport activity in the EU still about 9% below pre-crisis levels of 2007. This development has not been uniform throughout the EU though. The distribution of the inland freight transport in Europe in 2010 is shown in Figure 1.

According to some analysis developed by the European Commission, the road transport sector contributes hugely to the European economy: it provides about 4.5 million jobs and generates a turnover worth about 1.6% of EU gross domestic product. Moreover, most of the freight deliveries begin and end with a trip on the road. Road transport therefore also plays a vital role in the development of Europe’s integrated transport networks and intermodal transport solutions.

Figure 1. Distribution of the Inland freight transport in Europe in 2010. Source: European Commission.