



Capture the energy ⚡ Release the potential

©2010 Frontline BioEnergy, LLC. All Rights Reserved.
1421 S. Bell Avenue Suite 105, Ames, Iowa 50010

(Phone) 515-292-1200

www.frontlinebioenergy.com

(Fax) 515-292-1201

Energy It is the lifeblood of the modern world, powering our cities and driving an increasingly demanding global economy. Keeping up with demand —while also being conscious of carbon emissions and other environmental concerns — means seeking out new energy resources that are both efficient and sustainable.

Biomass— biological material derived from living, or recently living organisms, such as wood or agricultural residues — contains stored energy from the sun that can be liberated through combustion. Our ancestors have been doing it for ages in the form of campfires. But there's a cleaner, more efficient and cost effective way to tap into that energy source ... gasification.

Gasification

Gasification: The right choice for releasing biomass energy

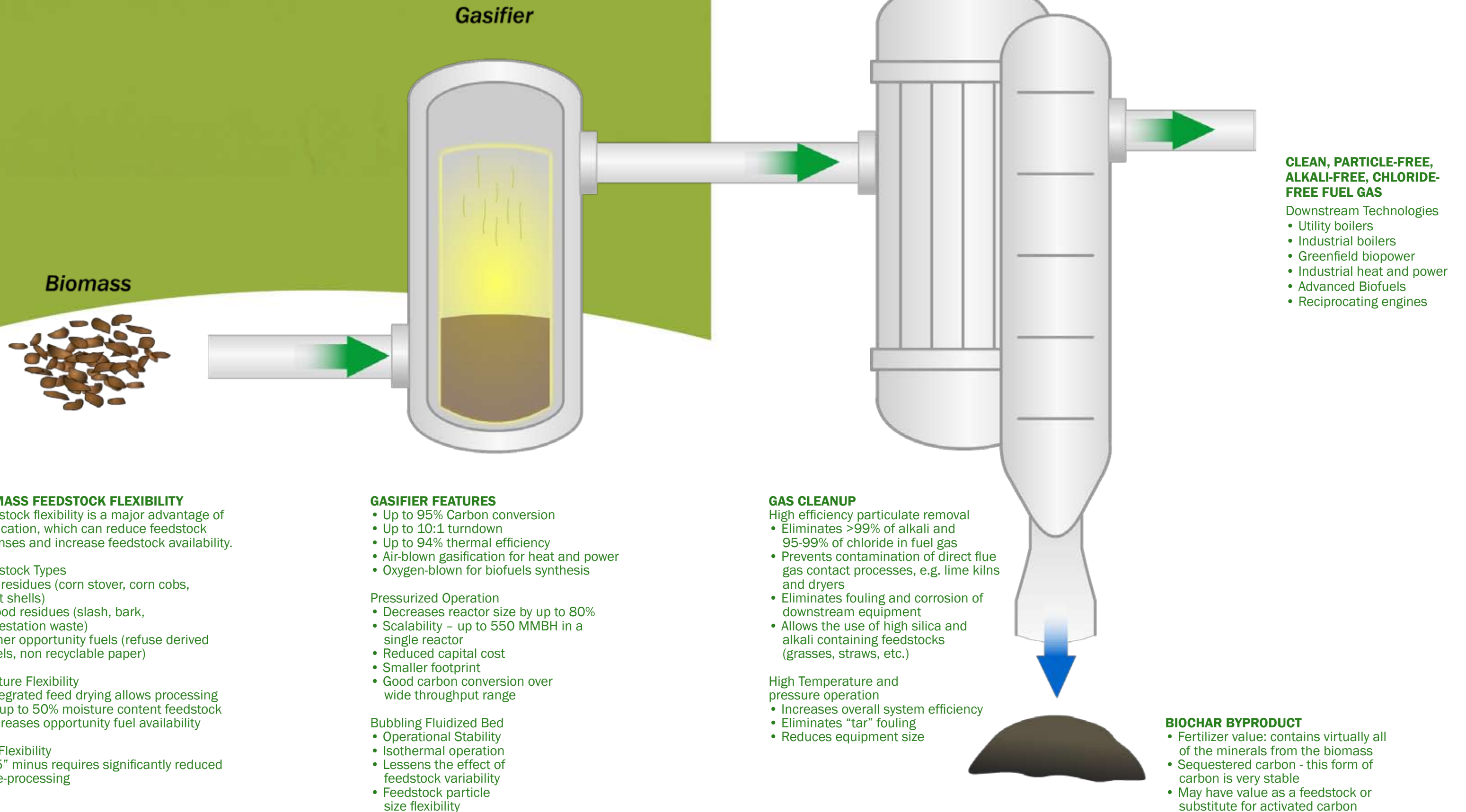


Frontline BioEnergy sits at the intersection of two undeniable global trends — the increasing demand for cost-effective energy, and the need for energy resources that are sustainable and environmentally friendly. Our gasification technology allows for the efficient, cost-effective use of sustainable biomass for renewable power, heat, and biofuels.

Frontline BioEnergy's proprietary technology centers on a biomass gasification system that converts solid fuel particles into a combustible gas. This renewable, gaseous fuel is cleaned and conditioned in our system and can be used in a variety of applications. Gasification allows for the production of a more energy efficient, cleaner burning, and environmentally friendly fuel source compared to non-gasified biomass, natural gas or coal.

PMFreeGas™

The Frontline Gasification System: How It Works



BIOMASS FEEDSTOCK FLEXIBILITY

Feedstock flexibility is a major advantage of gasification, which can reduce feedstock expenses and increase feedstock availability.

Feedstock Types

- Ag residues (corn stover, corn cobs, nut shells)
- Wood residues (slash, bark, infestation waste)
- Other opportunity fuels (refuse derived fuels, non recyclable paper)

Moisture Flexibility

- Integrated feed drying allows processing of up to 50% moisture content feedstock
- Increases opportunity fuel availability

Size Flexibility

- 2.5" minus requires significantly reduced pre-processing

GASIFIER FEATURES

- Up to 95% Carbon conversion
- Up to 10:1 turndown
- Up to 94% thermal efficiency
- Air-blown gasification for heat and power
- Oxygen-blown for biofuels synthesis

Pressurized Operation

- Decreases reactor size by up to 80%
- Scalability – up to 550 MMBH in a single reactor
- Reduced capital cost
- Smaller footprint
- Good carbon conversion over wide throughput range

Bubbling Fluidized Bed

- Operational Stability
- Isothermal operation
- Lessens the effect of feedstock variability
- Feedstock particle size flexibility

GAS CLEANUP

High efficiency particulate removal

- Eliminates >99% of alkali and 95-99% of chloride in fuel gas
- Prevents contamination of direct flue gas contact processes, e.g. lime kilns and dryers
- Eliminates fouling and corrosion of downstream equipment
- Allows the use of high silica and alkali containing feedstocks (grasses, straws, etc.)

High Temperature and pressure operation

- Increases overall system efficiency
- Eliminates "tar" fouling
- Reduces equipment size

CLEAN, PARTICLE-FREE, ALKALI-FREE, CHLORIDE-FREE FUEL GAS

Downstream Technologies

- Utility boilers
- Industrial boilers
- Greenfield biopower
- Industrial heat and power
- Advanced Biofuels
- Reciprocating engines

BIOCHAR BYPRODUCT

- Fertilizer value: contains virtually all of the minerals from the biomass
- Sequestered carbon - this form of carbon is very stable
- May have value as a feedstock or substitute for activated carbon

Advantages

Advantages of PMFree Gas™ over direct combustion biomass energy systems

Cost Advantage

- Lower CAPEX/kw than combustion due to higher efficiency
- Lower fuel expense per MWh produced power
- Lower O&M and repair expense due to production of clean-burning fuel gas
- Less downtime due to repairs
- Less expensive emissions compliance since a smaller gas volume is being treated

Reliability Advantage

- Gasification with ash removal removes problematic alkali and chloride from the gas
- Alkali and chloride are responsible for major boiler maintenance: fouling, slagging, corrosion
- Feedstock flexibility of gasifier system enhances process reliability
- Gasifier and solids system reliability is decoupled from electric generating reliability with instant natural gas backup system

Efficiency Advantage

- Gasification allows repowering without significant de-rate of generating asset – maintains ability to operate near peak efficiency point without turbine rebuild
- More efficient combustion for steam-based power cycles: 10% excess air for fuel gas combustion v. 50%-100% excess air for solids combustion
- High (up to 94%) hot gas efficiency (HGE) for direct gasification conversion; main losses from incomplete carbon conversion, which can be recovered off-site

Emmissions Advantage

- Emissions control managed on the fuel side, not the combustion side: smaller gas volume to treat
- Gasification with ash removal removes particulate matter (PM) emissions prior to combustion
- Frontline gasification technologies have excellent chloride removal, down to MACT compliant levels
- Gas fuel allows the use of low-NOx burner technology