CDM INVESTMENT NEWSLETTER

Nr. 3/2007 A joint initiative of BEA International and the Climate Business Network

Biofuels & the CDM—Extract

Table of contents

Biofuels for Transportation, by Naomi Pena, Pew Center on Global Climate Change and John Sheehan, LiveFuels

EXECUTIVE SUMMARY Interest in creating transportation fuels form plant materials is escalating worldwide. For climate change, the most important issue is the greenhouse gas consequences of these fuels. These depend on the emissions per unit of energy in the biofuels, the total amount of biofuels produced, and the efficiency of vehicles in which the fuels are used. Determining the greenhouse gas emissions of a biofuel is a major challenge. Biofuels can be produced in many ways, and a biofuel's emissions result from the particular choices of lands and crops used, management practices, conversion processes, and conversion energy. Consequently, these choices play important roles in biofuels' contribution to meeting climate goals. They also play a major role in the extent to which biofuel production can be harmonized with other land uses and objectives. Decisions with significant implications for biofuels are likely to be made in two distinct venues: the United Nations Framework Convention on Climate Change and the World Trade Organization. Ensuring that decisions in each arena takes cognisance of decisions in the other, and work in concert rather than at cross-purposes, should be a high-priority for biofuel stakeholders.

INTEREST IN THE USE OF PLANT MATERIAL TO PROVIDE TRANSPORTATION FUELS is increasing world-wide. The desire to reduce greenhouse gas emissions and reliance on imported petroleum together with prospects for new sources of income for rural populations are key reasons for this trend. Petroleum price increases and, particularly in developing countries, opportunities to earn foreign income are also significant factors. These multiple drivers are expanding the feedstocks (i.e., plants), conversion processes, and end products under consideration.

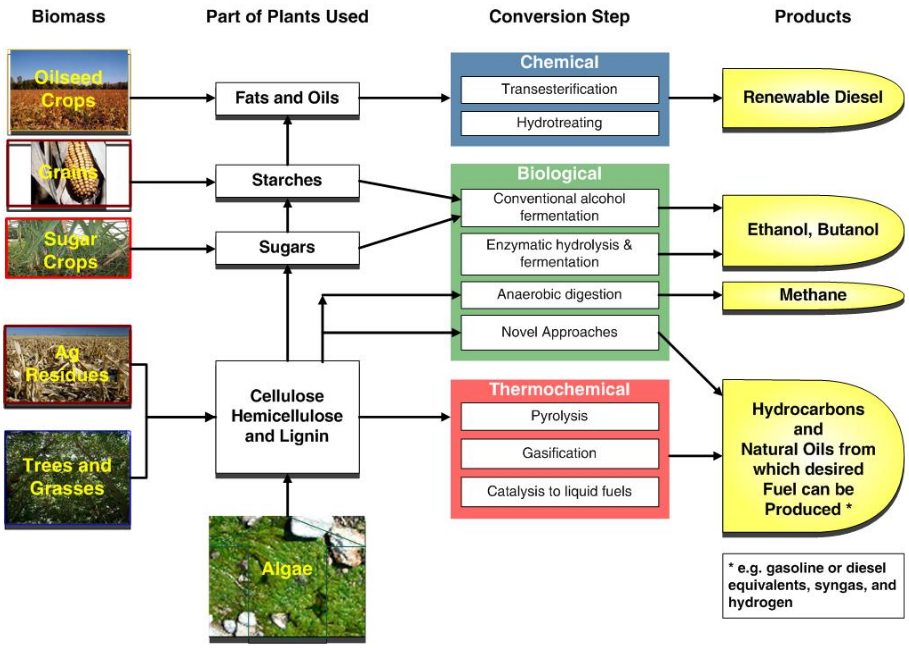
Greenhouse gas (GHG) emissions can be caused by each step in the fuel production process and during transport of feedstocks to processing plants and fuels to end users. Taken together, these emissions determine the GHG profile of a biofuel, and it is a biofuel's GHG profile, not the fact that it is a biofuel, that is critical for climate change. In addition to the fuels' GHG profile, other fuel characteristics, total volume and, very importantly, the efficiency of vehicles in which the fuels are consumed will determine the extent to which biofuels contribute to GHG reduction efforts.

As nations consider the promise of biofuels, two major challenges lie ahead: reaching agreement on the GHG profiles of these fuels, and evaluating and addressing competing options for land use, including preservation of old growth forests.

PRIMARY CURRENT AND EMERGING PATHWAYS As countries expand biofuel production, it will become increasingly important to consider impacts on food and fiber supply, water quality and availability, other land use opportunities, and GHG emissions. Stakeholder attention frequently focuses on biofuel volumes and area devoted to feedstock growth. However, choice of feedstock, conversion process, and energy used for conversion can play equally important roles in overall impact of biofuel production.

Any biomass can be converted into a transportation fuel through some process, as suggested by Figure 1. In the United States, the predominant commercial biomass-based transportation fuel pathway is to use corn as the feedstock, ferment the starch-derived sugars in corn kernels, use natural gas for the conversion process energy, produce ethanol, and transport the ethanol to retailers using infrastructure separate from gasoline (since current pipelines are not designed to carry gasoline-ethanol mixes).

Figure 1



In Europe rapeseed is the primary feedstock. The oils in the rapeseed are converted to biodiesel using a process called transesterification[1]. Since biodiesel can be transported using the same infrastructure as petroleum-based diesel, no separate infrastructure is needed. In Brazil the primary feedstock is sugar cane. The sugars are fermented to ethanol using crop wastes for the conversion process energy.

Internationally, a very wide variety of feedstocks are in use or under development for transportation fuels, and many feedstocks are well-suited to developing countries where climate, lower land and labour costs, and potentially available land area may offer both cost and yield advantages. Current and emerging feedstocks include algae, barley, coconut oil, corn, jatropha, manioc, neem, palm oil, perennial grasses, rapeseed, short rotation trees, soybeans, sugar beets, sugar cane, sweet sorghum, and sunflower seed. Of currently used feedstocks, sugar cane, sugar beets, and palm oil yield the highest amounts of fuel per acre.

Promising emerging feedstocks include algae, crop wastes, jatropha, perennial grasses, and wood and wood wastes. While jatropha can be converted to fuels with current commercial processes, conversion processes for the other emerging feedstocks are still in development stages. Jatropha is being pursued due to its relatively high per-acre productivity, ability to grow on poor or degraded soils, and low water requirements. Algae are being investigated for similar reasons. It can be grown in brackish water or in tubes, and it can produce up to 30 times more oil per acre than soybeans (http://www.eesi.org/publications/Newsletters/BCO/bco_41/bco_41.html). Forest and agriculture wastes are of interest due to their potential low costs.

Commercial conversion processes capable of utilizing a plant's entire biomass are likely to be the single most important enabler for biomass to playing a significant role in meeting transportation fuel needs and climate goals without resulting in serious compromises for other objectives. Current commercial processes convert only simple sugars, starches, and oils and, with the exception of sugar-cane based ethanol, use fossil fuels as the source of conversion-process energy.

However, the vast majority of plant material consists of cellulose, hemicellulose, and lignin. Processes capable of converting the energy in cellulose to energy in a transportation fuel at competitive costs would lower land requirements for producing a given volume of fuel. Use of lignin as the source of conversion-process energy would virtually eliminate conversion process CO_2 emissions, yielding biofuels with very small GHG footprints. A number of processes with these capabilities are under development but are currently too expensive to be commercial.

Given the wide variety of biofuel production pathways, there is an urgent need to develop transparent, equitable methods that can provide consistent, comparable GHG profiles[2] for biofuels from alternative pathways. Such methods should also be able to compare biofuel GHG profiles to those of petroleum-based fuels. Finally, it should be noted that while many stakeholders have focused on using biomass[3] for transportation fuels, biomass can also be used in ways that are more effective in reducing GHG emissions than many transportation fuel options. For example, a study undertaken in Sweden found that three times the CO_2 reductions could be achieved by using a given amount of biomass for heat and power, building materials, and to substitute for charcoal than could be achieved using it for transportation fuels (Gustavsson, et al., 2007).

GHG EMISSIONS – FACTORS AND RESULTS The GHG profile of a particular biofuel pathway is determined by choices made at each pathway step. Unlike petroleum-based fuels, biofuels are not considered to result in carbon dioxide (CO_2) emissions when used. This convention is sound as long as the same amount of plant material is grown as is used to make a biofuel. Under this condition, plant growth in a subsequent season will remove as much carbon from the atmosphere (via photosynthesis) as was emitted during fuel use[4]. This contrasts with petroleum-based fuels where most of the emissions occur during use. Combustion of fossil fuels in vehicles results in releases of CO_2 into the atmosphere from carbon that has been stored for eons underground and that cannot be returned underground with current technology.

The biofuel production industry can make feedstock production and conversion process choices that significantly affect GHG profiles. The following discussion focuses on biofuels from plant materials because animal and municipal wastes are most often used for heat and power generation and currently represent a very small fraction of transport fuel except in Sweden.

Some of the most important determinants of GHG emissions at the feedstock production step are current and prior land uses, management practices, and crop choices, including per-acre yields. Land use changes -- particularly the conversion of grass and forest lands to row crops, including tree plantations -- are likely to result in substantial releases of CO_2. Land use changes can occur either directly or indirectly. Indirect land use change occurs if, as a result of producing biomass for energy on land previously used to meet food, fuel (e.g., charcoal or wood for fires), or timber needs, lands elsewhere are converted to meet those demands. This is particularly likely to occur if prices of food crops and wood products rise as a result of using land for energy crops.

Reaching agreement on equitable, environmentally sound, and consistent ways to account for a biofuel's emissions due to land use changes is one of the most difficult challenges. First, determining emissions from indirect land use change is extremely difficult. A potentially even greater challenge is the fact that in the northern hemisphere only about one fifth of the land remains in forests whereas in the southern hemisphere almost 40 percent of the land base is still forested (Blaser, 2006).

Consequently in the northern hemisphere feedstocks are more likely to be produced on land that was converted from forests a century or more ago, while feedstocks in the southern hemisphere are more likely to be grown of land currently undergoing deforestation. An equity issue may thus arise if GHG emissions due to conversion of forests in the southern hemisphere are included in biofuel footprints without a mechanism that recognizes that feedstocks grown in the northern hemisphere are also grown on previously forested land whose conversion to cropland resulted in GHG emissions. A concerted effort by policymakers together with experts in biofuel production, land use, and modeling will be needed to resolve this issue in a manner acceptable to the broad range of stakeholders.

Management practices and crop choices also have significant impacts on GHG emissions. For example, no-till practices, which are suitable to some crops, can remove carbon from the atmosphere, while switching from no-till to conventional tillage will cause GHG emissions until soils reach a new equilibrium. Fertilizer amounts, timing, and application method determine how much nitrous oxide (N2O)[5] is released to the atmosphere. Yields can vary by over an order of magnitude.

Soybeans typically yield 440 litres of oil per hectare per year while palm can yield 4,000 or more litres. (Fagundes de Almeida et al., 2007; http://journeytoforever.org/biodiesel_yield.html). High yields have the advantage of requiring less land for a given amount of biofuel, but per-gallon GHG emissions of a biofuel are affected by the complete set: crop choice, management practices, and land use changes, if any, caused by their production.

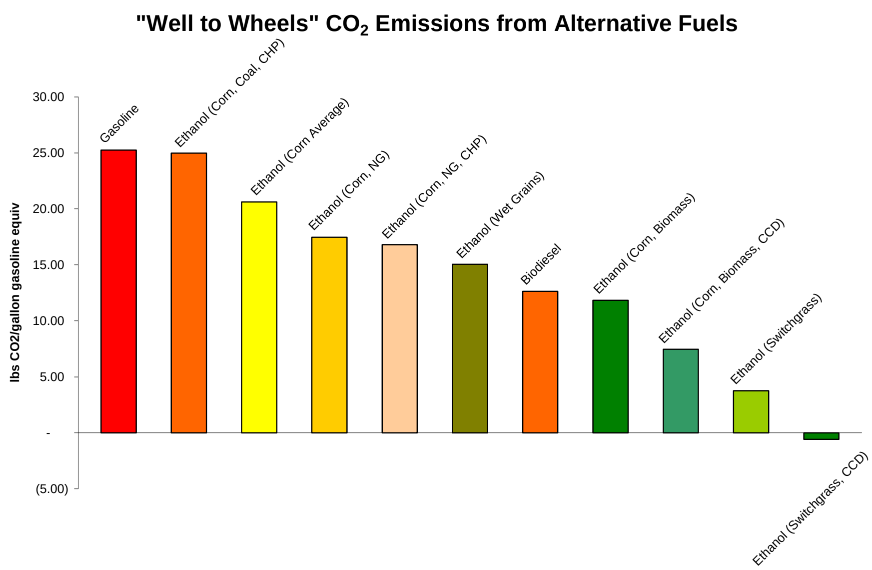
Emissions from the conversion process are determined by two key factors: (1) the energy efficiency of the process (i.e., the amount of energy in the final product per unit of energy used in the conversion); and (2) the type of energy used. As can be seen in Figure 1, conversion processes fall into three major categories: chemical, biological, and thermochemical, with different processes utilizing different parts of plants.

The most efficient processes may be those that combine two or more categories or use the entire plant. Current fermentation processes require more energy per unit of output than transesterification. For example, the energy efficiency of corn-based ethanol is 1.5, while it is 3.0 for biodiesel from soybeans. Consequently, if fossil fuels are used, fermentation results in more GHG emissions per unit of energy in a biofuel than transesterification.

Among currently used processes, ethanol from sugar cane and biodiesel from palm oil result in the lowest conversion-process GHG emissions. In the case of palm-based biodiesel, this results from low conversion energy requirements. In the case of sugar cane, it is a result of using biomass instead of fossil fuels for the conversion energy. For these pathways, the energy efficiency ranges from about 4-to-one under “worst case assumptions” to ten-to-one under “best case” assumptions (Fagundes et al., 2007)[6].

Of the multiple pathways suggested by Figure 1, only a few have been studied sufficiently to be able to provide quantitative estimates of their GHG emissions. Figure 2 shows GHG emissions per gallon of gasoline equivalent for a number of ethanol pathways and only one biodiesel pathway, reflecting the greater use of, and interest in, ethanol in the United States.

Figure 2



NOTES: CCD = carbon capture and disposal. Negative emissions mean that this pathway would remove more CO_2 from the atmosphere than it releases. In effect, some of the CO2 removed from the atmosphere during photosynthesis is not returned to the atmosphere but rather is permanently (or for very long time periods) kept out of the atmosphere. Storage of CO_2 in geologic formations is one way to do this.

NG = natural gas

CHP = combined heat and power

Source: Adapted from NRDC: Getting Biofuels Right. http://www.nrdc.org/air/trasnportation/biofules/right.pdf.

These estimates do not include estimates of emissions due to land use change. As can be seen, ethanol produced using current, average production and conversion technologies (yellow bar) provides a modest emissions improvement – about 20 percent -- compared to use of gasoline, with biodiesel doing significantly better.

COSTS AND BIOMASS AVAILABILITY With the exception of Brazilian sugar-cane based ethanol and biodiesel produced from waste grease and oils, biofuels are usually more expensive to produce than petroleum-based fuels. Except when petroleum prices are quite high -- as they have been recently -- most biofuel produced in both Europe and the United States is only competitive in the market due to subsidies. In the United State biodiesel requires larger per-gallon subsidies than ethanol[7].

However, costs of biofuels relative to petroleum products change as prices of oil, feedstocks, natural gas, and by-products change. For biodiesel, the most important factor is feedstock cost, as it accounts for 80 percent of production costs. For U.S. corn-based ethanol, corn, natural gas, and co-product prices all play significant roles[8].

Brazilian ethanol has the lowest production costs of any commercially produced biofuel in the world. Costs are estimated to be $0.85 to $1.40 on a per gallon gasoline equivalent basis[9] (IEA, 2004; Fagundes de Almeida, et al., 2007). A recent assessment concluded that Brazilian ethanol was 15 percent less expensive to produce than gasoline, while U.S. corn-based ethanol was 18 percent more expensive (Davis and Etter, 2007). Thus Brazilian ethanol could clearly underbid U.S. ethanol, and Indonesian palm-based biodiesel has production costs less than half U.S. soybean-based biodiesel production costs. Countries such as Malaysia and China also have production costs substantially below U.S. costs (Kaltner et al., 2005).

However, many countries -- including the United States, members of the European Union, and Australia -- impose tariffs or import duties on biofuels. Such charges reduce the competitiveness of imported biofuels, even biofuels with low GHG footprints. In the case of low-cost, low-GHG profile biofuels, import restrictions and fees that reduce trade also reduce biofuels' contribution to emission reduction objectives (Doornbosch and Steenblik, 2007; GTZ, 2006; Paustian et al., 2006).

Global estimates of energy that might be available from biomass by 2050 range from as low as 40 exajoules[10]-- close to current global biomass energy which supplies roughly ten percent of global energy demand -- to over 1,000 exajoules, conceivably enough to supply total 2050 energy demand (UNDP, 2000; GTZ, 2006). The many unknowns that contribute to this wide range include future crop yields and prices, water availability, and competition with other land uses.

However, potential supply is not the critical issue. The two critical issues are economically viable supply and vehicle efficiency. For example, at $25 to $30 per dry ton (the feedstock cost considered to be economically viable for U.S. producers), 25 to 50 million dry tons from U.S. forest residues might be available by 2025. At $60 per dry ton over 100 million dry tons would be available (http://www.bioweb.sungrant.org). Although these numbers are from U.S. studies, they indicate the importance of supply cost information in estimating potential biofuel supply at economically viable prices.

While vehicle efficiency is outside the control of the biofuel production industry, it is one of the most important factors in determining the extent to which biofuels can satisfy transportation fuel needs and contribute to emission reduction efforts while minimizing conflicts with other goals. A vehicle that goes twice as far per gallon will double the contribution any given biomass supply makes to satisfying transportation demand, at the same level of GHG emissions and use of land and water.

In short, highly efficient vehicles maximize the usefulness of biofuels and, consequently, policies designed to increase vehicle efficiency are critically important for using biofuels to address GHG emissions and fuel independence.

POLICY ISSUES Biofuel mandates are being established in a number of countries around the world. Such mandates may have a variety of objectives, but for climate change the fuels' GHG profiles -- not the fact that they are made from biomass -- are the critical issue. Consequently, for use in reaching climate goals, it will be critical that biofuels have GHG profiles lower than the fuels they are replacing.

To evaluate biofuels' GHG profiles requires the development of environmentally sound, transparent, and equitable methods. Such methods must also be acceptable to the broad range of stakeholders involved. A larger issue facing individual nations and the international community is harmonizing biofuel and other policies that affect land use.

Current international climate negotiations are examining ways to reduce deforestation in the developing world, particularly through incentives. However, past attempts to include only a subset of the actions that affect land use and land cover, such as deforestation or reforestation, in climate agreements have led to significant difficulties. It is difficult to define what will qualify as an included action and to address spill-over effects, particularly displacement of an activity from one geographic location to another.

For these reasons a more holistic or inclusive approach that considers a nation's overall increases and losses of carbon stocks across soils and vegetation may prove more useful in the long term. Holistic approaches also have the potential to engage a wider range of nations, since the carbon stock opportunities of many nations lie predominantly in agricultural soils, revegetation, grasslands, or improved forest management practices rather than in reducing deforestation.

If incentives become available for improved carbon stocks, for example, as compared to some baseline, nations may respond by adopting and strengthening land use and management policies. As policies focused on carbon stocks and biofuels proliferate – as seems likely -- it will become increasingly important to consider their interactions.

One way to design biofuel policies to work in conjunction with, rather than in opposition to, land use policies would be to focus feedstock production on lands with low carbon content, e.g., degraded lands, or lands unsuitable to production of food and fiber crops for other reasons. Growing feedstocks on low-carbon soils can increase terrestrial carbon because feedstock production has the potential to increase soil carbon. Assessments of available lands and the specific uses to which a nation intends to devote specified areas would assist in setting realistic, compatible goals.

Looking forward, key international discussions could affect utilization of biofuels around the world, particularly the discussions taking place in connection with UNFCCC climate negotiations and ones within the World Trade Organization (WTO). Commitments under future climate agreements could take various forms, some of which are articulated in the Climate Dialogue at Pocantico (http://www.pewclimate.org/pocantico.cfm), and others in Options for Including Agriculture and Forestry Activities in a Post-2012 International Climate Agreements (Environmental Science and Policy, Vol. 10, Issue 4, June, 2007).

Two types of commitment described in the Dialogue's report hold promise for both biofuels and terrestrial carbon: international agreements in key sectors and policy-based approaches. An international sectoral agreement on biofuels could take the form of a global target on production of transportation fuels with GHG profiles below a specified level. Each country participating in the agreement would accept responsibility for contributions to the target.

Alternatively, major biofuel or feedstock producers could agree on low-GHG fuel standards. Under a policy-based approach a nation might propose a low GHG standard for its transportation fuels and a specified vehicle efficiency level, committing to adopt a particular set of policies to achieve those goals as part of an international climate change agreement.

While discussions of future commitments for climate purposes are taking place within the context of the UNFCCC, using carbon profiles to regulate imports would fall under WTO authority, as it can decide what constitutes discrimination in trade. A special committee on trade and environment has been created and could be used as a forum for discussing both acceptable profiles and methods for determining them (Doornbosh and Steenblik, 2007). Such decisions could support or undermine agreements under the UNFCCC.

If, for example, the WTO decided that current import charges or restrictions on imports of biofuels were illegal, developing countries' opportunities to sell biofuels would be significantly enhanced, increasing feedstock production land values. Restrictions, or charges on, biofuel imports based on GHG emissions in the country of origin will also be subject to WTO review, and crafting WTO-compliant mechanisms that allow such actions will be challenging. WTO decisions on GHG-based trade regulations thus also contribute to increased land values, particularly where land conversion for feedstock production results in significant GHG emissions. Increased land values will render achieving reductions in deforestation under UNFCC agreements by means of payments, as currently envisioned by many stakeholders, less feasible or more expensive. Under these circumstances there is a need for significant attention to crafting WTO-compliant mechanisms that promote trade in biofuels while fostering both equity and environmental goals.

A chain of decisions will determine the landscape in which future climate change, economic development, and energy security initiatives play out. Bringing WTO and UNFCCC stakeholders together so that participants in each of these discussions understand key terms, issues, and agreements in both arenas is a vitally needed and, to date, missing link in this chain. Active participation in both the WTO and UNFCCC processes will be the best guarantee that the future will be shaped to meet environmental and economic development goals.

Bibliography

–*Blaser, J. 2006. Lessons learned from other national and international efforts to reduce deforestation. Presented at the Reducing Emissions from Deforestation in Developing Countries (REDD) workshop. Bad Blumau, Austria. May 10-12.*

–*Davis, B. and L. Etter. Brazil's Sugar-Cane Ethanol Gets a Boost from IMF Report. Wall Street Jounal. October 18, 2007.*

–*Doornbosch, R. and R. Steenblik. 2007. Biofules: is the cure worse than the disease? OECD. Paris. September 11-12.*

–*Faguendes de Almeida, E., Bomtempo, J.V., and Souze e Silva, C.M.. 2007. The Performance of Brazilian Biofuels: An Economic, Environmental and Social Analysis. Energy Economics Group, Institute of Economics, Federal University of Rio de Janeiro. To be published by OECD.*

–*Farrell A., R. Plevin, B. Turner, A. Jones, M. O'Hare, and D. Kammen. Ethanol can contribute to Energy and environmental goals. Science. Vol. 311. January 27.*

–*Greene, N. 2006. Biofuels and the Environment: Promises and Challenges. September 14.*

–*GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit). 2006. Conference Handout. Biofuels for Transportation: Global potential and implications for sustainable agriculture and energy in the 21st century. Bonn, May 16-17. www.gtz.de/biofuels-conference.*

–*Gustavsson, L., J. Holmberg, kV. Dornburg, R. Sathre, T. Eggers, K. Mahapatra, and G. Marland. Using biomass for climate change mititation and oil use reduction. Energy Policy. Vol. 35. August 2, 2007)*

–*IEA (International Energy Agency. Biofuels for Transport: An International Perspective. 2004. http://www.iea.org/textbase/nppdf/free/2004/biofuels2004.pdf.*

–*Jefferies CleanTech Review. 2007. Biofuels in 2007: A U.S. Perspective. Vol. 2, No. 1.*

–*Kaltner, F.J., G.F.P. Azevedo, I.A. Campos, A.O.F. Mundim. 2005. Liquid Biofules for Transportation in Brazil. http://www.fbds.org.br/IMG/pdf/doc-116.pdf.*

–*Paustian, K., J. Antle, J. Sheehan, and E. Paul. 2006. Agriculture's Role in Greenhouse Gas Mitigation. Pew Center on Global Climate Change. Arlington, VA.*

–*Perlack, R., L. Wright, A. Turhollow, R. Graham, B. Stokes, and D. Erbach. 2005. Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply. www.osti.gov/bridge.*

–*Schlamadinger, B. 2001. Greenhouse Bas Balances of Biomass and Bioenergy Systems. www.joanneum.at/iea-bioenergy-task38.*

–*Schnepf, R. 2005. Agriculture-Based Renewable Energy Production. CRS Report for Congress. RL32712. May 18.*

–*Sheehan, J. 2007. Biofuels and climate change...a sustainable opportunity? Presented at the Colorado Agricultural Outlook Forum, Denver, CO, February 21st.*

–*UNDP (United Nations Development Program), United Nations Department of Economic and Social Affairs, and World Energy Council. 2000. World Energy Assessment: energy and the challenge of sustainability. UNDP. New York, New York.*

–*Wegner, S. 2007. Realities in Cellulose Ethanol from Wood. Presented at: Biomass Energy: Biorefineries Seminar. Resources for the Future, April 4.*

–*Worldwatch Institute. 2006. Biofuels for Transportation: Global Potential and Implications for Sustainable Agriculture and Energy in the 21st Century.*

Endnotes

1 a process which modifies the oils in the feedstocks by replacing glycerin in fatty acid chains of vegetable oils with methanol.

2 A GHG profile of a product is a measure of the GHG emissions caused by its manufacture and use. In practice boundaries must be set as on which emissions to include. For example, in the case of biofuels, emissions from manufacture and use of fertilizer to produce the feedstocks are included but emissions caused by building the fertilizer plant itself are not.

3 Biomass is a term covering any plant-derived organic matter, including food and feed crops, crop residues, perennial grasses, wood, wood wastes, aquatic plants, animal wastes, and municipal wastes of biologic origin.

4 Animal wastes are, ultimately derived from plant material. This means that plant materials used for feed must also be sustainably produced.

5 N2O has a much higher global warming potential than CO_2. Each ton of N2O emitted into the atmosphere causes approximately 310 times as much warming as a ton of CO_2.

6 This means that there are four to ten Btus of energy in the sugarcane ethanol or biodiesel products for each Btu of fossil fuel used to produce the fuel.

7 Refinery gate prices for ethanol typically been twice the refinery price of gasoline, gate rices for biodiesel have typically been three times diesel refinery prices (IEA, 2004)

8 Estimated ethanol costs and GHG profiles depend on assumptions about co-products because the production process results in co-products that can be sold. Models of GHG emissions attribute some of the total ethanol plant emissions to these co-products, and the stated costs reflect a negative cost for the ethanol from co-product sales. If co-product prices or the market for them falls, ethanol's costs and GHG emissions would rise.

9 Gasoline has 115,000 Btu per gallon while ethanol contains 75,700 Btu per gallon.

10 1 exajoule = 1018 joules

Bureau of Environmental Analysis (BEA International)

Dr. Patrick Karani
Mt. View # 121
Westlands off Waiyaki Way
P.O. Box 15953 Nairobi 00100
Kenya
Tel: +254(020)631174,(020)631433
Fax: +254(020)631421
Web: http://www.beainternational.org/
Contact info@beainternational.org

Climate Business Network (CBNet)

Dr. Peter Pembleton, Managing Editor
Ms. Nerissa Octavio, Editorial Assistant
newsletter@climatebusiness.net
171 Malvar Street, Ayala Aabang Village,
Muntinlupa City, Metro Manila
Philippines
Tel: +63 (0)928 4363 945
Web: http://www.climatebusiness.net/
General queries info@climatebusiness.net

Contributors

Naomi Pena (PenaN@pewclimate.org), Pew Center on Global Climate Change and John Sheehan, LiveFuels,
Tamara Levine (Tamara.Levine@intercooperation.ch) and Carmenza Robledo, Intercooperation
Clemens Plöchl (clemens.ploechl@energy-changes.com), Energy Changes
Phorntippha Prathumratana Kerr (phorntipphakerr@yahoo.com.sg)
Anandajit Goswami (anandjit@teri.res.in), Resources and Global Security Division, TERI

Sponsor

SECC, Netherlands