AgBioForum, 13(4): 398-412. ©2010 AgBioForum.

Targets and Mandates: Lessons Learned from EU and US Biofuels Policy Mechanisms

Jadwiga Ziolkowska
University of California at Berkeley

William H. Meyers, Seth Meyer, and Julian Binfield
Food and Agricultural Policy Research Institute (FAPRI)

The United States and the European Union have taken different paths in the design and implementation of biofuel policy measures. In the European Union, a target has been set for the contribution of renewable energy in transport use, but policy implementation mechanisms are diverse and decentralized. Mandatory targets have been approved voluntarily by several EU Member States, but these mandatory targets are national initiatives and not an obligation from the European Union. The US biofuel policy has specified targets in absolute quantities rather than in percentages of use, as was done in the European Union. Because of this quantitative target and the fact that the implementation is through a mandate rather than a less-binding target, compliance is assured, but different implementation problems may arise that may not occur in the EU system. In this article, we provide an analytical discussion on lessons learned from the current and previous EU and US biofuel policy mechanisms and consider the possibilities, opportunities, and challenges for future policy development in both economies.

***Key words*:** biofuels, climate change, Common Agricultural Policy, EU targets, US mandates.

Introduction

The differing paths taken by EU and US biofuels policies are in part driven by differing policy priorities and in part by differing institutional settings. In the European Union, policy was driven by a need to meet commitments made under the Kyoto Protocol and pressure from the EU population to address environmental issues. The policy is implemented by the Energy Directorate with little regard for the impact on EU farmers, as it was understood from the beginning that the majority of either the fuel or the feedstock to produce it would be imported. In the United States, policy was motivated by numerous interests, including the desire to reduce dependence on fossil fuels, to reduce greenhouse gas (GHG) emissions, and to increase demand for farm commodities, and the US policy relied primarily on domestic sources of raw material. It is primarily implemented by the Environmental Protection Agency (EPA), and the role of environment and climate change goals in the policy direction has increased with time.

In the European Union, renewable fuel policy has stated fuel security ambitions, but also aims to facilitate environmental protection, meet the challenges of climate change, and support infrastructure for bioenergy and renewable energy. As a result of the policy, the renewable energy sector is one of the fastest growing sectors in the European Union (European Commission [EC], 2006a, 2006b). The production and consumption of biodiesel and ethanol have both risen dramatically over the past decade. The production of biodiesel has grown from 1.42 billion gallons (5.37 billion liters) in 2006 to 2.47 billion gallons (9.35 billion liters) in 2009 (an increase of 74%), while ethanol production has increased from 0.43 billion gallons (1.63 million liters) in 2006 to 0.80 billion gallons (3.03 billion liters) in 2009 (an increase of 86%; Food and Agricultural Policy Research Institute [FAPRI], 2010b). From the background of the growing production and consumption of biodiesel and ethanol, the effectiveness of EU biofuels policies in terms of target achievement needs to be evaluated.

The US biofuels industry has also been growing rapidly since 2005, first due to the replacement of methyl tertiary butyl ether (MTBE) as an oxygenate for motor fuel in urban areas, then due to government policy incentives and rising petroleum prices in the years that followed. Ethanol production has grown from 3.9 billion gallons (14.8 billion liters) in 2005 to 10.7 billion gallons (40.5 billion liters) in 2009 (increased 1.7 times), and biodiesel production has grown from 0.107 billion gallons (0.4 billion liters) to 0.578 billion gallons (2.2 billion liters) in the same period (increased 4.4 times; US Department of Energy, Energy Information Agency [DOE EIA], 2010). Also, in early 2010 the EPA announced a new Renewable Fuel Standard (RFS2) that

implemented increased and more complex rules to govern biofuel mandates.

In this article, we investigate different policy and implementation approaches that the European Union and the United States have already implemented. We discuss the current policies and advantages and disadvantages of the respective policy instruments and implementation mechanisms, comparing their effectiveness and sustainability.

Biofuels Policies and Implementation Instruments in the European Union

EU Regulations for Biofuels

The development of the biofuels sector is a major issue in the Renewable Resources Program of the European Union. The aim of this program is to ensure energy efficiency, to reduce the GHG emissions, to reduce the dependence of the EU Member States on the fossil fuels imported from other countries, to diversify the supply of energy sources, to generate employment in agricultural and rural areas, and to promote innovation and technological development (Kraemer & Schlegel, 2007).

Until now, the renewable fuels in the transport sector have mostly come from what EU legislation terms "first-generation" biofuels (biodiesel from vegetable oil and ethanol from grain and sugar, as well as biofuels from animal fats or waste oils). However, biofuels are often more expensive than fossil fuels, which necessitates the intervention of government to encourage their consumption. In order to boost the use of renewable sources in the transport sector, the European Union approved several regulations, such as the Biofuels Directive 2003/30 EC, which established an indicative biofuels target (EC, 2003a). The target was set at the level of 2% of biofuels to be used in the transport sector by 2005 and 5.75% by 2010 at the EU level. The target of 2% by 2005 was not achieved in all EU countries, and the share of biofuels in fuel consumption amounted to 1.06% in 2005 in the EU-27 and to 2.6% in 2007. Only Germany and Sweden exceeded the 2005 target with 3.86% and 2.11% biofuels use in total fuel consumption, respectively (Eurostat, 2009).

Responding to the shortfall of Member State biofuels consumption relative to the EU target, the European Union approved additional instruments supporting the supply and demand for biofuels: the Biomass Action Plan and the Strategy for Biofuels. Both regulations have been amended and repealed by the Directive 2009/28/EC, which set forth the promotion of the use of energy from renewable sources and established a common framework for the use of energy from renewable sources. The Directive defined the necessity of National Action Plans (NAP) and procedures for the use of biofuels, with the aim to reduce GHG emissions and to promote cleaner transport fuels. This Directive underlies the commitments in the 2007 Renewable Energy Roadmap and Renewable Energy Directive (2009/29) that established new targets: (a) the share of renewable energy in total EU energy consumption is set at 20% by 2020 (including 10% share in the transport sector of each EU Member Country); (b) the GHG emissions are scheduled to be reduced by 20% from the 1990 level; and (c) the total energy consumption in the EU-27 is expected to be reduced by 20% by 2020 ("20-20-20 Policy" for the post-Kyoto period beyond 2012; EC, 2008a; Saundry, 2010). The underlying objectives of the Directive 2009/28/EC and the Renewable Energy Directive are mostly environment-oriented; the Directives refer to the GHG emission reductions and address the biofuels share in the transport sector through targets/mandates, which indicates the long-term goal of protecting the environment. However, biofuels are classified as renewable energy fuels and are therefore regulated by the energy legislation.

The mentioned Directives are not sufficient to achieve the goals of GHG emission reductions; hence, additional instruments have been implemented by the European Union. Currently, the most relevant measures are: Joint Implementation, Clean Development Mechanism, and International Emissions Trading incorporated in the Kyoto Protocol as well as the EU Emission Trading Scheme (ETS) introduced in 2005 and linked to the enumerated Kyoto Protocol measures (EC, 2008c; EurActiv, 2008c).[1]

The support for bioenergy in the European Union was also incorporated into the Common Agricultural Policy (CAP) in 1992, e.g., by introducing in 2004 an energy-crop premium of €45/ha on a maximum of 2.0 million ha of set-aside land (EC, n.d.). With the 'Health Check' reform of 2007, the energy-crop premium and the compulsory set-aside were abolished from 2009 onward. As a result, no support for bioenergy production is included in the first pillar of the CAP. However, within the Rural Development policy (second pillar of

1. *The ETS allows trading emission credits within and outside of the ETS system. Moreover, a new carbon tax measure has been proposed by the European Union with the aim to cover sectors that are currently not underlying the ETS system obligations (e.g., agriculture).*

the CAP) and through the modulation instrument, several measures supporting bioenergy development have been reinforced, i.e., biogas production, support for perennial energy crops, processing of agricultural and forest biomass for renewable energy, and investments in infrastructure for renewable energy using biomass (EC, n.d., 2008b).

EU Target Policy in the Biofuels Sector

The EU policy and its regulations regarding biofuels and the renewable energy sector are target-oriented. According to the EC (2007, p. 11), "targets serve as a public commitment on the part of the government or other authorities to maintain a certain policy stance, which will form the basis of justification for a range of implementing measures." Thus, setting targets for meeting objectives is acknowledged as an element of establishing a policy framework. Rather than implementing a common biofuels policy such as is the case in agriculture, the European Union has elected to set targets and allow Member States to devise their own policies to meet them. This gives the Member States some flexibility for policy to reflect their domestic objectives.

Different kinds of targets are to be mentioned in regard to biofuels and renewable resource sectors: indicative, mandatory, and voluntary targets. The current EU target framework is mostly based on indicative targets. The Kyoto Protocol targets are mandatory (where Member States are obliged by the EC legislation to fulfill the commitment), while voluntary targets have been agreed upon in the European Automobile Manufacturers Association (ACEA)[2] agreement on CO_2 reductions from cars (EC, 2007).

In the Biofuels Directive (2003/30/EC) and Renewable Energy Directive (EC, 2003a), Member States were required to set indicative national targets. While the Electricity Directive requires the Member States to undertake steps to achieve their objectives, the Biofuels Directive does not set a very distinct requirement and only indicates that Member States should ensure that a minimum level of biofuels is placed on the market in line with their national indicative targets. Since 2006, EU Member States are required to adopt the Energy Services Directive (2006/32/EC) and thus to achieve an overall national indicative energy savings target (EC, 2007). Due to the fact that the targets set by the Biofuels Directive and the Renewable Energy Roadmap are not binding, nine countries have decided to go beyond the EC Directive and adopted mandatory requirements for the incorporation of biofuels. The indicative and mandatory targets set by the respective countries are presented in Table 1.

Table 1. Minimum incorporation targets for EU Member States in place in summer 2010.

	Ethanol	Biodiesel	Total
Germany	2.80%	4.40%	6.25%
Belgium	4.00%	4.00%	4.00%
Luxembourg			2.00%
Denmark	5.00%		5.75%
Spain	3.90%	3.90%	5.83%
France	7.00%	7.00%	7.00%
Greece			5.75%
Ireland			4.00%
Italy			3.50%
Netherlands	3.50%	3.50%	4.00%
Portugal			7.00%
UK			3.50%
Austria	3.40%	6.30%	5.75%
Finland			4.00%
Sweden			5.75%
Poland			5.75%
Hungary	5.75%	5.75%	5.75%
Czech Rep.	4.10%	6.00%	
Estonia			
Latvia	5.00%	5.00%	
Lithuania	5.00%	5.00%	5.75%
Slovenia			3.00%
Slovakia			5.75%
Cyprus			2.50%
Malta			
Romania	4.00%	4.00%	
Bulgaria			5.75%

Source: Strategie Grains (2010).
Note: Shaded cells are indicative, others are mandatory. Belgium, Denmark, Ireland, The UK, Czech Republic, Lithuania and Romania targets are set for volume. Others are expressed as energy equivalents.

Lessons Learned from the Target System

The share of biofuels that has been established as a target in some EU Member Countries is acknowledged as a mandatory application in other EU countries. When analyzing the previous process of target achievement, the different forms of targets represented in the EU Member States' policies allow comparing the positive aspects of

2. *Fr: Association des Constructeurs Européens d'Automobiles (ACEA).*

this instrument and also showing weaknesses and challenges for the future.

The challenge of mandatory targets set in the Kyoto Protocol and strengthened by the ETS mobilized the EU Member States to undertake direct measures and actions to meet the goals. The Electricity Directive, requiring concrete actions to achieve the indicative targets, has induced rapid growth in the renewable electricity sector. However, due to the fact that different actions have been taken to a different degree by the respective EU Member States, the target was not completely reached. In the Biofuels Directive, neither targets nor actions are mandatory. As a result, even if there has been some rapid growth in the biofuels sector in some EU Member States, only two countries (Germany and Sweden) have taken sufficient measures and actions to exceed their targets. Referring to the ACEA agreement with the European Union, the voluntary targets did help improve CO_2 emissions from cars; however, the target has not been reached (EC, 2007).

Moreover, the mandatory targets established voluntarily by some EU countries have a more binding character than indicative targets; though, this instrument also has other effects. Generally, setting a mandatory obligation (mandate)—and, thus, a fixed market share—for an item usually puts an upward pressure on its price and has other implications as well. The scale of this impact depends on different factors, e.g., the extent to which the mandate increases consumption above the level that would be achieved otherwise, the degree to which output of the item increases as prices rise, whether it is accompanied by a tax exemption, and whether competition from imports is allowed. As the production costs of biofuels in the European Union are significantly higher than that of fossil fuels, the mandatory obligation to incorporate biofuels in the market share, *ceteris paribus*, is expected to increase the consumer price of biofuels and, therefore, transport fuel. However, the price increases can be offset with governmental subsidies (e.g., excise tax exemptions), where some of the cost of the measure is passed on to taxpayers. Different approaches to tax reductions are used in the EU Member States in which biofuels blending is mandatory; Austria, Slovakia, and Spain provide full tax exemption for biofuels, while the Netherlands, Slovenia, and the United Kingdom offer a partial exemption. In the other countries, tax exemptions for blended fuels have been removed (Kutas, Lindberg, & Steenblik, 2007).

EU Policy Instruments for Biofuels: Subsidies and Taxation

In order to help the EU Member Countries to achieve the targets set in the Biofuels Directive 2003/30/EC, the European Commission adopted the Directive 2003/96/EC on energy taxation, which set up a minimum level of taxation for different fuels and allowed an exemption or reduction of excise taxes (EC, 2003b). Biofuels production in the European Union is supported from the EU budget as well as from the national budgets of the EU Member Countries.

Currently, tax relief and obligations to blend are the two most common instruments implemented in the EU Member States. The total support for biofuels in the EU-27 amounts to around €3.7 billion annually. The largest subsidies are those provided through fuel excise tax relief. In total, the subsidies provided for liquid biofuels amounted to about €1.3 billion for ethanol (€0.74/liter) and €2.4 billion for biodiesel (€0.50/liter) in 2006 (Kutas et al., 2007). As this type of subsidy is directly linked to the biofuels production or consumption, the cost of this measure is expected to rise in the future due to the fact that biofuels production is boosted in the EU to achieve the targets.

Responding to this EU policy, the EU Member Countries have adopted additional mandatory blending requirements on the national level in order to complement or replace tax exemptions. The mandatory blending ratios are established at a level to achieve or even exceed the EU target for 2010. An important difference between the EU and the US situation is that because of the lack of competitiveness of EU biofuels, consumption above the mandated levels is unlikely, and the mandates are therefore binding in almost all cases.

In 2005-2006, the instruments supporting biofuels production were implemented in different combinations:

a. Tax relief was adopted by the EU Member Countries with little practical experience in the biofuels sector (i.e., Greece, Portugal, Italy), countries with experience of a more directly supported approach through funds (e.g., Poland), and countries with a more cautious approach (e.g., the Netherlands).
b. Tax exemption and obligation to blend or adoption of both measures together, replacing a tax relief in order to increase overall effectiveness of these measures in a shorter time (EC, 2007).[3]

Even though in 2005-2006 all Member States (except Finland) implemented tax exemptions as a main support measure, since 2007, most EU Member States (Austria, Cyprus, Czech Republic, France, Germany, Italy, Lithuania, Luxembourg, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the Netherlands, and the United Kingdom) have adopted obligations to blend.

Additionally, some countries (Belgium, France, Italy, Ireland, and Portugal) apply a quota mechanism where the amount of biofuels benefiting from the support is shared amongst different suppliers through calls for tender, which means that the right to supply biofuels is allocated through licenses to domestic firms. This mechanism allows national governments to specify the amount of biofuels needed to be supplied each year (EC, 2007).

In terms of the protection against biofuels imported to the European Union from third countries, particularly Brazil, high tariff barriers (€0.102/liter for denatured ethanol or €0.192/liter for undenatured ethanol) have been implemented. In 2006, the tariffs provided EU producers with the support of €420 million, but simultaneously largely denied EU consumers access to cheaper foreign imports (Kutas et al., 2007).

Further, in some EU Member States, the distribution and consumption of biofuels are encouraged through national user incentives, e.g., reduced vehicle registration fees and tax credits for flex-fuel vehicles (FFVs), as well as subsidies for E85 pumps. Within this framework in 2006, the support for ethanol on a petrol-equivalent basis was more than twice (€0.46) as high as ex-tax (before applying a tax) market price for regular unleaded (RON 91) petrol (Kutas et al., 2007).

Apart from these general market measures, several EU Member Countries have implemented other support measures to specific sectors in 2006-2007, such as

a. additional measures for farmers other than set-aside land or energy crop payments in Belgium, Greece, Ireland, Lithuania, and Poland (direct input subsidy for fertilizers, feed, energy, water, transportation, etc.; Organization for Economic Co-operation and Development [OECD], 2008);
b. additional measures for industry in Cyprus, Czech Republic, Latvia, Lithuania, and Poland in order to reduce the infrastructure costs, e.g., investments in renewable fuel plants;
c. measures for distribution in the United Kingdom; and
d. measures for purchase and maintenance of cars in Austria, Belgium, Cyprus, Denmark, Estonia, Ireland, Malta, Poland, and Sweden (EC, 2007).

Due to the decentralized approach of the biofuels policy in the European Union, different instruments have been implemented in different EU countries—depending on national preferences and possibilities in achieving the targeted goals of biofuels production. Despite the various incentives of applying different instruments on the national levels, the decentralized approach of the European Union allows the countries to find the most effective and sustainable way of achieving the targets.

A major difference between the US and the EU approach to biofuels policy is that in setting overall targets, rather than specific pan-European biofuels policies, the European Union has facilitated a diverse range of approaches across the Member States. This has the advantage of allowing Member States to address their own domestic objectives, which results in the policies being more attractive to their citizenry. Countries with large agricultural or biofuel production sectors can encourage domestic production. Derogations to import taxes on ethanol for the United Kingdom and Sweden allow them to follow policies that emphasize efficiency in cost or biofuel emissions. Tax incentives can shift the burden of the policy between taxpayers and fuel consumers. Over time, as targets have become harder to achieve and budget costs have risen, Member States have generally moved away from tax incentives and towards mandatory blending rates, but important differences still persist.

3. *The effects of implementing a tax credit and a binding mandate at the same time have been studied with stylized models by de Gorter and Just (2010) and Lapan and Moschini (2009). The authors showed that if the ethanol mandate is binding, then a lower ethanol tax rate does not foster ethanol consumption that has been already defined by the mandate. Hence, the lower ethanol tax rate can lead to a lower price for gasoline, boosting the demand for gasoline. Thus, only one instrument (mandate or the tax incentive) will influence the ethanol demand (see also: de Gorter & Just [2009]). Stochastic simulations with a detailed empirical model for US commodities and biofuels have confirmed these results and show that when the mandate is binding, a tax credit shifts costs from motor-fuel consumers to taxpayers, reduces the price of the fossil fuel portion of motor fuel, and thereby increases consumption of fossil fuels while biofuel consumption remains the same as required by the mandate (Meyer et al., 2009).*

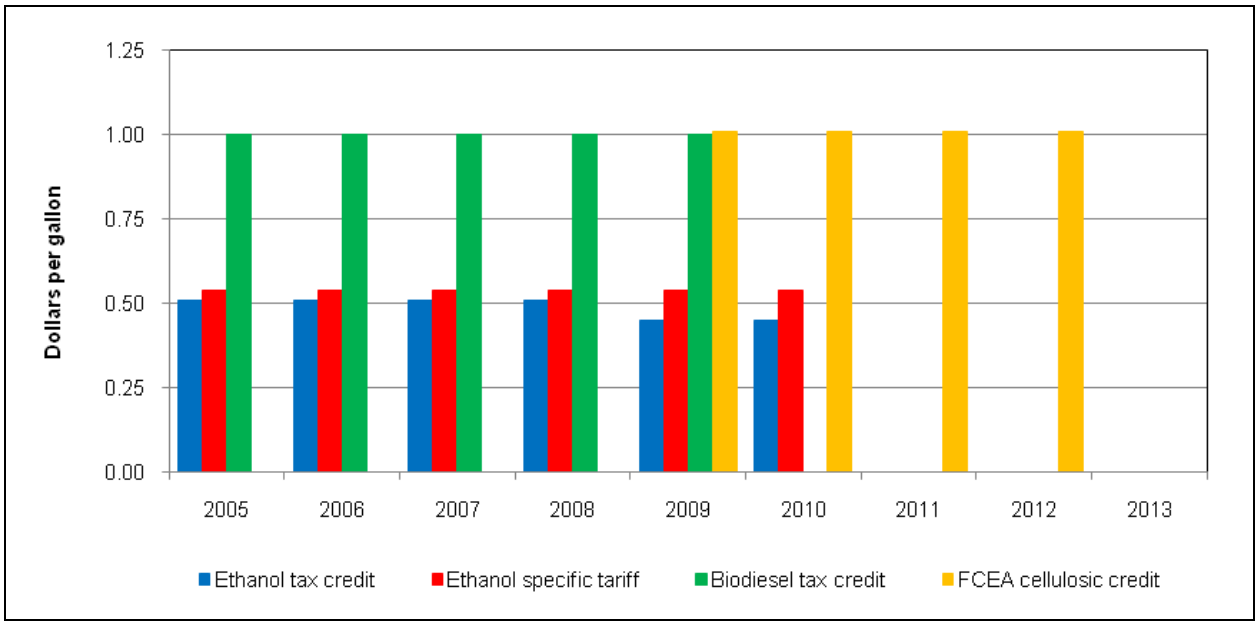

Figure 1. Tax credit by biofuel type and ethanol import tariff, 2005-2013 ($/gallon).
Source: US EPA (2010)

Biofuels Policies and Implementation Instruments in the United States

US Regulatory System of Subsidies, Tariffs, and Mandates

Origin and Evolution of US Biofuels Policies. Biofuels policies in the United States have evolved in steps since the Energy Policy Act (EPAct) of 2005 first established the renewable fuel volume mandate. The mandate was set at 7.5 billion gallons (by 2012) and the EPAct also set up the blender's tax credit and the offsetting import tariff on ethanol. Biofuels policy instruments include a combination of incentives, mandates, escape clauses, and implementation mechanisms. These are outlined separately, followed by a discussion of the interaction of these under different market conditions, because the relative impact of each policy instrument varies with market situations.

Credits and Tariffs. From 1978 through 2004, the federal government provided the payers of federal excise taxes on motor fuel with a tax credit for the amount of ethanol blended with gasoline. Over the years, the tax credit ranged from $0.40 to $0.60 per gallon ($0.11 to $0.16/liter) of ethanol. Due to concerns about the loss of federal revenue for transportation purposes, the tax credit was replaced in 2005 with a federal tax refund to blenders of motor fuel (Office of the Legislative Auditor [OLA], State of Minnesota, 2009). This was done in the 2005 EPAct, which established a $0.51/gallon ($0.14/liter) ethanol excise tax credit and a $1.00/gallon ($0.26/liter) biodiesel excise tax credit for blenders, as well as a $0.54/gallon ($0.14/liter) import tariff (about the same as the EU denatured ethanol tariff at current exchange rates) on ethanol to prevent foreign-produced ethanol (except from trading partners in the Caribbean Basin Initiative) from gaining the benefit of the domestic ethanol tax credit.

A $1.01/gallon ($0.27/liter) tax credit for cellulosic ethanol was introduced and the ethanol tax credit was reduced to $0.45/gallon ($0.12/liter) in the Food, Conservation, and Energy Act (FCEA) of 2008 (the Farm Bill of 2008), apparently as a cost saving measure to meet the budget targets. Because of the different vintages of these provisions, they also expire at different times (Figure 1); the biodiesel tax credit expired in December 2009, the ethanol tax credit and tariff expired at the end of 2010, and the cellulosic ethanol tax credit at the end of 2012. It is often presumed that such incentives and disincentives will be extended, but it is not automatic; and to prove the point, Congress had not yet managed (as of July 2010) to find a legislative vehicle to restore the biodiesel tax credit.

In addition to these federal policies, some states have additional incentives, such as waiving state taxes (e.g., Iowa and Minnesota) and state mandates (e.g., Missouri and Minnesota) on the use of biofuels. Califor-

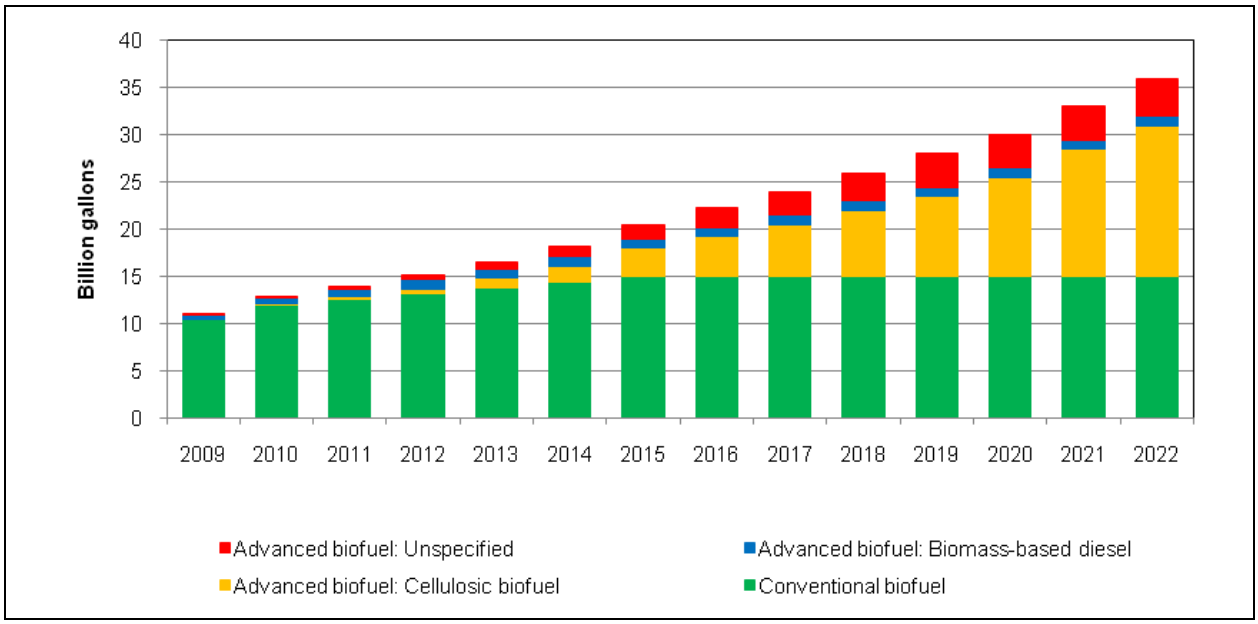

Figure 2. RFS2 volumes by fuel category.
Source: US EPA (2010)

nia is especially notable in that it's Low Carbon Fuel Standard—which seeks to limit the carbon intensity of fuels—is a different policy instrument and may also influence the national policy debate (Holland, Hughes, & Knittel, 2009). These state policies may increase the use and/or change the composition of biofuels in those states and thereby influence outcomes in other states as well, but have so far had little or no significant impact on national biofuels policies. US biofuels policy, therefore, has some of the flexibility of the EU approach, as states are to some extent free to implement additional policies to encourage biofuel use or achieve other objectives.

Mandates. From the beginning with the EPAct of 2005, US biofuel targets were specified as mandates in volumetric terms as a part of the Renewable Fuel Standard (RFS) program. In that law, the mandate was set at 4 billion gallons (15.14 billion liters) in 2006, growing to 7.5 billion gallons (28.39 billion liters) in 2012.[4] The Energy Independence and Security Act (EISA) of 2007 expanded the RFS program by adding a biodiesel mandate and expanded the total mandated quantity of renewable fuel to be blended into transport fuel to 9 billion gallons (34.07 billion liters) in 2008, growing to 36 billion gallons (136.27 billion liters) in 2022. These totals were also divided into specific categories, with separate volumes for each and requirements that EPA applies lifecycle GHG performance standards to ensure that each category of renewable fuel emits fewer GHG than the petroleum fuel it replaces. Of the total mandate, conventional (grain-based) ethanol cannot be more (but can be less) than 15 billion gallons (56.78 billion liters), which is the difference between the total of 36 and the advanced biofuels total of 21 billion gallons (79.49 billion liters). In April 2010, the EPA announced the RFS2, which implements the requirements of the EISA and went into effect July 1, 2010 (Figure 2).

The new standards specify minimal lifecycle GHG thresholds by type of biofuel (Table 2). Because several types of biofuel are nested in the "advanced biofuel" mandate, a further explanation of these relationships will be useful. The biofuel mandates established in the EISA of 2007 are not independent of each other but are hierarchical in nature. A mandate establishes the minimum quantity of use and is considered 'binding' in the marketplace if the market would result in use below the mandated quantity in its absence. Similar to its predecessor—the Energy Policy Act of 2005—the EISA establishes a minimum total quantity of biofuel (T in Figure 3) to be used in a given calendar year (FAPRI,

4. *A provision of EPAct 2005 that had important short-run market effects was the essential ban on the use of MTBE as an oxygenate in urban areas of the nation with high levels of smog. The relatively sudden increase in demand for ethanol stimulated rapid increases in profits and investment for ethanol plants during 2006 and 2007.*

Table 2. Requirements for new standards under RFS2.

Type	Volume by 2022	Lifecycle GHG threshold	Comment
Biodiesel	1 billion gal (3.79 billion l)	50%	For 2012 and beyond [a]
Cellulosic biofuel	16 billion gal (60.57 billion l)	60%	Subject to annual assessments
Advanced biofuel	21 billion gal (79.49 billion l)	50%	Anything but corn starch, minimum of 4 billion gal additional
Renewable biofuel	36 billion gal (136.27 billion l)	20% [b]	Minimum of 15 billion gal additional

Source: US EPA (2010)

[a] *Could be increased from 2013 onward*

[b] *Only applies to fuel from new facilities. "Grandfathered" facilities are those (domestic and foreign) that commenced construction before 31 Dec 2007 and ethanol facilities that commenced construction prior to 31 December 2009 and use natural gas and/or biomass for process heat.*

2010a). However, the new act goes on to specify minimum quantities that must come from specific feedstocks or biofuel types towards meeting that total. Another criterion is GHG emission reductions.

Conventional biofuel (*C*) meets the lowest GHG target and counts toward the total mandate. Advanced biofuels (*A*) are biofuels produced from feedstocks that generate greater GHG emissions savings. Conventional ethanol (*C*) cannot be used to meet the advanced submandate, but advanced biofuels do help to meet the total mandate (*T*). The legislation increases the share of advanced biofuels (*A*) in the mandate total (*T*) over time.

While it is often suggested that there is a corn-ethanol mandate, in fact, no such mandate exists. Corn ethanol, a conventional ethanol according to the EISA, can be used to satisfy the difference between the total mandate and the advanced mandate ($T - A = C$), but must compete with all other biofuels, including any production of advanced biofuels in excess of the advanced mandate (*A*). The advanced biofuel mandate is further subdivided. The two categories outlined are a mandated quantity for ethanol made from cellulosic or agricultural-waste-based feedstocks (*S*) and biodiesel (*B*). The remainder of the advanced ethanol mandate ($A - S - B = O$) can be met by additional cellulosic production, additional biodiesel production, or from another source. Imported sugarcane ethanol, for example, is an advanced biofuel that is neither cellulosic nor biodiesel (thus, type *O*). The mandates only restrict minimum quantities and are nested within each other, creating a hierarchy of biofuel types that can be used for compliance.

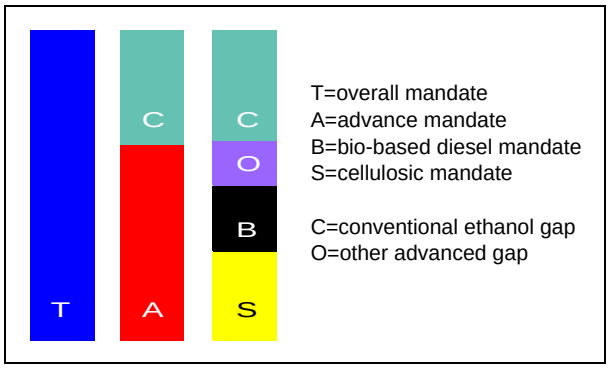

Figure 3. Categories of biofuels specified in the RFS2 regulations.

Source: Meyer and Thompson (2010)

Finally, the EPA has the authority to waive a mandate if it is technically unfeasible or economically not viable for the industry to provide it. This is most applicable to the cellulosic biofuel that is only at the small-scale experimental stage of processing and such a waiver is sure to be needed for some years to come. The next section discusses how such a reduction in the cellulosic mandate impacts the Renewable Identification Number (RIN) market.

Compliance Mechanisms and the Role of RINs

The mandates, if not waived, are the indicators to biofuel producers what will be the lower limit on the aggregate usage for each particular type of biofuel. Since these levels are specified in the legislation well into the future, it is also a signal for investment in production facilities. Of course, biofuel producers are competing with each other for that market. For fuel blenders, the mandates are a requirement on what needs to be blended by each based on the blender's share in the total fuel market. A blender is responsible for all four of the mandates even if only one type of fuel is blended by the company. The market mechanism that facilitates market clearing and makes it possible for these markets to reach equilibrium is the issuing and trading of RINs.[5]

Each batch of fuel produced or imported is assigned a RIN, which is a 38-character numeric code that identifies its vintage, volume, and fuel classification (cellulosic, bio-based diesel, advanced, or conventional).

5. *The functioning of RIN markets is briefly described here, but for the first detailed analysis of the structure and behavior of these markets, see Thompson, Meyer, and Westhoff (2010).*

These RINs accompany the fuel when it is sold by the producer or importer and becomes the property of the blender who buys the accompanying fuel. A blender can accumulate the required volume equivalent of RINs either by blending the exact mix of fuel that was assigned or—more likely—by some combination of buying and blending biofuels and purchasing RINs from other blenders. For example, a plant that purchases and blends only conventional ethanol needs to buy advanced biofuel RINs from another blender who has more than needed. This market in RINs determines the equilibrium prices of RINs that will clear this market.

The value of the RINs, with the exception of cellulosic RINs when the mandate is waived,[6] is determined by supply and demand and is linked to how "binding" the mandates are. If a mandate is not binding, such as when petroleum prices are high[7] and stimulate ethanol demand in excess of the mandate, the RIN value is negligible. However, as the mandate becomes more binding, the RIN value increases. The blenders must offer producers a price sufficient to obtain the quantities needed to meet the mandate. However, they are unable to pass the full cost onto the ethanol portion of blended fuels, or they will induce consumers to use fuels with the least ethanol content and stifle the use of higher-level blends such as E-85. Thus, the difference between the blender's selling price of the (blended) ethanol and the buying price is the value of the RIN. The blender passes on this cost to the consumer by increasing the overall price of motor fuels, maintaining the relative pricing of ethanol-blended fuels, which induces use by consumers. An alternative way to consider the RIN value is that it represents the price the blender would be willing to pay to avoid the mandate.

Because the mandates are nested, blending above that which is required to meet the mandate in one category can be used to fulfill a broader mandate (***demotion)*** or carried forward one year to meet up to 20% of next year's obligation ***(rollover).*** That is to say, advanced RINs generated when advanced biofuels are blended above the advanced mandate can be applied toward the larger overall mandate for compliance purposes. This hierarchy of biofuel mandates creates a hierarchy in RIN pricing in such a way that cellulosic and biodiesel RINs cannot be priced lower than advanced RINs, which cannot be priced lower than conventional RINs. Excess RIN production in a given year can be demoted to meet lower-level mandates or rolled forward for next year's obligations. A maximum of 20% of the current year's obligation can be met with last year's RIN production, and quantities above this amount will expire unused. The rollover provision is a mechanism that serves to stabilize year-to-year variation of ethanol and feedstock prices because blenders can accumulate and dispose of RINs in the same manner as the market deals with commodity stocks. Verification that each blender has acquired the required quantity and combination of RINs is done by the EPA; in the case of non-compliance, there is a daily civil penalty as well as the actual cost of purchasing the lacking RINs (US EPA, 2010).

Differing Roles of Policy Instruments under Different Market Conditions

Numerous analyses have been conducted to simulate how these markets would behave under differing conditions (Meyer & Thompson, 2009; Meyer, Westhoff, & Thompson, 2009; Westhoff, Thompson, & Meyer, 2008). When petroleum prices are relatively high, mandates are not binding and have little impact on the market outcomes. In this case, prices of petroleum, ethanol, and corn are closely linked and the blender's tax credit increases demand for biofuels and translates into higher prices for biofuel and the feedstock from which it is produced. When petroleum prices are low and mandates are binding, the mandate is critical to the quantity of transactions, and prices of petroleum and the feedstock are not so closely linked. In fact, the mandates have seldom been binding except in Fall 2008 to Spring 2009 when petroleum prices were so low. These studies have analyzed market behavior and demonstrated that the relative impacts of policy instruments differ and market behaviors differ when these different market conditions obtain. The most recent study, done with the FAPRI 2010 baseline (Meyer & Thompson, 2010), showed that without the tax credits and tariff, the mandate would lead to lower feedstock prices and more imports. When the mandate is binding, the removal of the tax credit also has the effect of shifting the cost of achieving the mandate from the taxpayers to the fuel consumers.

A new issue has arisen that is related to the US decision to specify the ethanol mandate at a volume that exceeded the 10% blend limit. It is called the "blend

6. *When the EPA waives or reduces the mandate for cellulosic biofuels, it is required to sell RINs at a fixed price, which is equal to the greater of $0.25 or $3.00 less the price of unleaded gasoline. These RINs are not tied to any actual fuel.*
7. *It could also be due to low input prices, especially for feedstock. Stochastic analysis shows a strong inverse relationship between RIN and petroleum prices but also shows the clear influence of other factors (Meyer, Binfield, & Westhoff, 2010).*

wall" and refers to the fact that if all gasoline-powered motor vehicles were to use a 10% ethanol blend, this alone would not be sufficient to meet the nationally mandated biofuels usage level. In response to this concern, on October 13, 2010, the EPA announced a partial waiver to allow 15% blends to be sold, but only for "model year 2007 and newer light-duty motor vehicles." The EPA has deferred a decision on 2001-2006 light-duty motor vehicles until further tests can be completed, and all other vehicles are not even under consideration. Still, there is no guarantee that consumers would find it acceptable to switch to a 15% blend. Meanwhile, there are not enough vehicles or fuel-dispensing pumps with E85 capability to overcome this usage barrier in the short term.

Lessons Learned and Prospects for Change in the Future

The new RFS2 was an opportunity to make some changes and indeed some were made. Greater emphasis was placed on measures to ensure that renewable fuel was indeed reducing GHG emissions as it was substituted for fossil fuels. Volumes of mandates were increased and were defined with minimums in specific categories, which somewhat reduced the flexibility of the mandate system.

As mentioned, there is a current debate on resolving the "blend wall" issue by increasing the allowed blend from 10% up to 15%, and the EPA has already issued a waiver to permit this only on 2007 or newer vehicles. Though this would only be a short-term solution, there are technical issues to resolve. Even if tests can ensure that no damage will be done to vehicles using the blend, it is not a guarantee that it will be accepted by consumers or even by filling stations. Stations could be concerned about practical or financial issues, such as the number of additional pumps needed or about liability issues if there were a problem with engine damage. Related to this issue is the lack of sufficient flex-fuel vehicles and possibly a lack of sufficient interest in buying them; the cost of E85 fuel is still priced too high in many markets to be attractive relative to its energy value. Finally, analysis has shown that with a mandate in place, the decision to extend tax credits and the ethanol import tariff is largely a question of who pays. Currently, the program costs are shared by taxpayers and fuel consumers. Eliminating the tax credits and tariff would shift the costs almost entirely to the fuel consumers (Meyer et al., 2009).

Comparative Analysis of EU and US Biofuels Policies

Differences in Indicative vs. Mandatory Targets and Volumetric vs. Percentage Targets

According to the European Commission (2007), the legal strength of a target largely determines its credibility, as stronger targets mean that efforts will be made by governments to achieve the targets. This in turn means that the markets have greater certainty for planning and undertaking investments, which clearly favors the mandatory over indicative targets. Moreover, setting a single target for all biofuel types gives the market flexibility to choose a cost-effective way of an appropriate technology, while sectoral targets (as in the United States) can—in theory—create the long-term confidence for inducing new investments in a broad range of renewable energy sources.

The fact that the United States chose volumetric targets and the European Union chose percentage targets in part reflects the political economy of the biofuels policy in those regions. By setting volumetric mandates, the United States reduces uncertainty faced by biofuels producers and farmers. In the European Union, setting a target in terms of percentages addresses the commitment of the sector in meeting the overall Kyoto limits. However, setting the targets in terms of GHG emissions themselves would increase the effectiveness of policy in this respect.

The effectiveness of either type of mandate is conditional on its interaction with any other policy or technical restriction that is in place and that impacts biofuel use. Both the United States and the European Union must find a way to overcome the problem of a "blend wall." This can be overcome by increasing the permitted volume of biofuels that can be blended, which is being investigated by both the European Union and the United States. The "blend wall" can also be overcome by increasing the volume of high-blend fuels, such as E-85. This requires an increase in the number of vehicles that can run on higher blends of ethanol, investment in infrastructure to provide pumps for the fuel, and—presumably—fuel priced at or below its energy equivalence to encourage consumers to use it.

Differences in Incentives for Second-Generation Biofuels vs. Quantitative Distribution of Mandate by Type

The EU approach of providing higher credit for second-generation biofuels provides an incentive for the

advanced technology development. The United States had such a credit, giving a 2.5 times credit to second-generation technology in RFS1, but it was converted to the quantitative categories in the RFS2. The EU approach is more flexible in that the volume of second-generation biofuels is related to their competitiveness with respect to other biofuels. The US approach, in theory, provides more certainty by setting a mandated volume, but this mandate can be (and has been) waived depending on the technology available and this undermines the advantages that this provides.

An interesting aspect of the EU approach is that if a successful cellulosic biofuel sector does emerge, this will probably reduce the volume of biofuels used, thereby undermining the advantages of setting percentage targets in reaching GHG emission goals.

Differences in Supranational vs. Country-Level Strategy

The US-wide approach to biofuels policy would not be possible in the confederate-type governance of the European Union unless Member Countries agreed to turn over authority and funding to the centralized governance of the Commission, as was done with the CAP and Regional Policy. Of course, granting such supranational authority was in exchange for substantial budgetary resources to support the policies. The current decentralized approach of the European Union has the advantage of allowing countries to find the most effective means to achieve the targets, which may differ country by country. In the United States, it is the RIN market that allows production and distribution to move to the most cost-effective facilities and regions. Such a trading of targets or quotas could also be considered in the European Union.

Subsidies vs. Mandates

Most policy instruments regulating the biofuels market in the European Union are tax exemptions (subsidies) or mandatory blending. The subsidy system has been implemented, but it has caused significant revenue losses for the governments. Another characteristic of tax exemptions is their ability to steer the market by applying different reduction rates to various types of biofuels. Thus, in Germany, only pure biofuels entered the market before 2004, as blends did not profit from tax reductions (Wiesenthal et al., 2009).

With the mandatory obligation to blend, fuel suppliers are obliged to achieve a certain share of biofuels in their total fuel sales. This instrument does not cause any revenue losses for the government since the fuel suppliers and final consumers are carrying the financial burden of this measure. The higher prices reduce transport fuel demand compared to a tax-exemption scheme.

One of the major advantages of the obligation to blend for fuel suppliers is the predictability of the market volumes to be sold in the respective years. The advantage of volumetric mandates is that they are certain regardless of oil and crop prices. Percentage mandates will change as oil prices and incomes change. If fixed tax exemptions are used, the volume of biofuels and agricultural feedstocks used will vary with both crop prices and oil prices.

On the other hand, a generalized obligation system represents some risks because it sets incentives for fuel suppliers to opt for the lowest-cost biofuels; also, fewer incentives for second- and third-generation innovations will exist. One study concluded that the European Union's obligatory system can be efficient when promoting the increase of biofuel consumption, while it is less suitable for promoting special types of biofuels (Wiesenthal et al., 2009), but both the United States and the European Union do have provisions that encourage the use of specific biofuels, such as second-generation biofuels.

According to the EU estimation (EC, 2007), the most effective combination of political measures supporting biofuels is the obligation to blend and a simultaneous tax relief. Comparing the two enumerated instruments, blend obligations (and US mandates) lead to a cost increase for consumers and no government cost, while tax relief (and US tax credits) shifts costs from consumers to taxpayers. Also, tax relief lowers fuel cost and increases fuel consumption, so the reduction of GHG is less effective with this policy. A theoretical study on this issue has shown that "an ethanol mandate is fully equivalent to a combination of fuel taxes and ethanol subsidies that is revenue neutral," and suggests that the mandate alone would be sufficient and any further subsidies are income transfers from taxpayers to consumers (Lapan & Moschini, 2009, p. 30).

Possibilities and Challenges for Policy-Making in the Biofuels Sector in the European Union and United States: Lessons to Be Learned from Each Other

According to the Directorate General for Agriculture and Rural Development, the target of 10% biofuels of the total fuel consumption in the transport sector in the EU-27 can be achieved by 2020. Many organizations

argue that reaching the European Union's target for renewable fuel usage in 2020 cannot be achieved in an environmental and socially sustainable way. Some experts underline the high pressure on feedstock prices that can subsequently impact food prices. Additionally, some scientific research studies show that, depending on the production method and the feedstock used, some biofuels might have no positive impact on CO_2 emissions (Kutas et al., 2007). Finally, the first-generation biofuels are sometimes criticized due to the fact that biomass is a more efficient feedstock for bioenergy production. Against this background, the challenge for the European Union is to guarantee an efficient policy for supporting bioenergy production.

Furthermore, subsidies for biofuels production in the EU-27 are likely to grow immensely over the next decade, during which financial support is linked to the biofuels production or consumption. However, due to the ambitious blending targets, the support to biofuels could double if the current rates of subsidization are not modified. In the Member States implementing exemptions or reductions in fuel-excise tax, the burden on national budgets will rise in proportion to the domestic consumption. However, for such cases, the European Union has established criteria that require EU Member States to limit support to the difference between oil prices and biofuels production costs. Thus, given a high increase of petroleum fuels prices, the Member States would be legally required to reduce the amounts of any tax exemptions accordingly.

According to EurActiv (2008a), EU ministers distanced themselves from an EU-wide target to boost the use of biofuels in transport and underlined that the target of 10% by 2020 should be accounted not only for biofuels but for all sources of renewable energy (hydrogen and electric cars). Therefore, in July 2008, the European Parliament's Environment Committee voted to scale down the proposed EU-wide biofuels target to only 4% by 2015. The major worry about not meeting the targets was exacerbated by concern about food-price effects of higher biofuels production, which had been blamed by some for the spike in commodity prices. Also, the Parliament's Industry and Energy Committee approved a report by Luxembourg Green MEP Claude Turmes in September 2008. The report confirmed the 10% target by 2020—setting an interim 5% target for 2015—and specified that at least 20% of the 2015 target and 40% of the 2020 goal must be met from "non-food and feed-competing" second-generation biofuels or from cars running on green electricity and hydrogen. The Turmes report also specified that traditional first-generation biofuels would only count towards the target if they meet strict sustainability criteria, i.e., social sustainability criteria and an obligation for biofuels to offer at least 45% carbon emission savings compared to fossil fuels that would rise to 60% in 2015. These numbers are much higher than those proposed by the European Commission (35% saving) and more ambitious than the estimations of national governments.

However, the Member State representatives have found a consensus on a two-phased approach, initially requiring biofuels to offer a 35% CO_2 saving that would then be scaled up to "at least 50%" in 2017, subject to a review in 2014 (EurActiv, 2008b). In the final agreement, no limit on first-generation fuels was included, with the Commission instead opting to allow second-generation fuels to count more towards the target.

Additionally, the 2010 EU report concluded that the share of biofuel in transport fuel beyond 5.6% could harm the environment, thus suggesting that such a policy and the current targets would not be sustainable. An EU report on indirect land-use change caused by biofuels is going to measure the extent to which the production of first-generation biofuels contributes to emissions by replacing crops grown for food production and accelerating deforestation (EC, Joint Research Centre, & Institue for Prospective Technological Studies, 2010; EurActiv, 2010). Currently, the EU is discussing the question of possible solutions, such as minimizing the production quotas, and how to insure that biofuel production can be sustainable and cost-effective. The new quality certification process announced by the European Union in July 2010 could restrict imported raw materials and biofuels by subjecting them to stricter GHG-reduction requirements. This regulation also addresses limits for biofuels from sensitive areas, forests, and partly drained peat lands, thus, promising sustainable solutions; but the details of this process remain to be formalized in policy.

The previous section on US biofuels policy indicates that the United States has moved in a similar direction in the new RFS2. Indirect land-use change was taken into account when calculating the emissions benefits that would be obtained from different technologies. Though the new standards apply to less than 60% of the mandated quantities of biofuels (see Table 2), 50% and 60% lifecycle GHG thresholds are the standard in the RFS2; the lower threshold of 20% applies only to new corn starch facilities or other first-generation ethanol feedstocks.

Mandates have been established as the principal mechanism for achieving US biofuel targets and there is

little pressure to change that direction. But market behaviors vary depending on whether mandates are binding or not and even depending on which of the mandates is binding. If anything, tax credits, subsidies, and tariffs are becoming less critical, since their impact is primarily to alter the consequences for "who pays" rather than what is produced and how. If tariffs and credits were removed in the presence of a binding mandate, the cost of achieving the mandate would shift almost entirely to the transport fuel consumer rather than being shared by taxpayers and fuel consumers. Another important impact is that the fossil fuel component of motor fuel would be relatively more costly, and the use of fossil fuel would therefore be reduced. If in the presence of credits and tariffs there is biofuel production above that required by the mandate (i.e., the mandate is not binding), the removal of these incentives has the additional impact of reducing production of biofuels and demand for and prices of feedstocks and other commodities linked through market supply and demand interactions (FAPRI, 2010a). In this situation, the political pressure to keep the subsidies and tariffs is clearly greater. The tax credit for biodiesel did expire at the end of 2009 and as of July 2010 has yet to be reinstated, but the ethanol industry is much larger and is expected to exert far more pressure to extend the ethanol tax credit before it expires at the end of 2010. Even that difference in political influence of the industries holds uncertain currency in the post-election political environment.

So, both the United States and the European Union may have opportunities to improve the efficiency of implementing biofuels policies, and both have tradeoffs to consider in determining who gains and loses from policy changes. The United States and the European Union (and Member States) have chosen to implement biofuels policy in different ways reflecting the different institutional environments in those countries, but both are relying on a combination of mandates (obligations), subsidies (credits), tariffs, and increased GHG emissions standards. These policy choices influence who benefits and loses from the policy, and the political economy of these choices also influences possible future directions of policy change as well as intersectoral relations. Also, rebound effects can be expected. As it is known for the United States, in the course of implementing the biofuels policy, government expenditures for price-based supports have been reduced in some sectors (see also Hochman, Sexton, & Zilberman, 2008). This tendency is less expected in the European Union since there is less dependence on price-based support, and agriculture is mainly supported with legally and politically well-established direct payments and rural development plans. However, it is true that the presence of the biofuels policy has decreased (but not eliminated) expenditures on the market intervention and export subsidies. The increased imports of feedstocks have also generated import tariff revenue.

It seems evident that, despite many differences in the starting points, the US and the EU policies are both converging toward more reliance on mandates (obligations) as the principal means to achieve policy objectives but are also relying to varying degrees on subsidies, tax credits, and tariffs. In building an industry so reliant on policy interventions, both regions have risked creating a situation where the removal of those policies would have significant impacts on parts of the rural economy and would therefore constrain the policy options for the future.

References

De Gorter, H., & Just, D. (2009). The welfare economics of a biofuel tax credit and the interaction e?ects with price contingent farm subsidies. *American Journal of Agricultural Economics*, *91*(2), 477-488.

De Gorter, H., & Just, D. (2010). The social costs and benefits of biofuels: The intersection of environmental, energy and agricultural policy. *Applied Economic Perspectives and Policy*, *32*(1), 4-32.

European Commission (EC). (n.d.). *Agriculture and bioenergy.* Brussels, Belgium: European Commission, Agriculture and Rural Development. Available on the World Wide Web: http://ec.europa.eu/agriculture/bioenergy/index_en.htm.

EC. (2003a). Directive 2003/30/EC of the European Parliament and of the Council on the promotion of the use of biofuels or other renewable fuels for transport. *Official Journal of the European Union*, *L123*, 42-46.

EC. (2003b). Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. *Official Journal of the European Union*, *L283*, 51-70.

EC. (2006a, August). *An EU strategy for biofuels* (Communication from the Commission [2006] 34 Final). Brussels, Belgium: Author.

EC. (2006b, March). *Environment fact sheet: Energy for sustainable development.* Brussels, Belgium: Author.

EC. (2007, October). *Renewable energy road map: Renewable energies in the 21st Century: Building a more sustainable future—Impact assessment* (Commission Staff Working Document SEC [2006] 1719; Accompanying document to the Communication from the Commission to the Council and the European Parliament). Brussels, Belgium: Author.

EC. (2008a, January). *Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/*

EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community (COM(2008) 16 Final, 2008/0013[COD]). Brussels, Belgium: Author.

EC. (2008b, May). *Proposal for a Council Regulation establishing common rules for direct support schemes for farmers under the Common Agricultural Policy and establishing certain support schemes for farmers* (COM [2008] 306 Final). Brussels, Belgium, Author.

EC. (2008c, January). *Questions and answers on the Commission's proposal to revise the EU Emissions Trading System* (Press Release Rapid Memo/08/35). Brussels, Belgium: Author. Available on the World Wide Web: http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/35.

EC, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS). (2010). *Impacts of the EU biofuel target on agricultural markets and land use: A comparative modeling assessment* (EUR 24449-2010). Luxembourg: Publications Office of the European Union.

EurActiv. (2008a, July 7). *Biofuels not an obligation, say EU ministers*. Brussels, Belgium: Author. Available on the World Wide Web: http://www.euractiv.com/en/transport/biofuels-obligation-eu-ministers/article-173992.

EurActiv. (2008b, September 12). *Biofuel-makers denounce target downgrade*. Brussels, Belgium: Author. Available on the World Wide Web: http://www.euractiv.com/en/transport/biofuel-makers-denounce-target-downgrade/article-175298.

Euractiv. (2008c, December 12). *EU leaders clinch deal on CO2 storage financing*. Brussels, Belgium: Author. Available on the World Wide Web: http://www.euractiv.com/en/energy/eu-leaders-clinch-deal-co2-storage-financing/article-178038.

Euractiv. (2010, March 16). *EU biofuels target borderline sustainable, report finds*. Brussels, Belgium: Author. World Wide Web: http://www.euractiv.com/en/climate-environment/eu-biofuels-target-borderline-sustainable-report-finds-news-382606.

Eurostat. (2009). *Share of biofuels in fuel consumption of transport* [database]. Available on the World Wide Web: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Food and Agricultural Policy Research Institute (FAPRI). (2010a). *FAPRI U.S. baseline briefing book* (FAPRI-MU Report No. 01-10). Columbia, MO: Author.

FAPRI. (2010b). *Activities for biodiesel and ethanol for the European Union* [database]. Columbia, MO: Author.

Hochman, G., Sexton, S., & Zilberman, D. (2008). The economics of biofuel policy and biotechnology. *Journal of Agricultural & Food Industrial Organization*, *6*(2), 1-22.

Holland, S.P., Hughes, J., & Knittel, C. (2009). Greenhouse gas reductions under low carbon fuel standards? *American Economic Journal: Economic Policy*, *1*(1), 106-146.

Kraemer, A., & Schlegel, S. (2007). *European Union policy on bioenergy. Policy brief: Economic policy program—Biofuels*. Washington, DC: The German Marshal Fund of the United States.

Kutas, G., Lindberg, C., & Steenblik, R. (2007). *Biofuels—At what cost? Government support for ethanol and biodiesel in the European Union*. Geneva, Switzerland: International Institute for Sustainable Development.

Lapan, H., & Moschini, G. (2009). *Biofuels policies and welfare: Is the stick of mandates better than the carrot of subsidies?* (Working Paper No. 09010). Ames, IA: Iowa State University.

Meyer, S., Binfield, J., & Westhoff, P. (2010, April). *Making the market: How US policy influences near term biofuel industry production and profitability under technology adoption*. Paper presented at the 114th meeting of the European Association of Agricultural Economists, Berlin, Germany.

Meyer, S., & Thompson, W. (2009) Demand and commodity price behavior under evolving biofuel markets and policies. In M. Khanna, J. Scheffran, & D. Zilberman (Eds.), *Handbook of bioenergy economics and policy* (pp. 133-150). New York: Springer-Verlag + Business Media.

Meyer, S., & Thompson, W. (2010). *FAPRI US biofuel baseline and credit and tariff expiration scenarios* (FAPRI-MU Report No. 04-10). Columbia, MO: FAPRI.

Meyer, S., Westhoff, P., & Thompson, W. (2009). *Impacts of selected US ethanol policy options* (FAPRI-MU Report No. 04-09). Columbia, MO: FAPRI.

Organization for Economic Co-operation and Development (OECD). (2008). *Biofuel support policies. An economic assessment.* Paris: Author.

Office of the Legislative Auditor (OLA), State of Minnesota. (2009). *Evaluation report: Biofuel policies and programs.* St. Paul, MN: Author.

Saundry, P. (2010). Greenhouse gas control policies in the European Union. In C. Cleveland (Ed.), *Encyclopedia of Earth*. Washington, DC: Environmental Information Coalition, National Council for Science and the Environment.

Strategie Grains. (2010). *Minimum incorporation targets for Member States in place in summer 2010* [online database]. Available on the World Wide Web: http://www.strategie-grains.com/.

Thompson, W., Meyer, S., & Westhoff, P. (2010). The new markets for renewable identification numbers. *Applied Economic Perspectives and Policy*, *32*(4), 588-603.

US Department of Energy, Energy Information Agency (DOE EIA). (2010, June). Biodiesel overview. (Monthly Energy Review DOE/EIA-0035[2010/06]). Washington, DC: US Energy Information Administration.

US Environmental Protection Agency (EPA). (2010, April 14). *National renewable fuel standard program—Overview.* Washington, DC: Office of Transportation and Air Quality, US EPA.

Westhoff, P., Thompson, W., & Meyer, S. (2008). *Biofuels: Impact of selected farm bill provisions and other biofuel policy*

options (FAPRI-MU Report No. 06-08). Columbia, MO: FAPRI.

Wiesenthal, T., Leduc, G., Christidis, P., Schade, B., Pelkmans, L., Govaerts, L., & Georgopoulos, P. (2009). Biofuel support policies in Europe: Lessons learnt for the long way ahead. *Renewable and Sustainable Energy Reviews*, *13*, 789-800.

Acknowledgements

The authors wish to acknowledge and thank the anonymous reviewers for their helpful comments.

Material in this publication is partially based upon work supported by the Economic Research Service, US Department of Agriculture, under Agreement No. 58-3000-8-0125.

The Marie Curie research grant within the 7th EU Framework Program is greatly acknowledged.