RTP GREEN FUEL: A CASE STUDY
BATES COLLEGE

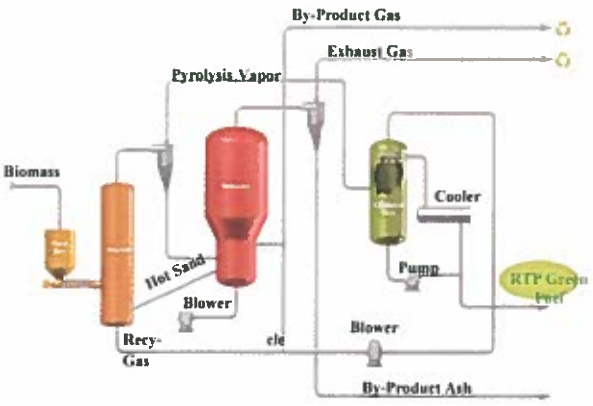
Bates College is a small liberal arts college located in Lewiston Maine. In 2009, Bates signed on to the American College and University Presidents Climate Commitment (ACUPCC) pledging to work toward becoming a climate neutral campus. The Bates Climate Action Plan's goal is to achieve climate neutrality by 2020.

Bates has a central heating plant, fueled by natural gas, which provides heat and hot water to a majority of the campus. In order to achieve climate neutrality, the fuel burned in the central heating plant needed to be addressed. After investigating many fuel options, Bates determined that Ensyn Fuels' **Renewable Fuel Oil (RFO)** was the fuel that would best meet their desire to reduce their greenhouse gas emissions in the most economical manner.

Bates College, Lewiston, ME

RFO: A RENEWABLE SOLUTION

RFO is manufactured using Ensyn's **RTP** process. **RTP** is a thermal conversion process known as fast pyrolysis, which is the rapid heating of biomass in the absence of oxygen. The process, shown in the figure below, utilizes a circulating transported bed reactor system in which sized and dried biomass is contacted with circulating hot sand in the reactor. The pyrolytic vapor is rapidly quenched to produce a high yield of liquid fuel.



RTP Process Flow Diagram

RFO FEEDSTOCK REQUIREMENTS

In order to qualify under the EPA's Renewable Fuel Standard, Ensyn Fuels must use "Renewable Biomass" as defined by the RFS. The credits generated as a qualified renewable fuel are critical to Ensyn Fuel's economics so all **RFO** is manufactured using feedstock that meets the "Renewable Biomass" definition. "Renewable Biomass" is defined as follows:

- Slash and pre-commercial thinning from non-federal forest lands.
- Planted trees and tree residue from actively managed tree plantations on non-federal lands.
- Biomass obtained from the immediate vicinity of buildings, public infrastructure and areas regularly occupied by people that are at risk of wild fire.
- Other activities, including planted crops and crop residue from non-forested agricultural land that is either actively managed or fallow.

Forest before thinning

Forest after thinning

Schematic of Products Derived from a Single Tree

Tops and Branches Chipped for biomass or mulch or left in woods.

8' to 16'
Depending on quality and local markets, sent to sawmill, pulp mill or chipped.

8' to 16'
Saw Log—sent to sawmill.

ENSYN fuels

GREENHOUSE GAS REDUCTIONS

Since **RFO** is manufactured from "Renewable Biomass" as defined by the EPA, it provides a significant reduction in life cycle greenhouse gases when compared to fossil fuels. **RFO** provides a 87.6% reduction in life cycle GHGs when compared to oil and a 81.7% reduction in life cycle GHGs when compared to natural gas.

GHG Emissions – Wood Feedstock

Fuel	Heating Oil	Natural Gas	PyOil (i.e., RFO)
Feedstock	Crude Oil	Natural Gas	Wood Residues
	g CO_2eq/GJ		
Fuel Dispensing	402	0	874
Fuel Distribution & Storage	698	2,063	361
Fuel Production	8,412	1,376	9,555
Feedstock Transmission	1,401	0	0
Feedstock Recovery	8,081	1,708	0
Land-use Changes, Cultivation	25	0	0
Fertilizer Manufacture	0	0	0
Gas Leaks & Flares	1,900	3,540	0
CO_2, H_2S Removed from NG	0	642	0
Emissions Displaced	-128	0	0
Sub-total Fuel Production	20,790	9,330	10,790
Fuel Combustion	68,718	51,432	301
Grand Total	89,508	60,762	11,091
% Change Compared to Heating Oil		-32.1%	-87.6%

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Bates College provides steam for heat and hot water to a majority of the campus from a central heating plant. The central heating plant utilizes 3 700 HP Cleaver Brooks boilers with the capability to burn both natural gas and #2 oil with natural gas as the primary fuel. The annual natural gas consumption for the central heating plant is 80,000 MMBtus. The total Scope 1 emissions from the central heating plant are 5,129 MTCO2eq.

Bates College has converted one of the boilers to burn **RFO**. A single boiler has the ability to carry the steam load a majority of the time. It is anticipated that the **RFO** boiler will provide 70% of the steam load for the campus while the reaming two natural gas boilers will provide 30% of the steam load. Of the 80,000 MMBtus consumed in the central heating plant, 56,000 MMBtus will come from **RFO** while 24,000 MMBtus will remain natural gas. After the conversion, the GHG emissions from **RFO** will be 676 MTCO2eq annually and the emissions from natural gas will be 1,539 MTCO2eq annually for a total of 2,215 MTCO2eq. This conversion to **RFO** yields a reduction of 2,914 MTCO2eq or 57%.

In the future, the 30% natural gas could be converted to **RFO** further reducing the GHG emissions by an additional 1,249 MTCO2eq for a total GHG reduction of 4,163 MTCO2eq or 81%.

CONVERSION PROCESS

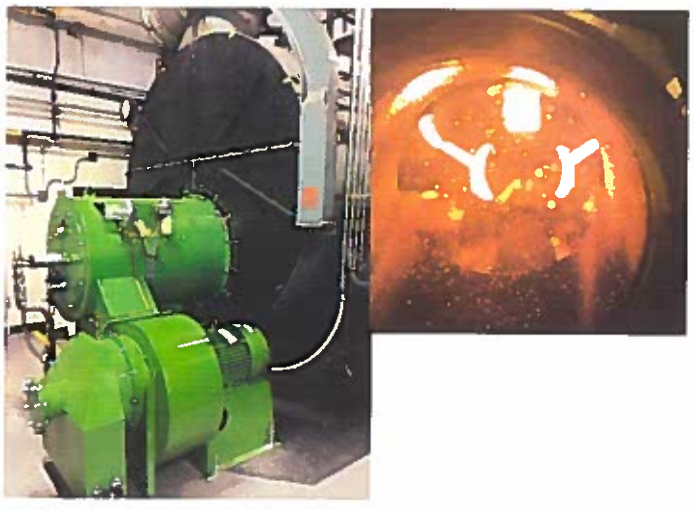
A typical conversion to **RFO** from natural gas or oil will include a tanker unloading pump, storage tank, pump and heating skid and a new or converted burner plus all interconnected piping. RFO is slightly acidic with a pH of approximately 3 which is similar to vinegar or red wine. Because of the acidity, the pre combustion fuel train and piping are constructed of stainless steel. Post combustion, no changes to the boiler are necessary.

RFO Pump and Heating Skid

RFO can be stored in either above ground storage tanks or underground storage tanks. A new stainless steel tank can be installed or an existing tank can be lined if it is not constructed of stainless steel.

Bates College has converted one Cleaver Brooks 700 HP boiler from a dual fuel natural gas/#2 oil burner to a **RFO** burner. Bates decided that with existing redundancy of the other 2 boilers that it was not necessary to have dual fuel **RFO**/ Natural gas burner although that is certainly an option.

Bates College installed a Preferred Manufacturing RFO burner onto their Cleaver Brooks boiler. Since Bates College already utilizes a burner management system from Preferred, they decided that integrating a Preferred RFO burner to their existing controls was their best option.



Bates College Converted Boiler