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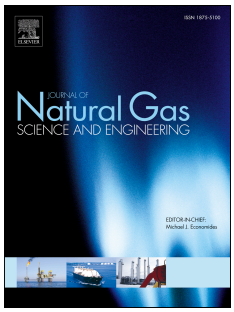

A multi-criteria sustainability assessment for biodiesel and liquefied natural gas as alternative fuels in transport systems [ECOS 2016]

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1. Introduction

Governments have been promoting the use of alternative fuels to reduce environmental pollution and oil dependence, especially after the 1973 petroleum crisis. At the beginning of this century, the European Union (EU) set the objective of replacing 20 % of conventional fuels by 2020 through the introduction of liquid biofuels in the short term, natural gas (NG) in the medium and long term and hydrogen in the distant long term (European Commission, 2000). In addition, it was expected that biofuels shared at least 6 % of the fuels used in road transport in 2010 (Commission of the European Communities, 2001). However, biofuels only shared 4.4 % by 2010 (European Commission, 2013), which was mainly the result of socioeconomic problems generated in Europe and in developing countries by the production of feedstocks, such as an increase in food prices and land use competition (EEGFTF, 2011). For that reason, the European Commission (2013) recommended different alternative fuels based on the maturity of the technologies for each application, such as electricity, compressed natural gas (CNG) and hydrogen, for urban use vehicles and liquefied natural gas (LNG) for long-haul transport.

Some of the reasons for governments to encourage the use of NG in vehicles are the benefits of reducing local air pollution, resources availability, the existence of distribution infrastructure and relatively lower prices than petroleum fuels (Yeh, 2007). NG has been widely and profitably applied in compressed form in many countries mainly in urban vehicles. CNG has only been popular in urban vehicles due to the low energy density of gaseous NG, which gives low autonomy, whereas by storing NG in liquid form, LNG vehicles can increase their autonomy by up to 1100 km (DENA, 2014). Additionally, there are many key facts that motivate the adoption of LNG technology for freight transport. Recent studies suggested that LNG use in heavy duty vehicles (HDV) has the potential to reduce environmental impacts and noise in cities, in addition to the maturity of the technology, energy resource availability and clear interest of the EU in supporting the LNG adoption (Osorio-Tejada et al., 2015). However, since the introduction of NG technologies, legislators and companies require compressive tools to perform an integrated assessment of all relevant aspects related to environment, economy and their social responsibility, as well as the reliability of technology, legislation and market issues.

Although corporate environmental responsibility and sustainable development have been discussed since the 80s (UNCED, 1992), companies in the transport sector have not been concerned with taking initiative to optimize operations and reduce environmental impacts. One of the reasons for this is that the regulations derived from the Kyoto Protocol (UNFCCC, 1998) to combat climate change were only focused on reducing emissions of greenhouse gases (GHG) in the industrial and energy sectors, which were included in the Emissions Trading Scheme (ETS) in Directive 2003/87/CE (European Parliament And The Council Of The European Union, 2003).

The growth in the share of freight transport by road, which carries 74.9 % of the tons-kilometer (tkm) inside the EU (European Commission, 2014), is a concern that has increased in importance. The transport sector in the EU released 24.4 % of the total GHG in 2013 (European Environment Agency, 2015a), and road transport contributed to 94.6 % of the total emissions (European Environment Agency, 2015b). Although regulations, such as the European air pollution standards (Euro I-VI) (European Parliament And The Council Of The European Union, 2009a), set limits on vehicle emissions of carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NOx) and particulate matter (PM), regulations to control the emissions of carbon dioxide (CO_2) in HDV have not been established.

Since the inclusion of diffuse sectors in the ETS in 2009 (European Parliament And The Council Of The European Union, 2009b), the calculation and reporting of GHG by freight companies has been