Southern Alternative Fuels

Torrefied Wood:

the Ideal Co-firing solution with Coal

Southern Alternative Fuels, LLC

SAF is in the business of producing cost effective fuel and feedstock from biomass to the Southeastern US energy and heat producers.

Company Focus:

- Produce torrefied wood from pulpwood and waste as feedstock
- Develop waste to a viable feedstock through torrefaction
- Develop energy crops in the Southeast US to lower raw material costs in the production of feedstocks
- Encourage and partner with liquid fuel companies to introduce gasifier technology producing bio fuels from torrefied biomass feedstocks

SAF Ownership & Operations

Operating Member Managers:

- **Production Management**
- **Marketing & Sales**
- **Coal brokerage & Utility Services**
- **Agriculture**
- **Land acquisition and management**

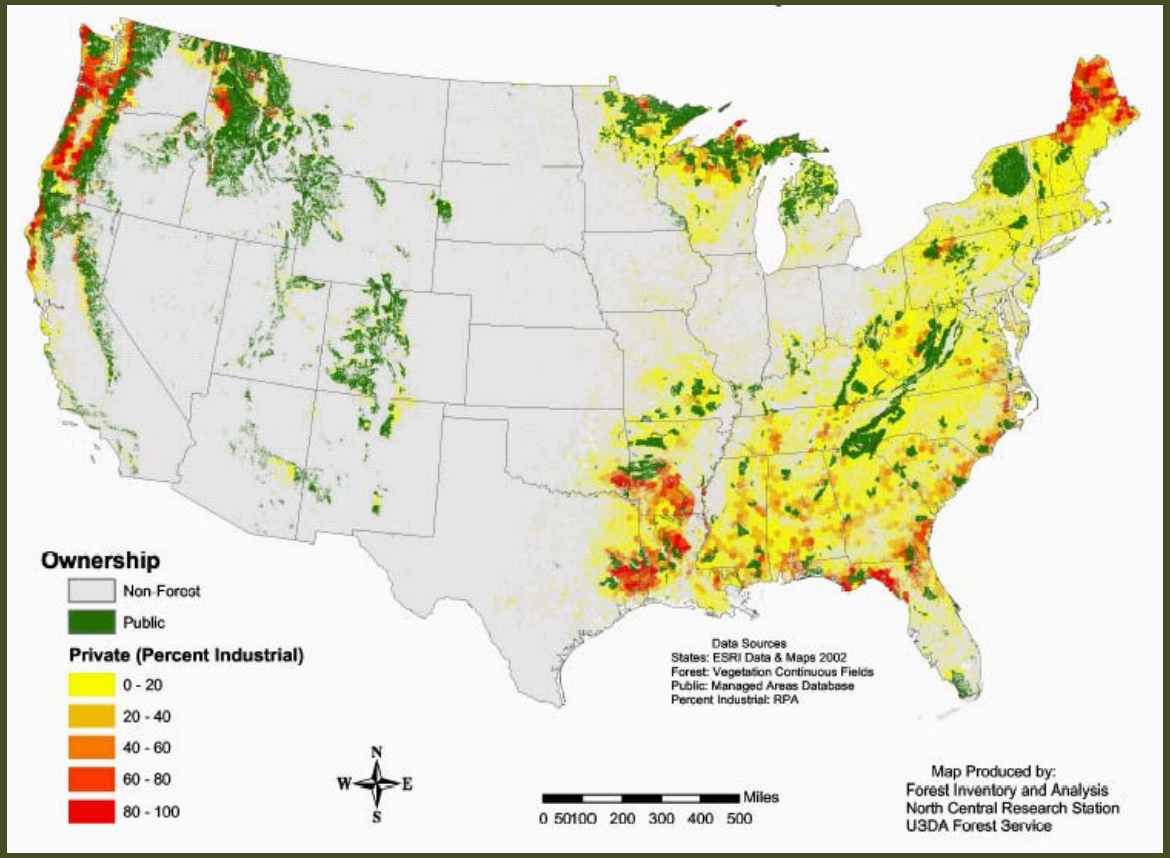
Funding Managers: ***Carolina Financial Group, LLC***

Exclusive North American License for the **Airless Technology**

Target Market: Geographic

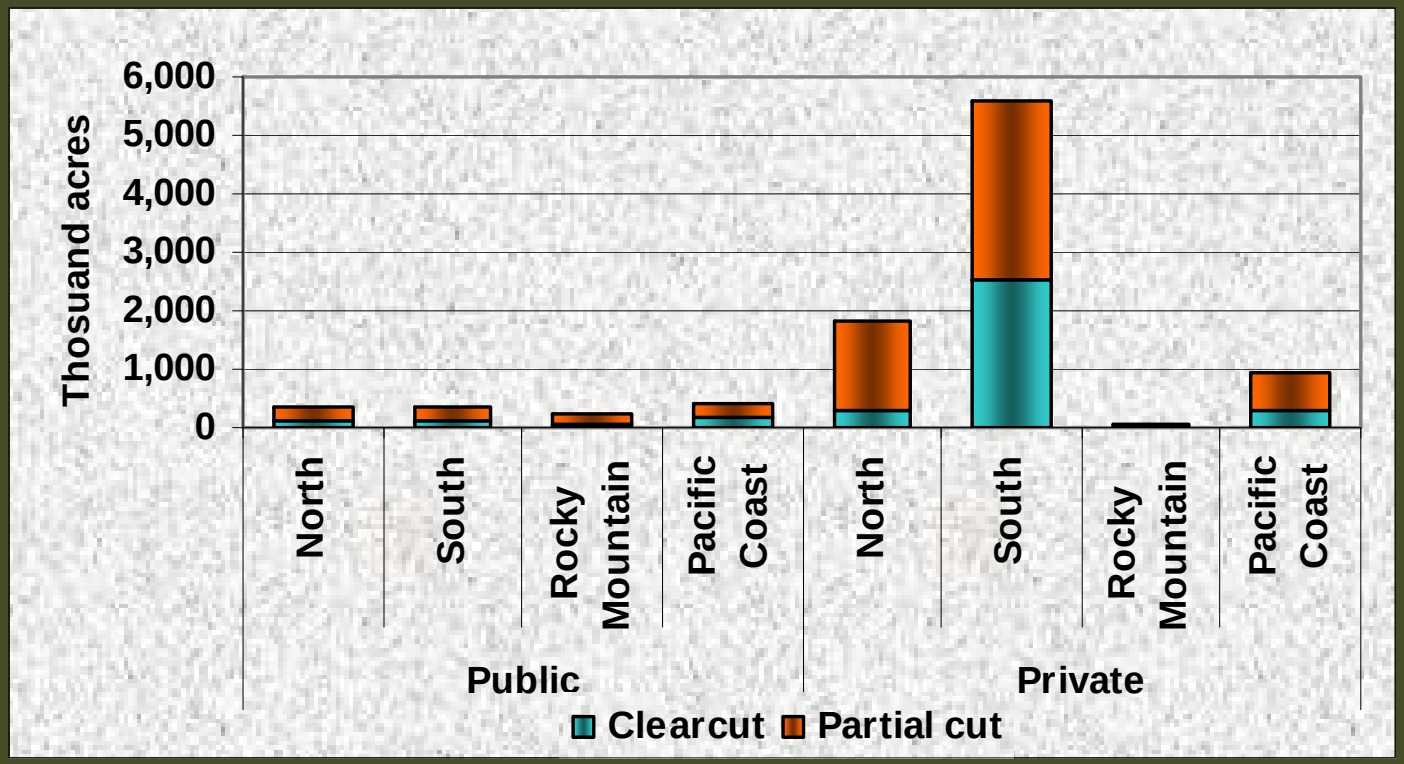
Private Forest ownership

Southeast US holds 45% of the nations pulpwood



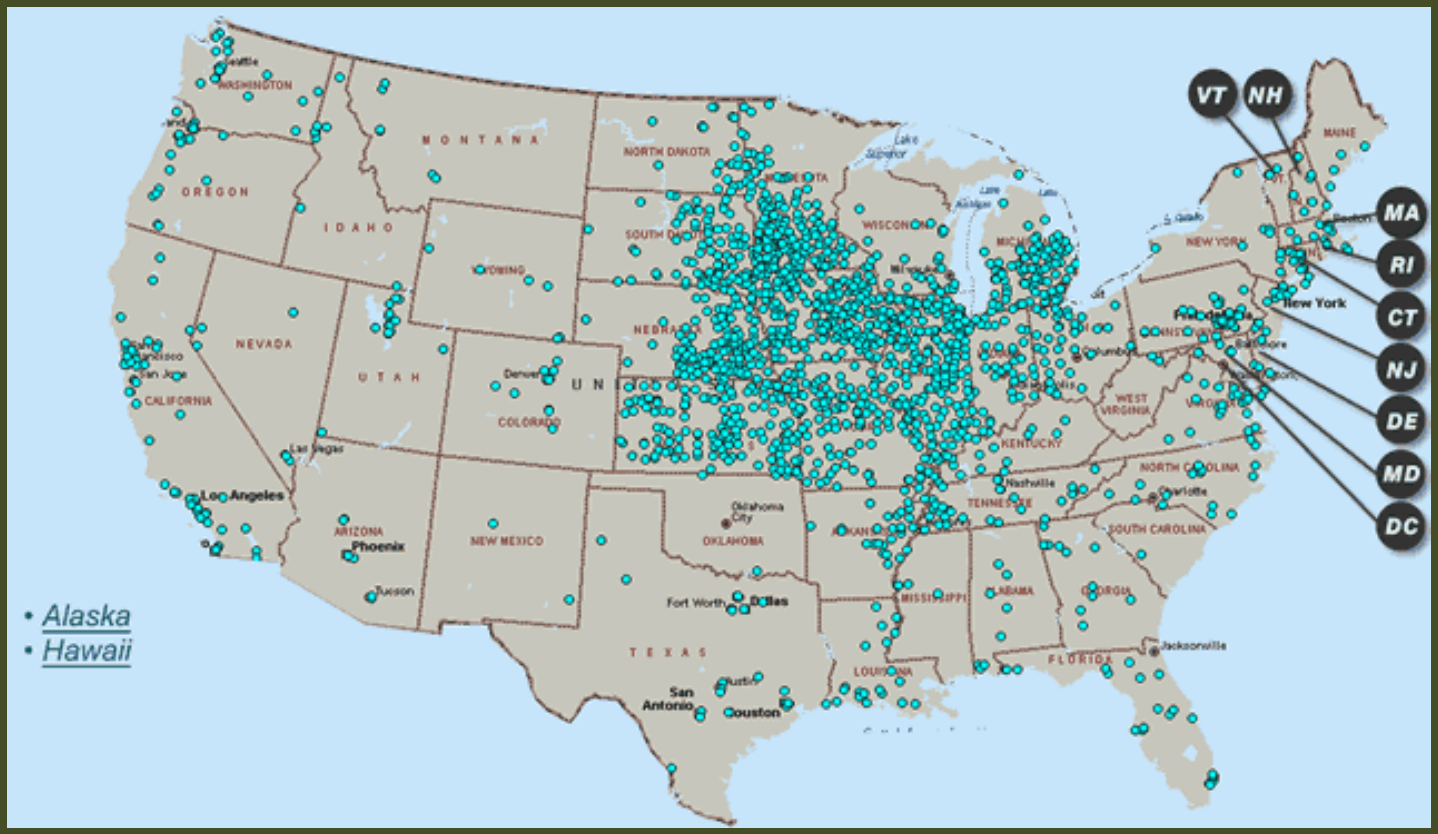
Source: National Report on Forest Resources

Target Market: Supply



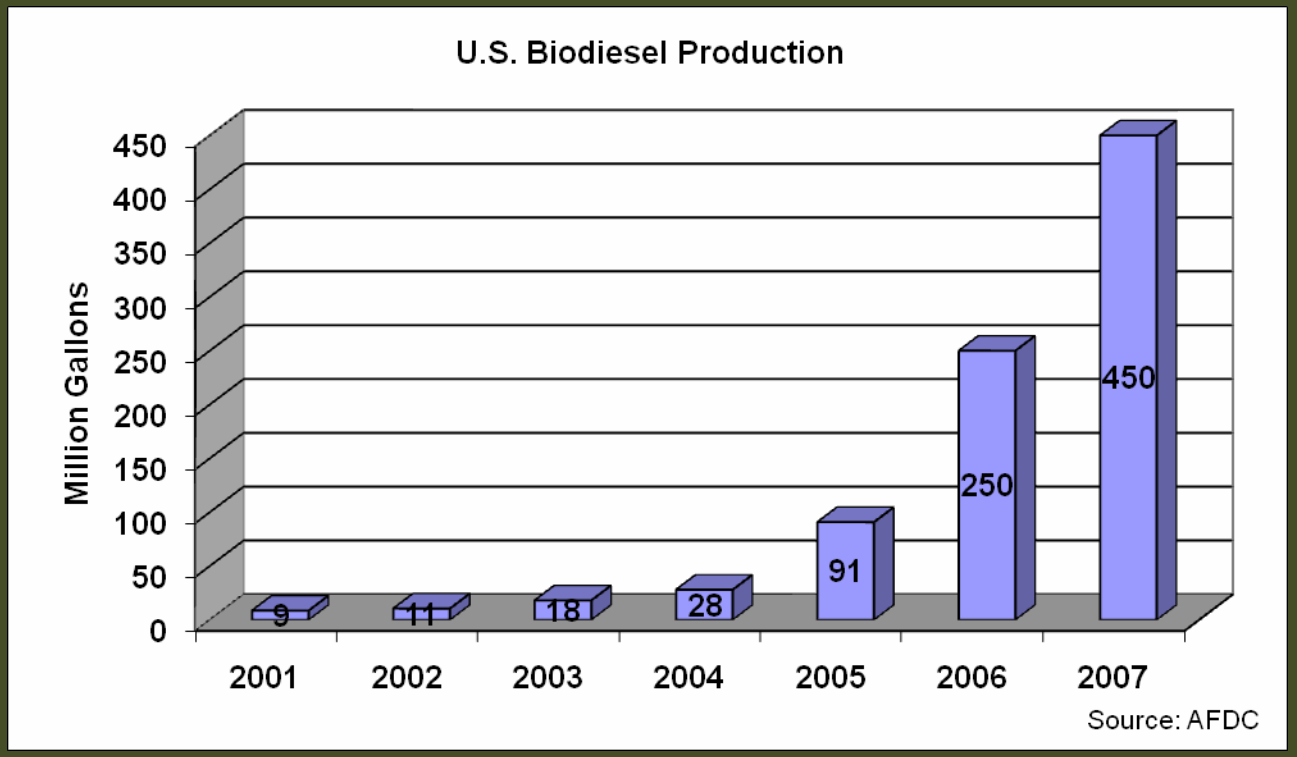
Target Market: Bio Liquid Fuels

Biodiesel Retail Outlets: Impact the South



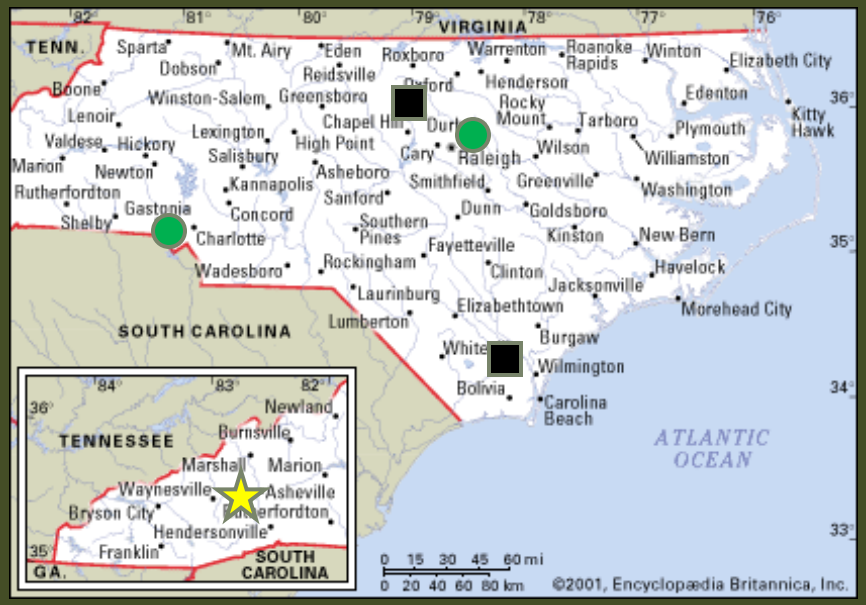
Target Market: Biodiesel Potential

2020 Target 20 billion gallons



SAF 3-year direction

- First two facilities will have 500,000 ton annual production capacity for UK & EU torrefied pellets
  - 30% of raw material from energy crops
  - 50,000 ton excess capacity for small off-take agreements and tests.
- Projects to provide feedstock to private and public facilities with coal-fire boilers for heating and power.
- Waste to Energy and Environmental clean up using Airless technology for torrefaction and carbonization
- Partnering to bring biodiesel production to the Southeast
- Work with Southeastern Utilities providing test materials and support for the low CapX solution in meeting 2012 emission reduction standards



Legend

- Potential Locations
- Headquarters
- Mills

What is Torrefied Wood

Torrefied wood (TW) is a high grade, nearly smokeless fuel suitable for commercial, industrial, and domestic use.

TW is made by mild pyrolysis of biomass materials at temperatures of 465F to 565F.

TW achieves a stable moisture content of less than 3%, reduction of mass by 30%, retention of 90% of original energy content and removal of smoke producing agents.

TW has a heating value of approximately 9,500 – 10,500 btu/lbs

TW is friable, ie. can be easily crushed or pulverized.

Feedstock for wood fuel pellets, briquettes or other densified biomass based fuels.

Characteristics of TW

- is CARBON NEUTRAL as it has no net release of CO_2 making it a great source for CO_2 reduction

- is hydrophobic with a moisture content of approximately 0.7% at the end of the process (rising to less than 3% when atmospheric moisture clings to TW).

- with a moisture content of less than 3%, it reduces long distance transportation cost significantly when shipped in chips and pellet forms

- is consistent, homogenous and with no or minimum contaminant level if any in the feedstock

- is friable and has much higher grinding properties than raw biomass or wood pellets

- has moisture content much lower than the moisture content of natural coal

- can be pelletised / densified at costs much lower than even saw-dust for distant shipments

- is preserved and can be stored uncovered for unlimited period

Wood Reaction Characteristics

Torrefaction characteristics of wood material processed in an inert gas atmosphere:

- Processing at up to 320F, wood loses water and very little else.
- Wood is lignocellulose (hemi-cellulose, cellulose and lignin)
- Raising the temperature to between 355F and 485F, wood gives off its additional moisture and begins to darken and brown and gives off hemi-cellulose, lignin, turpines, carbon dioxide and wood acids.
- Wood at this stage also loses its hygroscopic properties and structure strength and becomes more friable.
- Torrefaction occurs at temperatures between 485F and 535F.
- Significant cellulose de-volatilisation until 570F

Thermal Decomposition Regimes

Woody biomass is composed of

- Hemi-cellulose
- Cellulose
- Lignin

Component	Mass % in Softwoods	Mass % in Hardwoods
Cellulose	42 +/- 2	45 +/- 2
Hemicellulose	27 +/- 2	30 +/- 2
Lignin	28 +/- 3	20 +/- 4
Extractives	3 +/- 2	5 +/- 3

<u>Below 485F</u>

- Biomass dried
- Softens lignin
- De-volatilisation and carbonisation of hemi-cellulose

<u>Above 485F</u>

- Hemi cellulose decomposes into volatiles and char
- Limited de-volatilisation and carbonisation of lignin and cellulose

Properties: Chips ; Wood Pellets ; TOP Pellet

	Wood Chips	Wood Pellets	TOP Pellets
Moisture Content (%)	35	8-12	<3
Calorific Value (btu)	5,700	7,800	9,500-10,500
Bulk Density (lbs/yd3)	327	356	475+
Hygroscopic Nature	Wets	Wets	Hydrophobic
Behaviour in Storage	Gets mouldy Dry matter loss	Deteriorates Gets mouldy	Stable

Torrefied Wood Analysis

Species	Pine	Chestnut
Total Moisture %	2.76%	2.90%
Ash %	2.80%	2.95%
Carbon %	59.7%	57.8%
Chlorine %	0.01%	0.01%
Hydrogen %	5.6%	5.2%
Nitrogen %	0.25%	0.45%
Oxygen %	32.9%	36.2%
Yield by weight %	77%	77%
Low CV of dry wood, btu/lbs	8,233	7,674
Low CV of TW, btu/lbs	8,856	9,286
Volatile Matter % (DAF)	77%	77%
Calorific Value btu/lbs (DAF)	9,651	9,561

Test Results calculated to "As received" moisture basis

Co-firing TW with Coal.....

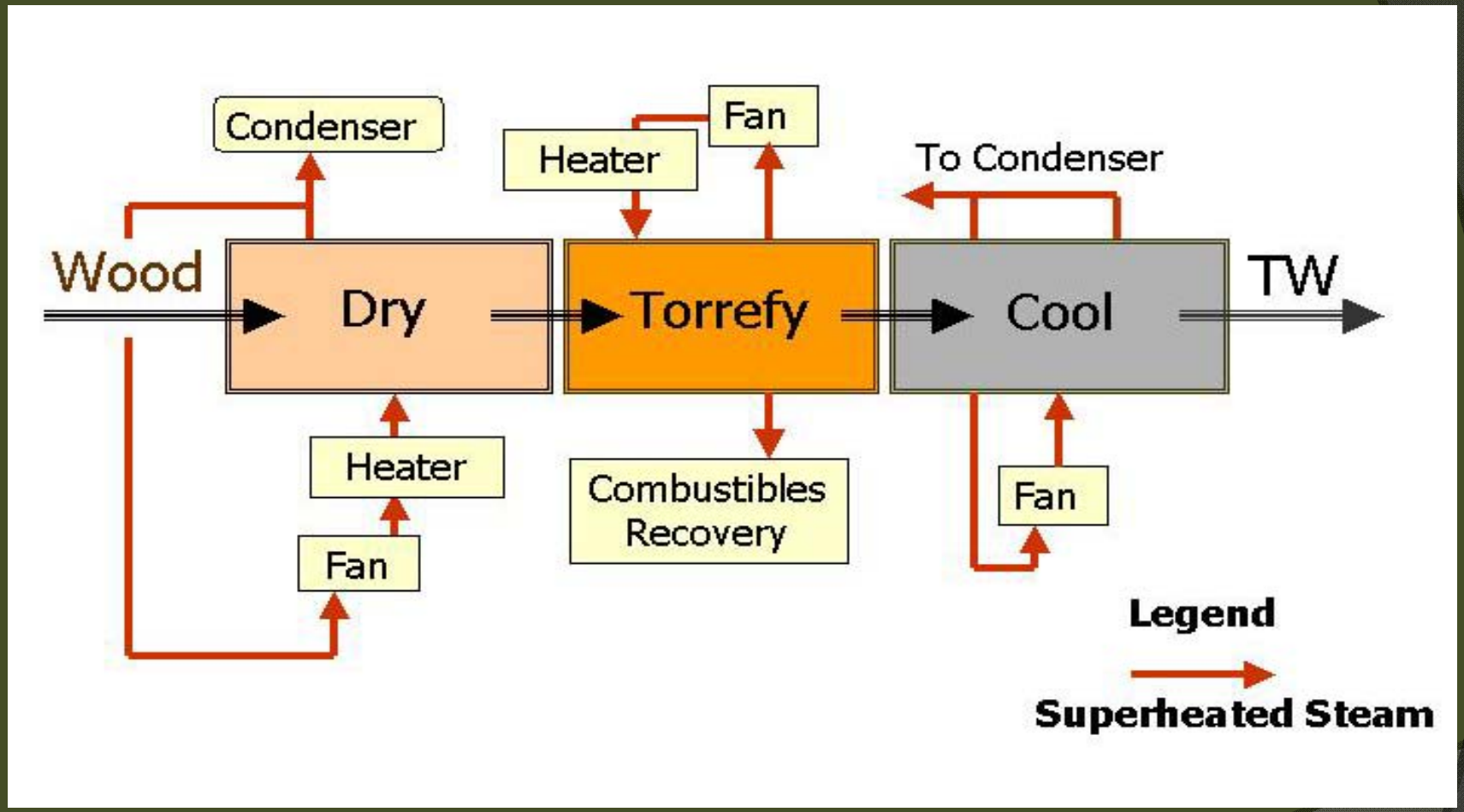
- TW's heating value, 10,500 btu/lbs is near to the 11,500 – 12,000 btu/lbs average for steam coals.
- TW has less moisture than coals used for power generation. The heat rate is improved by co-firing TW with coal.
- TW can be co-fired at higher percentage rates allowing for a higher caloric value over raw biomass.
- Business case driven, CER trading schemes
- Business case driven, torrefied wood cam be mixed with coal reducing CapX investment.
- Business case driven, is lowered SOx and Nox emissions


AIRLESS-SYSTEMS
DRYING · TORREFACTION · CARBONISATION
Drying
TORREFACTION
CARBONISATION
AIRLESS
Systems

Airless Patents

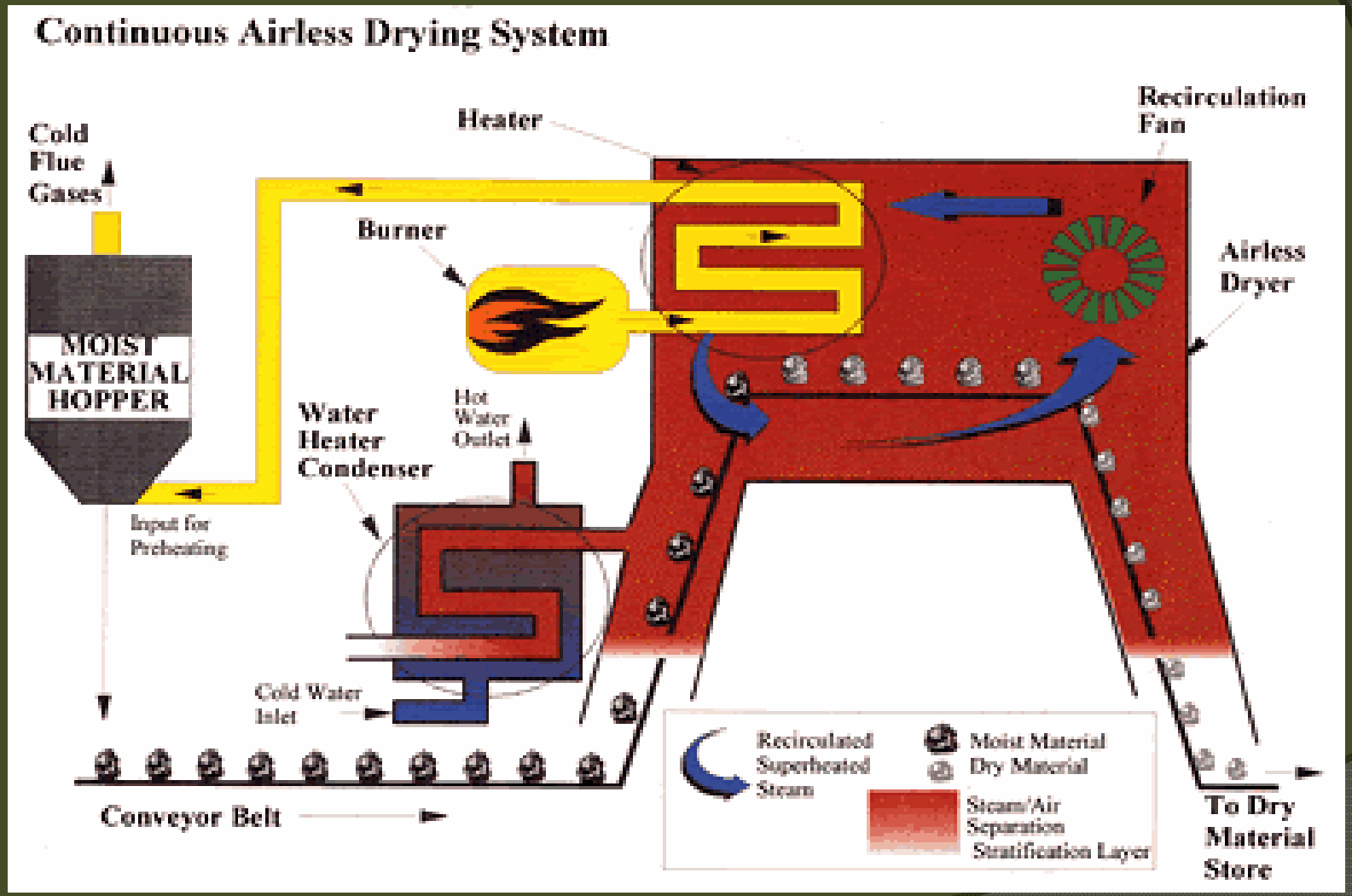
- Two of the Airless patents relevant to Torrefaction are:
  - U.S. 5,228,211: Method and apparatus for energy efficient drying and processing, using superheated steam as the drying medium; reheating and re-circulating the superheated steam, recovering energy, etc. from superheated steam
  - U.S. 5,711,086: Method and apparatus for continuous drying and processing in superheated steam, is a key patent including the temperature and density differential stratification layer acting as a non-mechanical seal.

Airless - TW Technology Flow Diagram

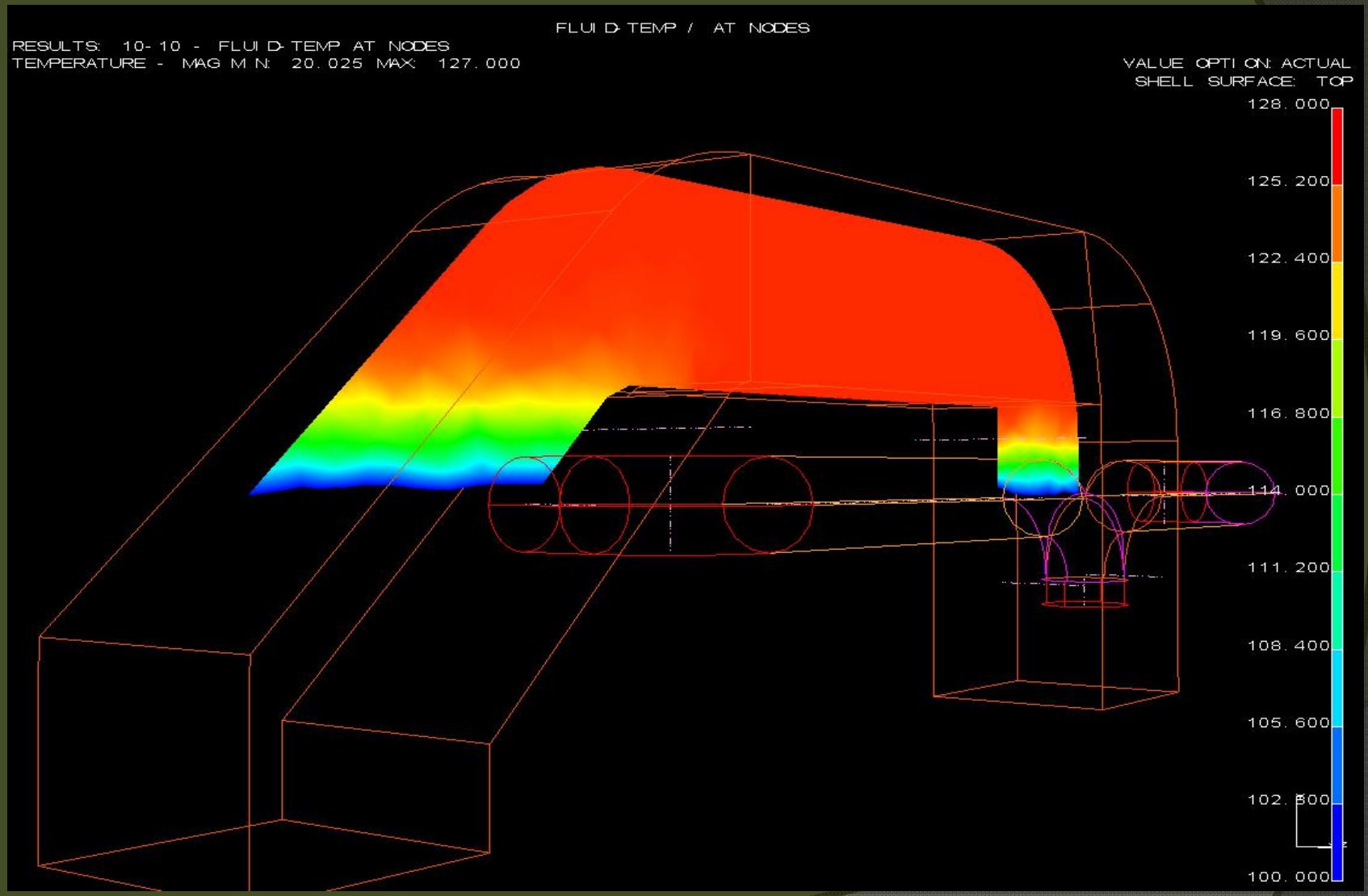


Superheated steam at atmospheric pressure is re-circulated over an indirect heater and through the feedstock to pre-condition and torrefy.

Airless - Continuous Drying System



Airless - Stratification Layer



Energy Efficiency

TW Energy Conversion Efficiency Derived from Previous Table
Energy content of dry wood input around 8.32 btu/lbs x 1,432.6 lbs = 11,918 kbtu/hr
Energy content of TW produced around 9.24 kbtu/lbs x 1,212.5 lbs = 11,208 kbtu/hr
Less heat input to dry the wood around 1,327 kbtu/hr
Net energy output 9,881 kbtu/hr
Energy Conversion Efficiency for Superheated Steam Drying and Torrefaction of Wood with 35% moisture content
Moist wood to TW conversion efficiency circa [(9,881/11,918) x 100] = 83%

Dry Wood Chips

12.9 lbs of previously dried Wood Chips.

(Original wet weight of 17.2 lbs At 35% M.C.)

Torrefied Wood Chips

11.2 lbs of Torrefied Wood

(12% weight reduction due to removal of wood acids tuppines, cellulose etc during torrefaction.)

Pulverised Wood Chips

11.2 lbs of Ground Torrefied Wood Chips

The now friable torrefied wood chip is easy to mill or grind to fine particle size for fluidised/pneumatic injection to steam boilers

Technology Benefits

- Faster drying and processing cycles
- Higher thermal efficiency
- Lower energy costs
- Lower operating costs
- Containment, useful recovery or elimination of process exhaust emissions
- Energy recovery facility

Independent Studies

Independent Studies have demonstrated that Airless Technology drying of ceramic materials and other products has demonstrated:

- drying time reductions of up to 80% and
- drying energy reductions by around 50% compared to conventional hot air drying.

CERAM

Rotary Dryer & Torrefier


Airless Rotary Drum

Board Dryer

Continuous Dryer

Summary

Torrefied Wood & Biomass qualities:

- Burns cleaner than coal for both clean air standards & CO_2 reduction
- Process can define CV and other qualities of product
- Product consistency
- Pelletized for higher density and clean conveyance
- Develops the quality of being hydrophobic: outdoor storage

Summary

Torrefied Wood & Biomass to a coal fire facility:

- Develops the quality of being hydrophobic
- Handled like and along side coal; little or no CapX
- Burns cleaner than coal for both clean air standards & CO2 reduction
- Airless torrefaction process qualifies user for nearly full Carbon Credit / effective cost below coal
- Lowered SoX
- Cleaner burning; hotter burning; cleaner ash