Using Torrefied Wood for Electricity and Pellet Production in South Carolina

by

North Carolina State University
and Agri-Tech Producers, LLC

Woody Biomass as an Energy Product

- Woody biomass, as an energy source, combustion has some advantages over fossil fuels:
  - Carbon neutral (if taken from continuing forestry operations)
  - Low in sulphur and mercury emissions
- and disadvantages:
  - Requires specialized boiler and handling systems
  - Is prone to glazing of boilers if soil is included in feedstock
  - Not energy dense (expensive to transport)
- Moisture content of fresh woodchips is about 50%
  - 20-50% of delivered cost is in transportation, so
  - 10-25% of delivered cost is in transportation of water

Torrefaction: Adding Value and Reducing Transportation Cost/BTU

- Woody Biomass is:
  - Bulky
  - Moist
  - Fibrous
  - Perishable
  - Waste
  - Expensive to transport
- Torrefied Wood (TW) is:
  - Dense (if pelletized)
  - Dry, water resistant
  - Easily crushed
  - Does not rot
  - Valuable Fuel
  - Energy Dense

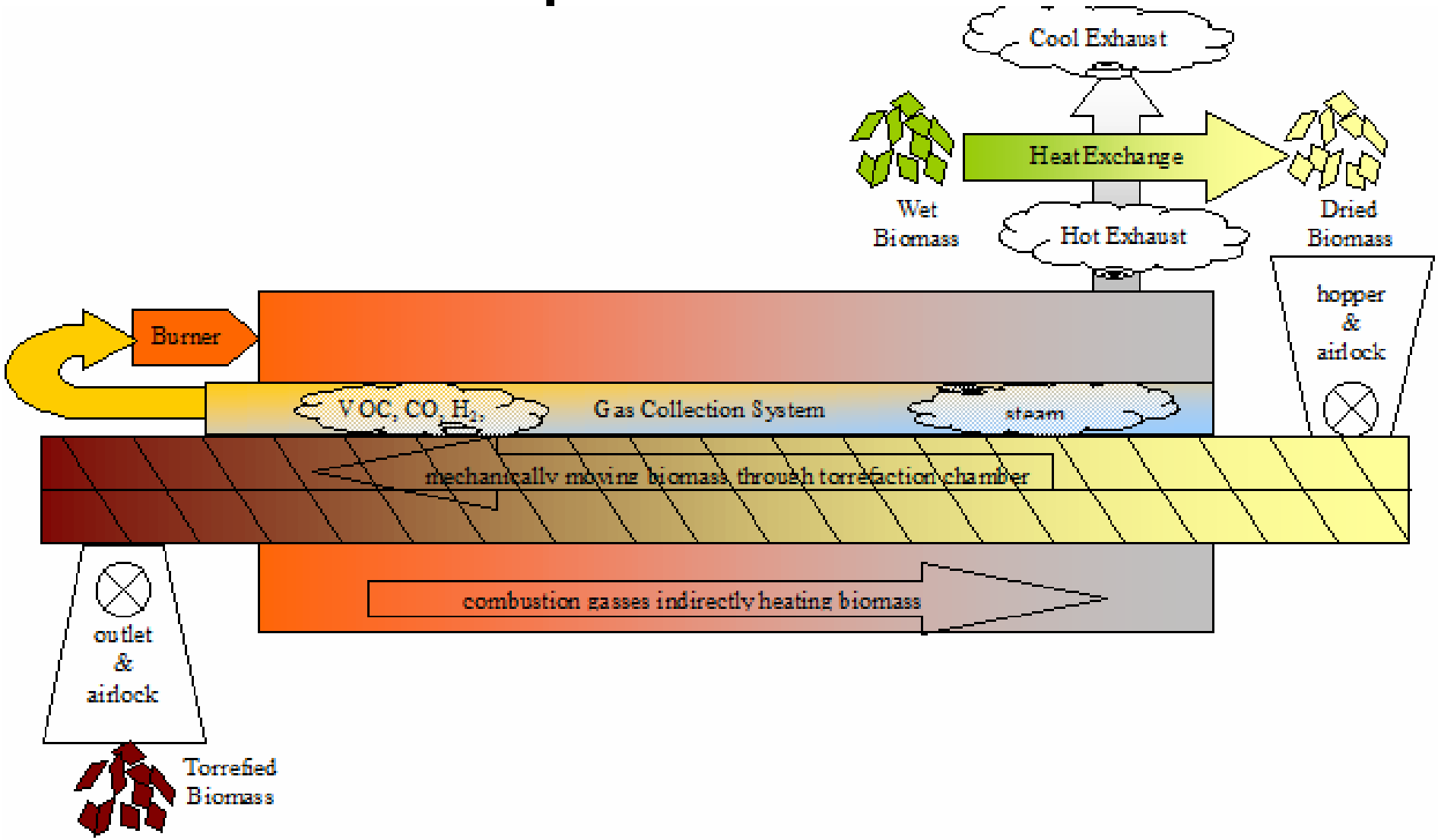
Mineral Content of Torrefied Wood and Coal

- Mineral content of torrefied wood is much lower than that of coal:
  - Ash content of coal:
    - Moderate 10-25%, Low <10%
  - Torrefied wood ash content is 1% to 2%
  - Torrefied wood contains much less ash than coal.
- Low sulfur coal has less than 0.4 lbs. of sulfur per million Btu
- Torrefied wood has about 0.02 lbs. of sulfur per million Btu,
  - about 5% of the sulfur content of low-sulfur coal

Torrefaction Process

- Torrefaction (300-400º C) liberates water, volatile organic compounds (VOC), and hemicellulose (HC) from the cellulose and lignin.
- The VOC and HC are combusted to generate process heat.
- TW can easily replace coal in combustion or be a feedstock for further pyrolysis or gasification for combined heat and power or Fischer-Tropsch liquids.
- The warm lignin acts as a binder when the torrefied wood (TW) is pelletized.

Torrefaction Machine Conceptual Schematic



Chemistry of Torrefaction

- When wood is exposed to heat in a low oxygen environment, torrefaction reactions happen between 300-400° C.
- Before these temperatures are reached, the water and volatile organic compounds (VOCs like turpene and pinene) are driven off .

Pulverizing Torrefied Wood

- Torrefied wood can be ground to a particle size similar to that of pulverized coal with the same or less energy use.
- Torrefied wood is a much better fuel for co-firing than untreated wood.
- Unteated wood requires many times the energy use in grinding (by a factor of 7.5 to 15) to achieve a similar particle size.

Pelletization of Torrefied Wood

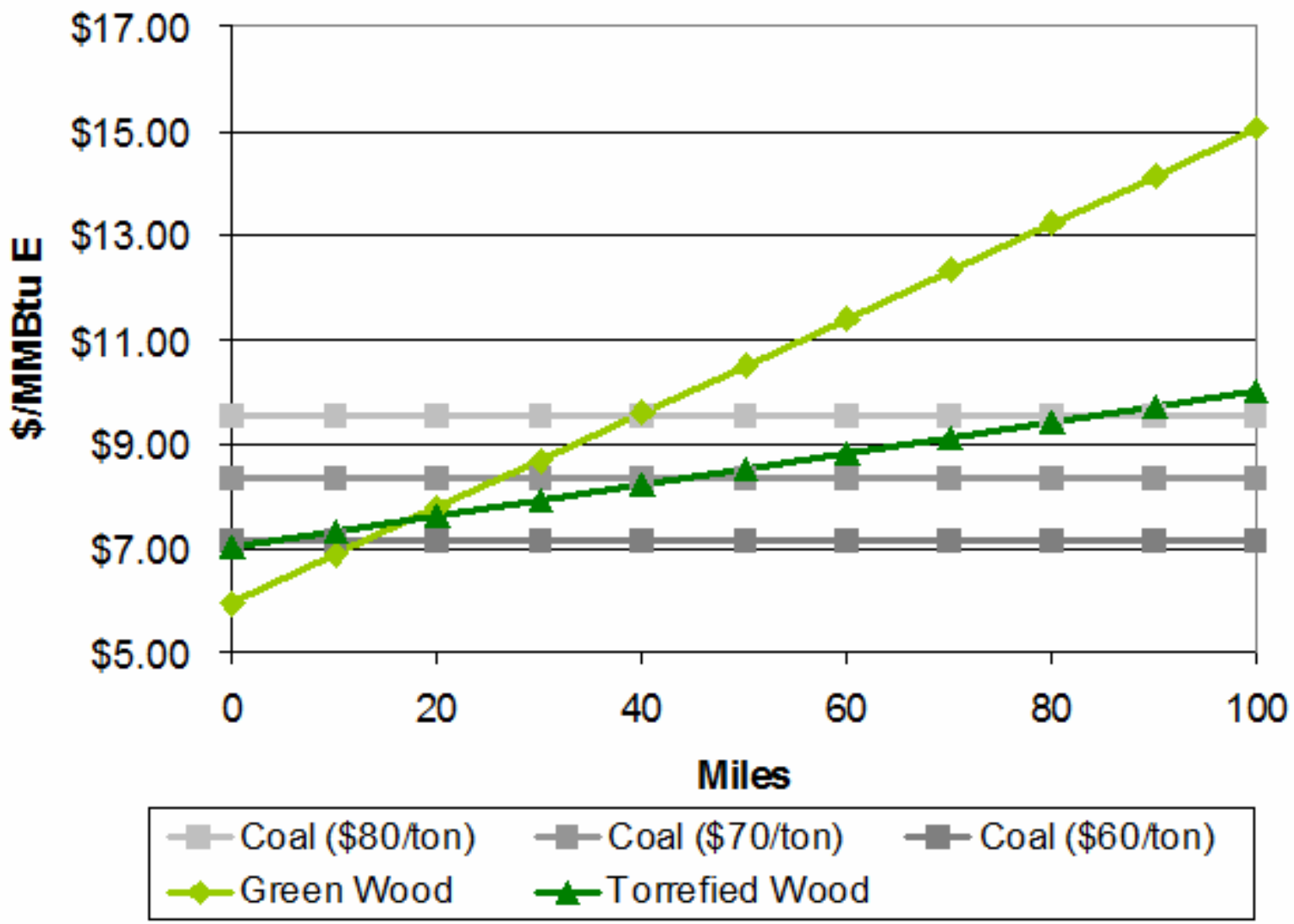
- At torrefaction temperatures, the lignin in wood becomes plastic and can actually become a binder for individual wood particles.
- Pellets made from torrefied wood may withstand 1.5 to 2 times the crushing force of normal wood pellets.
- Torrefied pellets show little water uptake on immersion (7-20% of mass), unlike normal pellets.
- University research in the 1930s and 1940s details methods for pelletizing torrefied wood.

Comparison of Untreated Wood, Torrefied Wood and Coal

Assuming:

- coal is valued at $60-$80 per ton delivered price ,
- that torrefied wood (11,000 BTU/lb.) has a heating value nearly that of coal (12,000 BTU/lb.) and
- that torrefied wood generates electricity with a similar efficiency to coal (35% fuel to electricity)
- Untreated wood has a lower efficiency of conversion (23% fuel to electricity),
- and wood can be processed into chips at a cost of about $15/green ton
- transportation costs for chips and torrefied wood are about $0.23 per ton per mile.

Fuel Cost per MMBtu Electricity by Distance to Plant



Market Opportunity in SC

- Coal power use in South Carolina (EIA, 2005) is about **16 million tons**, or a ~$1 billion market.
- South Carolina currently generates about 6.2 million green tons of logging residue annually, or potentially **1.8 million tons of torrefied wood substitutable for coal** (TPO, 2005).
- We estimate torrefied wood **will be cost competitive** with $80/ton coal (current NYMEX spot price) on an energy basis.
- Benefits of torrefied wood over coal:
  - Low sulfur, mercury
  - Carbon neutral
  - Locally derived, economic development fuel
  - Shorter transportation chain, lower fossil fuel use

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Chris Hopkins

North Carolina State University
919 515-9577

cbhopkin@unity.ncsu.edu

Joe James

Agri-Tech Producers, LLC

803 462-0153

JosephJJames@bellsouth.net