BIOdiesel Tech NOTES

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GREENHOUSE GAS CALCULATIONS OF BIODIESEL

Early U.S. Environmental Protection Agency (EPA) reports regarding the greenhouse gas (GHG) reductions achieved by using biofuels, were dramatically changed.

The EPA's first attempt, in May of 2009, at quantifying the GHG reductions of soy biodiesel raised enormous concerns in the biodiesel industry, because according to those initial numbers, soy biodiesel achieved only a 22% reduction in greenhouse gases compared to petro-diesel—not enough to meet the 50% reduction needed for an Advanced Biofuel under the Renewable Fuel Standard 2 (RFS2).

After gathering comments and revising their model, the EPA's final rule, released in February of 2010, states that soy biodiesel achieves on average a 57% reduction in greenhouse gases compared to petro-diesel (see chapter 2.6 of the EPA's Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis).

Where did these numbers come from? Why did they change so much? To answer these questions, we need to take a step back and look at the methods used to come up with these numbers.

Life Cycle Analysis

Policy makers want to know: if they create a larger mandate for biofuels, including biodiesel, would these fuels result in less greenhouse gases released into the atmosphere than petroleum-based fuels? This question can be answered using a technique called "life cycle analysis."

Life cycle analysis (LCA) is used to estimate the environmental, energy, and economic performance of a product or a system. In essence, it is a budgeting process that accounts for all inputs and outputs. Inputs include raw materials and energy, and outputs include products, waste materials, and environmental impacting components such as CO_2.

There are two categories of life cycle analysis: "attributional" and "consequential." The main controversy surrounding the EPA's numbers has to do with the consequential life cycle analysis dealing with the issue of indirect land use change (ILUC).

It is important for people in the biofuels industry to understand the differences between these two categories of life cycle analysis, because if used inappropriately, the numbers can be misleading.

Attributional vs. Consequential Life Cycle Analysis

"Attributional" LCA (ALCA) is also known as the 'business as-usual" scenario. Most LCA studies fall into this category. The life cycle impact is quantified by accounting for environmentally relevant physical flows to and from a product system. It is "business as usual" because the values used are averages based on normal, current business practices.

For example, when analyzing the carbon dioxide released throughout the life cycle of soy biodiesel, we would use average numbers for current CO_2 emissions for planting and harvesting soy, crushing the beans to extract the oil, transporting the oil to the biodiesel plant, making the biodiesel, and transporting the finished biodiesel to the retailer. The analysis doesn't include any indirect effects that are not directly related to the production of biodiesel.

Attributional LCA aims to describe the average **attributes** of the current, prevalent method of doing something. Attributional LCA can answer a range of questions, such as: how much energy is currently used to produce soy biodiesel, compared to petro-diesel? Or: how much carbon dioxide is released into the air from the current method of producing and using soy biodiesel?

"Consequential" LCA (CLCA), in contrast, aims to predict the **consequences** if **changes** are made to an established process. For example, a CLCA could be used to answer the question, how much CO_2 would be released into the atmosphere if the production of soy biodiesel doubled?

An important difference between ALCA and CLCA is that CLCA includes indirect effects of these changes, in addition to direct effects. So CLCA encompasses one or more attributional LCAs, plus other indirect factors.

For example, in addition to the direct CO_2 emissions from the production of soy biodiesel, CLCA has been used to attempt to quantify the indirect emissions of CO_2 that might result if more soy biodiesel is produced in the U.S. in response to a government mandate that then might cause land in other parts of the world to be converted from forest land to agricultural land. This kind of indirect effect would not be included in an attributional LCA, but could be included in a consequential LCA.

Consequential LCA can be especially interesting to policy makers, because CLCA can theoretically analyze what might happen if a law or policy were to make changes to an established process. For example, CLCA might be used to predict how much fossil energy would be used to produce soy biodiesel if all soybeans for biodiesel were planted and harvested using only biodiesel-powered tractors. CLCA might be used to predict how much carbon dioxide would be released into the atmosphere from soy biodiesel production if the soy yield per acre were to double. CLCA can come up with a life cycle analysis for any number of such hypothetical scenarios.

For CLCA to successfully predict indirect effects, it is essential to have accurate, verifiable models to connect these effects to the process changes.

Appropriate and Inappropriate Methodologies for Attributional and Consequential LCA

It is relatively less complex to conduct an attributional LCA appropriately, because the system boundary is relatively easy to delineate and the life cycle inventory is traceable and measurable. There is verifiable data from real measurements.

It is harder to know how to appropriately conduct a consequential LCA because at this time no standards exist for delineating the system boundary. Individual researchers conducting a consequential LCA must answer, on their own, such questions as: how many hypothetical changes should be introduced in one CLCA? How do these changes interact with each other? What time period should be analyzed?

Attributional LCA numbers tend to be fairly reliable because they are based on known numbers that most researchers could come to agreement around.

Consequential LCA numbers, on the other hand, tend to be questionable and sometimes unreliable because they are often based on guesses and model outcomes as to what might happen if the current scenario changed.

EPA's Life Cycle Analysis

Many people in the biodiesel industry have argued that the consequential life cycle analysis of biodiesel conducted by the EPA is highly unreliable, because they have included too many unknown variables. For example, the EPA attempts to analyze the GHG impact of biofuels in the year 2022. Agriculture and technology are changing so fast that many argue it is not possible to accurately predict what will happen so many years into the future. The EPA attempts to predict, in 2022 and beyond, what kind of land-use change patterns would occur if more biofuel feedstocks were produced in the U.S. This kind of prediction is based on innumerable factors, not all of which can be considered or even known at this time. Therefore, the numbers must be based on educated assumptions and guesses.

This is one reason that the EPA's numbers for GHG reduction from soy biodiesel use changed so much from the proposed rule released in May 2009, to the final rule released in February 2010. According to the EPA, "our lifecycle results were particularly impacted by assumptions about land use patterns and emissions in Brazil. During the public comment process we were able to update and refine these assumptions, including the incorporation of new, improved sources of data based on Brazil-specific data and programs" (p. 305, Renewable Fuel Standards Program Regulatory Impact Analysis.)

Because consequential life cycle analysis is based on assumptions about what might happen, changing these assumptions can dramatically change the results.

For More Information

EPA Renewable Fuel Standards --epa.gov/otaq/ fuels/renewablefuels/index

EPA's Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis -- epa.gov/sites/production/files/2015-08/documents/420r07004.pdf

Introduction to Life Cycle Analysis -- articles.extension.org/pages/26621/introduction-to-life-cycle-analysis-lca