CLEAN AIR TASK FORCE

Leaping Before They Looked

Lessons from Europe's Experience with the 2003 Biofuels Directive

JONATHAN LEWIS
OCTOBER 2007

CLEAN AIR TASK FORCE

Founded in 1996, the Clean Air Task Force is a nonprofit organization dedicated to restoring clean air and healthy environments through scientific research, public education, and legal advocacy.

MAIN OFFICE

18 Tremont Street
Suite 530
Boston, MA 02108

617.624.0234

info@catf.us
www.catf.us

EXECUTIVE SUMMARY

Although the current U.S. focus on boosting biofuel production and usage may be well-intentioned, caution regarding unintended consequences of these policies is warranted. In 2003 the EU issued a Directive promoting the use of biofuels and other renewable fuels for transport. The Directive sought/seeks to have biofuels account for 2% of EU transport fuels by 2005, 5.75% by 2010, and in a 2007 addendum, 10% by 2020.

The EU mandate was primarily driven by farm policy, to create new outlets for agricultural and forestry products, and to diversify rural economies. Reduced emissions of greenhouse gases (GHG), energy security, and improved environmental impacts were cited as ancillary benefits of the policies. However, due in part to global market forces and economic efficiencies in developing countries, the result is that the Directive has exacerbated some of the very problems it was designed to solve, driving up food prices, leading to increased deforestation in tropical countries, worsening global warming, and increasing imports of bio-oils.

The developing world offers both cheap land and inexpensive labor for bioenergy crop production, and tropical energy crops such as palm oil offer greater energy yields and lower production costs than traditional oil seeds and grains. The impact of the EU Directive has been to increase competition for food, water, land, and other resources in developed and developing countries, and to increase GHG emissions, tropical deforestation, and biodiversity loss. Biofuel production also encourages large-scale land-clearing and monoculture cropping, with attendant poverty, human rights abuses, and ecological degradation.

Importantly, while tropical deforestation is occurring at a staggering rate in many countries seeking to produce biofuels for the new and growing markets, the destruction of boggy peatlands in Southeast Asia now represents one of the leading sources of global warming emissions worldwide. The process of draining, clearing, and burning peatlands for palm oil plantations releases the equivalent of 8% of global carbon dioxide (CO_2) emissions from fossil fuel use, making Indonesia the 3rd ranking emitter of CO_2 emissions in the world, behind only the US and China.

EU member countries are also now realizing that the climate benefits of even those biofuels produced within the EU are in many cases overstated. Some life-cycle analyses (LCAs) of biofuel production

cite increased use of nitrogen-based fertilizers as negating much of the climate benefits associated with biofuels, and a new batch of research indicates that the benefits may be erased altogether by climate-harmful deforestation caused by displaced food production.

These unintended consequences – though not all unanticipated – highlight the need for updated, comprehensive tools to analyze the true net impacts of policies that increase biofuels use, particularly as the US contemplates following the same path that the EU has traversed. Current LCAs do not account for GHG emissions and other impacts to global warming that may be caused by changes in land use; food, fuel, and materials markets; and impacts and demand for natural resources such as water. Until we develop these tools to inform policy development, we should exhibit great caution in regards to biofuels production and use, and should take heed of lessons being learned elsewhere.

INTRODUCTION

Biofuels have become very big news. In the first few months of 2007 alone, President Bush used the State of the Union address to announce a plan to increase the production of renewable fuels in the United States fivefold over the next 10 years;[1] Brazil and the US – already the top two producers of ethanol globally – agreed amid fanfare and controversy to jointly develop markets and technologies for biofuels;[2] and, in what has been called "by far the largest alliance ever between industry and academia," energy giant BP committed $500 million to a public-private Energy Biosciences Institute.[3]

Global investment in alternative fuels rose from $5 billion in 1995 to $38 billion in 2005 and is expected to top $100 billion by 2010.[4] As of March 2007, 78 ethanol plants were being constructed in the United States, with another 113 already in operation.[5] State, local, and federal policymakers are busily introducing new measures designed to encourage further development.[6]

Some environmental organizations are equally enthusiastic. The Worldwatch Institute, for instance, characterizes the promise of biofuels "produced in a sustainable manner and on a large scale" in the broadest terms:

> In the coming years, the international development of biofuels and bio-based co-products has the potential to increase energy security for many nations; to create new economic opportunities for people in rural, agriculture areas the world over; to protect and enhance the environment on local, regional, and global scales; and to provide new and improved products to millions of consumers.[7]

The "biofuel rush" is clearly underway,[8] but to what end? What can we realistically expect from the exploding interest in biofuels? How will the use of biofuels impact energy supply, global warming, air pollution, and consumer choice?

Some partial answers may be found in Europe, where a similar outburst of enthusiasm for biofuels in 2003 led the European Union to establish consumption targets for 2005 and 2010. Promoting biofuels, the EU hoped, would "contribute to a reduction in energy import dependency and in emissions of greenhouse gases," as well as "create new opportunities for sustainable rural development."[9]

The results are discouraging, to say the least: despite its foundation of good intentions, the 2003 Directive has failed to meet its objectives and – even worse – is exacerbating some of the problems it was designed to solve. Countries throughout the continent fell short of the 2005 consumption target, and it is generally assumed they will miss the 2010 target as well. But even at below-target production and consumption levels, the institutionalized demand for biofuels created by the Directive has driven up food prices, contributed to deforestation in tropical countries, and worsened global warming.

[1] THE 2003 EU BIOFUELS DIRECTIVE: Background and Targets

Although biofuels accounted for only 0.2% of Europe's transport fuel market in 2000,[10] European policymakers, like their counterparts in the United States, were enamored with what they saw as the fuels' vast potential to address a host of challenges.

The European Commission roused Europe's interest in biofuels when it issued a 1997 White Paper on renewable energy sources. The White Paper endorsed what the Commission called an "ambitious but realistic" plan to replace 12% of Europe's transport fuel with renewable fuels by 2010. The Commission predicted the plan would boost employment, improve energy security, and "[make] a significant contribution toward the CO_2 reduction needed to successfully combat climate change."[11]

Shortly thereafter, in a resolution on renewable sources of energy, the Council of the European Union noted "the important role" the White Paper ascribed to biofuels in enlarging renewables' share of the transport fuel market and stated that "full account must be taken of renewables in the development of [Europe's] policies on agriculture and waste management."[12] The European Parliament followed suit within weeks, passing its own resolution that called on EU member countries to increase the market share of biofuels to 2% by 2003.[13] Spurred on by the resolutions, the European Commission proposed legislation in 2001 that called for measures to ensure that biofuels would replace a "minimum percentage" of the conventional transport fuel consumed in Europe.[14]

Little was done in Europe (or elsewhere) during the ensuing years to test the assumptions behind the growing chorus of endorsements for biofuels-based policy. The EU, says Ed Matthew of Friends of the Earth UK, "failed to think properly about what was a sustainable level of production within Europe and they certainly didn't think about the consequences outside Europe and particularly in the developing world."[15] Reanne Creyghton, who works for Friends of the Earth in the Netherlands, agrees. Palm oil, which is experiencing rapid production increases partly in response to the global demand for biofuels, "was advertised as green energy, but there was no research about whether it was really sustainable."[16]

The EU defines **biofuels** as "liquid or gaseous fuel for transport produced from biomass;" **biomass** is "the biodegradable fraction of products, waste, and residues from agricultural (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste." (EU 2003 Directive, 44)

Instead, assertions in EU materials about the "valuable contribution" that biofuels can make toward "environmental protection and the implementation of the commitments of the Kyoto Protocol"[17] went largely unexamined, as did claims that biofuels would "produce major fossil fuel cost savings."[18]

Without this examination, nothing stood in the way of the European Parliament and the Council in 2003 when they adopted the Commission's legislative proposal by jointly issuing the Directive promoting "the use of biofuels and other renewable fuels for transport."[19] According to the document, "[g]reater use of biofuels for transport forms a part of the package of measures needed to comply with the Kyoto Protocol, and of any policy package to meet further commitments in this respect."[20] Moreover, the substitution of biofuels for conventional transport fuels is described by the Directive as "one of the tools by which the [European] Community can reduce its dependence on imported energy" and as a source of "new opportunities for sustainable rural development."[21]

Speaking in 2006, Mariann Fischer Boel, the EU Commissioner for Agriculture and Rural Development, reaffirmed Europe's main rationales for adopting the Directive. "There has never been a better moment to push the case for biofuels," exclaimed Fischer Boel.

> Crude oil prices remain high. We face stringent targets under the Kyoto Protocol. And the recent controversy over imports of Russian gas has underlined the importance of increasing Europe's energy self-

> sufficiency. Raw materials for biofuels production also provide a potential new outlet for Europe's farmers, who have been freed by [agriculture policy] reform to become true entrepreneurs.[22]

The 2003 Directive instructs EU member countries to "ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets."[23] Countries are left to determine their own targets, but the Directive established "reference values" of 2% for 2005 and 5.75% for 2010. The general expectation, therefore, was that biofuels would provide at least 2% of the total energy content of transport fuels marketed across Europe as of December 31, 2005, and 5.75% as of December 31, 2010.[24] Most countries adopted the reference values but some departed from Directive's recommendations.

The **stated purpose of the Directive** is to encourage "the use of biofuels or other renewable fuels to replace diesel or petrol for transportation purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources." (EU 2003 Directive, 42)

Biofuels Targets Established by Select EU Countries (% total marketed transport fuel)[25]

	2005	*2010*		*2005*	*2010*
Germany	2.0	5.75	**Sweden**	3.0	5.75
France	2.0	5.75	**Czech Republic**	3.7 (2006)	5.55
UK	0.3	5.0 (2011)	**Italy**	1.0	2.5

In addition to setting consumption targets, the EU conditionally authorized member countries to give "preferential treatment" to biofuels through tax exemptions and tax reductions.[26]

Although the efforts to achieve the existing targets have resulted in complications, confusion, and unintended consequences, the EU Council recently announced another target – and took the extra step of making this one mandatory, provided certain conditions are met. The policy adopted in February 2007 establishes "a 10% binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption by 2020."[27] (According to the EU, "the binding character of this target is appropriate subject to production being sustainable, second-generation biofuels becoming commercially available and the Fuel Quality Directive being amended accordingly to allow for adequate levels of blending."[28] Some analysts suggest that these caveats will become deal-breakers, because substantial technological hurdles stand in the way of second-generation biofuels and because it is impossible to

demonstrate that biofuels are produced in a sustainable manner using the analytic tools that are currently available.[29])

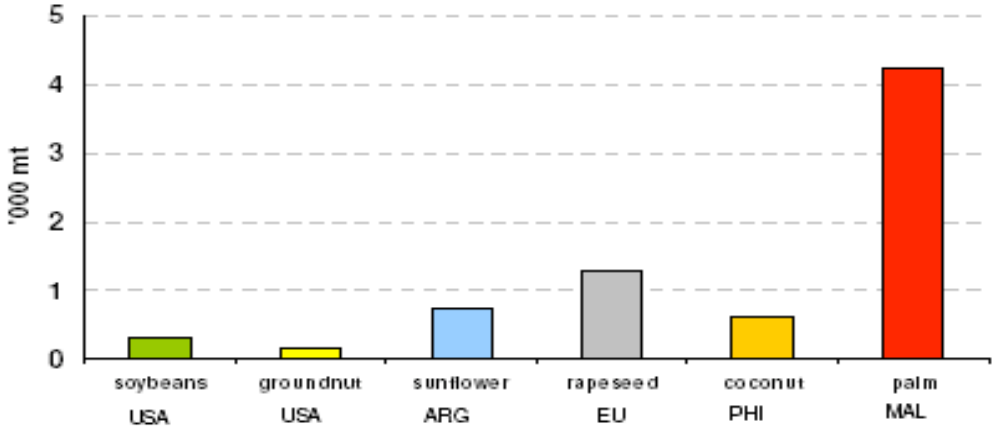
[2] BIOFUELS' GLOBAL SUPPLY CHAIN

The theory of comparative advantage – that capital will migrate to the most efficient producer – is being proven out in the biofuels sector. Demand created by the 2003 Directive intensified an on-going search for the most efficient crops and techniques for producing bioenergy. As a result, some of the biofuels production necessitated by the Directive is being outsourced to the developing world, where production costs are lower and feedstock yields are higher. In addition, as Europe increases the amount of homegrown oilcrops it converts into biodiesel rather than cooking oil, it has had to increase the amount of tropical vegetable oil it imports.[30] This shift to overseas production of oilcrops is just one of many unintended (but not unforeseeable) consequences of the Directive that cut directly against its environmental and economic goals.

Europe's efforts to promote biofuels have been primarily driven by farm policy.[31] After a series of recent agriculture policy reforms, "EU farmers are more and more required to orientate their activities towards viable markets."[32] A primary motivation behind the Directive was that increased biofuels usage would "contribute to creating new outlets for agricultural products and forestry by-products, the provision of local services and the diversification of the rural economy."[33] EU policymakers were particularly hopeful that biofuels could play an important role easing the social and economic transition underway in rural communities throughout formerly communist Central and Eastern European countries.[34] In part, the EU believed that the production requirements mandated by the Directive could be achieved domestically because European farmers were relatively experienced participants in the bioenergy market. Europe, after all, was already "by far the world's biggest producer of biodiesel," as well as the source of about 10% of the global supply of bioethanol.[35]

In terms of production costs and energy yields, though, European farmers are at a competitive disadvantage in the global energy market. The mainstays of European biofuel production – oil seeds (mainly rapeseed, the source of canola oil), sugar beets, and wheat and other cereals – generally pale in comparison with tropical species.

SELECT OILCROP YIELDS (OIL PER HECTARE, 2004-06 AVERAGE)



***From* FAO, *Biofuels and Commodity Markets – Palm Oil Focus* (2006), fig.8.**

Tropical energy crops get a lot of sunlight and are typically harvested by low-wage manual laborers; most temperate energy crops, in contrast, are harvested by petroleum-powered machines after a relatively short growing season and often require more fertilizers and pesticides.[36] In addition, the cost of land (which along with the cost of labor is a dominant factor in setting the cost of biofuels) is significantly lower in tropical countries with developing economies.[37] "It is generally acknowledged," writes the Worldwatch Institute, "that biofuels from temperate oil seeds, sugar beets, wheat, and corn have limited ability to displace other fuels, because of either their low yields or their high input requirements."[38]

In the wake of agriculture policy reform and trade liberalization, tropical energy crops are beginning to exert their competitive edge. Lured by greater energy yields and lower production costs, some new investment is being shifted away from the European farmers and toward tropical plantations – thereby undermining the Directive's goals of boosting European agriculture and reducing the continent's reliance on imported energy.[39] The combination of high-yield crops, cheap land, and inexpensive labor provide tropical countries with "an economic advantage that is hard for countries in temperate regions to match," the Worldwatch Institute reports.[40]

Meanwhile, Indonesia and other similarly-situated countries have aggressively pressed that advantage. In February 2007, the *Asia Times* reported that the "skyrocketing" demand in Europe for biofuels "prompt[ed] Indonesia and Malaysia to roll out ambitious national biofuels programs, including sweeteners for farmers to plant more

palm oil."[41] Malaysia's palm oil capacity was developed so quickly and so thoroughly the country has reportedly "reached its natural land limit for new plantations."[42] Indonesia has launched itself along a similar path by allocating massive tracts of land for oil palms and other bioenergy crops, offering low interest loans to plantation developers, and signing dozens of new production agreements with international energy companies.[43] The policies are expected to add 3.7 million acres of new plantations in the next five years, reports the *Wall Street Journal*, "an area more than half the size of New Hampshire."[44]

Palm oil plantations.[45]

Biodiesel produced from palm oil currently accounts for only a small fraction of the biofuels consumed by European drivers,[46] and some observers question whether Europe will ever import a substantial share of the biofuel it needs.[47] But "modeling domestic and global demand for biofuel represents a very complex task," writes Peter Thoenes of the UN's Food and Agriculture Organization.[48] EU biodiesel industry representatives indicated at a recent conference that to meet the new proposed 2020 biofuel targets, they would need to raise output by 15% per year and that 20% of the feedstock necessary to meet the new proposed 2020 targets would need to be imported.[49] Although "[v]arious forecasts are available regarding the rise of biofuel production and consumption in the EU over the next few years … all of them [are] subject to a high degree of uncertainty."[50] Perhaps because of that uncertainty, there seems to be little consensus about the size of Europe's appetite for imported biofuels. It appears, however, that plantation developers in Southeast Asia are responding to the more bullish projections for the EU import market.

One of those projections came from Fediol, a Brussels-based trade association of vegetable oil producers, which predicted that by 2010

plantations in Indonesia and Malaysia could meet as much as 20% of Europe's demand for biofuel.[51] Credit Suisse determined in 2006 that biofuel production could double by 2008; an increase that large "would easily soak up the world's available palm oil – creating even more demand for plantations."[52] Likewise, an investor at UOB-OSK Asset Management told Bloomberg that "[t]he move toward bio-fuel in Europe will augur well for long-term fundamentals" of Malyasian biofuel developers, who are already benefiting from a run-up in palm oil prices.[53]

According to Reuters, those palm oil exports are essential to Europe. "Rapidly sprouting biodiesel plants will need to import thousands of tonnes of Brazilian soy beans and Indonesian and Malaysian palm oil if they are to meet the European Commission's target of 5.75 percent biofuel use in transport by 2010."[54] EU Trade Commissioner Peter Mandelson acknowledged as much in July 2007, when he told attendees at a conference in Brussels that, despite the Directive's stated goal of promoting European agriculture, "Europe should be open to accepting that we will import a large part of our biofuel resources."[55]

Not coincidentally, the Malaysian government expects the global demand for biofuel will grow at 25% per year. "Considering this potential, the government is going to produce biofuel in a big way," announced Prime Minister Abdullah Ahmad Badawi, "particularly for Europe."[56] Indonesia, too, is gearing up to serve the perceived market, and President Susilo Bambang Yudhoyono has described biofuels as "a key engine of growth" for his country.[57] Thoenes, the FAO analyst, suggests that market forces are rendering the original intentions of EU policymakers obsolete:

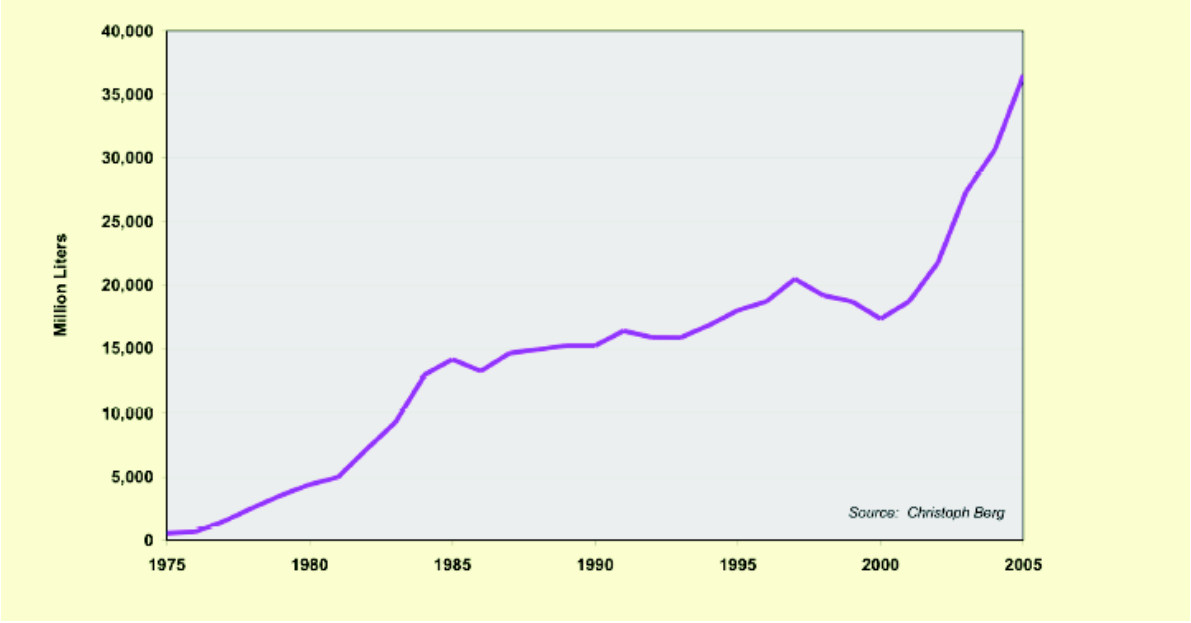
> [V]arious projections of future EU biofuel consumption seem to imply a need to produce biodiesel from imported raw material as opposed to local sources. While such assessments may not be in line with the current expectations of [the] EU Commission, they do seem to reflect current sentiments in the global market and help to explain the on-going investment in export oriented biofuel and biofuel feedstock production in a number of countries.[58]

Moreover, it may not matter much whether palm oil is imported to Europe for use as food or fuel when attempting to ascertain the impact of the EU Directive on the pace or scale of palm oil plantation development. Even if growing demand from the food market is the biggest reason Europe doubled the amount of palm oil it imported

during 2000-2006,[59] Europeans imported that palm oil "mostly to substitute for rapeseed oil diverted from food to fuel uses."[60]

China and India purchase the bulk of the palm oil that Indonesia and Malaysia produce for export,[61] but the demand (real, imagined, or indirect) created by the EU mandate has also contributed to a rapid expansion in global biofuels production. Biodiesel – which is used almost exclusively in Europe – saw a fourfold increase in global production between 2000 and 2005.[62] European producers have accounted for most of that growth,[63] but countries in Asia are quickly developing new capacity, in part because it is more efficient to export energetically-dense biofuel than the biomass feedstock. The Associated Press reported in 2006 that, "Malaysia, the world's largest producer of palm oil, has issued 10 licenses for plants to produce biodiesel for export, mostly to the European Union."[64] The Indonesian government, meanwhile, has embarked on a "crash program" to construct 11 biodiesel facilities so that the country can meet biodiesel production targets of 187 million liters by 2007 and 1.3 billion liters by 2010.[65]

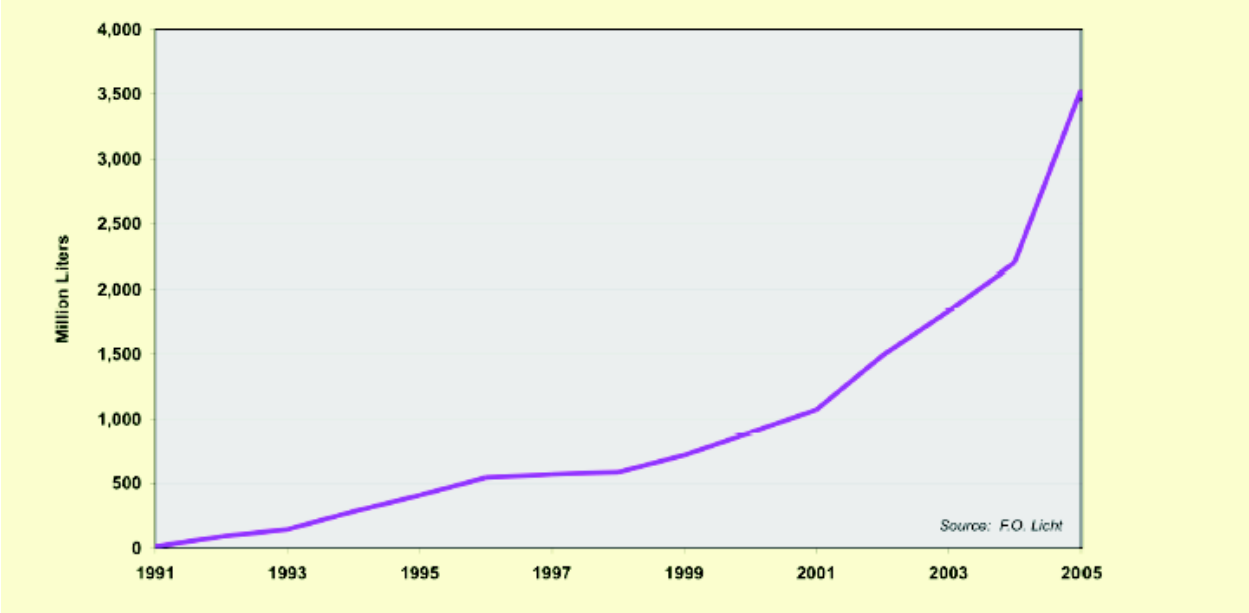
WORLD ETHANOL PRODUCTION, 1975-2005



From Worldwatch Institute., et al., *Biofuels For Transportation (2006)*

Europe consumes substantially more biodiesel than bioethanol, but its imports of the latter rose 72% during 2000-2004.[66] Most of the ethanol brought into the EU comes from Brazil, which, along with the United States, dominates global production of the fuel.

WORLD BIODIESEL PRODUCTION, 1991-2005



From Worldwatch Institute., et al., *Biofuels For Transportation (2006)*

[3] THE DOWNSIDE OF BIOFUELS

The EU failed to meet the 2005 target of 2.0% of the transport fuel market (biofuels achieved an EU-wide market share of 1.4%) and a "vast majority" of stakeholders doubt it will meet the 2010 target of 5.75%.[67] Countries that missed the mark have complained about perceived structural flaws within the Directive, including a lack of flexibility; the UK House of Lords, for example, believes it is "highly unlikely that the Biofuels Directive in its current form can provide the necessary impetus for the EU to reach the 2010 target."[68]

Nevertheless, the Directive has already given Europe and the world a taste of the myriad problems associated with biofuels-based policies. Demand for biofuels has risen throughout the world, and responsibility for the social, economic, and ecological changes precipitated by that market lies with consumers and producers everywhere.[69] But as the new archetype for institutionalized demand, the EU Directive has been linked to increased competition for food, water, land, and other resources; it is accused of playing a leading role in global warming, tropical deforestation and biodiversity loss; and it encourages

monoculture cropping, with its attendant baggage of poverty, human rights abuses, and ecological degradation. Resources are being redeployed and agricultural products are being rerouted. "Let's be brutally frank," an energy analyst recently told the *Wall Street Journal*, "[the biofuels rush] is going to cause significant changes for the environment."[70]

[3.1] DEFORESTATION, LAND COMPETITION, AND BIODIVERSITY LOSS

At ground level, the proliferation of biofuel plantations in Indonesia and other parts of the Global South is largely about replacing forests with plantations. Although tropical deforestation was already rampant in many countries when the Directive was passed, some European and Asian environmentalists believe that many of the recently-felled forests could have been spared if the EU had built in stronger sustainability rules. (Other advocates question whether it is even possible to develop sustainability rules that appropriately account for the substantial indirect effects associated with biofuel consumption.[71]) "If you open up the market in biodiesel and don't impose strong standards," says Ed Matthew of Friends of the Earth, "you are opening up the market in tropical deforestation in South East Asia."[72]

Commercially-available **first generation biofuels** consist mainly of **biodiesels**, which are made by reacting vegetable oils with an alcohol, and **bioethanols**, which are made by fermenting sugar and starch crops like corn or sugarcane. First generation biofuels usually come from food crops and provide relatively modest energy returns. **Second generation biofuels** – which include ligno-cellulosic ethanol, Fischer-Tropsch biodiesel, and dimethyl ether – are at least 5-10 years away from commercialization. As compared to the first generation, second generation biofuels can be produced from a wider range of feedstocks (*e.g.*, non-food crops or waste materials) and should offer better performance in terms of production cost and greenhouse gas output. Biomass could also be used to produce **synthetic fuels** through advanced feedstock conversion systems (such as co-gasification of biomass with coal, combined with carbon capture and geologic sequestration). Due to a range potentially significant but poorly understood indirect effects, the climate impact of these technologies is not yet known.

As things stand, though, deforestation actually makes economic sense for many producers. According to Wetlands International, siting palm oil plantations in readily available forest areas, including tropical peatlands (discussed below), can be far less expensive than trying to purchase existing agricultural areas.[73] And, because plantations can use the felled timber to finance their start-up costs, there is an

incentive for biofuel developers to seek heavily-forested land concessions.[74]

Moreover, energy-cropping can still lead to deforestation even when it is carried out on land already being farmed. Sugarcane, which typically generates more income per acre than other crops when it is sold for ethanol production, is displacing traditional farmers and ranchers in some of the most arable regions of Brazil. Consequently, as one observer told IRC Americas, "Grain producers move to the more remote regions, such as the center-west [of Brazil], which before were used for cattle. The result of this flux is that cattle ranchers seek new areas such as the Amazon region."[75] Understanding the indirect impacts of policies that create new demand for biofuel feedstocks – impacts like the crop displacement mentioned here or substitutions in the food market (discussed in the previous section) – are essential to any analysis of the effect such policies have on climate, markets, and other matters.

Regardless of whether the forests are cleared to make room for biofuel plantations or for the agriculture that has been displaced by energy crops, the pace at which forests around the world are being converted into plantations is staggering. Half of the forests in Borneo and more than two-thirds of the forests in Sumatra have been cleared.[76] In Malaysia, where almost 90% of deforestation is attributed to the country's effort to meet surging demand for biofuels, the country has reportedly "reached its natural land limit for new plantations."[77] When Malaysia started to run out of useable forest, biofuel producers began leveling two million acres of Indonesian forest annually.[78] China, which has banned the use of corn- and potato-based biofuels, continues to push for the expansion of non-food staple biofuels, including plans announced in January 2007 to convert 33 million acres of forest land – and area the size of England – into jatropha biofuel plantations.[79]

The conversion is taking a heavy toll on forest dwellers. According to Miguel Lovera of the Global Forest Coalition, "Soya plantations in Latin America and palm oil plantations in Indonesia, being developed for biofuels, are driving deforestation and pushing hundreds of thousands of farmers and indigenous peoples off of their lands."[80] The plantations "are often forcibly established on land traditionally owned by indigenous peoples," reports Friends of the Earth, "and plantation development has repeatedly been associated with violent conflict."[81] In Columbia, paramilitary groups normally engaged in coca production are reportedly "driving peasants off their land to make way for plantations of palm oil," partly because oil palms are safe from government eradication programs.[82]

Animals that require large and intact ecosystems – such as the Sumatran tiger, the Sumatran rhinoceros, Asian elephants, and the orangutan – are also vulnerable. "In reality it's over for the tiger, the elephant and the orangutan," Willie Smits, founder of the Borneo Orangutan Survival Foundation, told the London Guardian.[83] "Their entire lowland forest habitat is essentially gone already." In a recent report on the loss of orangutan habitat to palm oil plantations and loggers, the United Nations Environmental Programme estimated that within fifteen years the Indonesian orangutan population would be too small to be viable. According to UNEP:

> Previously released scenarios suggested that most natural rainforest in Indonesia would be degraded by 2032. Given the rate of deforestation in the past five years, and recent widespread investment in oil palm plantations and biodiesel refineries, new calculations suggest that 98% of lowland forest may be destroyed by 2022.[84]

The rate at which palm oil producers would replace Indonesian forests with plantations, and the likely consequences of that process for orangutans and other species, was entirely foreseeable when the EU passed the Biofuels Directive in 2003. According to Friends of the Earth, palm oil plantations were probably already responsible "for at least half of the observed reduction in orangutan habitat" even before the recent development boom spurred by the Directive.[85]

The UN estimates that orangutan habitat could virtually disappear by 2022.[86]

The European Commission's 2007 progress report on the Directive argues that the biofuel production has played an "insignificant" role in Southeast Asian deforestation, pointing out that the vast majority of palm oil produced in 2005 was sold as food. The data relied on by the Commission may not account for the recent development boom, and, more importantly, they fail to capture the downstream displacement in agricultural markets. In any event, the Commission acknowledges "it is clearly essential to design biofuel promotion policies so that they continue to contribute to sustainability in the future, in particular if biofuel use is to increase by an order of magnitude beyond today's levels."[87]

[3.2] INCREASED EMISSIONS

Given that the Directive was specifically intended to reduce greenhouse gas (GHG) emissions, its deepest failure might be its role in destroying the boggy peatlands of Southeast Asia. It is estimated that a quarter of existing Malaysian and Indonesian palm oil plantations and more than half of the plantations under development in those countries are sited on former peatlands.[88] As peatlands are destroyed, they release enormous quantities of CO_2 into the atmosphere – so much, in fact, that the recent peatland emissions more than swamp the CO_2 reductions that Europe hoped to achieve under the Directive.

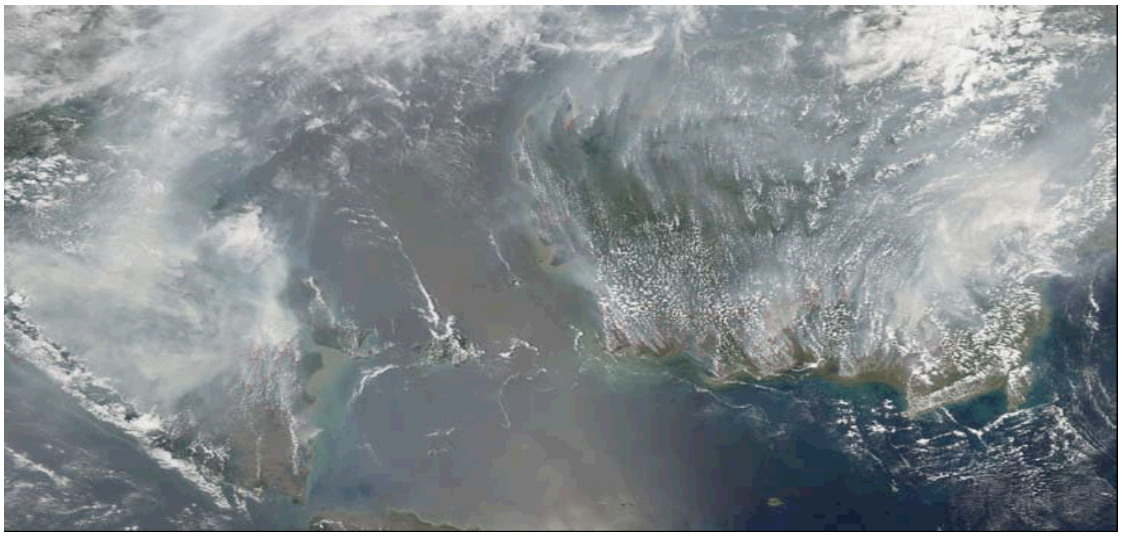
Undisturbed peat soils, which are formed by the accumulation of partially decomposed organic material, provide a variety of important environmental services. They reduce the incidence and severity of droughts by trapping moisture during rainy seasons and slowly releasing it during dry months. They filter water, prevent erosion, and provide valuable habitat for rare species. In addition, the peatlands of Southeast Asia store some 42 billion metric tons of soil carbon.[89]

When peatlands dry out, however, the underlying organic matter fully decomposes and the stored carbon escapes to the atmosphere. Moreover, because the embedded carbon acts as ready-made fuel, dried peatlands are exceptionally susceptible to fires, which in turn accelerate the carbon discharge.

Southeast Asian peatlands are currently releasing their carbon stocks at an astonishing rate, thanks in large part to the increased demand for biofuels. Peatlands are not suitable for most kinds of agriculture, but through a process of draining, clearing, and burning, they can be converted into productive palm oil plantations.[90] In 2006, Wetlands International and the Dutch consulting firm Delft Hydraulics reported

that almost 12 million hectares of Indonesian peatland have been drained, cleared, and often burned – much of it to make room for oil palms.[91] In the process, approximately 2000 million metric tons of CO_2 are released annually, making peatlands destruction a leading source of global warming emissions.[92] After accounting for these emissions – which equal 8% of global CO_2 emissions from fossil fuel use – researchers determined that Indonesia's CO_2 emissions were the third highest in the world, behind only the United States and China.[93] The problem is even worse in years when burning gets out of control. Fires that engulfed Indonesian forests and peatlands in 1997 released between 3000-9000 MT CO_2 – the equivalent of 15-40% of the CO_2 emissions from fossil fuel use that year.[94]

According to the Wetlands/Delft report, the EU Biofuels Directive is partly responsible for the massive amount of CO_2 being released from destroyed peatlands.[95] The carbon release is so enormous, in fact, it will easily negate any cooling effect that might be achieved if European motorists were to meet the Directive's biofuel-for-petroleum substitution target – even assuming that only a small fraction of EU biofuel is produced from palm oil. According to Biofuelwatch, an industry watchdog based in Britain, "the expected average CO_2 emissions caused by producing South East Asian palm oil for biodiesel are estimated at 2x - 8x the saving from the replaced mineral diesel emissions."[96] The Wetlands/Delft report estimates that "[p]roduction of 1 tonne of palm oil causes a CO_2 emission between 10 and 30 tonnes through peat oxidation" alone, not considering the carbon released from forest clearing and other greenhouse gas emissions associated with palm oil production.[97] Ironically, given the role biofuels played in bringing about the peatland fires, some climate experts are now proposing efforts to put out the fires as "one way of getting rid of some significant carbon emissions to the atmosphere."[98]



Satellite photograph of smoke from forest fires in Sumatra (left) and Borneo (right), taken in 2006.
(Photo: Jesse Allen, Earth Observatory/MODIS Rapid Response team, printed in UNEP, *Last Stand*, 31.)

The fires also contribute to a regional public health disaster. "The use of fire to clear land is entrenched in many Southeast Asian cultures," researchers reported in an April 2007 edition of *Science*, "and large commercial tree plantations – particularly in Indonesia and East Malaysia – have begun burning on an enormous scale."[99] Smoke from the fires has led to "increas[ed] hospital admissions throughout the region," as well as "increased mortality in Malaysia and lowered infant and fetal survival in Indonesia."[100] The city of Pontianak, in Borneo, has been particularly hard hit, reports the *Wall Street Journal*. Bluish haze from hundreds of forest fires – "many of them set to clear the land to produce palm oil" – can become so thick it darkens the city, closes down the local airport, and forces residents to wear face masks.[101]

The peatlands/climate debacle is being highlighted by European NGOs like Wetlands International in their campaign to get the EU to back off from the Directive's targets until more efficient and sustainable biofuels can be brought to market. The European Commission continues to embrace the Directive (as demonstrated by its recent decision to set a 10% target for 2020), but an official review is underway and several member countries have voiced their concern. In a response to the review, the Netherlands complained that:

> Many stakeholders in the biomass supply chain are not aware of the fact that biomass growing and farming practices potentially nullify the reductions gained. Clearance of natural vegetation and burning practices in Indonesia, burning practices in Brazil and low energy efficiency in the maize/ethanol supply chain

(South Africa) are decisive in the end when it comes to the *true* reduction in greenhouse gas emissions.[102]

The problems are not just limited to overseas production. Some life-cycle analyses (LCAs), which attempt to tally the total lifetime emissions associated with producing a given product, suggest that the climate benefits of biofuels produced with feedstocks grown within the EU may also be overstated. One such study published in 2007 compared the lifetime greenhouse gas emissions from rapeseed-derived biodiesel to those from petroleum diesel. The authors based their analysis on prevailing production and consumption practices in Europe. For biodiesel, "lifetime starts with growing rapeseed on a farm, which is then crushed to extract oil, which is chemically processed into biodiesel, which is burnt in an engine. For petroleum diesel, the lifetime begins as crude oil in a well, which is produced, refined and then also burnt." The authors found that "if rapeseed is grown on dedicated farmland, which over time is likely to be the case, then the contest is a draw: [rapeseed-derived biodiesel] accounts for nearly the same amount of CO_2e per kilometer driven." Moreover, the authors determined that net lifetime GHG emissions could be cut in half by switching from biodiesel to petroleum diesel and converting the erstwhile rapeseed fields into carbon-absorbent forestland. The main reason biodiesel performed so poorly is that rapeseed farming, like a lot of commercial-scale agriculture, relies heavily on nitrogen-based fertilizers which, in turn, give off nitrous oxide – a powerful global warming agent.[103]

Although such studies are cause for concern, they fall short of the kind of comprehensive analysis that is necessary to measure the true net impact of policies that increase biofuel use. LCAs for biofuels are derived from simple engineering-type LCA models that were developed for relatively straightforward problems, such as determining the energy use of fossil-fuel systems. As such, these models are not suited for more complex tasks such as understanding the climate impact of biofuel policies. Several major factors are omitted from the current crop of LCAs, including:

- In many cases, certain important production emissions that impact climate, like nitrous oxide.
- Greenhouse gas emissions and other climate impacts (see below) associated with both full crop rotations and placing land into biofuels feedstock production.
- Market and price impacts on the use of materials, fuels, land, and other commodities. This is important because price changes due to a biofuel policy will affect the price of a commodity, which in turn will affect the production or use of

that commodity in *other* markets which, finally, will result in changes in GHG emissions and the many other aspects of changes in land use or land cover that impact climate. An example of the chain of indirect, market-adjustment impacts that must be considered was described above with respect to Brazil, where new biofuel-related demand sugarcane is displacing grain production, which is shifting to pasturelands and thus driving cattle ranchers into the Amazon basin.

- Changes in land use due to changes in agricultural markets that affect carbon sequestration; albedo, surface roughness, hydrology and energy fluxes; and fluxes of methane and nitrous oxide.

New research is shedding light on the role these factors play individually. A recent article in Science showed that certain kinds of land use changes carried out to increase biofuel production – *e.g.*, the conversion of tropical forest to oil palm plantation – can, on net, accelerate global warming. The authors note that even a 10% substitution of biofuel for gasoline or diesel in the EU and the US would require approximately 40% of the EU/US's arable land. Consequently, "forests and grasslands would need to be cleared to enable production of the energy crops. Clearance results in the rapid oxidation of carbon stores in the vegetation and soil, creating a large up-front emissions cost that would, in all cases examined here, outweigh the avoided emissions [from the switch to biofuel]."[104]

Until tools that properly consider land use conversion impacts and other such factors ae developed, the net impact of biofuel policies on climate will remain unknown. It should also be noted that if LCAs included such tools, they could have been used to predict the many adverse impacts (climate and otherwise) driven by the EU Directive.

[3.3] COMPETITION FOR FOOD, WATER, AND OTHER RESOURCES

The tens of thousands of Mexicans who protested the rapidly rising cost of tortillas in January 2007 may have been at the vanguard of what Lester Brown of the Earth Policy Institute predicts will be an "epic competition between 800 million people with automobiles and the 2 billion poorest people."[105] While the protests had more to do with America's growing appetite for corn-based ethanol than with the EU Directive, they were emblematic of the strain that biofuels are putting on agricultural supply chains everywhere. The price of palm oil, for instance, rose more than 30% in 2006 – an increase due in no small part to the competing demand created by the Directive for a variety of oilcrops.[106] "In the last few years, demand for ethanol and

biodiesel derived from grains, vegetable oils, sugar, and other crops or derived products has risen sharply," reports the FAO, "reaching a level where the entire agricultural sector and its markets are being affected."[107]

The raw material for biofuels and for much of the processed food sold around the world often comes from the very same plants. Oil palms, rapeseed, corn, sugarcane, beets, soy – all of these crops can be used to make food or fuel, and some are even used for manufacturing. Concern is mounting, however, about whether supply can keep pace with demand. "It's not a rosy picture," a Dow Chemical executive told *BusinessWeek*. "There's only so much biologically based stuff around."[108]

No one disputes that biofuels are reshaping natural and agricultural landscapes, but there is an ongoing debate over whether they will ultimately help or hurt the world's poor. Many, including the drafters of the EU Directive, believe that increased demand for agricultural products will benefit farmers across the globe. In a paper it wrote for European development agencies, the Worldwatch Institute argues that expanded biofuel production will lead to "the creation of new jobs at every stage of the production process, from harvesting, to processing, to distribution. As more countries become producers of biofuels, their rural economies will likely benefit as they harness a greater share of their domestic resources."[109] The Wall Street Journal saw evidence of this process in western Borneo, where oil palm plantations have meant jobs and opportunity for the indigenous Dayak people.[110]

But others like Lester Brown worry that market forces will revise social priorities and undermine food security. "The amount of grain needed to produce enough biofuels to fill a single SUV tank could feed a person for a year," says Andrew Boswell, a UK-based activist.[111] In a marketplace that rewards energy cropping more than food production, the SUVs are likely to get served first.

In a 2007 report that casts doubt on biofuels' "supposed capacity to reduce GHGs or improve energy security,"[112] the Organization for Economic Co-operation and Development cites data indicating that "biofuels production using current technologies and crop types may begin to draw substantial amounts of land away from production of crops for food, animal feed, and fibre" once biofuels account for roughly 5% of the transport fuel market.[113] "Given the high ambitions of the EU, the US, China, Brazil and others," writes the OECD, "it is certain that without a serious change in policy the 'food-versus-fuel' debate will become more acute in coming years."[114]

A broad coalition of European NGOs recently told EU policymakers that, "[s]ince biofuels targets in the EU would promote the production of biomass in the global South, the EU could be responsible for reducing the area of land devoted to food production, [thus] eroding local and international food security and sovereignty and causing food shortages." The coalition noted that the stocks-to-use ratios for grains were at historically-low levels and that the record-high demand for energy crops is outstripping supply.[115] Neither trend bodes well for marginalized communities that cannot readily cope with supply shortages and price spikes. Furthermore, as the Worldwatch Institute cautions, "Not everyone will benefit equally [in the growing market for biofuels]. Of all the participants in the biofuels economy, agribusinesses are assured the most profit, since mechanized harvesting and production chains are the easiest option for rapidly scaling up biofuels production."[116]

In addition to competition for forests, farmland, and even the fate of the agricultural products themselves, biofuels will push the demand (and raise the price) for water, fertilizers, and other inputs.[117] These resource pressures are especially acute in the large, modernizing societies of China and India. Efforts to increase food production in those countries have been stymied by the resource demands of biofuel developers, says Reuters. It reports that, "Numerous scientists and economists say China and India do not have enough water to increase grain production, whether for animals or fuel."[118]

[4] SECOND THOUGHTS

Europe now finds itself in a difficult position. After committing to biofuels in 2003 without sufficiently analyzing either the benefits or the drawbacks, it is discovering that the benefits are scant and the drawbacks are so large that by some metrics – most notably the impact on global warming – the Directive can already be described in terms of abject failure. As a result, the EU does not seem to know whether it should push forward or pull back. A European Parliament committee recommended in 2006 that the EU ban palm oil-derived biofuels[119] and the European Commission is reviewing important aspects of the Directive, from the validity of its basic objectives to the methods used to calibrate the relative GHG emissions from different fuels.[120] However, as mentioned above, EU energy ministers adopted yet another target in February 2007, this time declaring that biofuels are to

account for 10% of the transport fuel sold in Europe by 2020, assuming several conditions are met.[121]

Policymakers in Brussels had hoped that 2005 and 2010 targets would "prepare the way" for the so-called "second generation" biofuels that are made from perennial grasses, poplar trees, and other ligno-cellulosic plants.[122] As compared to corn and other first generation energy crops, production of ligno-cellulosic biomass should typically result in fewer GHG emissions, cause less soil erosion, and require less water and fertilizer. However, the full climate impact of policies that require "second generation" biofuels will depend on many other factors, including the current use of lands that will be utilized for biofuel feedstock cultivation; the impact of the demand for biofuels on agricultural markets, energy markets, and other commodity production chains; and the full net GHG and non-GHG climate impacts of these indirect effects.

Whether or not the Directive has quickened the development of market-ready second generation biofuels, many in Europe deeply regret the haste with which the EU pushed the existing set of biofuels.

One forum for those misgivings has been the European Commission's review of the Directive – an ongoing process now scheduled to conclude in December 2007.[123] Environmental NGOs have taken the opportunity to express serious doubts about whether the promotion of biofuels remains a valid goal. The organizations are generally skeptical about "the actual contribution of biofuels to the three policy objectives of the EU, i.e., reduction of GHG emissions, improvement of security of supply, and contribution to rural development." The three goals should be tackled individually, they argue, "because biofuels promotion does not guarantee that these objectives will be met."[124]

Several countries have their doubts, too. Denmark believes the Directive has failed, and has urged the EU to concentrate on the development of more cost-efficient second generation biofuels.[125] The Danish are not the only ones disappointed by the return on Europe's investment. According to the *International Herald Tribune*, "Politicians in many countries are rethinking the billions of dollars in subsidies" that have been spent on first generation biofuels.[126]

Comments submitted by the UK and Ireland assert that the Directive's continued validity depends in part on whether it can be reworked to actually promote its environmental and economic goals.[127] Barbara Young, Chief Executive of Britain's Environment Agency, expressed a

few of those concerns in October 2006, before the Directive's role in the peatland CO_2 emissions came to light:

> Some of these biofuels are pretty heavy on water. Some of them do dreadful things to the soil. Some of them, unless they are very close to a processor, create more carbon dioxide than they save by reducing fossil fuels. All we are saying is, let's do the full lifecycle analysis to make sure we are actually producing something that is more environmentally sound and doesn't have environmental downsides.[128]

The agricultural interests campaigning for biofuel consumption targets failed to conduct that kind of analysis, Young complained, and as a result they have been "wrong every bloody time."[129]

Peder Jensen of the European Environment Agency echoes Young by urging stakeholders "to take a life cycle view" *prior* to making new biofuels commitments. "If you make biofuels properly," he says, "you will reduce greenhouse gas emissions. But that depends very much on the types of plants and how they're grown and processed. You can end up with a 90 percent reduction compared to fossil fuels – or a 20 percent increase."[130]

Unfortunately, the lifecycle analyses currently available to policymakers like Young and Jensen cannot adequately answer their questions, particularly those that relate to climate. "Changes in land use, the nitrogen cycle, CO_2-equivalency factors, and the economic effects of policies are important factors in LCAs of GHGs from biofuels, but are treated poorly or not at all in most LCAs," says Mark A. Delucchi, an expert on lifecycle analyses at the University of California-Davis. "This means that nobody has, yet, a clear understanding of the impact of biofuel policies on climate."[131] In addition, as noted above, LCAs do not address the potentially enormous impacts caused by the indirect market effects of policies that drive up biofuel demand (*e,g,*, palm oil production and the EU Directive). Impacts on energy markets must also be considered, as biofuel policies that significantly reduce fossil fuel demand will impact and likely lower fossil fuel prices, which in turn will likely increase their use. Thus, requiring a certain amount of biofuel use may not fully displace an equivalent amount of global fossil fuel use (or its associated GHG emissions) – another invalid assumption in current LCAs.

In light of the EU Directive's disturbing track record and the inadequacy of the tools being used (or not used) to predict the effect

that biofuel policies will have on the environment, the most prudent approach to biofuels at this point appears to be restraint. Assuming advanced biofuels can become technologically and economically viable, we still need analytic tools to guide us toward policies that define and promote truly beneficial biofuel use. Such policies would anticipate and address all of the impacts of biofuel policies on global agriculture and forest product markets, as well as the associated impacts on climate, food prices, biodiversity, and social conditions in feedstock production areas. As researchers develop new feedstocks and new production techniques over the next few years,[132] the European experience suggests that some of that time can be well spent comprehensively assessing the true environmental costs and benefits associated with biofuels.

NOTES

[1] "President Bush Delivers the State of the Union Address," January 23, 2007. <http://www.whitehouse.gov/news/ releases/2007/01/20070123-2.html>.
[2] "Bush hails biofuels pact in Brazil," *International Herald Tribune*, March 9, 2007. <http://www.iht.com/articles/ 2007/03/09/news/web-0309bio.php>.
[3] DelVecchio, Rick, "Cal sees BP deal as landmark," *San Francisco Chronicle*, February 2, 2007. <http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2007/02/02/BAG1GNTL911.DTL&type=printable>.
[4] Rothkopf, Garten and the Inter-American Development Bank, *A Blueprint for Green Energy in the Americas*, 2007. 1. < http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=945745>.
[5] Crenson, Matt, "Biofuels Boom Raises Tough Questions," *Associated Press*, March 12, 2007. <http://biz.yahoo.com/ap/070310/ethanol_q_a.html?.v=2>.
[6] *See, e.g.*, Patton Boggs LLP, *Biofuels Legislation and the 110th Congress*, February 23, 2007. <http://www.pattonboggs.com/ News/detail.aspx?news=341>.
[7] Worldwatch Institute, *et al*., *Biofuels for Transportation: Global Potential and Implications for Sustainable Agriculture and Energy in the 21st Century – Extended Summary*, July 7, 2006 ("Worldwatch, *Biofuels for Transportation*"). 18-19. <http://www.worldwatch.org/taxonomy/term/445>.
[8] Hippin, Andreas, "Around the Markets: Biofuel rush: Time to slow down?" *Bloomberg/International Herald Tribune*, September 5, 2006. <http://www.iht.com/articles/2006/09/04/bloomberg/bxatm.php>.
[9] The European Parliament and the Council of the European Union, "Directive 2003/30/EC of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport," *Official Journal of the European Communities*, May 17, 2003 ("EU 2003 Directive"). ¶¶15, 22. <http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/ l_123/l_12320030517en00420046.pdf>.
[10] The United Kingdom Parliament, *Select Committee on European Union Forty-Seventh Report*, November 7, 2006 (UK Parliament, *Forty-Seventh Report*). 2.19. <http://www.publications.parliament.uk/pa/ld200506/ldselect/ ldeucom/267/26704.htm>.
[11] European Commission, "Energy for the Future: Renewable Sources of Energy – White Paper for a Community Strategy and Action Plan," November 26, 1997. 9-13. <http://ec.europa.eu/energy/library/599fi_en.pdf>.
[12] Council of the European Union, "Council Resolution of 8 June 1998 on renewable sources of energy," *Official Journal of the European Communities*, June 24, 1998 ("EU 1998 Resolution"). 2, ¶18. <http://eur-lex.europa.eu/ LexUriServ/site/en/oj/1998/c_198/c_19819980624en00010003.pdf>.
[13] "Minutes of the Sitting of Thursday 18 June 1998 – 13. Energy for the Future," *Official Journal of the European Communities*, July 6, 1998 ("EU Energy for the Future"). 219, ¶14.
[14] The European Parliament and the Council of the European Union, "Proposal for a Directive of the European Parliament and the Council on the promotion of the use of biofuels for transport [submitted December 17, 2001]," *Official Journal of the European Communities*, April 30, 2002. 205-206. <http://eur-lex.europa.eu/LexUriServ/site/ en/oj/2002/ce103/ce10320020430en02050207.pdf>.
[15] Ed Matthew (Friends of the Earth UK) email to Jonathan Lewis (Clean Air Task Force), March 26, 2007.
[16] Rosenthal, Elizabeth, "Scientists area taking 2nd look at biofuels," *International Herald Tribune*, January 31, 2007. 2. http://www.iht.com/articles/2007/01/30/business/biofuel.php>; Thoenes, P. and the Food and Agriculture Organization Commodities and Trade Division, *Biofuels and Commodity Markets – Palm Oil Focus*, 2006 ("FAO Biofuels and Commodity Markets"). 4. < www.fao.org/es/ESC/common/ecg/110542_en_full_paper_English.pdf >.
[17] EU 1998 Resolution, 1.
[18] EU Energy for the Future, 217. The EU Parliament did call on the Commission to use a method for calculating energy balances that "gives a more reliable indication of CO_2 reductions" and to ensure that renewable energy sources, including energy crops, are used in "an ecologically sensible fashion." *Id*. at 217-18. These attempts to qualify the EU's support for biofuels were not enforced and went unheeded.
[19] EU 2003 Directive, 42.
[20] EU 2003 Directive, 42.
[21] EU 2003 Directive, 42-43.
[22] UK Parliament, *Forty-Seventh Report*, 1.8.
[23] EU 2003 Directive, 43 (Art. 3, 1(a)).

[24] EU 2003 Directive, 43 (Art. 3, 1(b)).
[25] UK Parliament, *Forty-Seventh Report*, 1.5 – Table 1; UK Report to the European Commission – Article 4 of the Biofuels Directive (2006). 3. <http://ec.europa.eu/energy/res/legislation/biofuels_members_states_en/ 2006_rapports/2003_30_uk_report_en.pdf>.
[26] The Council of the European Union, "Directive 2003/96/EC of 27 October 2003 on the restructuring of the Community framework for the taxation of energy products and electricity," *Official Journal of the European Communities*, October 31, 2003. L283/52, 56.
[27] Council of the European Union, "Press Release: Transport, Telecommunications, and Energy," February 15, 2007. 10. ("EU Council Press Release") <http://www.consilium.europa.eu/ueDocs/cms_Data/docs/ pressData/en/trans/92802.pdf>.
[28] EU Council Press Release, 9.
[29] Almuth Ernsting (Biofuelwatch) email to Jonathan Lewis (Clean Air Task Force), June 7, 2007.
[30] FAO Biofuels and Commodity Markets, 6.
[31] International Energy Agency, *World Energy Outlook 2006* (2006), 404.
[32] Commission of the European Communities, *Annex to the Communication from the Commission: An EU Strategy for Biofuels – Impact Assessment 2006* (EU 2006 Impact Assessment"). 5. <http://ec.europa.eu/agriculture/ biomass/biofuel/sec2006_142_en.pdf >.
[33] EU 2006 Impact Assessment, 6.
[34] European Union, "Biofuels Strategy: Background Memo," February 8, 2006 ("EU 2006 Background Memo"). 5. <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/06/65&format=HTML&aged=0&language=EN&guiLanguage=en>.
[35] EU 2006 Background Memo, 1.
[36] Worldwatch, *Biofuels for Transportation*, 18-19.
[37] Worldwatch, *Biofuels for Transportation*, 6.
[38] Worldwatch, *Biofuels for Transportation*, 19; FAO Biofuels and Commodity Markets, 5 ("There is general consensus that – in the absence of subsidies – palm oil is by far the most competitive vegetable oil for the production of biodiesel.").
[39] UK Parliament, *Forty-Seventh Report*, 5.71. Nevertheless, EU farmers are dedicating more and more land to rapeseed. According to the US Department of Agriculture's Foreign Agricultural Service, "Area [of rapeseed cultivation] … continues increasing each year due to the burgeoning demand for biodiesel in the EU." USDA FAS, "Commodity Intelligence Report: Biodiesel Demand Continues Pushing Rapeseed Area Up In The EU," June 21, 2006. 1. < http://www.pecad.fas.usda.gov/highlights/2006/06/europe_20_june_2006/ >
[40] Worldwatch, *Biofuels for Transportation*, 6.
[41] Guerin, Bill, "European blowback for Asian biofuels," *Asia Times*, February 8, 2007. <http://www.atimes.com/ atimes/Southeast_Asia/IB08Ae01.html >.
[42] Guerin, "European blowback;" FAO Biofuels and Commodity Markets, 4.
[43] Guerin, "European blowback;" Patrick Barta and Jane Spencer, "Crude Awakening: As Alternative Energy Heats Up, Environmental Concerns Grow," *Wall Street Journal*, December 5, 2006. 3.
[44] Barta and Spencer, "Crude Awakening," 3.
[45] Palm oil plantation photos © Shariff Che'Lah - Fotolia.com <http://us.fotolia.com/id/1755259 and http://us.fotolia.com/id/1755166>. Used with permission.
[46] *See* IEA, WEO 2006, 390; FAO Biofuels and Commodity Markets, 5. The FAO estimates that only 1% of biodiesel is currently made from palm oil. "Rapseed oil from domestic sources represents the main feedstock for biofuel production" in Europe because of "the high level of public support provided in EU countries … In fact, in the absence of public support, rapeseed based biodiesel should not be competitive, even on a long term basis." *Id*. at 5.
[47] FAO Biofuels and Commodity Markets, 7.
[48] FAO Biofuels and Commodity Markets, 3.
[49] "EU Says Biofuel Target Unlikely to Hit Food Prices", *Reuters*, May 7, 2007. <http://www.planetark.com/ dailynewsstory.cfm/newsid/41743/story.htm>.
[50] FAO Biofuels and Commodity Markets, 6.

[51] Krishnan, Barani, "Malaysia Targets Europe in Biofuel Push," *Reuters*, August 12, 2005. <http://www.planetark.com/dailynewsstory.cfm/newsid/32027/story.htm>.
[52] Barta and Spencer, "Crude Awakening," 1 (internal quotation omitted).
[53] Leow, Claire and Koh Chin Ling, Around Asia's markets: versatility of palm oil bodes well for prices," *International Herald Tribune*, August 10, 2005. <http://www.iht.com/articles/2005/08/09/bloomberg/sxasia.php>.
[54] Hayley, Julia, "Tropical forests felled for biofuels, ecologists say," *Reuters*, April 18, 2007. <http://www.alertnet.org/thenews/newsdesk/L17559074.htm>.
[55] "EU eyes imports to quench biofuels thirst," EurActiv, July 6, 2007. <http://www.euractiv.com/en/trade/eu-eyes-imports-quench-biofuels-thirst/article-165289>.
[56] Krishnan, "Malaysia Targets Europe."
[57] John Carey, *et al*., "Food vs. Fuel," *BusinessWeek*, February 5, 2007. <http://www.businessweek.com/magazine/ content/07_06/b4020093.htm?chan=top+news_top+news+index_top+story >.
[58] FAO Biofuels and Commodity Markets, 6.
[59] *See* European Commission, "Biofuels Progress Report – Report on the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union," January 10, 2007 ("EC 2007 Progress Report"). 9. <http://ec.europa.eu/energy/energy_policy/doc/07_biofuels_progress_report_en.pdf >; FAO Biofuels and Commodity Markets, 4, 6.
[60] FAO Biofuels and Commodity Markets, 6.
[61] Leow, Claire, "Indian Edible-Oil Imports May Rise 14%, Official Says," *Bloomberg*, May 2, 2007. <http://www.bloomberg.com/apps/news?pid=20601091&refer=india&sid=amHKP4j6g_Vg >.
[62] IEA, *WEO 2006*, 391; Worldwatch Institute, "Biofuels for Transportation – Selected Trends and Facts," June 7, 2006. <http://www.worldwatch.org/node/4081>. Europe consumes close to 90% of the global supply of biodiesel. IEA, *WEO 2006*, 390.
[63] IEA, *WEO 2006*, 390, 403.
[64] Casey, Michael, "Asia Races to Find Crops to Replace Imported Oil," *Associated Press*, May 1, 2006. 2. <http://www.msnbc.msn.com/id/12482341/>.
[65] "Biofuel Era Has Arrived," *Jakarta Post*, July 7, 2006. <http://www.emeraldplanetasia.com/pdf/ biofuel%20era.pdf>.
[66] National Board of Trade of Sweden, "Trade Aspects of Biofuels," March 28, 2007. 3. <http://www.kommers.se/ upload/Analysarkiv/In%20English/Trade%20Aspects%20of%20Biofuels.pdf>.
[67] UK Parliament, *Forty-Seventh Report*, 1.9; Energy Research Centre of the Netherlands, "Review of EU Biofuels Directive: Public consultation exercises – Summary of the responses," October 2006 ("ECN Response Summary"). 6. <http://ec.europa.eu/energy/res/legislation/doc/biofuels/contributions/2006_08_23_summary_responses.pdf >.
[68] UK Parliament, *Forty-Seventh Report*, 1.10. In a 2007 progress report on the Directive, the European Commission found that the countries that achieved the 2005 target – namely, Germany and Sweden – did so by relying on imports and tax exemptions. EC 2007 Progress Report, 6.
[69] Countries outside of Europe, particularly the United States and Brazil, account for the bulk of the demand for biofuels, although non-European countries mostly consume bioethanol as opposed to biodiesel. The International Energy Agency expects that domestic consumption of biofuels will increase significantly in developing Asian countries such as China, India, and Indonesia over the next several decades. IEA projects that the largest increase in consumption, in absolute terms, will occur in the EU. *See* IEA, *WEO 2006*, 387, 394.
[70] Barta and Spencer, "Crude Awakening," 1.
[71] Almuth Ersting (Biofuelwatch) email to Jonathan Lewis (Clean Air Task Force), June 7, 2007.
[72] Ed Matthew (Friends of the Earth UK) email to Jonathan Lewis (Clean Air Task Force), March 26, 2007.
[73] Wetlands International, "Factsheet on palmoil and tropical peatlands," March 8, 2007 ("Wetlands Intl Factsheet"). < http://www.wetlands.org/publication.aspx?ID=40938c7b-d689-4b17-87dc-9f65def5bfaa>.
[74] Friends of the Earth, "Briefing: The use of palm oil for biofuel and as biomass for energy, August 2006 ("FOE 2006 Briefing"). 2. <http://www.foe.co.uk/resource/briefings/palm_oil_biofuel_position.pdf>.

[75] Kenfield, Isabella, "Brazil's Ethanol Plan Breeds Rural Poverty, Environmental Degradation," *IRC Americas*, March 6, 2007. 3. <http://americas.irc-online.org/am/4049>.
[76] Maynard, Robin, "Against the Grain," *Ecologist*, March 2007. 29.
[77] Guerin, "European blowback;" Rosenthal, "Scientists are taking 2nd look," 2.
[78] Maynard, "Against the Grain," 29.
[79] "China to develop biofuel forest as big as England," *Financial Express*, February 9, 2007. <http://www.bcurtisblog.com/?p=111>.
[80] Petermann, Anne, "United Nations Framework Convention on Climate Change Fiddles While the Earth Burns," (unedited version of article that appears in Z Magazine, February 2007). 3. <http://tech.groups.yahoo.com/group/ biofuelwatch/message/331>.
[81] Friends of the Earth, *et al*., *The Oil for Ape Scandal – Summary* (2005) ("FOE, Oil for Ape Summary"). 4. <http://www.foe.co.uk/resource/reports/oil_for_ape_summary.pdf >.
[82] Bach, Oliver and Rory Carroll, "Massacres and paramilitary land seizure behind the biofuel revolution," *The Guardian*, June 5, 2007. <http://www.guardian.co.uk/international/story/0,,2095338,00.html>.
[83] MacKinnon, Ian, "Palm oil: the biofuel of the future driving an ecological disaster now," *Guardian*, April 4, 2007. <http://environment.guardian.co.uk/energy/story/0,,2049667,00.html>.
[84] UNEP, *Last Stand*, 43
[85] FOE 2006 Briefing, 2.
[86] Orangutan photo used with permission of Open Stock Photography <http://www.openstockphotography.org/image-licensing/orangutan/Orangutan_Cincinnati_Zoo_002.jpeg>.
[87] EC 2007 Progress Report 9.
[88] Wetlands Intl Factsheet, 1-2.
[89] Wetlands International and Delft Hydraulics, *Assessment of CO_2 emissions from drained peatlands in SE Asia* December 7, 2006 ("Wetlands Intl-Delft"). 6. <http://www.wetlands.org/publication.aspx?ID=51a80e5f-4479-4200-9be0-66f1aa9f9ca9 >.
[90] Wetlands Intl Factsheet, 1
[91] Wetlands Intl-Delft, summary.
[92] Wetlands Intl-Delft, 29.
[93] Wetlands Intl-Delft, 29.
[94] Wetlands Intl-Delft, 22.
[95] Wetlands Intl-Delft, 30. "The demand for biofuel, aiming to reduce global CO_2 emissions, may thus be causing an increase in global CO_2 emissions."
[96] Jim Roland-Biofuelwatch, "An estimation of the expected CO_2 emissions caused by producing South East Asian palm oil for biodiesel, compared with the avoided diesel emissions," February 2007 (internal citation omitted). <www.biofuelwatch.org.uk/SE_Asia_palm_biodiesel_analysis.doc>.
[97] Wetlands Intl-Delft, 30.
[98] Barta and Spencer, "Crude Awakening," 3.
[99] Lohman, David J., *et al.*, "The Burning Issue," *Science*, April 20, 2007. 376.
[100] Lohman, "The Burning Issue," 376.
[101] Barta and Spencer, "Crude Awakening," 1.
[102] CREM BV, *et al*., "Dutch import of biomass – producing countries' point of view on the sustainability of biomass exports," October 2006 working paper (emphasis in original). 49. http://www.bothends.org/project/ project_info.php?id=41&scr=st
[103] Johnson, Eric and Russell Heinen, "Petroleum diesel vs biodiesel: The race is on," *Chemistry & Industry*, April 23, 2007. 22-23. *See also* Mortimer, N.D., *et al*., "Evaluation of the Comparative Energy, Environmental and Socio-Economic Cost and Benefits of Biodiesel – Draft Report for Department of Environment, Food and Rural Affairs," June 2002. 28-30. <http://www.ienica.net/policy/sheffield.pdf>. Carbon dioxide equivalent, or CO_2e, is a measure used to express the global warming potential of a greenhouse gas in terms of the amount of carbon dioxide that would cause the same amount of warming.
[104] Righelato, Renton and Dominick V. Spracklen, "Carbon Mitigation by Biofuels or by Saving and Restoring Forests?" *Science*, August 17, 2007. 902.
[105] Carey, "Food vs. Fuel," 1-2
[106] Barta and Spencer, "Crude Awakening,"2.
[107] FAO Biofuels and Commodity Markets, 1.
[108] Carey, "Food vs. Fuel," 2.

[109] Worldwatch, *Biofuels for Transportation*, 15
[110] Barta and Spencer, "Crude Awakening,"3
[111] Petermann, "UNFCC Fiddles," 3.
[112] Doornbosch, Richard and Ronald Steenblik, / OECD, *Biofuels: Is the Cure Worse Than the Disease?* September 2007. 6. <http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf>.
[113] Doornbosch and Steenblik, *Biofuels: Is the Cure Worse Than the Disease?* 34.
[114] Doornbosch and Steenblik, *Biofuels: Is the Cure Worse Than the Disease?* 34.
[115] "Open Letter: We Call on the EU to Abandon Targets for Biofuel Use in Europe," January 31, 2007. 2. <http://www.biofuelwatch.org.uk/2007Jan31-openletterbiofuels.pdf>.
[116] Worldwatch, *Biofuels for Transportation*, 15
[117] IEA, *WEO 2006*, 414.
[118] Gidley, Ruth, "As biofuels boom, will more go hungry?" *Reuters*, March 6, 2007. 2
[119] European Parliament, *Report on a strategy for biomass and biofuels*, October 12, 2006. 10. <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A6-2006-0347+0+DOC+PDF+V0//EN&language=EN>. A ban on biofuel produced from palm oil ignores the indirect market effects of the Directive, as the ban would likely do little to address the importation of palm oil sold in Europe as a substitute for the domestic rapeseed oil used to produced biodiesel.
[120] ECN Response Summary, 4, 25.
[121] "EU ministers agree biofuel target," *BBC News*, February 15, 2007. <http://news.bbc.co.uk/2/hi/europe/6365985.stm>.
[122] Commission of the European Communities, *Communication from the Commission: An EU Strategy for Biofuels*, February 8, 2006. 4. <http://ec.europa.eu/agriculture/biomass/biofuel/com2006_34_en.pdf>.
[123] "Biofuels: the Next Generation," *Euractiv*, September 13, 2007. <http://www.euractiv.com/en/energy/biofuels-generation/article-165951>.
[124] ECN Response Summary, 5.
[125] ECN Response Summary, 4.
[126] Rosenthal, "Scientists are taking a 2nd look at biofuels."
[127] ECN Response Summary, 4.
[128] Maynard, "Against the Grain," 31.
[129] Maynard, "Against the Grain," 31.
[130] Rosenthal, "Scientists are taking a 2nd look at biofuels."
[131] Delucchi, Mark A., "Lifecycle Analysis of CO_2-Equivalent Greenhouse-Gas Emissions from Biofuels," Presentation to the Clean Tech Workshop, Menlo Park, California (January 29-Feburary 2, 2007). 3. <http://www.siliconvalley.um.dk/NR/rdonlyres/D6ABF771-75D7-4E78-BAFC-EACDED0B3939/0/MarkDelucchi_013007_BiofuelsEnvironment.pdf >.
[132] Sanderson, Katharine, "A field in ferment," *Nature*, December 2006. 673-76.