

# Rentech's BioEnergy Center of Excellence



Oklahoma EPSCoR Conference – April 2012

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BioEnergy Center of Excellence  
Rentech Energy Technology Center, llc

# Introduction to Rentech



- Established in 1981
- Employees: 250+
- Publicly-traded: NYSE AMEX: “RTK”
- Locations:
  - Los Angeles, CA (Headquarters)
  - Commerce City, CO (BECE location)
  - Natchez, MS
  - Honolulu, HI
  - East Dubuque, IL
- 30 years of technology operating experience
- 40 years of syngas production experience
- Nitrogen fertilizer facility: 600K tons/yr
- BioEnergy Center of Excellence “BECE”
  - \$150 Million Fully Integrated Biomass Synthetic Fuels, Power and Chemicals Facility
  - Majority Owner of ClearFuels Technology Inc.



# Introduction to Rentech



- Market capitalization: ~480M<sup>1</sup>
- Employees: ~250
- Headquarters: Los Angeles, CA

## BioEnergy Center of Excellence (BECE)



- Fully integrated biomass to synthetic drop-in fuels facility in North America
- Capable of producing 10 bbl/d biofuels
- Syngas production from variety of inputs (incl. natural gas and coal) for higher-value conversion

## Rentech Nitrogen Partners (RNF)



- Publicly Traded (NYSE: RNF)
- Market capitalization: ~\$1B
- Fertilizer facility produces +600,000 tons of fertilizer annually

<sup>1</sup> As of February 24, 2010

Source: Rentech, Yahoo Finance

# Introduction to Rentech Clean Energy Technologies



## Rentech-ClearFuels Biomass gasification

## Rentech-SilvaGas Biomass gasification

## Rentech Process Synthetic Jet / Diesel

### **Feedstocks:**

Sugarcane bagasse, wood processing by-products, agricultural residues, lignin using steam reformation

Wood, agricultural residues, straw, switch grass, & energy crops using dual circulating fluid bed gasification

Syngas from any carbon-bearing materials

### **Products:**

Syngas, Steam, Hydrogen and/or Power, Optimized for fuels or power

Power; fuels & power

Hydrocarbons for synthetic fuels; specialty chemicals

### **Readiness:**

Proven at pilot scale;  
To be proven at demo scale  
first half 2012

Proven at commercial scale;  
Deployable today

Proven at demonstration scale;  
Deployable today using natural  
gas and SMR

# Energy Products

## Certified Fuels from Rentech's FT Technology



**Diesel: Audi 1000 Mile Drive**



**Certified Jet: United Airlines Flight**



**Lower tailpipe emissions**

## Low carbon footprint & cellulosic RINs

### Other Cellulosic Fuels

- Cellulosic ethanol and other fuels from our biomass gasification technologies
- Fuels can qualify for cellulosic RINs

### Renewable Hydrogen

- Produced from biomass by Rentech-ClearFuels gasifier

### Renewable Power

- **Renewable baseload** power; no backup required
- **Close** to interconnection and transmission



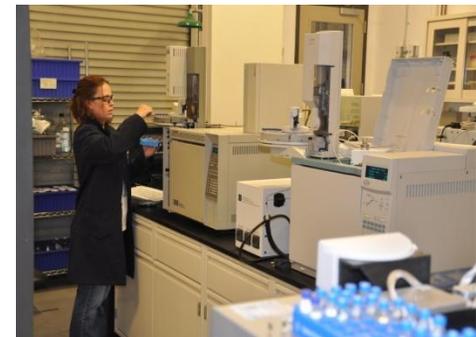
# BioEnergy Center of Excellence (BECE)

# Rentech Energy Technology Center, LLC

## BioEnergy Center of Excellence



- Integrated systems for Synthetic Fuels, BioFuel, Renewable Chemical, and Power Production; Steam-Methane Reformer, Biomass Gasification; Hydro-Processing; Catalyst Development and Testing Labs
  - Platform for development of BioEnergy technologies for commercial deployment
  - Designed to be highly flexible – “Plug and Play” for innovative new technologies
  - Produces ultra clean, certified aviation and diesel fuels, naphtha, power and chemicals
- Produced Ultra-clean diesel & aviation fuels and naphtha
  - Diesel fuel meets ASTM, D97566 and EN 590 specs
  - “Drop in” fuels
- Testing syngas and fuels from variety of feedstocks:
  - Wood Waste
  - Natural Gas
  - Corn Stover
  - Bagasse
  - Switchgrass
  - Sorghum
- \$150 million technology and R&D center
- 70 scientists, engineers, technicians and operators
- 3 catalyst development and evaluation labs
- 1 analytical lab and 1 wax/catalyst separation technology lab



## BECE – BioEnergy Center of Excellence

- **With the addition of a Rentech-ClearFuels Biomass Gasifier, the BioEnergy Center of Excellence (BECE) will be a fully-integrated biomass-to-liquids(BTL) facility**
  - \$23 million DOE grant for the RTK/CF Gasifier with an additional \$13 million invested by Rentech
  - Will allow flexibility of feedstock including wood chips, sugar cane bagasse, and corn stover in addition to the current feedstock of natural gas
  - The BECE has in place the necessary equipment to clean and remove any contaminants present in the various feedstock to the permitted levels
- **First production expected in mid 2012**

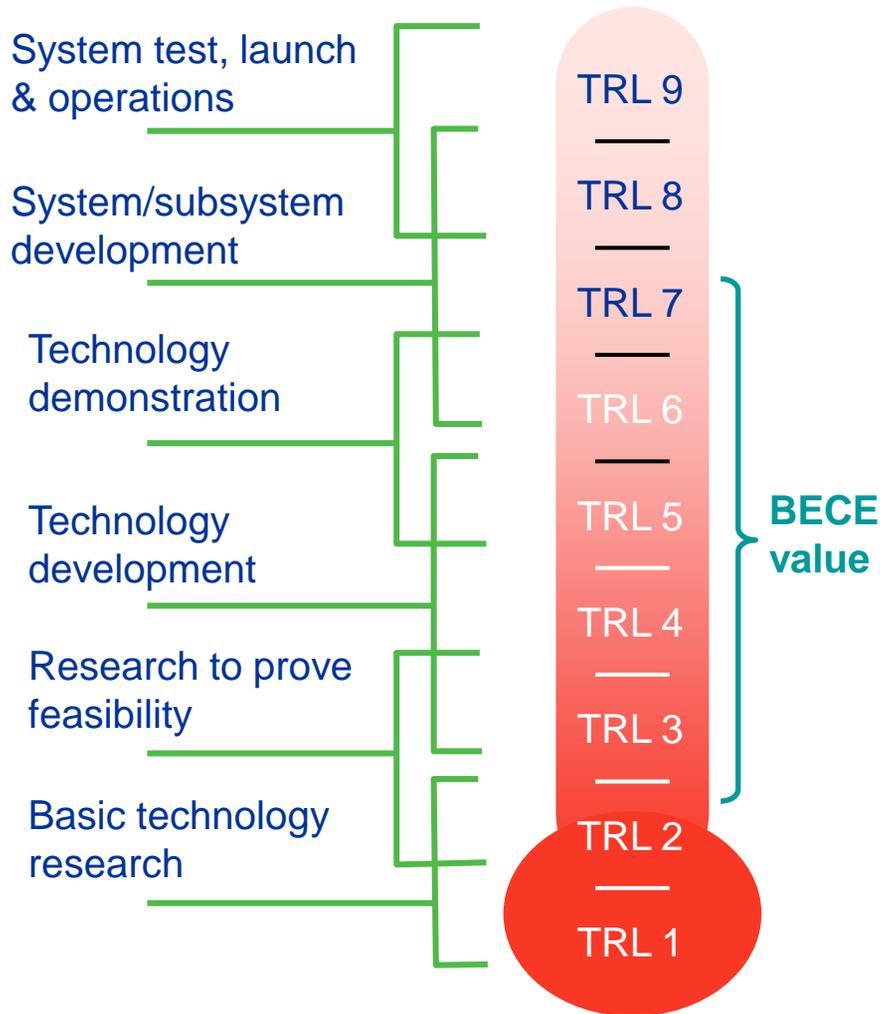


**Rentech-ClearFuels' Biomass Gasifier**

# BECE is developing a variety of technologies at pre-commercialization stage



## Stage of development and technology readiness level (TRL)

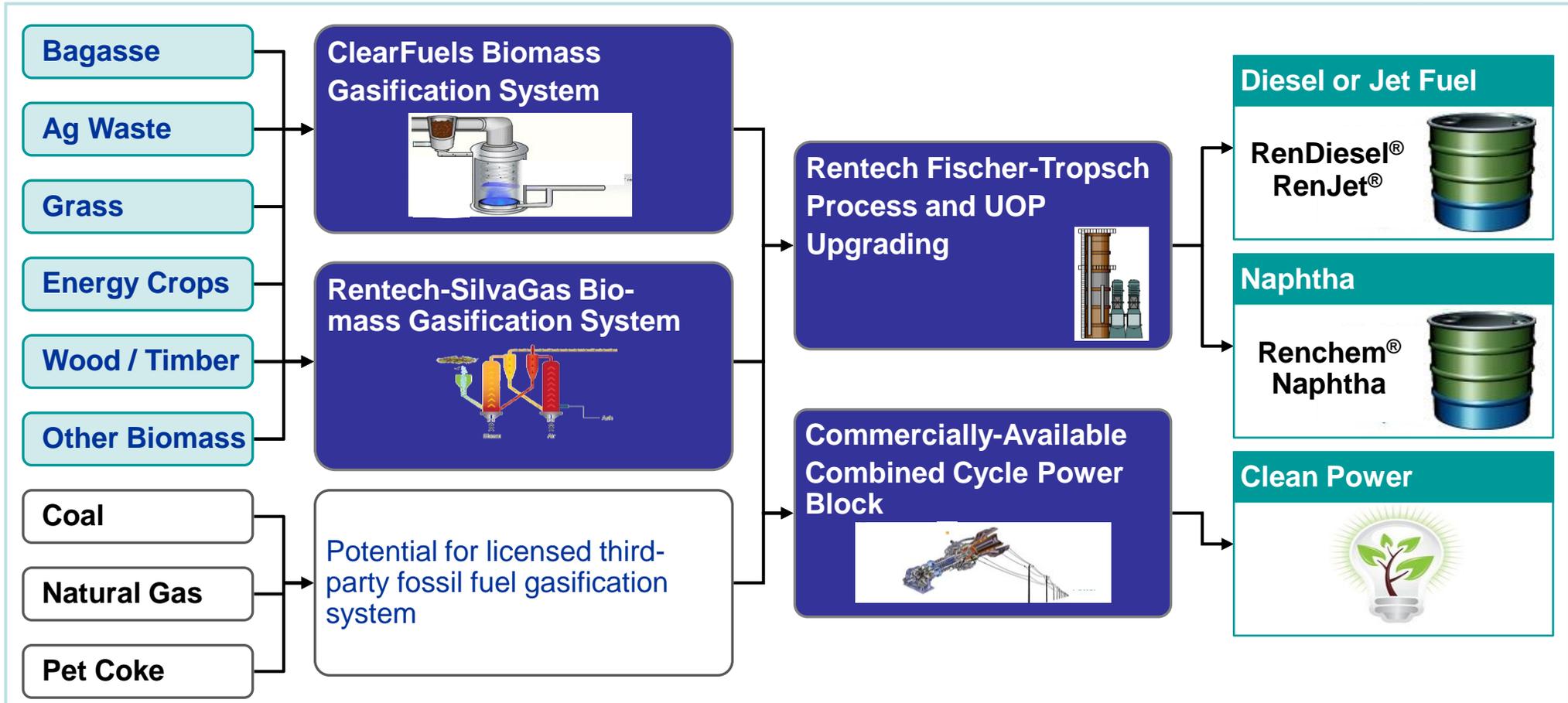


## Advanced development stage (TRL 6-7)

- Nat gas to fuels (GTL) Gen 1 – TRL 7
- Biomass to power (BTP) – TRL 7
- Biomass to fuels (BTL) Gen 1 – TRL 6+

## Next Gen technologies for improved yields, economics, or scale (TRL 2- 6)

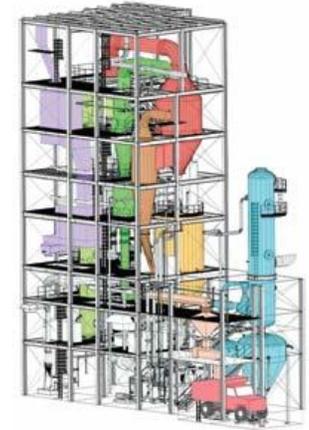
# Rentech's BioEnergy Technologies



- BECE integrates Rentech's **proprietary gasification and processing technologies** into a biorefinery capable of producing 10 bpd in drop-in fuels
- The Rentech Process can utilize **Fischer-Tropsch chemistry**, with improved catalyst composition, reactor design and design parameters of synthetic fuels and chemicals facilities
- BECE uses Rentech's proprietary **iron-based catalyst**, which performs well with a wide range of syngas compositions from a variety of feedstocks

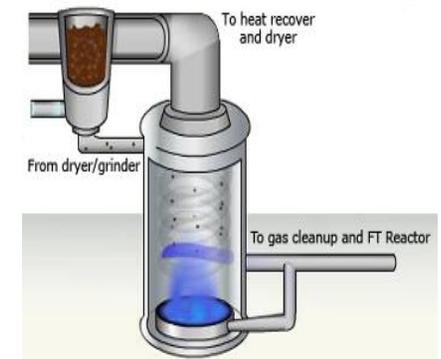
## Rentech SilvaGas gasifier

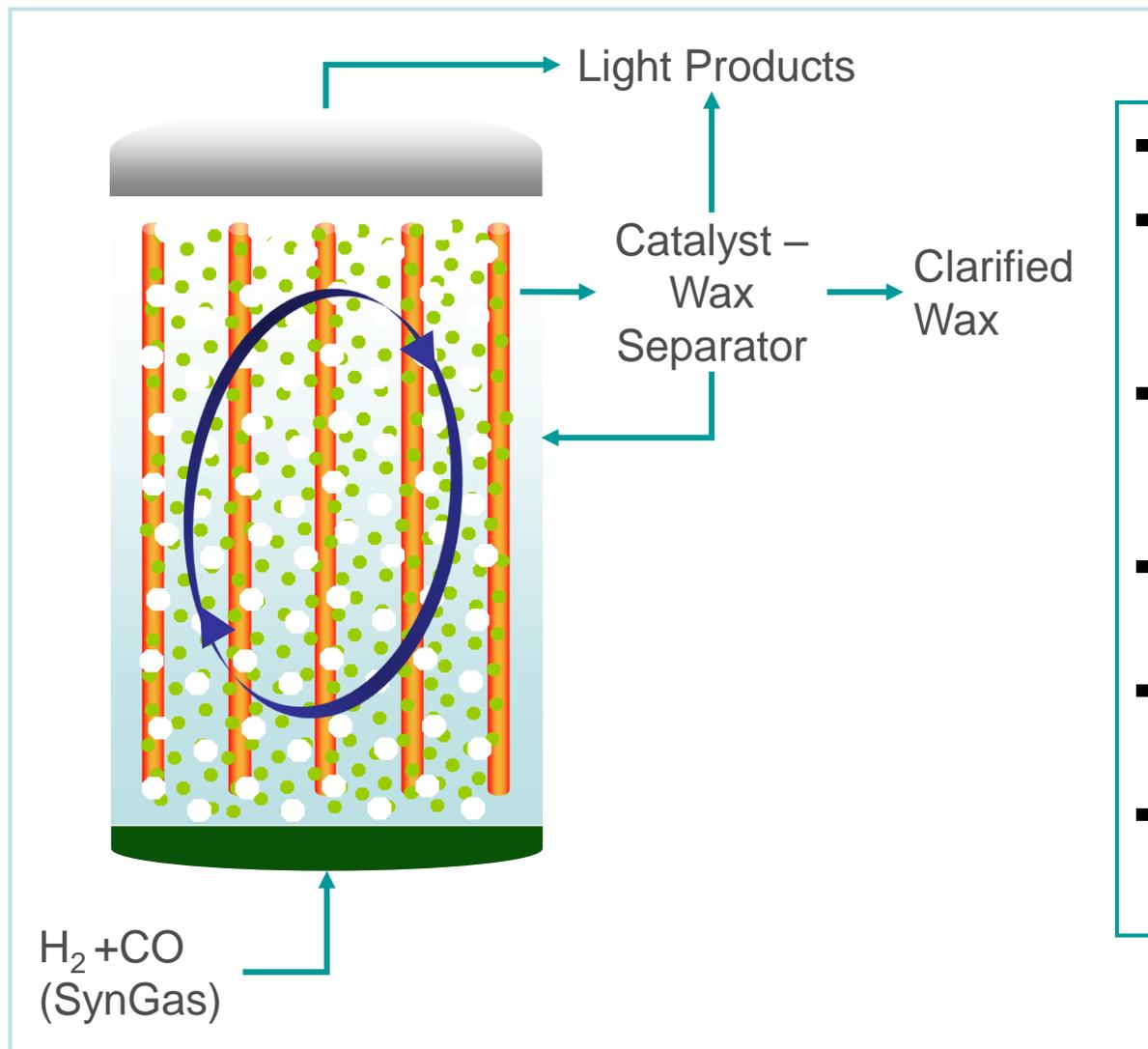
- **Patented, commercially proven**, gasification technology with over \$100 million invested in technology and assets
- Capability to **produce syngas from a wide variety of cellulosic feedstocks**, which can be used for renewable power or can be processed into drop-in, certified, renewable fuels
- The gasifier is **deployable today**, having successfully operated in Burlington, VT for 2+ years in partnership with the US Department of Energy, National Renewable Energy Laboratory (NREL) and Battelle Columbus Laboratory



## Rentech ClearFuels gasifier

- Produces **hydrogen and syngas** from finely-ground cellulosic feedstocks through a High Efficiency Hydrothermal Reformer (HEHTR).
- **Optimized for producing drop-in fuels** from syngas; can also produce renewable power
- Operated at pilot scale for >10,000 hours and multiple third parties, including Idaho National Laboratory and Hawaii Natural Energy Institute, have independently validated the results of the pilot scale data
- Currently **undergoing a demo-scale campaign** through a \$23 million grant from the US Department of Energy



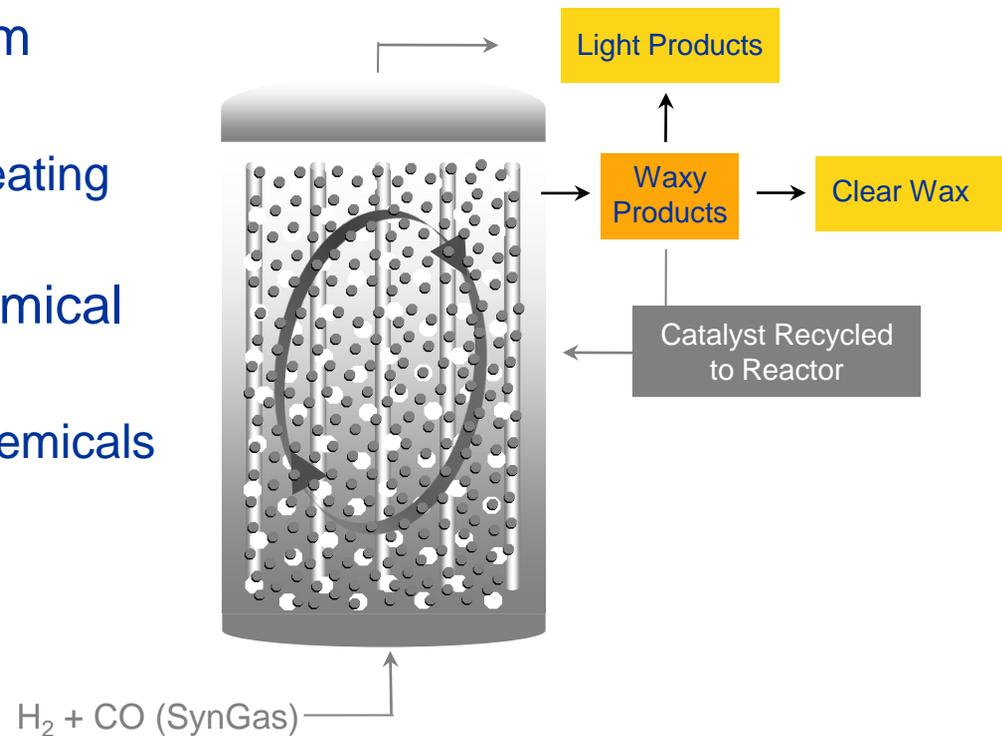


- No moving parts
- Proprietary catalyst form produced by world-class catalyst manufacturer
- Catalyst-wax separation using magnetically enhanced dynamic settler
- Demonstrated over the last 3 years at 10 bpd capacity
- Low catalyst losses – good separation
- Stable catalyst activity

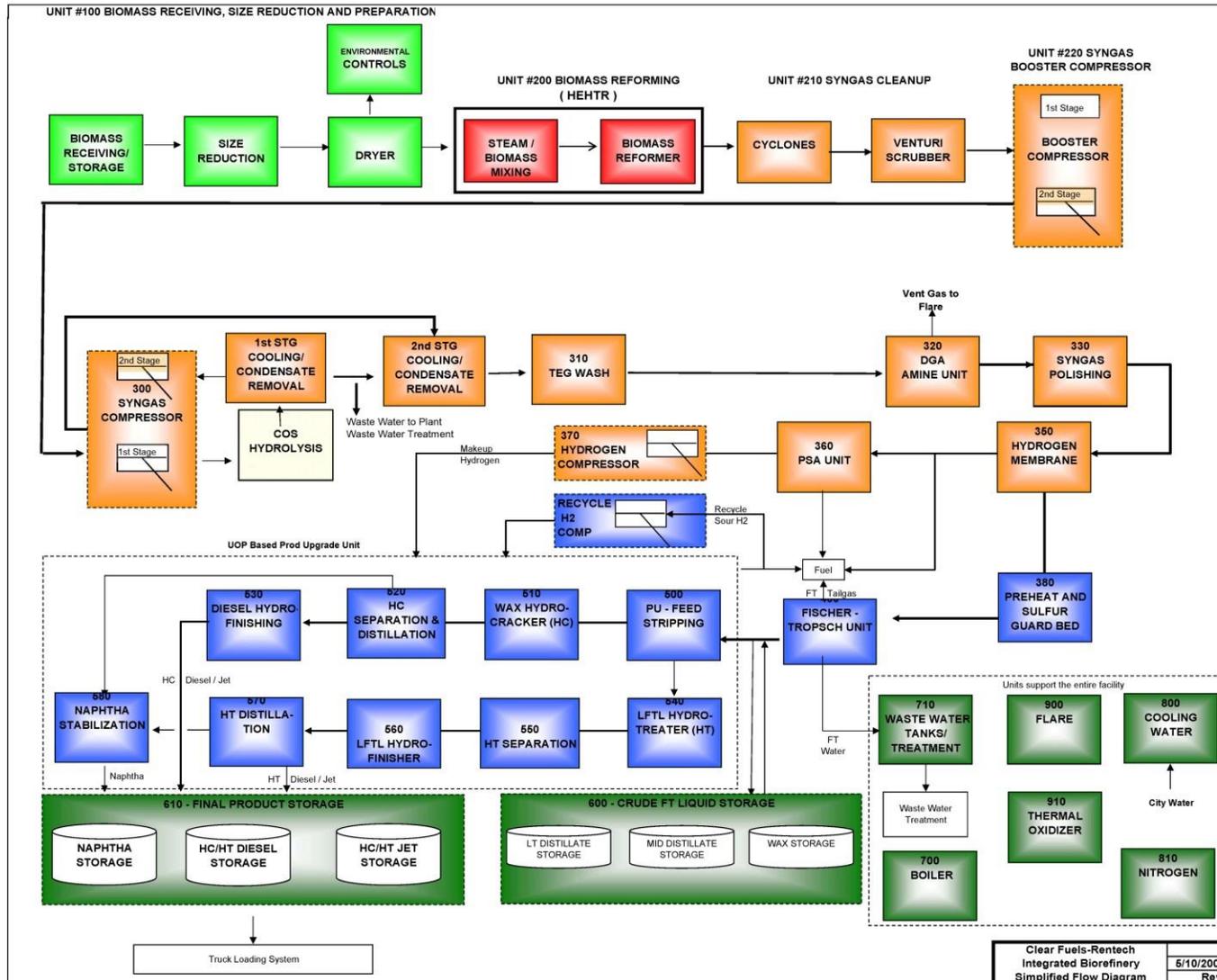
# Product Upgrading – The Final Step



- The final step in the Rentech Process is Product Upgrading
- Light products and clear wax from Rentech reactor are hydroprocessed to products
- Uses proven UOP Technology via our Alliance Agreement
- Low cost and simple relative to petroleum refining
  - Simpler than hydrocracking and hydrotreating used in refineries today
- Capable of making multiple fuel and chemical products
  - High quality Diesel or Jet or specialty chemicals



# Process Overview



# BECE offers flexibility in feedstock and output, underpinned by strong research and IP capability



## Conversion capability

- Flexible feedstocks:
  - Biomass (wood waste, corn stover, bagasse, MSW/RDF)
  - Fossil fuels (Natural gas, coal<sup>1</sup>)
- Up to 20 dry tons per day biomass feedstock
- Biomass gasification
- Syngas to syncrude conversion (Fisher-Tropsch)
- Hydro-processing

## Research / testing capability

- 70 scientists, engineers, technicians and operators
- Catalyst development and evaluation labs
- Analytical fuels testing lab
- Fluidization/separation technology lab

## Outputs

- Drop-in synthetic fuels – 10 bpd current capacity
- 7-8 bpd of diesel or jet fuel production
- Hydrogen production from natural gas or biomass
- Hydrocracking of C20+ materials and hydrotreating of C5-C20 materials
- Renewable chemicals
- Power production

## Intellectual property (IP)

- Only Fisher-Tropsch technology of this scale available for licensing<sup>2</sup>
- 40 US granted patents
- Continuously developing new IP

<sup>1</sup> Through a 3<sup>rd</sup>-party gasification system

<sup>2</sup> Sasol and Shell operate large-scale commercial F-T facilities but do not typically license the technology



# BioEnergy Center of Excellence (BECE) Photo Tour















# BioEnergy Center of Excellence (BECE) Status and Challenges

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