U.S. Army TARDEC Military Dual-Use Needs with Commercial Idling Reduction

DOE National Idling Reduction Planning Conference
Albany, NY
May 17-19, 2004

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Fleet Characterization

Combat Element

Cumulative Miles

Significant logistics support is required to transport fuel and supplies to the combat elements at the “tip of the spear”. An increase of truck fuel economy will reduce the numbers of trucks necessary to support a given fighting force.

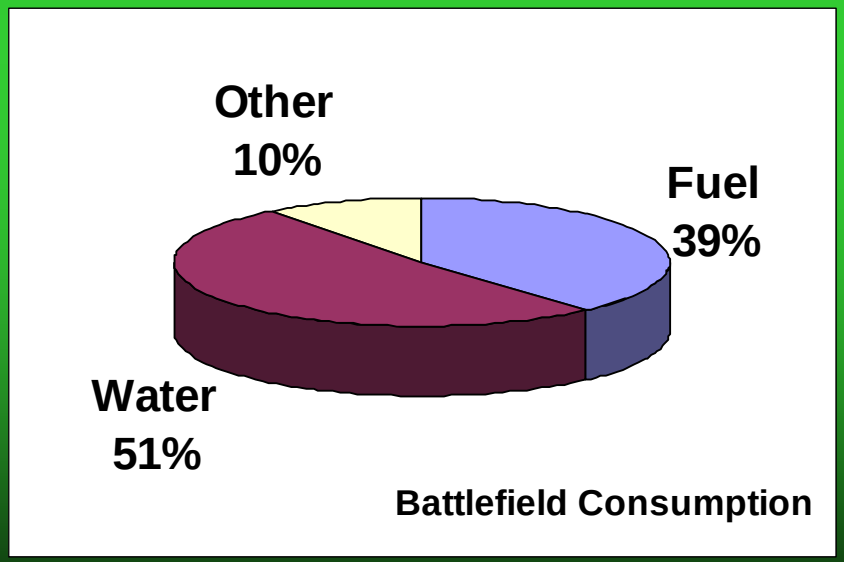
Tactical Wheeled Fleet Characterization

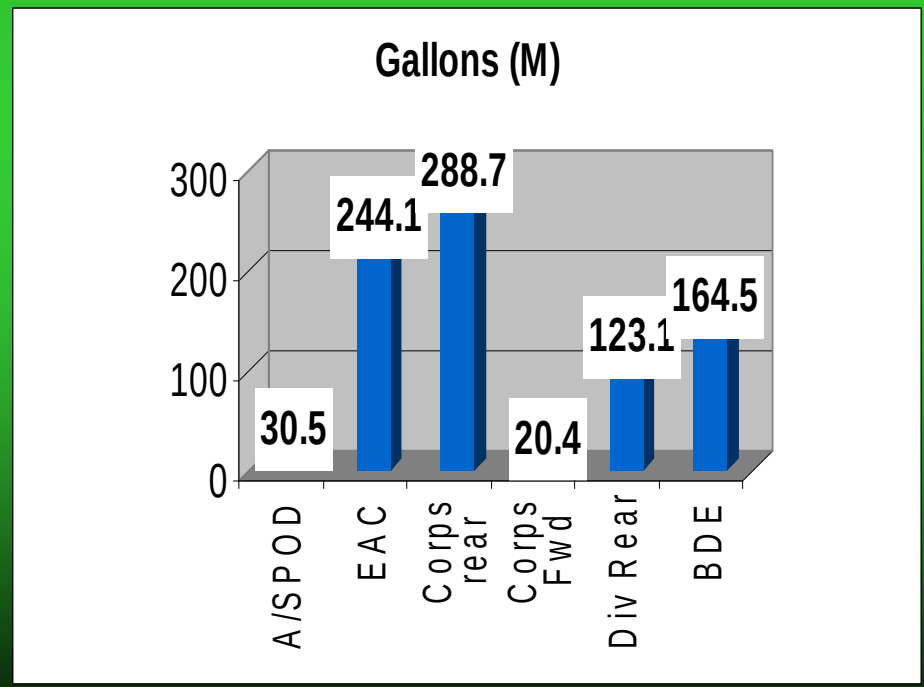
	Total Quantity	Avg Age	Replacement Age	O&S Costs $/mile *(includes fuel & parts)*
HMMWV	105225	13.2	15	0.74
FMTV LMTV 2.5 ton / MTV 5 ton	10294 / 8782	5.4 / 4.0	20 / 22	0.67 / 0.84
M809	10124	29.6	20	1.24
M939	30533	15.4	20	1.23
M35	23716	31.1	20	0.85
HEMTT	12626	13.6	20	3.43
PLS	3499	7.7	20	1.80
HETS	2263	6.4	20	2.98
M915	5791	13.9	20	0.61
LT Trailers	27300	22.1	20 – 30	Not Available
MD Trailers	31800	32.3	20 – 30	Not Available
HV Trailers	26500	19.5	20 – 30	Not Available

Source: Tactical Wheeled Vehicle Modernization Strategy Industry Update PEO CS&CSS 3/03

Logistics Footprint Reduction

~65% **of the fuel consumed in theater is for fuel transportation to the battlefield**



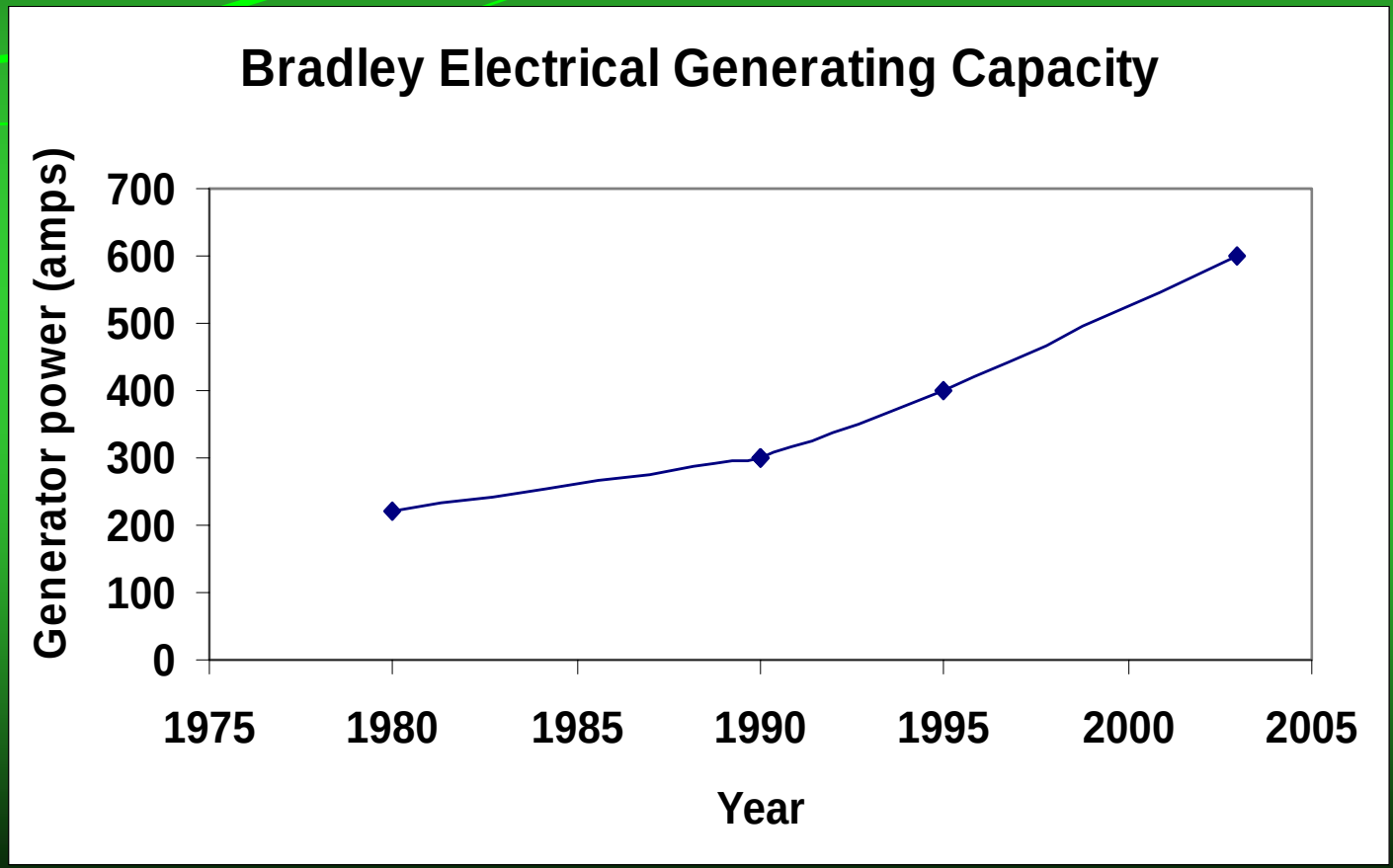


Source: Footprint Reduction 2 Study, CAA MTW – E1

"Diesel" Fuel Characterization

- **Single Fuel Forward policy**
  - **Deployed vehicles only**
  - **JP-8 primary fuel, diesel if JP-8 not available**
- **Military fuel usage within US**
  - **JP-8 / Diesel primary**
  - **Biodiesel also used to help meet alternative fuel requirements**
- **Benefits of synthetic and biomass for military**

Battlefield Power Requirements



Source: US Army TACOM BFVS PM office

In the Battlefield

- **Silent Watch**
  - **Reduce smoke, noise, thermal identification signatures**
- **Design needs**
  - **Simplicity of design and components**
  - **Supportability in the field**
  - **Packaging – MORE constrained than commercial applications!!!**

Commercial Industry & the EPA

- 95% reduction of nitrogen oxides and hydrocarbons from pre-Oct 2002 levels
- 99% reduction of particulate matter from pre-Oct 2002 levels
- California Air Resources Board is developing standards for hybrid vehicles that aren't tied to ICE power output
- Engines produced in 2007 will require low sulfur diesel fuels to meet these standards
- 2006 on-road diesel fuel sulfur limit will be 15 ppm

The Military & the EPA

- **Waivers / exemptions**
  - Combat vs. tactical
  - Deployed vs. non-deployable
- **Legislative mandates**
  - Above and beyond commercial requirements that military vehicles must comply to
  - Military vehicles must be emissions compliant for the year the vehicle is built, unless they have a waiver
  - Gov fleet vehicles (all agencies) in the US:
    - EPAct 1992
      - 75% of newly procured light duty vehicles for federal fleets must be alternative fuel vehicles
    - E.O. 13149 (April 01)
      - Mandates a 20% reduction in petroleum consumption from 1999 levels by 2005

Military Issues

- **Reduce logistical footprint**
- **Comply with EPA & legislative requirements**
- **Meet increasing vehicle electric power demands**
- **Fuel-flexible equipment**

All of these requirements have commonality with commercial market IR technologies

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National Automotive Center (NAC)

Military Needs

Industry Needs

Cooperative Agreements

Collaborative Environment

Common Specifications

Dual-Use

NAC

TARDEC

NAC Fuel Cell Technology Team

Solid Oxide Fuel Cell APU for a Heavy-Duty Truck

NAC

A Fuel Cell Is:

- A machine that makes electricity by chemically reacting fuel with an oxidizer
  - Usually hydrogen fuel and air oxidizer
  - An efficient electric power source
  - Runs as long as fuel and air are supplied
- There are several types of fuel cells: PEM, solid oxide, direct methanol, and others
- Fuel cells need air cleaners, radiators, electronic controls and starting batteries, just like engines

Fuel Cell Readiness for Military Vehicles

- **The first big battlefield use for fuel cells is quiet, efficient stand-by electric power**
- **Commercial vehicles will probably set the pace for military vehicle fuel cell propulsion**
  - **If a fuel cell works in general purpose commercial trucks, it will probably work in military trucks**
  - **Military vehicle fuel cells must be able to use JP-8 jet fuel**
  - **Fuel cell vehicles are only as good as their electric drive systems**
- **Heavy truck auxiliary power units (APUs) are a nearer-term commercial application with military benefits**
- **Strategy: Emphasize early APU applications**

Fuel Cell Strategy

- In an April 2002 report to Congress, the NAC proposed a Defense/Industry Fuel Cell Partnership to address three areas:
  - Develop auxiliary power units (APUs)
  - Demonstrate commercial fuel cell vehicles on military bases in conjunction with DOE programs
  - Pursue technologies to move fuel cell propulsion from civilian to military vehicles
- TARDEC is developing a fuel cell test lab and simulation capabilities to support its strategy

Hydrogen Fuel

- Hydrogen can work for cars – fuel cell Focus gets 200 miles per fill.
- Hydrogen must be made, it's not an energy source
  - Electrolysis – Electricity splits water into hydrogen & oxygen
  - Reforming – A chemical reactor uses petroleum energy to make hydrogen; around 80% efficient
- Hydrogen is very bulky
  - A 2-liter bottle at 5000 psi holds enough hydrogen for an hour at 800 watts or one horsepower
  - A gallon of liquid hydrogen holds about ¼ the energy of a gallon of gasoline
- The U.S. chemical industry makes and uses enough hydrogen for about 30 million fuel cell cars

Military Fuel Issues

- JP-8 jet fuel is the single battlefield fuel
  - Aircraft need it and it works in diesel engines, too
  - Basically commercial Jet A-1 fuel plus additives
  - 3,000 ppm S limit, but typically around 500 ppm
    - EGR and / or aftertreatment
- Sulfur is a fuel cell and reformer catalyst poison
- Overseas fuels can have very high sulfur levels
- Present-day aircraft can't be converted to hydrogen
- Battlefield hydrogen could work for low-volume, high-value uses – but its bulk makes high-volume use difficult

Fuel Cell Technology (Military Applications)

Ballard, Freightliner, University of Alabama

APU Test platform

Methanol APU

GM COMBATT

Hydrogenics

Fuel Cell Technology

Peterbilt test bed tractor

John Deere Fuel Cell Hybrid CWV

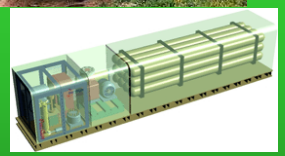
FreedomCAR

Upcoming Fuel Cell Investments

Transition APU Program to Military Platforms

JP-8

H_2



Investigate Tactical Hydrogen Refueling for Light Fuel Cell Vehicles

Operate Fuel Cell Vehicles and Hydrogen Infrastructure on CONUS Bases

Summary of TARDEC's Fuel Cell Approach

- **Get maximum leverage from industry work**
- **Maximize joint efforts with other services**
- **Enlist other agencies: DOE, DOT, EPA**
- **Apply R&D to unique military fuel cell problems**
- **Expand military automotive fuel cell uses**

Some Relevant Papers FYI

- **Delphi / NAC**
  - **SAE 2004-01-1586 “Logistics and Capability Implications of a Bradley Fighting Vehicle With a Fuel Cell Auxiliary Power Unit”**
- **Ballard / Freightliner / NAC**
  - **SAE 2003-01-0266 “Recent Results on Liquid-Fuelled APU for Truck Application”**
  - **SAE 2003-01-0267 “Synthetic Hydrocarbon Fuel for APU Application: The Fuel Processor System”**
  - **SAE 2002-01-3050 “Vibration and Shock Considerations in the Design of a Truck-Mounted Fuel Cell APU System”**
- **SwRI / Sunline Services Group / Modine / Masterflux / NAC**
  - **SAE 2004-01-1478 “42-Volt Electric Air Conditioning System Commissioning and Control for a Class-8 Tractor”**
  - **SAE 2003-01-3410 “Fuel Cell Introduction into a Class 8 Truck”**

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Questions?

NAC