



Caribou Biofuels

Biomass/Trash to Fuel



“Pyrolysis/Gasification”

thermal cracking in the absence of oxygen

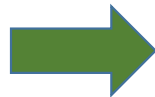
Army demonstration in process



**Research and development
Gasifier/Pyrolysis System**

**SUNY
Cobleskill**

U.S. ARMY



**Exclusive license to
commercialize**

**Caribou Biofuels
(New York & California)**

**SUNY owns a % of
Caribou and earns
royalties.**



**Partner
Institutions**

STATE UNIVERSITY OF NEW YORK
TO LEARN — TO SEARCH
TO SERVE
1948

ROCHESTER INSTITUTE OF TECHNOLOGY
R·I·T
1829

BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY

jbei
Joint BioEnergy Institute

Technology generating Liquid Biofuels



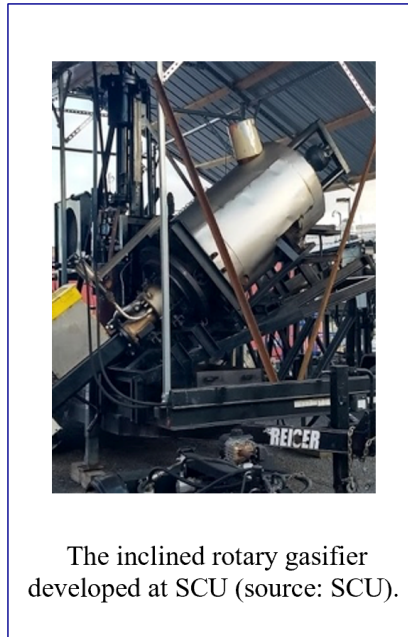
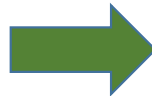
Forestry Waste



Agricultural Waste



Municipal Waste



The inclined rotary gasifier developed at SCU (source: SCU).

**Ultra Clean Emissions
Pyrolysis/gasifier system**



**Bio-gasoline or electricity
Sell & Earn Carbon Credits**



**Sequestered Carbon
Sell for fertilizer, asphalt or Composites**



Current Programs – US Army

Current US Army program for Gasifier, compact in a 20 Foot Shipping Container



Reduce Fuel Convoys



Eliminate Burn Pits



Current Programs – Cal Fire

Current Cal Fire program for Gasifier, to go into the woods, manage Forestry Biomass, And convert to bio-gasoline, Carbon Credits and Biochar



Fire-suppressed Forest



Ecologically managed Forest





Proposed Program

Waiting for approval of a program with the Department of Energy to keep plastics out of landfills. A full submission with the State University of New York, Cobleskill and The Rochester Institute of Technology and Waste Management.



U.S. DEPARTMENT OF
ENERGY

DOE: BOTTLE - Bio-Optimized Technologies to Keep Thermoplastics out of Landfills and the Environment [DE-FOA-0002244]





Birth of the Technology

Generate electrical power from raw wet waste on Forward Operating Bases (FOB)

Reduce JP-8 (diesel) fuel consumption

Fuel deliveries require military escort
Estimated delivered cost to FOB \$350 to \$800 per gallon

Eliminate burn pits

Smoke and pollutants
Health risks

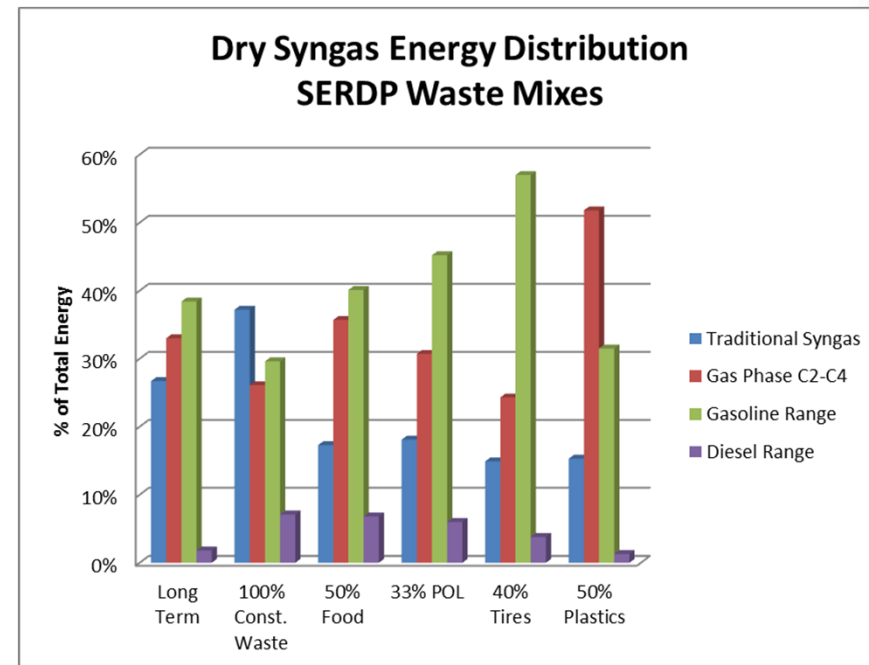


Image: JULIANNE SHOWALTER/U.S. AIR FORCE
[HTTP://WWW.STRIPES.COM/NEWS/FEDERAL-COURT-TO-WEIGH-LAWSUIT-ALLEGING-LUNG-DISEASES-FROM-IRAQ-AFGHANISTAN-BURN-PITS-1.386711](http://www.stripes.com/news/federal-court-to-weigh-lawsuit-alleging-lung-diseases-from-iraq-afghanistan-burn-pits-1.386711) -



Choice of liquid or gaseous fuel

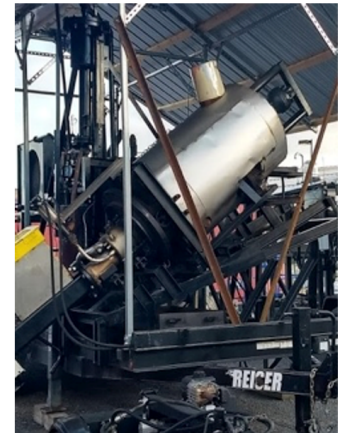
- Produces a liquid fuel similar to gasoline or a clean syngas.
- Simple thermal process
- De-volatilization – NOT incineration
- Accelerates what naturally occurs in the earth over thousands of years to less than 20 minutes





Compact and flexible system

- Low parasitic load
- Simple and light weight
- Small reactor and process vessels
- Minimal or no feedstock preparation
- Process dripping wet feedstock
- Able to process soil, stones, glass, and metals mixed with feedstock
- Safe (low hydrogen production)
- High energy syngas from cracking heavy oil into gasoline and diesel.



The inclined rotary gasifier developed at SCU (source: SCU).



Wet Feedstock

- Able to process dripping wet feedstock
- Ram feeder uses compression to dewater feedstock to < 50% moisture content (WB)
- Unique heat recovery and management allows gasifier to operate on wet feedstock
- Moisture evaporates into the syngas and passes thru the engine as superheated steam (invisible gas)



The inclined rotary gasifier developed at SCU (source: SCU).



Feedstock Tested

- **Cardboard (flat and corrugated)**
- **Wood (pallets, crates, demolition, etc.)**
- **Plastics (film, tarps, containers, etc.)**
- **Clothing (cotton, polyester, canvas, etc.)**
- **Food (bread, produce, meat, vegetables, etc.)**
- **Rubber (tires, hose, belts, etc.)**
- **Used lubricants (crankcase oil, gear lube, grease, off spec fuel, etc.)**
- **Ag wastes (manure, refusals, hay, grass, etc.)**
- **Trimmings (branches, leaves, cuttings, etc.)**

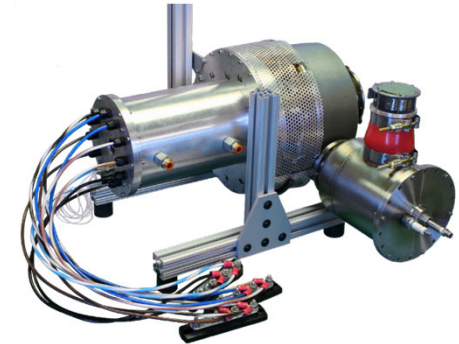


The inclined rotary gasifier developed at SCU (source: SCU).

Emissions



- **Low NOx**
 - **Ultra clean emissions Turbine-Generator**
 - **Ultra low NOx design**
- **Very low or undetectable SOx**
 - **Sulfur captured as synthetic gypsum with ash**
- **No unburnt hydrocarbons**
- **Particulate matter – removed from fuel gas prior to combustion**
- **No odor from complete and controlled combustion**



California Problems



“Waste biomass is widely available across California. Today, Most of the carbon from biomass returns to the atmosphere as CO2 or Methane”

Major forest management problems

Significant agricultural waste problem

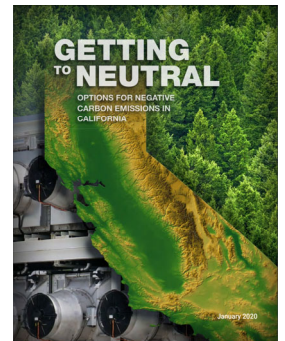
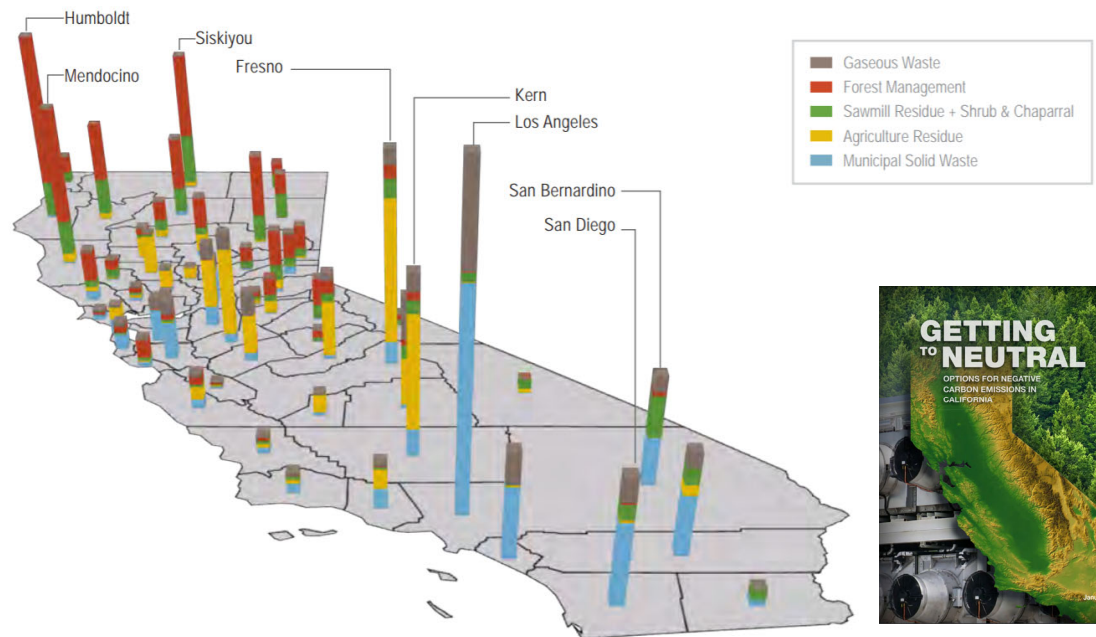
Significant landfill problem

Commitment to support employment development

Commitment to reduce emissions and global warming

Water

All of California can participate in gathering the biomass needed for negative emissions



https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf



“Getting to Neutral” – pathway example

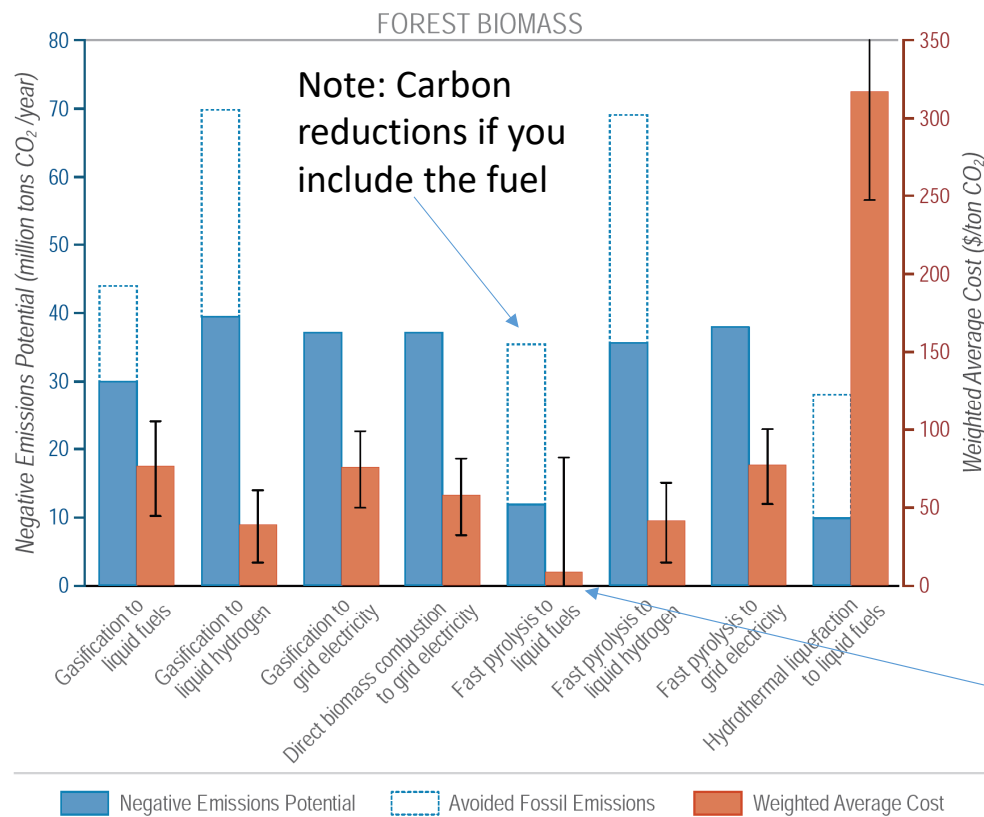


Figure 30. Negative emissions potential, avoided fossil emissions, and weighted average cost to capture CO₂ for forest biomass, calculated for the year 2045.

Note that the weighted average cost does not include the avoided fossil emissions—only the actual negative emissions were used in this calculation, per Equation 2 and Figure 16. Avoided fossil emissions are for 2045, when grid electricity is assumed to have zero carbon intensity. The error bars on the weighted average cost represent the range of costs arising from variation in feedstock collection costs.

**Note: Lowest cost.
(Caribou Biofuels, will be even lower cost.)**

Finances



Reduce Costs

By disposal of Waste in a Gasifier

1. Reduce disposal tipping fees.
2. Reduce costs to waste management companies.
3. Reduce handling and transportation costs.

Generate Revenue

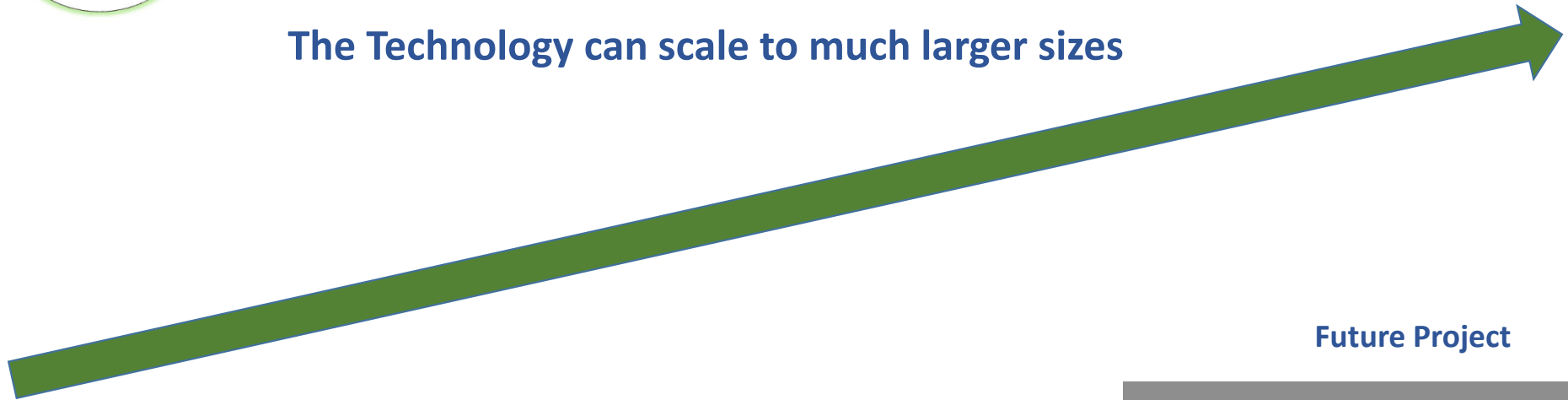
Sell outputs of the gasifier

1. Sell the fuel (or generate electricity and heat)
2. Sell the biochar as a soil amendment, for concrete or for (plastic like) composite material.
3. Sell Carbon Credits, currently approx. \$200 each.
4. Other government funding/grants.



Future -Scaling up

The Technology can scale to much larger sizes



Army Project



Cal Fire Project



Future Project

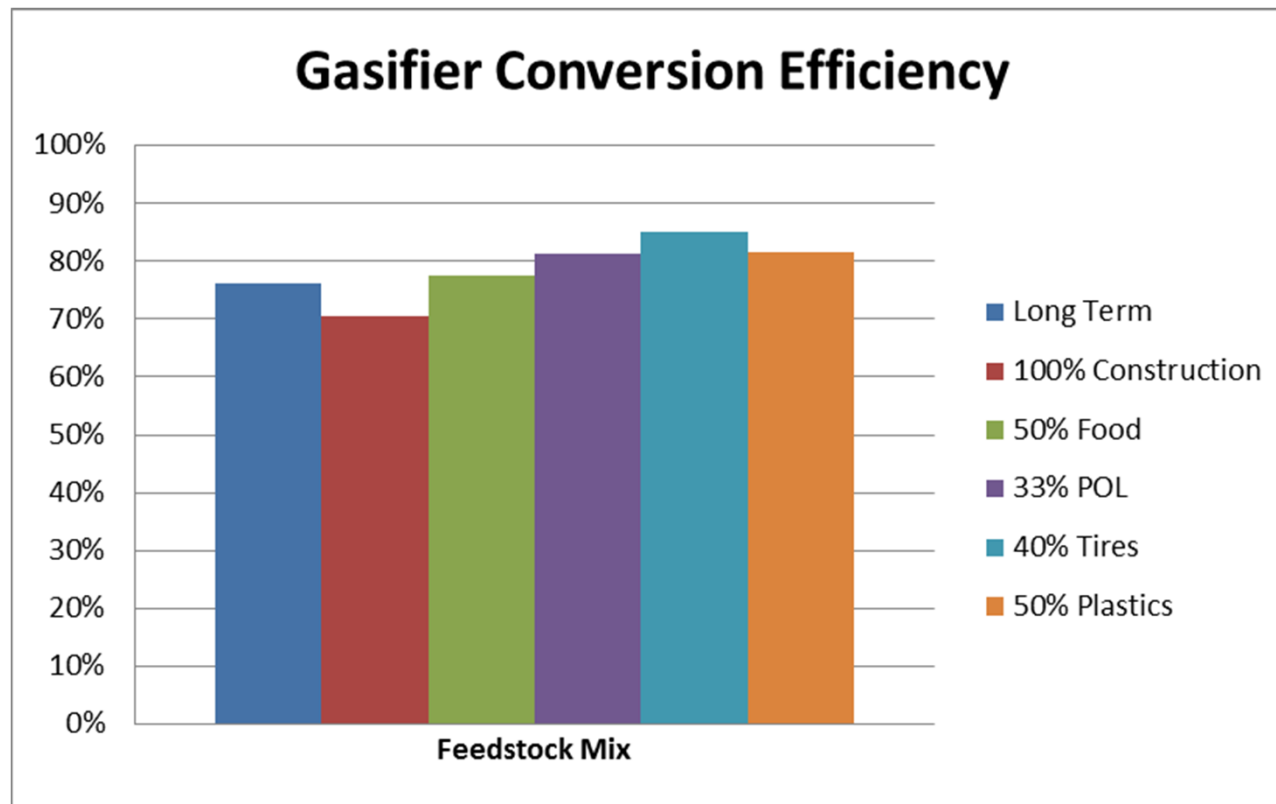


Future Project





Conversion Efficiency





**Here today to explore an opportunity to
work together?**



Caribou Biofuels



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