NATIONAL ENERGY TECHNOLOGY LABORATORY

Progress Update: Interagency Workgroup on Life Cycle GHG Emissions of Alternative Aviation Fuels

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NETL, Office of Systems Analysis, and Planning

4th Annual Alternative Energy Now Conference

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Work Group Charge

- **Develop *guidance* on how to develop life cycle analyses that satisfy Section 526 for alternative jet fuels (synthetic paraffinic kerosene) for comparison with a conventional jet fuel baseline**
  - Greenhouse gases
  - Drop-in fuels (straight or blends)
  - Technology non-specific
    - F-T Pathways
    - Soy-Based Hyroprocessed Renewable Jet (HRJ)
    - Algae-based HRJ
  - Facility/production pathway-specific

- **Justify with examples**

Energy Independence and Security Act of 2007 Section 526

"No Federal Agency shall enter into a contract for procurement of an alternative or synthetic fuel, including fuel produced from nonconventional petroleum sources, for any mobility-related use, other than research and testing, unless the contract specifies that the lifecycle greenhouse gas emissions associated with the production and combustion of the fuel supplied under the contract must, on an ongoing basis, be less than or equal to such emissions from the equivalent conventional fuel produced from conventional petroleum sources."

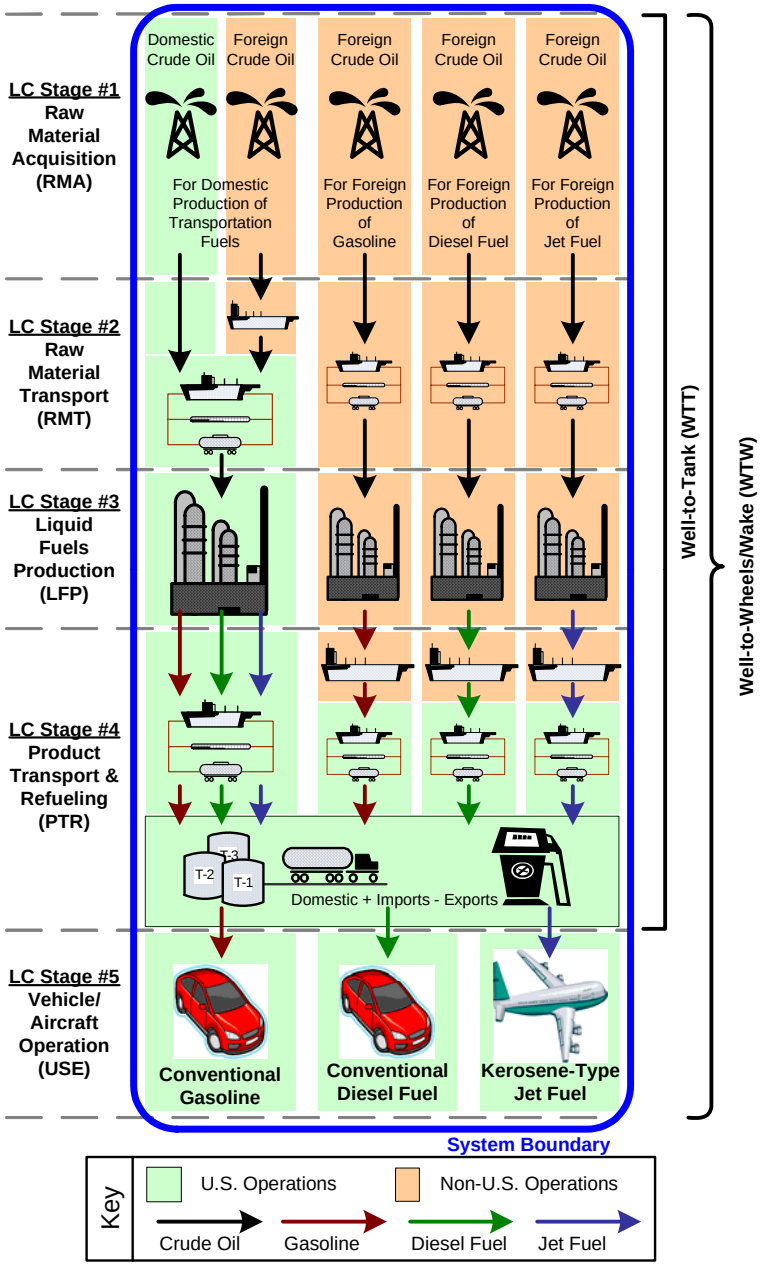
Life Cycle Greenhouse Gas Footprints are a Key Consideration for Alternative Fuels

NETL 2005 U.S. Petroleum Baseline Life Cycle GHG Analysis Study Boundary

Life Cycle Boundary	Well-to-Wheels/Wake (Raw Material Extraction thru Fuel Use)
Temporal Representation	Year 2005
Technological Representation	Industry Average
Geographical Representation	Transportation Fuel Sold or Distributed in the United States
Transportation Fuel Life Cycles Modeled	Conventional Gasoline Conventional Diesel Fuel Kerosene-Based Jet Fuel
Impact Assessment Methodology	Global Warming Potential, IPCC 2007, 100-year time-frame
Reporting Metric	kg CO_2E/MMBtu of Fuel Consumed
Data Quality Objectives	100% Publically Available Data Full Transparency of Modeling Approach and Data Sources Accounting for 99% of Mass and Energy Accounting for 99% of Environmental Relevance Process-based ("Bottoms-up") Modeling Approach

LC Stages	Gasoline	Diesel Fuel	Jet Fuel
NETL 2005 Baseline	96.3	95.0	92.3
EPA RFS2 Baseline	98.2	97.0	N/A
Percent Difference	+2%	+2%	N/A

EPA Used NETL Petroleum Baseline Model to develop RFS2 Baseline with different tail-pipe emission values and IPCC GWP values.



2005 Petroleum Baseline for Kerosene-based Jet Fuel (JP-8)

- **92.3 kg CO_2e/MMBtu, LHV of Fuel Consumed**
- **87.5 g CO_2e / MJ , LHV of Fuel Consumed**
- **Note: NETL Baseline for jet fuel was adjusted to exclude N_20 emissions included in IPCC methodology for aircraft emissions. NETL, November 2008 report original estimate is 92.9 kg CO_2e/MMBtu. DOD and FAA GHG modeling recommend 100% of carbon content of the fuel being converted to CO_2 for estimating wake emissions.**

30 Workgroup Members

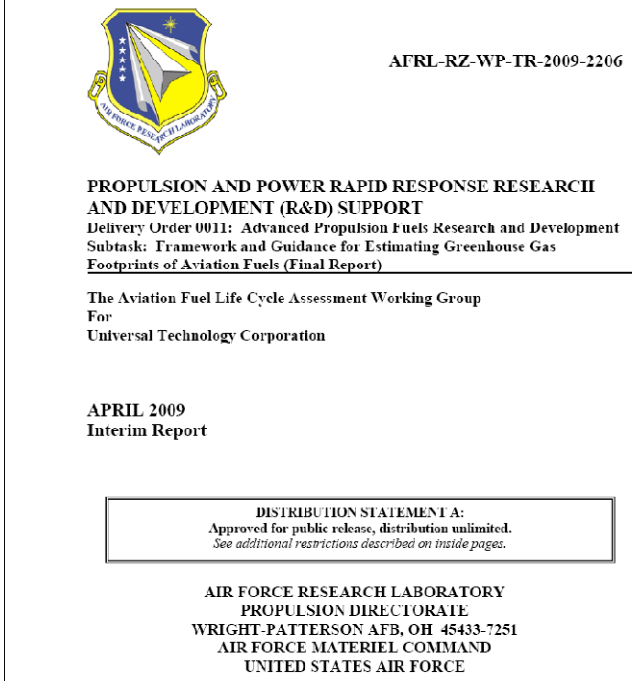
7 Federal Agencies, 5 Universities, 4 Companies

- Air Force Research Laboratory, Bill Harrison (Lead)
- DOE, National Energy Technology Laboratory (DOE, NETL)
- DOE, Argonne National Laboratory (DOE, ANL)
- Federal Aviation Administration (FAA)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Transportation (DOT)
- Defense Logistics Agency (DLA)

Workgroup Members

- University of Texas at Austin (UT)
- University of Washington (UW)
- Carnegie Mellon University (CMU)
- Massachusetts Institute of Technology (MIT)
- University of Dayton Research Institute (UDRI)
- Universal Technology Corporation (UTC)
- URS Corporation (URS)
- The Boeing Company (Boeing)
- Franklin Associates, A Division of ERG (ERG)

Framework and Guidance for Estimating Greenhouse Gas Footprints of Aviation Fuels



AFRL-RZ-WP-TR-2009-2206

PROPULSION AND POWER RAPID RESPONSE RESEARCH AND DEVELOPMENT (R&D) SUPPORT
Delivery Order 0011: Advanced Propulsion Fuels Research and Development
Subtask: Framework and Guidance for Estimating Greenhouse Gas Footprints of Aviation Fuels (Final Report)

The Aviation Fuel Life Cycle Assessment Working Group
For
Universal Technology Corporation

APRIL 2009
Interim Report

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- **www.netl.doe.gov/energy-analyses**
- **www.caafi.org**
- **www.dtic.mil (coming soon)**

Report Cleared for Public Release: December 2009

Life Cycle Guidance Document – Key Milestone

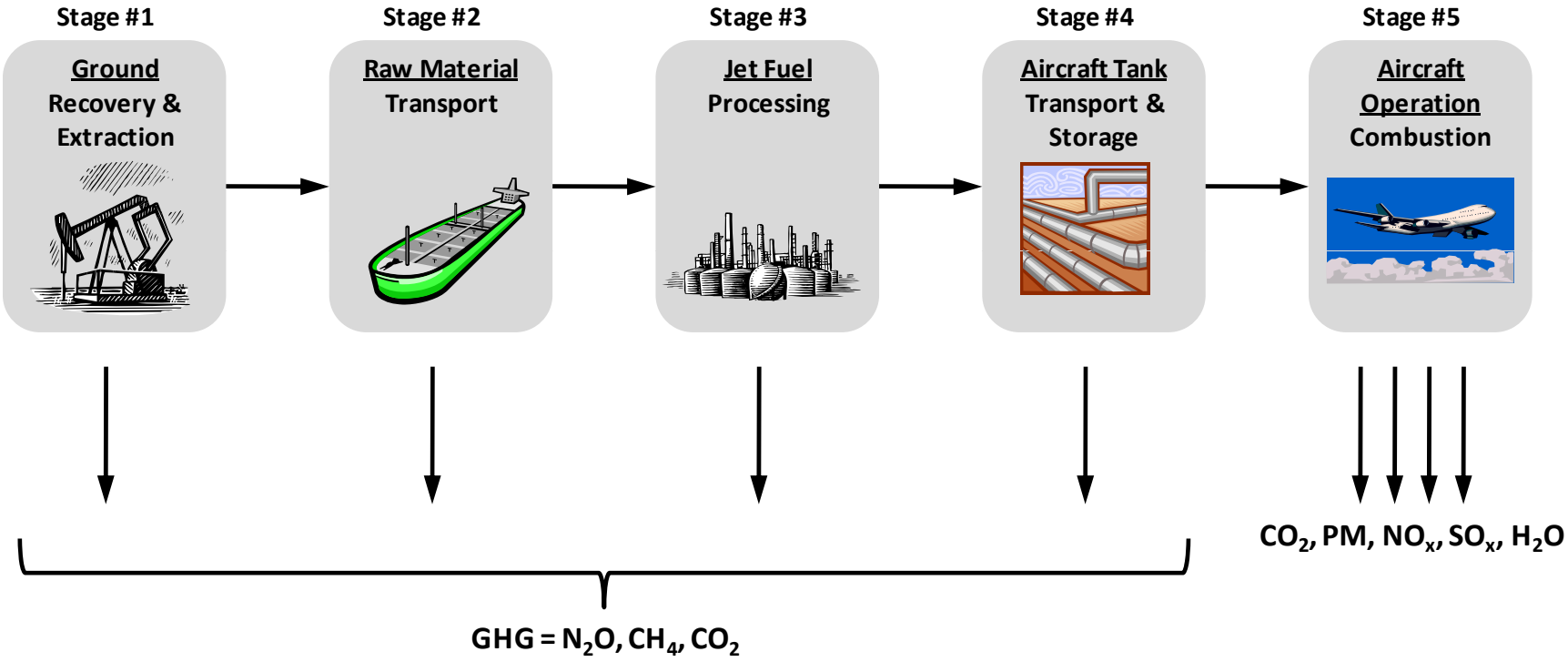
- **Consensus of LCA practitioners, Defense Energy Support Center, regulatory agencies and other stakeholders on:**
  - Methodological approach
  - Standards for data
  - Standards for documentation

- **Document Consistent with:**
  - SETAC (Society for Environmental Toxicology and Chemistry)
  - ISO 14040 and 14044
  - PAS 2050 standards
  - California Low Carbon Standards

Contents of Guidance Document

1. Executive Summary
2. Introduction
3. Guiding Principles and Functional Units
4. System Boundary Definitions and Analysis
5. Appropriate Management of Co-Products
6. Documenting Data Quality and Uncertainty
7. Conclusions

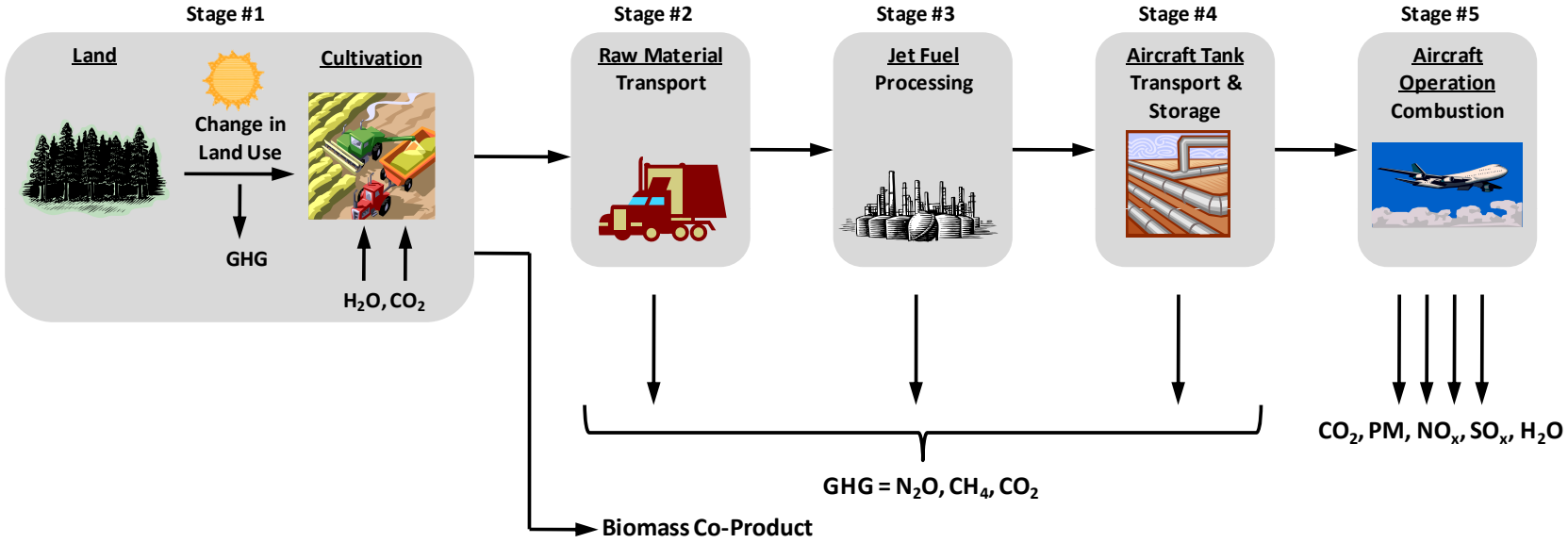
Simplified Schematic of Life Cycle for Petroleum-based Jet Fuel



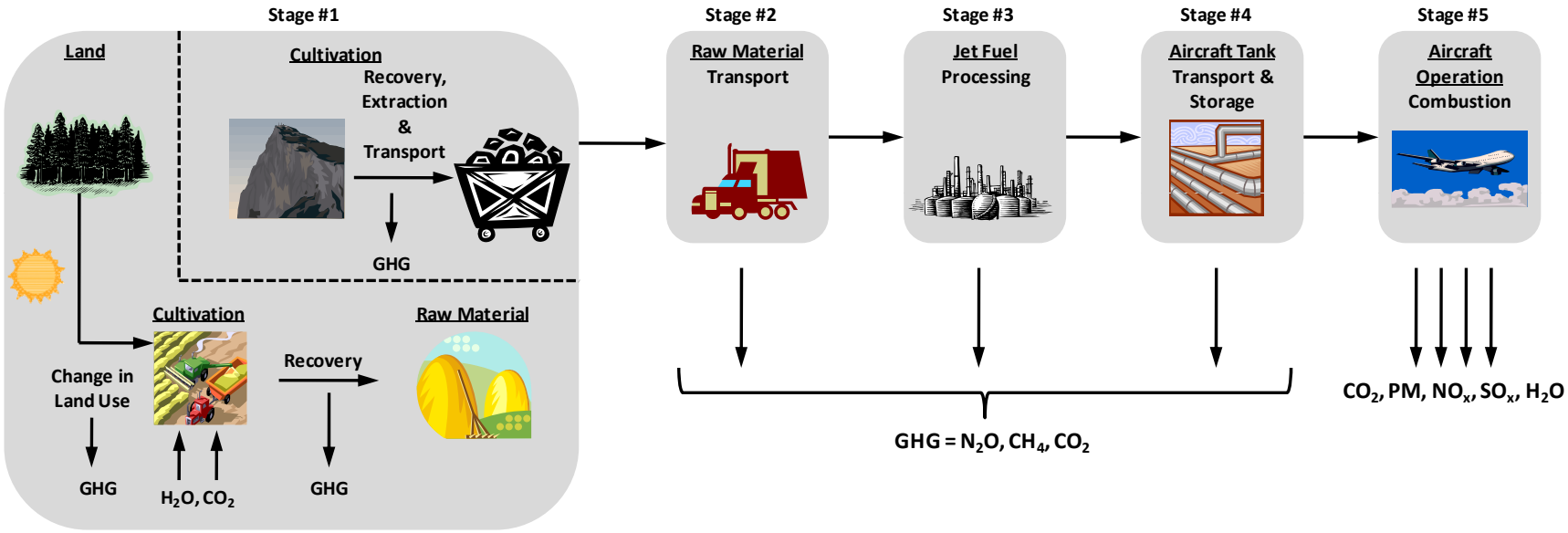
16% Well-to-Tank GHG Emissions

84% Tank-to-Wake GHG Emissions

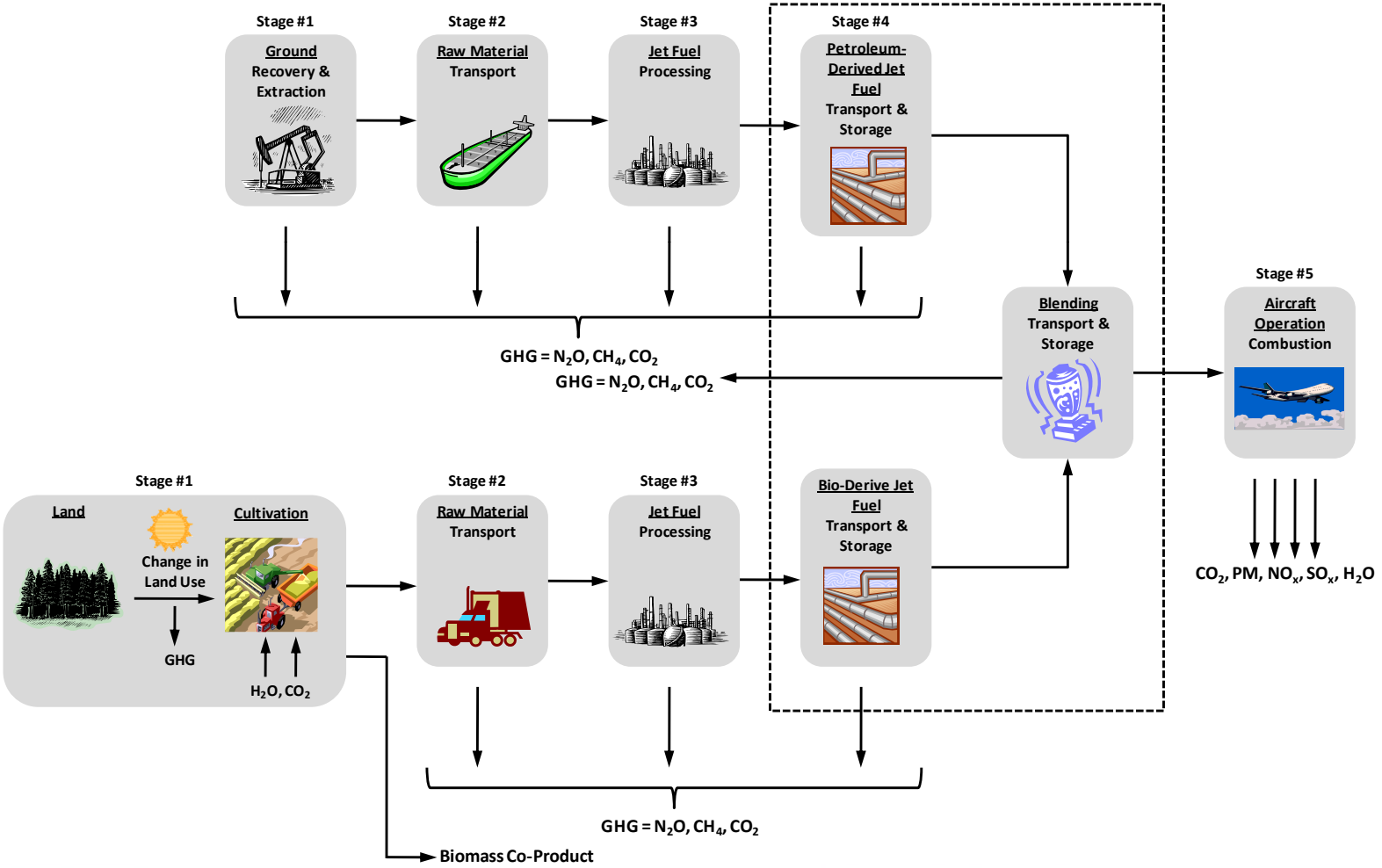
Simplified Schematic of Life Cycle for Bio-based Jet Fuel



Simplified Schematic of Life Cycle for Coal and Biomass-based Jet Fuel (CBTL)



Simplified Schematic of Life Cycle for Petroleum-based Jet Fuel Stock and Bio-based Jet Fuel Stock



Current Charge: FT-to-Jet Fuel Case Study

FT-to-Jet Fuel Case Study

- **Feedstock**
  - Illinois #6 Bituminous Coal
  - Switchgrass, 30% by weight
- **Plant Size: 30,000 BPD Plant**
- **Products**
  - SPK-1 Jet Fuel
  - Naphtha
  - Diesel fuel
- **Carbon Management Strategy**
  - Enhanced Oil Recovery (EOR)
  - Saline Aquifer (sensitivity analysis)

Fighter Jet Hits Mach 2 on Synthetic Fuel Blend

By Noah Sachtman, August 21, 2008
Source: www.wired.com

[excerpt] An Air Force F-15 Eagle flew twice the speed of sound this week, using a synthetic fuel blend. The service has already flown some of its bigger, heavier aircraft — like the C-17 cargo plane and B-52 bomber — on the 50-50 blend of synthetics and standard JP-8 jet fuel. A B-1 even broke the sound barrier, using the mixture. But this is the first time a maneuverable, high-performance fighter has been powered by the stuff.

LC Stage #1&2(a): Coal Acquisition

- NETL (Lead), ERG-FAL, DESC

LC Stage #1&2(b): Biomass Acquisition

- UW (Lead), MIT, UT-Austin, Boeing, ANL, DOT

LC Stage #1&2(c): Direct Land Use

- GaTech (Lead), NETL, MIT, UW, ANL

LC Stage #3a: FT Plant

- UT-Austin (Lead), NETL, Princeton, UDRI, ANL

LC Stage #3b: Enhanced Oil Recovery

- NETL (Lead), UW, CMU, UTC

LC Stage #4: Transport & Distribution

- NETL (Lead), ERG-FAL, UW, DESC, ANL

LC Stage #5: End Use

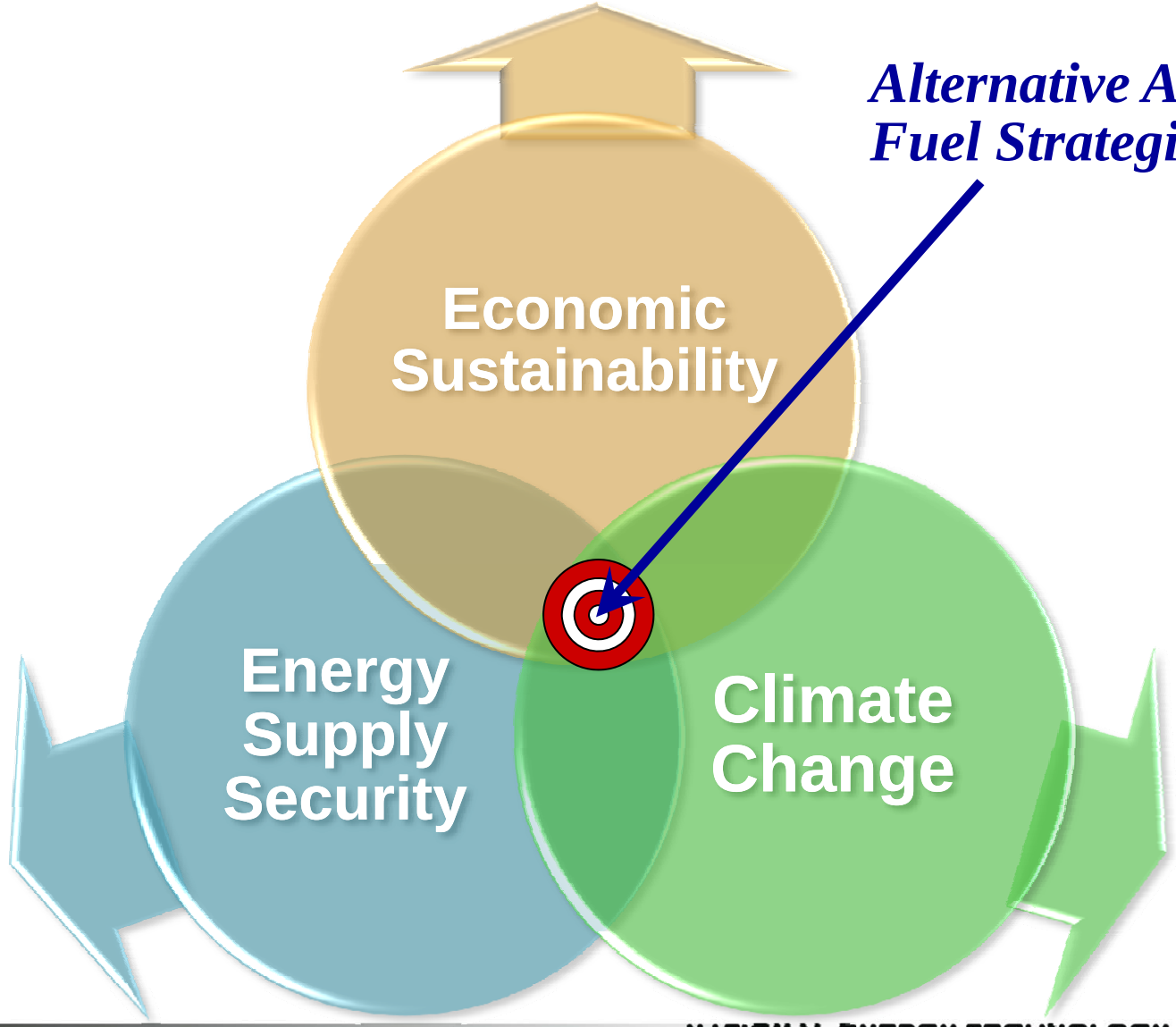
- MIT (Lead), Boeing, FAA, AFRL, GaTech

FT-Jet Case Study Sub-groups

ANL	Argonne National Laboratory
AFRL	U.S. Air Force Research Laboratory
Boeing	The Boeing Company
CMU	Carnegie Mellon University
DESC	Defense Energy Supply Center
DOT	Department of Transportation
ERG-FAL	Franklin Associates, A Division of ERG
FAA	Federal Aviation Administration
GaTech	Georgia Institute of Technology
MIT	Massachusetts Institute of Technology
NETL	National Energy Technology Laboratory
Princeton	Princeton University
UDRI	University of Dayton Research Institute
UTC	Universal Technology Corporation
UW	University of Washington

System Boundary

IAWG Workgroup Develops Guidance to Evaluate Potential Solutions



Next Steps for IAWG Workgroup

- **Spring/Summer 2010** — **FT-Jet Case Study**
- **Summer/Fall 2010** — **Soy-to-Jet Case Study**
- **Fall 2010/Spring 2011** — **Algae-to-Jet Case Study**

All Final Work Products Will Be Made Publically Available Upon Completion of Peer Review.

Thank you!

Questions?

For additional information about the IAWG-AF Jet Fuel Study contact:

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