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RTP™ Rapid Thermal Processing:

MJCleveland
Vice President and General Manager Latin America
Recife, Brazil
July 24, 2014

Envergent Technologies LLC – UOP / Ensyn Joint Venture

- **Formed in October 2008**
- **Delivers Rapid Thermal Processing (RTP™) technology for energy generation**

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- Independent oil, gas and renewables technology provider
- Commercialized first heterogeneous catalyst and synthetic zeolite.
- Modular process unit supplier
- Global strength of Honeywell & UOP sales and service teams

ENSYN

- Over 20 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

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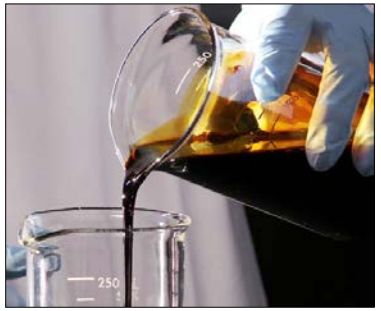
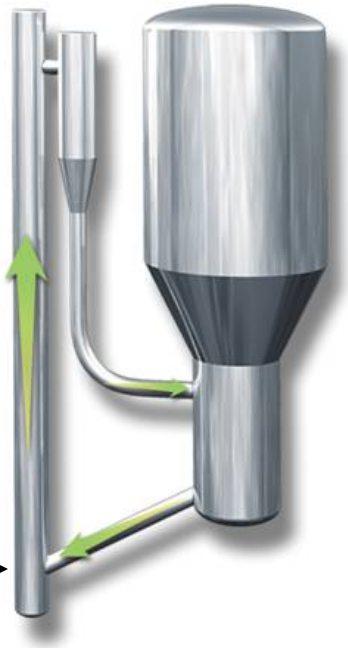
- **Transportable fuel**
- **Energy densification relative to biomass**
- **Maximum liquid yield 65 – 75 wt%**

RTP Green Fuel





Fuel Oil Substitution

Electricity Production

Upgrade to Transport Fuels (Gasoline, Jet & Diesel)

Decouples biomass conversion from energy generation

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Renewable Feedstock Sources

- **Forest Industry**
  - ✓**Wood chips, sawdust and bark**
  - ✓**Forest residues**
- **Agricultural**
  - ✓**Residues – corn stover, expended fruit bunches from palm (EFB), bagasse,**
  - ✓**Purpose-grown energy crops – miscanthus and elephant grass**

Second Generation Feedstock Widely Available

History and Commercial Experience

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

New Projects Under Development:

Location	*Application*	*Size (TPD)*
Northern Europe	District Heating	Up to 3 X 400
South America	Industrial Process Heat	400
Malaysia	Industrial Process Heat	150
North America	Building Heat	400
North America	Refinery Co-Processing	100
North America	Refinery Co-Processing	400

RTP Green Fuel Energy Applications

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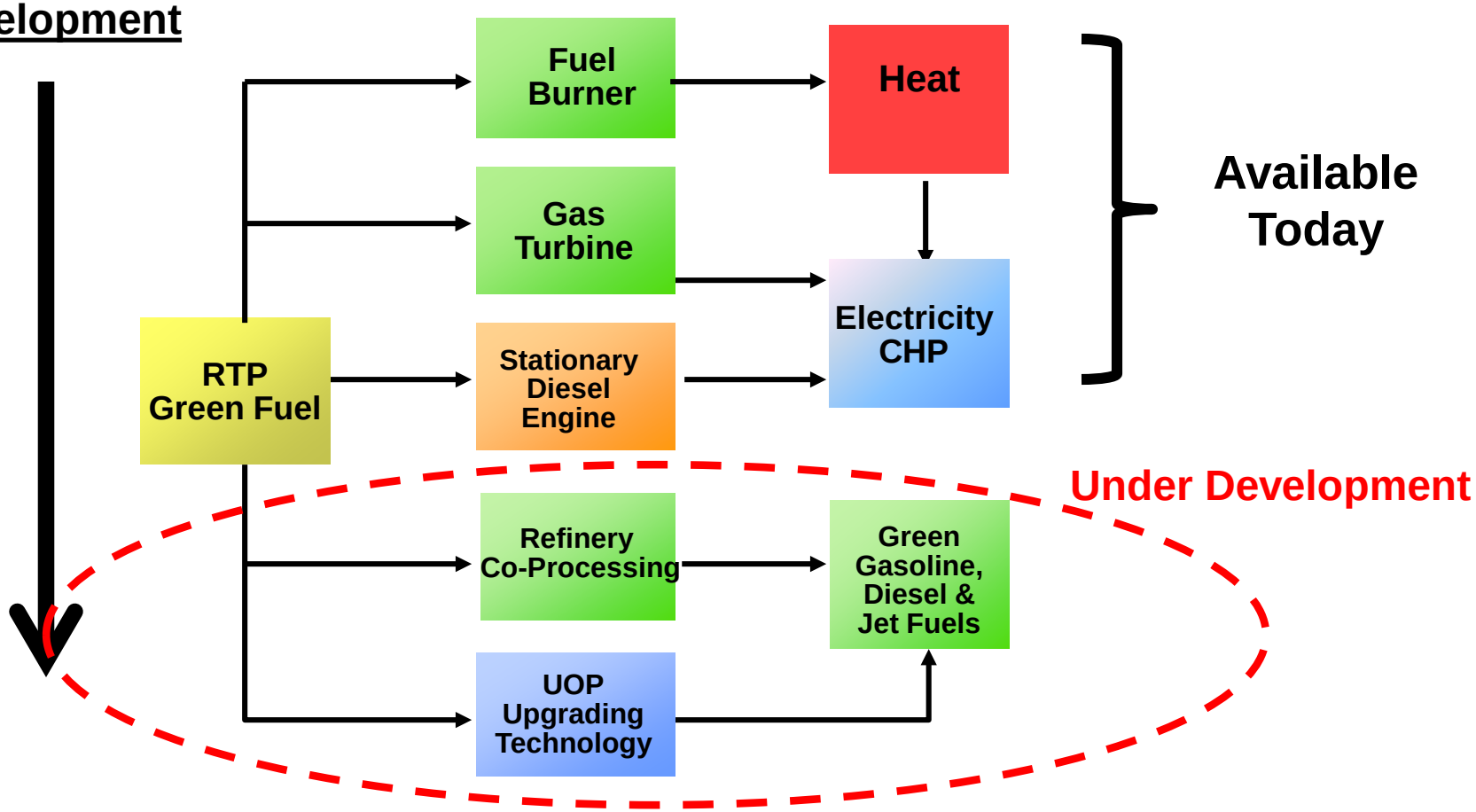
Applications Expand With Technology Development



Increasing Applications Grow Market for RTP Green Fuel

Stand Alone Upgrading of RTP Green Fuel To Transportation Fuel

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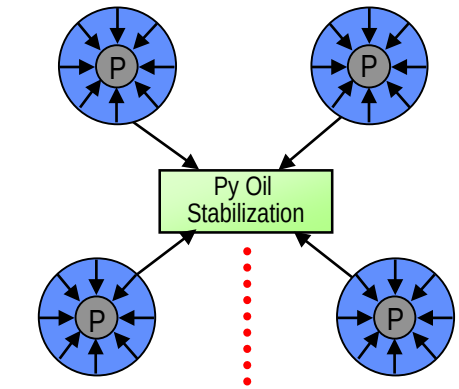


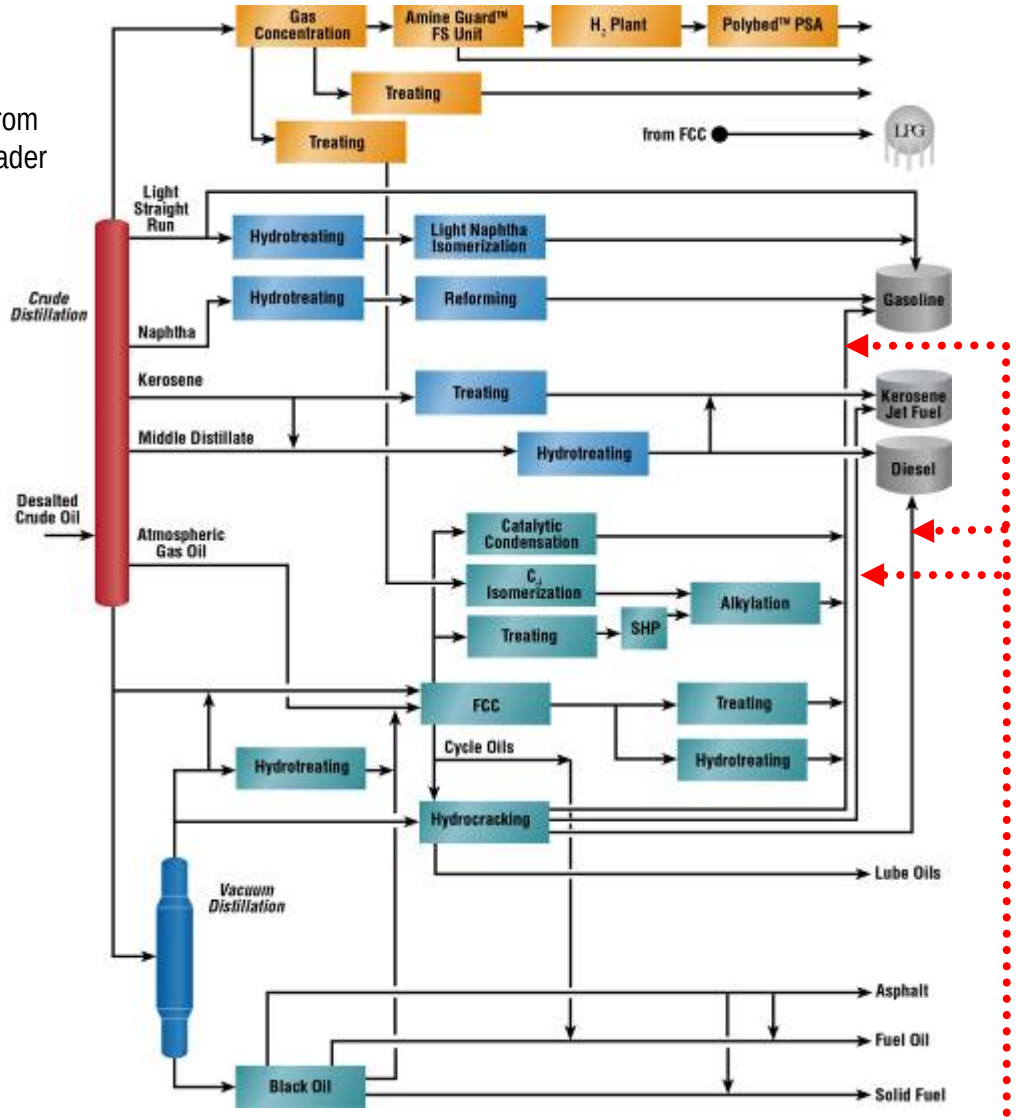
Pyrolysis close to biomass source for densification

Hydrogen from Refinery Header

Upgrader

Upgrader integrated with Refinery

Biofuels to Refinery Pool



Produces Neat Fuels For Transportation Pool Blending

Upgrading RTP Green Fuel To Transportation Fuels

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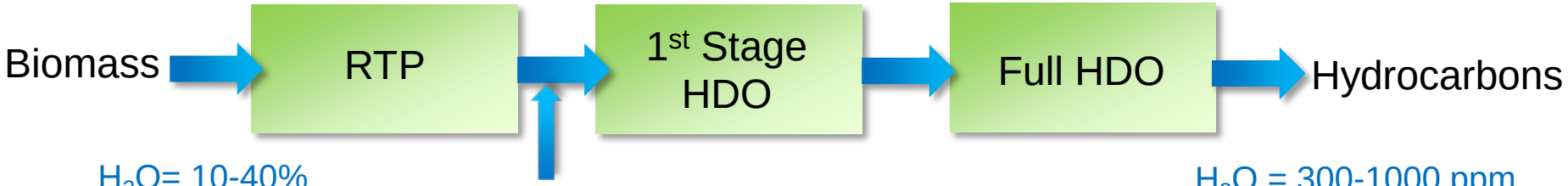
Objectives:

- Remove oxygen as water and CO_2 by hydrogen & catalyst
- pH neutral fuel with viscosity equivalent to refined fuels
- Produce high octane gasoline, or diesel/jet components

Two Stage Hydrodeoxygenation



Upgraded Pyrolysis Oil Products

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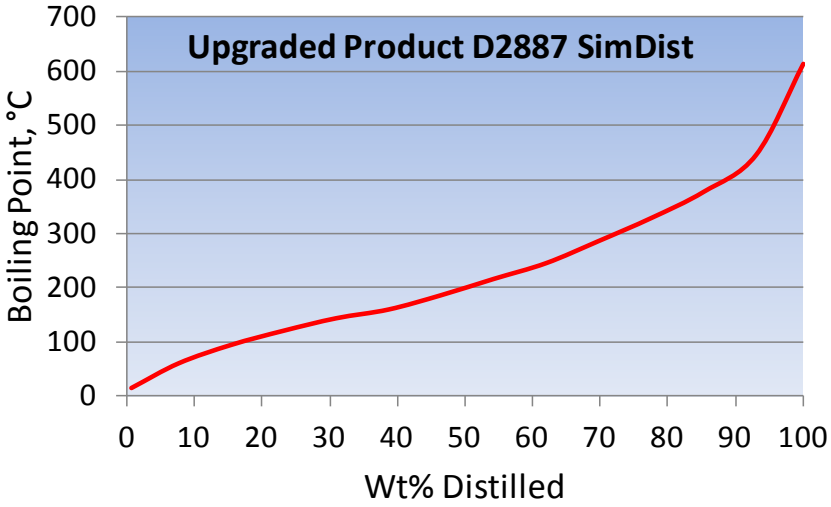
RTP Green Fuel to Fuels Feed/Product Analysis			
	RTP Green Fuel	Upgraded Fuel	Gasoline Requirements
Water, %	~25	0.03	<0.1
O, %	51	<0.1	<2.0
TAN, meq/g	91	<0.1	<0.1

RTP Green Fuel Transportation Fuel Yield[1]	
	Overall Yield, % of pyrolysis oil feed
Mass	41
Volume	60[2]

1. Demonstrated yield at multiple equipment scales.
2. Equals > 90 gallons per dry MT for woody biomass.



- ~50% of material in gasoline boiling range 40-200°C
- RON of gasoline ~85-90
- ~40% of material in diesel/jet boiling range

Renewable Gasoline GHG Emissions

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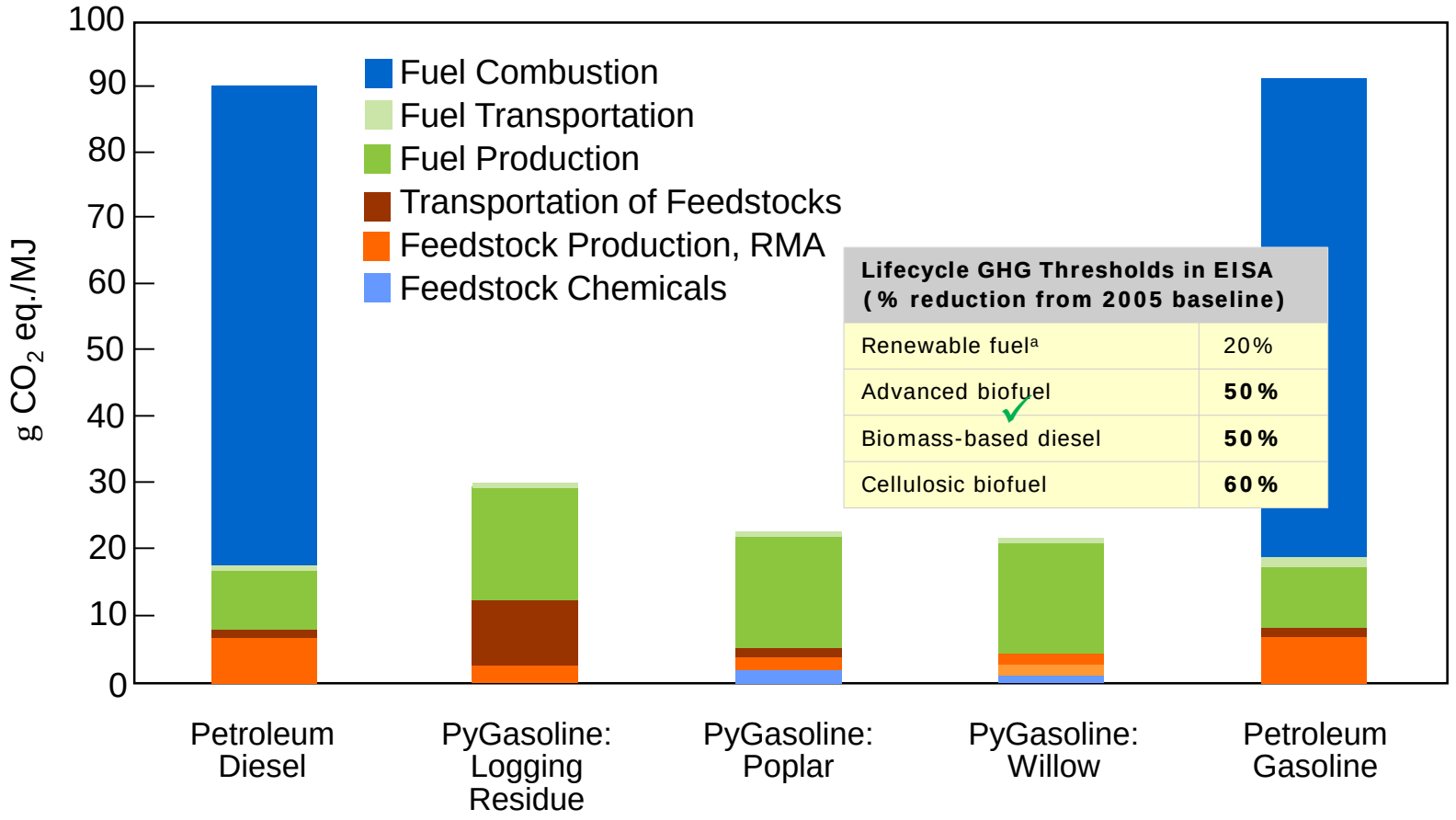
PRELIMINARY MODEL RESULTS (WOODY FEEDSTOCK)



Lifecycle GHG Thresholds in EISA (% reduction from 2005 baseline)	
Renewable fuel[a]	20%
Advanced biofuel ✓	**50%**
Biomass-based diesel	**50%**
Cellulosic biofuel	**60%**

Upgrading RTP Green Fuel Makes Cellulosic Biofuels

ENV 5233-19

Co-Processing Of RTP Green Fuel To Produce Transportation Fuel

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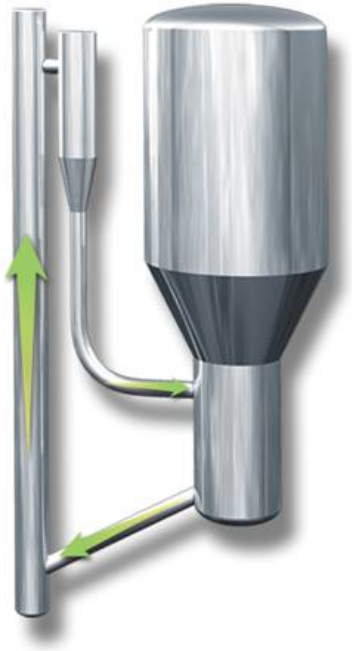
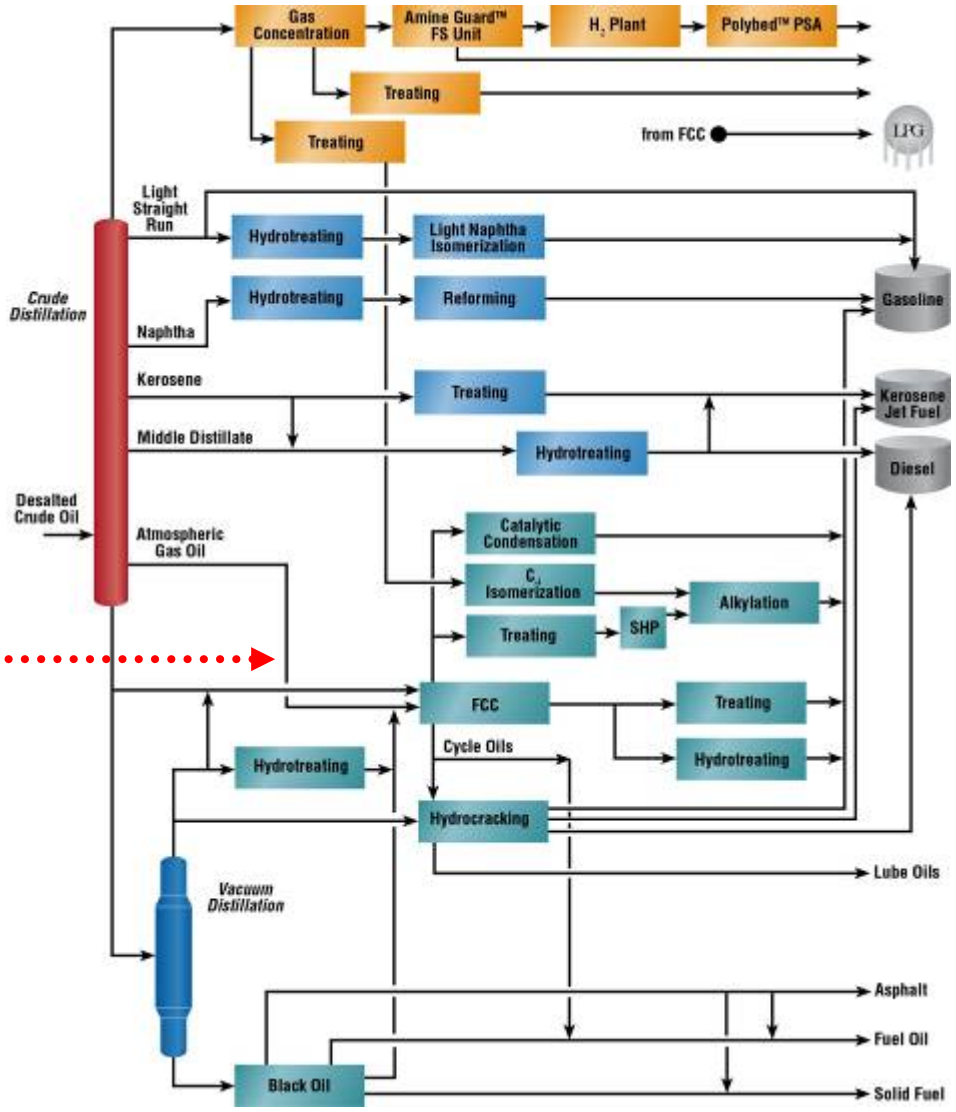
Pyrolysis close to biomass source for densification





Commercial Application is Distributed Model

Co-Processing Of RTP Green Fuel To Produce Transportation Fuel

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- In a co-processing application RTP green fuel is processed in a refinery
  FCC unit along with the traditional vacuum gas Oil (VGO) feed
- Feed blends containing up to 5% RTP green fuel are being considered
  by refiners
- Produces the same gasoline and diesel products with a renewable
  component
- Qualifies as a cellulosic biofuel under US RFS2
- Qualifies for double counting under European RED
- Low capex renewable fuel solution for the refiner
- High value added application for the RTP owner

RTP Summary

- Commercially proven fast pyrolysis process for converting biomass into a renewable fuel
  - Seven units and 20 years of commercial experience
- Decouples biomass conversion from energy generation
  - RTP located near biomass – energy generation located near the consumer
  - Enables on-demand renewable energy production
- High yield of liquid product
  - Produces a transportable and storable liquid fuel for heat and power generation
  - Can be co-processed in refinery
  - Can be upgraded to transportation fuels at high yields on biomass

Barriers to Solution Adoption

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- ***Is there a need for a solution***
- Practicality of the solution
- Government regulations / support – both in support and blocking
- Capital availability
- Robustness of the solution
- Financial returns
- Long term feedstock availability/cost
- Risk tolerance
- First mover advantage (and disadvantage)

Investors Look for Stability and Long Term Returns

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Thank You