Torrefaction: ATP's Innovative Process Converts Wood Into a Cost-Effective Co-Fire Fuel

Pellet Fuels Institute Annual Conference

July 20, 2010

Torrefaction: A Technology to Densify & Enhance Biomass

- **Untreated biomass may be 50% water, it's bulky and it's not the most efficient or useable fuel or bio-feedstock. Torrefaction:**
  - Drives off most of the water
  - Reduces the bulk
  - Makes a better co-fire fuel to burn with coal
  - Makes superior briquettes and pellets
- **Torrefaction, applied at or near the point of harvest:**
  - Reduces transportation costs of biomass, per BTU
  - Produces a more valuable biomass shipment

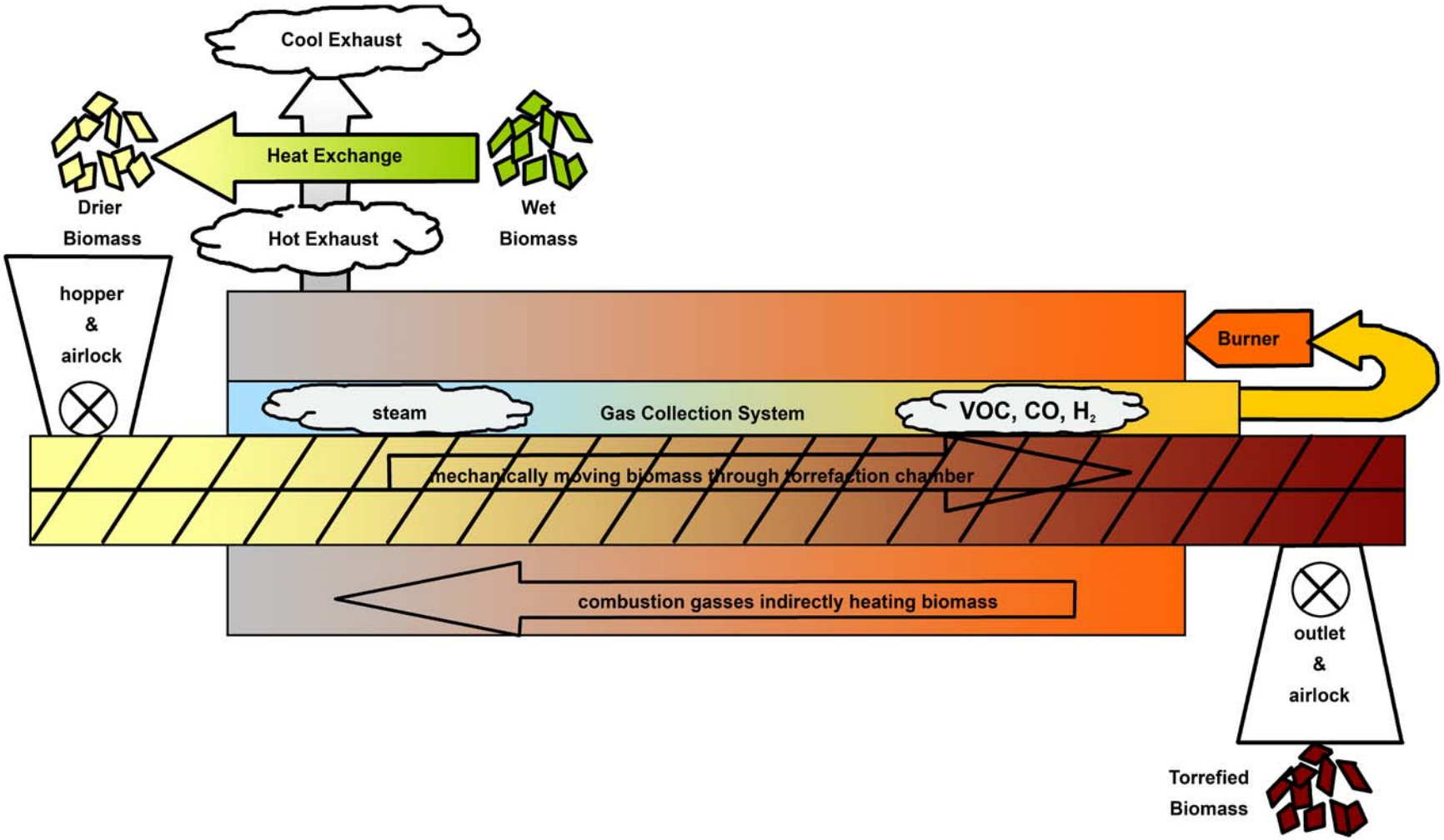
Torrefaction: Adding Value and Reducing Transportation Cost/BTU

- **Untreated Biomass:**
  - Bulky
  - Moist
  - Fibrous
  - Perishable
  - Waste
  - Expensive to transport
- **Torrefied Biomass:**:
  - Dense, If Pelletized, Etc.
  - Dry & Water Resistant
  - Easily Crushed
  - Does Not Rot
  - Valuable Fuel
  - Energy Dense

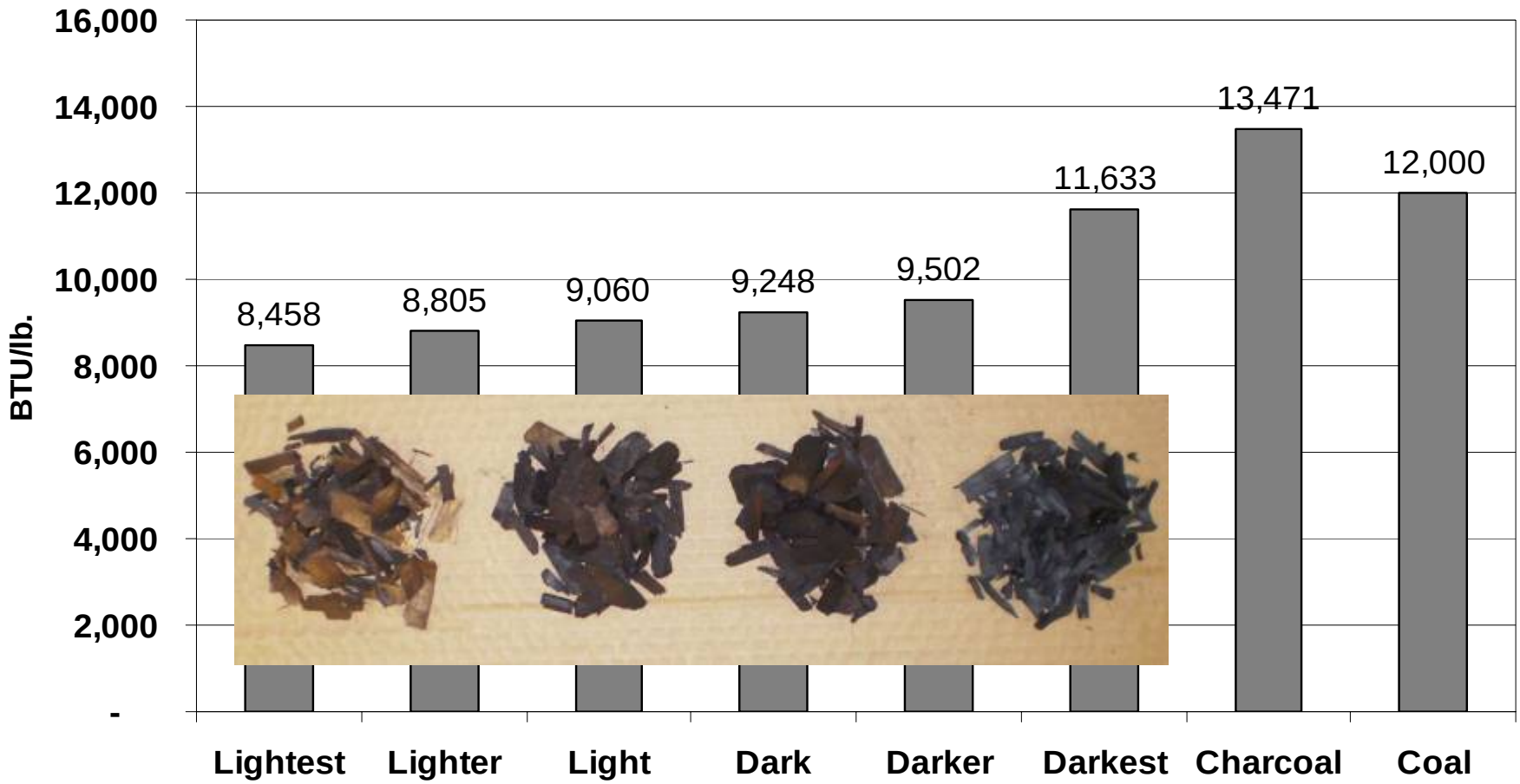
The Process of Torrefaction

- Heating (300-400° C) wood, in a low-oxygen environment, liberates water, volatile organic compounds (VOC's), and hemicellulose (HC) from the cellulose and lignin.
- The VOC's and HC are combusted to generate 80% of the torrefaction process heat.
- The remaining and warm lignin acts as a binder when the torrefied wood is pelletized.
- Torrefied wood can easily replace coal in combustion or be a feedstock for further pyrolysis or gasification for combined heat and power or Fischer-Tropsch liquids.

Schematic of Torrefaction Machine



Higher Heating Value of Torrefied Wood, Charcoal and Coal: Color Approximately Indicates Heating Value



Mass and Energy Balance of Torrefaction

- Published results indicate mass and energy balance of .8 and .9 respectively (for dry wood).
- This is consistent with the loss of the lower energy VOC and hemicellulose and retention of higher energy lignin and cellulose.
- Assuming
  - 50% MC wood,
  - HHV of 8700 Btu/lb for dry wood,
  - 1000 Btu/lb latent heat of water,
  - .4 Btu specific heat for wood and 1 Btu specific heat for water,
  - Starting temperature of 75 F and exit temperatures of 500° F.
- ~800 Btu used in processing, this energy is approximately equal to that of the VOC's and hemicellulose.
- ~3575 Btu left in remaining torrefied product, which weighs ~.33 lbs, for a HHV of 10,800 Btu/lb.

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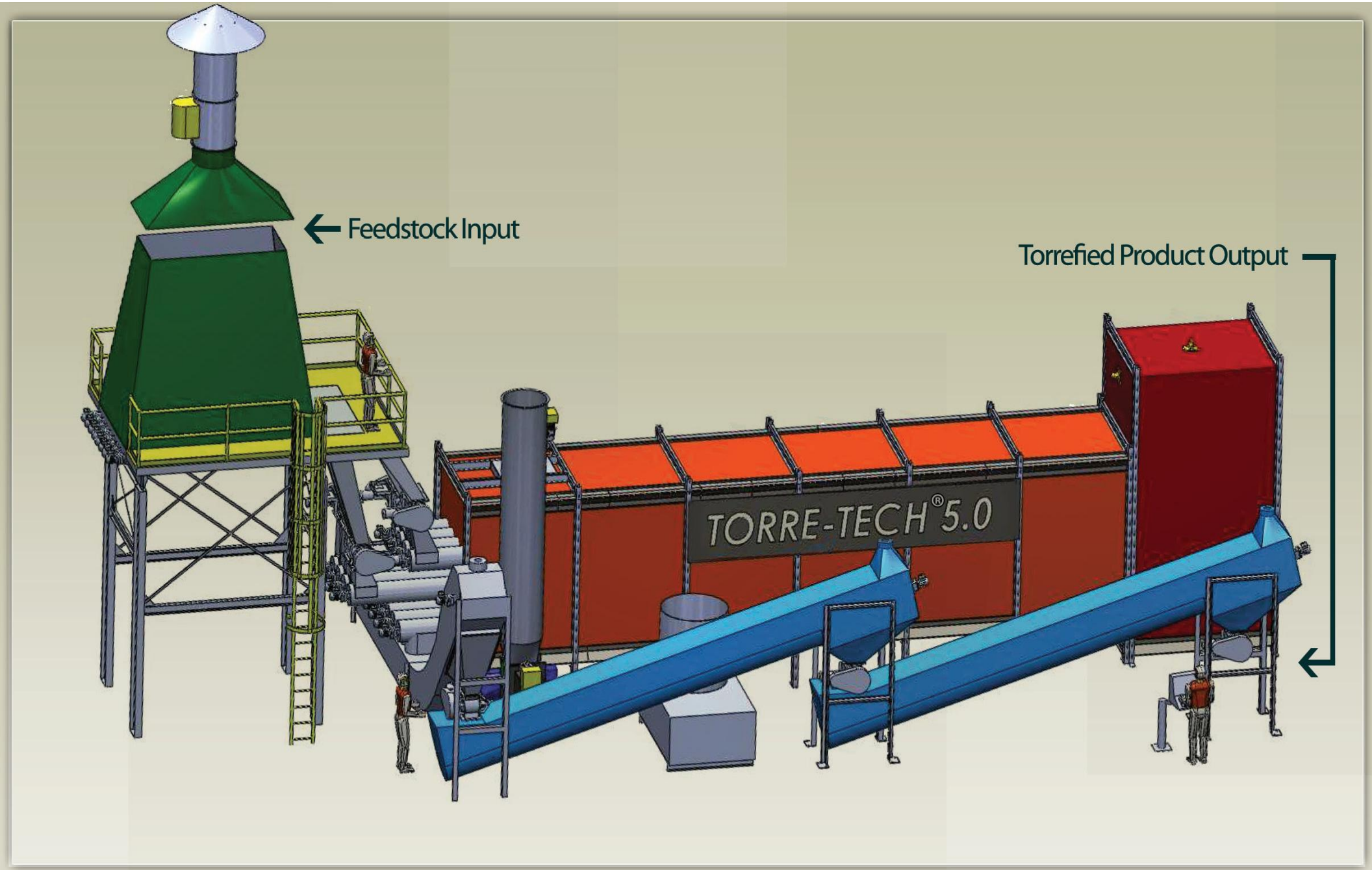
Feedstock Input
Torrefied Product Output
TORRE-TECH® 5.0

ATP's Partner: Kusters Zima Corporation

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8.74 Acres (35,362 Sq. Meters)

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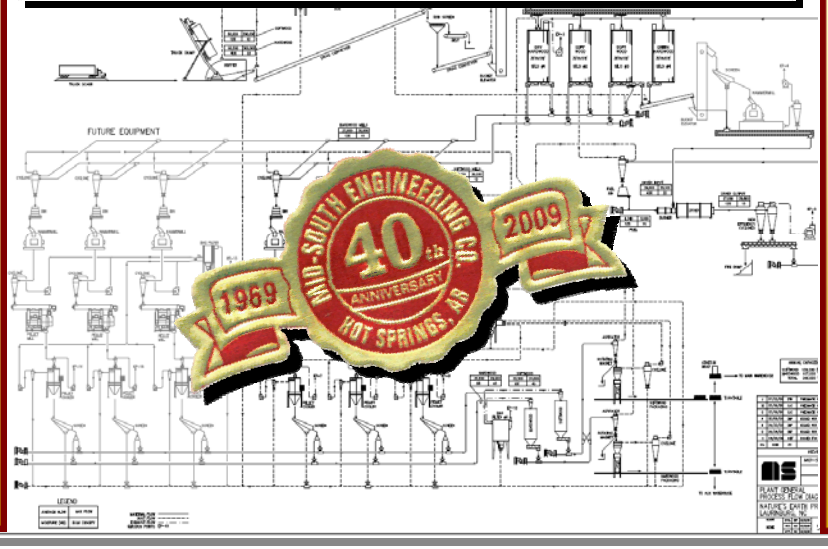

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