

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

# The 21<sup>st</sup> Century – Barrels of Alternative Fuels

2<sup>nd</sup> Annual Ground-Automotive Power & Energy Symposium  
August 8, 2007

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## Report Documentation Page

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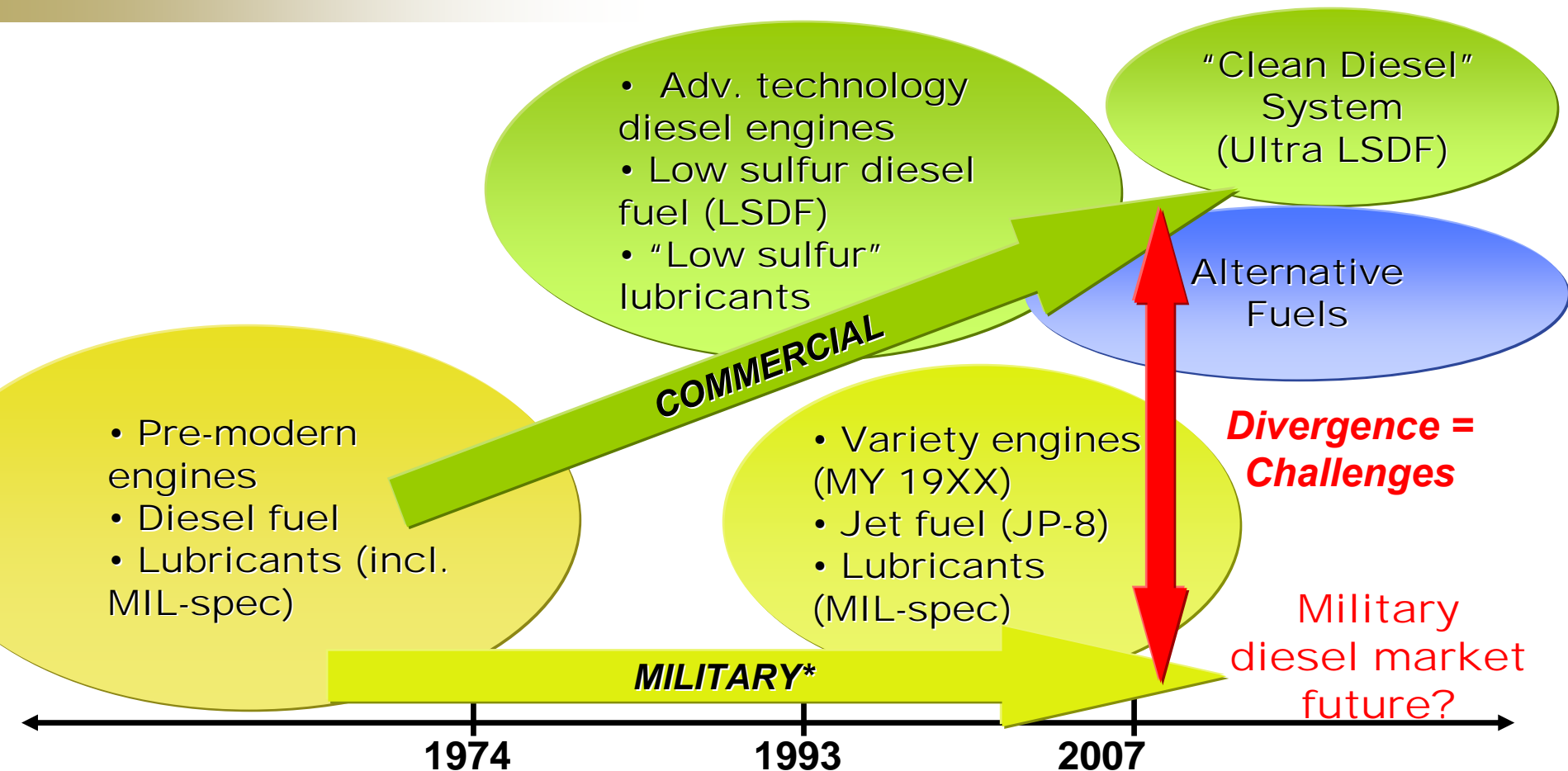
**“Strengthening Federal Environmental, Energy, and Transportation Management”, 26 Jan 2007, requires that each agency (alternative fuels related goal)**

*– 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.”*



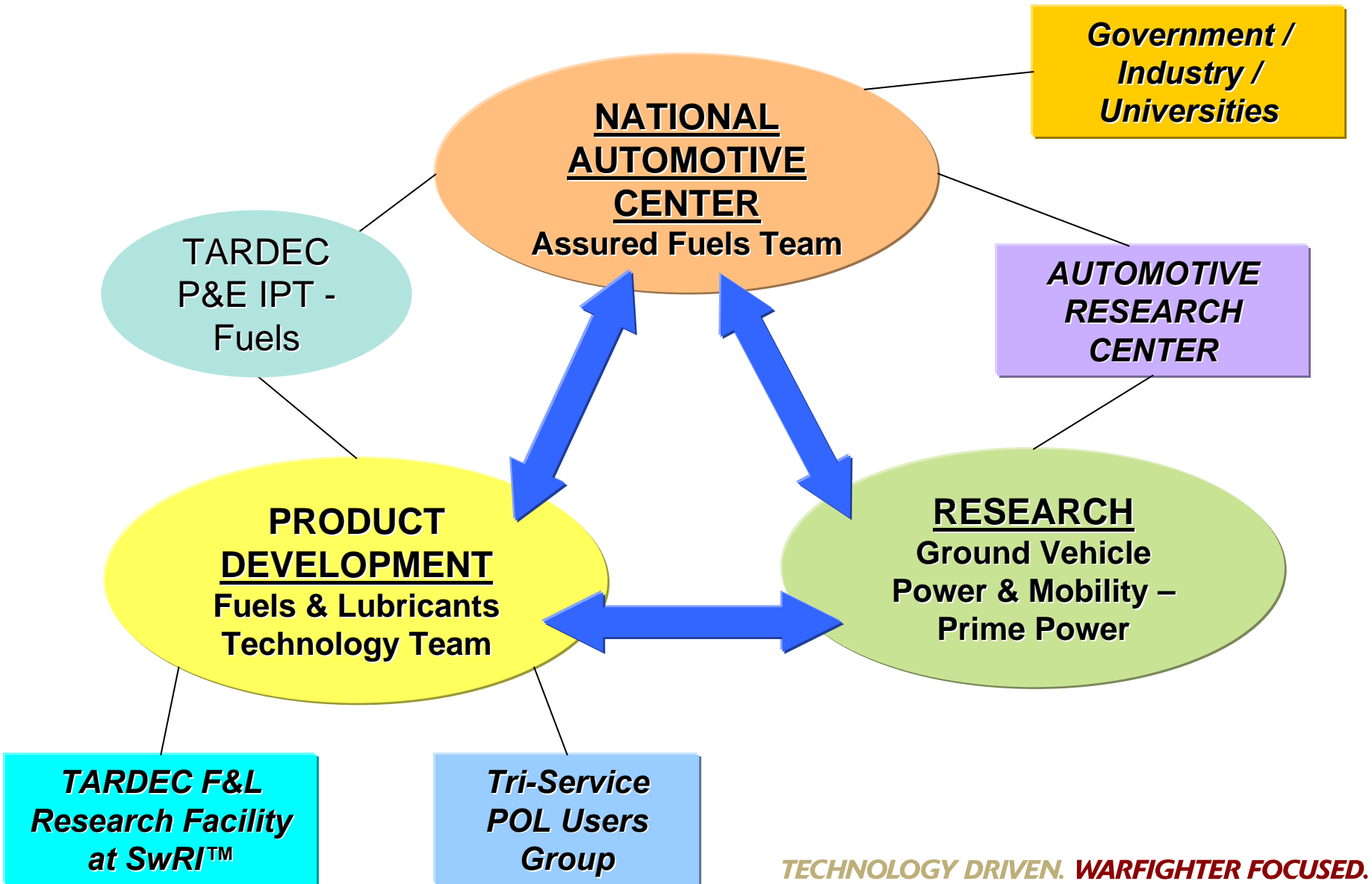
**20<sup>th</sup> Century**  
*Transportation market growth on cheap oil; evolution to less polluting vehicles initiated by early environmental legislation.*

**21<sup>st</sup> Century**  
*Transportation market evolution continues, shaped by heightened concerns about energy security and environment.*

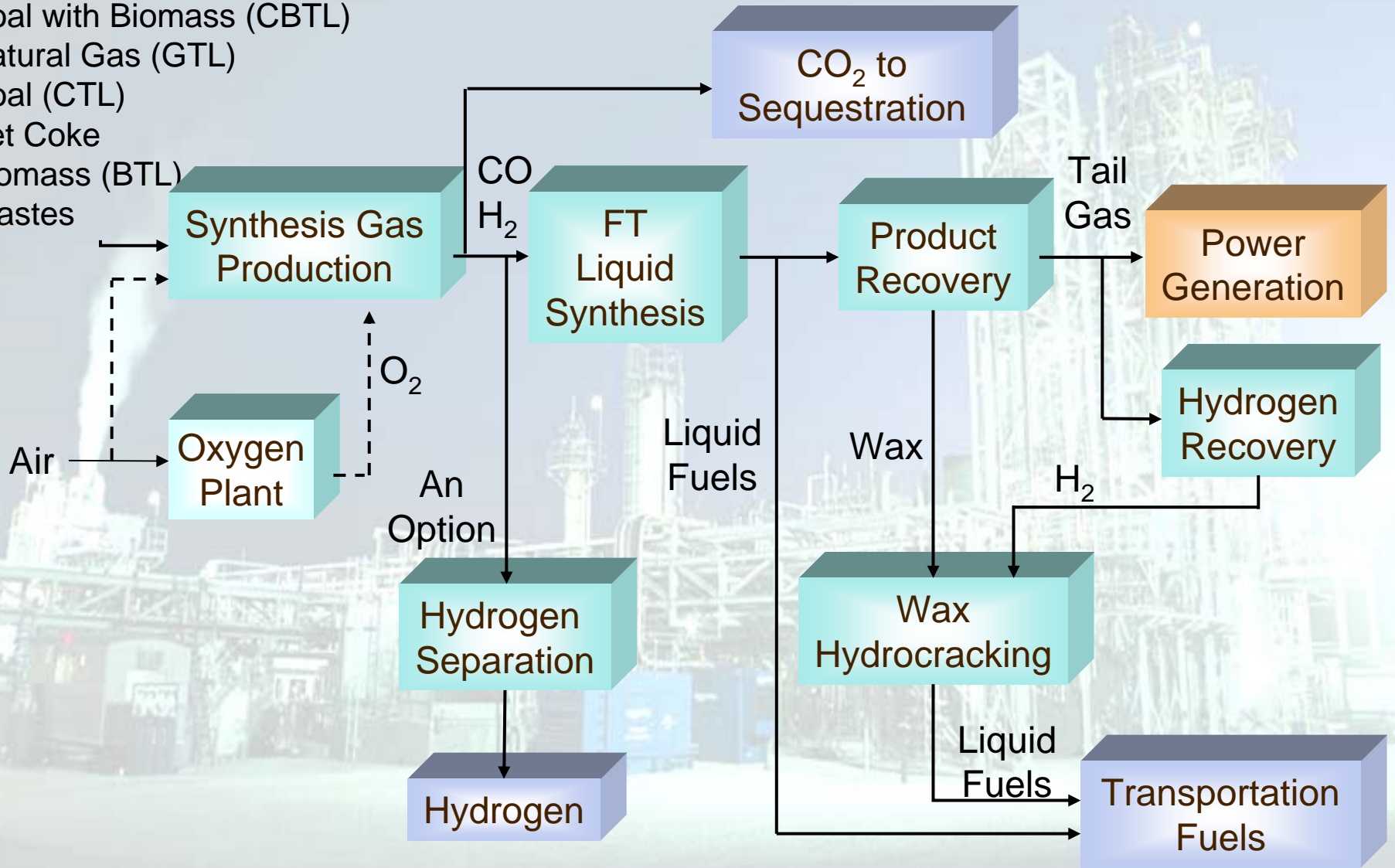
**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

\* Excluding non-tactical vehicles.

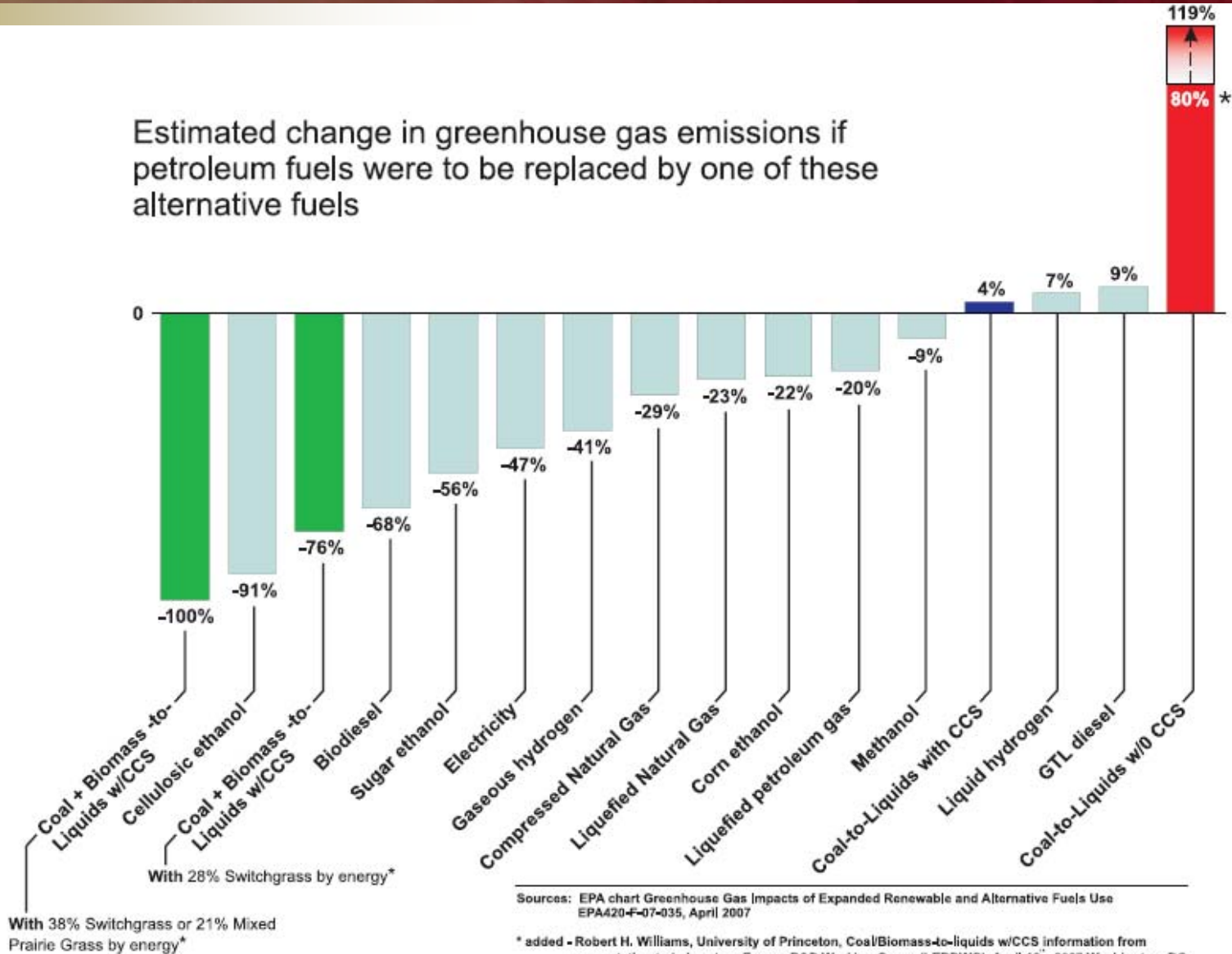
- Widely varying fuel sulfur levels
  - JP-8 allowable sulfur up to 3000 ppm
    - JP-8 is not compatible with “Clean Diesel” Systems
  - Not all diesel fuel is ULSD; sulfur levels vary worldwide
    - Not all diesel fuel is compatible with “Clean Diesel” Systems
- Fuel additives and lubricants – must 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



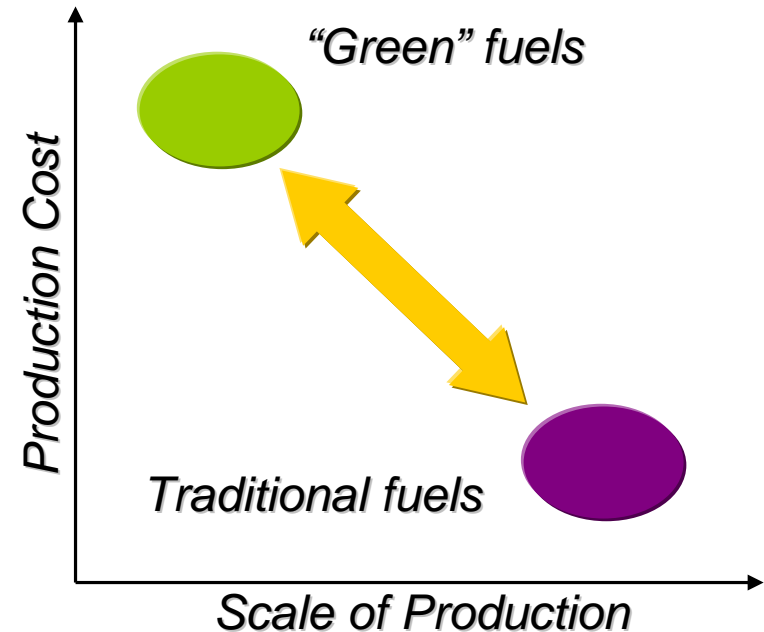
Coal with Biomass (CBTL)  
 Natural Gas (GTL)  
 Coal (CTL)  
 Pet Coke  
 Biomass (BTL)  
 Wastes



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



- 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?***

*Draft Spec*

*Revised Draft Spec*

*Final Spec*

**Laboratory Evaluations**

**Component Evaluations**

**System Evaluations**

**Demonstrations**

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

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

- controlled field trials (e.g., aircraft, vehicles)
- update technical manuals
- update training requirements
- manager approvals (weapon systems, platforms)
- Program Memorandum Decision

- build user awareness and acceptance for wide-spread implementation

***This process depends on working with Industry Standards Organizations.***

Laboratory  
Evaluations

Component  
Evaluations

System  
Evaluations

Demonstrations

## Fischer-Tropsch

*Draft Spec*

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

Air Force  
Army  
Navy

Air Force  
Army  
Navy

Air Force (B-52)  
Army (FY08)

Air Force  
(B-52)

## Shale Oil

Air Force  
Army  
Navy

## “Biojet” (non-FT)

Air Force

**Laboratory Evaluations**

**Component Evaluations**

**System Evaluations**

**Demonstrations**

- **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



## 21<sup>st</sup> 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
  - Legislation [Energy Policy Act of 2005], Executive Orders [EO 13423]
  - 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