

# **Transportation fuels from Solids via Gasification**

**Gasification Technologies  
Council**

**Tampa, Florida  
March 14, 2008**

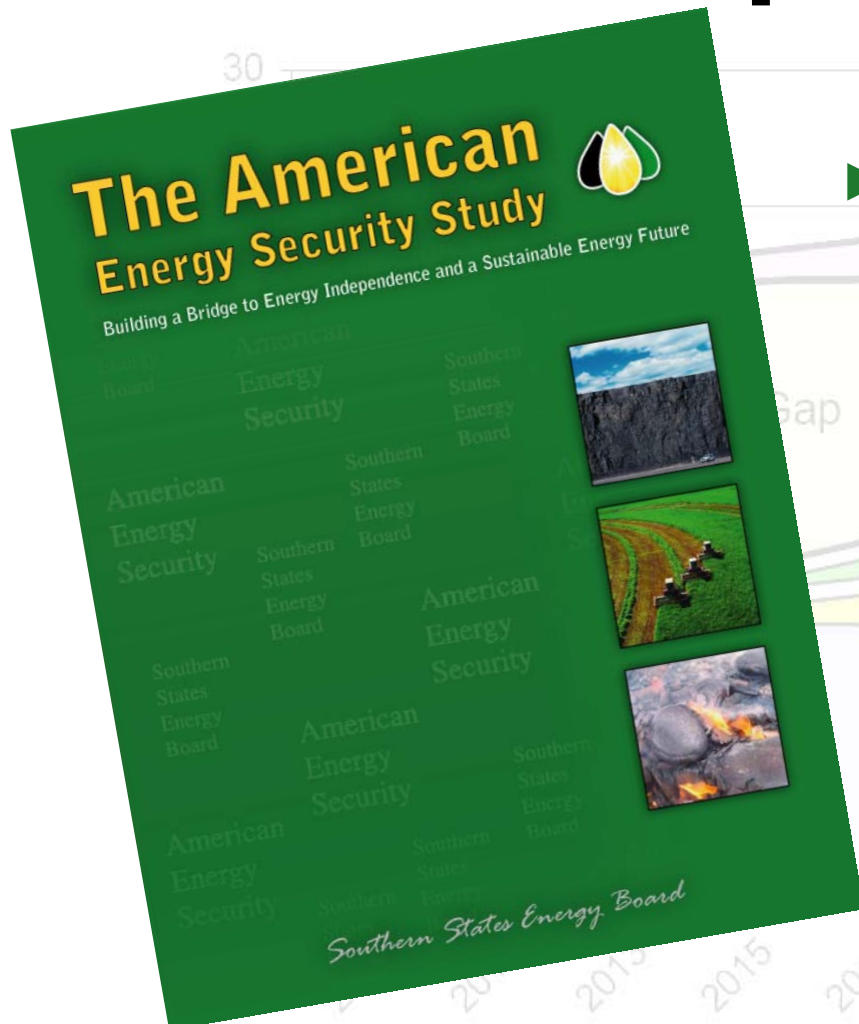




Today the United States is spending more than **\$900,000** per **minute** to buy transportation fuels from foreign sources. (Assuming \$105/barrel Crude)

Typical 18 wheeler is now spending between **\$800 to \$900** per fill up!

# Achieving U.S. Energy Independence



## \*The Goal

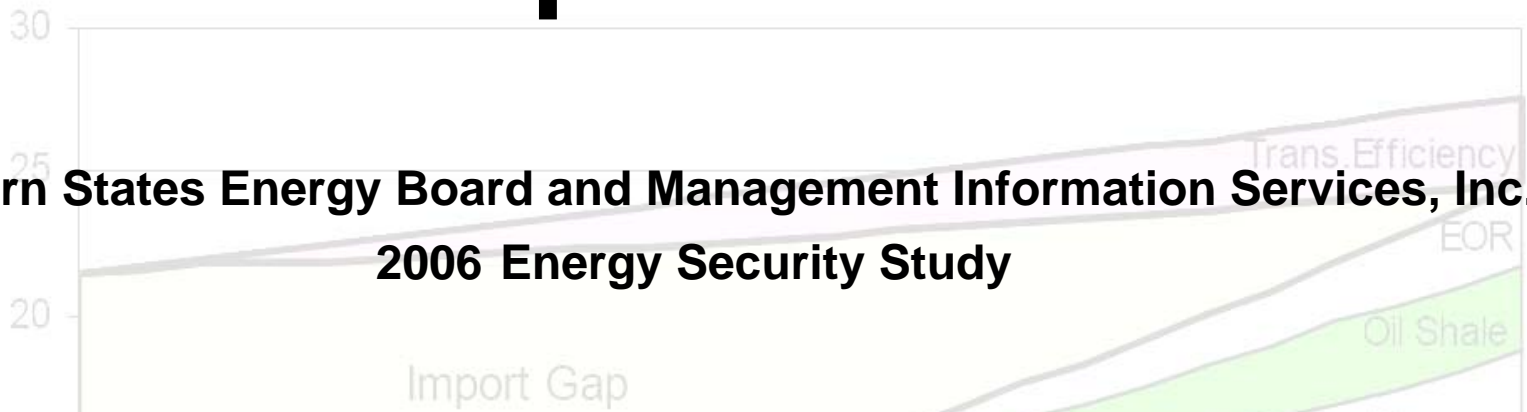
► **Eliminate dependence on imported oil for transportation fuels by 2030 will:**

- **Create 1.4 million new U.S. jobs**
- **Reduce trade and budget deficits, with a trade deficit that is \$600 billion less by 2030**
- **Generate economic investment and growth, with up to \$200 billion invested in energy sector**
- **Increase national security**
- **Help protect the environment**
- **Foster new technology development**

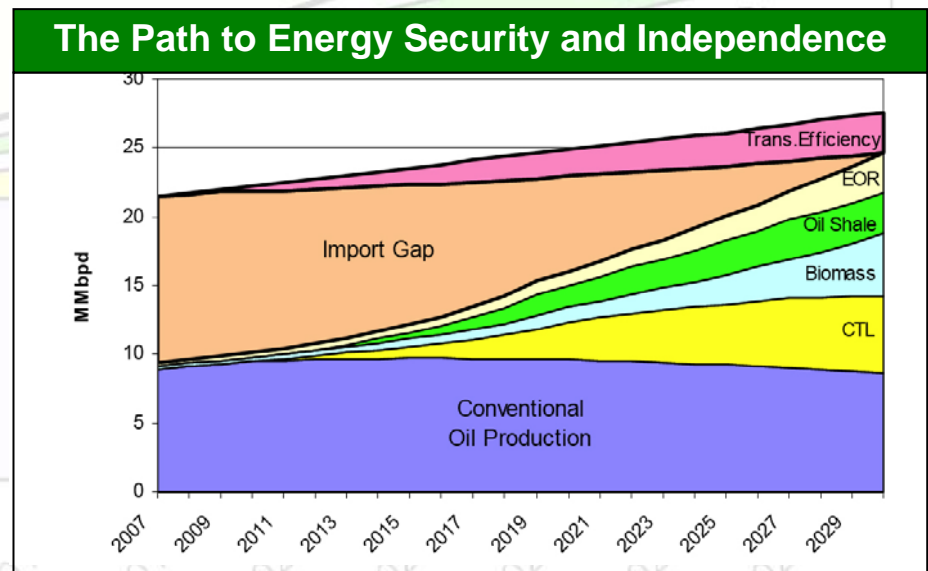
\*Southern States Energy Board

# Achieving U.S. Energy Independence

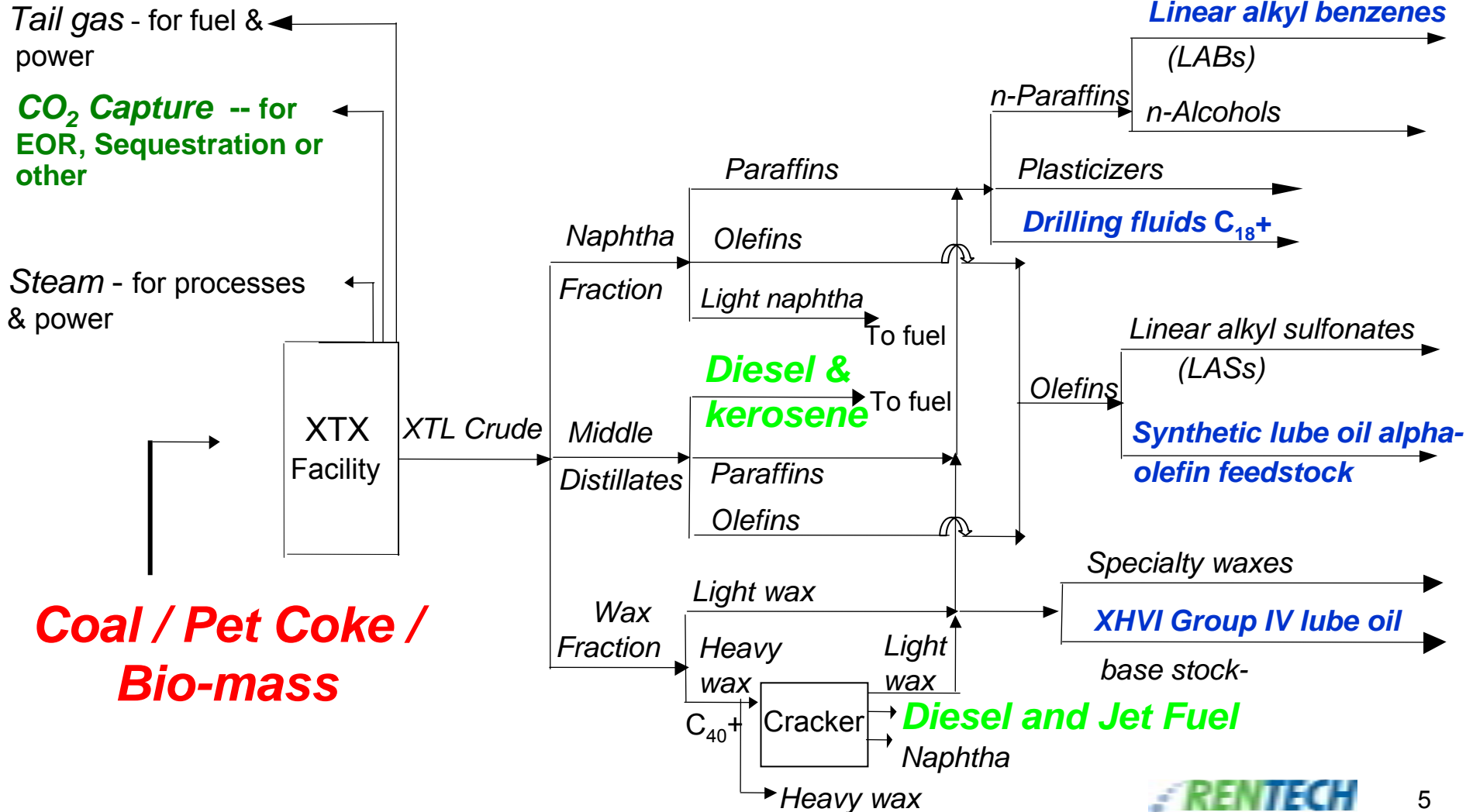
Southern States Energy Board and Management Information Services, Inc.  
2006 Energy Security Study



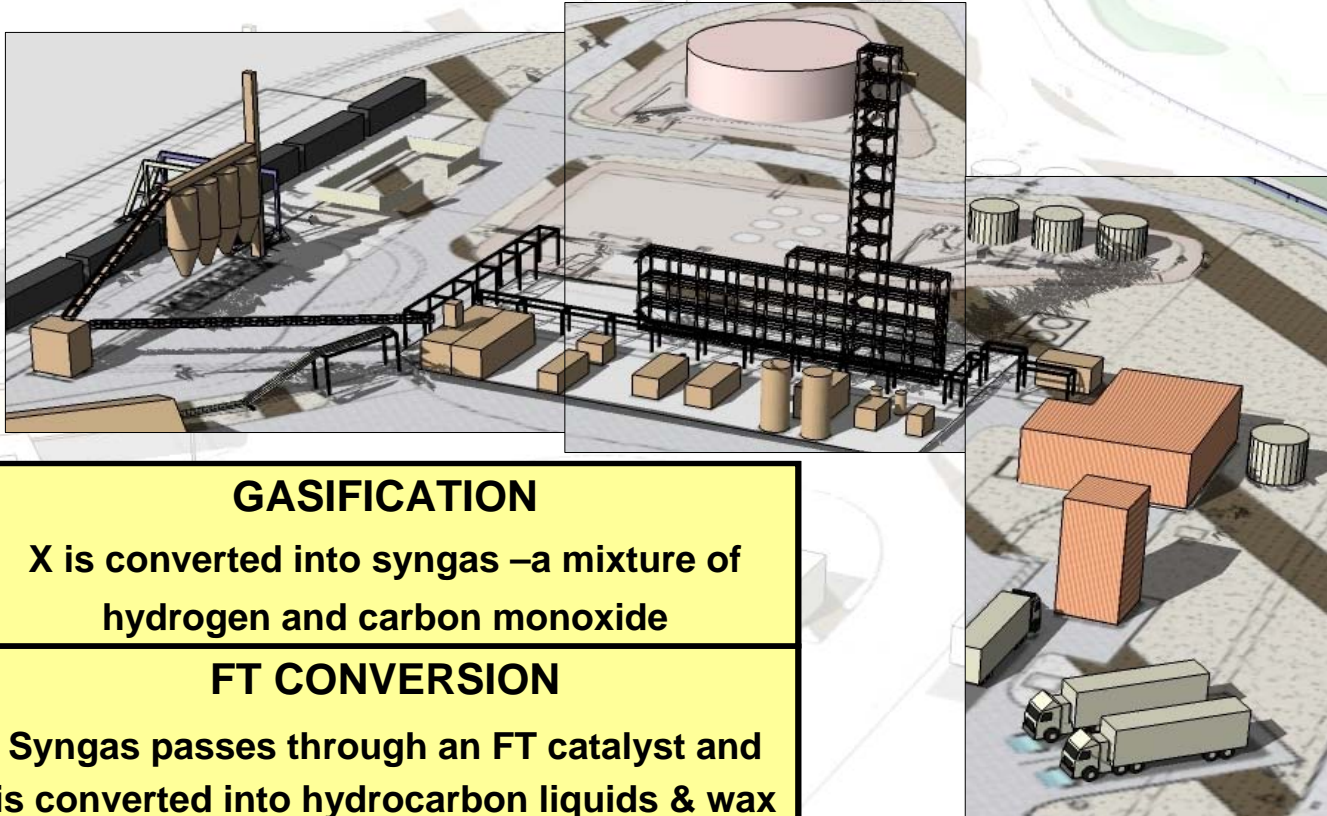
Domestic Energy Initiative	MM Barrels/day Total Contribution Required In 2030	Percent Contribution to Total U.S. Liquid Fuels Requirements
<b>CTL</b>	<b>5.6</b>	<b>20</b>
Oil Shale	3.0	11
EOR	2.8	10
Biomass	4.5	16
Transportation Energy Efficiency	3.0	11
<b>Total</b>	<b>18.9</b>	<b>68</b>



# Convert Coal, Pet Coke, Oil Sands, Biomass to *What* (XTL) ?



# What is X-to-Liquids?



<b>1</b>	<b>GASIFICATION</b> X is converted into syngas –a mixture of hydrogen and carbon monoxide
<b>2</b>	<b>FT CONVERSION</b> Syngas passes through an FT catalyst and is converted into hydrocarbon liquids & wax
<b>3</b>	<b>UPGRADE</b> FT liquids & wax produced are upgraded into ultra clean synthetic fuels

# The PDU @ the Rentech Technology Center



**A 10-15 bbl/day Integrated Coal-to-Liquid Fuels Facility  
for Producing Test Quantities of CTL Liquids**



# Transportation Fuels Include

## – Conventional Fuels

- Diesel
- Gasoline
- Jet Fuel

## – Popular Options

- CNG
- Ethanol
- Bio-Diesel
- Hybrids

# Popular Options

- **Compressed Natural Gas (CNG)**
  - Equipment Modifications and Costs
  - Highly Promoted for the past ten years (Clean Cities Program)
  - Infrastructure for Distribution
- **Ethanol**
  - Highly subsidized
  - Food vs fuel
  - Energy Balance
  - Fertilizer and Water
- **Bio-Diesel**
  - Quality
  - Feedstock Costs
  - Acceptance by manufacturers
- **Hybrids**
  - Potential
  - Diesel

# Today's Hybrids are Expensive

Based on the USAF Experience Li-ion Hybrids will average  
40 miles to the gallon with battery replacement  
at 80,000 miles at a cost of \$7,000!

This takes 2,000 gallons of fuel at \$3.50/gal = \$7,000  
Battery cost = \$7,000 or \$3.50/gallon

**Total affective fuel costs for Hybrids are  
\$7/gallon**

# **Solids to Liquid Transportation Fuels**

- **Direct blending stock or substitutes for conventional petroleum based**
  - **Gasoline**
  - **Diesel**
  - **Jet Fuel**
- **Use in legacy fleet with no modifications**
- **Improve all emissions immediately**

# Coal to Gasoline

- **Proven Technology offered by Exxon**

- DKRW Wyoming Project Projected for 2012
- 14,000 barrel per day
- Wyoming Bituminous Coal

- **Gasoline**

- Ultra Low Sulfur
- Regular Octane
- Direct Blend Stock or Substitute for Gasoline

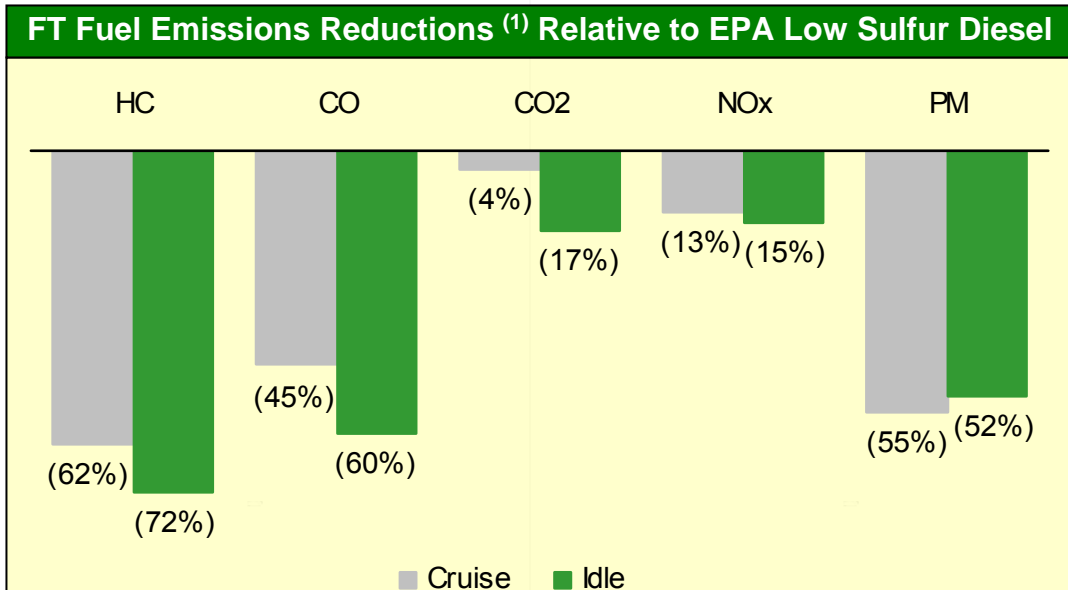
# FT Fuels from Coal

- **FT Diesel Approved and used world wide as blend stock or direct substitute for Petroleum Diesel**
  - Sasol
  - Shell
- **FT Jet Fuel Approved on a 50/50 blend for South African Airlines**
- **FT Jet Fuel approval for 50/50 blend is approved by the USAF for certain Engines (Synthesized Paraffinic Kerosene Blend Component)**
- **FT Commercial Jet Fuel is on a track for approval by 2011**

# “Hans and Franz” FT Primary Products are: Premium Synthetic Diesel and Jet Fuels



- ▶ Environmental Advantages
- ▶ Reduction in Regulated Emissions
- ▶ Ultra-low in sulfur
- ▶ Biodegradable
- ▶ Long Shelf Life (very stable fuel)



(1) HC = Hydrocarbon, CO = Carbon Monoxide, CO<sub>2</sub> = Carbon Dioxide, NO<sub>x</sub> = Nitrogen Oxide, PM = Particulate Matter. Data from U.S. Military testing.

# FT Fuels Burn Cleaner Than Conventional Diesel And Biodiesel In Existing And Future Diesel Engines

**Properties and CO<sub>2</sub> Emissions from FT Fuels** (source US DOE / NETL)

Property	Conventional Diesel Fuel	F-T Diesel Fuel
Carbon Content, %	86.82	84.69
Hydrogen Content, %	13.18	15.31
Net Heating Value, BTU/lb	18,400	18,900
Density, g/mL	0.84	0.77
CO <sub>2</sub> Emissions, g/mi (26.6 mpg Diesel Vehicle)	382.96	364.6
CO <sub>2</sub> Emissions Reduction, %	---	4.79

Note: Compared to Conventional Fuels, FT Fuel has lower density due to the lack of Aromatics, and Higher Heating Value due to the Higher Hydrogen content. Fuels should be compared based on their Net Heating values. The Relevant Comparisons are shown above.

# Range of Regulated Emissions Reductions for FT Fuels

Criteria Pollutant	Range of Reduction for F-T Fuel, percent
Particulate Matter (Soot)	20-60
Nitrogen Oxides (NOx)	5-20
Carbon Monoxide (CO)	20-50
Hydrocarbons (HC)	25-50
CO <sub>2</sub> Non Regulated	4-5

(Source: Southwest Research Institute)

- ▶ **Emissions reduction are dependent on Vehicle Technology / Testing Cycle**
- ▶ **Benefits vary with Engine Type and Testing Cycle**
- ▶ **Major benefits for Current and Older Diesel Technologies**
- ▶ **Significant benefits for Advanced Low Emissions Diesel Engines**
  - Less NOx Catalyst Deactivation due to virtually No Sulfur in FT Diesel
  - Less particulate trap plugging due to much Lower Engine Out Soot Emissions

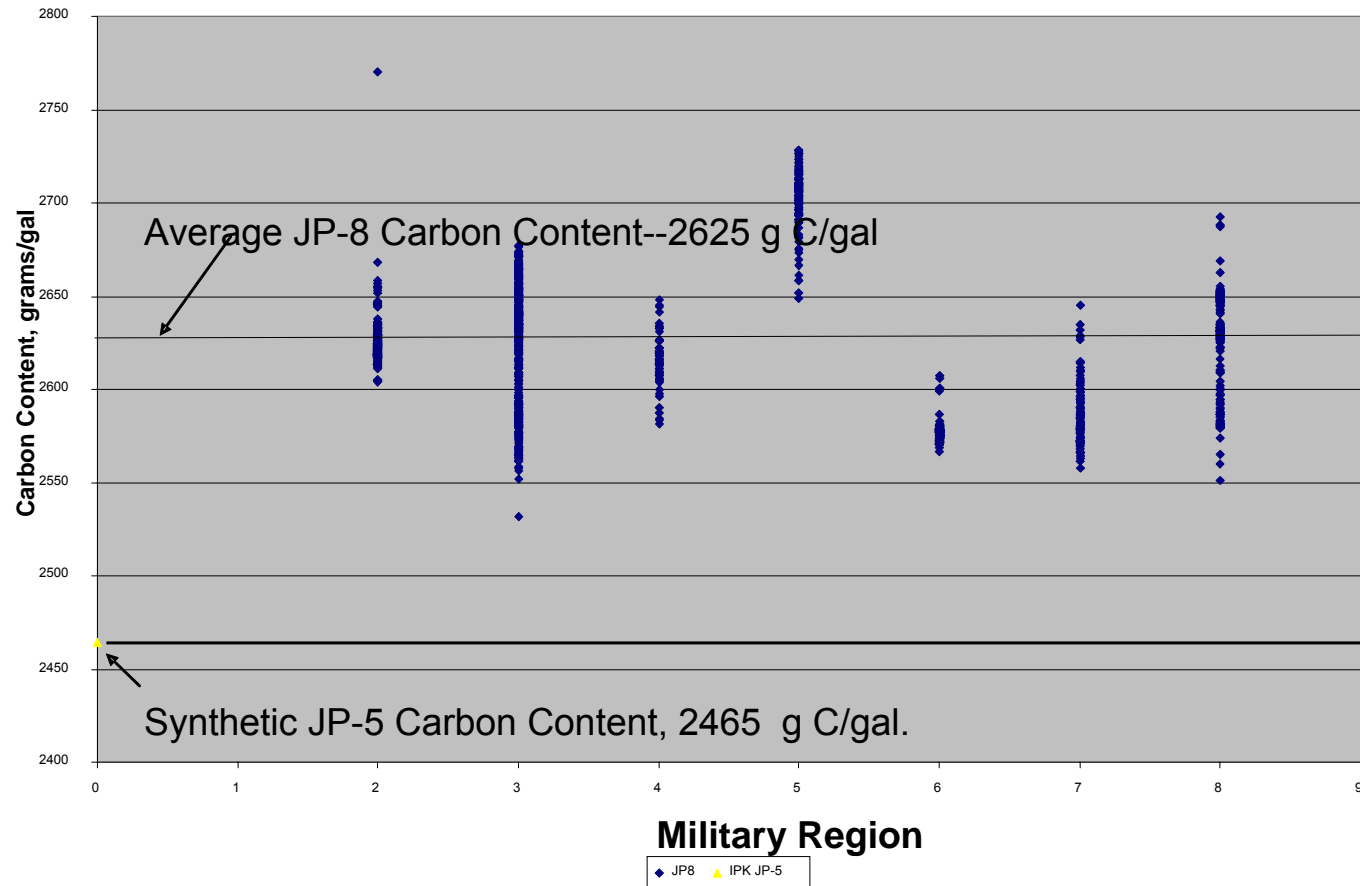
# What About CO<sub>2</sub>?

- ▶ **Rentech recognizes the future and all of our projects must have CO<sub>2</sub> Solutions!**
- ▶ **Gasification plants are already Carbon Capture Ready By Design**
- ▶ **CTL Plants with ~70% CO<sub>2</sub> capture and sequestration are lower in CO<sub>2</sub> Emissions than conventional Petroleum**
  - ▶ **Enhanced Oil Recovery (EOR)**
  - ▶ **Geo-sequestration**
    - DOE / NETL Regional Sequestration Partnerships in the US
  - ▶ **Bio-Mass Component Potential**
- ▶ **CTL Fuels have lower carbon resulting in lower CO<sub>2</sub> emissions**

# Not all Oils are Created Equal

## CTL life cycle CO<sub>2</sub> emissions

- About 5% less than diesel derived from high-quality crude
- About 15% less than diesel derived from low-quality crude



# Myths Regarding FT Fuels

## ► Myths:

- FT Fuels produce twice the CO<sub>2</sub> as gasoline when combusted (Tank to Wheels life cycle assessment) (*Without CO<sub>2</sub> Sequestration*)
- A Hybrid Diesel - Electric vehicle running on FT Diesel will pollute as much as a Hummer!

## ► Facts:

- The Low Density of FT Fuels does result in ~ 7% increase in Fuel Consumption on a *Volume Basis, However;*
- CO<sub>2</sub> Emissions are based on the *Mass* of Fuel consumed, not the Volume, the Net result is FT Fuels produce ~ 5% Less Co<sub>2</sub> Emissions than Conventional Fuels on a Tank-to-Wheels basis
- Diesel Vehicles enjoy ~ 30% Fuel Consumption Benefit vs. Gasoline
- Fuel Efficiency and Fuel Composition = FT Diesel Fuel ~ 35% Less Co<sub>2</sub> than Gasoline

# Rentech's Strategic Fuels Plant Natchez, Mississippi

## Natchez – Adams County Mississippi Site



### ► Strategic Location

- On the Mississippi River
- Not subject to Gulf Coast weather patterns

### ► Ideal location for CO<sub>2</sub> sequestration

- CO<sub>2</sub> used for Enhanced Oil Recovery

### ► Easy Access

- Multiple feedstock possibilities
  - Coals down Mississippi River
  - Pet Coke up from Gulf Coast
- Central location to several product distribution channels

### ► Federal, State, Local support for the project

### ► Currently in Feasibility Phase

### ► Est. COD - 2012



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