TARDEC Hybrid Electric Program
Last Decade

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1. REPORT DATE  
17 NOV 2010

2. REPORT TYPE  
N/A

3. DATES COVERED  
-

4. TITLE AND SUBTITLE  
TARDEC Hybrid Electric Program Last Decade

5a. CONTRACT NUMBER  
-

5b. GRANT NUMBER  
-

5c. PROGRAM ELEMENT NUMBER  
-

5d. PROJECT NUMBER  
-

5e. TASK NUMBER  
-

5f. WORK UNIT NUMBER  
-

6. AUTHOR(S)  
Gus Khalil

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  
US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA

8. PERFORMING ORGANIZATION REPORT NUMBER  
21346RC

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)  
US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA

10. SPONSOR/MONITOR’S ACRONYM(S)  
TACOM/TARDEC

11. SPONSOR/MONITOR’S REPORT NUMBER(S)  
21346RC

12. DISTRIBUTION/AVAILABILITY STATEMENT  
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES  
The original document contains color images.

14. ABSTRACT  
-

15. SUBJECT TERMS  
-

16. SECURITY CLASSIFICATION OF:  
a. REPORT  
unclassified

b. ABSTRACT  
unclassified

c. THIS PAGE  
unclassified

17. LIMITATION OF ABSTRACT  
SAR

18. NUMBER OF PAGES  
14

19a. NAME OF RESPONSIBLE PERSON  
-

Standard Form 298 (Rev. 8-98)  
Prescribed by ANSI Std Z39-18
Army Hybrid Electric Vehicles

**Combat Vehicle Demos**
- M113 HE
- Lancer
- AHED 8x8
- Pegasus
- FCS

**Technology Base**
- Traction Motors
- Energy Storage
- SiC Inverters/Converters
- Pulse Technology
- Alternative Architectures
- Modeling and Simulation

**Tactical Vehicles**
- HMMWV HE
- FMTV HE
- RSTV
- FTTS
Vehicle driven by one track. 0.9 te/wt transient

60% slope  te/wt=0.6 continuous

PERFORMANCE SPECS

Vehicle Speed
Ground Vehicle Power Needs

Non-Primary Power
- Thermal
- Communications
- Survivability
- Etc...

Power Needs

Mobility

FY02 FY12

Non-Primary Power Estimated Electrical Power Growth

Electrical Power (kw)

<table>
<thead>
<tr>
<th>Model</th>
<th>Current</th>
<th>Future</th>
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<tr>
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Actual Growth 1995-2007
Platform Electrification Technologies

The size of motors, power electronics, and batteries in a series hybrid system is the largest and thus presents the greatest Integration challenge.

Hybrid Electric Drive Configurations Can Vary to Fulfill Desired Capability
Hybrid Vehicle Challenges

Unprecedented use of emerging technologies never proven in battle field scenarios

- System integration and packaging
  - Power densities of components
    - Motors, generators, energy storage
    - Power electronics

- Thermal management
  - Low operating temperature
    - Large space claims
    - High power demand from the engine/generator

- Silent Watch requirement
  - Energy storage shortfalls
  - Control strategy and limited power budget

- Onboard Exportable power
  - Clean power for Tactical Operating Centers (TOC)
  - Power supply from mobile platforms for other applications
Hybrid Electric Component Program

- Traction Motors
- Energy Storage
  Li-Ion
- Power Electronics/cooling
- Vehicle tests:
  - ATC
  - AAEF
Technology Goals

**Prime Power**
- Engine
- kW/kg: FY 05 = 1, FY 06 = 1.5, FY 07 = 3X

**Energy Storage**
- W-hr/kg: Li-Ion Batteries
- FY 05 = 5, FY 06 = 10, FY 07 = 30
- kW/l: FY 05 = 1, FY 06 = 3, FY 07 = 6

**Motors**
- Traction, In-Hub
- kW/l: FY 05 = 5, FY 06 = 10, FY 07 = 3X

**Power Conditioning**
- Si dc-dc Converters
- kW/l: FY 05 = 3, FY 06 = 6, FY 07 = 6X
- SiC dc-dc converter

**Pulse Power**
- Capacitors
- J/cc: FY 05 = 1, FY 06 = 2.5, FY 07 = 4X
Power Electronics

• Thrust is SiC to overcome:
  ➢ Thermal issues
  ➢ Efficiency
  ➢ Low frequency requiring large capacitors
  ➢ Low power density

Approach: Develop power devices using SiC diodes as an interim step
Develop All SiC motor drives and DC-DC converters as the device technology matures
Advanced SiC Components will Reduce the Power Electronics Cooling Burden

- Si based power electronics require coolant inlet Temperature not to exceed 70°C resulting in large cooling system size
- SiC can operate at much higher temperatures ≥ 100°C thus reducing the size of the cooling system by half
Power and Energy SIL

The SIL provides capability to accelerate the integration and maturation of critical FCS MGV system technologies in order to meet FCS Performance within the weight and volume constraints.

System integration into vehicle platform

System Integration

HOTBUCK platform with FCS hardware
Currently there are no industry or SAE standards for measuring the fuel economy of hybrid vehicles in cross country environments.

**Objectives**

- Develop HEV Test Operating Procedure (TOP) using accepted industry practices and DOE processes
- Determine the fuel economy benefits of hybrid electric vehicles using quantifiable test data
- Develop and Validate TARDEC M&S models

**Testing**

9 conventional and 7 hybrid electric vehicles are being tested

**A. Conventional:**
- 2 - HMMWVs,
- 2 - 21/2T LMTVs
- 1 - 5T MTV
- 1 – FMTV CVT
- 2 - HEMTTS
- 1 – UV

**B. Hybrid Electric:**
- 1 – HMMWV
- 1 – RSTV
- 1 - UV
- 1 – UV
- 1 – AH/SS MSV
- 1 – FMTV
- 1 – HEMTT A3
Hybrid Electric Drive HMMWVs demonstrated a 4.2 – 10.9% Fuel Economy Improvement over various military courses under HEVEA program.
HTUF DOD Tech Model

• Proven process to launch commercial production, focusing on user needs
• Over 80 national fleets, including DOD, involved in process
• Eight National Meetings of top truck OEMs, suppliers, fleets
• First 24 Pre-Production Trucks tested & fielded w/in 3 Years; million miles of experience; directly led to commercial production launch
• Military receiving first in-use hybrid field data from geographically dispersed nationwide deployment
• Six fleet Working Groups active, new Construction Equip Forum launching
• Three additional pilot deployments ready