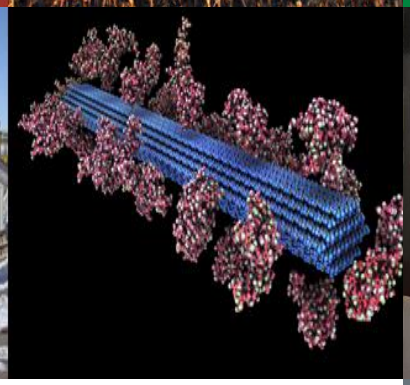





U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# CAAFI-CORE Jet Fuel Workshop

# DOE Aviation Overview

April 28, 2016

Zia Haq

# Bio-Energy Technology Office Core Focus Areas

## Program Portfolio Management

• Planning • Systems-Level Analysis • Performance Validation and Assessment
• MYPP • Peer Review • Merit Review • Quarterly Portfolio Review
• Competitive • Non-competitive • Lab Capabilities Matrix

## Research, Development, Demonstration, & Market Transformation

### Feedstock Supply & Logistics R&D

- Terrestrial
- Algae
- Product Logistics Preprocessing

### Conversion R&D

- Biochemical
- Thermochemical
- Deconstruction
- Biointermediate
- Upgrading

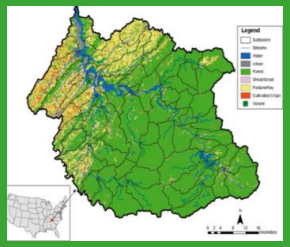
### Demonstration & Market Transformation

- Integrated Biorefineries
- Biofuels Distribution Infrastructure

## Cross Cutting

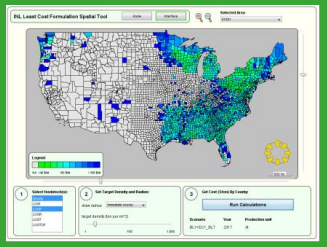
### Sustainability

- Sustainability Analysis
- Sustainable System Design



### Strategic Analysis

- Technology and Resource Assessment
- Market and Impact Analysis
- Model Development & Data compilation



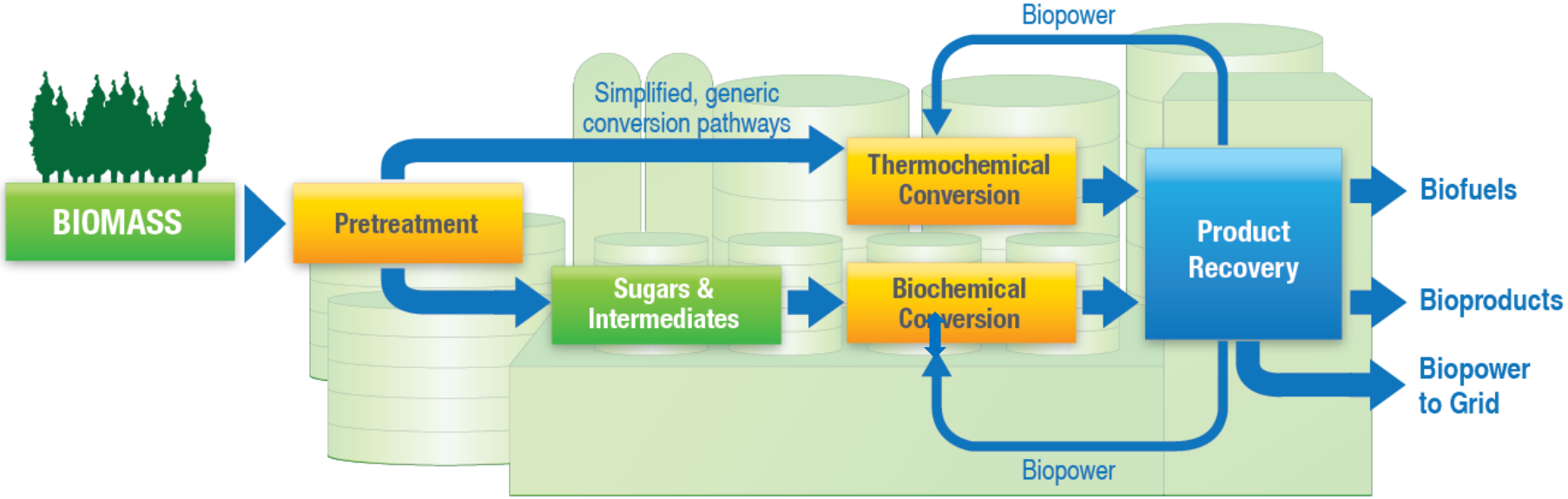
### Strategic Communications

- New Communications Vehicles & Outlets
- Awareness and Support of Office
- Benefits of Bioenergy/ Bioproducts

BIO ENERGY
U.S. DEPARTMENT OF ENERGY
2015

# Reducing Risk Along the Supply Chain

- Technical, construction, operational, financial and market risk reduction
- Demonstration through greater process integration and scale



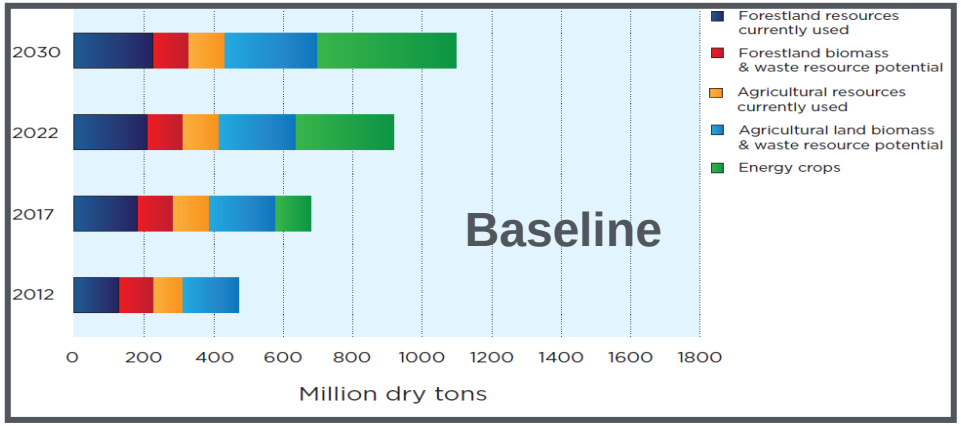

| Key Challenges | | | |
|---|---|---|---|
| **Biomass** | **Pretreatment** | **Conversion** | **Product** |
| • Reliable supply<br>• Consistent quality<br>• Affordable delivery | • Biomass feeding, sizing and moisture<br>• Solids handling<br>• Construction materials | • Products Yields<br>• Construction materials<br>• Catalysts<br>• Fermentation organisms | • Separations<br>• Catalytic upgrading<br>• Recycle loops |

***DOE works to address risks and reduce costs across the supply chain***

# Biomass Resource Assessment - U.S. Billion-Ton Update

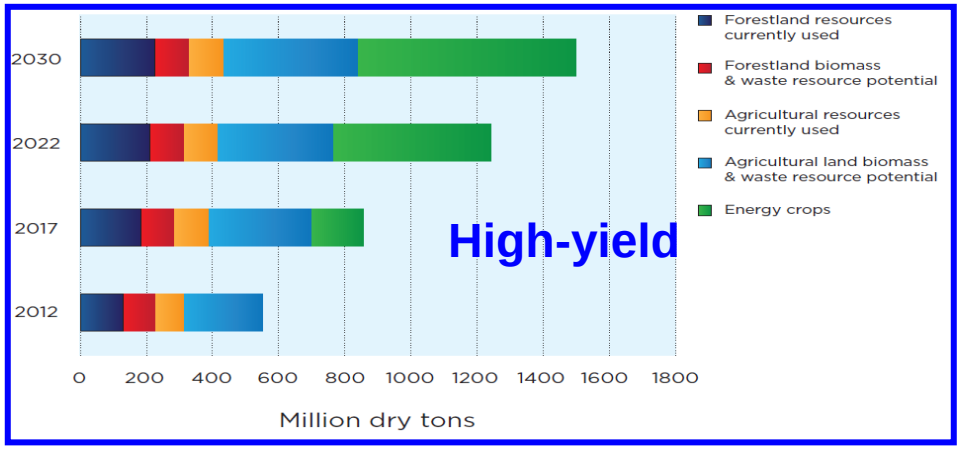
## Baseline scenario

- Current combined resources from forests and agricultural lands total about 473 million dry tons at $60 per dry ton or less.
- By 2030, estimated resources increase to nearly 1.1 billion dry tons.




## High-yield scenario

- By 2030, total resource ranges from 1.4-1.6 billion dry tons annually.
- No high-yield scenario was evaluated for forest resources.




Data is publicly available on the Bioenergy Knowledge Discovery Framework - https://www.bioenergykdf.net/

# Lab & Bench Scale R&D – Aviation Highlights

- Focus on biofuels catalyst development at national labs , e.g.:
  - PNNL - Alcohol to Jet
  - NREL – DME to branched paraffins
  - ORNL – dilute Alcohol to Jet
  - ANL – Catalyst characterization
- Focus on industrial partnerships, e.g:
  - Vertimass
  - Virent
  - Lanzatech
  - Kiverdi

Pacific Northwest NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

ornl OAK RIDGE NATIONAL LABORATORY

Argonne NATIONAL LABORATORY

Vertimass Transformative fungible biofuels.

LanzaTech capturing carbon. fueling growth.

Kiverdi

VIRENT

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# Defense Production Act (DPA) Initiative

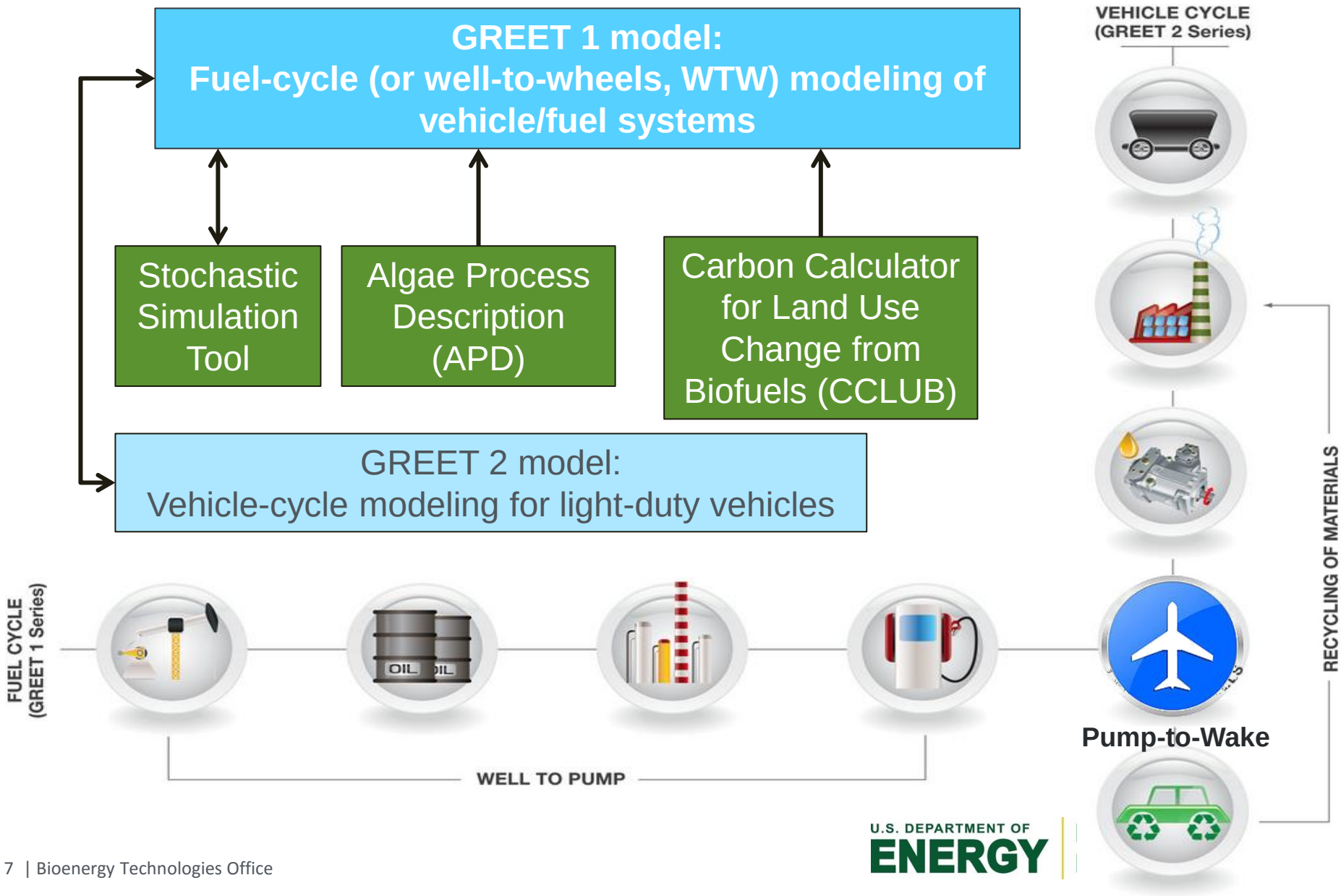
## In September 2014, 3 projects were selected under the DPA Initiative to build commercial biorefineries to produce:

- Drop-in fuels for military applications
- Domestic fuels from non-food biomass feedstocks
- Cost-competitive biofuels (w/o subsidies)
- Production anticipated to begin in 2018

| Company | Location | Feedstock | Capacity | Groundbreaking | Off-Take Agreements |
|---|---|---|---|---|---|
| EMERALD BIOFUELS | Gulf Coast | Fats and Greases | 82.0 MM g/y | TBA | TBD |
| Fulcrum BIOENERGY | McCarran, NV | MSW | 10.0 MM g/y | Fall of 2015 | UNITED, CATHAY PACIFIC |
| RED ROCK BIOFUELS | Lakeview, OR | Woody Biomass | 12.0 MM g/y | TBA | SOUTHWEST AIRLINES, FedEx |

***Interagency initiative to produce more than 100 MM g/y of advanced biofuels***

# *The GREET™ (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model*






U.S. DEPARTMENT OF ENERGY

# Aviation Fuel Options in GREET1_2014

## Fuels and Feedstocks

- **Petroleum Jet Fuel**
  - Conventional Crude
  - Oil Sand
- **Pyrolysis Oil Jet Fuel**
  - Crop Residues
  - Forest Residues
  - Dedicated Energy Crops
- **Hydrotreated Renewable Jet Fuel**
  - Soybeans
  - Palm Oil
  - Rapeseeds
  - Jatropha
  - Camelina
  - Algae
- **Alcohol-To-Jet**
  - Corn
  - Crop Residues
  - Forest Residues
  - Dedicated Energy Crops
- **Fischer-Tropsch Jet Fuel**
  - North American Natural Gas
  - Non-North American Natural Gas
  - Renewable Natural Gas
  - Shale Gas
  - Biomass via Gasification
  - Coal via Gasification
  - Coal/Biomass via Gasification
  - Natural Gas/Biomass via Gasification

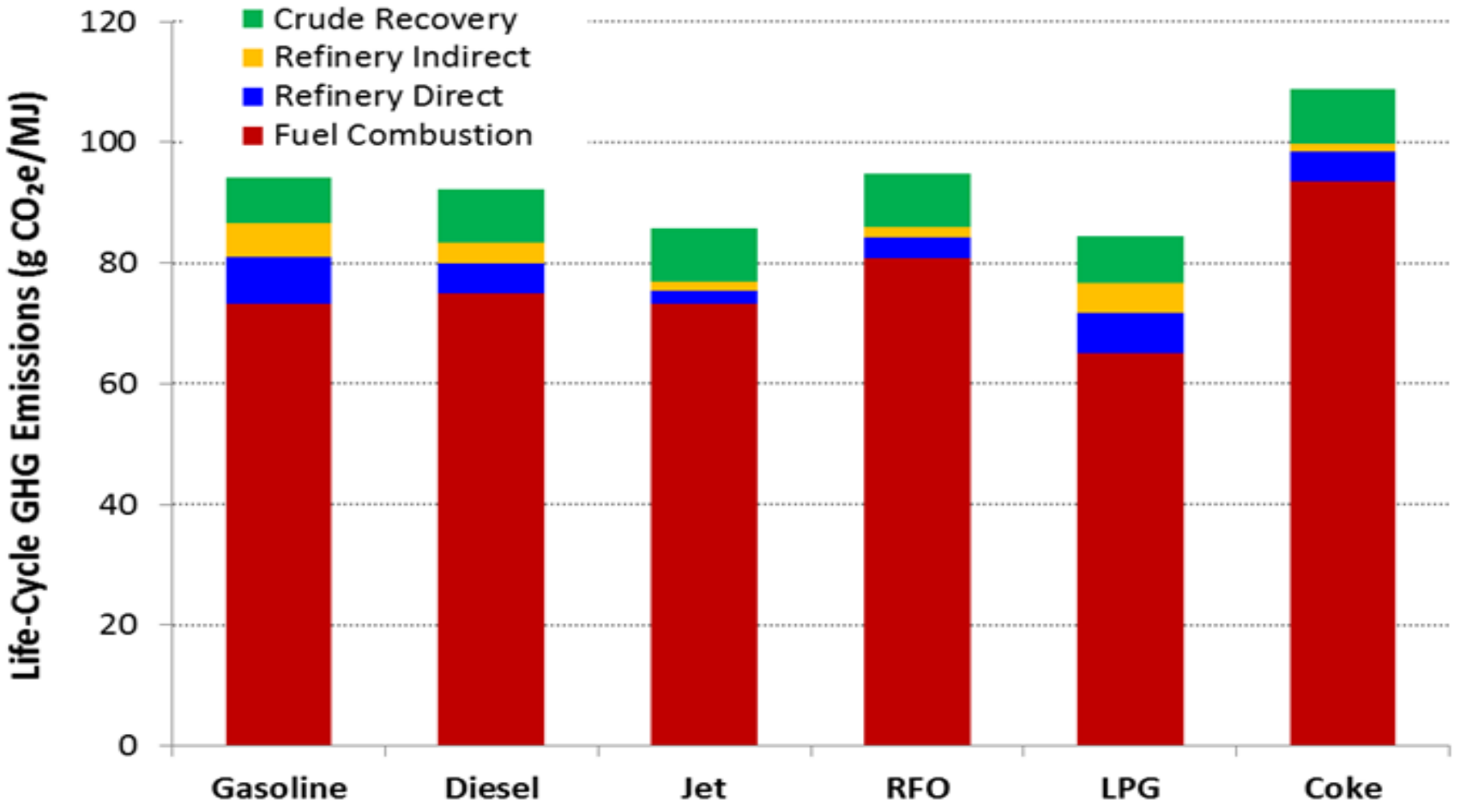
## Aircraft Types

- **Passenger Aircraft**
  - Single Aisle
  - Small Twin Aisle
  - Large Twin Aisle
  - Large Quad
  - Regional Jet
  - Business Jet
- **Freight Aircraft**
  - Single Aisle
  - Small Twin Aisle
  - Large Twin Aisle
  - Large Quad

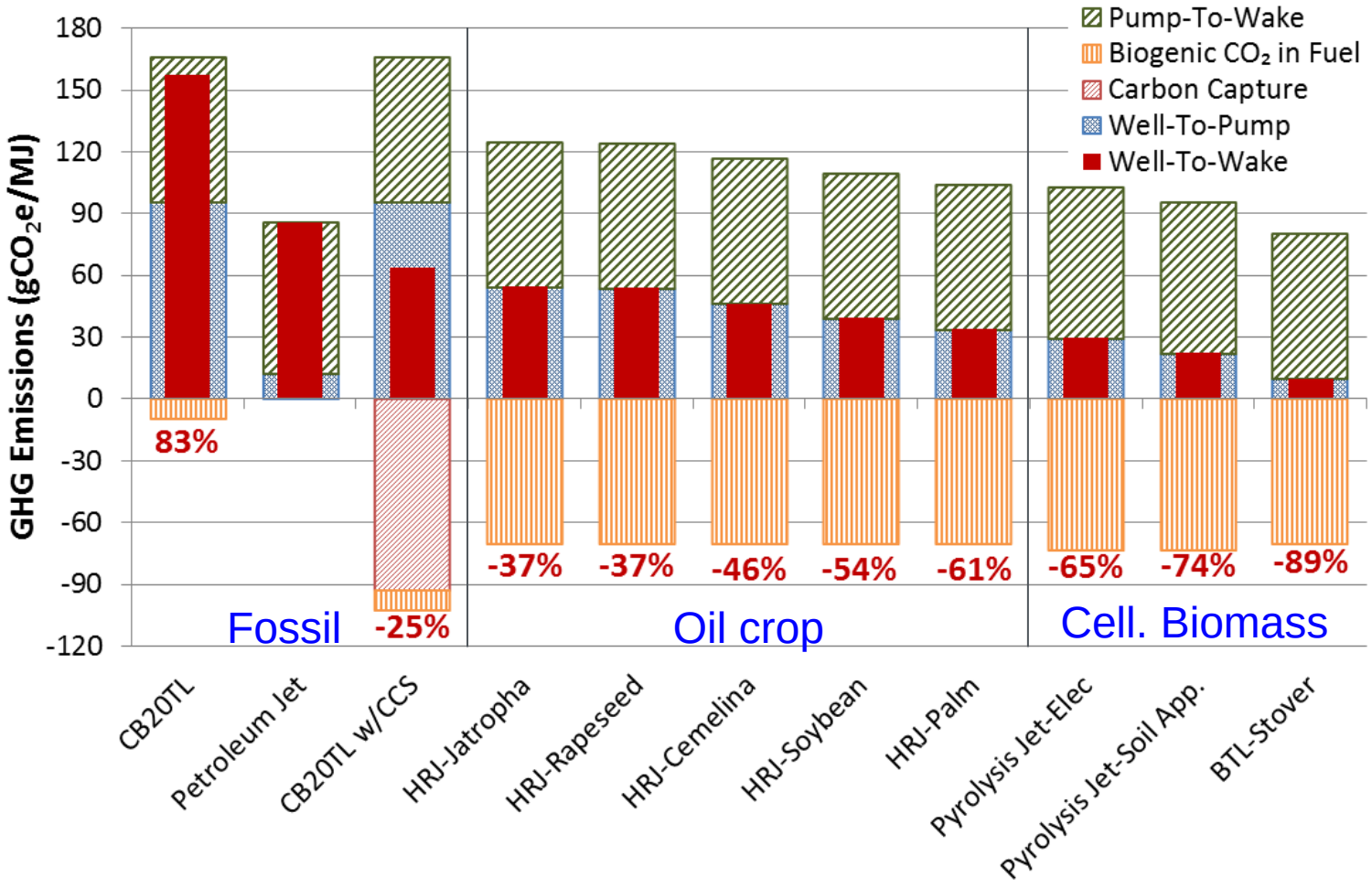
- **LCA Functional Units**
  - Per MJ of fuel
  - Per kg-km
  - Per passenger-km

With data from DOT Volpe Center

# LCA GHG Emissions of Petroleum Fuels



# Well-to-Wake GHG Emissions of Alternative Jet Fuels




- LUC-related emissions are not included
- Other key factors: Technology readiness level (TRL), production costs, resource availability and fuel types