Life Cycle Assessment (LCA) of Biofuels and/or Construction Products for Sustainable Carbon Mitigation from Forestland

Maureen Puettmann and Bruce Lippke with the support of the bioprocessing and feedstock collection collaborators
CORRIM Biofuels Research

- Pyrolysis
- Gasification
- Bioconversion
Research Objective: Integration

- Compare LCA’s for the integrated production of biofuels and construction products (they derive from the same land, co-products).

- Biofuels data based on biofuel processing models and feedstock collection models along with CORRIMs LCI/LCA database for construction products and their substitutes.
Global Warming Potential (GWP)

Biochem Ethanol vs gasoline

The graph compares the Global Warming Potential (GWP) of Biochem Ethanol versus gasoline. The y-axis represents GWP in kg CO2e per MJ fuel, ranging from -0.4 to 0.4. The x-axis categorizes emissions into various processes:

- Refinery infrastructure
- Transport to refinery
- Disposal of solid wastes
- Avoided production
- Others production
- Fuel distribution and use
- Conversion process
- Feedstock production and harvesting/mining
- CO2 absorption
- Net emissions

The net emissions for Ethanol are significantly lower compared to Gasoline, indicating a lower impact on global warming.
Each biofuel displaces fossil emissions
Biochem is better than carbon neutral (surplus energy to processing need)
(1) Meet the EPA LCA threshold of 60% emission reduction
t(2) Compare displacement efficiency (C:C or CO2: CO2)
LCA impacts integrated back to forest land (from cradle to grave)

- Track each process LCI starting from forest through collection, processing and fuel use
Carbon Pools from Sustainable Forest Management

Sustainable contribution to Carbon Mitigation (no short lived pools)
Biofuel Potential + 4tC/h/yr
5 times Forest C.
Product C. > Forest C.
Carbon Emission Reduction
by Displacing Non-wood Products & Fuels
(kgCO2/kg dry wood used)

ENERGY:
- Wood Residues vs Coal
- Wood Residues vs Natural Gas

WALL STUDS:
- BiDryStud vs Steel Stud

FLOOR JOIST:
- EWP I-joist vs Steel I-joist

COVERED FLOOR:
- EWP Joist+Ply vs Concrete Slab

CLADDED WALL:
- Biodry stud+Ply vs Concrete+Stucco

KgCO2 reduced per kg wood fiber used

Meta Substitution Ave:
C:C 2.1
CO2:bdt 3.8CO2/bdt
Sustainable Carbon Mitigation & Increasing Energy Independence

- The low ethanol carbon displacement efficiency (C:C = .37) is substantially offset by much higher growth (2:1)

- A consumer factoid:
  1 auto yr = 4tCO2  (12000 miles @24mpg = 500gal)

- BioChem @ 2.8tC/h/y = 10tCO2 eq = 2.5 auto yrs
Sustainable Carbon Mitigation & Increasing Energy Independence

- Residual recovery is very site specific
- 40% recovery = 0.4 tC/h/yr or 1.4 tCO2/h/yr

- Residuals from 3 hectares yrs displaces 1 auto yr
- 160 million hectares (private) = 53 million auto yrs

- Biofuel: Currently unused fiber can contribute to both carbon mitigation and energy independence if the price is right.

- The low cost of fossil fuel is the barrier not low carbon efficiency
Biomass Substitutions
INW Softwood Lumber Production

- **Base case**
  - 54% heat energy from biomass generated on site
  - 46% heat energy from natural gas
  - Electricity consumed was 60 kwh/m³ of lumber

![Graph showing GWP for BASE CASE boilers per m³]

- GWP kg CO₂ eq.
- Wood, softwood, INW, generated at lumber mill, combusted in industrial boiler
- Natural gas, combusted in industrial boiler/US
Substitution at the mill (Inland NW)

Biofuel Substitution Impacts on GWP

Product Carbon Stores (offsets) 845 KgCO2

Kg CO2 eq

Base Case 100% Nat Gas Displace Nat Gas Displace Electricity

(54 mill bio: 46 NG) (no bio resid) (54 Mill bio: 46 F. bio) (54 mill, 46 NG, 46 Cogen)
Better to use residuals (?)

1. In our mills, or
2. Co-gen electricity, or
3. Use natural gas in mills and residuals for big utilities

Highest carbon efficiency in our mills
Lowest by diverting residuals to utilities

Renewable energy mandates (standards) are counterproductive

The low cost of fossil fuel is the barrier not low carbon efficiency
Financial Support from USFS-FPL, several donors, seven institutions and 20+ authors

DOE is funding extensions to many more alternatives with regional stratification

www.corrim.org