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RESEARCH REPORT

Biofuels—At What Cost?

A review of costs and benefits of Spain's biofuel policies

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About GSI

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Acronyms

APPA	Spanish Renewable Energy Association
ASCM	Agreement on Subsidies and Countervailing Measures
CNE	National Energy Commission
EBB	European Biodiesel Board
EU	European Union
GATT	General Agreements on Tariffs and Trade
GDP	Gross Domestic Product
GHG	Greenhouse gas emissions
HVO	Hydrobiodiesel
IDAE	Institute for Diversification and Energy Saving
IEA	International Energy Agency
ILUC	Indirect land use change
IRENA	International Renewable Energy Agency
LCOE	Levelized Cost of Energy
MINETUR	Ministry of Industry, Energy and Tourism
Mt CO_2e	Million tonnes of CO_2 equivalent
NREAP	National Renewable Energy Action Plan
RED	Renewable Energy Directive
RES-T	Renewable Energy Sources-Transport
SPS	Single Payment Scheme (of the European Union)
UCO	Used cooking oil
USDA	United States Department of Agriculture
WTO	World Trade Organization
SICBIOS	Biofuel Certification information system
Toe	Tonne of oil equivalent

Executive Summary

This report evaluates some of the principal issues associated with Spain's biofuels industry, support policies, employment creation, emission abatement and the role of biofuels and other renewable transport technologies in meeting EU renewable energy targets. The report assesses the costs and benefits of Spain's policies in meeting the objectives that EU member states have set out to achieve—increased energy security, improvements in environmental performance and the generation of additional economic value.

Spain has supported the use of biofuels through a variety of laws (Law 12/2007) and ministerial decrees (Ministerial Order ITC/2877/2008) setting targets for the use of biofuels for transport fuels and mechanisms through which to achieve these targets.[1] The National Energy Commission (*Comisión Nacional de la Energía*, or CNE) has been appointed as the governmental agency responsible for implementation and monitoring of biofuel mandates as well as the certification system. According to the CNE, ethanol consumption in 2011 (the target year for this study) was 470 million litres, while biodiesel consumption was 1.880 million litres[2] (CNE, 2011).

Support to Biofuels

Support to Spain's biofuel industry in 2011 was estimated at between €213 million and €237 million for ethanol and from €955 million to €1,002 million for biodiesel.

The main support mechanism for promoting biofuels in Spain is a set of blending mandates putting upwards pressure on wholesale biofuels prices in the EU compared to lower world wholesale biofuel prices. The Spanish biofuels sector is estimated to have received market price support of between €34 million and €59 million for ethanol and between €393 million and €440 million for biodiesel via higher EU wholesale prices.

Biodiesel consumption was supported by a €0.31-per-litre excise tax exemption and resulted in an estimated €562 million in foregone revenue. Ethanol consumption was supported by a €0.40-per-litre excise tax exemption and resulted in an estimated €178 million in foregone revenue.

SPS payments

A relatively small amount of feedstock for the biofuels industry is produced in Spain. Consequently, single payment scheme (SPS) payments to Spanish farmers cultivating land used for biodiesel feedstock production in Spain is also relatively small, around €2 million per annum. This contrasts with the relatively larger amount of land used to produce ethanol feedstocks. Around €188 million in SPS payments go to farmers growing feedstock (mostly corn) bound for ethanol production.

Biofuels Carbon Abatement Costs

In total, biofuels were responsible for net emission increases of around 6.5 million tonnes of carbon dioxide (CO_2) equivalent in 2011, taking into account both direct and indirect land-use change (ILUC) emissions. Emissions are

[1] The Royal Decree 459/2011 setting targets for years of 2011, 2012 and 2013 and Royal Decree 4/2013 modifying targets for years 2013 and subsequent years.

[2] EurObserv'ER projections for biofuel consumption were slightly higher—about 475 million litres for ethanol consumption and about 1.900 billion litres for biodiesel consumption—this report used figures from the National Energy Commission since these were based on actual reporting.

expected to double by 2020, although projections might change if mandatory targets for biofuel consumption revised down in 2013 are continued.

Biodiesel consumption accounted for 90 per cent of direct emissions and 96 per cent of total emissions when ILUC emissions were included. When considering both direct and ILUC emissions, ethanol and non-land-using biodiesel (such as used cooking oil) were responsible for a modest amount of net emission savings. The Royal Decree 459/2011 set targets for years of 2011, 2012 and 2013 and Royal Decree 4/2013 modified targets for 2013 and subsequent years.

Ethanol and non-land-using biodiesel have an abatement cost of respectively €488 and €194 per tonne CO_2 avoided. Since conventional biodiesel is responsible for net emission increases, no abatement cost can be calculated.

Jobs Created by the Spanish Biofuels industry

There is a wide range for the number of direct and indirect jobs created by the Spanish biofuels sector, which were estimated at between 3,797 and 12,055 in 2011. A variety of job-counting approaches are applied in measuring biofuel and renewable energy jobs reflecting the challenges in assessing the numbers and quality of sectoral jobs. The Spanish government tracks the numbers of biofuel-related jobs, which goes some way to allowing an assessment of the extent to which biofuel policies meet their official objectives.

Sectorial GDP Impact

In terms of economic benefits, the biofuel sector was estimated by the Spanish Renewable Energy Association (*Asociación de Productores de Energías Renovables*, or APPA) to contribute €426 million in additional GDP in 2011. Due to difficult economic conditions, the sector contracted for the first time in 2011, with a 14.7 per cent decrease in the sector's contribution to GDP. This was mainly due to reductions in domestic biodiesel production and increases in biodiesel imports.

Energy Security, Biofuel and Feedstock Trade

Biofuels have displaced 4 per cent of petrol and 7 per cent of diesel in 2011 but Spain still relies on significant amounts of imported fossil transport fuels. More than 75 per cent of biodiesel consumed in Spain was imported in 2011. Around 95 per cent of biodiesel feedstock was imported, with 90 per cent coming from Argentinian soy and Indonesian palm oil. Spain also imported 73 per cent of ethanol-based feedstock. A high reliance on imported biodiesel and its feedstock, as well as ethanol feedstock, may not contribute to Spain's energy security as Spain is still reliant on foreign-imported energy.

Renewable Energy Options

Spanish energy statistics show that renewable energy use in transport appears to be below targeted levels, meaning renewable energy technologies will need to be scaled up and/or energy efficiency improved to meet the EU targets. If the role of food-crop based biofuels in meeting Spain's renewable energy transport target is capped, there are few lower-cost options to replace the shortfall in renewable energy generation. The cost of scaling up other technologies in its place will be dependent on a range of factors, including the availability of renewable resources, financial and non-financial barriers, as well as the potential of new technologies to reduce investment costs and subsidy levels.

Conclusions

There has been debate about the performance of Spain's biofuel policies in meeting their stated objectives. This report shows that, in many instances, the benefits accruing to Spain have been marginal, principally because of the significant importation of foreign biofuels and feedstocks. Spain's biofuel sector—and in particular its biodiesel sector—has contracted since 2011. This has affected employment generation and other co-benefits, with economic benefits often accruing instead to foreign exporters of biofuel and feedstock. Greater monitoring and assessment is needed to further distill the costs and benefits of meeting Spain's biofuel policy objectives. Next steps could involve developing a model that takes into account various factors determining the level of subsidy, such as border tariffs and sustainability costs.

1.0 Introduction

Biofuels can be used as liquid transport fuels and are principally produced from biomass. They can substitute for petrol or diesel for use in vehicles engines and aviation. The two main biofuels in use are ethanol (also called bioethanol) and biodiesel. The main production process for ethanol is through a process of fermentation of sugar and starch crops, with the more common feedstocks being corn, sugar beets and sugar cane. Biodiesel is produced through the transesterification of fats, either from plants or other sources. Feedstocks include crops containing vegetable oils, such as palm oil, rapeseed and soybean. They can also be produced from waste products, such as used cooking oil (UCO) and tallow, which is rendered fat from animals. A range of other advanced production processes not using food-based feedstocks are being investigated in Europe and elsewhere.

Greenhouse gas (GHG) emissions from burning fossil transport fuels are a major issue policy-makers have been trying to address in order to mitigate climate change. Biofuels have been pursued as a potential way to reduce the use of conventional petroleum products in order to reduce GHG emissions. Crop-based feedstocks remove carbon from the atmosphere as part of photosynthesis during their lifetime, and, when converted to biofuels and burnt in combustion engines, they can propel a vehicle with no net production of greenhouse gases. Biofuels offer a less carbon-intensive transport fuel in a sector where policy-makers have found it difficult to implement other renewable alternatives.

As energy and climate policies have developed, policy-makers have begun to implement targets for emissions savings for biofuels on the grounds that different biofuel production pathways have different emissions savings and life-cycle effects. These include emissions generated by chemical inputs and fertilizers, fossil fuels used to run farm machinery and refineries, and emissions from transporting the fuels from point of production to point of use. One source of emissions emerges from land-use change linked to human activities such as deforestation, which has led to changes in cropping patterns to accommodate the increased production of biofeedstocks (Joint Research Centre [JRC], 2010a, 2010b) including both direct and indirect emissions from land-use.

1.1 Key Policies

1.1.1 EU policies and objectives

The two principal EU Directives for increasing biofuel usage that Spain's policy takes into account are the Renewable Energy Directive (RED) (European Commission, 2009a) and Fuel Quality Directive (FQD) (European Commission, 2009b). The RED requires member states to meet 10 per cent of their transport energy demand from renewable sources by 2020, and the FQD requires that member states reduce the emissions intensity of their transport fuels by at least 6 per cent by 2020. Both directives require that transport biofuels deliver emission reductions of at least 35 per cent in relation to transport fossil fuels. In 2017, this target increases to 50 per cent, and in 2018 it increases further to 60 per cent for new biofuel production refineries. Support is provided to biofuels on the basis that they can deliver a range of public goods. The key policy objectives are (a) reducing GHG emissions, (b) promoting the security of energy supply and (c) providing opportunities for employment and regional development, in particular in rural and isolated areas (European Commission, 2009a).

1.1.2 Spanish Policies and Objectives

To comply with EU legislation, the Spanish government has passed several Royal Decrees to promote the use of biofuels and other renewable fuels for transport starting with Royal Decree 1700/2003, which partially transposed EU law into national law[3] (EurObserv'ER Database, 2012; APPA, 2013; United States Department of Agriculture [USDA],

[3] It only partially transposed EU legislation, since the Royal Decree was limited to ethanol and biodiesel while the European Directive sets a 10 per cent target that can be met by any source of renewable energy and not only by biofuels.

2012a). Even though the EU RED does not restrict the fulfillment of the 10 per cent target to biofuel use for transport, biofuels make up the largest share of all sources of energy used for this purpose in most member states, and Spain is no exception.

In June 2007, Spain imposed mandatory biofuels blending for transport starting from beginnings of 2009, through Law 12/2007, published in July 2007, amending Law 34/1998 of the hydrocarbon sector (Ministry of Industry, Energy and Tourism [*Ministerio de Industria, Energía y Turismo*, or MINETUR] & Institute for Diversification and Energy Saving [*Instituto para la Diversificación y Ahorro de la Energía*, or IDAE], 2013). The Spanish Government then passed a ministerial order (Orden Ministerial ITC/2877/2008) in October 2008, prepared by the Ministry of Industry, Energy and Tourism, with the aim to fully implement the EU RED and FQD directives that established minimum requirements for biodiesel and ethanol for the years 2008 and 2009 as well as the mechanisms to achieve the targets. The Order also appointed the National Energy Commission (*Comisión Nacional de Energía*, or CNE) as the implementer of the biofuels mandate with responsibility (through a National Certification Scheme system) to monitor and control the amount of biofuels marketed and consumed. Two further decrees in 2010 and—Royal Decree 1738/2010 and Royal Decree 459/2011—which repealed the previous decree, established biofuel targets for the years of 2011, 2012 and 2013, in accordance with the National Renewable Energy Action Plan (NREAP–PER 2011-2020) and the CNE (APPA, 2013; Royal Decree 1738/2010; 459/2011; USDA, 2012a). The targets for 2013 and subsequent years were later revised down by Royal Decree 4/2013 in February 2013 (MINETUR & IDAE, 2013; Royal Decree-Law 4/2013, 2013).

The FQD enabled fuel operators to market B7 and E10, which are blends with volumetric biodiesel content of 7 per cent and ethanol content of 10 per cent respectively. In Spain, Royal Decree 1088/2010 transposed in 2010 the EU regulations into national legislation. For all superior blending content, the biofuel content has to be labelled.

1.1.3 Implementing Targets for Biofuel Blending

Ministerial Order ICT/2877/2008 and Royal Decree 459/2011 established mandates for the years 2008 to 2013 on an energy content base, set the same way as the EU target. The mandates were later revised in February 2013 by Royal Decree 4/2013, which decreased the mandates for 2013 and subsequent years. The mandates for years 2008 until 2013 are shown below in Table 1[4] (Circular 1/2013; Royal Decree 1597/2011; Royal Decree 459/2011; Royal Decree-Law 4/2013).

TABLE 1: BIOFUEL TARGETS AS A PERCENTAGE OF ENERGY CONTENT

YEAR	OVERALL MANDATE	BIODIESEL MANDATE	ETHANOL MANDATE
2008	1.9*	1.9	1.9
2009	3.4	2.5	2.5
2010	5.83	3.9	3.9
2011	6.2	6	3.9
2012	6.5	7	4.1
2013	4.1	4.1	3.9**

**Voluntary target for 2008, while all other targets are compulsory.*

***The mandate for ethanol is set at 3.8 per cent of energy content for the Canary Islands, Ceuta and Melilla.*

Source: Adapted from EurObserver'ER, 2012; USDA, 2012.

[4] Biofuels mandates were revised in 2011, by Royal Decree 459/2011, which modified the global biofuel targets from 5.9 per cent, 6.0 per cent and 6.1 per cent in 2011, 2012 and 2013 to 6.2 per cent, 6.5 per cent and 6.5 per cent respectively. Likewise, targets from biodiesel were modified from 3.9 per cent, 4.1 per cent and 4.1 per cent for 2011, 2012 and 2013 to 6 per cent for 2011 and 7 per cent for both 2012 and 2013. Ethanol targets remained the same as per Royal Decree 1738/2010 (APPA, 2011). Global biofuel mandates were modified by Royal Decree 4/2013 from 6.5 per cent in 2013 to 4.1 per cent, for biodiesel from 7 per cent to 4.1 per cent and for ethanol from 4.1 per cent to 3.9 per cent.

Certification System

Ministerial Order ITC/2877/2008 established the CNE as the Biofuel Certification Agency in charge of the National Certification System. The CNE delivers certificates to all obligated parties that have mandatory amounts of biofuels to supply to the Spanish market, monitors and controls compliance to the certification scheme and, more recently, verifies compliance with the sustainability criteria set up by the EU (CNE, 2013). It has done so since 2009, via an online certification information system (SICBIOS) where obligated parties have to open accounts and provide required information. Section 3 on Support Measures provides further discussion of the system, while Box 1 outlines the details of the certification scheme.

BOX 1: CERTIFICATION SCHEME

Under the Ministerial Order ITC/2877/2008, Royal Decree-Law 4/2013 and the Circular 1/2013 of May 2013, through which the use of biofuels and other renewable energies for transport are regulated, obligated fuel suppliers[i] (such as wholesale petrol operators, petrol products retailers and consumers of petrol products, as described in Article Three of the Circular, p.44624) are required to deliver a percentage of fuels for road transport supplied in the Spanish market from renewable sources (Circular 1/2013, 2013; MINETUR & IDAE, 2013). From October 1, 2009 the Spanish government implemented a biofuel certificate scheme where any obligated party, including biofuel producers and importers that directly supply biofuels into the Spanish market, may claim and be issued certificates that have a maximum value of €763 per tonne of oil equivalent (toe) as of 2013, while obligated parties unable to meet legal targets are subject to a fine of €763 per certificate (Resolution 2013; Circular 1/2013; CNE, 2011). Until 2013, obligated parties were subject to a fine of €350 per certificate and the maximum value of a certificate was €350, including our reference year, 2011.[ii]

The certification scheme acts as a balancing mechanism for obligated parties unable to meet the required blending targets, allowing certificates to be retained or sold on to obligated companies to be used to meet their obligation to sell biofuels up to the legal target.[iii] The certification system also allows for transferring up to 30 per cent of each party's certificates to the next year since 2010 and buying (from a compensatory fund) surplus certificates from obliged parties at the end of the fiscal year. The money from the compensatory fund comes from fines of €763 per certificate paid by obligated parties who have not met their targets. The money in the fund is then redistributed among parties with surplus certificates with a value of up to €763 per certificate (Resolution 2013; Circular 1/2013; CNE, 2013b; USDA, 2012a;).

Based on National Energy Commission data, the number of biofuel certificates issued in 2011 was 1,511,658 (87 per cent) for biodiesel[iv] and 225,647 (13 per cent) for ethanol[v] (CNE, 2011) with a total of 1,737,305 certificates issued. There is no data available on the breakdown of certificates between parties, such as specialist biofuel-producing companies and companies producing or distributing biofuel and fossil fuels. It is theoretically possible for biofuel companies selling into the fuels market to claim certificates and redeem them as an additional revenue stream.

[i] There are also designated "verification parties" that are required to provide all relevant information on their biofuel market transactions (production, consumption, trade) to the CNE, but do not claim certificates, since they do not sell directly to the Spanish market (personal communication with CNE, 2013).
[ii] This meant that a fine of €350 per certificate, equal to €0.177/L for ethanol and to €0.276/L for toe of biodiesel.
[iii] CNE provides annual reports on the Spanish biofuel sector and monthly reports on certificates market transactions.
[iv] Called in Spanish Certificados de Biocarburantes en Diesel, or CBD.
[v] Called in Spanish Certificados de Biocarburantes en Gasolina, or CBG.

Sustainability Criteria and Transposition into National Regulations

Biofuel production and consumption has resulted in a number of unintended impacts, such as changes in land-use patterns, food price increases and food security concerns. These impacts have been the subject of significant research and analysis. As a result, Renewable Energy Directive 2009/28/EC enacted sustainability criteria[5] for biofuels and bioliquids, requiring that transport biofuels used to meet the mandates deliver a minimum of 35 per cent of emission reductions in relation to fossil transport fuels (European Commission, 2009a). From 2017, this target increases to 50 per cent and to 60 per cent from 2018 onwards for new biofuel production refineries. It

[5] The sustainability criteria are identified in Article 17 of Renewable Energy Directive 2009/28/EC.

also requires that biofuels not be made "from raw materials obtained from land with high biodiversity value" or from "land with high carbon stock" to be able to count towards the European Directive mandates (European Commission, 2009a, Art.17, pp. 24–25). Royal Decree 1597/2011, prepared by MINETUR, transposed these sustainability criteria into Spanish regulation. It defines the national scheme for verification of compliance and puts it under the authority of the CNE. Initially, a transition period was implemented until January 1, 2013, to allow time for the verification system to be set up, at which point meeting sustainability criteria would have been mandatory to obtain certification (CNE, 2009; USDA, 2012). However, Royal Decree 4/2013 modified this regulation and extended the transition period until further legislation guidance is provided.[6] This means that, for now, it is not mandatory to meet sustainability criteria to receive certification, but applicants must provide relevant information for monitoring purposes. Moreover, Royal Decree 1597/2011 and subsequent Decree 4/2013 also set out double counting regulation for biofuels made of waste materials, residues, non-food cellulosic and lignocellulosic material to be counted twice that of other biofuels towards obligations. This would allow more sustainable biofeedstocks to receive twice as many certificates as other types. Double counting has not yet been established and will only be implemented when the Resolution from the Energy Secretary of State is passed (Circular 1/2013).

Additionally, on October 17, 2012, the European Commission and Parliament began discussing a proposal that food-based biofuels be capped at 5 per cent, meaning they can only account for 5 per cent of the 10 per cent target for renewable energy in transport.

However, many questions remain about what policy options (and policy mixes) are best to transition to a low-carbon, resilient and economically prosperous society, and what role biofuels could play in this transition.

1.2 Objectives of This Study

The study is set against the three key official objectives justifying the support provided to the EU biofuel industry: (a) reducing carbon emissions from transport, (b) supporting rural development and (c) improving energy security. This study aims to help promote a better understanding of the cost-effectiveness of this support.

This study reviews a selection of costs and benefits associated with the use of biofuels, which are linked to a wide range of stakeholders, including motorists, the general public, taxpayers, the biofuels industry itself and EU farmers. Depending on the method of assessment, biofuel use may deliver a cost under one scenario and benefit under another. Some costs of using biofuels are: subsidizing the industry, which can be paid for by taxpayers or motorists; increased food prices due to the use of conventional biofuels pushing up commodity prices; higher motoring costs (because biofuels are more expensive than fossil fuels); and food-based feedstocks resulting in indirect land-use changes and thus generating more emissions than they displace.

Some of the benefits of using biofuels are: its ability to displace the use of fossil fuels (thus improving energy security in countries that are less reliant on unstable imports of oil for the refining of petrol and diesel); a reduction in emissions from biofuel replacing dirty petroleum transport fuels; employment creation, ranging from biofuel production and refining facilities to other parts of the supply chain and wider economy; the contribution of biofuel companies to the tax base of governments through corporate taxation; the use of first-generation feedstocks improving farmers' incomes via higher commodity prices;[7] and the use of ethanol as a fuel additive to improve vehicles engine performance.[8]

[6] The Royal Decree expands the transition period to eight more months minimum or until further legislation is passed.

[7] A significant amount has been written on the effects of biofuels on food commodity prices, and this report does not address this issue. Research by Ecofys (2012) found that between 2007 and 2010 EU-27 biofuel production may have contributed to between 1 to 2 per cent of wheat and coarse grain price increases, and non-cereal food commodities by about 4 per cent.

[8] Some of these issues are explored in an earlier IISD research publication *Biofuels: At What Cost? A review of costs and benefits of EU biofuel policies.* Additional information on these issues is available from intergovernmental organizations, such as the Organisation for Economic Co-operation and Development (OECD), Food and Agriculture Organization of the United Nations, the International Energy Agency (IEA), biofuel industry associations and a wide range of research organizations.

2.0 Background

2.1 Market Formation and Trends

In 2011, the market turnover[9] of the Spanish biofuel industry was estimated to be €1.6 billion (EurObserver'ER, 2013). At the same time, the contribution of the biofuel sector to GDP for the same year is estimated by the Spanish Renewable Energy Association (APPA) at €426.4 million[10] (APPA, 2011). Variations between GDP contribution and market turnover estimates likely reflect different methodologies used to calculate them as well as a 15 per cent decrease in GDP contributions between 2010 and 2011 (APPA, 2011). The Spanish biofuel industry has members within APPA listed under "Biofuels" (APPA, 2013). The CNE publishes annual reports with biofuel consumption data, feedstock, country of origin, estimated GHG savings and certification figures.

Spain is one of the leading countries in the European Union in terms of ethanol production capacity and consumption. It is also one of the EU member states with the most installed biodiesel production capacity, with establishment of biodiesel plants substantially increasingly until 2009 (USDA, 2011, 2012a). However, since 2009 (and especially since 2011), biodiesel production has decreased significantly due to poor market conditions, which have been ascribed to high competition from imported biodiesel, with most biodiesel plants working at only 25 per cent of their installed capacity in 2011 (CNE, 2011; USDA, 2011).

In terms of fuel mix, ethanol represented 4.2 per cent in terms of energy content and biodiesel represented 6.6 per cent in terms of energy content (see Table 2). Ethanol consumption had in 2011 thus exceeded its mandated amount of 3.9 per cent, with the same true for biodiesel consumption, which exceeded its mandated amount of 6 per cent (CNE, 2011). Consumption of both biofuels was 6.1 per cent in terms of energy content, which was slightly lower than the overall mandated amount of 6.2 per cent. See Table 2 below for past energy content percentages achieved against set mandates.

TABLE 2: MANDATE AND CONSUMPTION IN TERMS OF ENERGY CONTENT, IN PERCENTAGES[11]

YEAR	OVERALL MANDATE	OVERALL CONSUMPTION	ETHANOL MANDATE	ETHANOL CONSUMPTION	BIODIESEL MANDATE	BIODIESEL CONSUMPTION
2009	3.4	3.4	2.5	2.5	2.5	3.7
2010	5.8	4.9	3.9	3.9	3.9	5.0
2011	6.2	6.1	3.9	4.2	6	6.6

Source: Adapted from USDA, 2012a; CNE, 2011.

[9] Turnover figures calculated by EurObserv'ER are expressed in current euros and focus on the main economic investment activity of the supply chain (manufacturing, distribution and installation of equipment, plant operations and maintenance).

[10] €426.4 million, of which €289 million of direct share and €137.5 million of indirect share (APPA, 2011).

[11] Numbers are rounded up.

2.2 Methodology

For empirical data used in this study, discrepancies among different data sources are evident. European-level data sources such as Eurostat and the European Commission were used, while national information sources, primarily the CNE and the IDAE—part of the MINETUR—provided significant sources of data. On issues such as biofuel production, consumption and direct jobs, preference was given to the data compiled by the Spanish government and the industry associations (APPA, European Biodiesel Board [EBB], ePure) and also used by Ecofys and EurObserv'ER which formed the basis for authors' own calculations when needed. The authors reviewed the most frequently cited recent studies, looking at the range of available estimates and best available scientific research.[12] The year 2011 has been chosen as a reference year for the study, and most of the calculations have been conducted for this year, excluding the cases where this has not been possible due to a lack of data or estimates.

[12] When interpreting these estimates for policy, the authors were guided by the Precautionary Principle, which states that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically" (Wingspread Consensus Statement on the Precautionary Principle, 1998). This principle is legally binding for the European Union and has taken the form of Article 191 of the Treaty on the Functioning of the European Union (Consolidated Version of the Treaty on the Functioning of the European Union, 2008).

3.0 Support to the Spanish Biofuels Sector

3.1 Purpose

This section provides an assessment and quantified figure for the level of support provided to biofuel production and consumption in Spain. The support estimate put forward here is principally for conventional biofuels.[13]

3.2 Introduction

Identifying and measuring the various support mechanisms is a complex challenge. Often the necessary data are not available, either because member states do not report on their measures or because official statistical data—for example on trade volumes—are not available

The GSI method for estimating support is based on valuing individual support programs and a bottom-up approach. The method aims to value individual policies or programs provided by policy-makers at different points in the production and consumption value chain. The benefit of this approach is it provides better information on who bears the costs of the policy and the potential beneficiaries. For example, it provides a financial value on the benefit of EU mandates for those biofuel producers selling into the EU biofuels market. At the same time, measuring the cost of excise tax exemptions for biofuel consumption allows for a better understanding of the cost to taxpayers due to foregone revenue.

There are other approaches to measuring subsidies, such as that used by the IEA and described further below. The price-gap approach applied by the IEA is relatively less resource intensive and measures the cost of using biofuels by estimating the additional expense of ethanol and biodiesel per litre (multiplied by the amount of biofuels consumed in a given year and country) versus petrol and diesel. Motorists' additional expenditure on biofuels is estimated as the cost of the policy or subsidy. It does, however, mean the cost of individual policy instruments such R&D grants, capital grants or special excise taxes are not valued nor are the beneficiaries of these policies clearly identified.

The support estimate provided by GSI assesses a variety of policies (and identifies their beneficiaries). It is a broad estimate that should be considered to be for the wider biofuels industry or sector, as opposed specifically to biofuel producers.

Spanish support polices have included a legally enforceable mandate to blend biofuels and tax exemptions which

BOX 2: CONTEXTUALIZING THE NUMBERS—SUBSIDIES TO BIOFUELS COMPARED TO SUBSIDIES TO OTHER ENERGY SOURCES

All energy sources in the world are subsidized. Historically, the most subsidized energy source is fossil fuels. The International Energy Agency (IEA) estimates that fossil-fuel consumer subsidies in non-OECD (Organisation for Economic Co-operation and Development) countries amounted to US$523 billion in 2011 (IEA, 2012), while IISD's GSI estimates fossil-fuel producer subsidies worldwide at US$100 billion (APEC Energy Working Group, 2012). These estimates of fossil-fuel subsidy values do not include the non-internalized environmental externalities, first of all the cost of greenhouse gas emissions to the society. Hence, many countries have introduced energy-efficiency measures, subsidies to biofuels and renewable technologies amongst other objectives with the aim of creating public goods in the form of carbon emission reductions and to level the "playing field" already distorted by subsidies to fossil fuels. The high level of subsidies to fossil fuels, and especially petroleum transport fuels, poses barriers to the introduction of a diversified energy mix (especially in the transport sector). This is because subsidies to fossil-fuel producers encourage the continued exploration for and extraction of fossil fuels and consumer subsidies simply lower the price of the final product to consumers.

[13] A basic overview of R&D programs for second-generation or advanced biofuels is contained in Annex B.

were phased out on December 31, 2012.[14] At present, the principal policies supporting the deployment of conventional biofuels in Spain are Ministerial Order ITC/2877/2008 and Royal Decrees-Laws 12/2007, 459/2011 and 4/2013.

BOX 3: THE MECHANICS OF BIOFUEL SUBSIDIES IN EUROPE

In common usage, the word "subsidy" is often thought to refer only to a direct transfer of funds from a government to a private actor. In contrast, under international law the notion of subsidy includes a wide range of preferential treatment—financial and otherwise— that governments provide to consumers and producers on various grounds. Subsidies are often justified as being designed to supply public goods that the market fails to create or as being temporary measures to enable maturation of new technologies and create a larger market for subsidized products with the objective of reducing their cost and increasing their competitiveness over time (OECD, 1996).

One of the most authoritative "subsidy" definitions is formulated in Article 1 of the Agreement on Subsidies and Countervailing Measures (ASCM), which has been agreed by 155 members of the World Trade Organization (WTO) and covers direct and indirect transfer of funds and liabilities, various forms of tax relief, provision of access to capital, land, water and public infrastructure at below-market rates, as well as market and price support. Importantly, in order to be considered a subsidy, such preferential treatment has to be specific to a company or industry compared to other economic agents.

Importantly for the subject matter of this report, the ASCM definition does not include market price support induced through tariffs or mandates. Meanwhile, consumption mandates have become the main policy providing government support to biofuels in many countries.

Therefore, a number of stakeholders and experts, including the IEA and GSI, consider the market price support enabled by consumption mandates to be a subsidy (IEA, 2011; Lang, 2010). Mandates act in the same way as other subsidy forms, driving up market clearing prices and setting the demand floor, thereby improving competitiveness of biofuel producers (Koplow, 2009a).

3.3 Spain's Support Measures

3.3.1 Market Transfers

Market price support broadly measures the intervention affecting both consumer and producer prices by artificially elevating the price of biofuels. In the European Union, among the most important instruments are mandatory blending rates and border protection through tariffs (European Commission, 2011).

The former establishes mandatory requirements for the share of biofuels in transport fuels sold, whereas the latter aims at protecting European production of biofuels through tariffs on biofuel imports. A mandate allows biofuel producers to overcome technical or other barriers imposed by primary fuel suppliers, who may object to the use of biofuels, while also providing long(er)-term targets, thus enhancing the predictability of market developments and reducing investment risks. Because mandates put upwards pressure on wholesale biofuel clearing prices, the beneficiaries of this policy are biofuel producers who are able to sell into the EU market at an elevated price if the mandates were reduced or removed. Thus, since biofuels are currently more expensive to produce than fossil fuels, the additional costs at the pump are borne by consumers.

[14] Tax exemptions, such as those established by the Special Duty Act, remain in place for biofuel pilot projects, which are for the "technological development of less-polluting products" and are experimental and time-limited projects with a maximum annual production limit of 5,000 litres of biofuels. This is a voluntary scheme managed by the Tax Administration's Department of Customs and Excise Duties (cited in Ministry of Industry, Energy and Tourism & IDAE, 2012, pp. 36–37).

Market size (the total value of transactions) can be estimated from measuring the total production or consumption of biofuels and some measure of the market price. To put the following market price support estimates in context, the 2011 market size of Spain's ethanol industry was estimated at €309 million[15] and the biodiesel market at €1,650 million[16].

Valuing the support provided to the biofuels sector from mandates is challenging. This paper that recognizes there are a range of factors other than blending mandates that may affect EU wholesale biofuel prices (such as higher production costs, sustainability costs and tariffs on imported biofuels) and hence this is an initial effort to put forward a preliminary assessment of the level of market price support provided via blending mandates.

BOX 4: METHODOLOGICAL NOTE ON ESTIMATING THE SUPPORT PROVIDED BY MEMBER STATE CONSUMPTION MANDATES

The level of support provided by the consumption mandates is assessed from the viewpoint of a theoretical producer of biofuel (whether located inside or outside of the EU region). A biofuel producer will identify the best market to sell their product based on a range of factors, but it will principally be determined by the price they are able to secure. In the EU, prices for ethanol and biodiesel are higher than average world prices; hence, a biofuel producer will factor in transport costs for their product, and then estimate the profit they could make from selling into the EU market. The higher price for biofuel in the EU represents demand (and supply) forces. This analysis attempts to estimate the value of biofuel consumption mandates introduced by member states (the consumption mandates help establish a market for biofuels) while recognizing there are range of other factors affecting biofuel clearing prices (these are discussed further below). The value of consumption mandates implemented by EU member states in support of ethanol and biodiesel consumption was estimated as the difference between the EU wholesale price for biofuels and a world reference price, minus an adjustment for freight costs. The amount of support estimated is very sensitive to changes in either world or EU reference prices.* See Koplow (2009b) for a deeper discussion of the challenges in applying a price-gap methodology.

Limitations to This Analysis

There are a number of factors that complicate this method of assessment. There may also be a range of other factors pushing up (or down) EU wholesale market prices that are not accounted for in this method. These may include:

- **EU biofuel production costs will be higher than production costs in non-EU countries** due to a range of factors including higher energy costs, salaries, health and safety compliance etc.
- **The extent to which the EU market prices contribute to world reference prices will also affect any price-gap calculations**. While ethanol produced in the EU is a small part of the world market (an average of around 6 per cent of world production during 2008–2010), biodiesel produced in Europe forms a significant part of the global biodiesel market (an average of around 52 per cent of world production during 2008–2010) (OECD, 2011).
- **Sustainability costs** involving administrative and reporting requirements to meet EU regulations can result in additional operational costs pushing up EU biofuel prices as opposed to upward pressure from blending mandates. These costs can push up EU prices and the theoretical size of support provided by the mandates (Charles & Wooders, 2011).
- **Imported biofuel from outside of the EU is subject to border taxes**, such as taxes on undenatured ethanol of €0.19 and €0.10 on denatured, and import duty on biodiesel (6.5 per cent ad valorem) (Ecofys & German Union for the Promotion of Oils and Protein Plants, 2012). The effect of EU tariffs or anti-dumping duties on ethanol and biodiesel, while correcting unfair market situations, also push up the costs of imported biofuels, thereby increasing EU biofuel prices and increasing the size of the price-gap and the support value.

[15] The ethanol industry's market size in Spain in 2011 was calculated as the number of litres of ethanol consumed (490 million) multiplied by an average EU price per litre price for ethanol (€0.63 per litre).
[16] The biodiesel industry's market size in Spain in 2011 was calculated as the number of litres of biodiesel consumed (1,833 million) multiplied by an average EU price per litre price for ethanol (€0.90 per litre).

- There could also be a range of other policies or market forces affecting wholesale market prices.

Due to the complexity of these forces acting on EU whole market prices, they were not accounted for as part of the method for measuring market price support.

Market price support for ethanol was calculated by multiplying production and imports figures by a price gap of between €0.07–€0.12 per litre (the difference between the EU ethanol wholesale average price of between €0.58-€0.63[17] per litre and the world ethanol average price of €0.47 per litre minus transport and handling charges).

TABLE 3: MARKET PRICE SUPPORT TO ETHANOL FOR 2011†

	2011
Spanish production of ethanol (million litres)*	278
Spanish ethanol imports (million litres)**	212
EU ethanol wholesale average price (€/litre)***	0.58-0.63
World ethanol average price (€/litre)***	0.47
Transport and handling charges, Brazil to the EU (€/litre)****	0.04
Price gap (€/litre)	0.07-0.12
Market price support—production (million €)	19-33
Market price support—imports (million €)	15-25
Total Market price support (million €)	**34-59**

** Source : CNE, 2011.*
*** Source : CNE, 2011.*
**** Source: OECD-FAO, 2011.*
***** Source: Personal communications with Brazilian ethanol expert, 2013. €0.04 per litre for shipping ethanol from Brazil to Europe was used as a proxy for distribution costs, which would need to be paid by the ethanol producer (Personal communications with Brazilian ethanol expert, 2013). It is possible that this is a lower bound estimate, with shipping costs from Brazil to Europe being higher depending on conditions, which would reduce the price-gap figure and the level of support via the mandates to ethanol.*
† Statistical variance between the number of tonnes imported, exported and consumed of 18,504 m³ due to statistical anomalies and energy losses.
Note: columns may not sum due to rounding of figures.

Market price support for biodiesel was calculated by multiplying production and imports figures by a price gap of €0.21-0.24 per litre (the difference between EU biodiesel wholesale average price of €0.83-€0.90[18] per litre and the world biodiesel average price of €0.62 per litre minus transport and handling charges).

[17] A sensitivity analysis was provided for the EU wholesale ethanol price to develop a range estimate.
[18] A sensitivity analysis was provided for the EU wholesale ethanol price to develop a range estimate.

TABLE 4: MARKET PRICE SUPPORT TO BIODIESEL FOR 2011†

	2011
Spanish production of biodiesel (million litres)*	444
Spanish biodiesel imports (litres)*	1,391
EU biodiesel wholesale average price (€/litre)**	0.83-0.90
World biodiesel average price (€/litre)***	0.62
Internal domestic transport and handling charges (€/litre)****	0.04
Price gap (€/litre)	0.21-0.24
Market price support—production (€ million)	95-106
Market price support-imports (million €)	298-334
Total Market Price support (million €)	**393-440**

** Source: CNE, 2011.*

*** Source: BigOil.net, 2012.*

**** Source: Ecofys & German Union for the Promotion of Oils and Protein Plants, 2012.*

***** Source: Authors' calculations: €0.04 per litre for biodiesel distributed within Europe was used as a proxy for distribution costs that would need to be paid by the biodiesel producers. It is possible that this is a lower bound estimate, with shipping and distribution costs being higher depending on conditions, which would reduce the price-gap figure and the level of support via the mandates to biodiesel.*

† Statistical variance between the number of litres imported, exported and consumed of 44,729 m^3 due to statistical anomalies and energy losses)

3.3.2 Budgetary Support Linked to Volume Produced or Consumed

To decrease the end price of biofuels to consumers and make them similar to the prices of the conventional petroleum-based fuels, fiscal incentives for the commercialization of biofuels were established under Law 22/2005, through until the end of year 2012[19] (European Renewable Energy Council [EREC], 2008).

Within the European Union the Commission's proposed amendments to the Energy Taxation Directive focuses on setting taxation levels of products based on the energy and carbon traits of fuels (European Commission, 2013). Applying the Energy Taxation Directive would result in a per-litre excise tax exemption for biofuels up to a level consistent with the energy content of petrol and ethanol, and biodiesel and diesel, so the fuels were taxed equally on the basis of energy and removing any subsidy to biofuels.

Ethanol

In 2011, ethanol enjoyed a 100 per cent tax exemption of the *impuesto especial de hidrocarburos* (€0.401/l) but no exemption on the "impuesto de ventas minoristas de determinados hidrocarburos" (€0,041/l) as an average for Spain.

[19] The consumption of biofuels was not exempted from two other existing taxes: the "tax on the retail sales of certain hydrocarbons" (IVMH), including a national component and regional component, as well as the value-added tax (IVA).

TABLE 5: EXCISE TAX EXEMPTIONS FOR ETHANOL ON A PER-LITRE BASIS

2011 ETHANOL				
QUANTITY CONSUMED (MILLION LITRES)	GASOLINE EXCISE TAX (€/L)	ETHANOL EXCISE TAX (€/L)	EXCISE TAX EXEMPTION (€/L)	LOSS OF FISCAL REVENUES (€ MILLION)
444	0.442	0.041	0.401	178

Sources:
**2011 Unleaded petrol excise tax rate, source: AOP, 2011.*
**2011 Ethanol excise tax exemption, source: European Commission, p. 8, 2012*
**Consumption data: source: CNE, 2011 (note there is some variation in consumption data based on source).*

Biodiesel

In 2011, biodiesel enjoyed a 100 per cent tax exemption of the *impuesto especial de hidrocarburos* (€0.307/l) but no exemption on the *impuesto de ventas minoristas de determinados hidrocarburos* (€0.039/l) as an average for Spain.

TABLE 6: EXCISE TAX EXEMPTIONS FOR BIODIESEL ON A PER-LITRE BASIS

2011 BIODIESEL				
QUANTITY CONSUMED (MILLION LITRES)	DIESEL EXCISE TAX (€/L)	BIODIESEL EXCISE TAX (€/L)	EXCISE TAX EXEMPTION (€/L)	LOSS OF FISCAL REVENUES (€ MILLION)
1,830	0.346	0.039	0.307	562

Sources:
**2011 Diesel excise tax rate, source: AOP, 2011.*
**2011 Biodiesel excise tax exemption, source: European Commission, p. 13, 2012.*
**Consumption data: source: CNE, 2011 (note there is some variation in consumption data based on source).*

3.4 Summary of Subsidies to Biofuels

The following table summarizes the level of support provided to the Spanish biofuels sector in 2011 via blending mandates and excise tax exemptions.

TABLE 7: SUMMARY TABLE OF BIOFUEL SUPPORT PROVIDED IN 2011

2011[†]	ETHANOL	BIODIESEL	TOTAL
Tax exemptions (million €)	178	562	740
Market price support via blending mandates (million €)	34-59	393-440	428-499
Total subsidy (million €)	**213-237**	**955-1,002**	**1,168-1,239**
Spanish Biofuel consumption (litres)	469	1,880	2,349

[†]Due to subsidy estimates being rounded to the nearest million € there may be some variation in the summing of rows or columns.

The form of support are legally binding blending requirement which, provides a strong market pull mechanism guaranteeing investors and biofuel producers a market for their product and putting upward pressure of Spanish wholesale biofuel prices and excise tax exemptions for biofuels.

4.0 *SPS Payments*

4.1 Purpose

This section estimates the volumes of agricultural payments under the Single Payment Scheme (SPS) provided to farmers growing food crops based on their end consumptive use whether it is for food or biofeedstock markets.

4.2 Introduction

Spanish farmers are eligible for subsidies under the Single Payment Scheme (SPS), sometimes referred to as the Single Farm Payment Scheme, which is part of the European Union's Common Agricultural policy (CAP). Introduced in 2005, the SPS was part of the CAP reforms designed to decouple subsidies from production-related aid and allows farmers greater freedom to switch to alternative enterprises, such as bioenergy crop production. The aim of the regulation was also to help simplify and modernize the CAP's administration (Europa, 2009).

There are no specific SPS payments or schemes to support biofeedstock production. Instead, those annual energy crops grown for biofeedstock production (e.g., rapeseed, sugar beets and cereals) are eligible for the SPS payment, as are other crops that meet the necessary SPS regulations. This analysis does not infer that the SPS payments are a direct subsidy or transfer to the biofuels industry. Calculating the portion of the SPS payments going to farmers growing energy crops is aimed at providing better information on how the CAP is spent and the type of activities to be helpful to policy makers. **Hence, knowing what percentage of SPS payments accruing to farmers for growing crops destined for the biofuels market, versus crops destined for food or feed markets, is of public benefit**.

There is relatively little transparency across European countries on how many hectares are being utilized for biofeedstock production. Therefore, this study had to rely on an indirect method to calculate the amount. While the production of biofeedstock in Spain was unknown (CNE, 2011), average yields were calculated by dividing the amount of tonnes of different types of feedstock produced in the whole of Spain with the amount of hectares used for this production.[20] This data is made available by the Ministry of Agriculture (Ministry of Agriculture and Environment, 2013). The number of hectares were then multiplied by the average per-hectare SPS rate in Spain, which in 2011 was around €77.8 per hectare (personal communication with Spanish Agrarian Guarantee Fund [*Fondo Espanol de Garantia Agraria,* or FEGA], 2013). See Table 8 below for the amount of SPS payments for land used to grow biofuel feedstocks for the year 2010[21] in Spain.

4.3 Results

The following table shows the amount of land being used to grow biofeedstocks and the SPS payments that have accrued to farmers for this activity.

[20] The number of hectares of arable land used for biofeedstock production may be underestimated in certain cases due to data constraints. SPS payments may also be overestimated, as this calculation does not take into account the production of co-products from biofeedstock production.

[21] The year 2010 was used to calculate SPS since no data were available for 2011.

TABLE 8: SPS PAYMENTS TO BIOFEEDSTOCK PRODUCTION IN SPAIN

COUNTRY	BIOFUEL	HA FEEDSTOCK	YEAR (HA)	AVERAGE (€/HA)	TOTAL (€MILLION)
European Union	**Total**	**3,600,000**	**2008**	**266**	**958**
Spain	Ethanol	675,181	2010	278	188
	Biodiesel	6,548	2010	278	2
	Total	**681,729**	**2010**	**278**	**190**

Source: Author's calculations based on EU data from GSI, 2013.

This section summarizes the distribution of SPS payments based on the quantity of land used to produce feedstocks used in biofuel production, while noting SPS payments are not used to promote energy crops directly and are available to farmers irrelevant of their crops' final end use. Based on 2010 cropping data, €190 million in farm payments went to farmers growing crops for biofuels production. Of this figure, around €2 million in SPS payments went to farmers growing food crops used in biodiesel production. Given the extensive imports of biodiesel feedstock, it is not surprising that the level of SPS payments paid to farmers producing crops for the biodiesel market was small. Unlike biodiesel feedstock, a smaller proportion of ethanol feedstock is imported. Around €188 million annually in SPS payments are paid to farmers producing ethanol feedstock. Most of this goes to production of corn and wheat. The amount of SPS payments provided to farmers growing crops channelled to food or other markets wasn't calculated.

5.0 *Emission Reductions*

5.1 Purpose

This section estimates the amount of direct and indirect emissions from biofuels based on Spain's government biofuel consumption data and European Commission emission factors, generating carbon abatement costs for ethanol and biodiesel.

5.2 Introduction

Emissions from biofuels can be broadly split up into two different groups: (1) direct emissions from the cultivation, processing and transport of biofuels, including direct land-use change, and (2) emissions from indirect land-use change (ILUC) associated with the growing of biofuel feedstock crops (European Commission, 2012a). This section addresses total emissions and emission savings associated with non-land-using biodiesel (tallow and used cooking oil), conventional biodiesel (based on virgin vegetable oils), ethanol and total biofuel consumption in Spain, for the calendar year 2011.

5.3 Methodology

The amount of emissions is to a great degree related to what crop is being used to produce the biofuel. However, there is a lack of transparency in most European countries on what types of feedstock the consumed biofuels are based upon. Spain does provide an overview in percentages and in cubic metres of the underlying feedstock used for biofuels consumed. The National Energy Commission has been in charge of producing annual reports on the use of biofuels in Spain since 2009. These reports include production and consumption figures, what feedstock types are used and from which countries Spain imports feedstocks and biofuels.

This analysis has therefore relied on the feedstock distribution patterns in the calendar year 2011. For 2020, a business-as-usual scenario for ethanol and biodiesel based on 2011 feedstock figures was assumed, attributing an equal proportion of biodiesel based on used cooking oil (UCO) and tallow in 2020 as observed in 2011 (6.58 per cent).

For estimates of direct emissions from biofuels, the assessment relied on the numbers used by the European Commission in its proposal of October 17, 2012 to amend the Fuel Quality Directive (FQD) and the Renewable Energy Directive (RED) (European Commission, 2012b). To estimate biofuel-associated emissions from ILUC, the analysis used central ILUC factors proposed by the European Commission in the same proposal. These factors are based on the Laborde (2011) study, which is considered the best available science in the area of ILUC modelling. The European Commission uses a zero ILUC-factor for biodiesel made from UCO and tallow.

This analysis estimates the amount of emissions and emission savings for the year 2011 based on actual consumption data, and for the year 2020 based on projections of biodiesel and ethanol consumption in the National Renewable Energy Action Plan of Spain. Note that with the pending proposal and legislative changes of EU biofuels policy, as well as the reduced Spanish mandates for 2013 and the years to come, these projections may need to be adjusted in the near future. That is why the 2020 number reflects the amount of emissions and emissions savings in a business-as-usual scenario, which can be used as a reference number in future analysis.

5.4 Direct, Indirect and Total Emissions Associated With Biofuel Consumption in Spain

TABLE 9: EMISSIONS RELATED TO BIOFUEL CONSUMPTION IN SPAIN IN 2011 AND 2020 (MT CO_2EQ)

	DIRECT EMISSIONS		ILUC EMISSIONS		TOTAL EMISSIONS	
	2011	2020	2011	2020	2011	2020
Conventional biodiesel	2.82	5.88	3.20	6.67	6.02	12.55
Non-land-using biodiesel	0.04	0.08	0	0	0.04	0.08
Ethanol	0.32	0.54	0.12	0.88	0.44	1.42
Total	3.18	6.50	3.32	7.55	6.50	14.05

Source: Author's calculations.
ILUC factors: European Commission, 2012a.
Direct emission factors: European Commission, 2012b.

In 2011, Spain consumed more than six times as much biodiesel as ethanol. Only a limited amount of this biodiesel (6.58 per cent) was sourced from UCO and tallow. Most of the biodiesel and biofuels was conventional biodiesel, which is highly emission-intensive. Ethanol is generally less emission-intensive than biodiesel, but was used to a lesser extent in Spain. This is true for direct emissions, but even more so for ILUC-emissions, in which ethanol emits an amount of CO_2 about four times less per unit of energy than conventional biodiesel. According to Spain's NREAP, biodiesel use is set to increase faster than ethanol. In 2020, biodiesel would be consumed almost 8 times more than ethanol (Beurskens Hekkenberg, & Vethman, 2011).

5.4.1 Direct Emissions

In terms of direct emissions, biofuels consumed in Spain were responsible for over 3 million tonnes of CO_2 equivalent (Mt CO_2eq), of which almost 90 per cent was associated with conventional biodiesel. By 2020, biofuels will be responsible for direct emissions of around 6.5 Mt CO_2eq, of which almost 6 Mt is associated with conventional biodiesel.

5.4.2 ILUC-Related Emissions

What is Indirect Land-Use Change?

Indirect land-use change (ILUC) refers to the displacement of farming for feed or food production to other areas as a result of arable land being used for biofuel feedstock production. Simply put, when the use of arable land in the European Union shifts from food or feed production to the production of biofeedstocks (and food or feed demand patterns do not change), extra crops grown on additional land are needed to meet that demand and replace biofeedstocks diverted to biofuel production (JRC, 2008, 2010).

This additional demand is often met by increasing the cultivation of food/feed crops in jurisdictions outside of the European Union for subsequent exportation to the EU market. When carbon sinks such as forests and peat lands are cleared for such production, indirect emissions as a result of EU biofuel policies occur (JRC, 2008, 2010). In particular, vegetable oil markets are globally linked and thus prone to ILUC. Direct and indirect land-use changes are not phenomena exclusive to biofuels. Among others, agricultural and trade policies can have significant land-use change effects

Measuring or observing the exact extent of ILUC is not possible, as feedstock producers cannot measure land-use change patterns in different parts of the world; however, it is possible to model some estimates (di Lucia, Ahlgren & Ericsson, 2012). This analysis estimates ILUC-associated emissions in line with the proposal of the European Commission for biofuel emission reporting (European Commission, 2012b). The European Commission relies on ILUC factors developed by Laborde (2011).

Background on the International Food Policy Research Institute (IFPRI) Model

The Laborde study is built upon a General Equilibrium Model based on future projections of agricultural productivity, biofuel policies and international trade. Such projections are based on assumptions that are subject to a wide degree of uncertainty (JRC, 2008; Laborde, 2011). The most advanced modelling exercise to date was performed by the International Food Policy Research Institute (IFPRI). To reduce uncertainty, IFPRI performed 1,000 rounds of Monte Carlo simulations by which a sensitivity analysis of seven parameters that have the most important effect on the supply side of the model were scrutinized.

Some Key Issues

Uncertainty relating to the projected results is the main reason why the models are often criticized. Like any model, the IFPRI model is imperfect. As the author himself recognizes, there is room for improvement with regards to assumptions related to land-use expansion and substitution. Uncertainties related to additional land needed are both independent from and dependent on policies (Laborde, 2011).

Other issues have included whether the model sufficiently accounts for the protein content of biofuel co-products and that palm oil is modelled as a perennial crop. Consequently, the reporting factors in the proposals are criticized for being inaccurate. The French National Institute for Agricultural Research (INRA) recently published a report stating assumptions on crop yields for biodiesel feedstocks may be lower than actually observed (INRA, 2013).

One such issue is how the modelled emissions are partially dependent on the assumption that increased palm oil production will take place on peat land forest areas in countries like Indonesia and Malaysia. According to Delzeit (2012), this is formally illegal according to Indonesian law and the assumption is dependent on political factors such as the non-enforcement of existing regulations. A review of this Indonesian moratorium on new forest concessions indeed found that there have been clearings in primary forest in spite of the moratorium. In addition, the moratorium only applies to new concessions and it excludes secondary forests, which are also large carbon sinks (Union of Concerned Scientists, Greenpeace and World Resources Institute, 2012). Similarly, one could argue that the IFPRI numbers are underestimated, as they assume higher yields in the baseline than most other ILUC models (Marelli, 2013).

The use of Laborde's ILUC factors for consumption in 2011 may raise some questions as well. This is mainly because the ILUC factors in that study are factors for the year 2020, based on an increase in biofuel consumption relative to a 2008 baseline. In this regard, it is important to note that as part of the sensitivity analysis mentioned above, the European Commission requested that Laborde investigate the linearity of the ILUC factors. As the European Commission points out in its impact assessment accompanying the proposal, it should be noted that some crops with a strong non-linearity effect will indeed have a lower ILUC factor at lower consumption volumes (European Commission, 2012a). This is particularly the case for vegetable oils like rapeseed.

Nevertheless, based on the Laborde analysis, the European Commission still regarded the factors as the best available to estimate ILUC-related emissions of all biofuel consumption today. This is the approach this study follows, until a more sound methodology is developed and published in an authoritative source. It is advisable when reviewing the results of this paper to take into account the uncertainties related to ILUC-emission estimation for the year 2011 when analyzing the results.[22]

5.4.3 Estimated ILUC Emissions

Similarly to direct emissions associated with Spain's biofuels, ILUC-related emissions are much higher for biodiesel than for ethanol. This is in part because of higher consumption, and in part because of the higher ILUC intensity of vegetable oils compared to ethanol feedstock. In 2011, ILUC emissions associated with Spain's biofuel consumption were around 3.3 Mt CO_2eq, of which 3.2 Mt was from conventional biodiesel. While the consumption of conventional biodiesel represented about 85 per cent of conventional biofuels, it was responsible for more than 96 per cent of ILUC-related emissions. In 2020, biodiesel will be responsible for 6.7 Mt of CO_2eq in ILUC emissions. Ethanol, which is consumed to a much lesser extent, would generate less than 1 Mt of CO_2eq of ILUC emissions in 2020.

5.4.4 Total Emissions

Total emissions associated with biofuel consumption in Spain reached almost 6.5 Mt CO_2eq in 2011. 93 per cent of these emissions are related to conventional biodiesel. In 2020, it is projected that biofuels in Spain will be responsible for 14 Mt of CO_2eq in emissions, of which 12.5 Mt are related to conventional biodiesel.

5.4 Emissions Savings from Spain Biofuels

Once the total emissions associated with biofuel consumption have been estimated, a next step is to find out whether biofuels are responsible for net emissions savings or not. To do this, we first calculate how many emissions would have been emitted if fossil fuels were used to cover an equal transport energy demand.[23] In line with the European Commission (2012a), the analysis used a fossil fuel comparator of 90.3 grams/megajoule (MJ).

The results indicate a large difference between conventional biodiesel and ethanol. From one side, conventional biodiesel is responsible for a slight net emission increase. From another side, ethanol is responsible for some emission reductions. In 2011, emissions savings from ethanol were limited to about 0.5 Mt CO_2eq. As projected in Spain's NREAP, an increase in biodiesel consumption could lead to net emission increases of around 1.6 Mt CO_2eq annually from 2020 onward. Projections might change in the future if the reduced mandatory biofuel targets set in 2013 are kept.

Since countries are not yet mandated to include ILUC-related emissions into their emission reporting, estimates given by governments are often higher than the actual emission savings. For example, the CNE 2011 annual report states that biofuels in Spain are responsible for a 40 per cent GHG reduction compared to the fossil-fuel equivalent. The study estimates that this is 35 per cent and 66 per cent for biodiesel and ethanol respectively. However, when including ILUC, GSI finds that emissions savings from ethanol are 50 per cent, while there are no longer emissions savings for biodiesel. In total, biofuels were not responsible for any emission savings in 2011 and would be responsible for emission increases of 0.8 Mt of CO_2eq annually from 2020 on.

[22] For di Lucia, Ahlgren and Ericsson (2012) the precautionary principle implies the selection of high ILUC factors to guide policy making aimed at improving the certainty that no negative ILUC occurs. The choice of factors from central values would imply a preventive approach, which aims at reducing the risk of negative ILUC but has less certainty of its success than higher values. This analysis is in line with the approach of the European Commission, based on central ILUC factors.

[23] Unconventional sources of fossil fuels were not accounted for in this study.

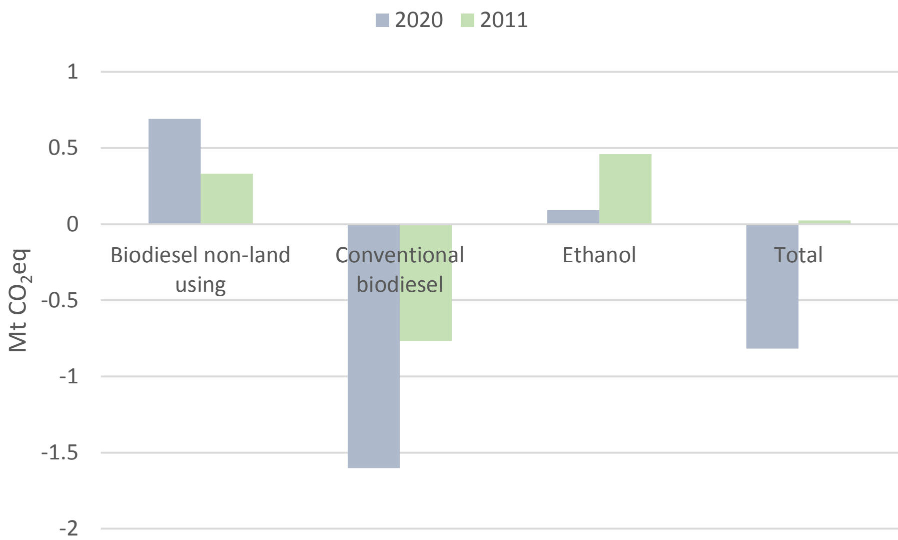

FIGURE 1: NET EMISSION SAVINGS OR INCREASES AS A RESULT OF BIOFUEL CONSUMPTION IN SPAIN (2011, 2020)

Source: Author's calculations.

ILUC factors: European Commission, 2012a.

Direct emission factors: European Commission, 2012b.

Note: "Biodiesel non-land-using" refers to used cooking oil and tallow. Conventional biodiesel represents biodiesel produced from virgin vegetable oils.

5.5 CO_2 Abatement Costs

The abatement costs estimate how much it costs for a given technology to reduce 1 tonne of CO_2eq from the atmosphere in order to mitigate climate change. The abatement cost is only calculated for 2011, as this study does not provide biofuel subsidy estimates for 2020. Based on this approach, abatement costs are highly dependent on subsidy estimates, which can be calculated using a variety of methodologies and may vary significantly (they can also change from year to year depending on the policies assessed and estimation method adopted). There are different methods and approaches to estimating abatement costs, often resulting in different figures that measure different things. The abatement cost figure in this study is done on a support-cost basis in which costs have been calculated using a bottom-up approach (see section 3 Support to Spain's Biofuels Sector).

Because conventional biodiesel is in most scenarios responsible for emissions increases, no abatement cost can be calculated. Ethanol, on the other hand, had an abatement cost in 2011 of a little over €488 per tonne CO_2 abated. UCO and tallow-based biodiesel perform best in terms of emission savings but are also subsidized. Since 6.5 per cent of biodiesel is UCO-based, this part of the market price support has been allocated to UCO support. UCO-based biodiesel is being supported at around €194 per tonne CO_2 abated. This indicates that when biofuels are seen as one singular policy for emission reductions, it is a disproportionate costly policy. The opportunity costs are very high and emission reductions can be achieved in a much more cost-effective way.

6.0 Employment Creation

6.1 Purpose

This section provides a review of employment estimates generated for Spain's biofuels sector and the geographical distribution of jobs within Spain.

6.2 Introduction

In a time of economic recession, the Spanish government, like many EU governments, considers the potential impacts of various options on employment in developing biofuel and energy-sector policy. As this section illustrates, if job creation is considered an important objective for supporting the development and deployment of biofuels, the level of detailed information available on employment effects is probably inadequate. Governmental institutions such as the Institute for Diversification and Energy Saving (IDAE) do estimate, monitor and publish job creation figures of all renewable energy sources; however, they do not disaggregate them between indirect jobs created in Spanish territory and indirect jobs created elsewhere according to the methodology used[24] (IDAE, 2011b).

BOX 5: BIOFUEL PRODUCTION: WHAT TYPES OF JOBS ARE BEING CREATED?

The biofuel industry involves the construction of biofuel plants which can provide short-term construction-related jobs that can include: labourers, civil works personnel, surveyors, structural engineers, quantity surveyors and electricians (IDAE, 2011b; MINETUR and IDAE, 2010).

Once the plants are completed, examples of jobs in general administration and management include: plant and operations managers, office administrators, health and safety managers, environment officers, labourers, financial accounting staff, feedstock purchasers, marketing and logistics personnel (MINETUR and IDAE, 2010; IDAE, 2011b).

Liquid biofuels for transport differ from wind and solar renewable energy as they involve energy inputs that are not freely available (in contrast with the wind and solar radiation) such as crops used as biofeedstocks or residues from various industries. The production of agricultural commodities used as biofuel feedstocks result in jobs in agriculture–notably those of farmers and seasonal workers (Charles, Gerasimchuk, Bridle, Moerenhout, Asmelash, & Laan, 2013).

For second-generation biofuels, to the extent that they are based on residues or waste products, their collection and pre-treatment generates jobs in this stage of the production process. Refining ethanol and biodiesel requires technically skilled labour, like chemists, plant operators and engineers, before the biofuel can be distributed for sale (ePure, 2012).

Research and development activity is carried out by the industry and can also involve academic institutions throughout Spain (IDAE, 2011b; MINETUR and IDAE, 2010).

Ethanol and biodiesel industry representatives claim that an expansion of biofuel consumption, either first-generation or second-generation fuels, would create direct jobs within the industry and additional jobs in other sectors, such as agriculture (EBB, 2012e; Pure, 2012).

6.3 Is it a Numbers Game? Jobs in the Ethanol and Biodiesel Industry

Based on an employment factor[25] proposed by the European Renewable Ethanol Association (ePure), for every 1 million litres of domestically produced renewable ethanol, approximately 16 jobs are created (ePure, 2012). Based on the ePure multiplier, Spanish ethanol production in 2011 (490 million litres) generated 7,834 jobs (production figures

[24] See methodology used to calculate indirect employment generated on p.45 and in section 4 (MINETUR & IDAE, 2011b).

[25] Employment factors refers to estimates of the average number of jobs per unit of capacity installed or fuel generated in litres, multiplied across the production base or volume of litres produced in the European Union in a given year (data sources could include reports and studies, survey in industry and farming, case studies, national statistics on consumption and production capacities).

CNE, 2011, p.41; GSI; authors' calculations). Based on an employment factor for the EU biodiesel industry extrapolated from a EurObserv'ER figure of 0.007 jobs per toe, every 1 million litres of biodiesel produced in the European Union is roughly estimated to create 5.3 jobs[26] (EurObserv'ER, 2012b). Applying this employment factor to 2011 biodiesel production figures (797 million litres) the number of jobs generated by the industry was 4,222 (production figures CNE, 2011, p. 39; GSI; authors' calculations). A combined total 12,055 jobs were estimated to have been created.

Figures generated by APPA estimated that total Spanish biofuel jobs were 3,797 in 2011, made up of 2,337 direct jobs and 1,480 induced jobs (APPA, 2011), while a EurObserv'ER report estimated jobs across the supply chain at 10,200 in 2011 (EurObserv'ER, 2012a).

A key issue is that of additionality (does the biofuels sector create new jobs or are the farm-related jobs likely to have existed with or without biofuels), in that the additional jobs created by the biofuels sector are likely those associated with biofuel processing, logistics, R&D, sustainability certification, innovation, management (due to the increased use of tanker drivers delivering biofuels) (Swenson, 2006).

6.4 The Sustainability of Jobs

If job creation is a key goal for supporting the biofuels industry, the sustainability and quality of jobs are important challenges. The employment factors used in this section for Spain (ePure, 2012; EurObserv'ER, 2012a) are based on biofuel production that occurs within the country's territory. As increasing amounts of imported biofuels and feedstocks (such as soybeans, palm oil, sugarcane and corn) are observed, especially in Spain, where 75 per cent of biodiesel is imported, the amount of jobs (based on these employment factors) would decrease proportionally. Increased importation of biofuels and feedstocks, followed by reduced production in the EU, could lead to a reduction in jobs within Spain and the EU and an increase in jobs in those countries from which the EU imports biofuels (Charles et al., 2013). In April 2012, the Spanish government attempted to introduce a biodiesel production quota system (Ministerial Order IET 822/2012) allowing only EU-based biodiesel production to be eligible for the consumption mandate. The quota system was removed from Spanish regulation shortly afterwards, due to a World Trade Organization complaint from the Argentinian government (see section 8 for more detail; International Centre for Trade and Sustainable Development [ICTSD], 2013b; WTO, 2013). Reduction in support to the EU biofuels industry may affect Spanish or EU biofuel production levels, with the number of jobs linked to biofuel production falling (or increasing) based on changing domestic production levels.

APPA estimated that 1,375 jobs generated by biofuels were lost in 2011, which was the first time the sector witnessed substantial contractions. Reductions of 1.3 per cent in direct jobs were witnessed in most renewable energy sources in 2011; except for biomass, marine energy and solar thermoelectricity sources (APPA, 2011). Detailed figures on employment generated by main renewable energies in Spain in 2011 are displayed in Table 10 below, including biofuel job-creation figures provided by the industry associations and estimates generated as part of this report. The number of direct and indirect jobs created by different renewable energy sources varies according to the information source; both lower and higher estimates found relevant are shown here.

[26] The EurObserv'ER based its estimate of the socioeconomic impacts of EU biodiesel and vegetable oil production on an assumption of 0.007 jobs per toe (EurObserv'ER, 2011).

TABLE 10: EMPLOYMENT CREATION IN 2011 FOR MAIN RENEWABLE ENERGY SOURCES IN SPAIN IN 2011[27]

RENEWABLE ENERGY	DIRECT JOBS (IN 2011)	INDIRECT JOBS (IN 2011)	TOTAL CREATED JOBS (IN 2011)
Wind power	15,813a	11,306a	27,119a – 30,000e
Solar PV	10,013a	1,670a	11,683a - 15,000e
Solar thermal	766a	221a	987a - 5,000e
Solar thermoelectricity	2,434a	31,121a	33,555a
Solid biomass	20,891a	17,758a	14,400e–38,649a
Biofuelsa	2,337a	1,460a	3,797a–10,200e
Biofuels†	4,222	7,834	12,056

Sources:
a APPA, 2011.
e EurObserv'ER, 2012a.
† Authors' calculations based on ePure, 2012; EurObserv'ER, 2011.

The 2011–2020 Renewable Energy Plan provides projections of direct job creation associated with renewable energy technologies for 2015 of 82,568, reaching 128,374 by 2020 (IDAE, 2011a; IDAE, 2011b; MINETUR and IDAE, 2010). Table 11 below shows detailed jobs estimates for 2015 and 2020 for main renewable energy sources, including biofuels.

TABLE 11: JOB CREATION ESTIMATES FOR 2015 AND 2020 IN SPAIN FOR RENEWABLE ENERGY SOURCES

RENEWABLE ENERGY	DIRECT JOBS (IN 2015)	INDIRECT JOBS (IN 2015)	DIRECT JOBS (IN 2020)	INDIRECT JOBS (IN 2020)
Wind power	21,434	17,147	30,309	24,247
Solar PV	33,617	15,128	47,527	21,387
Solar thermal	13,986	6,294	28,180	12,681
Solar thermoelectricity	1,283	770	2,093	1,256
Solid biomass	2,306	2,029	4,304	3,788
Biofuels	1,116	1,144	1,513	1,550
Others (hydraulic, biogas, geothermal, waste incinerations)	8,847	4,499	14,448	8,734
Total	82,589	47,011	128,374	73,643

Source: Adapted from IDAE, 2011b.

Caution should be exercised when comparing the numbers of jobs for a specific industry, given the inherent variation in market structure and the technological stage of development. Biofuels, for example, are part of the road transport sector, while other technologies such as solar PV are for renewable electricity generation. The table above only indicates the overall number of jobs for specific sectors. Biofuels is at the lower end in terms of employment generation relative to other sectors. Wind power, solar PV and solar thermoelectricity are the sectors that created the most jobs in 2011: they are projected to continue generating increasing levels of employment, with solar thermal exceeding solar thermoelectricity job generation (IDAE, 2011b).

[27] APPA (2011) developed biofuel employment estimates in conjunction with industry associations in assessing number of indirect jobs using annual surveys. Employment coefficients for biofuels of 1.025 applied in IDAE (2011b).

Nevertheless, it is challenging to compare the relative effectiveness of investing in one renewable energy sector over another with the objective of creating jobs. The sustainability and quality of jobs will likely be a factor in the ability of the specific industry to continue without regulatory support.

6.5 Rural Development and the Geographic Location of Jobs

The European Union supports the use of biofuels in order to pursue "opportunities offered by biofuels in terms of economic activity and job creation within the context of the cohesion policy and rural development policy" (European Commission, 2006a, p. 1). The geographic spread of jobs is seen as important, with many rural areas of Europe experiencing higher-than-average unemployment, and average incomes being lower in rural areas, when compared with urban areas. Hence ethanol and biodiesel industry jobs in rural areas are seen to correspond to one of the original policy objectives for subsidizing biofuels: rural development.

The following table provides an illustrative breakdown of the potential spread of biofuel-related jobs between EU designated Competitiveness and Employment regions and Convergence regions based on a formula incorporating the distribution of production capacity between regions and their surface land.

TABLE 12: BREAKDOWN OF BIOFUEL RELATED JOBS IN SPAIN BASED ON EU DEVELOPMENT REGIONS IN 2011[28]

EMPLOYMENT FIGURES BASED ON 2011 PRODUCTION FIGURES				
	ETHANOL		BIODIESEL	
EU designated region	Number of jobs	Percentage split between region	Number of jobs	Percentage split between regions
Convergence region	2,195	52%	4,387	56%
Competitiveness and Employment region	2,026	48%	3,447	44%
Total	4,222	100%	7,834	100%

Sources: Ethanol production, (ePure, 2012); biodiesel production, (EBB, 2012). Biofuel production numbers converted into number of jobs based on employment multiplier factors (Ethanol: ePure [2012]; Biodiesel: EurObserv'ER [2011]).

The locations of Spain's biodiesel and ethanol plants represented in Figure 2 are shown in relation to the European designations for Convergence Regions (where per capita GDP is less than 75 per cent of the European average) and Competitiveness and Development Regions. A variety of factors affect the selection of biofuel refining plants, such as the local road network and access to ports and feedstocks. Any jobs created in the agricultural sector are likely to be located near biofuel plants, as feedstocks are sourced locally.

[28] The employment figures represented in this table are illustrative, and the number of jobs separated by region does not represent specific Spanish job figures. In estimating the number of jobs in Spain (which has both Convergence regions and Competitiveness and Employment regions) the surface area of the Convergence region was divided by the total surface area of Spain (Internet World Stats, 2013) to establish the percentage surface area of the country with Convergence-designated areas. The geographic location of Spanish biofuel refineries was then plotted between Convergence regions and Competitiveness and Employment regions; a percentage of the country's installed production capacity was estimated for each region. The two percentages (for the amount of land designated as either Convergence or Competiveness and Employment areas and the average distribution of installed production capacity split between the two regions) were then averaged out and used as the factor multiplied with biofuel production for that year in order to estimate whether jobs were situated in Convergence regions or Competitiveness and Employment regions.

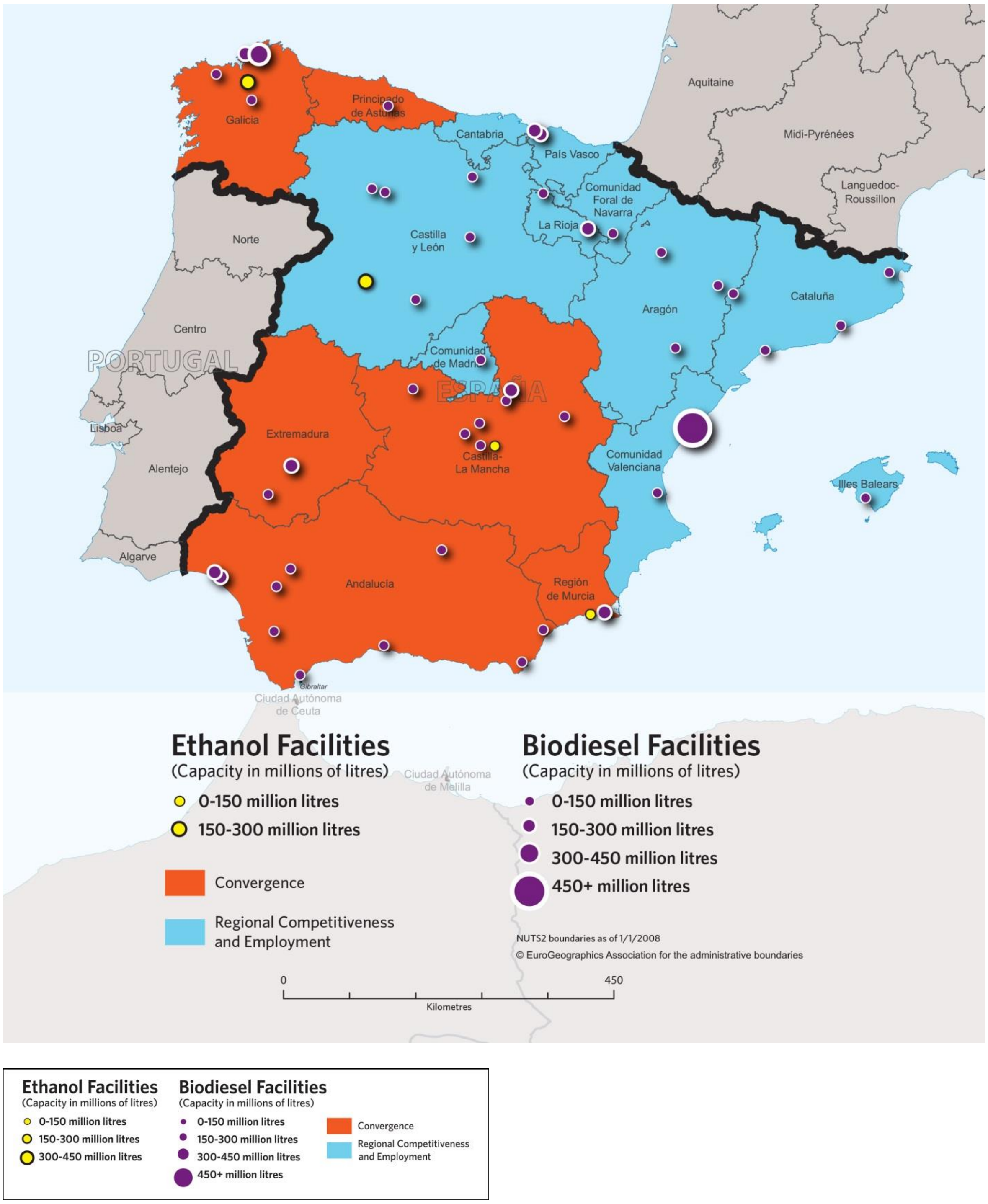

FIGURE 2: SPAIN'S BIODIESEL AND ETHANOL PLANTS

Sources: Biofuel facilities: GSI data collection (a list of biofuel plants, locations and refining capacity is located in Annex 1); Map of Spain showing Convergence or Competiveness and Employment areas, European Commission (2013). Reproduced with permission.

In general, there appears to be a fairly even split in the distribution of jobs between the two regions, with slightly more jobs located in the Convergence regions (less-economically developed relative to the Competitiveness and Development Regions as defined by the EU) as more production capacity is located in the northeast and south.

6.6 Conclusions

Due to the complexity of job counting, there are difficulties in estimating the number and quality of sectoral jobs in the biofuels sector or the renewable energy sector more broadly. Previous reports have raised the question of additionality in job counting for biofuels, arguing that farm-based agricultural jobs in the biofuel supply chain would still exist without the biofuel industry. Given the economic slowdown in Europe (and resultant high unemployment rates) job creation is an important factor for policy-makers; jobs created in the biofuels industry can be viewed as important to an economy in recession, especially if they are located in poorer rural areas. The biofuels sector may deliver net economic and employment benefits if related jobs are sustainable and not linked to on going subsidies. Better monitoring of the number of biofuel-sector-related jobs will help contrast the anticipated benefits from the industry with any associated costs.

7.0 Sectorial GDP Impact

7.1 Purpose

This section looks at the contribution of the Spanish biofuels sector contribution to GDP between 2009 and 2011.

7.2 Introduction

Contributions of the biofuel sector to the Spanish economy are said to be wider than the number of jobs directly and indirectly generated, notably by bringing benefits from the high-value employment opportunities in this sector (Deloitte, 2011). However, only two studies have looked at the economic impacts of the Spanish renewable energy sector as a whole, namely APPA (2011) and IDAE (2011c), and they have not undertaken an assessment of the wider economic benefits of the sector to the national economy (see also IDAE, 2011a). Figures from these two studies vary, with industry associations presenting higher estimates than the government institute on the contributions of the renewable energy sector to total GDP, although these differences are generally small.[29] It is worth noting that the contraction of the biofuels sector in Spain (due to significant increases in biofuel imports) has been partly responsible for the small decrease (by 2 per cent) of the renewable energy sector's contribution to GDP in 2011 compared to 2010, with a total GDP contribution of €6,740 million, representing 0.63 per cent of total national GDP in 2011 and €6,792 million in 2010 (APPA, 2011). This is the first time that the sector's contribution to total GDP has decreased since 2005: until now it has been increasing. The biofuel sector accounted for €426.4 million in 2011, of which €289.0 million was considered a direct share and €137.5 million indirect (APPA, 2011). Total biofuel sector contributions to GDP have decreased by 14.7 per cent in 2011 from 2010, and accounted for 6.33 per cent of renewable energy's total GDP contribution, according to the industry association (APPA, 2011). However, looking at the biodiesel and the ethanol sectors separately, the ethanol sector has maintained its contribution to total GDP in 2011 compared to 2010, contributing €166.3 million in 2011, while the biodiesel sector's contribution decreased by 20.9 per cent compared to 2010, contributing €260.1 million in 2011 against €328.9 million in 2010 (see Figure 3 below) (APPA, 2011). Thus the biodiesel sector is mostly responsible for the decrease in the biofuel sector's contribution to GDP in 2011, which helps explain why an increase in domestic biodiesel consumption in 2011 did not transfer to the continued development of the Spanish biofuel sector within the wider economy.

[29] Figures in the APPA and IDAE studies do not correspond exactly; for example, the biofuel sector's contributions to GDP (as well as the overall renewable energy sector's) are higher in the APPA figures compared to those of the IDAE. However, since we use 2011 as our reference year, and IDAE only has data up to 2009, APPA figures were used here.

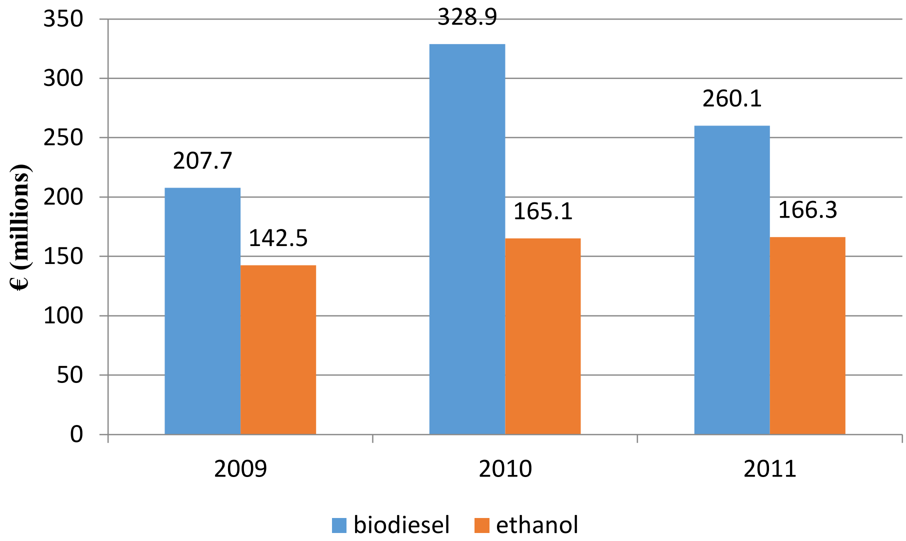

FIGURE 3: BIODIESEL AND ETHANOL GDP CONTRIBUTIONS IN MILLION EUROS

Source: Adapted from APPA, 2011.

7.3 Conclusions

Nevertheless, much more information is needed to be able to adequately assess the wider economic implications of the biofuel sector in Spain, in particular if seeking an overall picture of the economic and social ramifications of the biofuel sector in Spain compared to that of other renewable energy sources, taking into account varying costs of policy implementations and support systems.

8.0 Energy Security and the Biofuel Trade

8.1 Purpose

This section discusses international trade in biofuels and feedstocks and the role of biofuels in supporting energy security objectives through displacing the use of crude oil or petroleum products imported from outside of the EU.

8.2 Introduction

Overall, there is a trend in Europe toward reduced energy consumption due to the economic slowdown, with consumption decreasing by 6 per cent between 2008 and 2011 (Eurostat, 2013a). However, some modes of transport showed increases in absolute terms, with energy consumption in road transport use in the EU-27 rising by 20.0 million toe between 2000 and 2010 (Eurostat, 2013a, 2013b).

The IEA defines energy security as the uninterrupted availability of energy products at an affordable price (IEA, 2013). The European Commission adds a sustainability dimension by describing security of energy supply as:

> [T]he uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking toward sustainable development. (European Commission, 2000)

Energy security can be improved by increasing the security of supply of traditional energy sources (through long-term contracts or investments), increasing diversity of energy sources (both geographically and the types of fuels), reducing demand (by improving energy efficiency) and increasing flexibility within the energy sector.

The European Commission's strategy for energy security is linked to its strategy for diversification, emission reductions and energy efficiency. Biofuels have the potential to improve energy security by diversifying fuel supply, including from primary sources that are locally available and more widely distributed than crude oil (European Commission, 2006b). The same considerations are valid for the individual EU member countries including Spain.

There are two key parameters to assess the effectiveness of meeting the objective of improving energy security through expanding the share of biofuels in the energy mix:

- Quantifying the amount of imported fossil fuels replaced with biofuels.
- Analyzing the extent to which the biofuels replacing fossil fuels are domestically produced or imported.

The following table illustrates the amount of petrol and diesel displaced by biofuel use in Spain in 2011.

TABLE 13: PETROLEUM PRODUCTS DISPLACED BY SPAIN'S BIOFUEL USE

	BIOFUEL CONSUMED IN 2011 (MILLION LITRES)	PETROL AND DIESEL DISPLACED IN 2011 (MILLION LITRES)
Ethanol	470	310
Biodiesel	1,880	1,730

Source: Author's elaboration based on data from CNE, 2011 and Corporacion de Reservas Estrategicas de Productos Petroliferos [CORES], 2011.

Approximately 310 million litres of petrol were displaced in 2011 by ethanol use and 1,730 million litres of diesel were displaced by biodiesel use. Taking into account the total volume of petrol (about 7 billion litres) and diesel (about 25.6 billion litres) consumed in Spain in 2011, about 4 per cent of petrol and 7 per cent of diesel were displaced by biofuels (relative to a no-biofuels scenario that would involve nearly 100 per cent fossil-fuel use).

The second parameter of biofuel policies affecting energy security relates to the domestic or external origin of biofuels and their feedstock. Generally, trade balance data in the EU may be confusing because of the third-party trade (re-export and re-import). Further, Harmonised System trade codes do not always distinguish between feedstocks and other commodities being imported or exported for biofuel or other purposes (for instance, ethanol is also used for technical purposes other than road transport fuels and in the beverages industry).[30] Therefore, analyzing trade flows of biofuels and their feedstocks in the EU necessitates a large number of assumptions and caveats.

However, the Spanish National Energy Commission provides clear figures on the type of feedstock (reported in cubic metres and percentages) and country of origin as part of the certification, monitoring and control mechanism obligation set by Ministerial Order ICT/2877/2008. Other trade statistics are available on biofuels and feedstock, such as USDA Global Agricultural Information Network (GAIN) EU-27 and national reports (USDA, 2011, 2012b).

8.3 Ethanol

Trends

Figure 4 below shows Spanish trends in consumption, production, imports and exports of ethanol from 2009 to 2011. Ethanol consumption slightly decreased (by about 5 per cent) in 2011, while production remained more or less stable (decreasing by about 1 per cent), with sufficient production to, in theory, cover domestic consumption. Consumption seems to continue its slight decreasing trend, since in 2012 it decreased an additional 11 per cent (BiodieselSpain.com, 2013). This reflects a general decrease in energy consumption in the EU due to the economic slowdown. Exports have been slowly decreasing since 2009 and were around the same level as imports in 2011 (about 200,000 cubic metres in 2011).

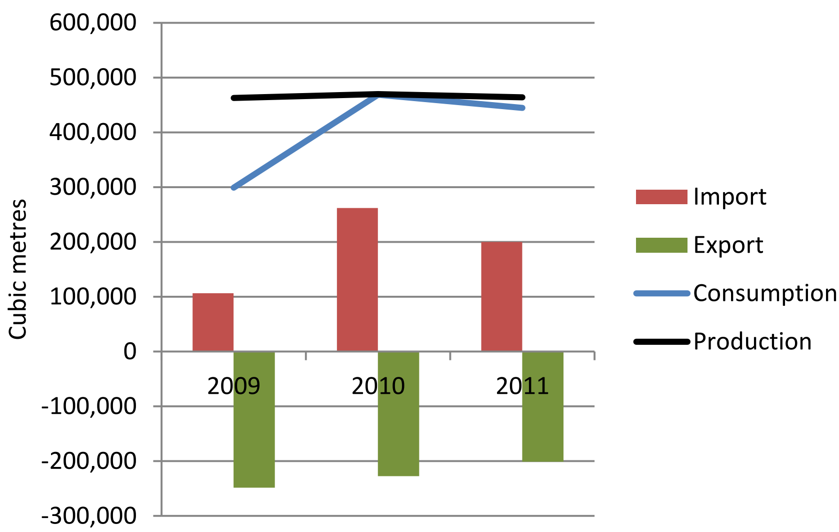

FIGURE 4: TREND IN ETHANOL TRADING IN SPAIN FROM 2009 TO 2011

Source: Author's elaboration based on CNE, 2011.

[30] Biofuels can also be traded as blends with fossil fuels, and trade statistics do not always make a clear distinction between pure and blended products.

Domestic production and imports

Spain produced more than half (58 per cent) of the total ethanol it consumed 2011 (see Figure 5 below displaying shares of producing countries in 2011, underlying consumption in 2011). This represents an increase in production of 9 per cent from 2010 (production was approximately 49 per cent). Spain also imported about 42 per cent of ethanol for domestic consumption in 2011, mainly from Brazil. Spain imported 73 per cent of ethanol feedstocks in 2011 to support its own production, also mostly from Brazil (see Figure 6 on the right).

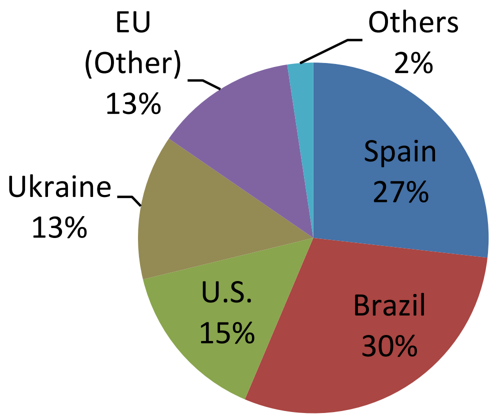

FIGURE 5: ETHANOL FEEDSTOCK AND COUNTRY OF ORIGIN SUPPLYING SPANISH CONSUMPTION OF ETHANOL IN 2011

Source: Author figure based on CNE, 2011.

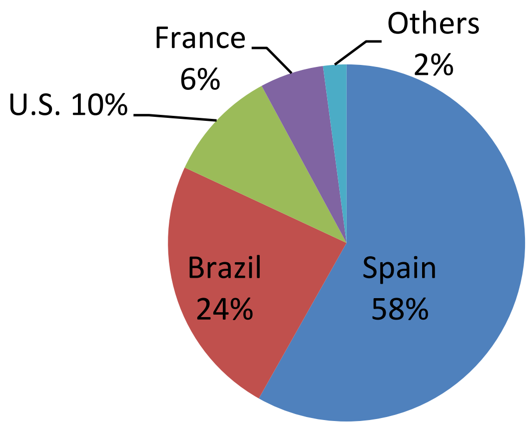

FIGURE 6: ETHANOL-PRODUCING COUNTRIES SUPPLYING SPANISH CONSUMPTION IN 2011

Source: Author figure based on CNE, 2011.

Corn-based ethanol made up 50 per cent of all feedstocks and came mainly from Spain (36 per cent), the United States (28 per cent) and Ukraine (15 per cent), followed by about 25 per cent of sugarcane feedstock mostly from Brazil (96 per cent) and 18 per cent of wheat mainly sourced from EU member countries (98 per cent). Other feedstocks used in much smaller proportions (7 per cent) compared to the first three included: barley, beetroot, citric alcohol, wine alcohol, sorghum, triticale and rye, mostly from Spain and other EU countries.

Even though 58 per cent of ethanol was produced domestically in 2011, Spain relies significantly on imported ethanol feedstocks (73 per cent imported), a trend that seems set to continue with a 21 per cent decrease in feedstocks coming from Spain compared to 2010. This does not promote Spain's energy security, since it relies substantially on external sources of feedstocks, a fact which could expose Spain to supply interruptions since it is sourced overseas and potentially vulnerable to supply-side issues.

8.4 Biodiesel

Trends

Figure 7 below shows Spanish trends in consumption, production, imports and exports of biodiesel from 2009 to 2011. Consumption of biodiesel in Spain has been increasing since 2009, and increased by 18 per cent in 2011 relative to 2010, while at the same time domestic production decreased by 25 per cent in 2011. A large share of domestic production was replaced by increased imports (75 per cent of biodiesel was imported in 2011) that supported biodiesel consumption. Exports have continued to increase, albeit at much smaller rates than imports.

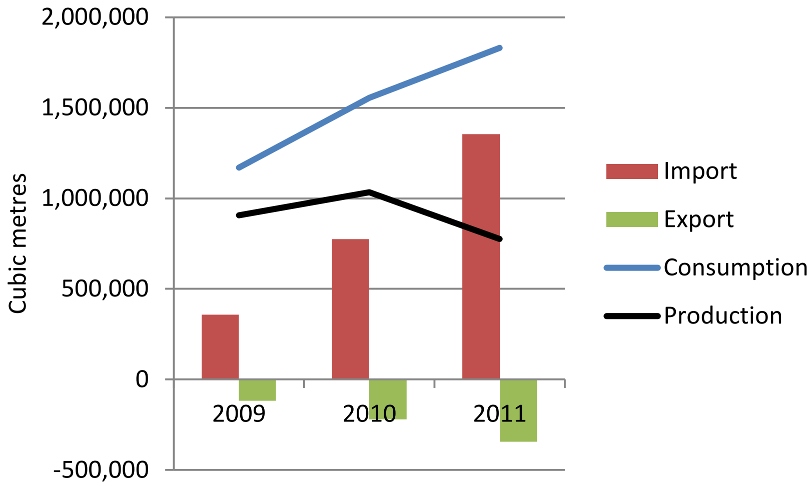

FIGURE 7: TREND IN BIODIESEL TRADING IN SPAIN FROM 2009 TO 2011

Source: Author figure based on CNE, 2011.

Additionally, since 2011, hydrobiodiesel (HVO) has also been consumed in Spain and is almost all imported (CNE, 2010). This is not shown in the figure nor is it included in this study's calculations.

Domestic Production and Imports

The biodiesel sector in Spain offers a radically different picture than the ethanol sector.

In 2011, more than 75 per cent of the biodiesel consumed in Spain was imported, as displayed in Figure 8 (below left), of which 45 per cent was imported from Argentina and 25 per cent from Indonesia. About 95 per cent of total biodiesel feedstocks were imported in 2011 as shown in Figure 9 (below right), of which more than 90 per cent consisted of soybeans from Argentina and palm oil from Indonesia (CNE, 2011). Other biodiesel feedstock types used in much smaller proportions (10 per cent in total) in 2011 included: UCO; tallow, rapeseed, canola oil, safflower oil, sunflower oil, linen and olive oil, mostly supplied by Spain itself and other EU countries.

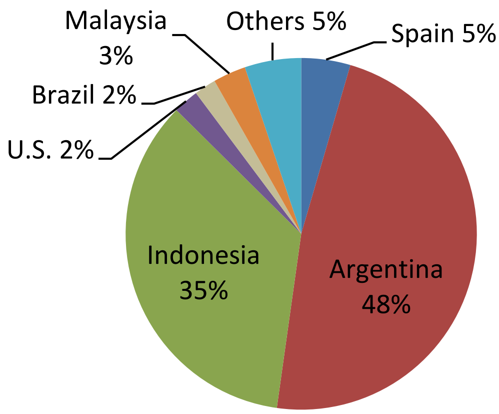

FIGURE 8: BIODIESEL FEEDSTOCK AND COUNTRY OF ORIGIN UNDERLYING SPANISH CONSUMPTION OF BIODIESEL IN 2011

Source: Author figure based on CNE, 2011.

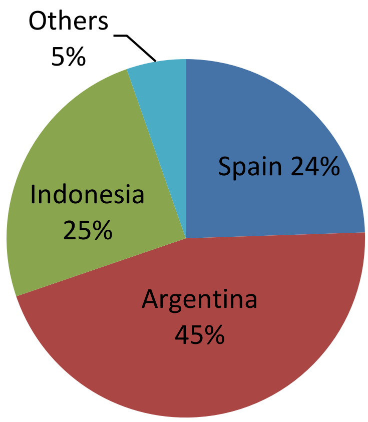

FIGURE 9: BIODIESEL PRODUCING COUNTRIES UNDERLYING SPANISH CONSUMPTION IN 2011

Source: Author figure based on CNE, 2011.

8.5 Conclusions

Spain thus heavily relies on imports of both biodiesel and its feedstocks for its consumption, and it imports them mostly from only two countries—Argentina and Indonesia. A reliance on imported biofuels and feedstocks may not increase Spain's energy security as defined by the IEA its given low levels of domestically generated sources of energy. The European Commission's definition of energy security contains a sustainability dimension, and the Spanish market uses large amounts of palm oil and soybean feedstocks,which have been linked to environmental issues involving land-use changes such as deforestation.

Moreover, out of the 44 biodiesel production plants in Spain, only 31 were in use in 2011 and were running at only 25 per cent of their total installed capacity,[31] a situation that worsened in 2012 with operational use down to 9.5 per cent in some cases (BiodieselSpain.com, 2013; CNE, 2011). The Spanish biodiesel sector is essentially stagnant, with staggeringly low levels of use of its total theoretical productive capacity.

The situation in the ethanol sector is strikingly different: all four ethanol plants in Spain worked at 75 per cent of their total production capacity in 2011 (CNE, 2011).

In the context of improving Spain's energy security, biofuels consumed in Spain would need to be supplied from domestic sources while the use of feedstocks and biofuels sourced from outside of Spain or the EU should decline.

Trade Negotiations

The Spanish biodiesel industry blames the stagnation of the sector on the considerable (and growing) imports of biodiesel from Argentina and Indonesia. The industry has stated that these imports have been prompted by unfair trade practices, that is to say, Argentinian and Indonesian governments using differential export taxes favouring the export of biodiesel over raw materials. The industry has estimated the level of this export support at €100 per tonne of biodiesel (APPA, 2012).

To respond to the demands of the domestic biodiesel industry, the Spanish government issued new measures regarding biodiesel imports in April 2012 through Ministerial Order IET 822/2012, which is part of a larger piece of legislation implementing the EU Renewable Energy Directive (RED). The Order favoured EU-produced biofuels over non-EU ones and was enacted shortly after Argentina's controversial nationalization of the Spanish oil and gas company Repsol YPF (ICTSD, 2012a; ICTSD, 2013a). Spain later modified this Ministerial Order (by the subsequent Ministerial Orders of IET/2199/2012 in October 2012 and IET/2736/2012 in December 2012) suppressing the controversial parts that had led Argentina to officially launch a complaint at the World Trade Organization (WTO)[32] against the EU and Spanish legislation (Ministerial Order IET/2199/2012; Ministerial Order IET/2736/2012; ICTSD, 2013a; ICTSD, 2013b; WTO, 2013).

In September 2012, the European Biodiesel Board (EBB) requested that the European Commission launch an investigation into Argentina and Indonesia's possible dumping policies, which, according to the EBB, have significant adverse effects on the European biodiesel industry (ICTSD, 2012b). EBB, like the Spanish APPA industry association,

[31] A list of all existing biodiesel and ethanol plants in Spain can be found in Annex 1 with total installed capacity and operational use in 2011. Operational capacity was estimated by APPA to be even lower in 2011 (14 per cent) (APPA, 2011).

[32] Argentina lodged its first official complaint to the WTO against the EU and Spanish legislation in August 2012, under the DS443 case, claiming that the Spanish measure was inconsistent with WTO's General Agreements on Tariffs and Trade. Specifically, Argentina claims that the Spanish measure is inconsistent with Articles III:1, III:4, III:5 and XI:1 of the GATT 1994; Articles 2.1 and 2.2 of the TRIMs Agreement; and Article XVI:4 of the WTO Agreement (see WTO website: http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds443_e.htm).

states that both Argentina and Indonesia maintain differential export tax regimes that artificially favour biodiesel over raw materials exports, by having much lower export duties on finished products than raw materials prices such as soybeans and palm oil used to produce biodiesel (ICTSD, 2012b; ICTSD, 2013c). As a result of the European Commission investigation, provisional anti-dumping duties[33] on imports of biodiesel from Argentina and Indonesia were implemented on May 27, 2013, via Regulation 490/2013, for a minimum duration of six months until receiving final results of the investigation (ICTSD, 2013c; Official Journal of the European Union, 2013). Moreover, the European Commission is also investigating subsidies that Argentinian and Indonesian governments have been said to provide to biodiesel producers, with no known results as of July 2013 (ICTSD, 2013c).

Furthermore, Argentina has filed a new WTO complaint against the EU biodiesel policies in May 2013 over its importing and marketing policies[34] including those of Spain (ICTSD, 2013b). This WTO complaint is the last addition to several WTO challenges between Argentina and the EU (ICTSD, 2013b).

In sum, much of the Spanish biodiesel industry's future seems to depend on the results and decisions of the WTO and the European Union over its biofuel policies, in particular its importing policies.

[33] The implemented duties amount to between €75.97 to €104.92 per metric tonne for Argentinian producers and between €0 and €83.84 per metric tonne for Indonesian producers. In percentage terms, the dumping margins are 6.8 to 10.6 percent for Argentinian producers and 0 to 9.6 per cent for Indonesian producers (ICTSD, 2013c).

[34] WTO complaint under the DS459 case, in particular regarding the EU member states Belgium, France, Italy, Poland and Spain (ICTSD, 2013b).

9.0 Renewable Energy Options

9.1 Purpose

To evaluate the costs of meeting EU renewable energy targets while reducing the role of food-based biofuels due to EU caps and increasing the contribution from other forms of renewable energy.

9.2 Renewable Energy Targets

The Spanish National Renewable Energy Action Plan (NREAP) anticipates the overall EU target of 20 per cent renewable energy in final energy consumption coming from the electricity, heating and cooling, and transport sectors. These sectors have the following sub-targets for the amount of renewable energy to be generated: 40.2 per cent of electricity (RES-E), 18.9 per cent of heating and cooling (RES-H&C) and 13.6 per cent of energy in transport (RES-T), coming from renewable forms (EREC, 2011). The renewable energy generated as part of these sectoral sub-targets aggregated together results in 20 per cent of all final energy consumed coming from renewable sources (EREC, 2011).

The Energy Research Centre of the Netherlands (ECN) reports that Spain has projected a total of 22,057 ktoe (256,523 GWh) of renewable energy generation in 2020 according to the National Renewable Energy Action Plan (NREAP) (ECN, 2011). The majority of this is expected to be derived from electricity production (57 per cent) followed by heating and cooling (25 per cent) with a smaller contribution from transport (18 per cent).

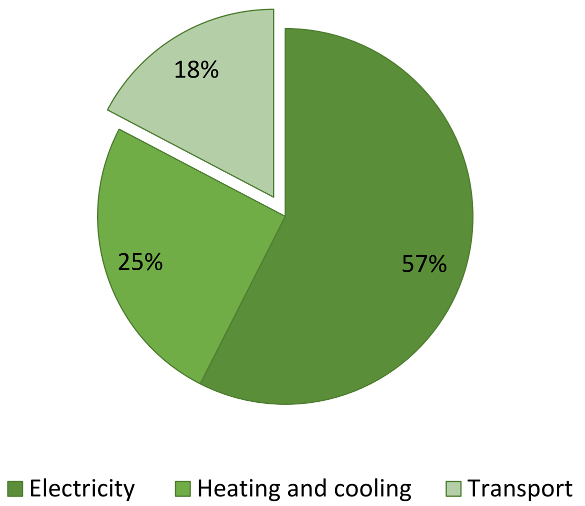

FIGURE 10: PROJECTED RENEWABLE ENERGY GENERATION IN SPAIN IN 2020

Source: ECN, 2011.

In 2010, the renewable energy target for Spain was 12.1 per cent. The majority of renewable energy (60 per cent) was generated in the form of electricity, with the remainder being split between heat and cooling and transport fuel, 12 per cent and 26 per cent respectively (ECN, 2011). To meet the targets set out above will require a relative increase in the contributions from heat and cooling, and transport.

The economic, social and environmental concerns around the production and consumption of biofuels that have led to the EU proposal to cap food-crop-based biofuels raise the question of whether it would be possible to reach the target for the total generation of renewable energy without expanding the use of biofuels and instead increasing generation of renewable energy from electricity or heating and cooling.

9.3 Deployments of Renewable Energy in Transport Fuels in Spain

Spain has used a number of measures to promote renewable energy, most notably: Law 82/1980, which marked the beginning of the development of renewable energies in Spain; Royal Decree 661/2007, which regulates electricity generation; and, most recently, Law 2/2011, which regulates the broader sustainable economy (IDAE, 2011a; MINETUR and IDAE, 2010; Law 2/2011). Two key renewable energy strategy plans include the National Renewable Action Plan 2011–2020 (NREAP) and the Renewable Energy Plan (REP) 2011–2020 (IDAE, 2011a; MINETUR and IDAE, 2010). Spanish energy statistics show that renewable energy in transport appears to be below targeted levels (see Figure 11 below for a comparison). Recent statements by the Spanish government indicate that the blending mandates for biofuel use in transport energy will be reduced. Royal Decree 4/2013 decreased the overall biofuel mandate to 4.1 per cent (4.1 per cent for biodiesel and to 3.9 per cent for ethanol in terms of energy content). If biofuel mandates are not increased or the EU proposal to cap food-crop-based biofuel is accepted, then the Spanish government will need to scale up other renewable energy technologies or energy efficiency in order to meet RES-T targets.

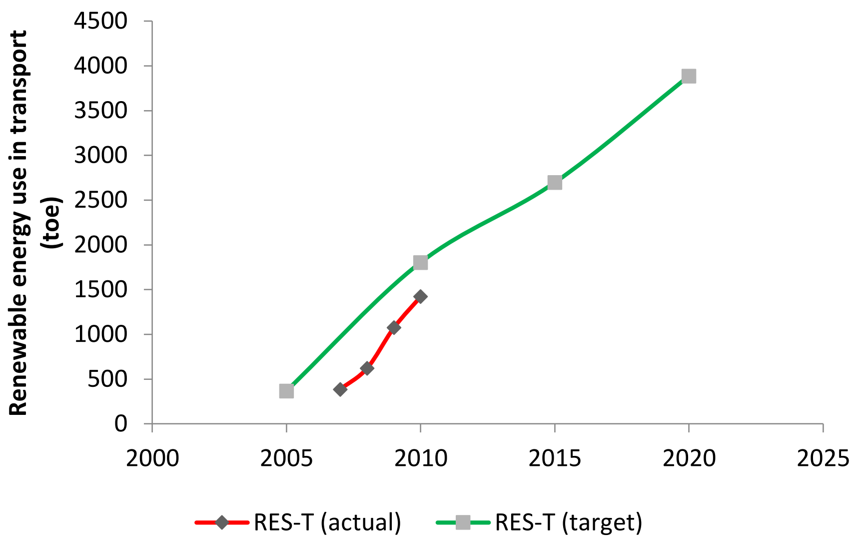

FIGURE 11: RENEWABLE ENERGY USE IN TRANSPORT

Sources: ECN, 2011; IDAE, 2011.

9.3.1 Costs

At an economic level, the cost implications of shifting from biofuels to other forms of renewable energy depends on the energy content and production costs of biofuels compared to other options. Data for biofuels production costs was taken from the IEA *World Energy Outlook 2012* (IEA, 2012) and data for the cost of energy from renewables was taken from a recent International Renewable Energy Agency (IRENA) report on generation costs (IRENA, 2012). Figure 12 shows a summary of this comparison.

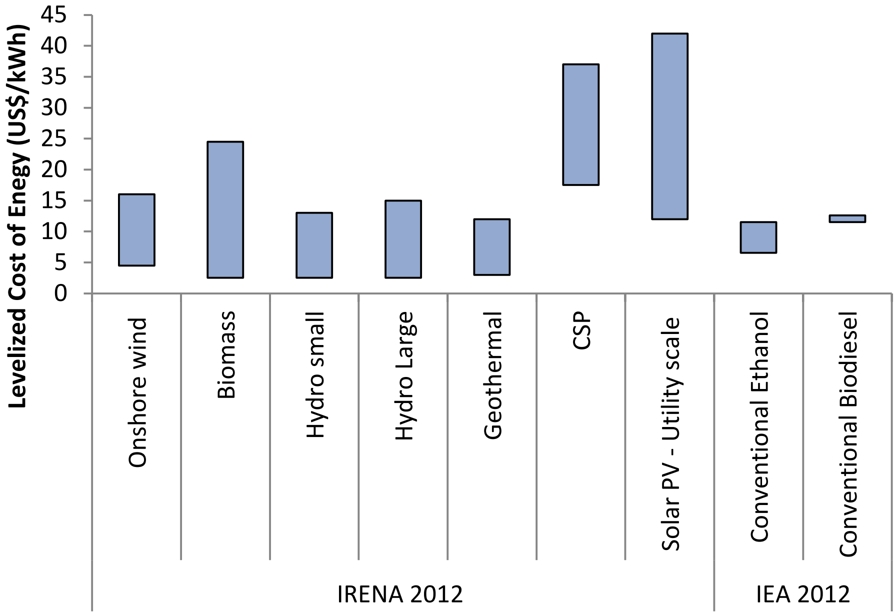

FIGURE 12: COSTS OF ENERGY GENERATION FROM VARIOUS RENEWABLE ENERGY TECHNOLOGIES, BIOFUELS AND PETROLEUM PRODUCTS

Source: Author's calculations based on IEA, 2012; IRENA, 2012.

The Levelized Cost of Energy (LCOE) is a measure of the total cost per unit of energy generated. It includes all the costs associated with the production of energy, including the cost of investment and operations and maintenance as well as any inputs. LCOE provides a single value for cost of energy to allow comparison of technologies with different investment and operating costs. However, the comparison does not account for the usefulness of each of these forms of energy. Liquid fuels are easy to store and very energy dense, but conversion to mechanical work has a lower efficiency than electric motors. Electricity must be consumed instantaneously or stored in chemical batteries or in pumped storage hydro plants, both of which are currently expensive. Despite the shortcomings of LCOE, it provides a useful comparison of the cost of energy, particularly in the context of this comparison of the costs of meeting the EU target for renewable energy production.

The comparison presented in Figure 13 shows that the costs of biodiesel and conventional ethanol are of a similar order of magnitude to other renewable energy technologies, although the midpoint of the ranges is higher than for some of the more widely deployed technologies including wind and biomass. Data from IRENA is not available for offshore wind, a technology that is expected to expand considerably. However other sources generally indicate that offshore wind is considerably more expensive than onshore wind (Mott Macdonald, 2011) and therefore is likely to be the same or more expensive than renewable energy from biofuels. However, the potential for future cost reductions is not the same for all technologies. PV costs have fallen at a rate of 15–24 per cent with each doubling in production since 2004 (Bazilian, et al., 2013). The LCOE from wind power declined by a factor of three between 1980 and 2003, but rose between 2004 and 2009 before falling slightly in recent years. From 2013 to 2030 both PV and wind are projected to see further reductions in the LCOE (Bloomberg New Energy Finance [BNEF], 2013; Lantz, Wiser, & Hand, 2012). Conventional biofuels have a relatively low potential for cost reduction in part because so much of the cost is tied to the feedstock (IEA, 2011).

The cost of meeting a greater proportion of the renewable energy target from other (non-biofuel) sources is likely to be higher than using biofuels, with the extent of costs being dependant on the ability to employ lower-cost renewables such as onshore wind. However, greater deployment of onshore wind power is facing a number of challenges. While solar PV continues to realize cost reductions, it is still significantly more expensive than biofuels on an energy basis. The support required to incentivize production depends on the alternatives and end uses, so a direct comparison requires detailed analysis. However, further expansion of renewable electricity may be limited by access to grid infrastructure, though this may be ameliorated by demand-side management and aggregation. The NREAP plans have been developed on the basis of consideration of existing constraints: further analysis would be required to establish the technical viability of replacing biofuels with other sources of renewable energy, though this remains an attractive option.

9.3.2 Subsidies

As a preliminary indication of the costs of reducing the use of biofuels and increasing the use of other renewables, the estimate of total support was compared with the value of Spain's main renewable energy support calculated by del Río and Mir-Artigues (forthcoming) based on the level of feed-in tariffs (FITs) and premiums paid to RES-E minus the average wholesale price multiplied by the amount of GWh of RES-E generated (del Río, & Mir-Artigues, forthcoming). As noted above, the delivered energy from each source does not necessarily have the same value. Energy derived from biofuels generally has to be converted via a heat engine to deliver useful work, while electricity can drive electric motors with substantially lower losses. The comparison (shown in Figure 13) is useful when considering the costs of meeting the renewable energy targets, which are based on energy, but is of limited use in comparing the cost of useful work from each source.

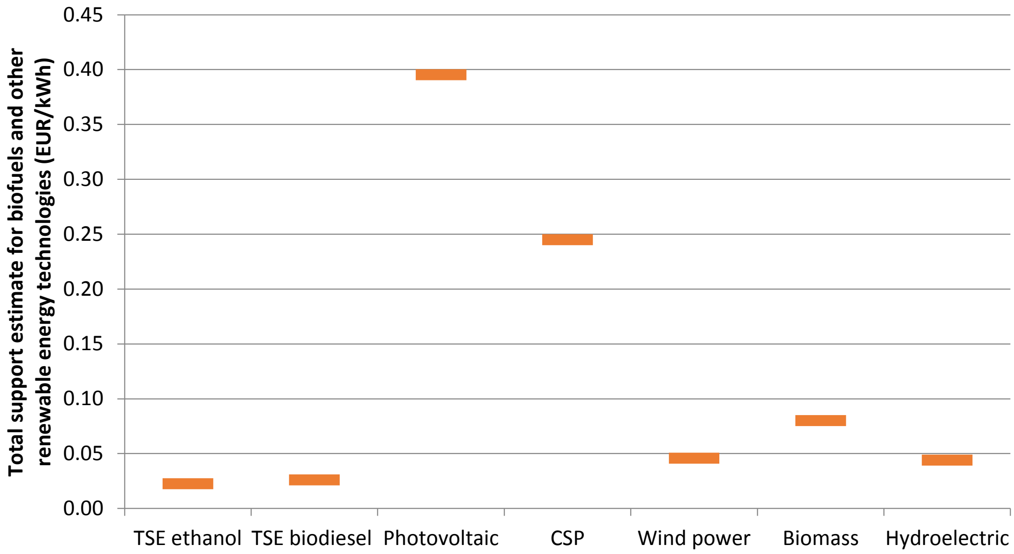

FIGURE 13: COMPARISON BETWEEN TOTAL SUPPORT ESTIMATE (TSE) FOR BIOFUELS AND OTHER SPANISH RENEWABLE TECHNOLOGIES

Source: del Río & Mir-Artigues, forthcoming.[35]

[35] Note regarding the method used by del Río and Mir-Artigues to estimate the level of subsidy to solar PV, CSP, wind power, biomass and hydro-electric: subsidy calculations based on an elaboration of data from CNE, 2012. The cost of net support is calculated as the level of FITs and premiums paid to RES-E minus the average wholesale price multiplied by the amount of GWh of RES-E generated. Subsidy estimates for Photovoltaic, CSP, wind power, biomass and hydroelectric, drawn from Table 9: Evolution of net support costs for all renewable energy technologies (thousand €).

Figure 13 shows that the subsidy to biofuels is slightly lower compared to the subsidy provided by the main support instruments in Spain to electricity from wind power, biomass and hydropower. This analysis includes only one source of subsidy for renewable electricity production and so is likely to be an underestimate. These findings indicate that while the subsidies to biofuels and renewable electricity are of similar orders of magnitude, the reduction in biofuel consumption and a corresponding increase in other sources of renewable energy may increase, or at least not reduce, the cost of meeting the 2020 renewable energy targets. Without detailed analysis and understanding of subsidies to electricity production it is difficult to understand the magnitude of this change.

While the impact on costs is uncertain, this cannot be considered in isolation. A key goal of the 2020 renewable targets is to realize environmental benefits through the deployment of renewable energy technologies. The concern around the environmental impacts of some biofuels may undermine this objective. A shift towards technologies with widely accepted environmental credentials would reduce the cost of environmental benefits including emission reductions, if not the absolute cost of meeting the renewable energy targets.

9.3.3 Other Options for the Transport Target

If the level of renewable energy from biofuels into the transport sector was reduced to 5 per cent (based on the cap on food-based biofuels) this would leave a shortfall of 9 per cent (based on the transport sector's contribution of renewable energy towards the overall 20 per cent renewable energy target) of the renewable energy target, as described in the Spanish NREAP, which would then need to be found from other sources.

The selection of areas in which targets could be increased would require further assessment but could include an increase in other transport technologies such as hydrogen or electric cars running on renewable electricity, though it is clear there are a number of challenges to scale up some renewable technologies from currently low levels. Decarbonizing the electricity sector for example, would allow for the deployment of renewable transport technologies such as electric vehicles and rail. Advanced biofuels (coming from wastes and residues, algae as well as other products and technologies) could also provide an alternative to conventional biofuels for transport.

Renewable energy sources from other sectors could also be looked at for their potential to fulfil the eventual 9 per cent shortfall. Increases in renewable energy from heating and cooling may also have to be examined. If it is possible to increase renewable electricity generation from the most competitive technologies, notably onshore wind, then the cost increase may be small. However, if additional generation were to come from more expensive technologies, such as offshore wind or PV, the cost of subsidies and deployment costs may increase. However, an increase in costs may be considered acceptable if the environmental and social impacts are promising.

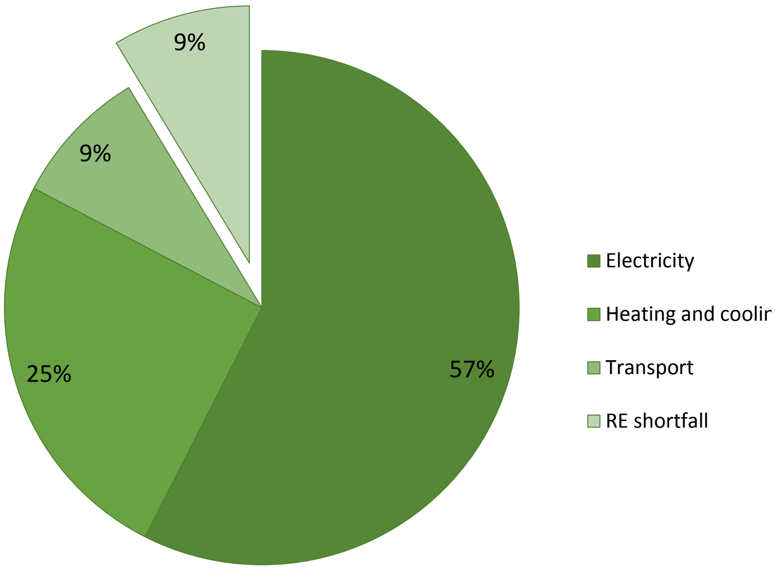

FIGURE 14: 2020 RENEWABLE ENERGY GENERATION (NREAP) PROJECTION WITH 5% BIOFUEL CAP

Source: Author calculations based on ECN, 2011.

9.4 Conclusions

If the role of food-crop-based biofuels in meeting Spain's renewable energy transport target is capped, there are few lower-cost options to replace the shortfall in renewable energy generation. The cost of scaling up other technologies in its place will be dependent on a range of factors, including the availability renewable resources, the financial and non-financial barriers that might hamper greater deployment, as well as the learning potential of specific technologies to reduce investment costs and subsidy levels. Given the complexity of factors affecting the ability to bring forward renewable energy technologies, this analysis does not recommend scaling up or substituting specific renewable technologies over others. However, in the context of binding EU targets for renewable energy use, it recommends government policy should support the use of low-carbon technologies that can deliver GHG savings up to and beyond 2020 targets.

10.0 Policy Recommendations

The recommendations that can be drawn from this study suggest that it is advisable for Spanish policy-makers, along with those at the national government level, to recognize the following:

- **Monitoring (and regularly publishing) support figures for biofuels, as well as for all forms of energy (including fossil fuels and nuclear), is important for improving the transparency of public policy making**. In particular, the Spanish government could consider publishing disaggregated figures of certificates it issues to obligated parties in the National Energy Commission's monthly reports and/or annual reports to improve transparency.
- **Biofuel support policies should differentiate between conventional and second-generation biofuels, ethanol and biodiesel, and ideally between feedstock**, such as UCO vs. palm oil, given the varying environmental performance of fuels and production processes. Moreover, Spain could be well positioned to increase its consumption of UCO and tallow over other feedstock since it already domestically produces most of these feedstocks for consumption.
- **In terms of GHG emission accounting of biofuels, if the Spanish government included ILUC as part of its accounting approach** it would be applying a precautionary approach, and it would ensure that public money does not support biofuels that increase CO_2 emissions. In the absence of European legislation, the Spanish government and the National Energy Commission could chose to voluntarily include a reporting section on ILUC to complement their existing GHG emissions savings calculations. This would increase accuracy of data and give a more comprehensive overview of the costs and benefits of supporting biofuel policies.
- **The Spanish government could consider improving its official government statistics on the number and types of jobs generated by the biofuels policies further**, in particular by disaggregating indirect jobs created in Spain versus those created in other countries. This would provide better information on how many jobs within the Spanish economy had been created by the biofuels sector.
- **Biofuel blending targets are a significant intervention in the liquid fuels transport market**, and the Spanish government's current decision to decrease the overall biofuel mandate to 4.1 per cent in terms of energy content, to 4.1 per cent for biodiesel and to 3.9 per cent for ethanol, could make Spanish policies more consistent with a food-based biofuel cap were it to be successful at an EU level, potentially decreasing uncertainty of the policy environment in the medium to long term.
- **Think in the longer term and phase out support to conventional biofuels**. Subsidies generally distort markets, and it is recommended that, in the long term, they should only be provided to technologies that meet their stated policy objectives. Support should not be provided to biofuels that do not meet stated policy objectives.

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Annex A: Breakdown of Biofuel Production Plants in Spain

TABLE A1: BIOFUEL PRODUCTION PLANTS IN SPAIN

NAME OF PLANT AND COMPANY	LOCATION	INSTALLED CAPACITY (MILLION LITRES)	ACTUAL PRODUCTION (MILLION LITRES)	TYPE
Biocombustibles y Energías Renovables de Castilla La Mancha, S.L. (BERCAM)	Los Yébenes (Toledo)	7	0.1	Biodiesel
Biocarburantes Castilla la Mancha, S.L. (NATURA BIO CLM)	Ocaña (Toledo)	119	2.8	Biodiesel
Biocarburantes de Castilla, S.A. (BIOCAST)	Valdescorriel (Zamora)	25	0.4	Biodiesel
Biocarburos del Almanzora, S.A. (BIOCARSA)	Cuevas del Almanzora (Almería)	7	n/a	Biodiesel
Abengoa Bioenergía, S.A. (ABENGOA B SR)	San Roque (Cadiz)	204	8.8	Biodiesel
Biocom Energía, S.L. (BIOCOM)	Algemesí (Valencia)	125	1.6	Biodiesel
Biocom Pisuerga, S.A. (BIOCOM PISUERGA)	Castrojeriz (Burgos)	6	0.1	Biodiesel
Biodiesel Andalucía 2004, S,A, (B I D A)	Fuentes de Andalucía (Sevilla)	136	n/a	Biodiesel
Biodiesel Caparroso, S.L. (BD CAPARROSO)	Caparroso (Navarra)	79	8.5	Biodiesel
Biodiesel Castilla-La Mancha, S.L. (BIODIESEL CLM)	Santa Olalla (Toledo)	51	0.6	Biodiesel
Bionet Europa, S.L. (BIONET EUROPA)	Reus (Tarragona)	56	3.7	Biodiesel
Bionor Berantevilla, S.L. (BIONOR BERANTEVILLA)	Berantevilla (Álava)	40	1.0	Biodiesel
Bionorte, S.A. (BIONORTE)	Sotrondio (Asturias)/ San Martín del Rey Aurelio	28	0.9	Biodiesel
Bioteruel, S.L. (BIOTERUEL)	Albalate del Arzobispo (Teruel)	8	0.5	Biodiesel
Combunet, S.L. (COMBUNET)	Monzón (Huesca)	45	0.3	Biodiesel
Combustibles Ecológicos Biotel, S.L. (BIOTEL)	Barajas de Melo (Cuenca)	169	9.7	Biodiesel
Sociedad Cooperativa general agropecuaria Acor (ACOR)	Olmedo (Valladolid)	113	6.0	Biodiesel
Entabán Biocombustibles del Guadalquivir, S.A. (ENTABAN GUADAL)	Sevilla	56	6.2	Biodiesel
Entabán Biocombustibles del Pirineo, S.A. (ENTABAN PIRINEO)	Alcalá de Gurrea (Huesca)	28	3.0	Biodiesel
Grupo Ecológico Natural S.L. (GEN)	Llucmajor (Mallorca)	37	1.3	Biodiesel
Hispaenergy del Cerrato, S.A. (HYSPAENERGY CTO)	Quintana del Puente/ Herrera de Valdecañas (Palencia)	25	0.8	Biodiesel
Recyoil Zona Centro, S.L. (RECYOIL Z CENTR)	Alcalá de Henares (Madrid)	17	0.3	Biodiesel
Linares Biodiesel Technologies, S.L.U. (LIBITEC)	Linares (Jaen)	113	6.7	Biodiesel
Biocombustibles de Castilla y León, S.A. (BIOCYL)	San Cristobal de Entreviñas (Zamora)	8	0.4	Biodiesel
Stocks del Vallés, S.A. (STOCKS)	Montmeló (Barcelona)	35	1.1	Biodiesel

Transportes Ceferino Martínez, S.L. (TRAN C MARTINEZ)	Vilafanat (Girona)	6	0.1	Biodiesel
Infinita Renovables, S.A. (INFINITA)	Castellón	677	n/a	Biodiesel
Bioenergética Extremeña 2020, S.L. (BIONEX)	Valdetorres (Badajoz)	282	21.0	Biodiesel
Biocombustibles Cuenca, S.A. (BC DE CUENCA)	Cuenca	45	2.2	Biodiesel
Iniciativas Bioenergéticas, S.L. (IB)	Calahorra (la Rioja)	282	26.7	Biodiesel
Energía Gallega Alternativa, S.L.U. (EGAL)	Cerceda (Coruña)	45	0.2	Biodiesel
Saras Energía, S.A. (SARAS)	Valle de Escombreras (Murcia)	226	n/a	Biodiesel
Biocarburantes de Galicia, S.L. (BGAL)	Begonte (Lugo)	38	0.1	Biodiesel
Biodiesel Bilbao, S.L. (BD BILBAO)	Zierbena (Vizcaya)	224	11.3	Biodiesel
Entabán Biocombustibles Galicia, S.A. (ENTABAN GALICIA)	El Ferrol (a Coruña)	226	20.7	Biodiesel
Bio Oils Huelva, S.L. (BIO OILS HUELVA)	Palos de la Frontera (Huelva)	279	67.9	Biodiesel
Biocombustibles de Zierbana, S.A. (BIO ZIERBANA)	Zierbana (Vizcaya)	227	22.3	Biodiesel
Biodiesel Aragón, S.L. (BIOARAG)	Altorricón (Huesca)	113	7.9	Biodiesel
Albabio Andalucia, S.L. (ALBABIO)	Níjar (Almería)	7	0.6	Biodiesel
Lamaro Energy, S.A. (LAMARO)	Vélez-Málaga (Málaga))	7	0.1	Biodiesel
Gestión de Recursos y soluciones empresariales, S.L. (SOLARTIA)	Los Arcos (Navarra)	32	0.9	Biodiesel
Infinita Renovables, S.A. (INFINITA)	Ferrol (A Coruña)	338	n/a	Biodiesel
Biosur Transformación, S.L.U.	Palos de la Frontera (Huelva)	199	26.0	Biodiesel
Aceites del Sur Coosur, S.A. (ENERSUR BIO)	Tarancón (Cuenca)	60	2.1	Biodiesel
Green Fuel Extremadura, S.A. (GREENFUEL)	Los Santos de Maimona (Badajoz)	125	3.2	Biodiesel
Biocarburantes Castilla y León	Babilafuente (Salamanca)	209	18.1	Ethanol
Bioetanol de La Mancha	Alcazar de San Juan (Ciudad Real)	45	4.4	Ethanol
Bioetanol Galicia	Teixeiro (La Coruña)	205	10.4	Ethanol
Ecocarburantes Españoles	Cartagena (Murcia)	136	23.4	Ethanol

Annex B: Second-Generation Research and Development

The European Union and Member States foster R&D activities in the field of biofuels via various programs; these programs are directed at R&D into advanced biofuels (in contrast to first-generation biofuels) from non-edible feedstocks such as wood and straw. Government funding of R&D programs was estimated by IDAE at €4.5 million in 2009. In Spain, R&D biofuel projects with a maximum annual production limit of 5,000 litres are still exempted from hydrocarbon excise taxes though no information was available on whether any plants were actually operating under this regime (MINETUR & IDAE, 2012).

European Commission-funded projects listed in the table below generally involve a consortium of organizations, often spread across a large number of countries which share the total value of the project funding (often only a smaller portion of the overall project funding is directed to activities within a particular country, such as Spain). Spanish Government-funded projects will, however, have a Spanish focus.

PROJECT NAME	DURATION	EU CONTRIBUTION (EUROS)	COORDINATOR	DESCRIPTION	SOURCE
LED	March 2009 to August 2013	8,632,722	ABENGOA BIOENERGIA NUEVAS TECNOLOGIAS SA	Lignocellulosic Ethanol Demonstration (LED) project to design, construct and operate the first biofuel commercial facility in Europe using second-generation technology, consisting of a lignocellulosic biomass to ethanol plant.	http://cordis.europa.eu/projects/index.cfm
ALL-GAS	May, 2011 to April 2016	5,043,580	AQUALIA GESTION INTERGRAL DEL AGUA SA	Demonstrate on a large scale the sustainable production of biofuels based on low-cost microalgae cultures. The full chain of processes from algal ponds to biomass separation, processing for oil and other chemicals extraction, and downstream biofuel production, as well as the use in vehicles, will be implemented on a 10-hectare site.	http://cordis.europa.eu/projects/index.cfm
BIOFAT	May 2011 to April 2015	7,351,074	ABENGOA BIOENERGIA NUEVAS TECNOLOGIAS SA	BIOFAT is a microalgae-to-biofuel demonstration project with a farming area of 10 hectares for microalgae cultivation and a target annual productivity of 100 tons per hectare. The project will integrate all the processes from single cell to biofuel production.	http://cordis.europa.eu/projects/index.cfm
ECODIESEL	January 2008 to December 2011	4,971,572	ACCIONA BIOCOMBUSTIBLES, S.A.	The project will demonstrate a 200,000 t/year capacity flexible FAME production plant, starting from different kinds of raw material oils, with the aim of reducing 40% of the CO2 balance compared to the well-to-wheel emissions of a conventional fossil diesel plant.	http://cordis.europa.eu/projects/index.cfm
The European Investment Bank (EIB) funding R&D into biofuels	2013- 2016	EIB 200 million; repsol 400 million	REPSOL	The European Investment Bank (EIB) to co-finance Repsol's research, development and innovation program. The EIB will finance a development program that includes programs for systems development in renewable energy, biofuels and transport solutions. Most projects are developed at the Repsol Technology Centre, in Móstoles (Madrid).	http://www.repsol.com/es_en/corporacion/prensa/

Genetically modified algae and biofuels	2011	3,500,000	Financed by the Ministry of Science and Innovation's INNPACTO program, ENDESA; with partners: AITEMIN, University of Almeía, TECNALIA and BIOMASS BOOSTER	Endesa working with genetically-modified algae to capture CO2 and produce biofuels; it has finished construction of extension of its pilot plant, on the site of its Litoral de Almeria thermal plant.	http://www.endesa.com/en/saladeprensa/noticias/microalgae
Integral-b.com	2011	1,400,000–50% co-financed by the EC's Life Porgamme	Bionorte (with project members: Ainia Centro Tecnolõgicom Biogas Fuel Cell and Cidaut)	The plant currently produces biodiesel from used vegetable oil, but thanks to the pilot facility, it will also produce biogas using the plant's very own by-products – mainly glycerine, and other organic waste from the Horeca (hotels, restaurants and catering) industry – which it will then use to generate electricity and heat for own consumption.	http://www.renovablesmadeinspain.com/noticia/

GSI Global Subsidies Initiative

iisd International Institute for Sustainable Development Institut international du développement durable

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