Transportation fuels from woody biomass promising way to reduce emissions

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A special issue of Forest Products Journal considers 15 processes where woody biomass was turned into liquid fuel, burned directly to create heat, steam or electricity, or processed into pellets for burning. Credit: Food Products Journal

(Phys.org) —Two processes that turn woody biomass into transportation fuels have the potential to exceed current Environmental Protection Agency requirements for renewable fuels, according to research published in the *Forest Products Journal* and currently featured on its publications page.

The Environmental Protection Agency's standard for emissions from wood based

transportation fuels requires a 60 percent reduction in greenhouse gas emissions compared

to using fossil fuels. The standards don't just concern greenhouse gases generated when biofuel is burned to run vehicles or provide energy: What's required is life-cycle analysis, a tally of emissions all along the growing, collecting, producing and shipping chain.

The special Forest Products Journal issue does just that for energy produced in various ways from woody biomass. For instance, two processes for making ethanol reviewed in the issue – one a gasification process using trees thinned from forests and the other a fermentation process using plantation-grown willows – reduces greenhouse gas emissions by 70 percent or better compared with gasoline. In contrast, producing and using corn ethanol reduces greenhouse gas emissions 24 percent compared to gasoline, according Argonne National Laboratory research published in 2011.

For the publication, researchers from the 17 research institutions that make up the Consortium for Research on Renewable Industrial Materials determined the life-cycle emissions of 15 processes where woody biomass was turned into liquid fuel, burned directly to create heat, steam or electricity, or processed into pellets for burning.

The common advantage of these processes over fossil fuels is that trees growing in replanted forests reabsorb the carbon dioxide emitted when woody biomass burns as fuel in cars or other uses, said Elaine Oneil, a University of Washington research scientist in ecological and forest sciences and director of the consortium. While fossil fuels cause a one-way flow of carbon dioxide to the atmosphere when they burn, forests that are harvested for wood products or fuels and regrown represent a two-way flow, into and back out of the atmosphere.

The processes reviewed have the added advantage of using woody debris not only as a component of fuels but to produce energy needed for manufacturing the biofuel. The fermentation process to produce ethanol, for example, ends up with leftover organic matter that can be burned to produce electricity. Only one-third of the electricity generated by the leftovers is needed to make the ethanol, so two-thirds can go to the power grid for other uses, offsetting the need to burn fossil fuels to produce electricity.

This is among the reasons that ethanol from plantation-grown feedstock using the fermentation process approaches being carbon neutral, that is, during its life cycle as much carbon is removed as is added to the atmosphere, according to Rick Gustafson, UW professor of environmental and forest sciences and a co-author in the special issue.

The researchers looking at the fermentation process also took into account such things as water consumption. They found that the process – which among other things needs water to support the enzymes – uses about 70 percent more water per unit of energy produced than gasoline. A biofuel industry using woody material will be a lot less water intense than today's pulp and paper industry – still, water use should be taken into account when moving from pilot biofuel production to full-scale commercialization, Gustafson said.

"The value of life-cycle analysis is that it gives you information such as the amount of energy you get in relation to how much you put in, how emissions are affected and the impacts to resources such as land and water," Oneil said.

In the U.S. last year, some 15 facilities produced about 20,000 gallons of fuels using cellulosic biomass such as wood waste and sugarcane bagasse, according to a U.S. Energy Information Administration website. The administration estimates this output could grow to more than 5 million gallons in 2013, as operations ramp up at several plants.

In the special issue, the biofuels analyzed came only from forest residues, forest thinnings, wood bits left after manufacturing such things as hardwood flooring or fast-growing plantation trees like willow. That's because, from a greenhouse emissions perspective, it makes no sense to produce biofuels using trees that can be made into long-lived building materials and furniture, said Bruce Lippke, UW professor emeritus of environmental and forest sciences, who oversaw the contents of the special issue.

"Substituting wood for non-wood building materials such as steel and concrete, can displace far more carbon emissions than using such wood for biofuels," Lippke said. "It's another example of how life-cycle analysis helps us judge how to use resources wisely."

The modeling and simulations used for life-cycle analysis in the special *Forest Products Journal* issue can be used to evaluate other woody materials and biofuel processes in use now or in the future, with the models being refined as more data is collected. The data also will be submitted to the U.S. Life Cycle Inventory Database of the U.S. Department of Energy's National Renewable Energy Laboratory, which has data available for everyone to use on hundreds of products.

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