

Subject: References for Co-Product Credits ad Land Use Issues
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Date: Mon, 22 Oct 2007 17:56:21 -0700
To: John Curtis <jcourtis@arb.ca.gov>

John:

At the October 4, 2007, Life Cycle Analysis (LCA) workgroup meeting, you asked for comments related to two specific elements of LCA: (1) treatment of co-product credits and (2) land use issues. As you know, LCA as applied to GHG emissions from the transportation sector is an evolving science. As a result, estimates used today as part of the calculations will most certainly change as more research is conducted. It is therefore important to use the most advanced, up-to-date thinking in constructing an LCA model for the LCFS. With this in mind, we have highlighted below a number of references that may be useful in your work.

Co-Product Credits

In the staff presentation made at the October 4 workgroup meeting, the slide summarizing co-product credit issues outlined several approaches used in previous studies (e.g., energy, value, mass). There was also a short discussion at the meeting of dealing with co-products via a substitution/displacement method (e.g., DDGS from corn ethanol production displacing a portion of grain that would otherwise be used).

The following references contain information related to crediting of co-products that you might find useful:

Wang, Michael, "Updated Energy and Greenhouse Gas Emission Results of Fuel Ethanol," The 15th International Symposium on Alcohol Fuels, San Diego, CA, September 26-28, 2005. (<http://www.transportation.anl.gov/pdfs/TA/375.pdf>)

Delucchi, Mark, "Incorporating the Effect of Price Changes on CO₂-Equivalent Emissions from Alternative Fuel Lifecycles: Scoping the Issues," Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-05-19, October 2005. (<http://www.its.ucdavis.edu/publications/2005/UCD-ITS-RR-05-19.pdf>)

Land Use Issues

This is likely the most complicated, and often controversial, element of LCA modeling. It also can have a significant impact on the overall global warming intensity of a particular fuel pathway. In Part 1 of the University of California report, "A Low-Carbon Fuel Standard for California," the U.C. professors acknowledged that land use change is among the most important market-mediated effects in LCA modeling. They also note that Delucchi's LEM model contains the most complex treatment of land use change of the existing LCA models. New studies on the impacts of land use changes on GHG

emissions of transportation fuels are appearing with increasing frequency. For example, the following report was published earlier this month:

SRI Consulting, “Carbon Footprint of Biofuels & Petrofuels.” According to SRI’s press release, this report shows that land use is the most significant factor in the carbon footprint of biofuels. (See http://www.sriconsulting.com/SRIC/Public/NewsEventsArt/PR_Articles/PROct07_CarbFoot.html.)

In addition, a recent Science paper by researchers at the University of Leeds argued that forestation of an equivalent area of land used to produce fuel crops would sequester two to nine times more carbon over a 30-year period than the emissions avoided by the use of the biofuel. (Righelato, R. and Spracklen, D., “Carbon Mitigation by Biofuels or by Saving and Restoring Forests?” Science, vol. 17, August 17, 2007.)

The staff presentation at the LCA workgroup meeting specifically noted nitrogen impacts as an issue related to land use. This is also a very important topic, and it is subject to considerable uncertainty. As noted in the latest CONCAWE/EUCAR report on WTW assessment of future automotive fuels (March 2007, full citation below under “Additional References”):

The fossil energy and GHG savings of conventionally produced bio-fuels such as ethanol and bio-diesel are critically dependent on manufacturing processes and the fate of by-products. The GHG balance is particularly uncertain because of nitrous oxide emissions from agriculture.

Recent research authored by 1995 Nobel Prize winner Paul Crutzen et al. also points to considerable uncertainty with respect to the impact of N₂O emissions on the GHG reductions associated with agro-biofuel production. Their analysis showed that the replacement of fossil fuels by biofuels may not result in the intended climate cooling impact because of accompanying N₂O emissions. (See <http://www.atmos-chem-phys-discuss.net/7/11191/2007/acpd-7-11191-2007.pdf>.)

Clearly, land use issues need to be properly accounted for in the LCA model developed by CARB for the LCFS. Ignoring or giving short-shrift to this issue could potentially lead to incorrect decisions regarding which fuel pathways truly result in reduced global warming intensity. Many of the references listed below include discussions of land use issues.

Additional References

Additional references that you might find helpful are summarized below. Many of these include discussions of co-product credits and land use issues along with other topics.

CONCAWE/EUCAR, “Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context,” Version 2c, March 2007. (This report and related appendices are available for download at <http://ies.jrc.cec.eu.int/wtw.html>)

Delucchi, Mark, “A Lifecycle Emissions Model (LEM): Lifecycle Emissions from Transportation Fuels, Motor Vehicles, Transportation Modes, Electricity Use, Heating and Cooking Fuels, and Materials,” Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-03-17, December 2003. (<http://www.its.ucdavis.edu/publications/2003/UCD-ITS-RR-03-17-MAIN.pdf>)

Delucchi, Mark, “Conceptual and Methodological Issues in Lifecycle Analyses of Transportation Fuels,” Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-04-45, October 2004. (http://pubs.its.ucdavis.edu/download_pdf.php?id=203)

Delucchi, Mark, “Lifecycle Analyses of Biofuels,” Draft manuscript, Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-04-45, May 2006. (<http://www.its.ucdavis.edu/publications/2006/UCD-ITS-RR-06-08.pdf>)

Farrell, Alexander E., et al., “Ethanol Can Contribute to Energy and Environmental Goals,” *Science*, January 27, 2006. (This paper and related materials can be downloaded at <http://rael.berkeley.edu/ebamm/>)

General Motors, Argonne National Laboratory, Air Improvement Resource, “Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems—A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions,” May 2005. (<http://www.transportation.anl.gov/pdfs/TA/339.pdf>)

General Motors, BP, ExxonMobil, Shell, et al., “GM Well-to-Wheel Analysis of Energy Use and Greenhouse Gas Emissions of Advanced Fuel/Vehicle Systems - A European Study,” September 27, 2002. (http://www.lbst.de/publications/studies_d/2002/TheReport_Euro-WTW_27092002.pdf)

Kammen, Daniel, “The Rise of Renewable Energy,” *Scientific American*, September 2006. (<http://rael.berkeley.edu/files/2006/Kammen-SciAm-Renewables-9-06.pdf>)

Organisation for Economic Co-operation and Development (OECD), “Biofuels: Is the Cure Worse Than the Disease?” Roundtable on Sustainable Development, September 11-12, 2007. (<http://media.ft.com/cms/fb8b5078-5fdb-11dc-b0fe-0000779fd2ac.pdf>)

Patzek, Tad, "The Real Biofuel Cycles," Online supporting material for Science Letter, Vol. 312, p. 1747, June 26, 2006.

(<http://petroleum.berkeley.edu/patzek/BiofuelQA/Materials/RealFuelCycles-Web.pdf>)

Sheehan, John, et al., "Energy and Environmental Aspects of Using Corn Stover for Fuel Ethanol," Journal of Industrial Ecology, Vol. 7, No. 3-4, 2004.

(<http://devafdc.nrel.gov/pdfs/8427.pdf>)

Wang, Michael, ""The Debate on Energy and Greenhouse Gas Emissions, Impacts of Fuel Ethanol," Energy Systems Division Seminar, Argonne National Laboratory, August 3, 2005. (<http://www.transportation.anl.gov/pdfs/TA/347.pdf>). In addition, a number of technical reports and articles related to Wang's lifecycle work are also available for download at <http://www.transportation.anl.gov/software/GREET/publications.html>)

World Business Council for Sustainable Development, "Mobility 2030: Meeting the Challenges to Sustainability," June 2004.

(<http://www.wbcsd.org/web/publications/mobility/mobility-full.pdf>)

I hope you find this material useful.

Best regards,

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