The 21st Century – Barrels of Alternative Fuels

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US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000

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The original document contains color images.
“Strengthening Federal Environmental, Energy, and Transportation Management”, 26 Jan 2007, requires that each agency (alternative fuels related goal)

– For fleets of at least 20 vehicles, reduce associated petroleum consumption by at least 2% annually through FY2015, increase non-petroleum fuel consumption by 10% annually, and use plug-in hybrid vehicles when commercially available at a reasonable cost. [non-tactical vehicles]

Memorandum for Secretaries of Military Departments; Deputy Secretary of Defense, 16 Feb 2007

– “As the federal leader in the use of renewable energy, alternative fueled vehicles, and reduced facility energy consumption, the Department has set and should continue to set an example by aggressively implementing the guidance outlined in the EO.”

– “In addition, the Department should consider energy efficiency and the ability to use alternative sources in its weapons platforms and tactical vehicles, as identified by the Energy Security Task Force in September 2006, where practical.”
Diesel Market – Military vs. Commercial (U.S.)

- Adv. technology diesel engines
- Low sulfur diesel fuel (LSDF)
- “Low sulfur” lubricants

“Clean Diesel” System (Ultra LSDF)

- Variety engines (MY 19XX)
- Jet fuel (JP-8)
- Lubricants (MIL-spec)

Alternative Fuels

Military diesel market future?

Divergence = Challenges

20th Century
Transportation market growth on cheap oil; evolution to less polluting vehicles initiated by early environmental legislation.

21st Century
Transportation market evolution continues, shaped by heightened concerns about energy security and environment.

* Excluding non-tactical vehicles.
Challenges

• Widely varying fuel sulfur levels
  – JP-8 allowable sulfur up to 3000 ppm
    • JP-8 is not compatible with “Clean Diesel” Systems
  – Not all diesel fuel is ULSDF; sulfur levels vary worldwide
    • Not all diesel fuel is compatible with “Clean Diesel” Systems

• Fuel additives and lubricants – must be suited to fuel/system
  – Lubricity improvers approved for JP-8 (MIL-spec) differ from commercial lubricity improvers developed for “Clean Diesel” Systems
  – Lubricants approved for military equipment (MIL-spec) differ from commercial lubricants developed for “Clean Diesel” Systems

• Emerging Alternative Fuels
  – Knowledge base of fuel composition and properties
  – Understanding suitability for use in existing and future military equipment
Coal with Biomass (CBTL)
Natural Gas (GTL)
Coal (CTL)
Pet Coke
Biomass (BTL)
Wastes

Synthesis Gas Production

FT Liquid Synthesis

Product Recovery

Power Generation

An Option

Liquid Fuels

Wax

Hydrogen Recovery

Transportation Fuels

Hydrogen Separation

Wax Hydrocracking

Hydrogen

Hydrogen Recovery

Tail Gas

O2

CO

H2

FT Fuels Production

Oxygen Plant

Liquid Fuels

CO2 to Sequestration

CO2 to Sequestration
Comparing Fuels GHG Emissions

Estimated change in greenhouse gas emissions if petroleum fuels were to be replaced by one of these alternative fuels


* added - Robert H. Williams, University of Princeton, Coal+Biomassto-liquids w/CCS information from presentation to Laboratory Energy R&D Working Group (LERDWG), April 18, 2007 Washington, DC
• DARPA Biojet Program
  – General Electric (GE)
  – University of North Dakota EERC
  – UOP

• Feedstocks
  – Seed Crop Oils (canola, jatropha, soy, safflower, palm)
  – Green algae
  – Animal manure
  – Animal renderings

Can biojet be produced on large-scale and be cost competitive?
DoD Jet Fuel Approval Process

Draft Spec
- Laboratory Evaluations
  - chemical composition
  - physical properties
  - storage stability
  - thermal stability
  - lubricity (bench-top)
  - material compatibility
  - co-mingling ability
  - environmental suitability
  - toxicology, health, safety

Revised Draft Spec
- Component Evaluations
  - fuel pumps/controls
  - engines
  - simulations
  - coordinate draft spec (DoD, Industry, DLA)
  - identify volumes required (DLA)
  - identify vendors (DLA)

Final Spec
- System Evaluations
  - controlled field trials (e.g., aircraft, vehicles)
  - update technical manuals
  - update training requirements
  - manager approvals (weapon systems, platforms)
  - Program Memorandum Decision
- Demonstrations
  - build user awareness and acceptance for wide-spread implementation

This process depends on working with Industry Standards Organizations.

TECHNOLOGY DRIVEN. WARFFIGHTER FOCUSED.
Tri-Service Coordination – Alternative Fuels Qualification

- Laboratory Evaluations
- Component Evaluations
- System Evaluations
- Demonstrations

Fischer-Tropsch

- Draft Spec
- Revised Draft Spec (allows ≤50% by volume FT)

Air Force
Army
Navy

Shale Oil

Air Force
Army
Navy

“Biojet” (non-FT)

Air Force

unclassified
**TARDEC FT Fuels Qualification**

- **Completed**
  - Fuel chemical composition and properties
  - Materials compatibility evaluations
  - Fuel lubricity evaluations
  - Fuel blending studies
  - Emissions evaluation (6.5L GEP engine)

- **Current**
  - Performance / durability evaluations
    - Caterpillar C7 engine (2 x 210-hr wheeled vehicle test cycle)
    - 10 kW tactical generators

- **Future**
  - Performance / durability evaluations
    - 6.5L GEP, Caterpillar C7, DDC 8V92TA, Cummins V903C engines (NATO 400-hr test cycle)
  - HMMWV test track evaluation
  - 25 tactical vehicle (5x5) field demo
**21st Century**

*Transportation market evolution continues, shaped by heightened concerns about energy security and environment.*

- Alternative fuels making their way into the jet/diesel fuel supply (e.g., B20 biodiesel)
- Changes driven by
  - Air Force Synthetic Fuels Program (goal to certify aircraft on alt. fuels by 2011)
  - Various domestic initiatives to produce synthetic, shale oil, and biofuels
- TARDEC proactive in assessing emerging changes
  - Qualifying current fleet engines and platforms to use JP-8 fuel containing synthetic FT hydrocarbons up to 50% by volume
  - Tri-service coordination of alternative fuels qualification efforts
  - Building alternative fuels knowledge database and assessment capability
    - Fuel composition and physical properties
    - Fuel lubricity and additive detection methodology
    - Ignition behavior