Biofuel Policies: Fuel versus Food, Forests, and Climate

Kimberly Elliott

Abstract

In the late 1990s and early 2000s, agricultural commodity prices reached new lows and subsidies and mandates to promote biofuels seemed like a solution for multiple problems. Replacing petroleum-based fuels with ethanol or biodiesel made from corn, wheat, sugar, or oilseeds would prop up prices for struggling farmers. In theory, it would also reduce greenhouse gas emissions and promote energy independence. When the expansion of these policies contributed to spiking food prices and increased food insecurity in the late 2000s, most developing countries retreated on biofuels. Many environmental groups also reconsidered their support for biofuels as rising agricultural prices increased the incentives to turn tropical forests into cropland. A growing body of research suggests that first generation biofuels based on food crops could lead to a net increase in greenhouse gas emissions. Despite the growing concerns, American and European policymakers plunged ahead with even more support.

This paper reviews the evolution of biofuel policies in the United States, because it is by far the largest market for biofuels, and the European Union, because the use of oilseed crops for biodiesel, including palm oil, poses particular risks for tropical forests and for climate change. The paper analyzes the economics and politics behind these policies, and shows that agricultural interests played a more influential role than is often recognized. By contrast, specific measures to ensure that these policies are sustainable and assist with climate change mitigation in practice came later and remain inadequate. In sum, biofuel support is one more way that American and European policymakers support agriculture at the expense of important developing country interests.

There are growing pressures in the United States and European Union to reform biofuel support policies to reduce the economic costs, and to ensure they do not increase food insecurity or cause overall net increases in greenhouse gas emissions. A start would be to cap the further expansion of first generation biofuel consumption, as proposed by the US Environmental Protection Agency and the European Union. Going forward, conservation measures, reduced fossil fuel subsidies, higher fuel taxes, and financial and other support to reduce tropical deforestation would be more economically efficient and more effective ways than biofuels to promote energy independence and mitigate climate change.

CGD Climate and Forest Paper Series #18

This material has been funded by UK aid from UK Government's Department for International Development under the Knowledge Partnership Programme, however the views expressed do not necessarily reflect the UK Government's official policies. CGD is grateful for contributions from the Norwegian Agency for Development Cooperation and the UK Department for International Development in support of this work.

The author would like to thank Frances Seymour for suggesting that the author focus on the impact of biofuel policies on forests, and for her willingness to devote time to reading drafts and discussing these issues with the author. Colleagues Jonah Busch, Erin Collinson, and Michele de Nevers also provided extremely helpful comments, as did Derek Byerlee, Peter Riggs and two anonymous reviewers. The author would also like to thank Albert Alwang for his excellent research assistance and John Osterman for seeing the paper through to publication.

Kimberly Elliott. 2015. "Biofuel Policies: Fuel versus Food, Forests, and Climate Change." CGD Policy Paper 51. Washington DC: Center for Global Development.
http://www.cgdev.org/publication/biofuel-policies-fuel-versus-food-forests-and-climate

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CGD Policy Paper 051
January 2015

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Introduction

In the late 1990s and early 2000s, agricultural commodity prices reached new lows and subsidies and mandates to promote biofuel use seemed like a solution for multiple problems. Replacing petroleum-based fuels with ethanol or biodiesel made from corn, wheat, sugar, or oilseeds would prop up prices for struggling farmers. In theory, it would also reduce greenhouse gas (GHG) emissions and promote energy independence. While the weight attached to these rationales differed, numerous countries, led by the United States and European Union, embraced policies to encourage biofuel development.

As the United States and European Union ramped up their consumption mandates in the mid-2000s, increasing demand for maize, soybeans, rapeseed, and palm oil for biofuels contributed to sharply rising food prices. That made farmers with access to global markets happy. But many poor consumers suffered increased food insecurity, at least in the short run. The current generation of biofuels are also contributing relatively little to energy security and there is growing skepticism about the purported climate change benefits (Gerasimchuk et al. 2012). Far from being clearly superior to fossil fuels, biofuels' potential to mitigate climate change depends on how and where producers grow feedstock crops, and how they process them.

Earlier papers focus on the links between biofuels and agricultural prices (Elliott 2008) and the impacts on food security and economic development (Elliott 2013). This paper focuses on how policy-driven biofuel demand influences global commodity markets and increases pressures on tropical forests. For example, as a result of its biofuel blending mandate European demand for palm oil has increased sharply. Yet, research cited by the Intergovernmental Panel on Climate Change concludes that it would take 600-900 years of burning biodiesel instead of petroleum-based diesel to make up for the carbon released from converting peatland to oil palm plantations (Chum et al. 2011, p. 264). Though it is harder to quantify, indirect land use change also occurs as farmers seek to replace the food and livestock feed crops that are going to fuel instead.

This paper focuses on biofuel policies in the United States, because it is by far the largest market for biofuels, and the European Union, because the use of oilseed crops as biodiesel feedstocks poses particular risks for forests and climate change. It begins by showing how rapidly biofuels demand increased in the 2000s and discusses why this is a potential problem for food security, and how that leads to potential problems for forests. It then traces the evolution of US and EU biofuel policies and shows that support for agriculture was a key motivation. Indeed, American and European policymakers did not add measures specifically to address climate change and sustainability concerns until later in the process. And even then, policymakers included loopholes that undercut the effectiveness of these provisions. The final section before concluding looks at how, even with these sustainability standards in place, biofuels-derived demand for palm oil is rising and, with it, the threat to tropical forests.

The Risks of Rising Biofuel Demand

In 2000, not quite 20 billion liters of biofuels were consumed globally, mostly in Brazil and the United States. A decade later, with a large boost from subsidies and government mandates, global consumption was five times larger (figure 1). US consumption eclipsed that of Brazil in the mid-2000s and now accounts for half of the world's total. EU consumption, which barely registered in 2000, nearly caught up with that of Brazil. Overall, these three markets accounted for nearly 90 percent of total global consumption in 2011.[1] Among those consuming the remaining 10 percent, Canada and China are the largest. Most countries produce biofuels primarily for their own consumption and they mostly use home-grown feedstocks. Until recently, Argentina and Indonesia were exceptional in exporting more than they consumed, mostly to the European Union.

Table 1 provides a summary of the major feedstock crops that the US and EU industries diverted from food to fuel in 2013—corn and soybeans in the United States; rapeseed, palm oil, and sugar beets in Europe. US corn production not going into ethanol mostly goes to feed livestock, so the effects on human food consumption are mostly indirect—through higher prices for animal products and through substitution effects. For example, if the higher corn price leads producers to use more wheat to feed livestock, then the price of wheat will also go up. And if consumers replace more costly wheat with rice, then the price of rice will go up as well. When processors crush soybeans and rapeseed, they produce meal, which is fed to livestock, and oil, which is an important source of fat and protein in developing countries where meat is a luxury.

Unfortunately for poor consumers around the world, the adoption of new US and EU biofuel support policies coincided with, and exacerbated, rising food prices (figure 1). While

[1] The US Energy Information Agency has data on biofuel consumption and production, but only through 2011 at http://www.eia.gov/countries/data.cfm#undefined accessed November 14, 2014.

the contribution of various factors remains contested, a World Bank economist estimated that policy-driven demand for biofuels was behind as much as three-quarters of the 140 percent rise in the World Bank's food price index from 2002 to February 2008 (Mitchell 2008). Other analysts at the time pegged other factors—weather-related shocks, financial speculation, and the decline of the dollar—as being at least as important.

In a recent article for the *Journal of Economic Perspectives,* Brian Wright analyzes the competing explanations for the food price spikes and supports Mitchell's conclusions. Wright (2014, p. 88) concludes that, against a backdrop of tighter commodity markets, "biofuels policy was the major driver of the price spikes." Moreover:

> [T]he world grain market will continue to be sensitive to small shocks, and price levels will remain high overall as long as continued shifts in total calories demanded generated [sic] by biofuels demand outrun the expansion of supply. The political economy of biofuels expansion reflects the fact that policies originally supported as reducing the emission of greenhouse gases have been captured by the beneficiaries of the large induced wealth transfers (ibid., p. 94).

Certainly the American and European decisions to ramp up support for biofuels in the mid-2000s could not have come at a worse time from the perspective of short-term food security. Biofuel policies added a relatively large, new, and inelastic source of demand for food crops at a time when commodity prices were already rising. This had offsetting benefits for producers in developing countries, but the short-run volatility induced by biofuel mandates is a problem for everyone.[2] And, while food prices have softened recently,[3] they remain well above the levels of the mid-2000s. The underlying demand-side pressures on food prices will also not abate any time soon: the global population is set to increase by two billion people by 2050, and many more people will have higher incomes that allow them to eat more meat and dairy products.[4]

[2] Elliott (2013) discusses the net effects of rising food prices on poverty in developing countries and examines how advanced country agricultural and biofuel policies exacerbate price volatility for producers and consumers alike.

[3] Data from the FAO Food Price Index is here http://www.fao.org/worldfoodsituation/foodpricesindex/en/, accessed December 11, 2014.

[4] The ratio of feed grains needed per pound of meat ranges from 3:1 for poultry to around 7:1 for pork and beef (Trostle 2008, p. 12).

Growing consumption of biofuels also increases the pressures on tropical forests. Biodiesel *directly* increases demand for palm oil as a feedstock, which increases the pressure to convert tropical forests and peatlands in Southeast Asia to oil palm plantations. The higher prices triggered by biofuels demand also *indirectly* increase deforestation pressures. Schnepf and Yacobucci (2013, p. 6) succinctly define biofuel-driven indirect land use change (ILUC) and why it is a problem:

> ILUC refers to the idea that diversion of an acre of traditional field cropland in the United States to grow a biofuels feedstock crop might result (due to market price effects) in that same acre reappearing at another location and potentially on virgin soils, such as the Amazon rainforest.

In a CGD working paper, Ferretti-Gallon and Busch (2014) reviewed 117 studies of the drivers of deforestation and found, not surprisingly, that forest-clearing increases when economic returns to agriculture rise. Higher agricultural prices were more likely to be associated with increased deforestation than other commonly studied drivers (Busch and Ferretti-Gallon 2014b, p. 3). This makes the claims that the current generation of biofuels is a tool for climate change mitigation questionable at best, an issue to which I return below.

The good news is that there are signs that biofuel demand may be slowing in key countries. More recent and consistent data on biofuel consumption are not available, but production data through 2013 suggest that the slowdown in growth seen in the European Union and Brazil (figure 1) continued, and that it spread to the United States.[5] The apparent plateau in demand is due partly to declining overall fuel consumption, a result of conservation measures and higher gasoline prices, and partly to policymakers' declining willingness to provide fiscal incentives in tight budgetary times. Technological constraints on higher biofuel blends are also a growing problem, particularly in the United States.

The not so good news is that many other countries also adopted policies to promote biofuels over the past decade. According to the Global Sustainability Report for 2014, the number of countries with biofuel support policies increased from 10 in 2005 to just over 60 in 2013 (REN21. 2014, p. 15). Many developing countries retreated from those policies after food prices spiked, however. Even now, very few of them are close to meeting biofuel blending mandates. The future direction of commodity markets will no doubt affect implementation

[5] Data on biofuels production through 2013 is available in various editions of *Renewables 2014: Global Status Report* from the Renewable Energy Policy Network for the 21st Century.

of these policies, but it is difficult to predict how. Softening agricultural prices might be expected to revive interest, but plunging oil prices would cut the other way.

Indonesia and Argentina are facing particular challenges. The European Union blocked their biodiesel exports in a trade dispute and these countries are now pushing domestic demand to absorb the resulting surplus. I discuss this situation further below.

Brazil deserves special attention because it was an early adopter of biofuel policies and has become a large producer and consumer of biofuels, mainly ethanol from sugar cane. Overall, Brazil's biofuel policies are of relatively less concern than in other countries because sugar cane is a relatively efficient feedstock and estimates are consistent in showing relatively large reductions in (per gallon) net GHG emissions from Brazilian ethanol. The main sugar cane growing areas are also not near the Amazonian areas that are at the center of deforestation concerns (Valdes 2011, pp. 5-6). But Brazil's ethanol industry has struggled in recent years. First, high sugar prices raised feedstock costs; then government policies to stem inflation involved holding down gasoline prices; and, more recently, market forces drove down oil prices. So Brazil's role in the global biofuels market is uncertain, despite the relative efficiency of its industry.

Annex 1 briefly summarizes biofuels policies in key developing countries. The remainder of the paper focuses on policies in the United States, because it is so large, and the European Union, because its policies pose particular threats to forests.

US and EU Biofuel Policies: Motivation and Evolution

The United States, like Brazil, initially introduced ethanol subsidies in response to the 1970s oil price shocks. While Brazil stuck with its policy, making it the leading ethanol producer and consumer until the early 2000s, American interest faded along with the price of oil. American interest revived in the early 2000s, however, initially because of historically low agricultural prices, and later because of rising oil prices. Similarly, EU member states began providing support to biofuel production in the 1990s as a means of protecting farmers from reduced agricultural subsidies. Mitigating climate change was not a prominent motive early on.

United States[6]

The initial US subsidies for ethanol spurred sharp increases in production, but from a low base. The ethanol share of the US gasoline market was still just 1 percent in the late 1990s.[7] In 1999, after sharp drops in agricultural prices, President William Jefferson Clinton authorized modest payments to biofuel producers with the goal of increasing corn and soybean demand. The 2002 farm bill codified those subsidies and added other renewable energy incentives, as did subsequent farm bills.

The next bump in ethanol demand (figure 1) came from a nonagricultural source. The Clean Air Act requires refiners to blend in oxygenates to make gasoline burn cleaner. In 2003, California and New York began to phase out the then most common oxygenate, methyl tertiary butyl ether (MTBE), because it was suspected of contaminating groundwater. Refiners turned to corn-based ethanol as a replacement. Then, in 2005, with oil prices rising (and corn prices flat), Congress passed the Energy Policy Act of 2005 to ensure "secure, affordable, and reliable energy" through measures aimed at increased energy efficiency and domestic production, including of renewable energy sources. Amidst the plethora of subsidies and other initiatives was a mandate for the blending of ethanol in gasoline.

The Renewal Fuel Standard (RFS1) mandated the blending of 4 billion gallons of ethanol with gasoline in 2006, rising to 7.5 billion gallons by 2012. Rapidly rising gasoline prices and the long-standing tax credit for blending ethanol with gasoline spurred demand and ethanol production quickly surpassed the RFS levels. Congress responded in 2007 with the US Energy Independence and Security Act (EISA), which doubled the biofuels mandate (RFS2) for 2008 to 9 billion gallons and set a target of 36 billion gallons by 2022. An increasing share of the mandate volume was supposed to come from cellulosic and other "advanced" biofuels, while corn-based ethanol was capped at 15 billion gallons after 2014 (table 2). Within the advanced biofuel part of the mandate, there is a separate category requiring at least 1 billion gallons of biodiesel.

In EISA, Congress also added sustainability standards (discussed in the next section) and charged the US Environmental Protection Agency (EPA) with conducting life-cycle analyses to determine which "biofuel pathways" (feedstocks and processing methods) would be

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[6] The background in this section draws heavily on Schnepf (2013) and Schnepf and Yacobucci (2013).

[7] The Renewable Fuel Association reports figures on ethanol production while the Energy Information Administration tracks gasoline consumption. Yacobucci (2012a) details in the various federal government incentives for biofuels; many states also offer various incentives to encourage biofuel production or use.

eligible under the mandate. Since there had been a boom in investments under the original mandate, however, Congress also exempted ethanol plants from the sustainability requirements if construction had begun prior to EISA's enactment.

Before the ink was even dry on the new legislation, a number of challenges emerged. While farmers and biofuel investors celebrated the boon to their business, the agricultural price spikes that were emerging even as Congress passed EISA generated a backlash. Many in the development community protested the negative impact on food security. And environmental advocates expressed growing concerns about the potential impact on climate change and biodiversity if biofuel demand contributed to deforestation or other land use changes in sensitive areas. Figure 2 summarizes the forces jockeying for influence.

At the peak of the food price spikes in 2008, Texas Governor Rick Perry petitioned the EPA to partially waive the mandate to alleviate the impact on corn and other livestock feed prices. EISA authorizes the EPA to issue such a waiver if the administrator, in consultation with the secretaries of agriculture and energy, determines that domestic biofuel supplies are inadequate, or that implementation of the mandate "would severely harm the economy or environment of a State, a region, or the United States" (Yacobucci 2012b, p. 3). When drought sent corn prices soaring again in 2012, the governors of Arkansas and North Carolina requested another waiver because of the impact of high feed costs on their poultry and pork producers (ibid.). The EPA declined to provide relief in either case.

The only change in policy has come from pressures to cut the budget. The principal subsidy to ethanol before 2000 was a tax credit that varied between $0.40 and $0.60 for each gallon of ethanol blended with gasoline. When Congress created RFS1, the tax credit was $0.45 per gallon and the cost quickly escalated as the mandate, and relatively high gasoline prices, stimulated ethanol demand. In 2011, after the cost of the tax credit hit $6 billion per year, Congress let the tax credit expire. It also eliminated an import duty that was designed to offset the subsidy and ensure that imports did not benefit (Schnepf 2013, p. 30-31).

There is also a $1 per gallon tax credit for blending biodiesel with conventional fuel, but the cost is only around $1 billion because biodiesel use is lower. While this tax credit also expired at the end of 2011, Congress restored it a year later under pressure from biodiesel producers who struggled to turn a profit without it.[8] Since then, Congress has repeatedly

[8] The farmdocDaily online publication from the University of Illinois Urbana-Champaign has been tracking biodiesel profitability. The most recent analysis at the time of writing is here:

allowed the tax credit to expire and then reinstated it retroactively and for short periods. Beyond surviving budget-cutting pressure, the biodiesel tax credit has another unique feature. Unlike ethanol, imported biodiesel is also eligible for the tax credit. I discuss the implications of US this for palm oil demand and tropical forests below and in box 1.

Withdrawal of the ethanol tax credit, combined with high corn prices due to severe drought, led to ethanol falling below the RFS2 mandate level for the first time in 2012 (table 2). Refiners need to blend oxygenates with gasoline to comply with Clean Air Act regulations and they also use ethanol to boost octane levels. That puts a floor under ethanol demand of 5 percent to 6 percent of gasoline consumption (Schnepf 2013, p. 4-5; Abbott 2013, p. 8). Beyond that level, however, demand is a function of the mandate, relative fuel and feedstock prices, and constraints imposed by automobile technology and distribution infrastructure. As 2014 was ending, ethanol was facing challenges on both the economic and technological fronts.

At RFS2 volumes up to about 10 percent of gasoline consumption, market demand for ethanol depends on the prices of corn and natural gas, which are the major input costs for ethanol, and gasoline prices. At the prices that prevailed until 2012 when the drought drove up corn prices, ethanol was generally competitive with gasoline and demand likely would have remained at around 10 percent, even without the government mandate (table 2). Analyses by some agricultural experts in 2012 concluded that market conditions at that time were such that, even with the drought, ethanol demand would have fallen relatively little had the EPA waived the mandate at that time (Babcock 2012; Thompson et al. 2012). On the other hand, sharply falling oil prices since mid-2014, are putting pressure on ethanol demand and profits and, if sustained, will give the mandate a more important role in maintaining demand.

Beyond blend levels of 10 percent, however, ethanol runs into technological and infrastructure obstacles that make meeting the mandate increasingly difficult and costly. Until 2011, EPA regulations limited the ethanol content of gasoline to 10 percent (E10) when used in unmodified vehicles because of concerns about engine corrosion. Flex fuel vehicles can use blends up to 85 percent (E85), but there are few of those in operation in the United States. The corrosive properties of ethanol also mean that higher blends require

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http://farmdocdaily.illinois.edu/2014/10/2014-a-tough-year-for-biodiesel-producers.html, accessed November 17, 2014.

separate pipelines, fuel tanks, and other delivery infrastructure. In effect, these technological and infrastructure constraints create an ethanol "blend wall" at around 10 percent.

When the mandate was revised upwards in 2007, US gasoline consumption was 142 billion gallons and the Energy Information Administration projected 1 percent annual growth for the foreseeable future. With the RFS2 capping conventional ethanol at 15 billion gallons, Congress did not anticipate problems with this "blend wall" because it expected ethanol consumption to remain below 10 percent. Instead, rising gasoline prices, increased fuel economy standards, and a decline in driving for other reasons combined to send annual US gasoline consumption down to 130 billion to 135 billion gallons.[9] That meant that refiners began hitting the blend wall in 2012-13 (Dinan et al. 2014, pp. 7-8). For those advocating biofuels for energy security reasons, It should be noted that conservation measures and market forces reduced fossil fuel use from its projected level by roughly the same amount that ethanol replaced gasoline. Unfortunately, recent sharp declines in gasoline prices could reverse that progress.

To at least partially address the blend wall, the EPA raised the permitted ethanol blend level for vehicles built in 2001 or later to 15 percent (E15). But automobile manufacturers recognized E15 as appropriate only for 2013 and later models and warned that warranties might not be valid on older vehicles if E15 caused engine damage. In addition, having different blends for different model-year vehicles would mean that gasoline stations would have to invest in additional pumps and storage tanks. Not surprisingly, since consumers are not vocally demanding E15, there is little interest on the part of retailers (Energy Information Administration 2012, p. 5). In addition, E15 is not approved for other engines. Producers and retailers of recreational motor boats, lawn mowers, and other products using engines that risk corrosion from ethanol are lobbying for changes in the mandate. Opposition from the major oil companies, which never liked the mandate, is also growing as the blend wall raises the costs of meeting the mandate.

The challenges to meeting the cellulosic biofuel portion of the mandate are far bigger and production continues to fall well short of the targets. The Environmental Protection Agency (EPA) has regularly used its authority under the statute to adjust the mandate level for cellulosic biofuels (table 2). But EPA officials also wanted to retain incentives to invest in

[9] For a discussion of potential explanations for the drop in driving, see "Per capita VMT drops for ninth straight year; DOTs taking notice," *State Smart Transportation Initiative,* February 24th, 2014, available online http://www.ssti.us/2014/02/vmt-drops-ninth-year-dots-taking-notice/, accessed December 18, 2014.

cellulosic development so they set targets that were a stretch for the industry. In 2011, for example, RFS2 called for 250 million gallons of cellulosic biofuels, which the EPA scaled back to 6 million gallons. But even that amount was unavailable and oil companies and other blenders had to pay $7 million in penalties for noncompliance.[10] When the EPA set the 2012 target for cellulosic biofuel even higher, at 10.5 million gallons, the oil industry sued and a federal judge threw out the EPA target. The EPA retroactively lowered the 2012 target to zero and sharply lowered the 2013 target from its initial proposal of 14 million gallons. By sometime in 2015, plants capable of producing 75 million gallons or so are expected to be online, but the gap with the formal RFS2 targets—3 billion gallons in 2015 and 16 billion gallons by 2022—continues to grow.[11]

In 2013, the American Petroleum Institute and another industry group filed another petition asking the EPA to waive the RFS2 targets for cellulosic biofuels. The petitioners also asked for a partial waiver of the conventional ethanol target because of the blend wall. With the conventional ethanol target rising to 14.4 billion gallons and Energy Information Agency projecting US gasoline consumption to fall to just under 133 billion gallons (prior to the recent price declines), the EPA took the unprecedented step of proposing reductions in the targets for both conventional and cellulosic biofuels (table 2).

After being inundated with comments on the proposed revisions to the mandate, the EPA announced on November 21, 2014, that it would not set the targets for either 2014 or 2015, due at the end of November 2013 and 2014, respectively, until sometime in 2015.[12] The dilemma for the EPA is that the E10 market is saturated (because of the blend wall), the oil industry does not want to bear the infrastructure investment costs to make E15 available, and there are too few flex fuel vehicles consuming E85 to meet the mandate levels. But the EPA's authority to reduce the mandate levels to accommodate the blend wall is unclear and the agency is likely to face a lawsuit if it goes forward with reductions in the conventional ethanol target.

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[10] Wald, M. L. "A Fine for Not Using a Biofuel That Doesn't Exist" The New York Times. January 9, 2012. http://www.nytimes.com/2012/01/10/business/energy-environment/companies-face-fines-for-not-using-unavailable-biofuel.html?_r=2&adxnnl=1&adxnnlx=1418846621-YSq/9PRkBIfbGE5MOLw4Rw

[11] Krauss, C. "Dual Turning Point for Biofuels." The New York Times. April 14, 2014. http://www.nytimes.com/2014/04/15/business/energy-environment/dual-turning-point-for-biofuels.html?_r=0

[12] The EPA announcement is here: http://www.epa.gov/otaq/fuels/renewablefuels/documents/fr-notice-2014-rf-standards.pdf, accessed December 11, 2014.

In late 2013, Senators Dianne Feinstein (D-CA) and Tom Coburn (R-OK) introduced legislation to eliminate the RFS2 mandate, citing the blend wall and the impact on livestock feed prices.[13] That legislation did not pass, but further efforts to address the blend wall are likely. Given the constraints on the EPA's waiver authority and the growing costs of fulfilling the mandate, a major political battle between the American Petroleum Institute and the American Farm Bureau could be looming in 2015.

European Union

European support for biofuels began as a response to settlement of a trade dispute with the United States over oilseed subsidies. By the early 1990s, EU subsidies had led to a three-fold increase in oilseed production from the mid-1980s. When that caused soybean exports to Europe to drop by half, the United States filed a complaint under international trade rules. After two dispute settlement panels concurred with the US arguments, and US policymakers threatened to retaliate against EU exports, European policymakers finally agreed to reduce oilseed subsidies.

To compensate for the reduction in direct subsidies, the European Union cut a deal to allow farmers to use set-aside land to grow a limited amount of oilseeds that could not be used for food or animal feed, and therefore would not compete with US soybean exports. To boost industrial demand for this domestically-produced rapeseed, France and Germany opted to subsidize biodiesel (Iceland 1994; USDA 2013). In a reply to a 1998 inquiry from three EU parliamentarians, EU Commissioner for Agriculture, Rural Development and Fisheries Franz Fischler noted that while this policy "also has advantages from the environmental point of view, [it] is to some extent a by-product of the set-aside scheme."[14]

In 2003, the European Council ramped up support for biofuels and adopted a directive that set a blend target of 2 percent of transportation fuels in 2005 and 5.75 percent by 2010 (EU 2003). The biofuels directive justified the policy as being necessary to comply with the EU's Kyoto Protocol commitments to reduce greenhouse gas emissions. But it also referenced

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[13] The press release from Senator Feinstein's office is here: http://www.feinstein.senate.gov/public/index.cfm/press-releases?ID=82d3db11-efc7-421a-8c5d-0636b31ca9cd, accessed December 12, 2014.

[14] The land set-aside scheme was adopted as part of the EU's supply management policies under the Common Agricultural Policy. The exchange, "Written Question No. 1055/98 by Giacomo Santini, Claudio Azzolini, Umberto Scapagnini to the Commission, Encouraging the non-food use of agricultural products," can be found at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:91998E001055&qid=1416351961702 accessed November 18, 2014.

benefits in terms of energy security and the opening of new markets for "innovative agricultural products." The biofuels directive left it to member states to figure out how to reach the targets.[15]

In 2009, even though food prices were rising again, the Commission adopted the Renewable Energy Directive (RED) which raised the target to 10 percent of transportation fuels by 2020. The directive also created sustainability requirements for biofuels prohibiting the use of sensitive land to produce feedstocks, setting minimum thresholds for net emission reductions, and requiring the Commission to study the potential impact on GHG emissions of indirect land use change (ILUC). I discuss the sustainability standards in detail below. The Fuel Quality Directive, passed at the same time, sets out technical specifications that limit the use of ethanol in gasoline blends to 10 percent. The technical specifications for biodiesel also effectively limit the use of palm oil because it becomes solid at much higher temperatures and can plug fuel filters in cold weather conditions (Ramos et al. 2009, p. 265).

With the increase in the biofuel blend target, political opposition flared because of concerns about biofuels' contribution to the food price spikes and about the impact of land use changes on forests and climate change. With food prices spiking again in 2010-11 and opposition growing, the European Commission proposed changes to the directive that would retain the overall 10 percent biofuel blend target, but cap food crop-based biofuels at 5 percent. Farm and industry groups criticized the proposal for changing the rules in midstream, which would strand investments made in the expectation of continued support. Environmentalists criticized the proposal because it did not require policymakers to consider ILUC when evaluating biofuels against the new sustainability criteria.

In the face of these competing pressures, and splits among member states along similar lines, the environment committee of the European Parliament voted in July 2013 for a slightly higher cap of 5.5 percent for food-based biofuels. The parliament also voted to include ILUC considerations in the sustainability requirements.[16] In the fall, the full parliament approved a cap of 6 percent and required member states only to report on ILUC effects. After initial attempts at compromise failed in December, the Council of Ministers agreed in

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[15] See Amezaga, Boyes, and Harrison (2010) for a more detailed history and discussion of the current policy; the series of Global Agricultural Information Network (GAIN) annual reports from the US Department of Agriculture are an incredibly useful source of information and data on EU biofuels.

[16] Reece, A. "EU Votes to Cap Biofuels from Food Crops." Resource. July 12, 2013. http://resource.co/article/Futurevision/EU_votes_cap_biofuels_food_crops-3325 , accessed August 6, 2013.

June 2014 to further water down the proposal by raising the cap for food-based biofuels to 7 percent.[17] That level is a bit above recent blend levels of around 5 percent and will, thus, allow for increased consumption. It has the political advantage, however, of minimizing the potential for stranding assets that the industry developed in response to the 10 percent target.

After the new Council of Ministers took office in Fall 2014, however, there were rumors that the proposal might be dropped from the 2015 work program. Energy ministers finally endorsed the proposal in December, however, and the Parliament will review it again in early 2015. In ratifying the compromise proposal, the energy ministers described the aim of the amended directive as aiming to:

> … start a transition to biofuels that deliver substantial greenhouse gas savings when provisional estimated indirect land-use change emissions are also reported, *while existing investments should be protected* (emphasis added).

In addition to scaling back the mandate for 2020, the European Commission released its proposal for EU energy and environment policies to 2030. The new strategy eschews targets for renewable energy use in the transport sector. The Commission concluded that the debate over how to assess ILUC "made clear that first generation biofuels have a limited role in decarbonising the transport sector" (European Commission 2014a, pp. 6-7). Also in early 2014, the Commission issued guidelines that prohibit public subsidies for investments in new capacity for the production of food-based biofuels. It allows member states to continue to provide *operating* support for existing facilities, but only until existing plants are fully depreciated, or the end of 2020, whichever comes first (European Commission 2014b, pp. 24). Several member states, notably France and Spain, have reduced support for the current generation of biofuels because of the rising fiscal costs of tax exemptions and in response to rising feedstock costs (Flach et al. 2013, pp. 13-16).

[17] Hall, M. "Biofuels debate continues, despite EU agreement." EurActiv.com. June 17, 2014. http://www.euractiv.com/sections/sustainable-dev/biofuels-debate-continues-despite-eu-agreement-302834

Biofuel Policies and Climate Change

At the time policymakers were ramping up support for biofuel policies in the early 2000s, there was broad support for replacing fossil fuels with renewables as part of a policy to address climate change. The transportation sector is responsible for 14 percent of global GHG emissions, more than two-thirds of which are from road transport, and there are few alternatives to biofuels as alternative fuels in the short run (IPCC 2014a, 2014b). As the 2000s wore on however, a growing body of research raised questions about the *net* benefits of first generation biofuels in mitigating climate change.

Most of the current generation of biofuels are produced from food and feed crops—mainly corn, sugar (beet and cane), and wheat for ethanol; rapeseed, soybean, and palm oils for biodiesel. The economic and energy efficiency with which these feedstocks are transformed into fuel varies widely and depends on how and where crops are grown and how they are processed. In addition, growing demand for biofuels feedstocks can trigger land use changes—the plowing of grasslands or the cutting of forests—that release carbon. The land use changes, in turn, can be either *direct*, to grow feedstocks for biofuel plants, or *indirect,* to make up for the food crops that are now going to into fuel tanks.

Because of variations in these factors, research shows a wide range of potential reductions in GHG emissions, even without taking land use change into account.[18] To take an extreme case, when ethanol is made from corn that is grown with copious amounts of energy-intensive fertilizer; cultivated, harvested, and transported with fossil fuel burning vehicles; and processed in a plant powered by coal, life-cycle analysis shows that it would emit more greenhouse gases overall than regular gasoline (Yacobucci and Bracmort 2010, pp. 7-9).

In addition to differences in processing technologies and energy sources, there a number of other factors these life-cycle analyses must take into account and some are harder to measure than others. Key uncertainties include how to measure the emissions from nitrogen fertilizer use and how much credit to allow for "co-products" deriving from biofuel production, such as the dried distiller grains produced along with corn ethanol that can be used for animal feed. Finally, estimating emissions associated with *indirect* land use change remains among the most difficult elements to estimate.

[18] The Gallagher Review (Renewable Fuels Agency 2008, p. 23) shows that emissions savings from wheat ethanol vary between 20 percent and 60 percent, depending only on whether natural gas or biomass are used and the processing technology used. The analysis ignores all other factors. See Also figure 2.2 for other feedstocks.

Among the first-generation biofuels, most studies find that sugar cane ethanol produced in Brazil reduces net emissions relative to gasoline by around 80 percent.[19] Sugar cane is a relatively high-yield feedstock, so it requires less land to produce a unit of fuel than many other feedstocks. Processing mills can also use the bagasse (plant residue) to produce heat and power and some are able to sell electricity to the grid (IPCC 2014, p. 234, 244). Other first-generation feedstocks and processes are generally more costly and produce more variable, and, most often, lower net emissions savings. With respect to biodiesel, the recent IPCC (2014, p. 245) report, for example, finds that oil palm is a lower cost source of biodiesel feedstock because, like sugar cane, it has very high yields of oil per unit of land. And, as long as there is no land use change, the net emissions savings are as good as or better than those for rapeseed oil, the major feedstock used in the European Union.

Emissions associated with land use change, however, can alter the results dramatically. In the future, American and European policymakers are pushing for new, commercially scalable technologies that rely on crop or forestry residues—corn stover instead of corn—and mitigate the land use effects. Until then, land use change will be an important factor in determining whether the *net* impact of biofuels on greenhouse gas (GHG) emissions is positive or negative when compared to fossil fuels.

This section looks, first, at how US and EU policymakers modified their initial biofuel policies to try and ensure that these policies would reduce GHG emissions overall—and how biofuel proponents blocked stronger actions. It then turns to the problem of indirect land use change and how to effectively account for it in policy.

Biofuel Politics and US, EU Sustainability Standards

When American and European policymakers decided to increase biofuel support in the midst of the 2007-08 food price spikes, concerns about the impact on food prices, and the links from that to land use change and climate change, grew in prominence. Thus, while the earlier US and EU mandates mostly overlooked sustainability issues, their successors did not. Both the American Energy Independence and Security Act (EISA) of 2007 and the EU's 2009 Renewable Energy Directive (RED) addressed the potential for unsustainable *direct* land use change by restricting the use of sensitive lands for feedstock production. They also

[19]The Organization for Economic Cooperation and Development (2008, pp. 47-49) also summarizes a number of these studies, as does Gerasimchuk et al. (2012) more recently. The Gallagher Review (op cit., p. 24) does show estimated net negative emissions from a sugarcane ethanol plant in South Africa that uses coal-based electricity from the grid.

set standards for minimum emissions reductions, relative to conventional fuels, that biofuels have to achieve under the respective blend mandates. In both cases, the sustainability standards apply to imports, as well as domestic production. Nevertheless, the outcomes of the processes for crafting and implementing the sustainability criteria reflect the competing interests of domestic feedstock producers as well.

Under the revised EISA, the US EPA is charged with developing a methodology for conducting life-cycle analyses and determining which feedstocks and technological pathways would be eligible under the mandate. The net emissions targets specified in US policy include estimates of ILUC. EISA also specifies that eligible feedstocks must come from "renewable biomass," which excludes virgin agricultural land cleared or cultivated after December 2007, as well as tree crops, residues, or other biomass from federal lands. It is not clear, however, how the EPA monitors and verifies that producers are meeting these conditions. With respect to GHG emissions, EISA requires that net emissions from the production of conventional biofuels are at least 20 percent lower than for gasoline. The threshold for cellulosic biofuels is a 60 percent, while other advanced biofuels and biodiesel must achieve a net reduction in emissions of at least 50 percent.

The EPA determined that corn ethanol produced using natural gas, biomass, or biogas *and* designated technologies meets the standard for conventional biofuels. Sugar and sorghum, again using certain technologies and cleaner energy sources for processing, meet the standard for advanced biofuels (Schnepf and Yacobucci 2013, p. 7). However, ethanol plants where construction started before Congress added these conditions in December 2007 are grandfathered and do not have to comply with the 20 percent net emission reduction target. Plants that use natural gas or biomass for processing and where construction was begun between 2007 and 2009 are also exempt from the 20 percent emissions reduction threshold (ibid., p. 8).

According to the EPA, most corn ethanol plants were grandfathered and are thus exempt from the 20 percent minimum GHG reduction target. These plants must still comply with the other requirements (for example, using renewable biomass).[20] But, In practice, it is hard

[20] See question 7 under section 3 of "Questions and Answers on Changes to the Renewable Fuel Standard Program (RFS2) on the EPA's website: http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/rfs2-aq.htm#4.

to know whether corn-based ethanol is reducing net GHG emissions because information about the grandfathered plants is not available.

The EPA also approved soybean, canola, and rapeseed oils as eligible feedstocks for biodiesel. But the EPA concluded that land use changes could wipe out much of the GHG emissions savings from using palm oil. Therefore, palm oil is not currently an eligible feedstock under RFS2, but there is a petition asking the EPA to reconsider that decision. Moreover, some palm oil is apparently being used in US biodiesel in order to take advantage of a $1 per gallon tax credit under different legislation (see box 1).

Under EU policy as revised in 2009, biofuels must reduce emissions relative to gasoline or diesel by at least 35 percent to be eligible for financial support or count towards the mandate. In 2017, that figure is slated to rise to 50 percent for existing plants and 60 percent for new ones. The European Commission's Joint Research Center estimated the "typical" greenhouse gas reductions for various feedstocks using specific production pathways, but these calculations do not include the ILUC effects.[21] The European Commission then applied "pre-determined" discount factors to these calculations so that the default estimates of net emissions reductions would be conservative (Flach et al. 2013, p. 6). Producers using feedstocks where the default calculation does not reach the 35 percent target can try to gain entry by submitting data to show their process meets the threshold.

In addition, the EU sustainability standards prohibit feedstocks produced on land with "high biodiversity value, such as primary forests and highly biodiverse grasslands… land with high carbon stocks such as wetlands or continuously forested areas… [or] peatland" (Flach et al. 2013, p. 5). There are also social standards related to the impact on food prices and adherence to International Labor Organization conventions. EU-sourced feedstocks must meet the requirements for "good agricultural and environmental conditions" under the Common Agricultural Policy (ibid.).

The methodology behind the calculations of net emissions savings are complex and consensus on how to measure the impact of ILUC is elusive. This opens the door for competing interests to influence the process. In the case of the US EPA's analysis of lifecycle emissions from various feedstocks, the estimates changed substantially between the

[21] The calculations are available in Annex V of the Renewable Energy Directive, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0028&from=EN, accessed December 17, 2014.

time the initial rule was posted for public comment and when the final rule was published. In the initial EPA analysis, neither soy biodiesel nor corn ethanol would have achieved the net emission reductions that the RFS requires. But both did when the final rule was published, primarily because of sharply lower estimates of ILUC. Moreover, Yacobucci and Bracmort (2010, pp. 15-16) point out that, in the final EPA ruling, corn ethanol just barely qualified, with net life cycle emissions just 21 percent lower than gasoline. An annex table at the back of the ruling showed corn ethanol with net emissions savings of 19 percent, just below the 20 percent threshold. An EPA official told the authors that the latter figure was a typo (ibid.).

Even though they do not include ILUC effects, the results of the EU exercise to set minimum GHG reduction thresholds are interesting and, again, there are hints of political influence. For example, biodiesel using EU-grown rapeseed just barely surpasses the default threshold of 35 percent, lowering net emissions by an estimated 38 percent compared to diesel. Soy-based biodiesel, which would likely be imported or use imported feedstocks, falls just short of the default value at 31 percent. There are few independent estimates of GHG emission savings from soy-based biodiesel, but the Commission's estimate is 30 percent below that of the US EPA, even though the EPA's estimate includes indirect land use change. The Commission also applied a larger discount factor to the typical savings in calculating the default value for soy biodiesel than it did for rapeseed (Flach et al. 2011, p. 8). Given the small margin for rapeseed biodiesel in meeting the minimum emissions savings (38 percent versus the 35 percent default), any consideration of potential ILUC would almost certainly disqualify the major biofuel currently in use in the European Union, something that the Commission's impact assessment confirmed (European Commission 2012, pp. 26-27).

The 2009 RED policy also introduced a provision that gives double credit under the mandate for second generation biofuels. That provision includes recycled waste oil, but the definition is vague and some products apparently are counted even if a relatively small share of used oil is mixed with unused oil. That provision led to a three-fold increase in the amount of biodiesel that producers claimed was from waste oil by 2012 (Flach et al. 2013, p. 19).

Finally, even if oil palm plantations are operated sustainably, the effluent from palm oil processing can emit high levels of methane. Thus, palm oil biodiesel is only eligible under RED if the feedstock is not from sensitive land *and* the oil mill uses methods to capture methane released during processing (ibid., p. 6). I discuss issues related to palm oil in more detail below.

First generation biofuels from food crops were supposed to be a bridge to more advanced biofuels that would not threaten food security or forests. Cellulosic and other second generation products are trying to develop products using plant waste, such as corn stalks, rather than the grain, or nonfood crops, such as switchgrass or jatropha, that can grow on marginal lands. But these feedstocks, and the technologies associated with converting them into commercial scale fuel sources, are proving more difficult and expensive to develop than anticipated. Moreover, policymakers need to be cautious about subsidizing these products as well. Crop residues often have other uses, as ground cover to maintain soil quality or as livestock fodder. One recent study suggested that removing corn residue in the American Midwest reduces soil carbon (Liska et al. 2014). The authors conclude that incorporating the resulting CO_2 emissions in a lifecycle analysis could mean that cellulosic ethanol from corn stover would not meet the RFS2's 60 percent threshold for reducing net emissions.

Meanwhile, whether and by how much the use of food-based biofuels contributes to climate change mitigation still depends very much on how and where they are produced. One area of particular concern, is how the EU and US demand for biofuels is contributing to deforestation and increased emissions through land use change.

Accounting for Land Use Change

In early 2008, a series of articles appeared in *Science* magazine underscoring how land use changes could undermine the environmental benefits of biofuels. In January, an overview article by two scholars at the Smithsonian Tropical Research Institute summarized research assessing all the potential environmental impacts of biofuels, including biodiversity loss and emissions other than CO_2 and found that many first-generation biofuels do not fare well when compared to gasoline (Scharlemann and Laurance 2008).

Two articles followed in February that reported estimates of the carbon debts created when land is cleared because of biofuels. Fargione et al (2008) estimated the number of years it would take to repay carbon debts created when various types of native ecosystems are converted to production of biofuel feedstocks. In the worst case, if producers convert either former tropical rainforests or peatlands to oil palm plantations, the authors estimated that it would take nearly a century in the former case and more than four centuries in the latter case before biofuel use would make up for the carbon released through deforestation and peatland destruction. Searchinger et al. (2008) focused on *indirect* land use changes associated with US corn ethanol consumption. They found that the change in net GHG emissions relative to gasoline shifts from a -20 percent to +93 percent when virgin land is cultivated. While research for the IPCC concluded that more recent models with higher geographic resolution suggest that some of those estimates were on the high side, the research was critical in reshaping the debate over biofuels (Chum et al. 2011, p. 305).[22]

Moreover, the conclusions regarding palm oil biodiesel remain highly disturbing. The IPCC report summarizes newer research on carbon debts arising from biofuel demand. It finds that, even with higher crop yields, if feedstock production results in tropical deforestation, it will often take 50 years or more of emissions reductions at the tailpipe to make up for the release of stored carbon. When producers drain peatlands to put in oil palm plantations, the payback period could be as much as 600 to 900 years, so even higher than Fargione et al. (ibid., p. 264).

The EU's 2009 directive asked the Commission to review GHG emissions associated with ILUC by December 2010 and to recommend changes to the directive if appropriate. The resulting report concluded that ILUC could affect GHG emissions savings from using biofuels, but that there were uncertainties in measuring those effects. The Commission, therefore, determined that it should prepare an impact assessment and it commissioned the International Food Policy Research Institute to model the impacts of the EU biofuels policy on land use change and of those changes on net emissions savings (European Commission 2012, 6). The IFPRI report (Laborde 2011) concluded that land use changes would eliminate about two-thirds of expected GHG emissions savings from using biofuels. The summary of the results in the Commission's impact assessment shows that none of the major biodiesel feedstocks would come close to meeting the RED's 35 percent reduction in net greenhouse gas emissions if land use change is considered (European Commission 2012, 26). Indeed, rapeseed and soybean oils, along with palm oil not using methane capture during processing, all came out looking *worse* than diesel.

Scholars at the Commission's Joint Research Centre raised questions about some of the assumptions in the report and worked with IFPRI to make adjustments and to conduct

[22] See Achten and Verchot (2011) for another set of estimates that also show long repayment periods for biodiesel from palm oil, soybean oil, and jatropha under a variety of scenarios.

additional sensitivity analysis (Laborde et al. 2014).[23] The net effect was to cause ethanol from sugar cane, maize, and, especially wheat, to look somewhat worse in terms of net savings. But the qualitative results were similar in general and ILUC still looks like a problem for oilseeds as biodiesel feedstocks.

Overall, the IPCC report on bioenergy (Chum et al. 2011) still sees a role for certain types of biofuels as part of climate change mitigation strategies, but only under fairly stringent conditions. The report concludes that growing perennial crops, such as switchgrass, on marginal or degraded lands would offer the greatest opportunities for expanded biofuels production to contribute to climate change mitigation. Assuming that the technological obstacles to producing biofuels from cellulose are overcome, however, there are still questions as to whether crops grown on marginal lands will have high enough yields to be profitable. And if they are profitable on marginal lands, they would be even more profitable on more productive land, perhaps making it difficult to confine production to marginal areas.

Schoneveld (2010, pp. 6-8) analyzes the potential land use pressures that could arise from biofuel expansion in developing countries. He identifies land that is both suitable for producing biofuel feedstocks and potentially "available," meaning that it is not already forested or under cultivation. But Schoneveld also notes that the land so identified may "not be the most convenient or economically appropriate lands for producers, either because it is not near key transportation routes or markets, or because forested land is less populated." Moreover, land deemed "available" by this relatively broad definition is often used by local people for fuelwood, grazing, or non-timber forest products. Overall, Schoneveld concludes that there is very little suitable land available in Asia and that increased biofuel feedstock production would create "severe land use competition" there. There is more available land in South America and Africa but, even there, he finds that "most is under competing uses" (ibid., p. 1).

Overall, there are many reasons to suggest that the prospects for biofuels, even a second generation, to contribute to climate change mitigation are more limited than many hope. The

[23] A key concern was that the IFPRI model assumes, like most general equilibrium models, that consumers would respond to higher prices by reducing food consumption. The revised analysis dropped this assumption (Laborde et al. 2014, pp. 20-21).

IPCC bioenergy report's conclusion on the conditions needed for *sustainable* expansion of biomass for energy (including biofuels) also suggests caution (Chum et al. 2011, p. 306):

> In order to achieve the high potential deployment levels of biomass for energy, increases in competing food and fibre demand must be moderate, land must be properly managed and agricultural and forestry yields must increase substantially. Expansion of bioenergy *in the absence of monitoring and good governance of land use* carries the risk of significant conflicts with respect to food supplies, water resources and biodiversity, as well as a risk of low GHG benefits (emphasis added).

Biofuels, Tropical Forests, and Palm Oil Demand

The debate over land use change is important because deforestation is an important contributor to climate change, as well as biodiversity loss. A recent paper for CGD's Tropical Forests for Climate and Development Initiative synthesizes a number of technical papers on the role of tropical forests as a cost effective tool for climate change mitigation. As summarized in the paper's abstract (Goodman and Herold 2014):

> Tropical forests have the highest carbon density and cover more land area than [other] forests…. Unfortunately, tropical forests, mangroves, and peatlands are also subjected to the highest levels of deforestation.

Moreover, American and European biofuel policies are important because they affect global commodity markets, which are a growing source of tropical deforestation. Another paper for CGD's tropical forests initiative takes a detailed look at this issue and identifies four main "forest-risk" commodities—beef, soybeans, palm oil, and wood products—two of which are potential biodiesel feedstocks (Persson et al. 2014). These four commodities in eight case study countries accounted for one-third of estimated tropical deforestation and the emissions associated with it. In turn, about a third of those emissions were associated with exports, though that figure rises to more than half when the authors exclude Brazilian beef, which is mostly consumed at home.

Most of the consumption of these commodities is for food and many of the exports go to China, though India is also a large importer of palm oil. That demand will continue to rise as populations and incomes in developing countries rise. The European Union is also a significant importer of both soybean products and palm oil, and some of that demand is being driven by biofuel policies of questionable efficacy. US biofuels policies also stimulate demand for oilseeds, including palm oil, but it at a far lower level than in the EU market (see box 1). Thus, it is worth a closer look at the links between global commodity markets, deforestation, and EU biofuel policy.

Global Commodity Trade and Deforestation

Agriculture directly contributes about 13 percent of greenhouse gas emissions, while net deforestation contributes another 11 percent (IPCC 2014, pp. 7-8). Focusing just on emissions associated with deforestation, Persson et al. (2014, p. 14) find that beef, mostly from Brazil, accounts for half the carbon emissions and two-thirds of the deforestation associated with the four forest-risk commodities. Soybean production in Brazil and Argentina is second in terms of the area of deforestation, but much of that occurs in dryland forests that do not store as much carbon as tropical forests and peatlands. Wood products and oil palm are behind soybeans as a source of deforestation, but well ahead in terms of emissions because much of the deforestation is occurring in the tropical forests of Southeast Asia, including in peatland areas that release huge amounts of carbon when drained (ibid., p. 14). The emissions embedded in soy and palm products are also more likely to be exported, compared to beef and timber, so northern consumers are implicated in these emissions (ibid., p. 21).

In most of the world, soybean oil and palm oil are used primarily for food, with China and India as major importers. In the European Union, however, a growing share is going into biodiesel. Domestically-produced rapeseed oil is the major feedstock for EU biodiesel, accounting for around 60 percent of the total; palm oil contributes another 15 percent (table 1). The share of soybean oil in EU biodiesel feedstocks declined 20 percent while the share of palm oil more than doubled. Land use change related to soybean production is less emissions-intensive than oil palm and, according to Persson et al., less soybean production is on recently cleared lands in Argentina and Brazil, which are the major exporters to the EU.

EU Palm Oil Demand

Figure 3 shows the rapid rise in EU consumption of biodiesel after the 2003 directive setting a target for renewable transportation fuels. The use of rapeseed oil for industrial purposes, mostly biodiesel, surged at the same time. Palm oil consumption also increased sharply, mostly for industrial purposes but also for food uses, to replace rapeseed oil. According to the most recent report on EU biofuels from the US Department of Agriculture (USDA), palm oil surpassed both soybean oil and waste oil to become the second largest feedstock for biodiesel (table 1).[24]

In addition to importing palm and soybean oils to feed its own processing facilities, EU members states also import biodiesel incorporating those feedstocks. Whenever domestic producers have come under pressure from imports, however, EU authorities have taken steps to protect them from foreign competitors. Tracking trade in biofuels is difficult because, until recently, there were no specific tariff codes for ethanol for fuel use or for biodiesel. This also allowed importers to manipulate their customs declarations to avoid high tariffs, particularly for ethanol. In 2012, EU authorities closed a loophole that had allowed some ethanol to enter under a relatively low import duty. And, a year later, they slapped antidumping duties on US-origin ethanol that were high enough, in combination with the normal tariff, to shut off those imports. Overall, USDA experts project that imports as a share of EU ethanol consumption will drop from 20 percent in 2011 to less than 10 percent in 2014 (Flach et al. 2013, p. 12).

The normal tariff on biodiesel imports is lower than that on ethanol and EU officials responded to increased import competition with a series of ad hoc trade actions targeting imports as they moved from one exporter to the next. Figure 4 shows Argentina and Indonesia replacing the United States as the principal biodiesel exporters to the European Union after authorities imposed antidumping and countervailing duties on certain US exports in 2009. EU officials extended those duties to all imports of biodiesel from the United States and Canada in 2011. EU biodiesel imports from Argentina and Indonesia surged in response and then dropped just as sharply in mid-2012 after authorities announced they would investigate whether those imports were also being dumped at unfairly low prices. Figure 5 shows monthly EU imports from Malaysia turning upward, in turn, after final antidumping duties were imposed on Argentina and Indonesia in late 2013. Argentina and Indonesia are challenging the EU action at the World Trade Organization, but resolution of the dispute could take years.

Combining a mandate that relies on first generation biofuels, with a protectionist trade policy makes things worse. Indonesia is ramping up its own mandate to use biodiesel to soak up

[24] Governments do not always report fully on biofuel feedstocks so the numbers here are USDA estimates as reported in various GAIN reports. Gerasimchuk and Koh (2013) find somewhat higher levels for EU use of palm oil as a biodiesel feedstock, but the overall patterns are similar. Unfortunately, the data those authors use are proprietary and not publicly available.

the excess production created by the EU trade barriers (as is Argentina). And, while the palm oil embodied in EU biodiesel imports decreased, EU imports of crude palm oil to supply the domestic biodiesel industry increased (figure 6). After an initial sharp jump when EU authorities opened the trade remedy investigation, palm oil imports, and the use of palm oil as a feedstock, stayed high even as the price competitiveness of palm oil relative to rapeseed oil declined somewhat.

Under the EU biofuels policy, the palm oil used in biodiesel, whether processed in the European Union or SE Asia, should not originate from recently cleared land. But, even if we assume that the certification programs are effective, there are no community-wide EU standards for palm oil used in food or other industrial products.[25] Thus, for example, one study found that rapeseed meeting RED's sustainability criteria went into biodiesel, but uncertified rapeseed was used for food (Flach et al. 2011, p. 26). The same could easily happen with palm oil, with products from newly cleared land going for food uses to customers with little interest in sustainability (Gerasimchuk and Koh 2013, p. 3). Moreover, the diversion of palm oil biodiesel to domestic consumption in Indonesia means that the sustainability of production there depends on the willingness and ability of the new Indonesian government to stick to commitments to reduce deforestation (box 2). Guariguata et al. (2014, p. 21) point to the potential for such "leakage," due to either direct or indirect land use change, as a key reason that sustainability standards, however effective, are only part of the solution to preventing negative environmental effects from biofuels policies.

Fundamentally, the problem is that increased EU demand for oilseeds to put into fuel tanks raises the price of palm and other commodities, and that increases pressures to expand production, including into peatland and tropical forest areas.

Conclusions and Recommendations

In sum, American and European policies to promote first generation biofuels are failing to significantly contribute toward any objective other than providing additional subsidies to relatively well-off farmers in rich countries. The oil production boom in the United States is making biofuels practically irrelevant for US energy independence, albeit with troubling effects on greenhouse gas emissions. And poor consumers around the world are less secure

[25] There are public or private commitments in a number of EU countries to ensure that most or all palm oil meets RSPO sustainability standards: http://www.rspo.org/en/national_commitments accessed August 7, 2014. More generally on the weaknesses in and lack of information about the implementation of biofuel sustainability standards, see Guariguata et al. (2011).

as a result of higher and more volatile food prices. By pitting fuel against food, first generation biofuel policies are also creating incentives to convert forests to cropland, and that undermines the goal of reducing GHG emissions.

Because of the relatively large, and growing, role that transportation plays in global greenhouse gas emissions, continued public investment in research and development on second and third generation biofuels is worthwhile. But current biofuel policies are doing little to promote advanced biofuels, and are helping little, if at all, with climate change mitigation in the meantime.

Moreover, there are far more cost-effective ways to promote energy independence and reduce GHG emissions in the short run. Conservation measures, reduced fossil fuel subsidies, higher fuel taxes, and financial and other support to reduce tropical deforestation would be more economically efficient and more effective policies than biofuels to promote these goals. The plunge in oil prices in late 2014 also highlights the benefits of a variable gas tax to ensure that market fluctuations do not reverse previous gains in reducing fuel consumption.

Finally, the moment may be ripe for reform. Rising private costs are increasing the backlash against biofuels in the United States. In the European Union, governments have similar concerns about the growing costs of fiscal incentives to promote biofuels. But civil society concerns about the impact on the climate and food security in poorer countries also appear more prominently.

In the United States, escalating budget pressures led Congress to let the tax credit for blending ethanol in gasoline expire at the end of 2011. Multi-million dollar penalties for not blending cellulosic fuel that does not exist and problems associated with the blend wall also triggered a backlash from the oil industry, small engine producers, and other private sector interests that bear the costs of implementing the mandate. Development advocates are concerned about the impact on food security among the poor around the world, and environmental concerns are growing over the (mainly local) effects on soil and water quality, as well as decreased biodiversity from the expansion of corn production, including on sensitive lands. There also continue to be questions about the net impact on climate change.

In the European Union, some member state governments are reining in tax and other fiscal incentives for biofuels development because of growing costs at a time of budget austerity. As in the United States, development advocates are concerned about the impact on food security. But EU reliance on biodiesel and oilseed crops, including palm oil, makes the threat to tropical forests a particularly potent issue that critically weakens the arguments for biofuels as part of the EU's climate change mitigation strategy.

So what should be done? Beyond increasing support for alternative policies that could do more to reduce GHG emissions at lower cost, policymakers also need to reform existing policies to contain the potential damage from expanded use of first generation biofuels. The first step is to at least rollback mandates and limit subsidies so as to limit further expansion of these fuels. The second is to ensure that sustainability standards, particularly around land use change, are effective, and fair.

Despite the increasing political pressures for reform, farm and biofuel industry groups are vigorously fighting efforts to rollback current policies, and, so far, they have been relatively successful. In the United States, the EPA is being challenged by biofuel industry interests for trying to use existing statutory authority to reduce the ethanol mandate. If the industry is successful there, and Congress does not act, then there will be growing pressure for additional subsidies—either directly from taxpayers or indirectly through higher costs for consumers—to overcome the infrastructure and other technical issues related to the blend wall. In the European Union, biofuel defenders were able to claw back a nearly 50 percent increase in the proposed 5 percent cap on food-based biofuels, which will allow modest expansion from the current levels of use. Policymakers and civil society need to ensure that the policy's sustainability standards are met, as well as continue efforts to make global supply chains sustainable.

The focus of reform efforts in the United States, then, should be two-fold. First, Congress should at least change the mandate to accommodate the blend wall by changing the targets for conventional ethanol from 15 billion gallons going forward to no more than 10 percent of gasoline consumption. Depending on how relative commodity prices evolve, *market* demand for higher blends might grow, for example, in the corn belt of the upper Midwest where the distribution infrastructure is more developed. But there is no reason that taxpayers, or consumers, should subsidize the expansion of infrastructure to help ethanol producers get around the blend wall.

In the European Union, it is important to make sustainability standards effective, but they also need to be fair to developing countries. Those countries may also need financial assistance and other measures to help them bring their operations into compliance, particularly those involving smallholder producers. But there also need to be sector-wide and country-wide approaches to avoid the problem of leakage of production into other markets, including for domestic consumption such as increasing use of palm oil biodiesel in Indonesia. Thus, efforts to support the Indonesian government in its efforts to stem deforestation, such as the Norwegian REDD+ compact, are also a critical piece of the puzzle. Paying Indonesia to keep its forests intact would do more to mitigate climate change than importing palm oil to put into European fuel tanks.

The bottom line is that, even with the strongest, most effective sustainability standards and certification provisions in place, US and EU policies are increasing demand for palm oil and other commodities that are also used for food and livestock feed. Since demand for food is not going to decline as long as the global populations is growing, these policies inevitably make it more difficult to save the world's forests, and to ensure that the world's poor are adequately fed.

Box 1: US Biofuel Policy Subsidizes Palm Oil Demand

In contrast to Europe, the United States relies less on diesel for transportation fuel and biodiesel is a far smaller share of that diesel consumption. Soybean oil is the principal feedstock for biodiesel in the United States and, by 2011, biodiesel demand was diverting around a quarter of US soybean oil production from other uses.[26] But these policies are also contributing to demand for palm oil, both as a feedstock and as a substitute for soybean oil that is more expensive as a result of those policies. Though systematic data on palm oil use in biodiesel are not available, a rough estimate suggests that, in 2013, US demand for palm oil as a biodiesel feedstock was about a quarter of that in the European Union (table 1.1).

The US Congress did not initially include a biodiesel mandate in the Renewable Fuel Standard in 2005. But it had approved a $1 per gallon tax credit for blending biodiesel in 2004. Demand surged the next year when disruptions to Gulf coast refineries from Hurricane Katrina disrupted supplies of conventional fuels (Schnepf 2013, pp. 10, 21). Congress then added a biodiesel mandate to the revised Renewable Fuel Mandate in 2008, which the EPA began implementing in 2010. The EPA ultimately concluded that palm oil was not an eligible feedstock under the mandate because greenhouse gas emissions from indirect land use change would keep palm oil biodiesel below the 50 percent net emissions reduction threshold (US EPA 2011).

Despite the EPA decision, the $1 per gallon tax credit for blending biodiesel, which is under a separate law, can make it profitable to import palm oil biodiesel.[27] For 2013, the US International Trade Commission (USITC) reports that the United States imported 253,000 MT of biodiesel from Indonesia (none from Malaysia). The USITC database shows no US imports of biodiesel from Indonesia (or Malaysia) in 2012 and only 86,000 MT through August 2014, periods when the tax credit had lapsed. Since palm oil biodiesel cannot be counted against the RFS2 mandate, blenders may be collecting the tax credit and then exporting that fuel while importing other biodiesel to fill the mandate. The Energy Information Agency's Monthly Energy Review shows some circular trade in biodiesel in 2013, with 188 million gallons exported and 315 million gallons imported.

US imports of palm oil have also been on the rise, quintupling from around 0.2 million metric tons (MT) in the early 2000s to 1 million MT in the late 2000s, and 1.4 million MT in 2013. In addition to some use as a biodiesel feedstock, concerns about the health risks of transfats that arose in the mid-

[26] USDA reports on the supply and use of oilseeds, including soybean oil, here: http://www.ers.usda.gov/data-products/oil-crops-yearbook.aspx accessed November 18, 2014.

[27] Irwin (March 19, 2014) notes that the only two recent periods of profitability for biodiesel producers were in 2011 and 2013 when blenders increased demand to take advantage of the tax credit before it expired. See also, "KL Shares rebound, CI up 7.96 points." The Malaysian Insider. December 17, 2014. http://www.themalaysianinsider.com/business/article/se-asian-palm-oil-producers-target-us-biofuel-market%20accessed%20August%207, accessed August 7, 2014.

2000s led food companies to substitute palm oil for hydrogenated oils in some products. Unfortunately, it is difficult from the publicly available data to determine exactly how much of the imported palm oil is for biodiesel and how much is for food or other uses. US government statistical agencies cannot report data that might have the effect of disclosing individual company data. Thus, Bureau of Census data, which typically have the most detail, are spotty at best. The Energy Information Agency has been reporting monthly on biodiesel production and feedstocks since 2009. That series indicates that palm oil was used as a feedstock in all but three of those months. And, in 2013, enough companies were apparently active that the EIA was able to report that 632 million pounds (287,000 MT) of palm oil were used in the production of biodiesel.[28] The table below shows estimates of the American use of palm oil for biodiesel and compares it to that in the European Union.

Unless there is a supply shock affecting soybean production that opens up a significant price gap in favor of palm oil, the tax credit is the only reason for palm oil biodiesel to be in the US market. The tax credit has been off and on because of budget constraints, expiring in 2010 and again in 2012 and 2013. Each time the credit was reinstated retroactively, as Congress did once again at the end of 2014, and again for just one year. That means the tax credit is not in place for 2015, which could reduce pressures on tropical forests and save more than $1 billion if it stays that way.

Table 1.1 Comparing palm oil use for biodiesel in the United States and European Union, 2013 (thousand metric tons, with data sources in parentheses)

	United States	European Union
Palm oil imports used as feedstocks by domestic industry	287 (EIA)	1,410 (USDA)
Biodiesel imports from Indonesia, Malaysia	253 (USITC) = 287m liters	602 (Comtrade) *
Palm oil content in biodiesel (at mid-range yield)	298	712
Total effective palm oil	585	2,122
US, EU biodiesel share in global palm oil exports (including biodiesel exports from Indo/Mal)	6.7%	

MT biodiesel = 1,136 liters
MT palm oil = 1,087 liters
MT palm oil yields 905-1,016 liters of FAME (83.3 to 93.5%); conversion factors from Flach et al. (2013); Wright and Wiyono (2014)..
World imports of palm oil, 2013 = 39 million MT
World imports biodiesel from Indonesia, Malaysia = 1.2 million MT = 1.4 million MT of palm oil as feedstock (Comtrade, author's calculations)
* This figures is down about a third from the 2012 level, before the EU imposed import duties. Estimates of EU use of palm oil as a feedstock in its own industry show a similar increase.

[28] The Monthly Biodiesel Production Report is available here http://www.eia.gov/biofuels/biodiesel/production/ accessed November 18, 2014.

Box 2 Indonesian Forest and Biofuel Policies

Indonesia's biofuel and forest protection policies are key factors in this story because Indonesia has the fastest rate of deforestation in the world, which, in turn, is making it one of the top emitters of greenhouse gas emitters in the world (Margono et al.). And new oil palm plantations are an important cause of those trends (Persson et al 2014). Palm oil is mainly used for food, especially in India, China, and elsewhere in Asia, but it is also a relatively efficient feedstock for biodiesel because high yields mean that the price of palm oil is generally below that of alternatives such as rapeseed or soybean oils.

While Indonesia hopes to resume exports to Europe, it is also promoting its use domestically as a means of reducing the import bill for transportation fuels (Caroko et al. 2011, p. 3).[29] The government first adopted a policy to promote biofuels in 2006, with a mandate for 5 percent of diesel for transportation to be from renewable sources by 2025, basically meaning palm oil biodiesel.[30] The 2025 target was raised to 20 percent in a 2008 regulation and raised again to 25 percent in 2013. Also that year, as the European Union was imposing import duties, the mandate for 2015 was doubled from 5 percent to 10 percent. That would be a substantial increase from the estimated biodiesel share of 5.6 percent in 2013. The biofuel subsidy was also increased from 2,000 Indonesian rupiah (IDR) in 2012 to 3,500 IDR in 2013.

Indonesia does not appear to have explicit sustainability criteria for the biodiesel it will use domestically. Moreover, the moratorium on new commercial concessions in primary natural forests and peatland areas put in place by the previous government included exceptions for food and energy security, though it is not clear exactly where biofuels fit in this picture (Murdiyarso et al. 2011). So it is not clear whether biofuel policies and the still developing policies to stem deforestation will be complementary or competing. A paper commissioned by CGD's tropical forests initiative describes the political and other challenges to reducing deforestation in Indonesia (Dharmasaputra and Wahyudi 2014). But CGD Senior Fellow Frances Seymour argues that the election of President Jokowi could mark a turning point in Indonesia's efforts, and that the international community should provide financial and political support.[31]

[29] While Indonesia remains a modest oil exporter, those exports have been falling as (subsidized) domestic demand rises. Overall, Indonesia's trade balance in petroleum and products fell from a small surplus of $1.7 billion in 2000 to a deficit of $25 billion in 2012 (authors' calculations based on data from the UN Comtrade database, accessed November 13, 2014).

[30] There were also targets for ethanol and for biofuel use in industry and for electricity generation but production has not responded as of 2014, so the focus here is on biodiesel in transportation.

[31] "A Burning Issue for Indonesia's New Jokowi Administration," http://www.cgdev.org/blog/burning-issue-indonesias-new-jokowi-administration accessed November 18, 2014.

Annex 1 Biofuel Support in Emerging Markets

According to the Global Sustainability Report for 2014, the number of countries with biofuel support policies increased from 10 in 2005 to just over 60 in 2013 (REN21. 2014, p. 15). About half of that increase occurred in just the past four years. The report identifies 33 countries with mandates to blend biofuels with gasoline or diesel: 31 at the national level, 24 of which also have state or provincial mandates, and 2 that have mandates only at the local or provincial level. Other countries provide tax incentives or other subsidies or have indicative targets only.

Many developing countries that adopted policies to support biofuel use became more cautious after commodity prices surged in 2007-08. Most of the blending mandates, which fall in the 2-10 percent range, are not being met (IEA. 2012, pp. 10-12; Timilsina and Shrestha 2010, pp. 6-8, 12). Moreover, annual new investments in biofuels peaked at $29 billion in 2007 and had fallen to just $4.9 billion by 2013 (REN21. 2014, p. 15). Only Brazil is (more than) meeting its targets for ethanol, though Indonesia and Argentina may do so for biodiesel in the next year or two. But the two largest emerging markets, China and India, are thus far falling short.

Brazil led the way in using policy to create a biofuel industry. It has traditionally been a large oil importer and the price shocks of the 1970s left it with a huge import bill. Brazil is also the world's most efficient sugar cane producer, which also happens to be an efficient ethanol feedstock. Brazil's concerted efforts to develop a biofuels industry resulted in it being the largest producer and consumer of ethanol by 2000. The blend rate mandate for ethanol in gasoline since then has generally been between 20 percent and 25 percent (Valdez 2011, p. 45). In 2003, the Brazilian auto industry introduced (tax-preferred) flex fuel cars that can handle any ethanol-gasoline blend and those vehicles now account for around half of the vehicle fleet. That means that ethanol consumption fluctuates with relative gasoline and ethanol prices, reaching as high as 50 percent of fuel consumption in 2008 before dropping back to a third in recent years (Barros 2014, p. 7).

Sugar cane is the most efficient biofuel feedstock currently in commercial-scale use, both economically and in terms of GHG gas emission reductions (Valdes 2011, p. 2).[32] Sugar cane has relatively high yields per hectare and producers can use the cane biomass (bagasse) to

[32] Biodiesel from used cooking or other waste oil is also quite cheap and it generally reduces GHG emissions even more than sugarcane. But it is not widely available

power their mills, which also further reduces greenhouse gas emissions relative to fossil fuels. Upward pressure on sugar prices is also not a major concern for food security.

The Brazilian ethanol industry is facing challenges, however. The government continues to provide various financial incentives to support ethanol, as well as maintaining the blending mandate, but the government ended price controls and other direct interventions in sugar and ethanol markets in 1999 (Valdez 2011, p. 46). The government is also concerned about holding down inflation and promoting economic growth and it recently cut taxes on gasoline as part of its "all of the above" energy strategy. That, combined with the recent oil price drop, led consumers to switch from ethanol to gasoline.[33]

China, with 2.5 percent of global consumption, was the fifth largest global consumer in 2011, after the United States, European Union, Brazil, and Canada.[34] China has a national ethanol blend target of 10 percent by 2020 and several provinces also have E-10 blending mandates. The national government provided some support for biofuels in the early 2000s as a means of supporting farmers at a time of commodity oversupply and low crop prices. When food prices spiked in 2007-08, however, China imposed restrictions on the use of crops or land for biofuels if it would compete with food or feed. In recent years, it has also reduced ethanol subsidies. Consumption flattened in the wake of the global recession before resuming modest growth in 2012. Scott and Junyang (2013, pp. 2-6) report that industry and provincial sources say the ethanol blend rate in some provinces is 8-12 percent, but the data in their report suggests a lower blend rate of around 2.5 percent.

Argentina produces more biofuels than China, and ***Indonesia*** is close behind. But both, until recently, were responding to global demand, mainly in Europe. Then, in 2013, the European Union slapped relatively high duties on biodiesel imports from both countries. That sharply reduced the EU's imports of biodiesel from those countries and led them to ratchet up their domestic fuel blending mandates for domestic fuel consumption. USDA experts expect that Indonesia could reach a biodiesel blend rate of 8 percent in 2015, close to the current target of 10 percent (up from 5 percent) (Wright and Wiyono 2014, p. 12). The Argentine government took a similar action to double its biodiesel blend target from 5

[33] Personal communication with Peter Riggs, December 12, 2014.

[34] Data are from the U.S. Energy Information Administration, International Energy Statistics, at http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=79&pid=79&aid=1, accessed April 15, 2014.

percent to 10 percent in late 2013, after EU officials implemented the final import duties. USDA experts there expect the target could be reached in 2015 (Joseph 2014).

India adopted a mandate for sugar cane ethanol in the mid-2000s as part of a strategy to reduce dependence on imported oil. But domestic sugar production is volatile and ethanol consumption remains well short of the targets, and well below the levels of other emerging markets (Aradhey 2014).

In sum, like the rich countries, developing countries motivations for promoting biofuels are generally a mix of energy security and support for commodity producers. But many developing countries also have concerns about food security that push in the opposite direction. Lower energy prices triggered by the US fracking boom may also undercut the economic and energy security rationales for promoting biofuels. Overall, consumption outside the top three markets remains quite small but trends in the emerging markets bear watching.

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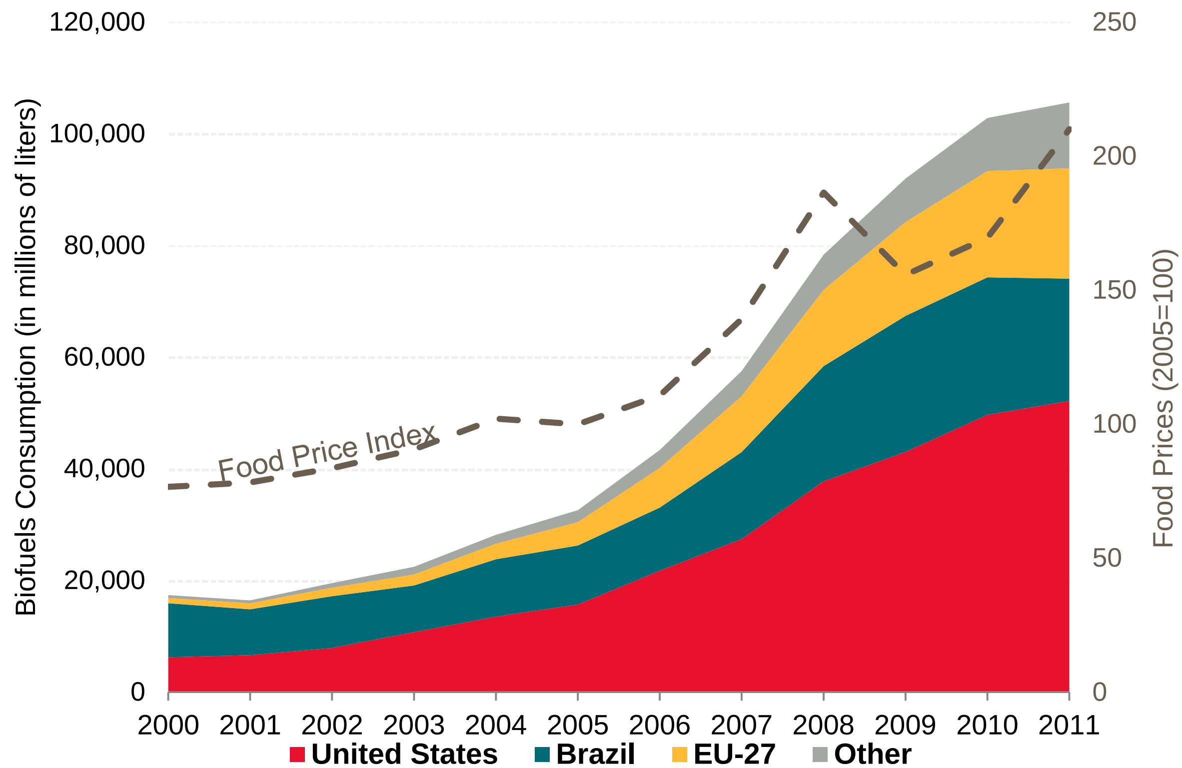
Table 1 Fuels and Feedstocks in the United States and European Union, 2013		
	United States	European Union
Gasoline:		
Share of transportation fuels	73.0%	30.0%
Ethanol share of gasoline	9.7%	3.4%
Major feedstocks (share)	Corn (95%)	Sugar beet (54%) Corn (26%)
Diesel:		
Share of transportation fuels	27.0%	70.0%
Biodiesel share of diesel	1.5%	5.9%
Major feedstocks (share)	Soybean oil (53%) Recycled oils (13%) Animal fats (11%)	Rapeseed oil (58%) Palm oil (15%) Recycled oils (10%)
Source: Schnepf 2013, pp. 2, 3, 25; US Energy Information Administration, *Monthly Biodiesel Production Report,* May 2014; Flach et al. 2014, pp. 12-13, 20-21.		

Table 2 Mandates and Consumption under RFS2 (billion gallons)					
Year	Conventional ethanol cap	Actual ethanol consumption	Cellulosic biofuel mandate	EPA-adjusted cellulosic target	Total renewable fuels mandate[a]
2008	9.0	9.7	0	0	9.00
2009	10.5	11.0	0	0	11.10
2010	12.0	12.9	0.100	0.0065	12.95
2011	12.6	12.9	0.250	0.0060	13.95
2012	13.2	12.9	0.500	0.01045/0[b]	15.20
2013	13.8	13.2	1.000	0.014/0.006[b]	16.55
2014	14.4	13.0-13.55[c]	1.750	.017-.023[c]	18.15 [c]
2015	15.0	N/A	3.000	N/A	20.50
2022	15.0	N/A	16.000	N/A	36.00

a. The balance is biodiesel, which has a target of at least 1 billion gallons/year and other advanced, which can include sugar cane ethanol from Brazil. Until 2014, the EPA had not proposed lowering the overall mandate, requiring biodiesel or other advanced biofuels to make up the difference from the lower cellulosic mandate.
b. The first figure is the EPA's initial target and the second figure is the final, adjusted mandate after the EPA lost a lawsuit challenging the initial target as unrealistic.
c. The EPA's initial proposal released for comment in November 2013 is the first figure; the second is what it is reportedly considering as it reviews comments on the proposal. As a result of the potential adjustments, the overall mandate level could fall to a range between 15.2 and 16 billion gallons.
Sources: Schnepf and Yacobucci (2013, p. 3) for mandates and EPA adjustments; CBO (2014), supplementary data worksheet for actual consumption, 2008-2012, http://www.cbo.gov/publication/45477; Renewable Fuels Association Statistics for 2013 actual ethanol demand, http://ethanolrfa.org/pages/monthly-fuel-ethanol-production-demand , and http://blog.braginfo.org/entry/white-house-weighs-higher-epa-2014-rfs-targets-to-help-climate-efforts/ for the proposed adjustments to the 2014 mandate.

Figure 1. Biofuel Consumption and Global Food Prices



Source: US Energy Information Administration, International

Figure 2. The Politics of Biofuel Makes for Strange Bedfellows

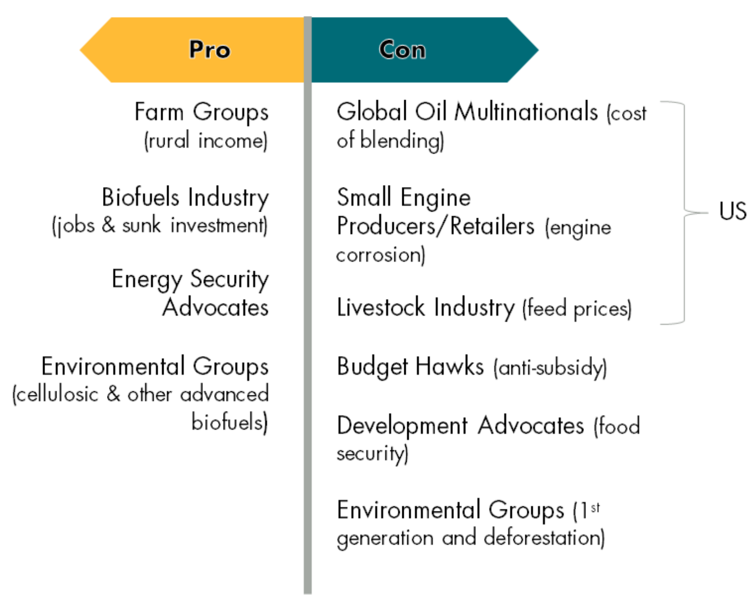
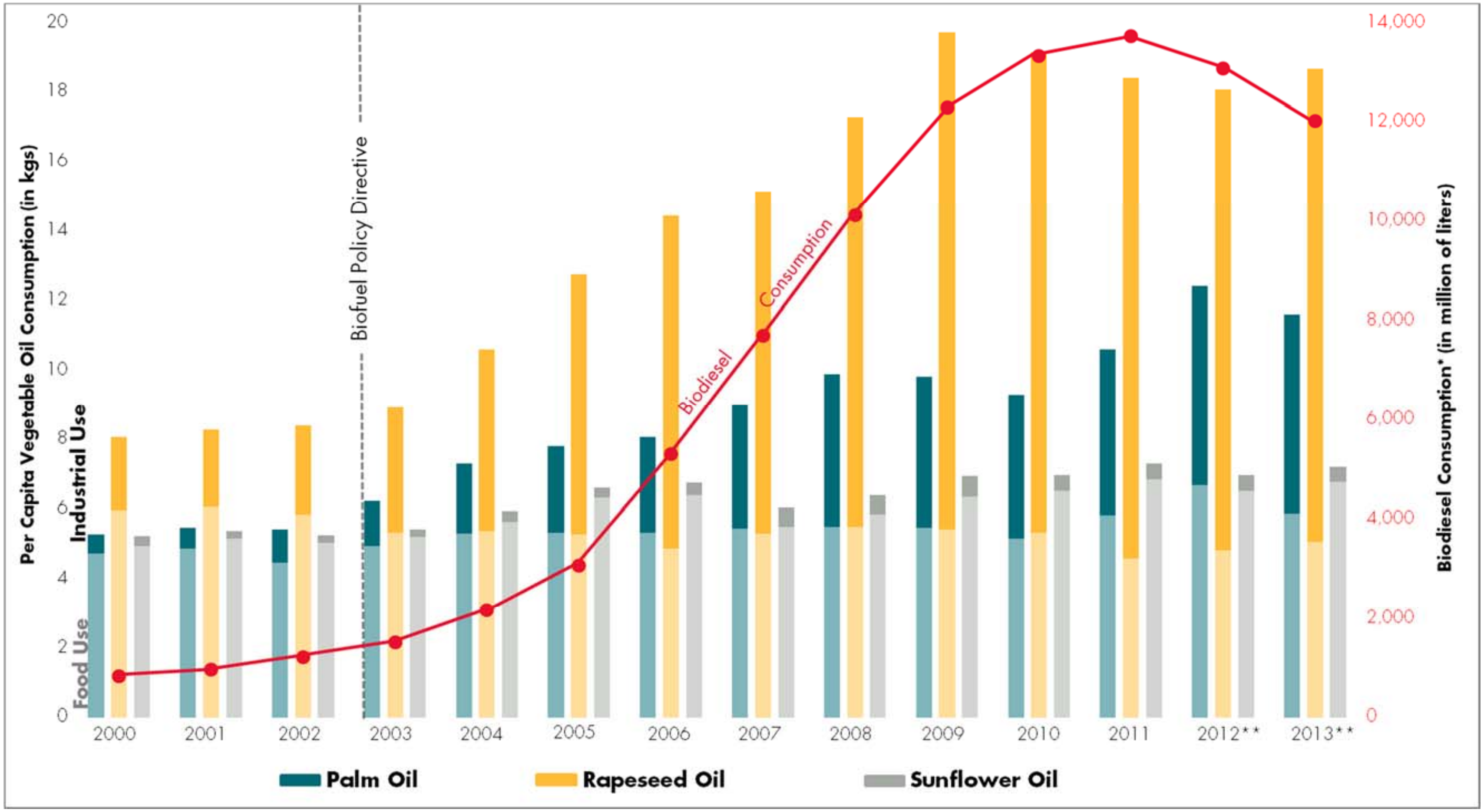


Figure 3. EU Per Capita Consumption of Vegetable Oil and Biodiesel

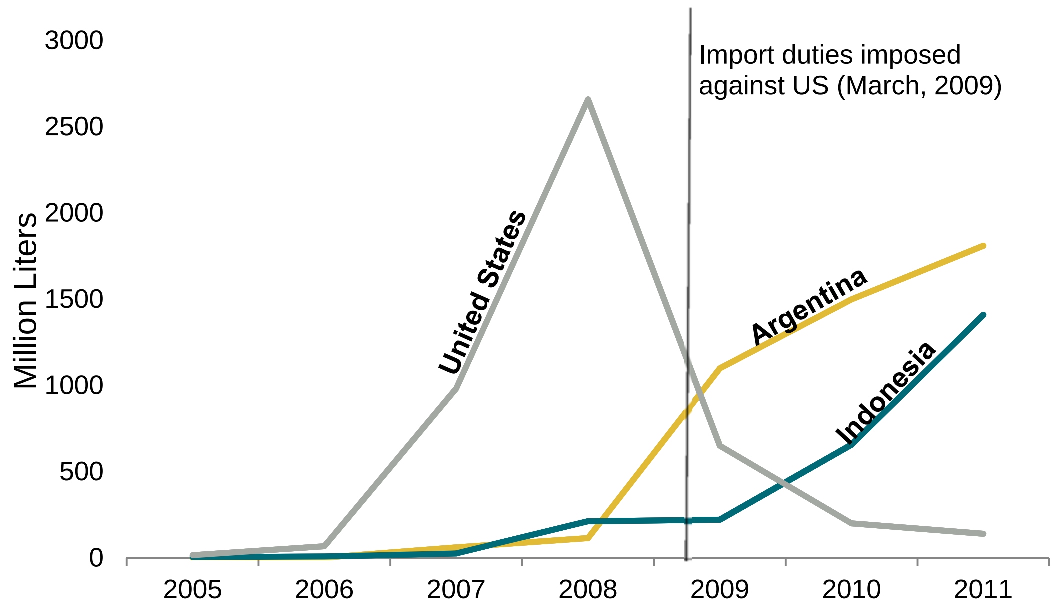


*Biodiesel consumption is total industrial consumption, converted from '000Barrels a day using EIA's unit conversion of 158.99 liters per barrel.

**2012-13 biodiesel consumption based on percent change from USDA estimates.

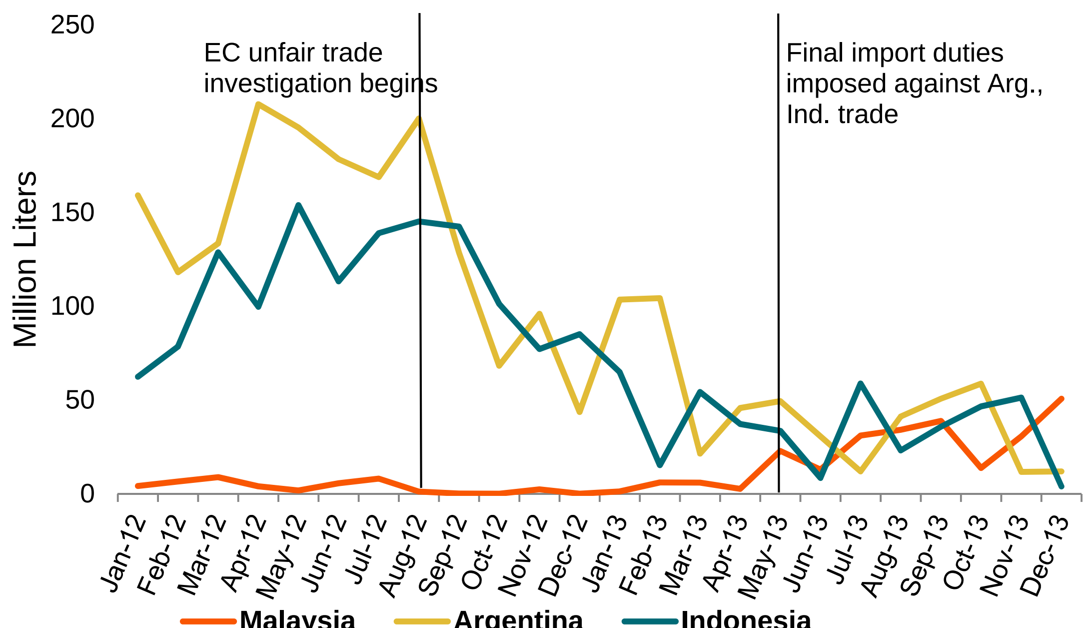
Sources: Vegetable Oil Consumption, USDA Foreign Agricultural Service, Production, Supply and Distribution database; per capita calculated using World Bank, World Development Indicators data on population. Biodiesel Consumption is from US Energy Information Administration, International Energy Statistics.

Figure 4. Annual EU imports of Biodiesel by Source



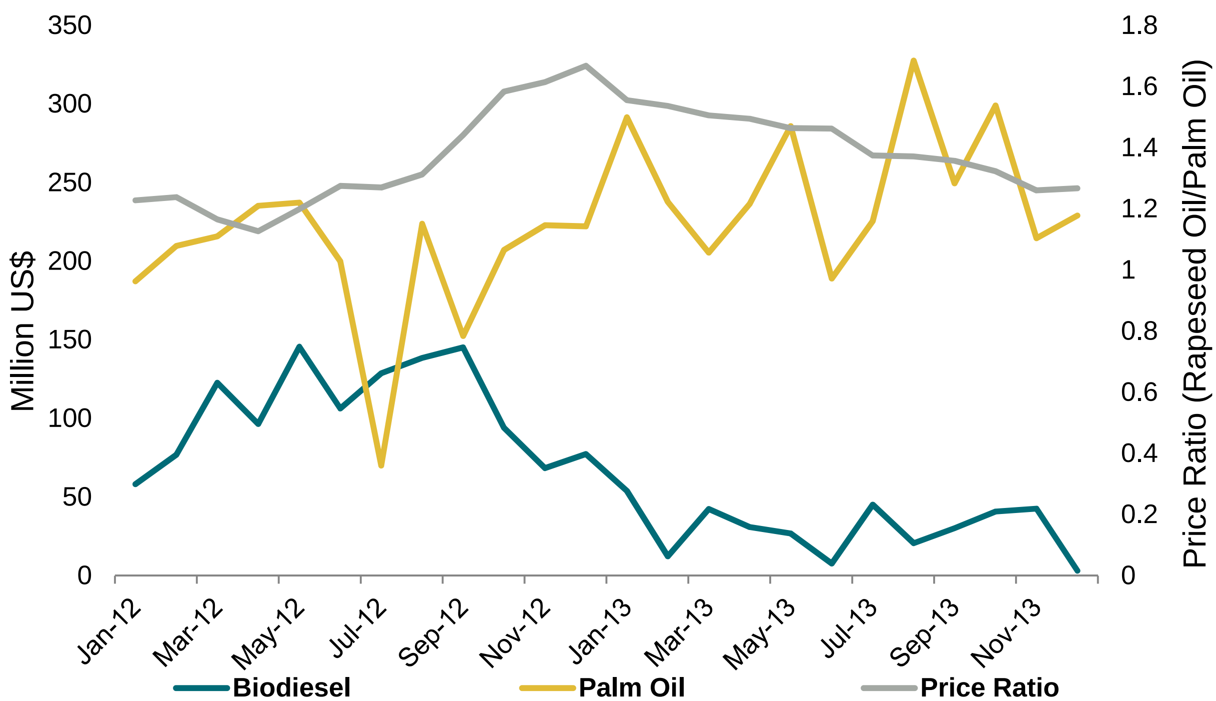
Sources: United States exports (HS 3824.90.4000) from 2005-2010, 2011Exports (HS 3248.90.4030), United States International Trade Commission Trade Dataweb; Argentina, Indonesia imports (HS 824.90), Eurostat.

Figure 5. Monthly EU Imports of Biodiesel by Source



Note: *June, 2013 Argentina Imports are a simple ave. between May and July, due to missing data.*
Source: UN Comtrade (HS 3826).

Figure 6. EU Monthly Imports of Biodiesel, Palm Oil from Indonesia



Sources: Import value, UN Comtrade; price ratio, indexmundi.com.