

# Thermal Conversion of Dry Feedstocks

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# Biomass Combustion - Heat

- At 2013 pricing in Virginia
- Fuel Oil to Wood Chips – Save 90%
- Propane to Wood Chips – Save 50%
- Electric Heat Pumps to Wood Chips – 50%
- Natural Gas to Wood Chips – No Savings
- Fuel Oil to Pellets – Save 50%

# Biomass Combustion - Power

- Scale matters – labor cost & conversion efficiency
- Small-scale power production only financially feasible in CHP mode
- Full-time operators may be required – increasing operating costs

# Biomass Combustion - Fuel

- Multi-Fuel Systems – highest capital cost
  - Chips, shavings, sawdust, sanderdust, bark, slabs..
  - Ag residual; ground or shredded
  - Pellets
- Pellet Fuel Systems – 50% less capital
  - Wood or grass pellets
  - Easier to operate
  - Limits to size

# Biomass Fuels

- Fuel Types - Woody
  - Round wood
  - Forest residuals
  - Forest product facility residuals
  - Manufacturing facility residuals
  - Construction residuals
  - Pellet
- Considered traditional fuel and easier to obtain air emissions permit

# Biomass Fuels

- Fuel Types - Agricultural
  - Energy crops (grasses) as Pellets or Ground
  - Ag residuals
  - Animal residuals
  - Food processing facility residuals
- Challenging ash & alkalinity levels
- Additional effort required for permitting – processing residual to qualify as fuel and not waste is recommended

# Biomass Fuels

- Fuel Types – Organic Residuals
  - Pre-consumer food waste
  - Post consumer food waste
  - Sorted organic materials
  - Organic manufacturing residuals
  - Wastewater treatment sludge
- Challenging moisture content, caloric variability & air emissions permitting

# Biomass Combustion

- Combustion : Two-Stage Gasification
  - Conventional combustion process
  - Under/over air
  - Reduces air emissions
  - Low/high fire 1:4
  - Flat grates, reciprocating grates, fluidized bed



# Biomass Combustion

- Combustion: Suspension Burners
  - Dry fuel only
  - Small particle size
  - Low/high fire 1:8
  - Can be retrofitted to existing fuel oil boilers

# Biomass Gasifiers

- Gasifiers: heat (decompose) biomass with Oxygen
  - Up/down/horizontal draft
  - Generates CO, VOCs & H<sub>2</sub>
  - Several in commercial operation
- Pyrolysis: heat (decompose) biomass without Oxygen
  - Initial step in biofuel & chemical production
  - Can be used for heat & power

# Biomass Heat & Power

- Steam
  - Steam turbine generators
  - Organic Rankine cycle generators
  - Sterling engine generators
- Hot Water
  - Organic Rankine cycle generators
- Thermal Oil
  - High efficiency Organic Rankine cycle generators

# Biomass Heat & Power

- Biomass small scale power generation is financial viable in CHP mode
- Power production is variable based on heating load
- Including absorption chillers allows biomass boiler to operate year-round; can increase financial viability

# Biomass for a Facility

- 2 MMBTU Multi-Fuel System
  - 130,000 SF Building
  - Fuel Oil to Biomass
  - \$800,000 Capital
  - \$90,000 annual fuel savings
- 1.2 MMBTU Pellet Retrofit System
  - 42,000 SF School
  - Fuel Oil to Pellets
  - \$120,000 Capital
  - \$40,000 annual fuel savings

# Biomass for a Facility

- 25 KW Pellet System
  - Electric Heat Pump to Pellet
  - 2 Buildings 6,000 SF
  - \$30,000 Capital
  - \$3,000 annual savings