Introduction

To provide a detailed environmental and economical profile of biorefinery systems co-producing jet-fuel (IPK, short for iso-paraffinic kerosene) and bio-chemicals, a first step has been taken to establish a separate life cycle assessment model of one promising co-product – bio-polyethylene terephthalate (bio-PET) bottles. A portion of isobutanol was deviated from the primary product system to produce paraxylene and then processed to purified terephthalic acid (PTA), one of the two precursors for PET. The other precursor, corn based ethylene glycol (EG), has been commercialized for a while. The goal of this study was to calculate and model environmental impacts of co-producing PET bottle and IPK system.

Objective

- Calculate the life cycle GHG emissions of PET bottles produced through the traditional petrochemical pathway (crude oil refinery) and under a biorefinery system.
- Figure out the allocation method for primary products and co-products
- Compare GHG emissions of PET bottles under different production scenarios

Methods

- Attributional Life Cycle Assessment (LCA)
  - Conduct a “cradle to factory gate” LCA, including processes from raw material extraction, components production to product manufacturing
  - Baseline scenario and scenarios 2-3 were retrieved from GaBi 6. Scenario 1 was modeled from literature.
  - Allocation of environmental impacts specified by the EPA
  - Allocate environmental impacts on mass basis for fuel co-products
  - Avoid impacts for forest biomass handling are accounted for.
- Replace fossil fuel with bio-energy/generated by boiler within the biorefinery system

Analysis

- Baseline: PTA (crude oil) & EG (crude oil)
- Scenario 1: PTA (wood) & EG (crude oil)
- Scenario 2: PTA (wood) & EG (corn grain)
- Scenario 3: PTA (crude oil) & EG (wheat)

Conclusions

Replacing traditional PET bottles with woody-biomass based bio-PET bottle creates a 3% carbon credit. It also has lower GHG emissions comparing to wheat based PET bottles. However, looking at a single precursor only, generating purified terephthalic acid (PTA) from woody biomass results in a 3% emission debt comparing to petrochemical PTA processing (Scenario 1 and Scenario 3). The process of injection blow molding (forming PET bottles from bottle grade PET sheets) are most responsible for impacts. Future work will focus on modifying the model and evaluate economical profile of co-producing PET bottle and IPK.