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Conventional fossil fuels sometimes 'greener' than biofuels: study

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Graphic: Patrick Gillooly

There's a race afoot to give biofuel wings in the aviation industry, part of an effort to combat soaring fuel prices and cut greenhouse gas emissions. In 2008, Virgin Atlantic became the first commercial airline to fly a plane on a blend of biofuel and petroleum. Since then, Air New Zealand, Qatar Airways and Continental Airlines, among others, have flown biofuel test flights, and Lufthansa is racing to be the first carrier to run daily flights on a biofuel blend.

However, researchers at MIT say the industry may want to cool its jets and make sure it has examined biofuels' complete carbon footprint before making an all-out push. They say that when a biofuel's origins are factored in — for example, taking into account whether the fuel is made from palm oil grown in a clear-cut rainforest — conventional fossil fuels may sometimes be the "greener" choice.

"What we found was that technologies that look very promising could also result in high emissions, if done improperly," says James Hileman, principal research engineer in the Department of Aeronautics and Astronautics, who has published the results of a study conducted with MIT graduate students Russell Stratton and Hsin Min Wong in the online version of the journal *Environmental Science and Technology*. "You can't simply say a biofuel is good or bad — it depends on how it's produced and processed, and that's part of the debate that hasn't been brought forward."

Hileman and his team performed a life-cycle analysis of 14 fuel sources, including conventional petroleum-based jet fuel and "drop-in" biofuels: alternatives that can directly replace conventional fuels with little or no change to existing infrastructure or vehicles. In a previous report for the Federal Aviation Administration's Partnership for Air Transportation Noise and Emissions Reduction, they calculated the emissions throughout the life cycle of a biofuel, "from well to wake" — from acquiring the biomass to transporting it to converting it to fuel, as well as its combustion.

"All those processes require energy," Hileman says, "and that ends up in the release of carbon dioxide."

In the current Environmental Science and Technology paper, Hileman considered the entire biofuel life cycle of diesel engine fuel compared with jet fuel, and found that changing key parameters can dramatically change the total greenhouse gas emissions from a given biofuel.

Land-locked

In particular, the team found that emissions varied widely depending on the type of land used to grow biofuel components such as soy, palm and rapeseed. For example, Hileman and his team calculated that biofuels derived from palm oil emitted 55 times more carbon dioxide if the palm oil came from a plantation located in a converted rainforest rather than a previously cleared area. Depending on the type of land used, biofuels could ultimately emit 10 times more carbon dioxide than conventional fuel.

"Severe cases of land-use change could make coal-to-liquid fuels look green," says Hileman, noting that by conventional standards, "coal-to-liquid is not a green option."

Hileman says the airline industry needs to account for such scenarios when thinking about how to scale up biofuel production. The problem, he says, is not so much the technology to convert biofuels: Companies like Choren and Rentech have successfully built small-scale biofuel production facilities and are looking to expand in the near future. Rather, Hileman says the challenge is in allocating large swaths of land to cultivate enough biomass, in a sustainable fashion, to feed the growing demand for biofuels.

He says one solution to the land-use problem may be to explore crops like algae and salicornia that don't require deforestation or fertile soil to grow. Scientists are exploring these as a fuel source, particularly since they also do not require fresh water.

Feeding the tank

Total emissions from biofuel production may also be mitigated by a biofuel's byproducts. For example, the process of converting jatropha to biofuel also yields solid biomass: For every kilogram of jatropha oil produced, 0.8 kilograms of meal, 1.1 kilograms of shells and 1.7 kilograms of husks are created. These co-products could be used to produce electricity, for animal feed or as fertilizer. Hileman says that this is a great example of how co-products can have a large impact on the carbon dioxide emissions of a fuel.

Hileman says his analysis is one lens through which policymakers can view biofuel production. In making decisions on how to build infrastructure and resources to support a larger biofuel economy, he says researchers also need to look at the biofuel life cycle in terms of cost and yield.

"We need to have fuels that can be made at an economical price, and at large quantity," Hileman says. "Greenhouse gases [are] just part of the equation, and there's a lot of interesting work going on in this field."

The study is the culmination of four years of research by Hileman, Stratton and Wong. The work was funded by the Federal Aviation Administration and Air Force Research Labs.

Provided by MIT

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