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RTP™ Rapid Thermal Processing: A Proven Pathway to Renewable Liquid Fuel

DOE Biomass 2012

July 10, 2012

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Envergent Technologies LLC – UOP / Ensyn Joint Venture

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- A Honeywell company, formed in October 2008
- Delivers RTP™ Rapid Thermal Processing technology for heat, power and fuels production
- Second generation renewable energy company providing global support

UOP
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- Leading process technology licensor ~$2 billion in sales, 3000 employees
- Co-inventor of FCC technology
- Modular process unit supplier
- Global reach via Honeywell & UOP sales channels

ENSYN

- Over 20 years of commercial fast pyrolysis operating experience
- Developers of innovative RTP fast pyrolysis process
- Seven commercial RTP units designed and operated

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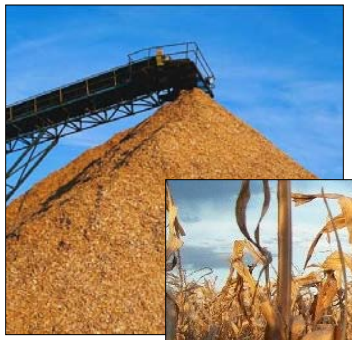
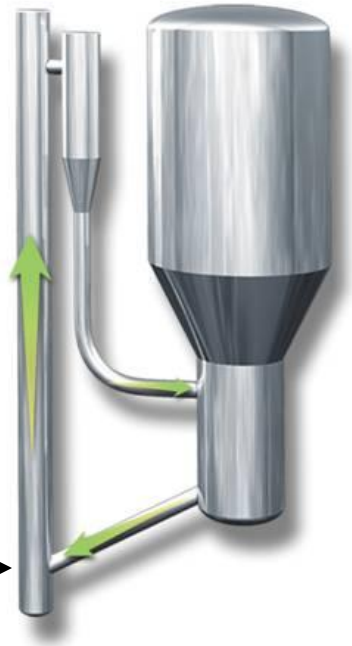
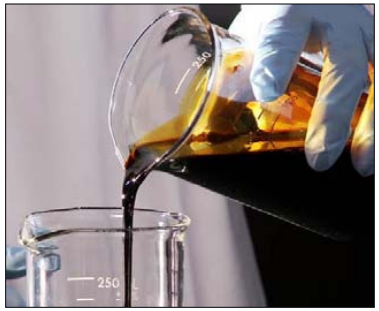
RTP – Second Generation Residues to Energy

- Transportable fuel
- Energy densification relative to biomass
- Maximum liquid yield 65 – 75 wt%



Forest and Agriculture Residues





RTP Green Fuel

Fuel Oil Substitution

Electricity Production

Upgrade to Transport Fuels (Gasoline, Jet & Diesel)

Liquid Fuel Decouples Biomass Conversion from Energy Generation

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History and Commercial Experience

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- Commercialized in the 1980's
- Seven units designed and operated in the US and Canada
- Largest is in Renfrew, Ontario, Canada
  - Can process up to 100 BDMTPD of biomass and produce up to 20M liters of renewable fuel per year

New Projects Under Development:

Location	*Application*	*Size (TPD)*
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

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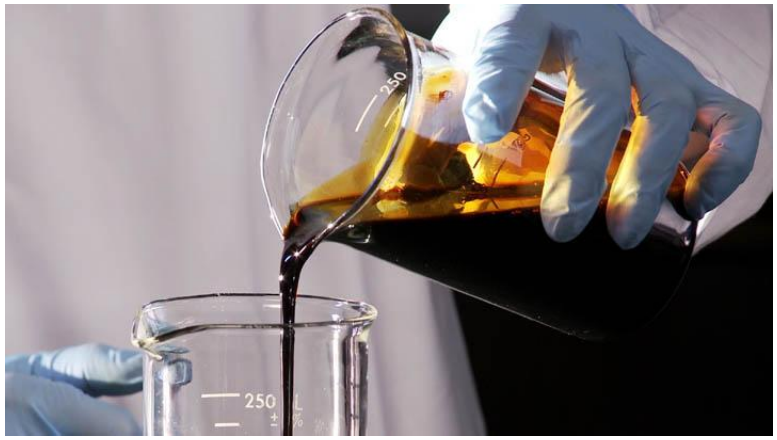
RTP Green Fuel Properties

- 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

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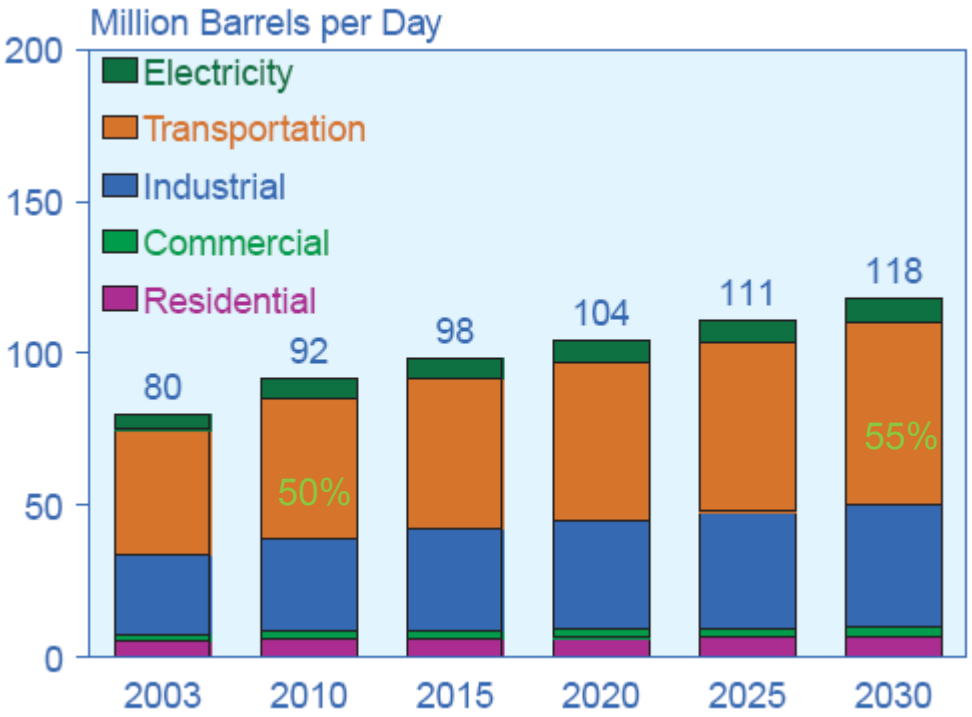
RTP Green Fuel Energy Applications

- Transportation dominates liquid fuel markets
  - Growing in significance
  - Largest value uplift versus feed
- Heat and power markets offer significant opportunity that can be addressed today

World oil use by sector, 2003-2030



EIA, International Energy Outlook 2006

Flexibility to address today's markets while developing tomorrow's technology

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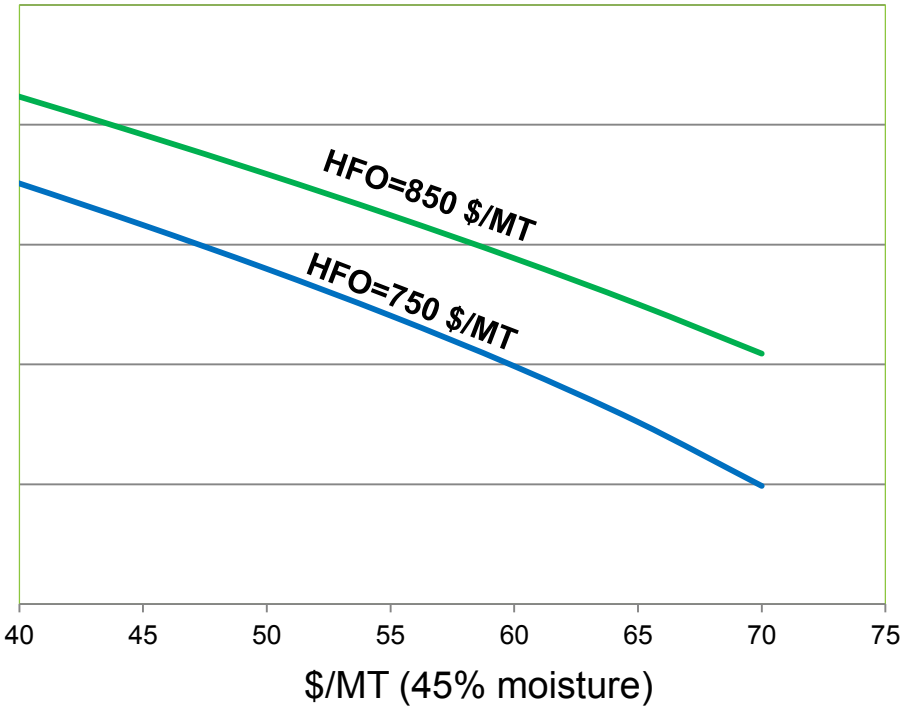
RTP Green Fuel - Combustion

- Over 20 years of industrial experience combusting RTP liquids
  - Red Arrow, Wisconsin
  - Manitowoc Public Utilities, Wisconsin
  - Over 15 million gallons combusted for heat
- RTP green fuel can be co-fired or used alone in conventional commercial and industrial boilers with little modification
  - Extension to residential with infrastructure/logistics development
- Combustion emissions compare favorably with heavy fuel oil
  - SO_X reduction > 99%
  - NO_X reduction up to 40%

Effect of Biomass Cost on Project Economics



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RTP Green Fuel vs. Fossil Fuel LCA

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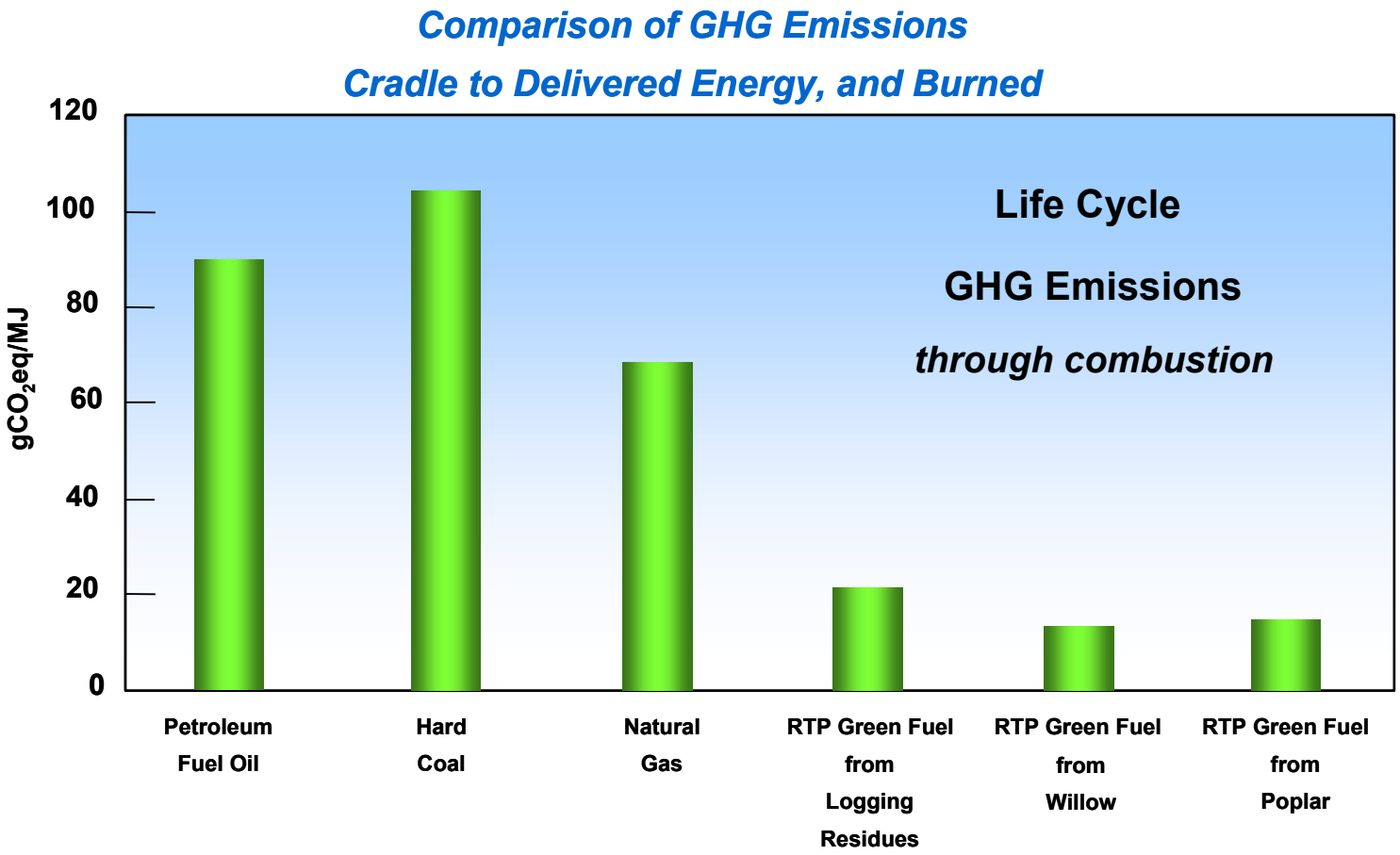

- RTP green fuel *Life Cycle* foot print *Greener* than other alternatives
- Carbon neutral combustion emission 70-88% lower GHG emissions
- SO_x emissions similar to Natural Gas

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RTP Green Fuel – Combustion

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RTP Green Fuel Flame

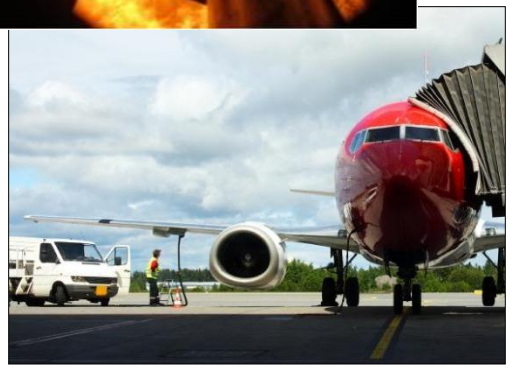
Iron Ore Pelletizing Furnace

Fuel Delivery Skid

Process Boiler

Summary

- Commercially proven fast pyrolysis process for converting biomass into a renewable liquid fuel
  - Seven units and 20 years of commercial experience
  - High yield of liquid product
  - Energy densification improves transport economics
- Decouples biomass conversion from energy generation
  - RTP located near biomass – energy generation located near the consumer
  - Enables distributed power production
- Produces a transportable and storable liquid fuel with optionality for end-use
  - Heat and power generation applications possible today
  - Significantly improved emissions and carbon footprint relative to combustion of heavy fuel oil
  - Can be upgraded to transportation fuels at high yields in the near future



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Thank You

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