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Biochar: Production, Characterization and Applications

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Life cycle assessment of biochar production from southern pine

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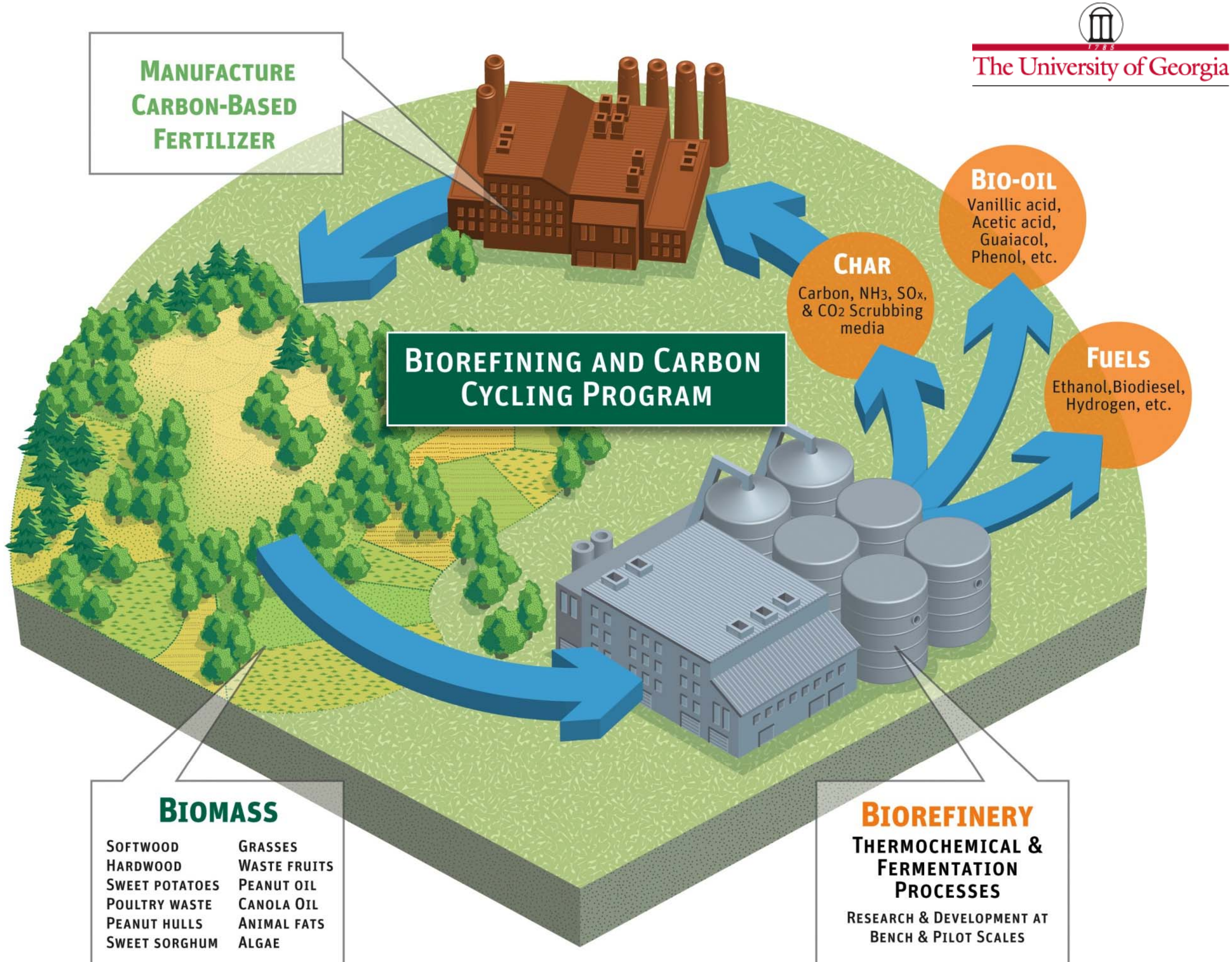


http://www.biorefinery.uga.edu/

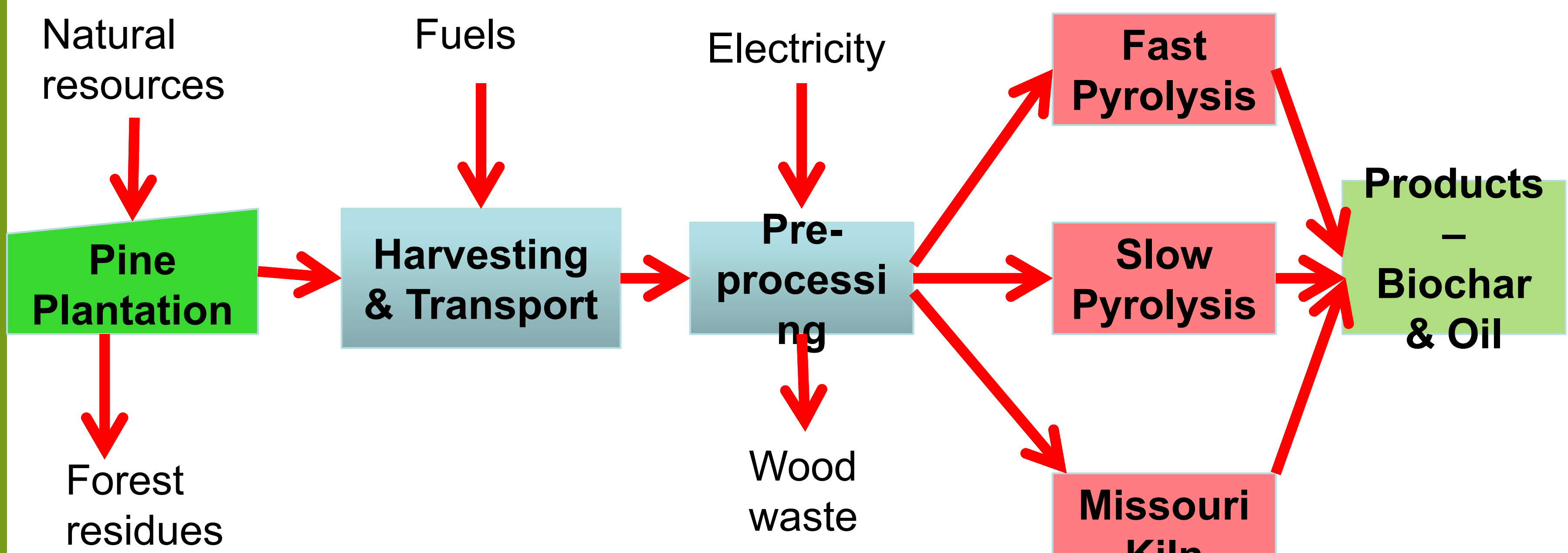
Historical Development - Biochar

- Charcoal is considered as a first synthetic material produced by human 38,000 yrs ago (Brad, 2001)
- Late 1800s– Black earth in Amazon
- 1950s – Biochar for seedling growth medium
- 1950s – 1970s – Charcoal production for energy
- 1980s – Japan biochar research for soil application
- 1990s – Biochar as potting mix
- 2000s – Intensive Biochar R & D; Rediscovery of Amazonian Black soil (*Terra Preta de Indio*) – 2500 yrs ago. Soil contains 150g of C/kg of soil compared to 20-30 g of C/kg of soil.

Life Cycle Analysis Approach

- Cradle to Gate approach to assess the environmental impacts of biochar with co-product allocations (mass)
- Functional unit – per tonne of biochar produced
- Feedstock – Southern Pine in US (average of 25 year harvest cycle)
- Clean chips are produced from regular pulp wood logs and barks are used as a heat source for drying
- Soil Carbon Sequestration is not considered
- Computing platform: SimaPro 7.4(US LCI database)
- Impact assessment – TRACI & BEES

Production Pathways

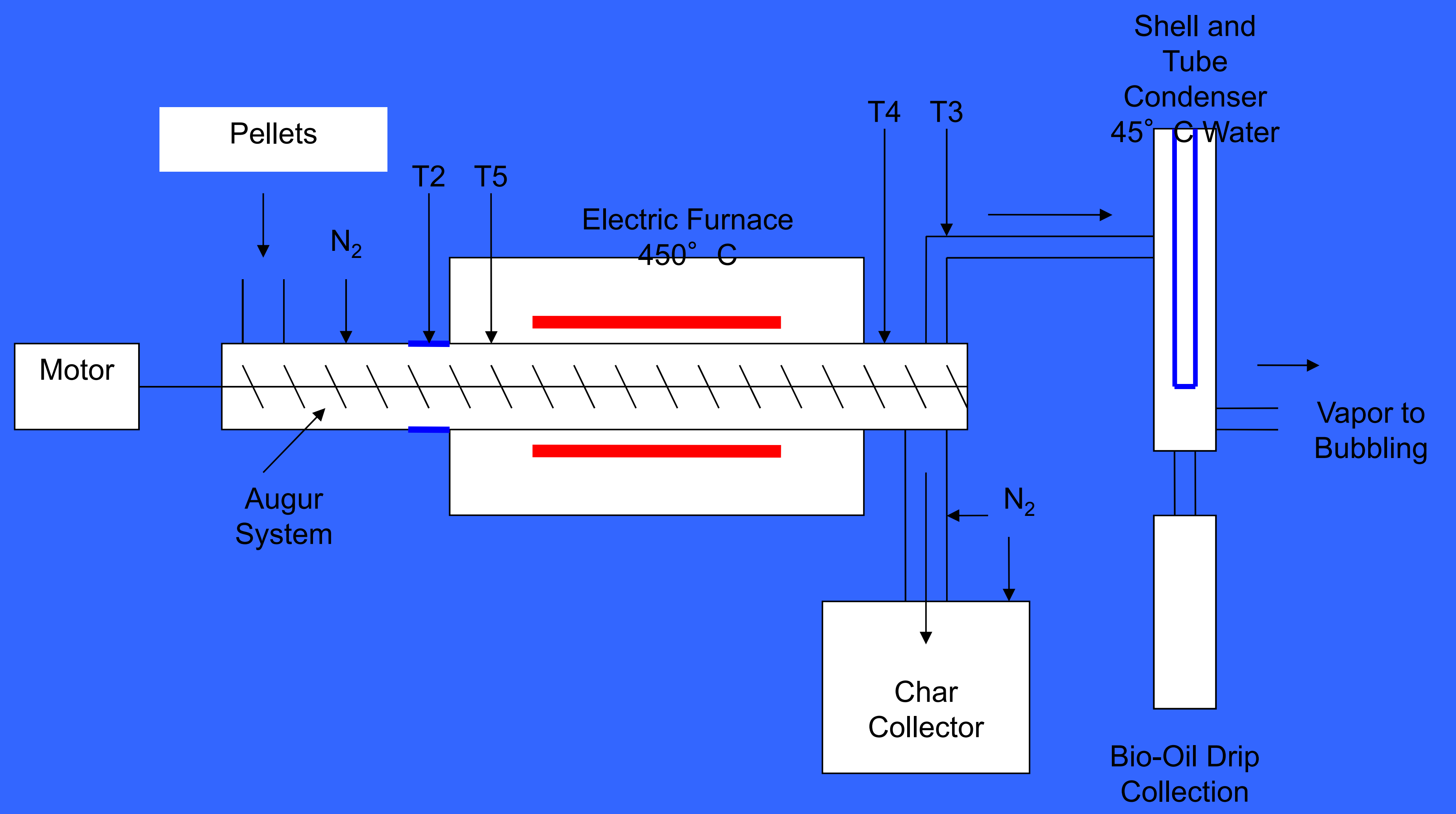


Biochar Production & Technologies

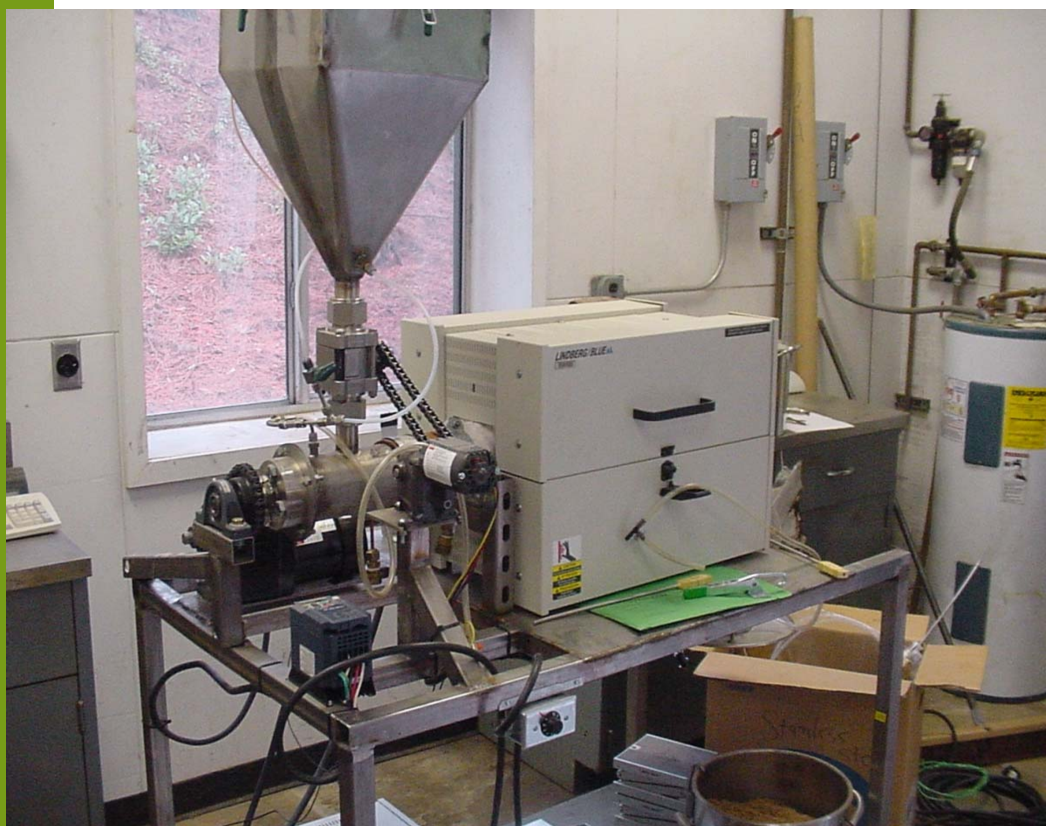
- World Production – 41 million t
- South Africa - 50% of the production
- Char yield
  - Traditional kilns = 10-20%
  - Missouri kiln = 20-30%
  - Linann Kiln = ~ 30% (China, Brazil)
  - High pressure kilns = ~45% (U of Hawaii)
- Pyrolysis Technologies with co-production
  - Slow pyrolysis – 30% (char) & 35% (bio-oil)
  - Fast pyrolysis – 15% (char) & 50-60% (bio-oil)

Source: Hillring (2006); Hollingdale (1999)

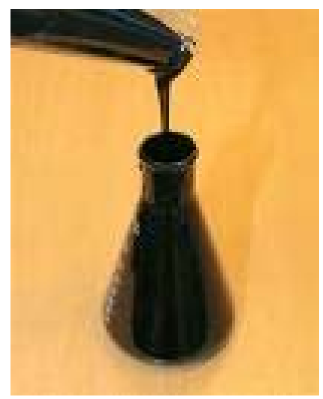
UGA's Continuous Pyrolysis Unit



Slow Pyrolysis Reactor



Biochar

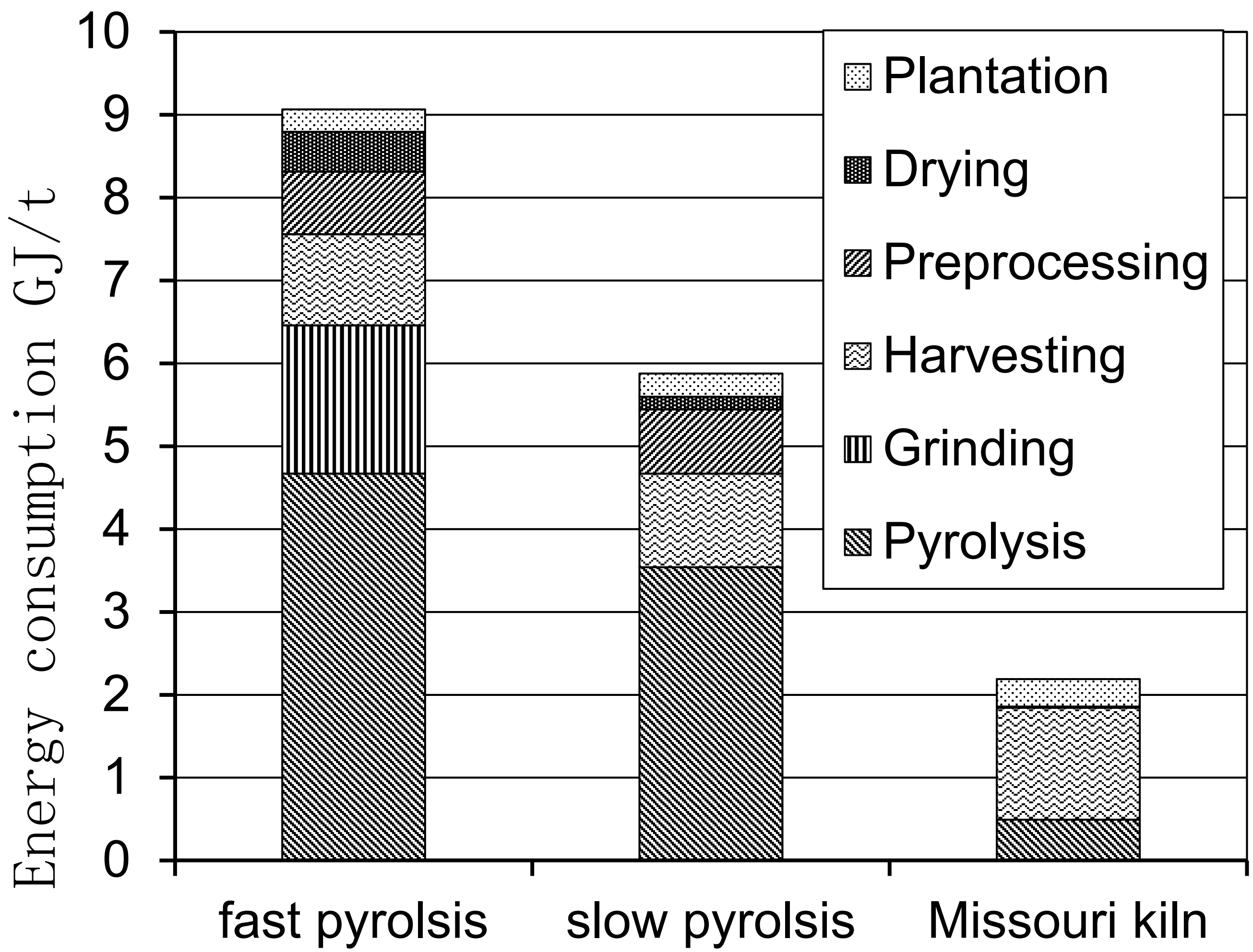


Bio-oil

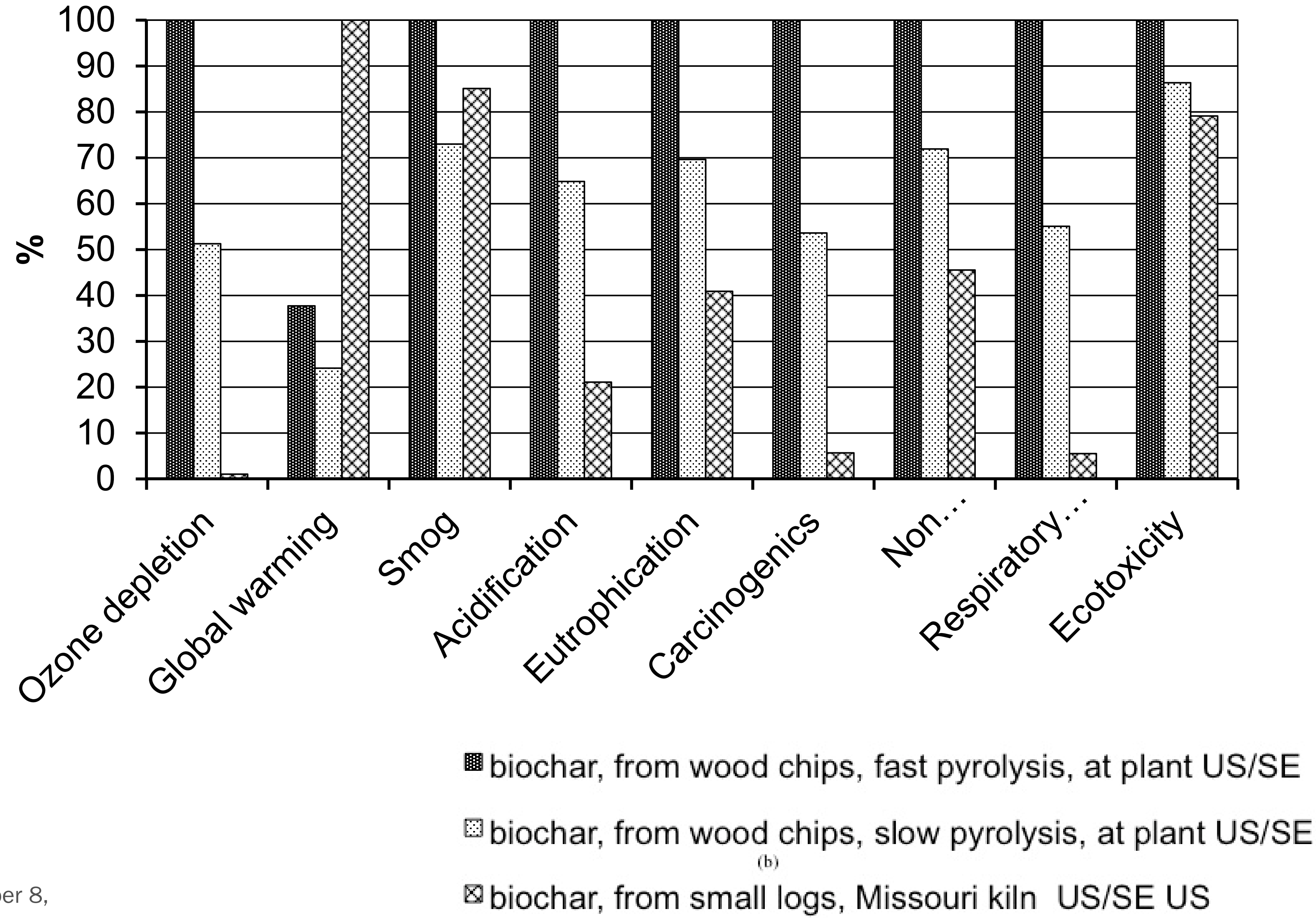
Rotary drum reactor – UGA

(indirect heating)

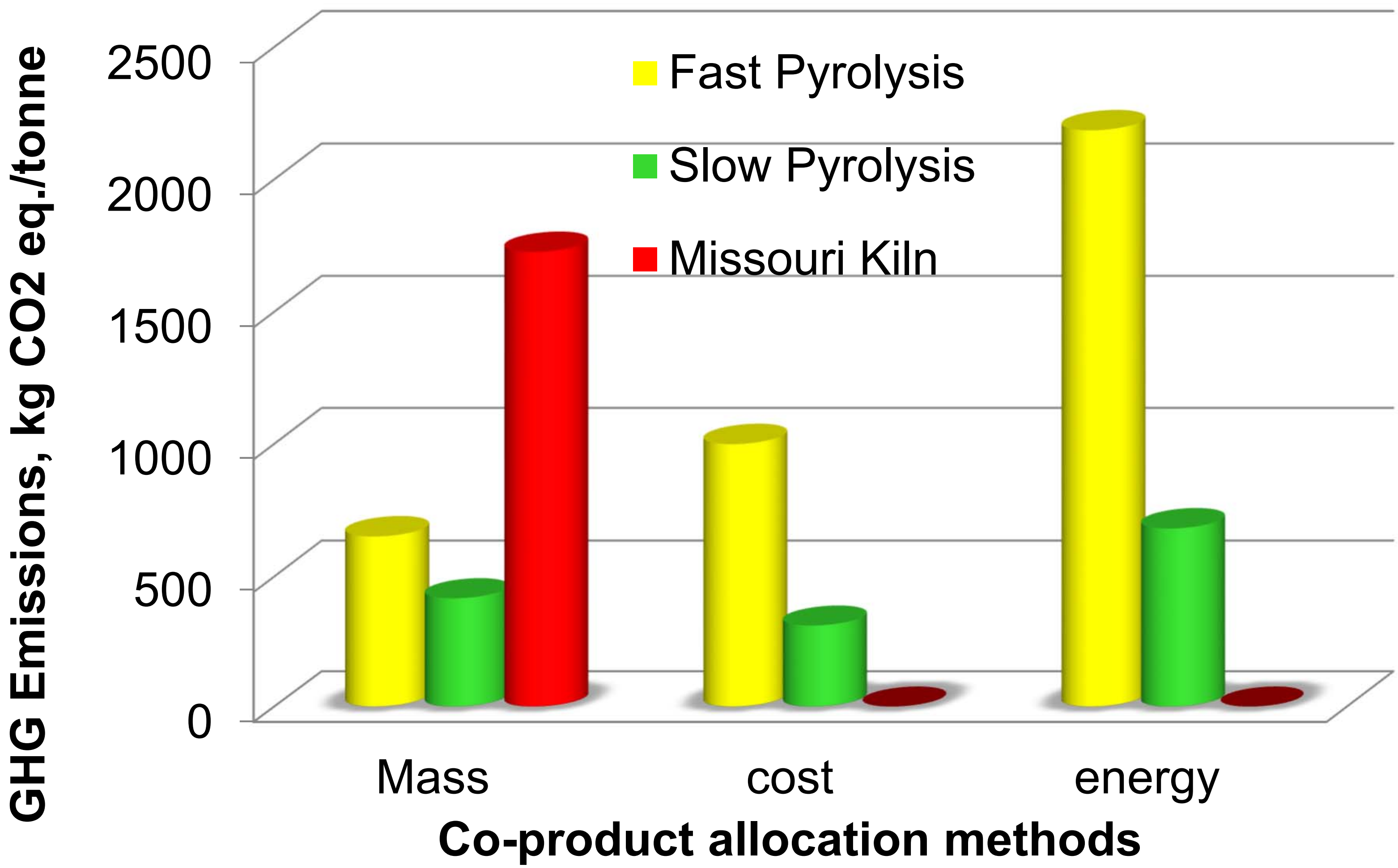
Results: Energy Consumption



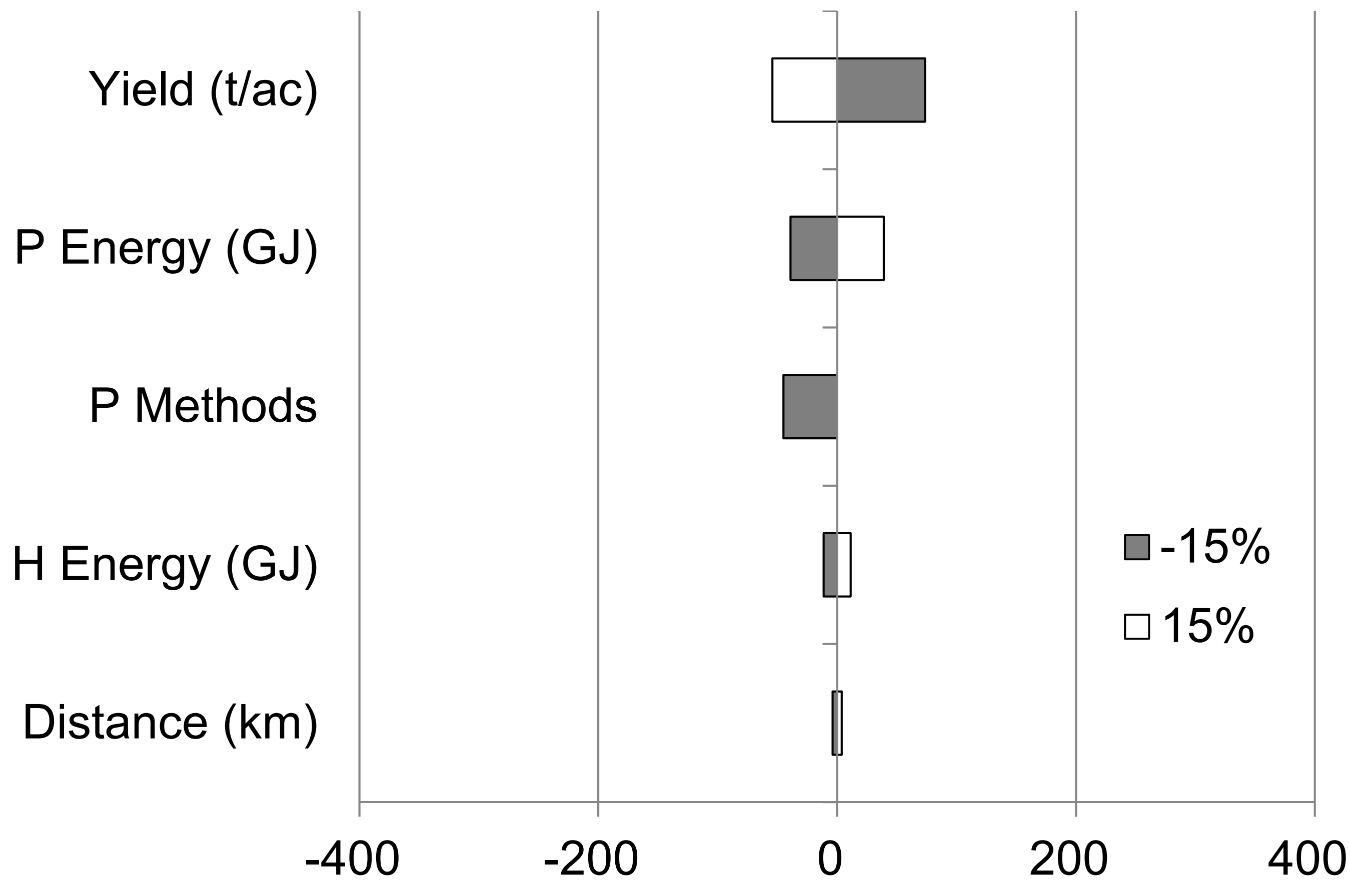
Results: Environmental Impacts



Results: Co-product allocation methods



Sensitivity Analysis of GHG emissions ($kg\ CO_2$ eq./tonne): Slow Pyrolysis



Conclusions

- A cradle to gate assessment of producing biochar via three production of routes were investigated from Southern Pine wood.
- Environmental impacts, specifically GHG emissions were the lowest for slow pyrolysis technology – (417 kg of CO_2 eq./tonne)
- Among different co-product allocation methods (mass, cost and energy use), both cost and mass based allocation methods had lower emissions for the slow pyrolysis technology
- Pine wood yield and pyrolysis and pre-processing energy consumption data were more sensitive to the GHG emissions for the slow pyrolysis technology
- Future research is focused on estimating the GHG emissions savings from biochar use in soil applications (2,600 to 16,000 kg CO_2 eq./tonne of biochar).

Thank you