Co-Product Implications on the Environmental Preference of Bio-jet Fuel

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Introduction

Several co-product and intermediate products can result from the IPK bio-refinery system, having important economic implications on the viability of the bio-refinery. These co-products also have important environmental implications, which affect the market preference for these products as well as the market preference for the IPK fuel.

The market preference for biofuels relies largely on the Renewable Fuels Standard which requires that almost 35 billion gallons per year of cellulosic-based fuel (which must reduce life cycle CO_2e emissions by 60% from the baseline (2005) fossil jet fuel) be purchased by 2022. Although bio-jet fuel is not required under the RFS, it does qualify for RIN credits, which offsets the costs of bio-refining. The market preference for bio-jet fuel has been consistently demonstrated through the numerous public commitments from aviation organizations to purchase renewable jet fuels with lower environmental impacts. Regarding the market preference for bio-refinery co-products, the USDA BioPreferred Program designates products containing biobased content as federally preferred for procurement, which is signaled through the USDA Certified Biobased Product label.

The goal of this research is to characterize the environmental performance of the co-products (i.e. the comparative global warming potential impacts of the bio-based products compared to the conventional products) and the resulting effect on the environmental preference of the IPK fuel. Different scenarios of produced co-products and their applications are presented, showing the results for the production scenarios where the FRS lignin is used to produce activated carbon and where a portion of the isobutanol (IBA) intermediate product is diverted to produce paraxylene for use in bio-plastics (PET) production.

Scenarios of Analysis

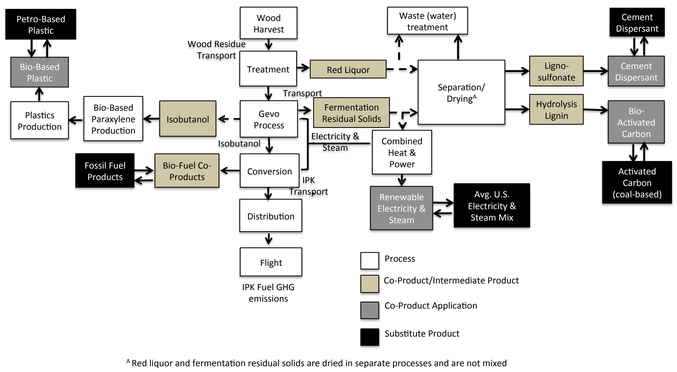
TABLE 1 – Scenarios of possible IPK bio-refinery co-product production portfolios.

Scenario Number*	Scenario Description			
Baseline	100% FRS lignin to CHP (100% Red liquor to waste treatment; 100% IBA to Fuels)			
Scenario 1	100% FRS lignin to Powdered Activated Carbon (100% Red liquor to waste treatment; 100% IBA to Fuels)			
	Sub-Scenarios	Natural Gas Substitute in CHP	Biogas Substitute in CHP	Biomass (solid) substitute in CHP
	Spray drying FRS lignin (Natural Gas)	A	B	C
	Spray drying FRS lignin (Biogas)		D	E
Scenario 2	50% FRS lignin to CHP, 50% FRS lignin to Powdered Activated Carbon (100% Red liquor to waste treatment; 100% IBA to Fuels)			
	Sub-Scenarios	Natural Gas Substitute CHP	Biogas Substitute in CHP	Biomass (solid) Substitute in CHP
	Natural Gas in spray drying FRS lignin	A	B	C
	Biogas in spray drying FRS lignin		D	E
Scenario 3	16% IBA diverted to Paraxylene (PX), 84% IBA to Fuels (100% Red liquor to Cement Dispersant, 100% of FRS lignin to CHP)			
Scenario 4**	100% Red liquor to Cement Dispersant (100% FRS lignin to CHP; 100% IBA to Fuels)			

* All scenario's include the generation of an electricity credit.

**Next step in the scenario analysis, data still required.

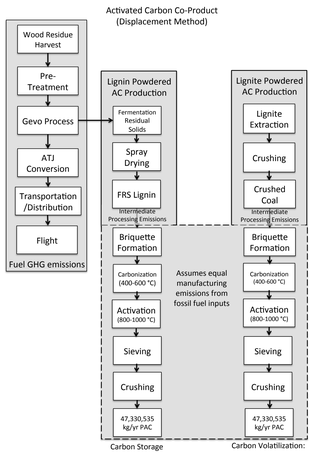
IPK Bio-refinery Co-Product/Intermediate Products and their Applications



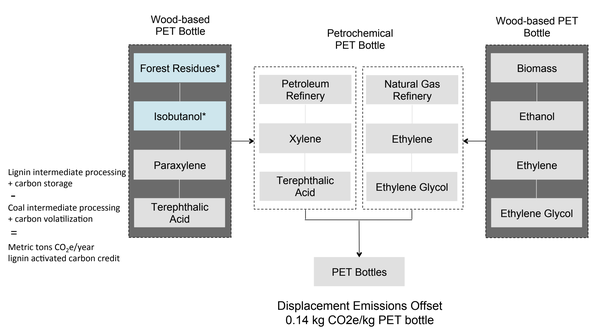
[A] Red liquor and fermentation residual solids are dried in separate processes and are not mixed

Analysis

Scenario 1 & 2: FRS Lignin to Powdered Activated Carbon



Scenario 3: 16% IBA Diverted to Paraxylene, 84% Diverted to Fuel*

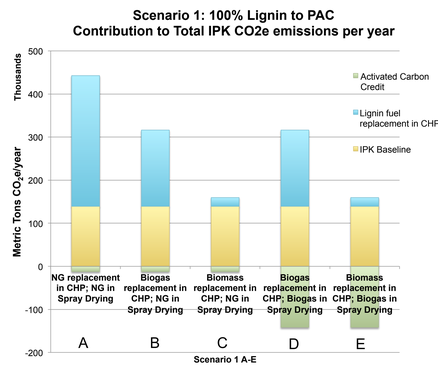


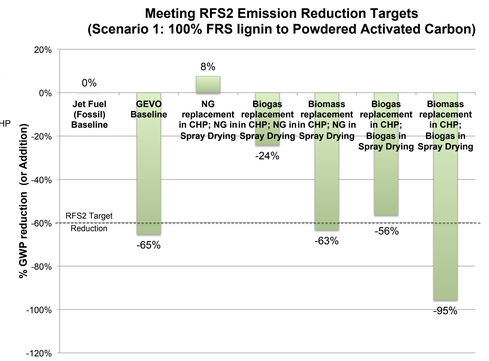
Displacement Emissions Offset
0.14 kg CO2e/kg PET bottle

* Due to the nature of the data, further analysis will be required to determine the environmental effect of diverting 16% IBA to Paraxylene production on the IPK jet fuel .

Results

Scenario 1: 100% FRS Lignin to Powdered Activated Carbon





Scenario 2: 50% FRS Lignin to Powdered Activated Carbon, 50% to CHP

Conclusions

The production portfolios in bio-refineries are rarely static, but instead change in response to changing market conditions. The results demonstrate the possible effects that changes in the bio-refinery co-product portfolios have on the environmental performance of the IPK fuel. Diverting either 100% of the FRS lignin to produce powdered activated carbon or just 50% can result in comparable or greater emission reduction than the baseline scenario, where the FRS lignin is used only for energy generation, if particular design specification are taken into consideration. When natural gas or biogas is used as the substitute fuel source in the CHP, the jet fuel will not qualify for RIN credits because it does not meet the reduction targets. The results for scenario 1 and 2 show that the only sub-scenario that meets the RFS emission reduction target of at least 60% is when woody biomass substitutes for the FRS lignin BTUs in the CHP generator. Further benefits are accrued when the spray dryer to dry the FRS lignin is run on biogas instead of natural gas. An economic assessment of these scenarios is still required to determine whether producing these co-product applications is profitable for the bio-refinery and to determine whether they can be sold at competitive market prices.

NARA
Northwest Advanced Renewables Alliance

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