Biofuels: The Climate-Related Threats and Opportunities, and the Need to Develop Policies Based on a Comprehensive Assessment of Their Direct and Indirect Impacts

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OVERVIEW

Policies that encourage biofuel production affect climate change in a variety of ways, through the net greenhouse gas emissions resulting from the production and use of biofuels and through the effects from changes to global agricultural markets. Their net impact on climate is poorly understood, because the analytic tools used to assess biofuel policies have some significant remaining gaps in addressing the production process (direct effects) and are not yet capable of quantifying market (or indirect) effects. It is clear, however, that adverse indirect effects – particularly the release of carbon dioxide as forests and wetlands are cleared to accommodate increased demand for farmland – can overwhelm the direct benefits of replacing fossil fuels with fuels made from conventional crops like corn, soy, rapeseed, and oil palms.

Niche biofuel policies that are carefully tailored to protect the climate are worth exploring, but it today appears unlikely that biofuels can play a large role in reducing domestic mobility climate impacts over the next twenty years. The barriers – *e.g.*, the magnitude of land conversion net climate impacts, the current lack of useful tools for analyzing biofuel policy, the limited availability of waste feedstocks and the lack of clarity about feasibility, costs and net climate impacts of advanced biofuel production systems under development – are too large and too numerous.

IMPACT OF BIOFUELS ON CLIMATE STABILITY AND SOCIAL DEVELOPMENT

With help from policymakers around the world, interest in biofuels has exploded in recent years. Annual production levels for ethanol doubled globally between 2000 and 2005, while biodiesel production tripled. The European Union instituted ambitious biofuel consumption targets for 2005, 2010, and 2020. China expects to meet fifteen percent of transport fuel demand in 2020 using biofuels. Dozens of ethanol refineries are being built across the United States, fueling record corn plantings. The US Congress is considering legislation that would increase domestic production of biofuels almost five-fold, and a growing number of states are exploring ways to develop local bioethanol and biodiesel markets.

The main engine behind the surging interest in biofuels is their theoretical potential to strengthen agricultural economies, to expand the options for transport fuel at a time of record oil prices, and to reduce emissions of greenhouse gases and other harmful air pollutants.

This focus on biofuels' theoretical benefits has obscured their actual track record. In practice, the recent policy-driven demand for biofuels has inflated food prices, contributed to deforestation in tropical countries, and probably worsened global warming. Moreover, biofuels are doing little to reduce petroleum consumption: already, 14.3 percent of corn grown in the US is converted to ethanol, and it replaces just 1.72 percent of gasoline use. Indeed, converting *all* of the corn grown in the US into ethanol would offset only twelve percent of the country's gasoline usage.[1]

Policies that promote the use of current biofuels produce a range of direct and indirect impacts. Direct effects are climate-relevant events (typically emissions) that explicitly result from the use or production of biofuels; indirect effects occur as a variety of markets adjust to fluctuations in the demand for biofuels. The most obvious direct impact biofuels have on climate is a reduction in the amount greenhouse gases emitted from the tailpipes of automobiles that run on biofuel, as compared to those powered by petroleum. When biofuels made from plant matter are combusted, the carbon dioxide emitted is the same carbon dioxide absorbed by the plant matter before it was harvested and made into fuel, thus the term "carbon neutral". However, the climate benefit from reduced tailpipe emissions is undermined by other effects directly tied to the production of biofuels. According to a recent University of Sheffield (UK) study, biodiesel made from rapeseed grown on dedicated European farmland accounted for nearly the same amount of CO2-equivalent-per-kilometer-driven as petroleum diesel. 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.[2]

Regardless of whether biofuels' direct impact on climate is beneficial or negligible, it pales in scope when compared to their indirect impacts. Because the vast majority of biofuels are made from sugars and oils extracted from commonplace crops, policies that expand the market for biofuels tend to also increase demand for agricultural crops and such inputs as water, fertilizer, and land.

The demand for crops has roiled food markets because the most widely cultivated "energy crops" are also food and feed staples like corn, soy, sugarcane, rapeseed, and oil palm. The majority of ethanol and biodiesel produced in the United States comes from corn and soy, respectively, and will continue to do so for some time. Demand from recently-built corn-ethanol refineries contributed to a dramatic spike in the price of corn in late 2006, pushing up the cost of corn-intensive foods including dairy, eggs, and meat from corn-fed livestock. In January 2007, a sharp rise in the price of corn tortillas even touched off street protests in Mexico. A 2007 OECD report found that, "Given the high ambitions of the EU, the US, China, Brazil, and others" with respect to biofuel production, "it is certain that without a serious change in policy the 'food-versus-fuel' debate will become more acute in coming years."[3]

Biofuel policies' indirect impact on climate is just as troubling. When farmers respond to subsidy-enhanced biofuel demand by diverting crops like corn, soy, or rapeseed from food markets to energy markets, farmers elsewhere in the world satisfy the unmet demand for food and feed products by clearing and cultivating enough new farmland to reestablish food market equilibrium. The same basic process will occur in coming years when food-producing farmland is given over to swtichgrass, miscanthus, and other non-edible "next generation" energy crops. The foregone food will be grown somewhere else – a process that ultimately results in the conversion of forests, wetlands, grasslands, and other areas that serve as important carbon

[1] Hill, Jason *et al*., "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels," *Proceedings of the National Academy of Science*, July 25, 2006. <http://www.pnas.org/cgi/content/full/103/30/11206>.
[2] 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>.
[3] Doornbosch, Richard and Ronald Steenblik, / OECD, *Biofuels: Is the Cure Worse Than the Disease?* September 2007. 34. <http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf>.

sinks. As land is cleared, drained, and/or burned to make it suitable for farming or grazing, there is a large one-time loss of soil and plant carbon. These negative climate impacts from converting forest or grassland to farmland dwarf even the most optimistic assessments of the annual climate benefit derived from biofuels made from energy crops grown on what was formerly food-producing farmland. Adding to the uncertainty are the non-greenhouse gas climate impacts associated with land conversion, which include changes in albedo, hydrology, surface roughness, and energy flux.[4] While recent studies suggests that non-GHG impacts of land use changes can be significant,[5] they have not yet been addressed by any researchers exploring the climate impacts of biofuel policy.

The scale of these indirect climate impacts, as well as the complicated nexus between policies that promote biofuels and activities that accelerate global warming, is exemplified by the EU's 2003 Biofuel Directive. The EU Directive, which is similar in several respects to state- and national-level biofuel policies under consideration in the US, established successively larger biofuel consumption targets for 2005, 2010, and, in a recent addendum, 2020. European biodiesel is usually made from domestically grown rapeseed oil, which also happens to be a popular cooking oil. By diverting more and more of the annual rapeseed harvest to biodiesel refineries, the Directive inadvertently created a demand for anything that could fill the void in the market for cooking oils. Part of that demand has been met by Malaysian and Indonesian palm oil, much of which is produced at plantations carved from forests and peatlands.

The bog-like peatlands of Southeast Asia store enormous quantities of soil carbon. According to a 2006 report issued by Wetlands International and the Dutch engineering firm Delft Hydraulics, almost 12 million hectares of Indonesian peatland have been drained and cleared – often to make room for palm oil plantations. In the process, approximately two billion metric tons of CO2 are released annually, making peatlands destruction a leading source of global warming emissions. After accounting for these emissions – which equal eight percent of global CO2 emissions from fossil fuel use – researchers determined that Indonesia's CO2 emissions were the third highest in the world, behind only the United States and China.[6]

The carbon release is large enough, in fact, to easily negate any of the purported carbon benefits that might be achieved if European motorists were to meet the Directive's biofuel-for-petroleum substitution targets. Biofuelwatch, an industry watchdog based in Britain, calculates that the average net CO2 emissions caused by producing South East Asian palm oil for biodiesel are between two and eight times larger than the emissions that are avoided by substituting the biodiesel for petroleum-based diesel.[7] The Wetlands/Delft report estimates that at least 10 and 30 metric tons of CO2 are released for every metric ton of palm oil produced.[8]

WHAT CAN BE DONE?

Several steps can be taken to ensure that biofuel policies do not lead to reenactments of the Southeast Asian palm oil debacle elsewhere, and that such polices actually serve the goals of climate stability, energy diversity, and agricultural development.

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[4] Marland, Gregg *et.al.*"The climatic impacts of land surface change and carbon management, and the implications for climate-change mitigation policy," *Climate Policy* 3 ,2003. 149-157.
[5]Pielke, R.A., Sr., "Land use and climate change," *Science*, Vol 310, December 9, 2005, 1625-1626
[6] Wetlands International and Delft Hydraulics, *Assessment of CO2 emissions from drained peatlands in SE Asia,* December 7, 2006. Summary, 29-30. <http://www.wetlands.org/publication.aspx?ID=51a80e5f-4479-4200-9be0-66f1aa9f9ca9>.
[7] Jim Roland-Biofuelwatch, "An estimation of the expected CO2 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>.
[8] Wetlands Intl/Delft, 30.

First, given how little is understood about the full ramifications of policies that promote biofuels, policymakers must slow down the current rush toward broad production and consumption mandates. Currently, "life-cycle" analyses barely consider or ignore altogether critically important factors like land use changes, the nitrogen cycle, CO2-equivalency factors, and the range of market-driven indirect effects. (See Figure 1)

While such advanced biofuels as cellulosic ethanol or synthetic fuels produced from co-gasifying biomass and fossil feedstocks with carbon capture and geologic sequestration may become technologically and economically viable, we still need analytic tools to guide us toward policies that define and promote truly beneficial biofuel use. Such tools would anticipate and assess 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, the European experience suggests that some of that time can be well spent developing and applying tools that comprehensively analyze the full costs and benefits associated with biofuels. (See Figure 2)

Second, once tools have been developed (the development process is expected to take 2-3 years) that can comprehensively analyze the range of economic and environmental impacts associated with a particular policy, we need to determine the most beneficial use of limited biomass resources. It is clear, for example, that a policy will only accelerate global warming if it shifts corn from the food market to the fuel market, and in doing so encourages farmers elsewhere to convert forest to farmland in order to restock global food supplies. From a climate policy perspective, a far better biomass-related initiative would be to simply preserve the standing forest.

Third, as analytic tools described above are being developed, policymakers should explore niche biofuel policies that are carefully tailored to protect climate, These would be initiatives for advancing the development (and, where appropriate, the deployment) of feedstocks and production practices that, in terms of climate stability and social development, are either beneficial or benign. Based on existing research and the European/Southeast Asian experience, such initiatives should, at a minimum, focus on already processed waste oil and feedstocks like municipal and industrial waste, algae that do not require a significant amount of farmland, and biomass produced on marginal lands that will not displace crops. Once analytical tools are available, these policies would be further tested to confirm their impact.

CATF'S OBJECTIVES FOR BIOFUEL POLICY DEVELOPMENT

Numerous policies designed to promote the production and use of biofuels are being developed internationally, in Congress, and in a handful of states. CATF aims to:

- Support efforts in the United States, Europe, and elsewhere aimed at developing analytic tools that comprehensively assess the full suite of direct and indirect climate impacts associated with a given biofuel policy.
- Educate policymakers about the role of such indirect effects as land-use conversion and how the scope of those effects can determine the net climate impact of a biofuel policy.
- When possible, urge policymakers to postpone the development of biofuel policies until the net climate impact of such policies can be fully assessed. Otherwise, work to include provisions within biofuel policies that require full consideration of the direct and indirect impacts.

FIGURE 1:

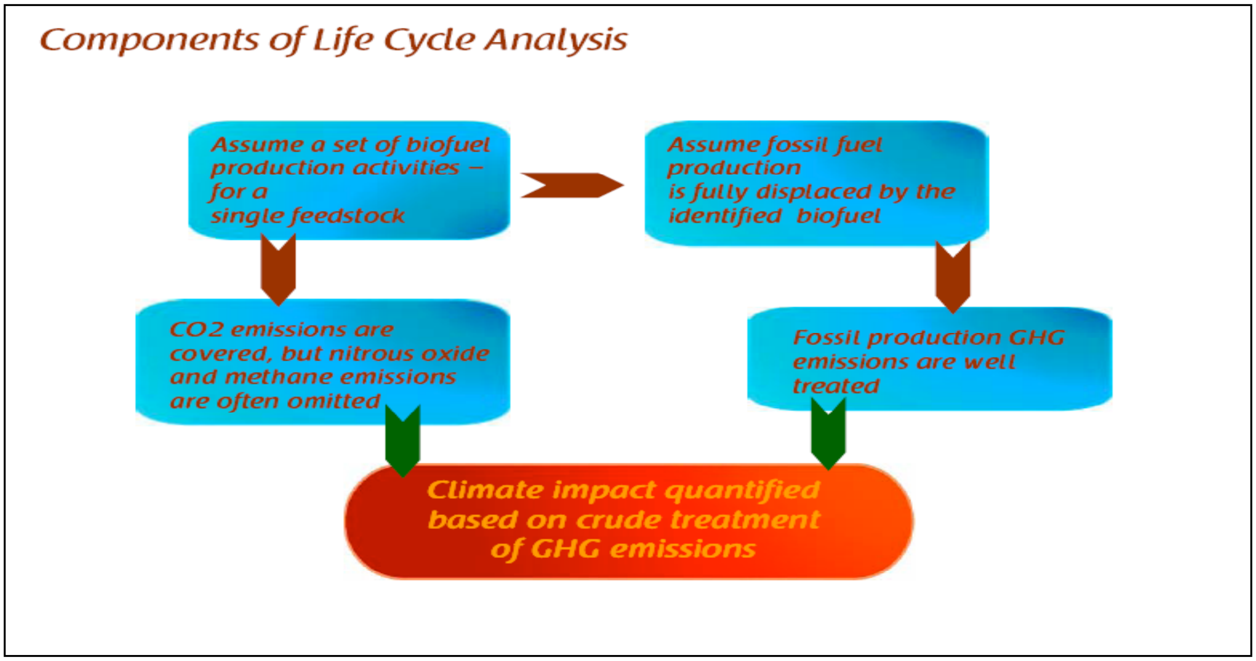

FIGURE 2: