# OSD Assured Fuels Initiative

Vision: DoD/AT&L intends to catalyze commercial industry to produce clean fuels for the military from secure domestic resources using environmentally sensitive processes as a bridge to the future.

## 2006 Aerospace in the News Executive Symposium


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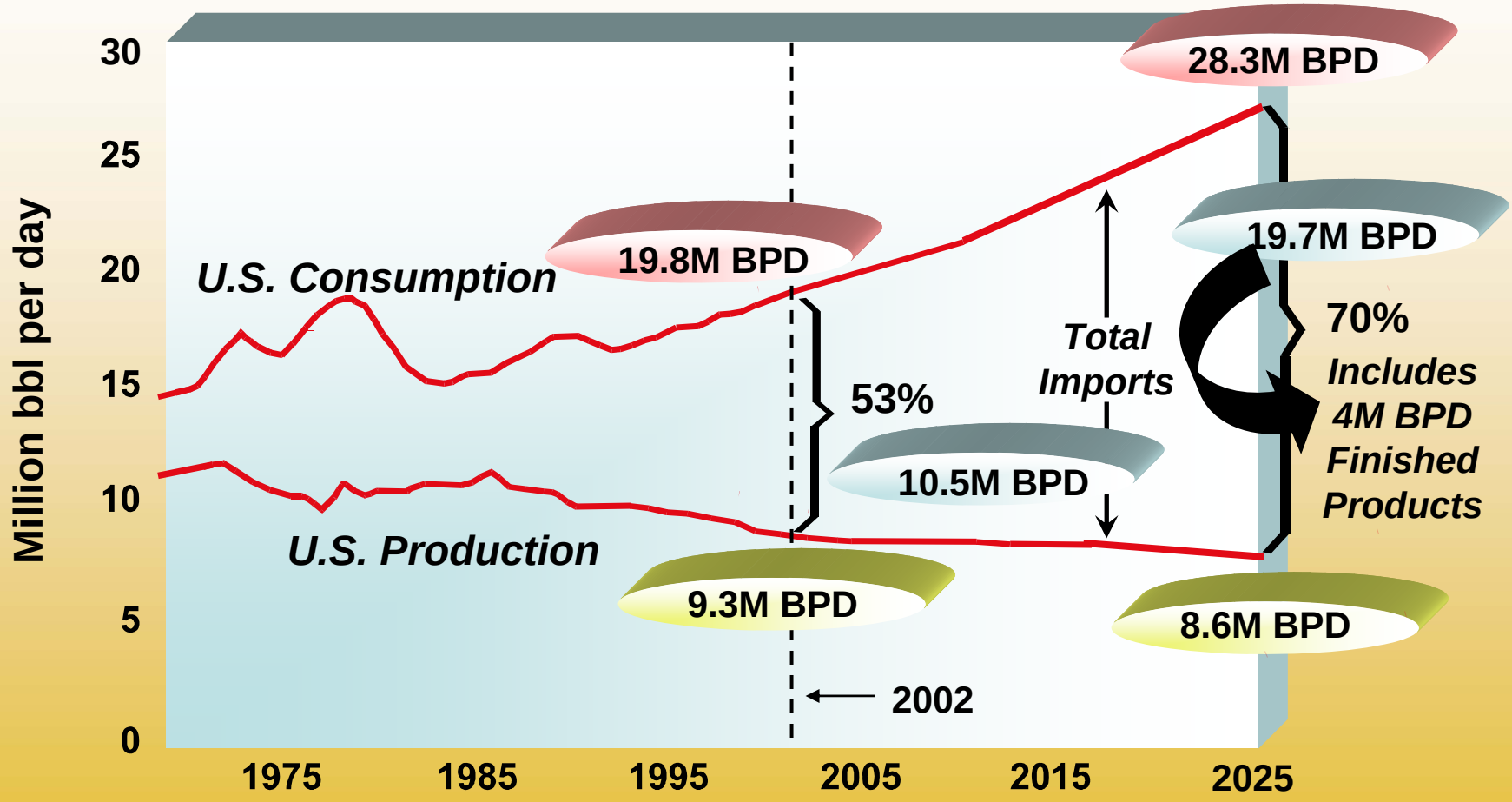
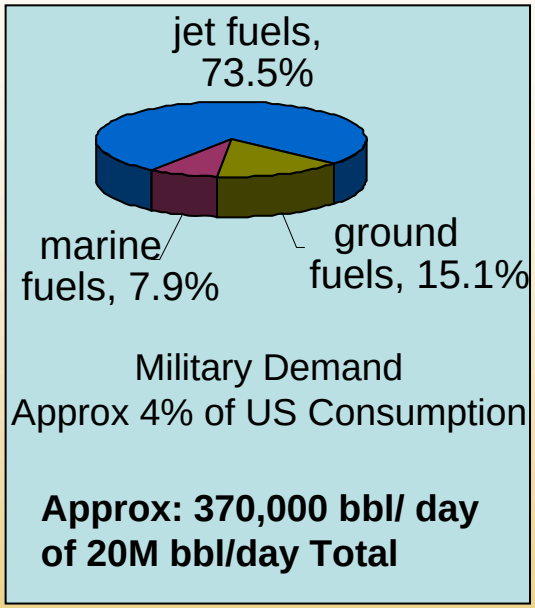
# Increasing Reliance on Petroleum Imports

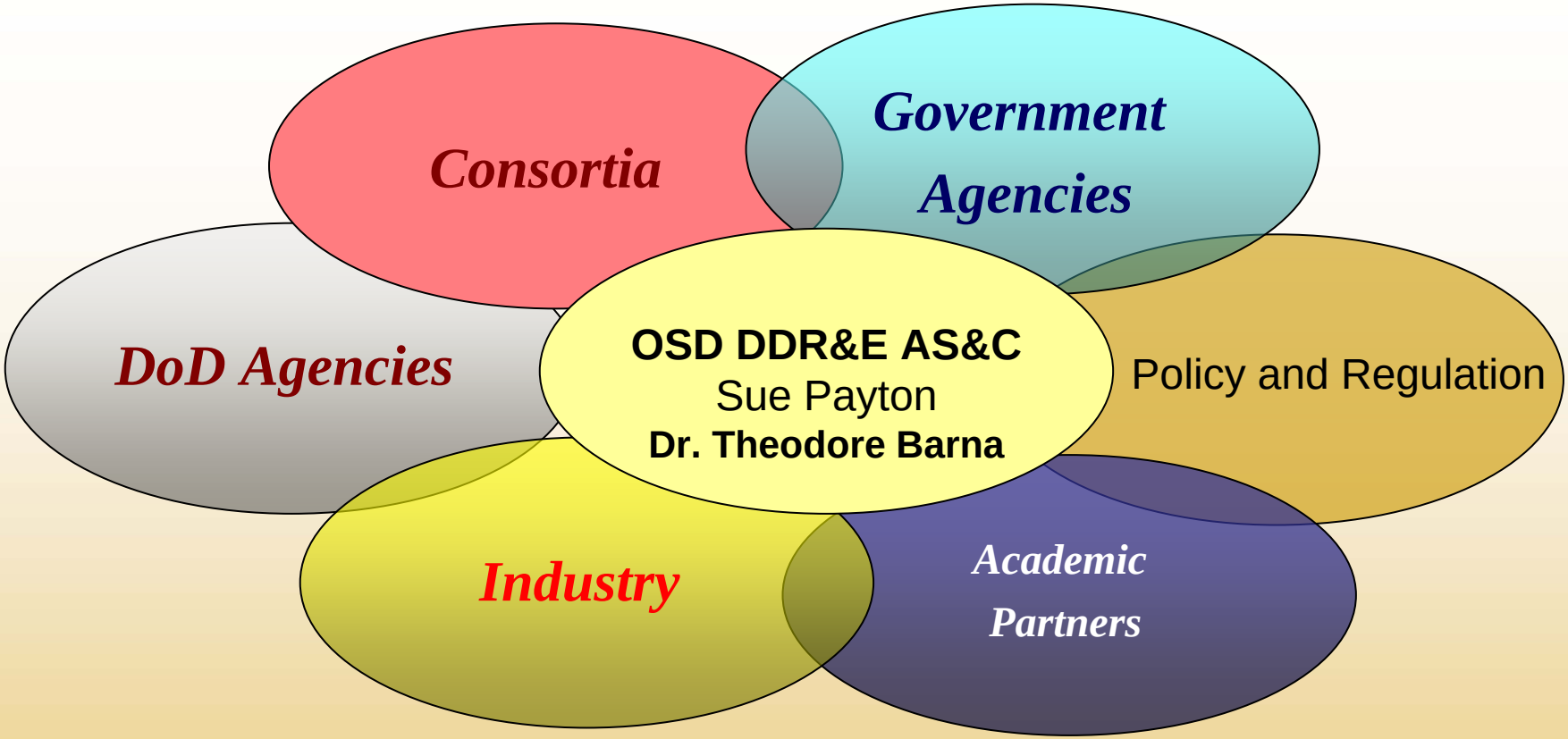



*Source: EIA (AEO 2004); Reference Case Scenario*
*[Courtesy John Winslow-DoE]*

# DOD Energy Concerns

- Lack secure and reliable sources of energy
  - Dependent on foreign oil
  - Becoming dependent on foreign refined fuels
- Supply chain vulnerability
  - Rely on mega-refineries
  - Vulnerable to Terrorist threats or natural disasters
- Need for cleaner fuels
  - DoD exempt from some EPA regulations
- Need for Better Fuels
  - Thermal Stability, Fuel Cells, Advanced Engines
- Need for Fewer Fuels
  - 7-9 Fuels presently in AOR
- Potential limits on deployments
  - Possible Conflict with EU rules






# Office of the Secretary Of Defense Initiative

- Form partnerships with other government agencies (DOE, DOT,EPA, Interior, Commerce etc.), industry and academia
- Catalyze industry development and investment in energy resources: Total Energy Development Program (TED)
- Evaluate, demonstrate, certify and implement turbine fuels produced from diverse energy resources**:** Joint Battlespace Use Fuel of the Future (J-BUFF)

# OSD Assured Fuels Initiative Goals

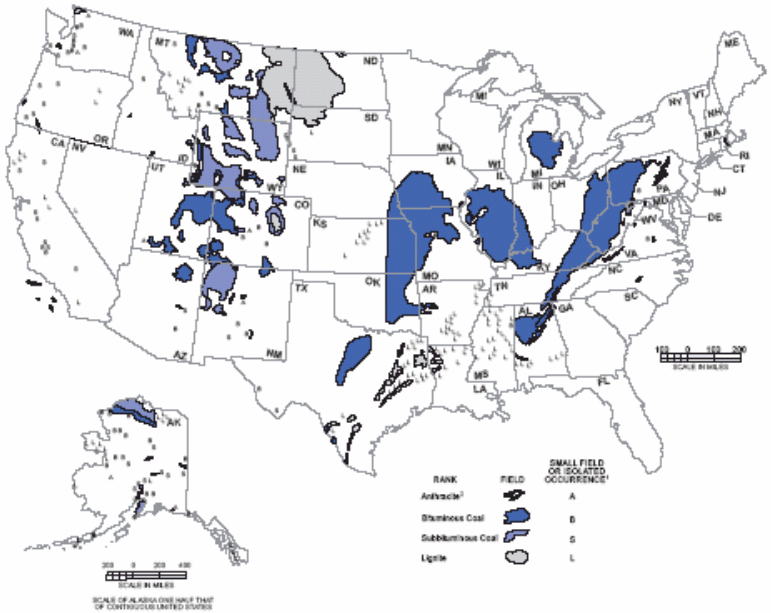
**Total Energy Development (TED)**

- Catalyze the industry to produce fuels for the military from domestic energy resources (up to 300,000 barrels per day)
- Break down hurdles and impediments that prevent production
- Coordinate activities with other federal agencies, states, industry and academia
- Determine economic viability
- Develop a roadmap to provide fuel for the Joint Battlespace Use Fuel of the Future program and implementation

- **Joint Battlespace Use Fuel of the Future (J-BUFF)**
  - Develop fuel specifications for fuels from alternative energy resources that enable single fuel for the entire battle space (tactical ground vehicles, aircraft, ships, hypersonics, rockets and fuel cells) and reduce emissions
  - Evaluate, demonstrate (ACTD in FY08/09) and certify fuels to enable DoD to use fuels in all tactical vehicles, aircraft and ships
  - Provide a transition plan for DoD wide deployment

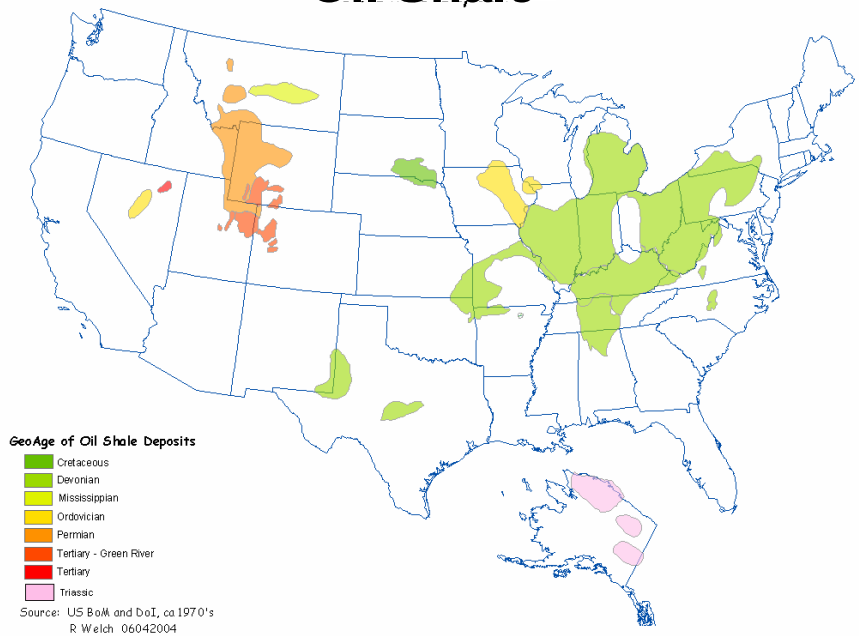
# Evaluating All US Energy Resources

## Coal

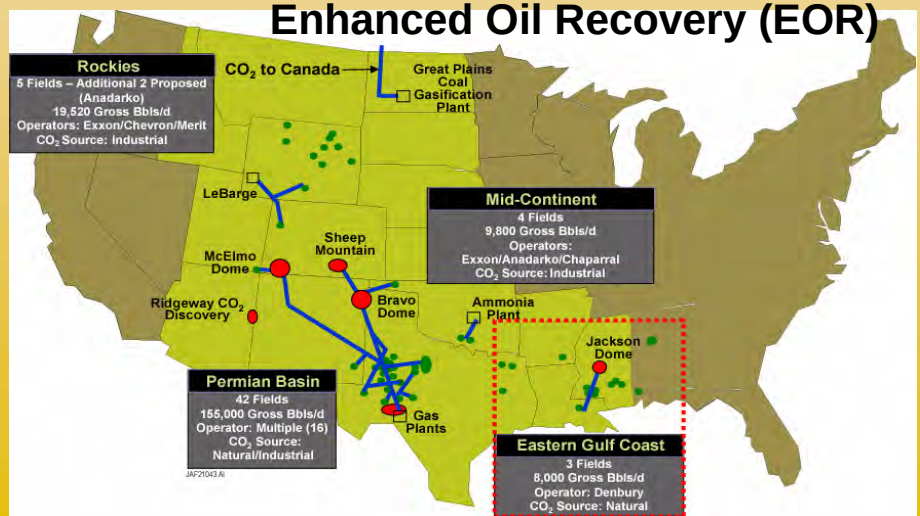



Sources: United States Geological Survey, *Coalfields of the United States, 1960-1961*; Texas Bureau of Economic Geology, *Lignite Resources in Texas, 1980*; Louisiana Geological Survey, *Near Surface Lignite in Louisiana, 1981*; Colorado Geological Survey, *Coal Resources and Development Map, 1981*; and Mississippi Bureau of Geology, 1963.

## Oil Shale




## Enhanced Oil Recovery (EOR)




## Domestic Resources

- 1.4 trillion barrels (shale)
- 900 billion barrels of FT (coal)
- 0.15 billion barrels (pet coke)
- 22.7 billion barrels oil reserves
- 32+ billion barrels of oil (EOR)
- 100 million pounds of pulp waste/year

**Total 2.3+ trillion barrels equivalent**

# Western States Have More Barrels of Oil
## (1.5 Trillion bbls) than the Middle East (685 Billion bbls)

| | Coal | Oil Shale |
|---|---|---|
| • Alaska | 12 B Bbls | |
| • Colorado | 33 B Bbls | 600 B Bbls |
| • Montana | 240 B Bbls | |
| • New Mexi | 25 B Bbls | |
| • North Dakota | 20 B Bbls | |
| • Utah | 12 B Bbls | 300 B Bbls |
| • Wyoming | 135 B Bbls | 150 B Bbls |
| | **477 B Bbls** | **1050 B Bbls** |

# Appalachian States Have More Equivalent Barrels of Oil (904.6 Billion bbls) as Middle East (685.5 Billion bbls)

| | Coal | Shale |
|---|---|---|
| • Illinois | 218 B Bbls | |
| • Kentucky | 64 B Bbls | 190 B Bbls |
| • West Virginia | 70 B Bbls | |
| • Pennsylvania | 57 B Bbls | |
| • Ohio | 47 B Bbls | 140 B Bbls |
| • Indiana | 20 B Bbls | 40 B Bbls |
| • Alabama | 9 B Bbls | 4 B Bbls |
| • Tennessee | 1.6 B Bbls | 44 B Bbls |
| | **486.6 B Bbls** | **418 B Bbls** |

# Bottom Line: We could be the New Middle East—2.3+ Trillion Barrels

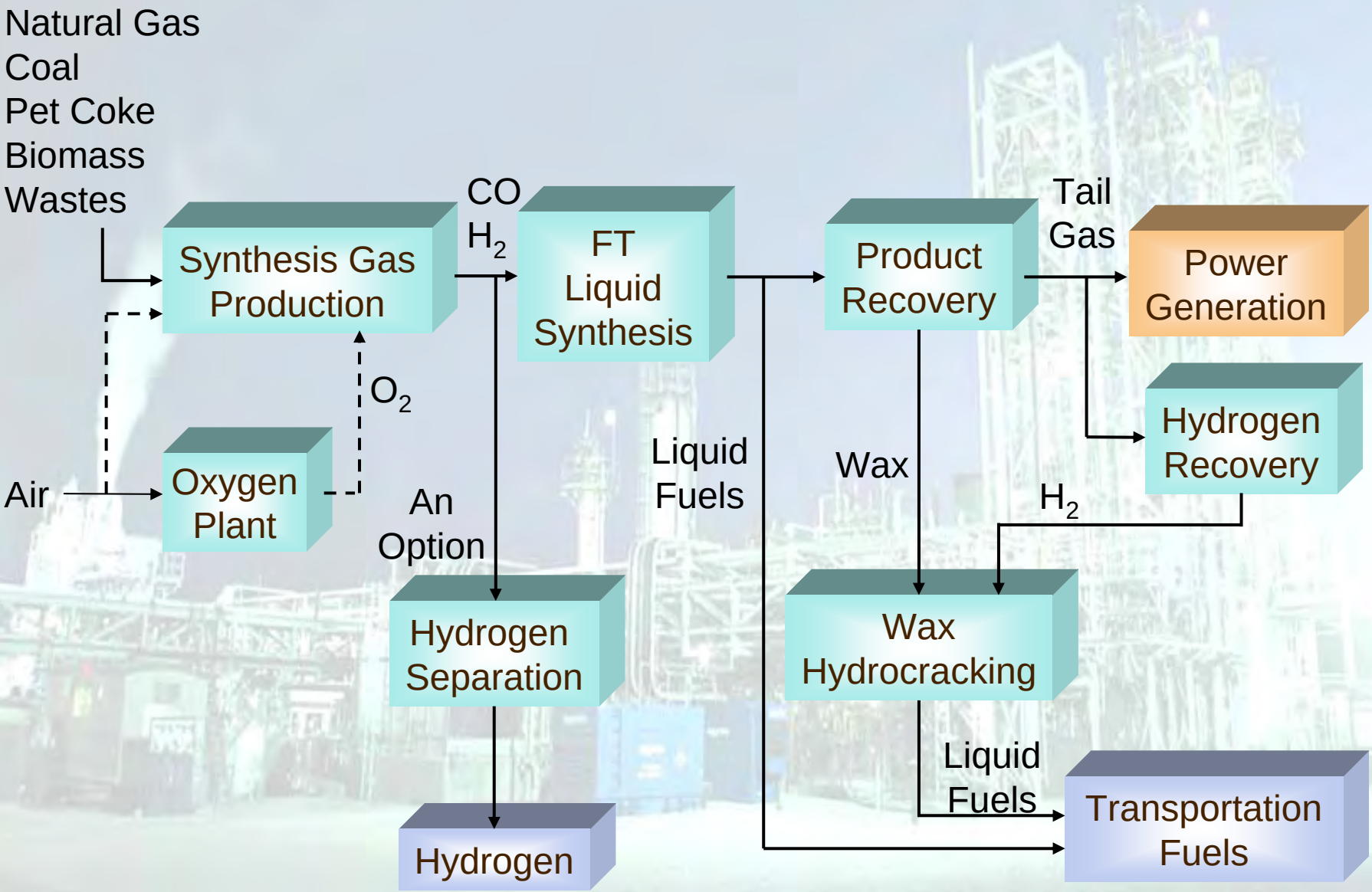
## Old Middle East

| | |
|---|---|
| Saudi Arabia: | 261.8 Billion Barrels |
| Iraq: | 112.5 Billion Barrels |
| UAE: | 97.8 Billion Barrels |
| Kuwait: | 96.5 Billion Barrels |
| Iran: | 89.7 Billion Barrels |
| Qatar: | 15.2 Billion Barrels |
| Oman: | 5.5 Billion Barrels |
| Yemen: | 4.0 Billion Barrels |
| Syria: | 2.5 Billion Barrels |
| TOTAL | 685.5 Billion Barrels |

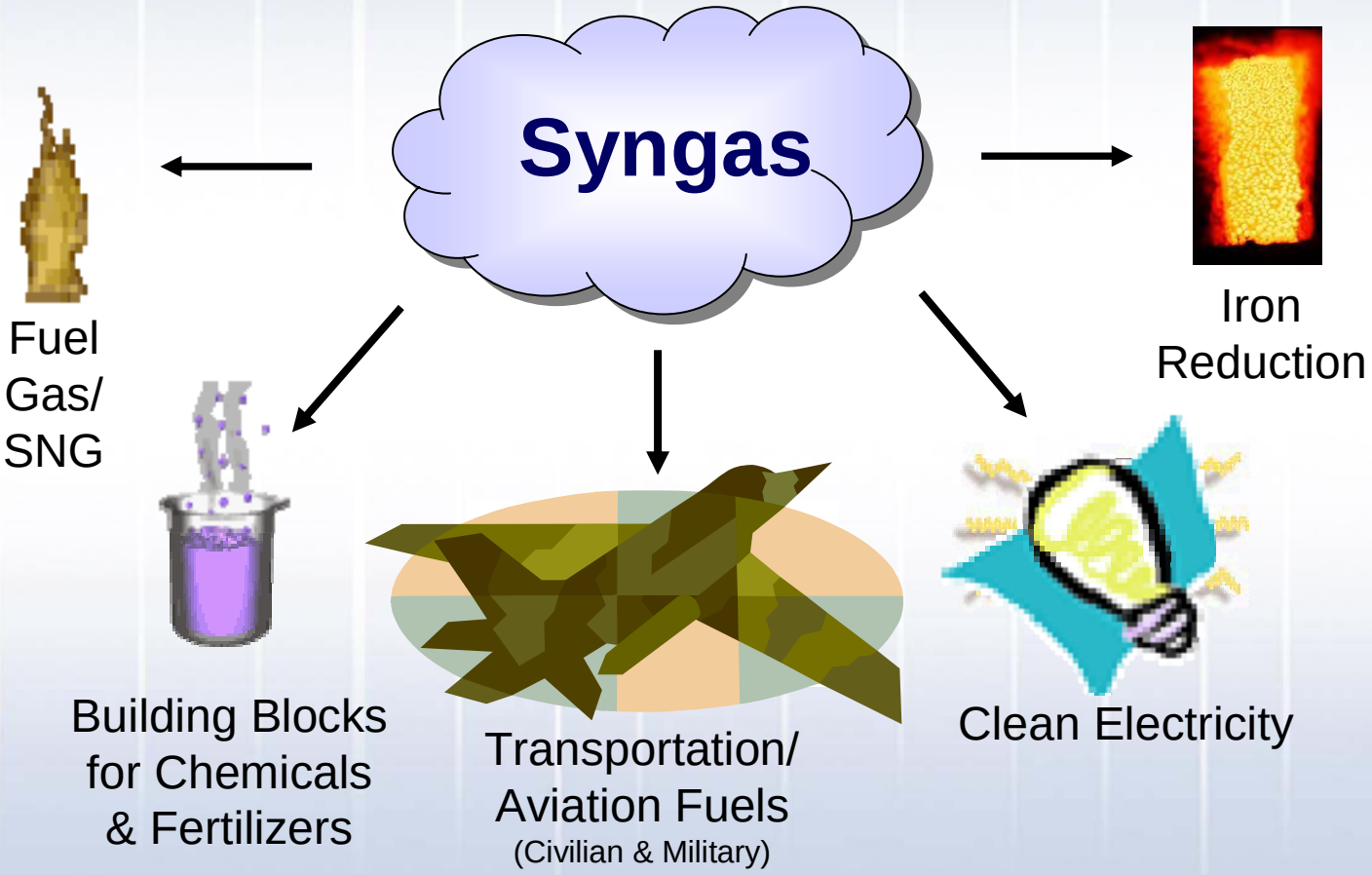
# Total Energy Development (TED)
# All Sources of Energy

- **Coal Fuels:** Outreach to industry
  - Mining, gasification, power production, Fischer Tropsch production, chemical production, product distribution
- **Shale Fuels:** Co-Chair DOE/DOD task force
  - Evaluate Latest Technology
  - Coordination with DOE (Hq Fossil Energy, NETL) and Dept of Interior
  - Briefed House and Senate Energy Committees
- **Biomass Fuels:** Trees
  - Identified potential with pulp and paper industry and US Forrest Service
  - Coordinating activities with American Forest and Paper Association
- **$CO_2$ for Enhanced Oil Recovery:** Economics and Environment
  - Climate Vision – Presidential Initiative
  - DOE Programs and Industry development
- **Technology Evaluation:** Poly-generation
  - Gasification, Fischer Tropsch wax production, wax upgrading
  - Transportation fuels, power production, chemicals, and fertilizer
  - For example: Chevron/SASOL, Shell, UOP, RenTech, Syntroleum, Eastman Chemical, Southern Companies, Royster Clark, HTI
- **Monitoring Congressional Legislation**
  - Energy, Transportation, Defense
  - EPAct legislation that affects DoD
  - National Defense Authorization Act

# Fischer-Tropsch Technology



# What can you do with CO and H2 ?



# Value Added Choices For Coal

## A choice to make:

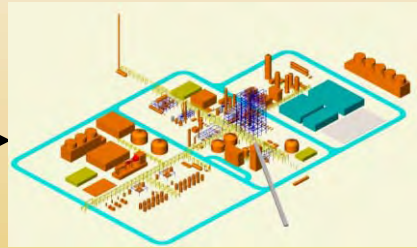
**1 ton of Il. Coal $32/ton**

Combustion

Gasification

Gasification

Gasification



**Electric Power Production**

| Products | Value |
|---|---|
| 2 MWh electricity | $70.00 |
| **Total** | **$70.00** |

**FT Fuels and Power**

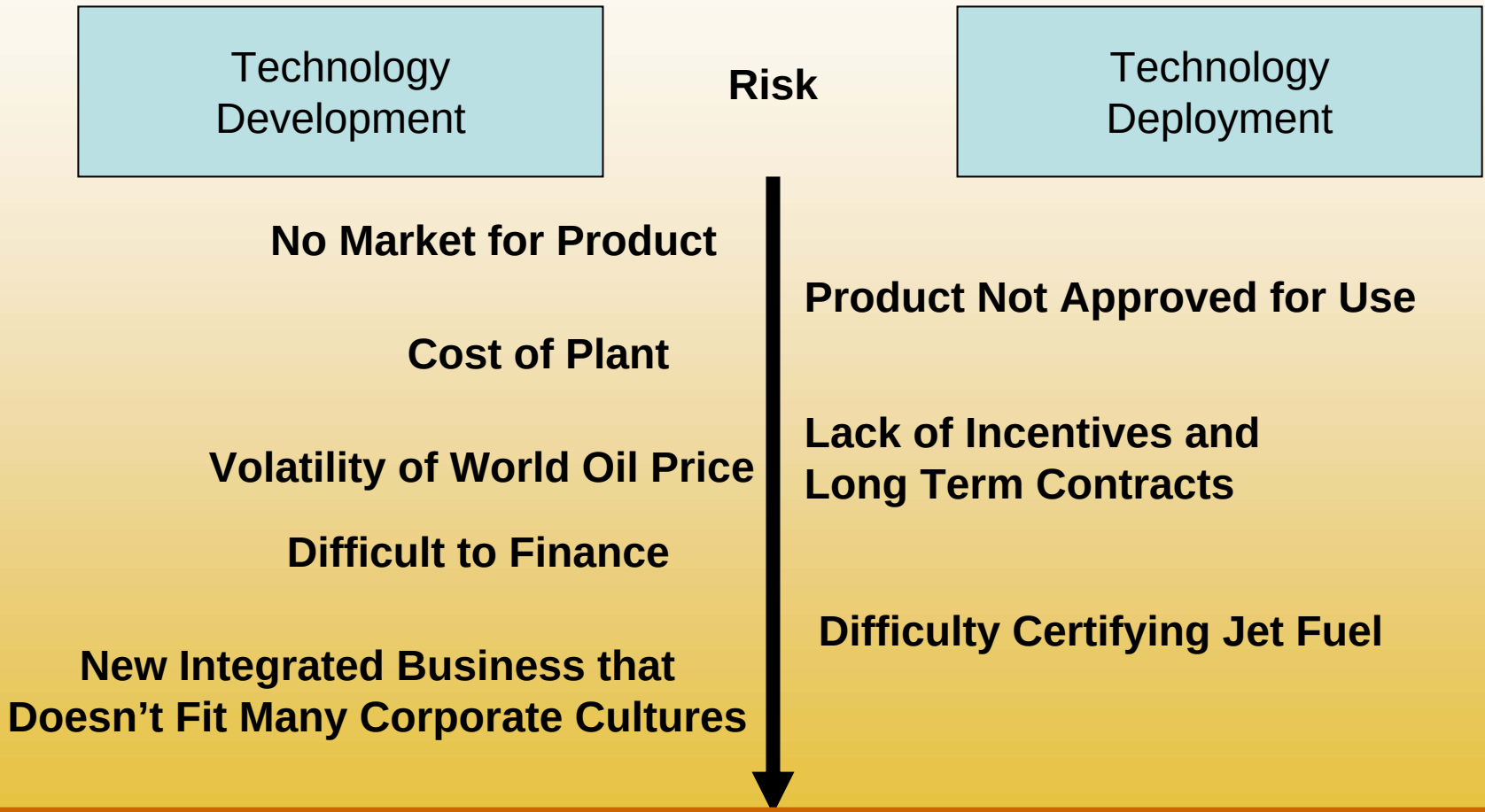
| Products | Value |
|---|---|
| 0.41MWh electricity | $14.00 |
| 0.34 bbls naphtha | $15.00 |
| 1.36 bbls jet fuel | $81.00 |
| **Total** | **$110.00** |

**Fertilizer, FT Fuels and Electric Power**

| Products | Value |
|---|---|
| 0.07 MWh electricity | $ 0.23 |
| 0.17 bbls naphtha | $ 8.00 |
| 0.78 bbls jet fuel | $46.50 |
| 0.25 tons of ammonia | $87.00 |
| **Total** | **$141.73** |

**Projected Numbers RenTech**

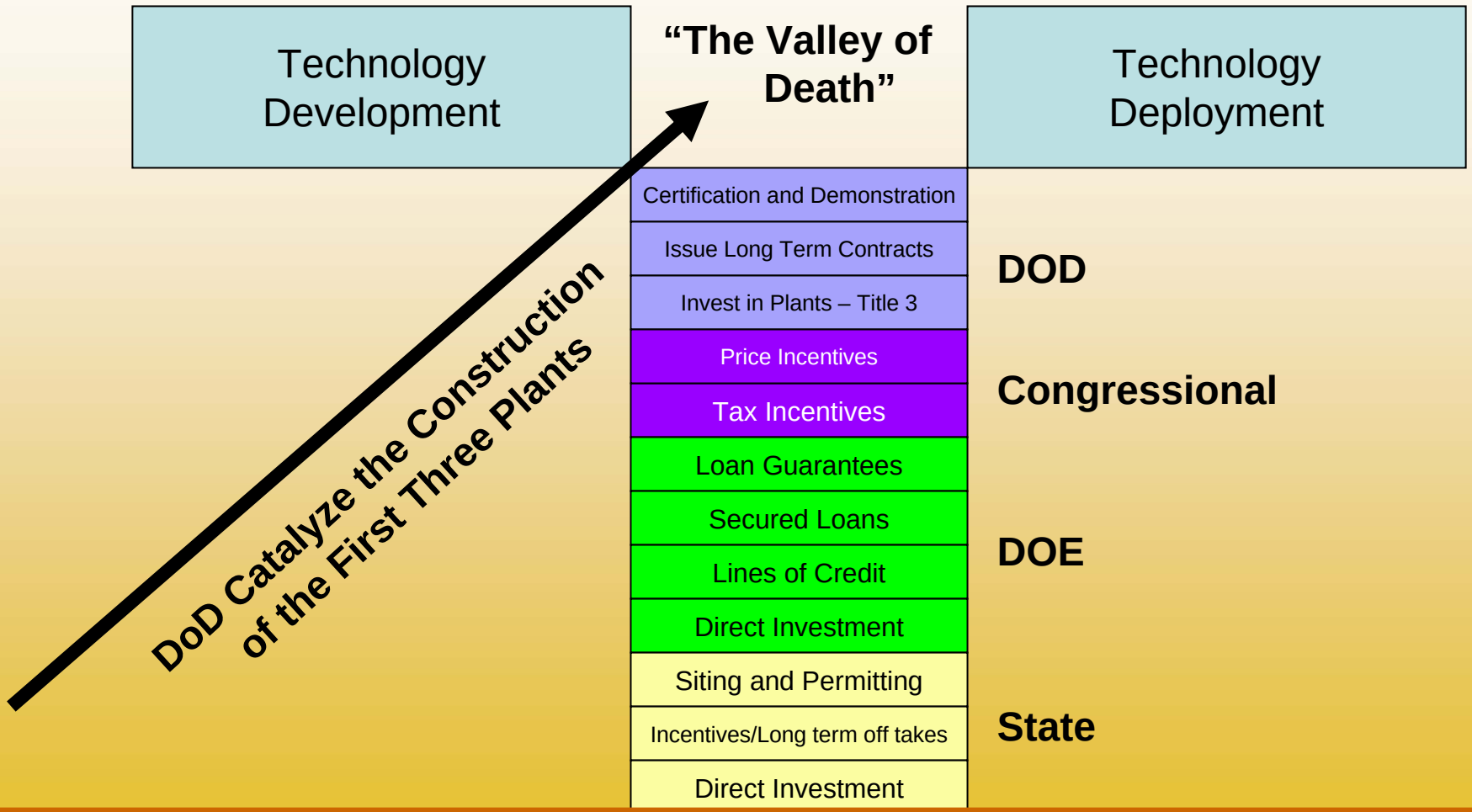
# Hurdles and Impediments






**DoD leadership key to bridging the "Valley of Death" to obtain secure, domestic sources of fuel**

# Industry Needs DoD Leadership



# EPAct 2005 Sec 369

- Declaration of Policy – Congress declares that it is the policy of the United States that –
  - (1) **United States oil shale, tar sands, and other unconventional fuels are strategically important domestic resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil imports**
  - (2) The development of oil shale, tar sands, and other strategic unconventional fuels, for research and commercial development, should be conducted in an environmentally sound manner, using practices that minimize impacts: and
  - (3) Development of those strategic unconventional fuels should occur, with an emphasis on sustainability, to benefit the United States while taking into account affected States and communities

# EPAct 2005 Sec 2398a Procurement of fuel derived from coal, oil shale and tar sands

- (a) Use of Fuel to Meet Department of Defense Needs – **The Secretary of Defense shall develop a strategy to use fuel produced, in whole or in part, form coal, oil shale, and tar sands** (referred to in this section as a "covered" fuel) that are extracted by either mining or in-situ methods and refined or otherwise processed in the United States in order to assist in meeting the fuel requirements of the Department of Defense when the Secretary determines that it is in the national interest
- (b) Authority to Procure – The Secretary of Defense may enter into 1 or more contract or other agreements (that meet the requirements of this section) to procure a covered fuel to meet 1 or more fuel requirement of the Department of Defense
- (c) Clean Fuel Requirements – A covered fuel may be procured under subsection (b) only if the covered fuel meets such standards for clean fuel produced from domestic sources as the Secretary of Defense shall establish for purposes of this section in consultation with the Department of Energy
- (d) Multi-year Contract Authority – Subject to applicable provisions of law, any contract or other agreement for procurements of covered fuel under subsection (b) may be for 1 or more years at the election of the Secretary of Defense
- (e) Fuel Source Analysis – In order to facilitate the procurement by the Department of Defense of covered fuel under subsection (b), the Secretary of Defense may carry out a comprehensive assessment of current and potential location in the United States for the supply of covered fuel to the Department

# EPAct 2005 Task Force Requirement

- **The Secretary of Energy, in cooperation with the Secretary of the Interior and the Secretary of Defense, shall establish a task force to develop a program to coordinate and accelerate the commercial development of strategic unconventional fuels, including but not limited to oil shale and tar sands resources in the United States**
  - Composition
    - Sec or Energy or designee
    - Sec or Interior or designee
    - Sec or Defense or designee
    - Governors of affected States
    - Representatives of local governments in affected areas
  - Recommendations – The Task Force shall make recommendations regarding promoting the development of strategic unconventional fuel resources with in the Untied States as it may deem appropriate
  - Reporting
    - **Not later than 180 days after the enactment of the Act (Signed 8 Aug 05), the Task Force shall submit to the President and Congress a report that describes the analysis and recommendations of the task force**
    - The Secretary of Energy will provide annual reports for 5 years describing the progress in developing strategic unconventional resources

# OSD Clean Fuels Initiative Goals

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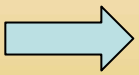


**Joint Battlespace Use Fuel of the Future (JBUFF)**

  - Develop fuel specifications for fuels from alternative energy resources that enable single fuel for the entire battle space (tactical ground vehicles, aircraft, ships, hypersonics, rockets and fuel cells) and reduce emissions
  - Evaluate, demonstrate (ACTD in FY08/09) and certify fuels to enable DoD to use fuels in all tactical vehicles, aircraft and ships
  - Provide a transition plan for DoD wide deployment

# Joint Battlespace Use Fuel of the Future (J-BUFF) Program

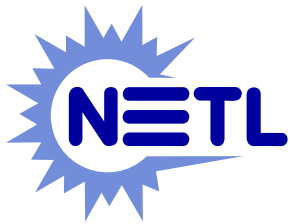
- **Evaluation Phase (2003 – 2009):**
  - **Determine the characteristics of clean fuels**
  - **Develop specifications (FT Blends, FT and Shale Fuels)**
  - **Develop modeling and simulations tools**
  - **Qualify fuel at subcomponent level**
  - **Determine key logistic parameters**
  - **Determine health and safety benefits**
- **ACTD Phase (2007 – 2009):**
  - **Demonstrate, validate and certify clean fuels in tactical Vehicles, aircraft, ships and advanced technologies such as fuel cells, hybrid tactical vehicles, scramjets, rockets and advanced turbine engines**
- **Implementation Phase (2010 – 201X):**
  - **Implement lead the fleet Pacer programs in tactical vehicles, aircraft and ships**
  - **Develop full implementation plan based on commercial availability of clean fuels**

# Research Participants

- Air Force
  - Air Force Fuels Research Laboratory/NAFRC
  - University of Dayton Research Institute
- Army
  - TARDEC Fuels & Lubricants Laboratory
  - Southwest Research Institute
- Navy
  - NAVAIR Fuels and Lubricants Laboratory
  - Naval Fuels and Lubricants Integrated Product Team
- DoE
  - National Energy Technology Laboratory
- Syntroleum Corp.





# Emerging Technologies Require Improved Fuels

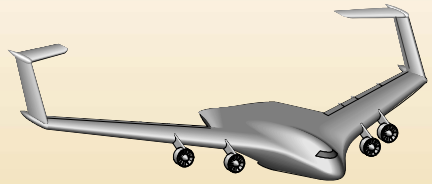
FT iso-paraffinic kerosene (100%)

low emissions, high stability

2.2X – 9X increase in cooling

Current and advanced gas turbine aircraft

(Jet A/JP-8 replacement)



high stability, endotherm

1200 Btu/lb cooling

No sulfur, no aromatics

No poisoning, less coking of reformer catalyst

High thermal stability, high H/C

Hypersonic Vehicles

(JP-7 replacement)

ISP=362.5

Hydrocarbon reformers

(fuel cell power generation)

Hydrocarbon Rockets

(RP-1 replacement)

# FT Fuels Benefit Air / Ground / Marine Propulsion and Power Systems

FT Fuels

clean alternative to petroleum fuel
(MADE IN USA)

E.O. 13149, EPAct

Alternative Fuel Vehicles (AFVs)
(non-tactical fleets; Post, Camp & Station)

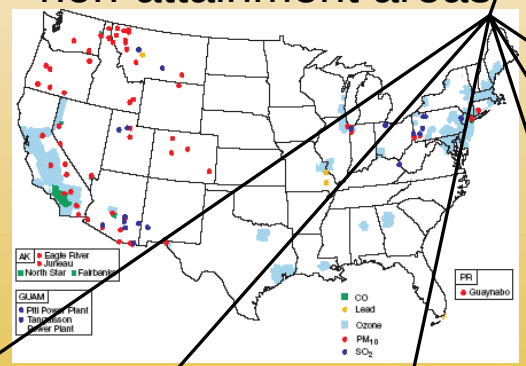
reduced exhaust pollutants
lower CO, PM, NOx

easier starts, all climates
high cetane, >74

source of hydrogen
easily reformed

Diesel engine fleets

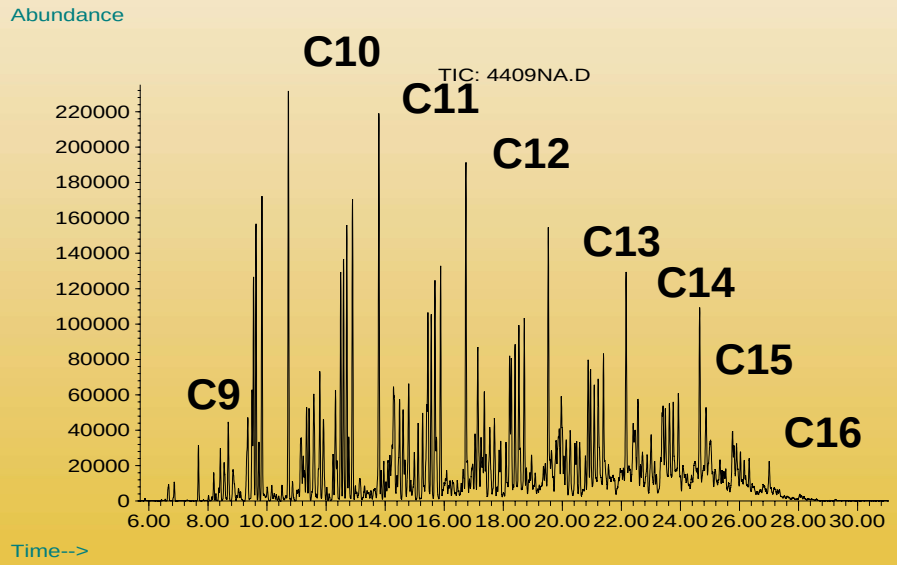
Fleets operating in
non-attainment areas



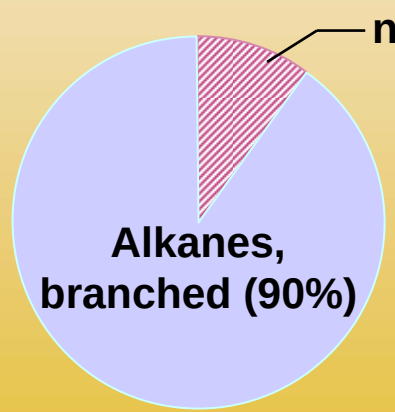

Fuel Cell Applications
(APUs in Vehicles)

# FT Fuels Reduce Emissions

- Less Pollutant Emissions
  - 2.4% less $CO_2$
  - 50% to 90% less particulate matter (PM)
  - 100% reduction in SOx
  - ~1% less fuel burn (increased gravimetric energy density)




Hydrocarbon types in Syntroleum S-5




***Zero aromatics***

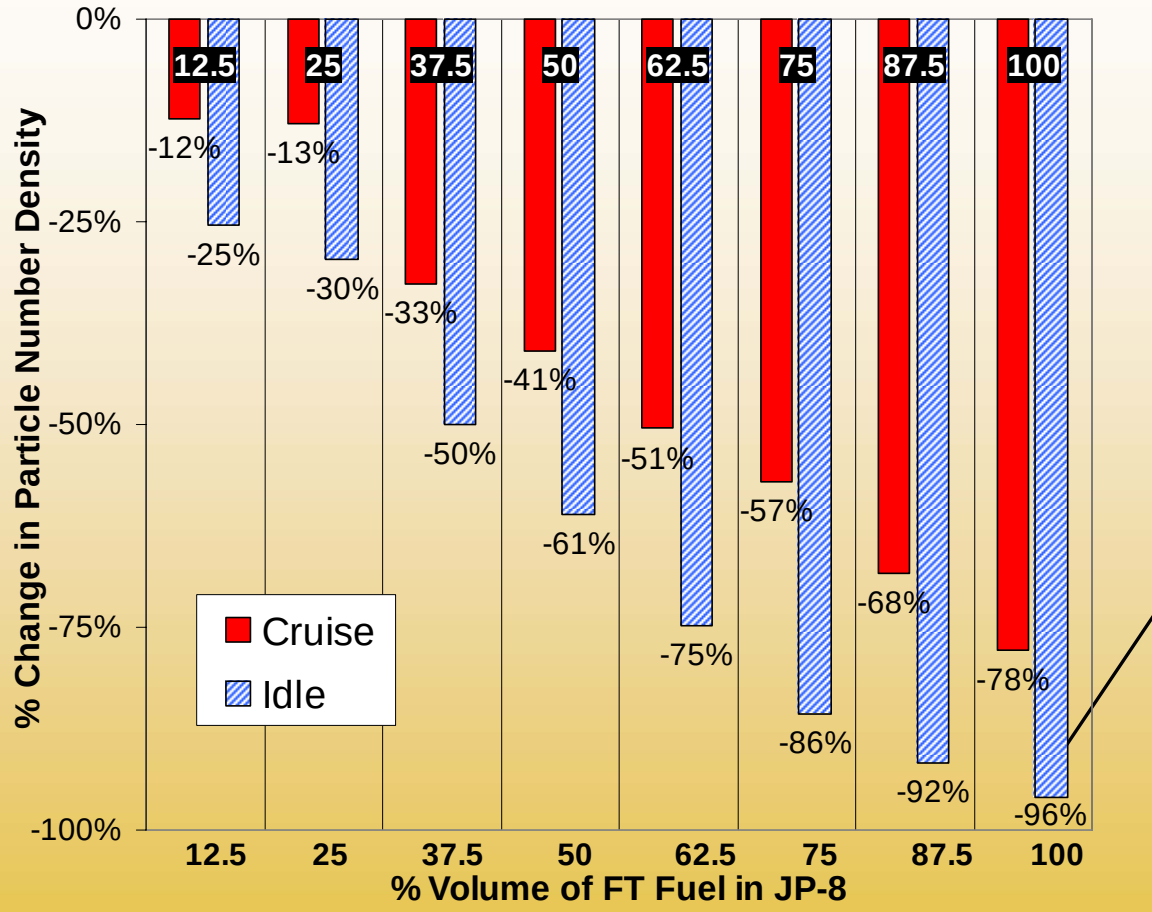
***Zero sulfur***

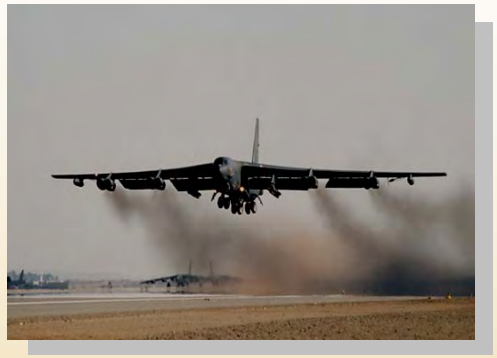
***No heteroatoms***

**Highly Paraffinic Fuel – normal and isoparaffins**

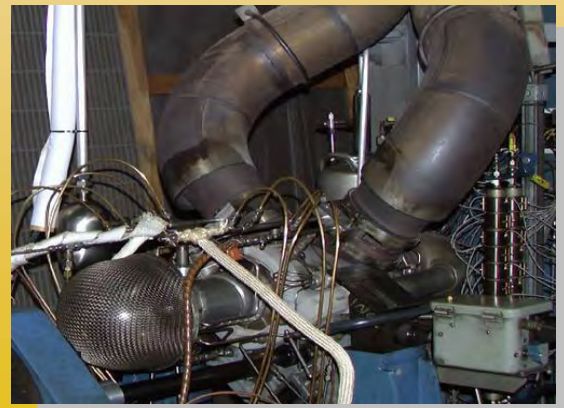
**Petroleum derived fuels are rich in aromatics, cycloparaffins, and heteroatoms**

# Clean Fuels Can Reduce Aircraft Emissions



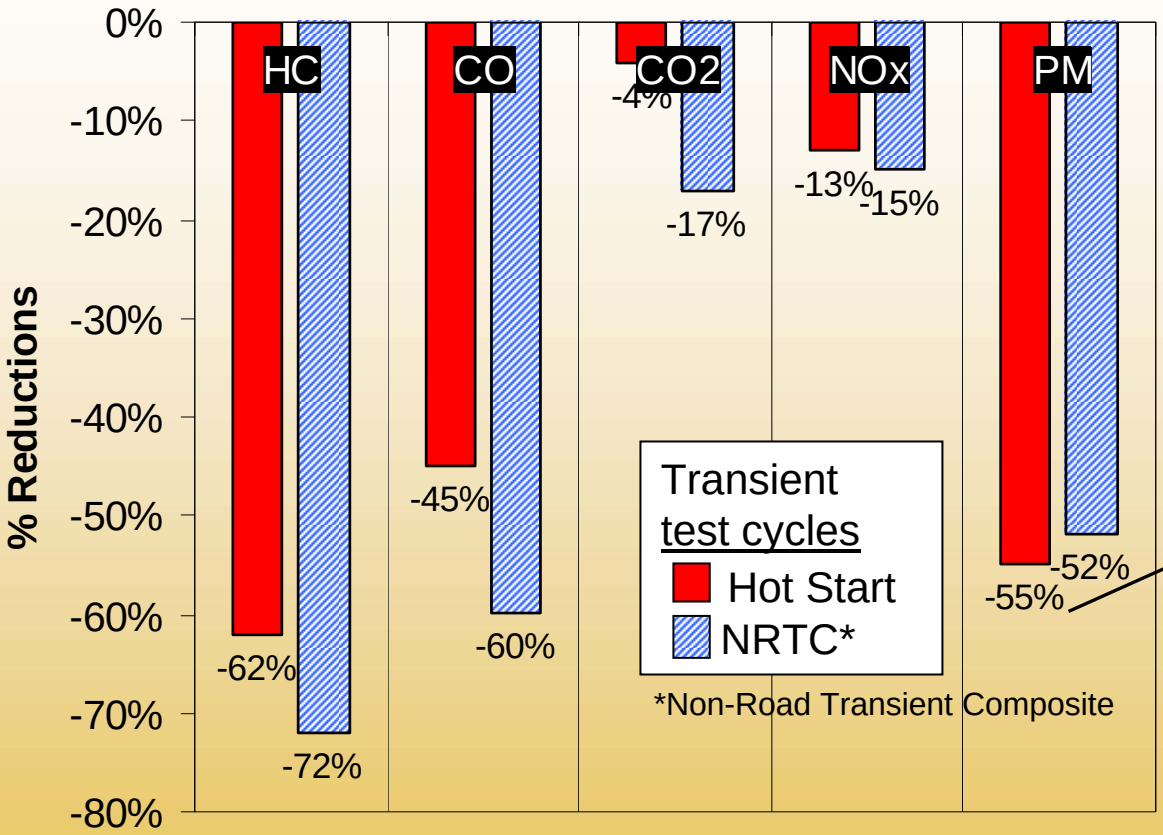
***96% reduction* in particulate emissions at idle conditions.***



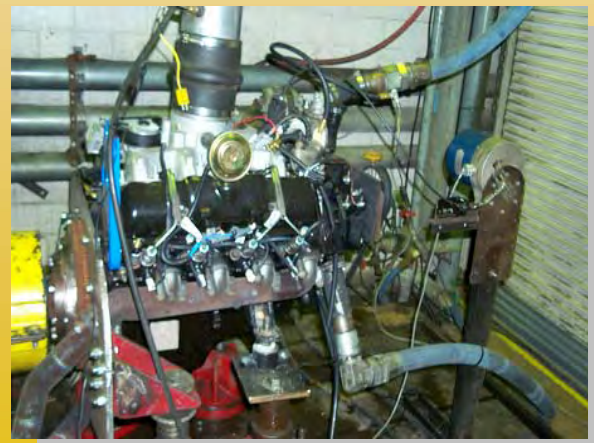
***Even moderate fractions of FT fuel blended in JP-8 significantly reduce exhaust emission particulates in T63 turbine engine testing.***

** Note: Results are highly dependent on engine model/year and composition of baseline fuel.*

# Reduced Exhaust Emissions with Fischer Tropsch Clean Fuel Relative to Low-Sulfur Diesel Fuel

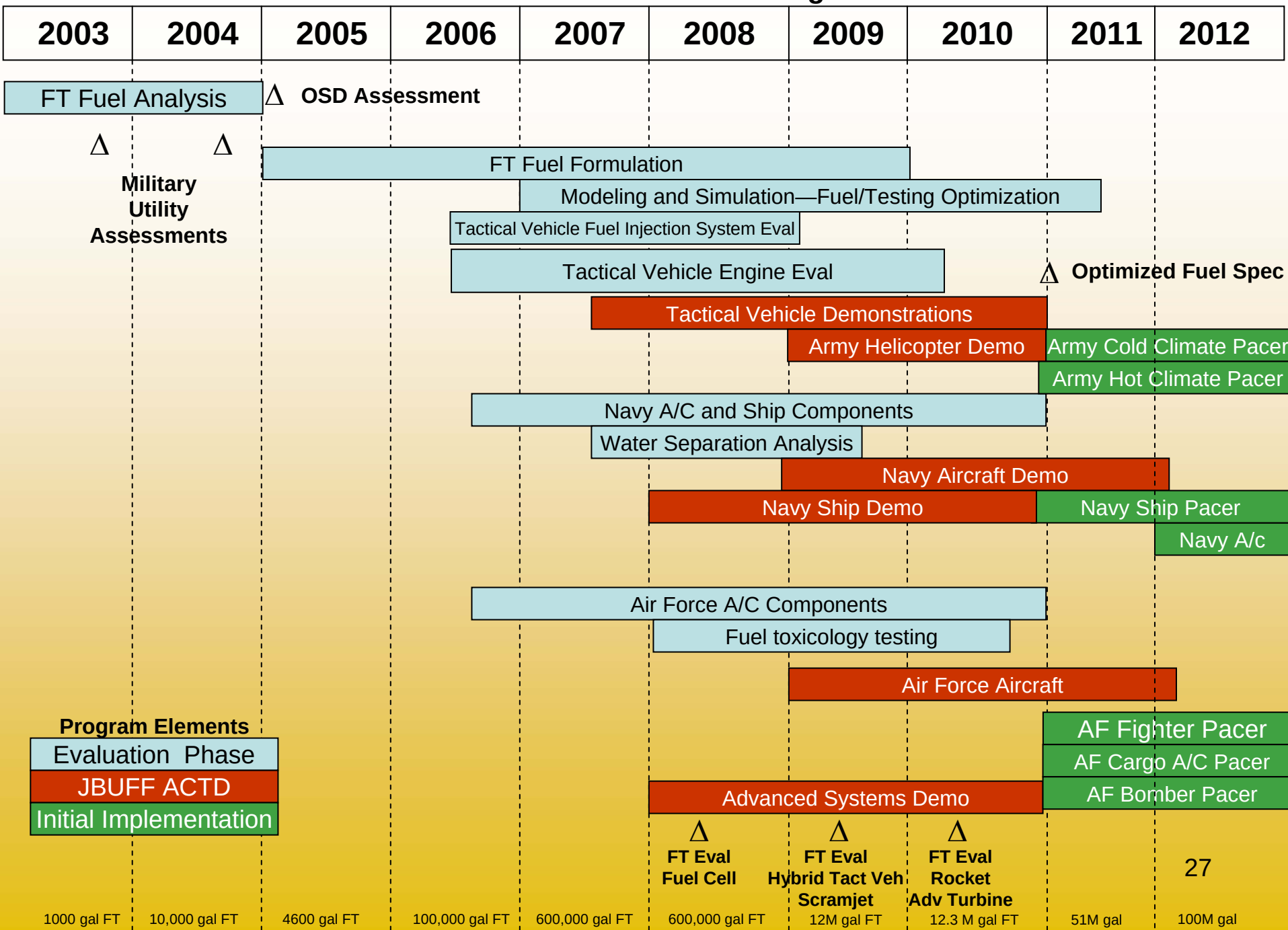



***Over 50% reduction in particulate emissions in transient mode.***



***FT fuel burns more completely and emissions are significantly cleaner than EPA certified low-sulfur diesel fuel tested in 6.5L diesel engine.***

# Straw-man Overall JBUFF Coal FT Fuel Program to Produce SBF-1



# Time for Action is Now!

- US need for secure clean energy is real and growing
- DoD has a vested interest in catalyzing the development of energy resources to reduce dependence on foreign oil
- DoD would like to see all energy resources developed in an integrated fashion
- State Governors can be our bridge between the government and private industry to develop the vast energy resources in the US
- Coal, Oil Shale and Petroleum Coke are the near term source of Clean Fuels (New Middle East)
- Joint participations by other government agencies (EPA, DOT, FAA, HSA, Commerce, Interior) strengthens the program
- Open invitation to all industrial, government (state and federal), and academic partners to participate in our Initiative