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Economic assessment of CO_2 emissions savings in Spain associated with the use of biofuels for the transport sector in 2010

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ABSTRACT

This article provides an economic assessment of greenhouse gas emissions savings associated with the use of biofuels for the transportation sector in Spain. The reference year used is 2010 in accordance with the target for the implementation of biofuels and other renewable fuels set down in European legislation (Directive 2003/30). The assessment is based on the premise that an increased use of biofuel will displace a similar amount of fossil fuel on a BTU basis, with the amount of biofuel used in 2010 taken as a reference point to conduct the estimates.

The results show that the most cost-efficient biofuel is the biodiesel obtained from waste oil. Regarding the differences between first- and second-generation biofuels, the results show that the latter had very high associated costs. Reaching the biofuel target for 2010 by primarily using first-generation used-oil biodiesel blends would have led to a saving of 58°M€. In contrast, reaching this target by exclusively using second-generation biofuels would have led to a 1000 M€ increase in total costs.

1. Introduction

The strong commitment made by the EU-27 countries to combat climate change has been one of the main motives underlying political support for Renewable Energy Sources (RES). However, it is not as common to analyse the effectiveness of policies implemented by countries, for complying with the mandatory commitments, and their costs and benefits. The fact that the use of RES is usually promoted with taxpayer-contributed, government funding (Cansino et al., 2010) justifies our interest in knowing the impact of these policies on the reduction of greenhouse gas (GHG) emissions, particularly with regard to CO_2 emissions, and the economic outcomes of this reduction (Vergara, 2009; Gerasimchuk et al., 2012).

Difficulties associated with the mitigation of climate change are evident, and many projects are being developed in this regard despite the economic and social resources they require for implementation. These challenges must be considered by policy makers when designing appropriate public policies oriented to mitigating climate change. However, although anthropogenically provoked climate change can be considered as the main market failure (Stern, 2007), the complexity of the entire climate change scenario makes economic valuations a difficult task for the researcher, and complicates the decision-making process for the policy maker (Bell and Callan, 2011; García Fernández, 2006).

In the case of Spain, the transport sector is the largest user of final energy, accounting for 40% of the total final consumption. The fuel volume used is mainly derived from fossil fuel use, accentuating the high domestic dependence on fuels of this type (MITC, 2010). In 2010, fuels used in the transport sector represented 43.6% of the total demand for petroleum-derived products (MITC, 2011) and 26.4% of GHG emissions.

One of the measures, adopted by Spanish authorities to raise domestic targets for CO_2 emission reduction, has been to promote the use of biofuels by the transport sector. Similar to the situation in France, the Spanish incentive system was particularly conducive to the development and use of biofuels, as these fuels enjoyed total exemption from hydrocarbon taxes until 31 December 2012. This exemption was also applied to the biofuel volume contained in fuel mixtures (Wiesenthal et al., 2009).

Recent papers (Lechón et al., 2009) have estimated that reducing CO_2 emissions enables compliance with the objectives set by the EU-27 concerning the consumption of biofuel. These authors

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concluded that the introduction of first-generation biofuels (made from sugar, starch or vegetable oils) causes a positive effect on CO_2 emissions abatement. This conclusion is further discussed in Lechón et al. (2011), by including indirect land-use change (ILUC) emissions.[1] In that paper, the authors found that the positive effects of biofuel use are reduced and, in some of the scenarios analysed, can even give rise to a negative net outcome (i.e., CO_2 emissions are increased with respect to fossil fuel use).

Given that the future is uncertain for first-generation biofuels (Hernández Sobrino et al., 2010), this paper includes an analysis of second-generation biofuels, specifically concerning biodiesel from lignocellulosic biomass, and bioethanol from straw. In fact, recent papers recommend including second-generation biofuels in the estimates of the costs and benefits of biofuels (Gómez et al., 2011; Linares and Pérez-Arriaga, 2013).

The aim of this paper is to conduct an economic analysis of biofuel use, including first- and second-generation biofuels, by the transport sector in Spain in 2010. Perceived benefits would occur when the economic value of avoided GHG emissions, expressed in CO_2 equivalents, equals or exceeds the cost of production of the biofuel used.

A common assumption in lifecycle assessment (LCA) based estimates of GHG benefits (or costs) of renewable fuels, such as biofuel, is that these fuels simply replace an energy-equivalent amount of fossil fuel, such that the total fuel consumption remains unchanged. Accordingly, this paper assumes that an increased use of biofuels replaces a similar usage of fossil fuel. Calculations have been based on 2010 figures as this was the reference year for the targets, fixed by Directive 2003/30 of the European Parliament, concerning the promotion of biofuel use by EU Member States. The assumption made is that these biofuels simply replace an energy-equivalent amount of fossil fuel, such that the total fuel consumption remains unchanged. This is the aim of Directive 2003/30, although authors (Rajagopal et al., 2011) criticized the one-to-one displacement assumption.

The article is structured as follows: Section 2 summarises the relevant legal framework at national and EU-27 levels. Section 3 details the methodology used, and the database employed, for the valuation. Section 4 presents the results and discussion. Section 5 presents overall conclusions.

2. European community and national legal frameworks

European Directive 2003/30/EC addresses the promotion of the use of biofuels, or other renewable fuels, to replace diesel or petrol for transport purposes in each Member State, and thereby contribute to objectives such as meeting climate change commitments, achieving an environmentally friendly and secure fuel supply, and promoting RES usage.

The European Commission (EC) Biomass Action Plan, adopted at the end of 2005, responds to a threefold objective: further promotion of biofuels in the EU-27 and in developing countries; preparation for the large-scale use of biofuels; and, heightened cooperation with developing countries in the sustainable production of biofuels. Among measures intended for ensuring environmental benefits from the policy, the EC intends to highlight the advantages of biofuels in terms of reducing GHG emissions and, in particular, to link these advantages to promoting the implementation of biofuel use. The European Union Strategy for Biofuels (European Commission, 2006) highlighted these fuels as a RES alternative to fossil energy sources used in the transport sector.

Directive 2009/28/EC forms part of the "package" outlined in the "European Energy and Climate Change" strategy, which establishes ways for the EU to achieve its energy objectives for 2020; these objectives include: a 20% increase in energy efficiency; a 20% reduction in GHG emissions; and, a 20% share of RES in the overall EU energy consumption. This Directive also requires each Member State to ensure that the share of energy from renewable sources, in all types of transport in 2020, should be at least 10% of the final energy consumption by the transport sector. This objective now has a binding clause that has brought about a major shift in European policy in this area, since the earlier objective was not mandatory, and was fixed at 5.75% for 2010 (Directive 2003/30). The European Commission (2012) is therefore proposing to amend the current legislation on biofuels, and in particular:

1. To increase the minimum GHG savings threshold, for new installations, to 60% to improve the efficiency of biofuel production processes, as well as to discourage further investments in installations with low GHG performance;
2. To include ILUC factors in the reporting by fuel suppliers, and Member States, of GHG savings associated with biofuels and bioliquids;
3. To limit the amount of foodcrop-based biofuels and bioliquids which can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020; this means maintaining the use of such fuels at current levels (5% up to 2020), while maintaining the overall renewable energy and carbon intensity reduction targets;
4. To provide market incentives for biofuel use with no, or low, ILUC emissions. This approach is particularly aimed at second- and third-generation biofuels produced from feedstock which do not create an additional demand for land (including algae, straw, and various types of waste). These fuels will contribute towards the target of 10% renewable energy in the transport sector, as stipulated by the Renewable Energy Directive.

The development of renewable energy is a priority commitment in Spanish energy policy, as it involves various favourable effects, such as sustainable development, a reduction of GHG emissions, the introduction of new technologies, a reduction of external energy dependence, lowering of the trade deficit, and increasing the level of employment and rural development (R.D. 1738/2010). The sixteenth item in Spanish Government Law 12/2007 (Jefatura del Estado, 2007), dated 2 July 2007, concerning hydrocarbon use, sets annual targets for biofuels and other renewable fuels for transport purposes to be achieved by 2010. These targets were obligatory from 2009 and set to reach 5.83% in 2010 (which is above the 5.75% set in Directive 2003/30/EC; in other countries such as Ireland it was revised downwards, setting a 3% for 2010 (Thamsiriroj and Murphy, 2010)), 6.4% in 2011, and 6.5% in 2012 and 2013 (R.D. 459/2011). Nevertheless, in a resolution announced by the Spanish Government's Energy Secretariat on 7 January 2011, the 5.83% goal was downgraded to 4.78% based on the evolution of the biofuels market. This scenario had been foreshadowed and was written into Article 11.4 of Order ITC/2877/2008. In December 2012, the Spanish government approved a downward revision of the 2013 target, from 6.5% to 4.1%.

The promotion of biofuels in Spain, at the time in which this study is set (2010), was based on measures involving tax incentives (zero tax as part of the Special Tax on Hydrocarbons) that were in place until the end of 2012, and the establishment of compulsory quotas for the marketing of biofuels. The Order ITC/2877/2008 of 9

[1] The concept of ILUC is that a natural ecosystem becomes cropland and replaces grassland or other crops, in order to produce raw materials for biofuels production, and which could increase GHG emissions (Kim and Dale, 2011). For more information on this topic see Hellmann and Verburg (2010), where the consequences of Directive 2033/30 in this regard are analysed.