



Envergent
TECHNOLOGIES

A Honeywell Company

Renewable Fuel Oil – A Commercial Perspective

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**Technical Information Exchange on Pyrolysis Oil:
Potential for a Renewable Heating Oil Substitution Fuel in New England
May 9 – 10, 2012, Manchester, New Hampshire**

Envergent Technologies LLC – UOP / Ensyn Joint Venture



- **Formed in October 2008**
- **Provides pyrolysis technology for fuel oil substitution and electricity generation**
- **Development of technology for upgrading RTP green fuel to transportation fuels**



- **Leading process technology licensor~\$2 billion in sales, 3000 employees**
- **Nearly 100 years of refining technology development, scale-up and design**
- **Modular process unit supplier**
- **Global reach via Honeywell & UOP sales channels**



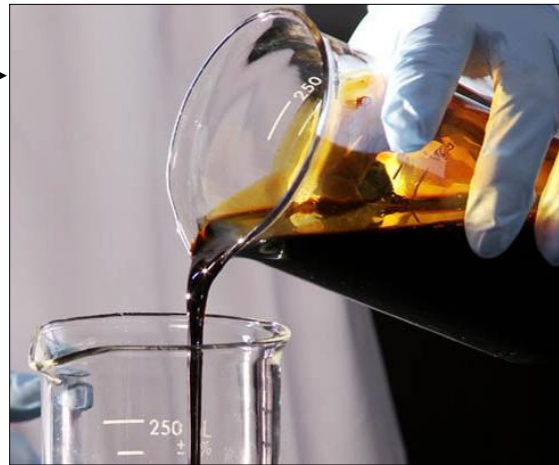
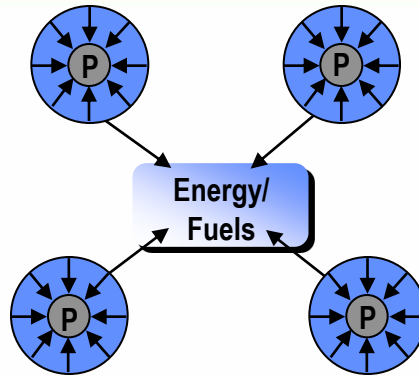
- **Over twenty years of commercial fast pyrolysis operating experience**
- **Developers of innovative RTP fast pyrolysis process**
- **Seven commercial RTP units designed and operated**

***Second Generation Renewable Energy Company –
Global Reach***

RTP – Second Generation Residues to Energy



**Forest Residue,
Agricultural Waste,
Construction & Demo Waste**



RTP Green Fuel

***Decouples Biomass
from Energy Generation***

Available Today

**Electricity
Production**

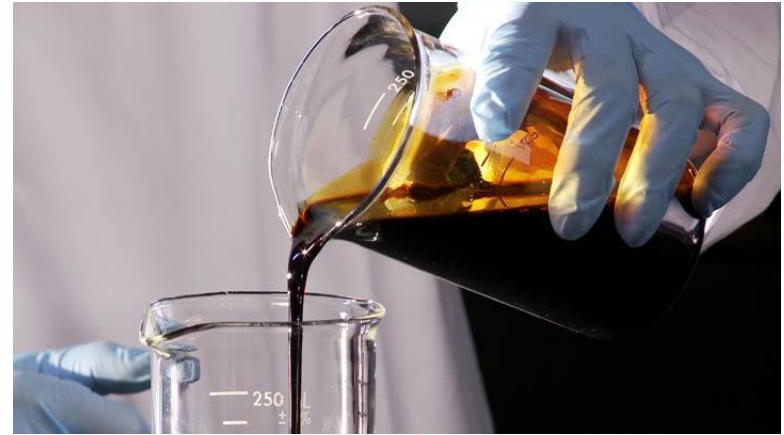
**Fuel Oil
Substitution**

Under Development

**Upgrade to
Transport
Fuels
(Gasoline,
Jet & Diesel)**

RTP Green Fuel Properties

- Pourable, storable and transportable liquid fuel
- Contains approximately 50-55% energy content of fossil fuel
- Meets applicable ASTM Standard for industrial use (ASTM D7544, Standard Specification for Pyrolysis Liquid Biofuel)



Comparison of Heating Value of RTP Green Fuel and Typical Fuels

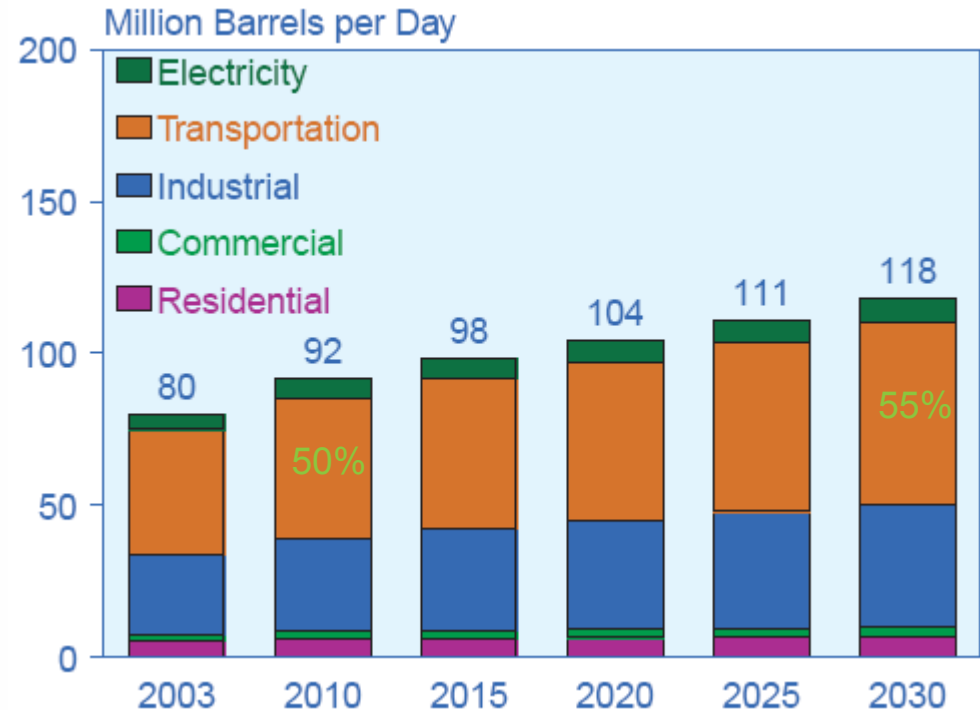
Fuel	MJ / Litre	BTU / US Gallon
Methanol	17.5	62,500
RTP Green Fuel	19.9	71,500
Ethanol	23.5	84,000
Light Fuel Oil (#2)	38.9	139,400

Suitable for Energy Applications

RTP Green Fuel End Markets

- Transportation dominates liquid fuel markets
- But industrial heat and power markets offer significant opportunity that can be addressed today
- Currently focused on industrial projects in areas where feed/product spread is favorable (with or without incentives)

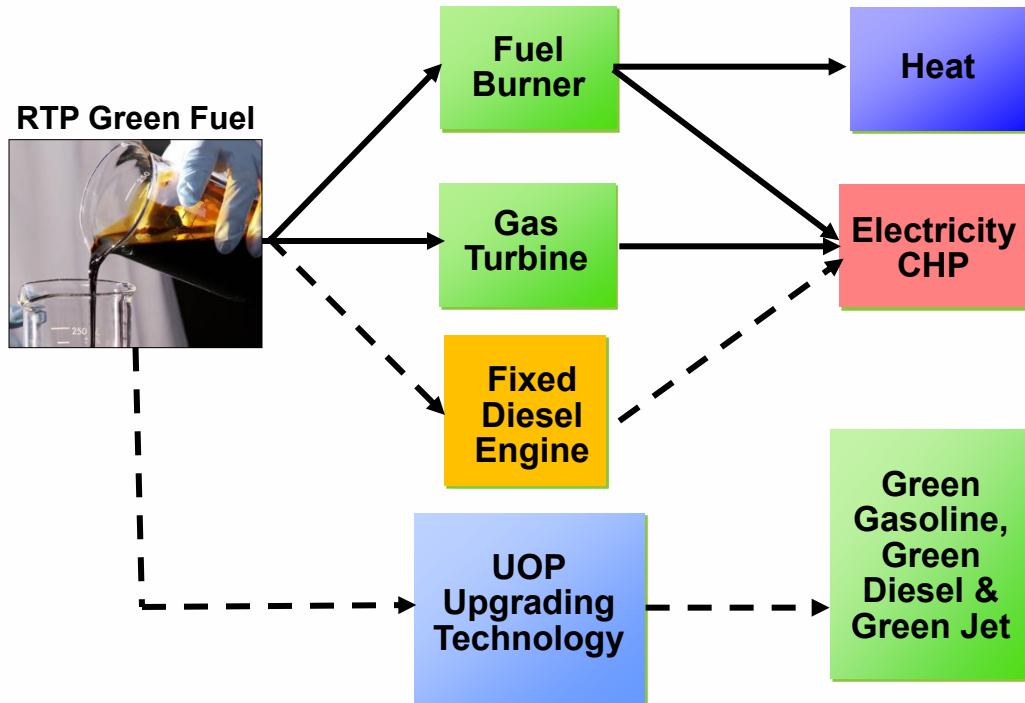
World oil use by sector, 2003-2030





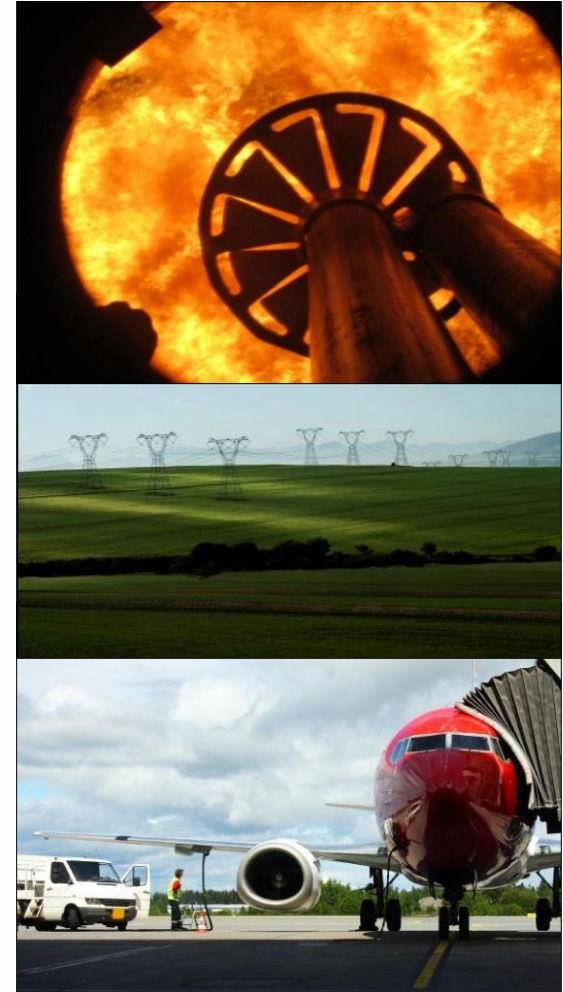
EIA, International Energy Outlook 2006

Address Today's Markets While Developing Tomorrow's Technology

RTP Green Fuel Applications



- Current Applications 
- Emerging Applications 



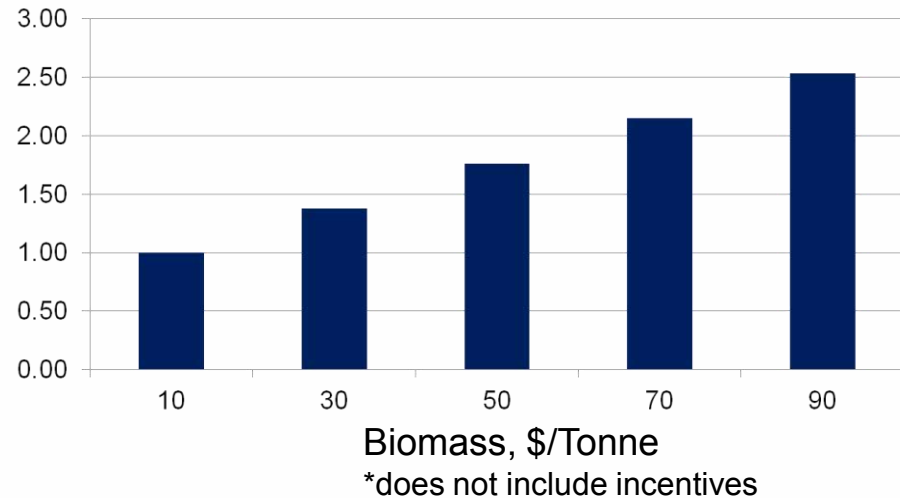
Multiple Applications Drive Multiple Market Opportunities

RTP Green Fuel-Replacement of Fossil Fuel Oil

- Low emissions (NO_x, SO_x)
- Fuel consistency - *ASTM D7544 standard*
- GHG emission reduction of 70-90%
- Low cost liquid biofuel
- Example Basis
 - Replacement of #6 fuel oil at equivalent heating value price
 - Assumed \$2.80/gal for #6
 - Feed cost = as received, 40% moisture

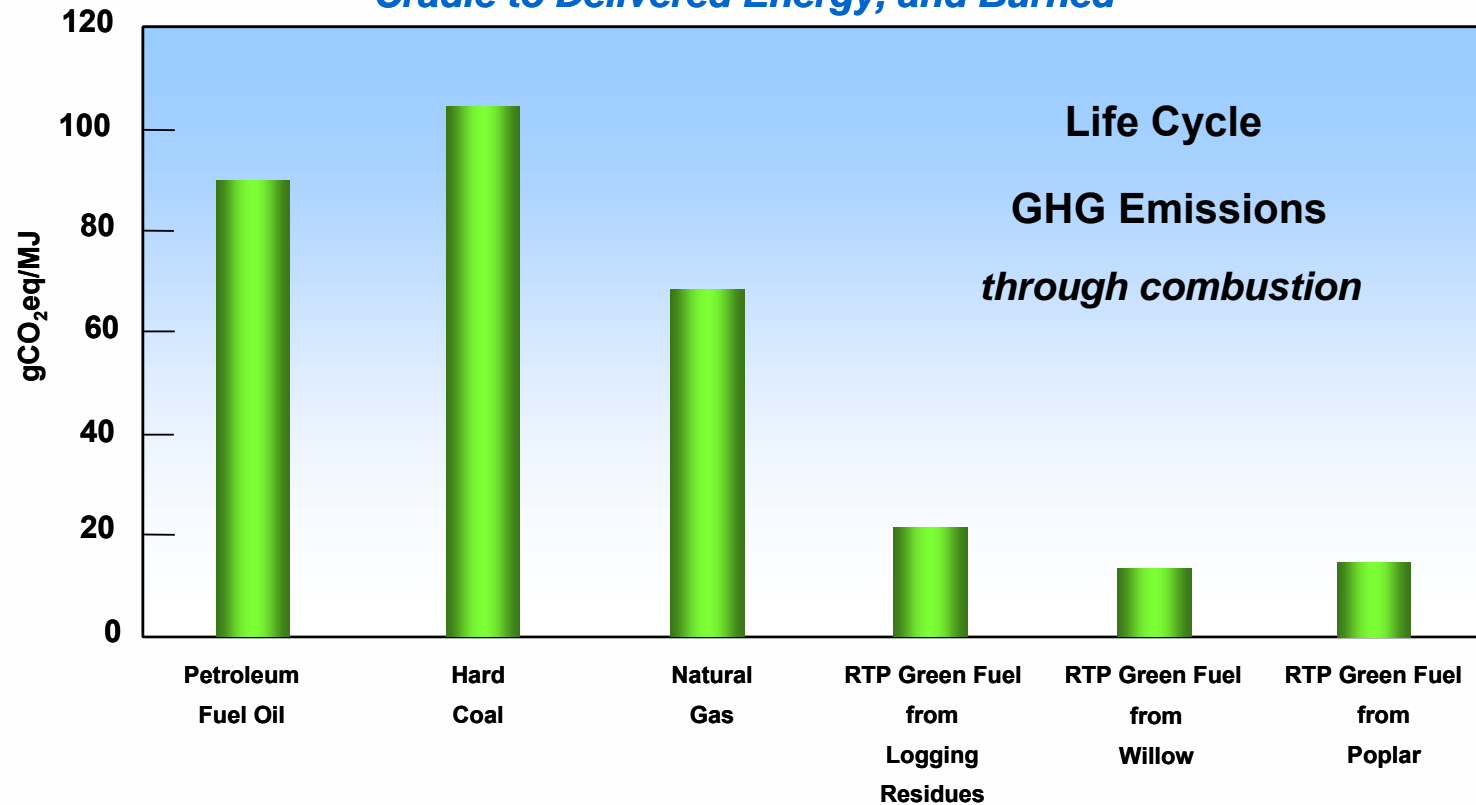


RTP Green Fuel Production Cost,
\$/BTU Equiv. Gal



A Cost Effective Green Alternative to Fuel Oil

Comparison of GHG Emissions Cradle to Delivered Energy, and Burned



- RTP green fuel **Life Cycle** foot print **Greener** than other alternatives
- Carbon neutral combustion emission 70-88% lower GHG emissions
- SO_x emissions similar to Natural Gas

RTP Green Fuel – Renewable Heat Experience

- **20+ years industrial experience combusting RTP liquids**
 - Red Arrow, Wisconsin
 - Manitowoc Public Utilities, Wisconsin
 - Over 65 million liters delivered for process heat
- **Recent successful demonstrations in a variety of applications**
 - Power boiler
 - Iron Ore pellet furnace
 - Various process and heating boilers



Commercial/Industrial Boiler

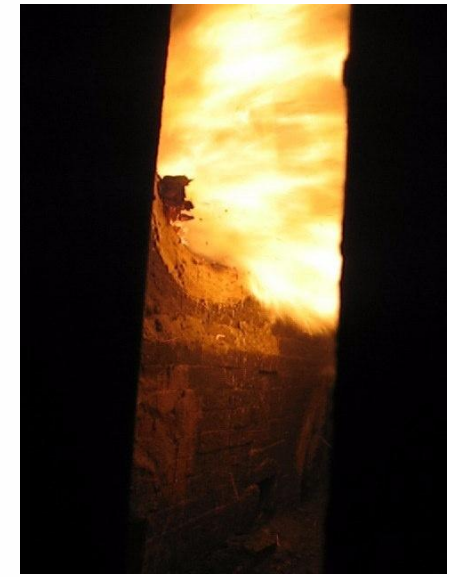
- **American specialty paper products company**
- **Ran up to 19.2 MMBtu/hr to produce space heat**
- **Fired exclusively on RTP green fuel**
- **Babcock and Wilcox heavy fuel oil burner and boiler**
- **Compared emissions to HFO**
 - Virtually eliminated SOx
 - NOx emissions lowered
- **November 2010**



HFO Flame

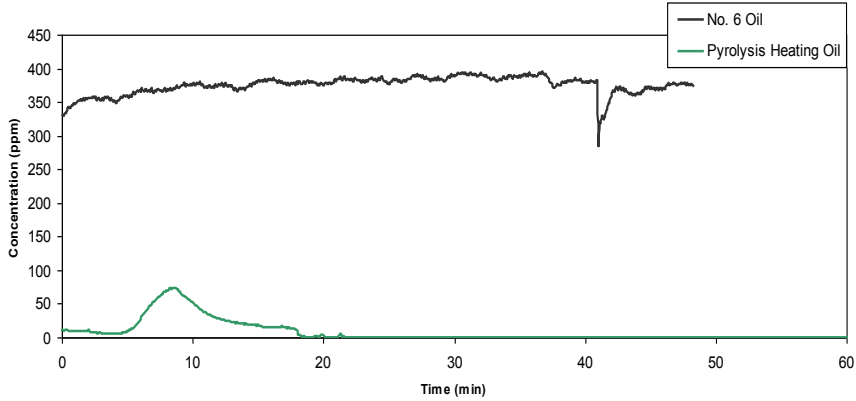


RTP Green Fuel Flame

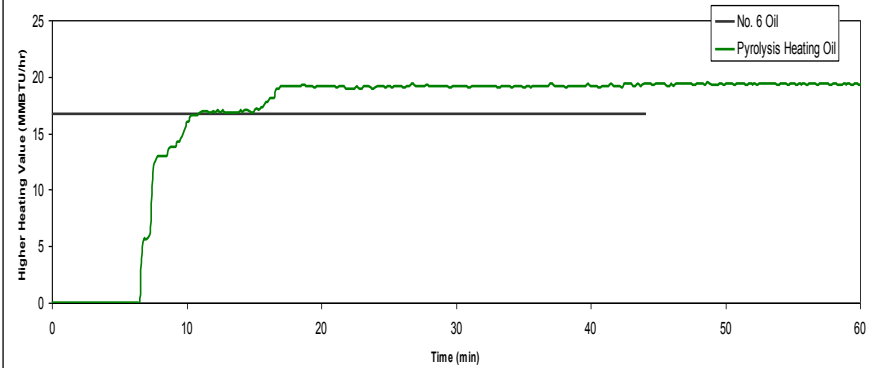


Commercial/Industrial Boiler

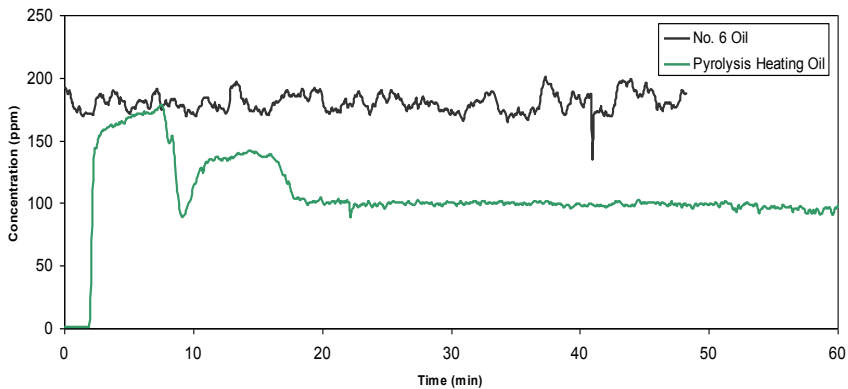
Sulfur Dioxide Concentration in Flue Gas



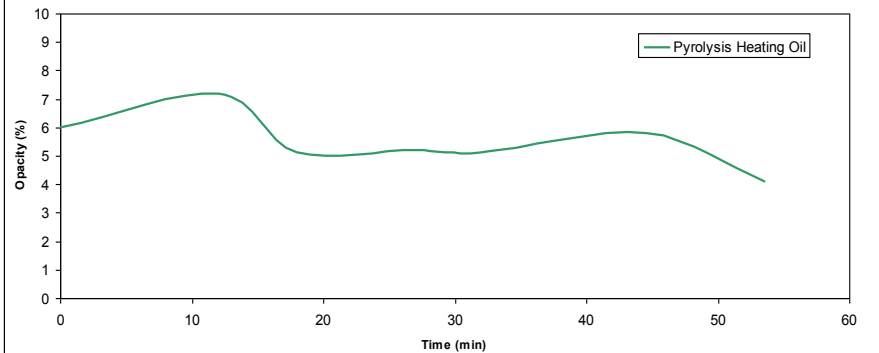
Fuel Inputs on a Higher Heating Value Basis



NOx Concentration in Flue Gas



Boiler #1 Stack Opacity

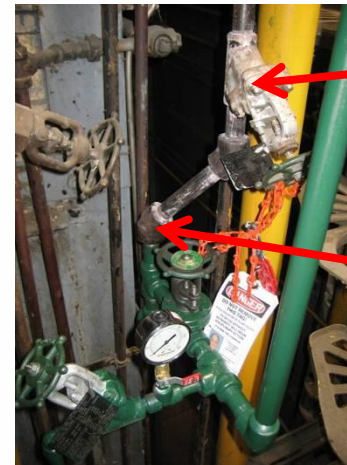


Commercial/Industrial Boiler

RTP Green Fuel Delivery Skid



Burner Nozzle



No.6 Fuel Line

Tie in

RTP Green Fuel HFO Connections

Process Boiler

- **European forestry company**
- **Ran at 20 MWth, replacing HFO**
- **Produced steam for use in plant**
- **PetroKraft rotating cup burner**
- **October 2009**



Iron Ore Pellet Furnace

- **Canadian iron ore company**
- **Ran up to 22 GJ/hr**
- **Fired one burner exclusively on RTP green fuel, replacing HFO**
- **Application was ideal for RTP green fuel**
- **June 2011**

RTP Green Fuel Flame

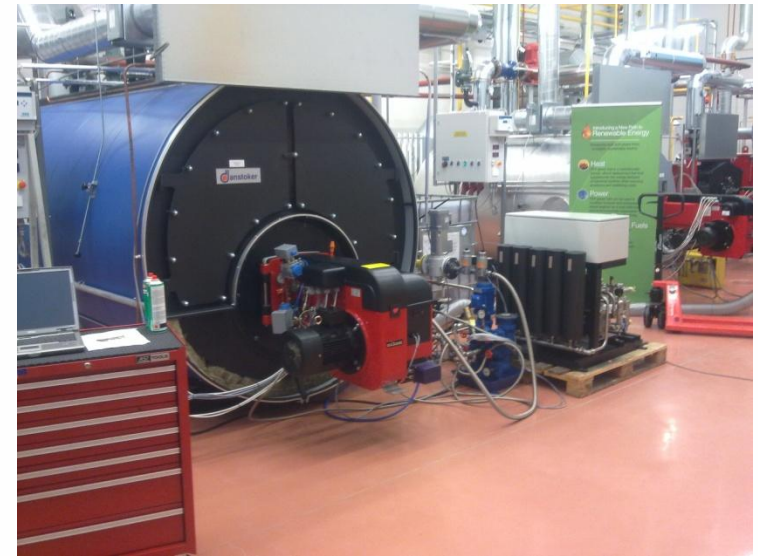


Ore Pellet Furnace



Oilon Burner Commercial Development

- **Oilon has developed a full burner solution for pyrolysis oil**
 - Includes fuel conditioning and burner controls
- **Recent testing at their Energon facility in Lahti, Finland**
 - 2.5 MWth boiler
 - 18 metric tonnes of RTP green fuel burned

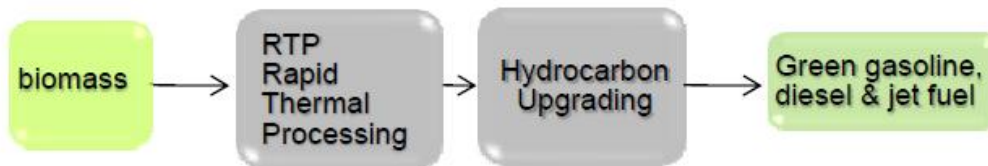


IBR – Biomass to Transportation Fuel Pilot

Honeywell



- Pilot-scale conversion of biomass into liquid transportation fuels
- Located at the Tesoro Refinery in Kapolei, HI
- Backed by a \$25 million award from the U.S. Department of Energy
- Utilizes a wide range of locally available biomass (switchgrass, algae, forest and agricultural residuals)
- Commercial units could create up to 800 construction jobs and 1,000 new jobs in biomass production and refinery operations
- Greater than 60% reduction in greenhouse gas emissions
- Phase 1 Start-up Underway 4/2/2012
- Fully Operation 1Q 2013



Making Cellulosic Biofuels a Reality

History and Commercial Experience

- **Commercialized in the 1980's**
- **7 units designed and operated in the US and Canada**
- **Continuous process with >90% availability**

New Projects Under Development:



<i>Location</i>	<i>Application</i>	<i>Size (TPD)</i>
Europe	Power Generation	150
Malaysia	Industrial Process Heat	400
Northern Europe	Power Generation	2 x 400
North America	Industrial Process Heat	400
Northern Europe	District Heating	up to 3 x 400

RTP Summary

- RTP green fuel is cost-competitive with fossil fuel oil
- Commercially proven technology: 7 units in operation; 3 new projects announced
- Decouples biomass conversion from energy generation
- Greater than 70% LCA green house gas emission reduction
- Heavy fuel oil replacement commercially available today

