



TARDEC Hybrid Electric Program Last Decade



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Army Hybrid Electric Vehicles

FY 98 99 00 01 02 03 04 05 06 07 08 09

Combat Vehicle Demos



M113 HE



Lancer



AHED 8x8



Pegasus



FCS

Technology Base



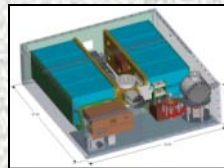
Traction Motors



Energy Storage



SiC Inverters/
Converters



Pulse
Technology



Alternative
Architectures



Modeling and
Simulation

Tactical Vehicles



HMMWV HE



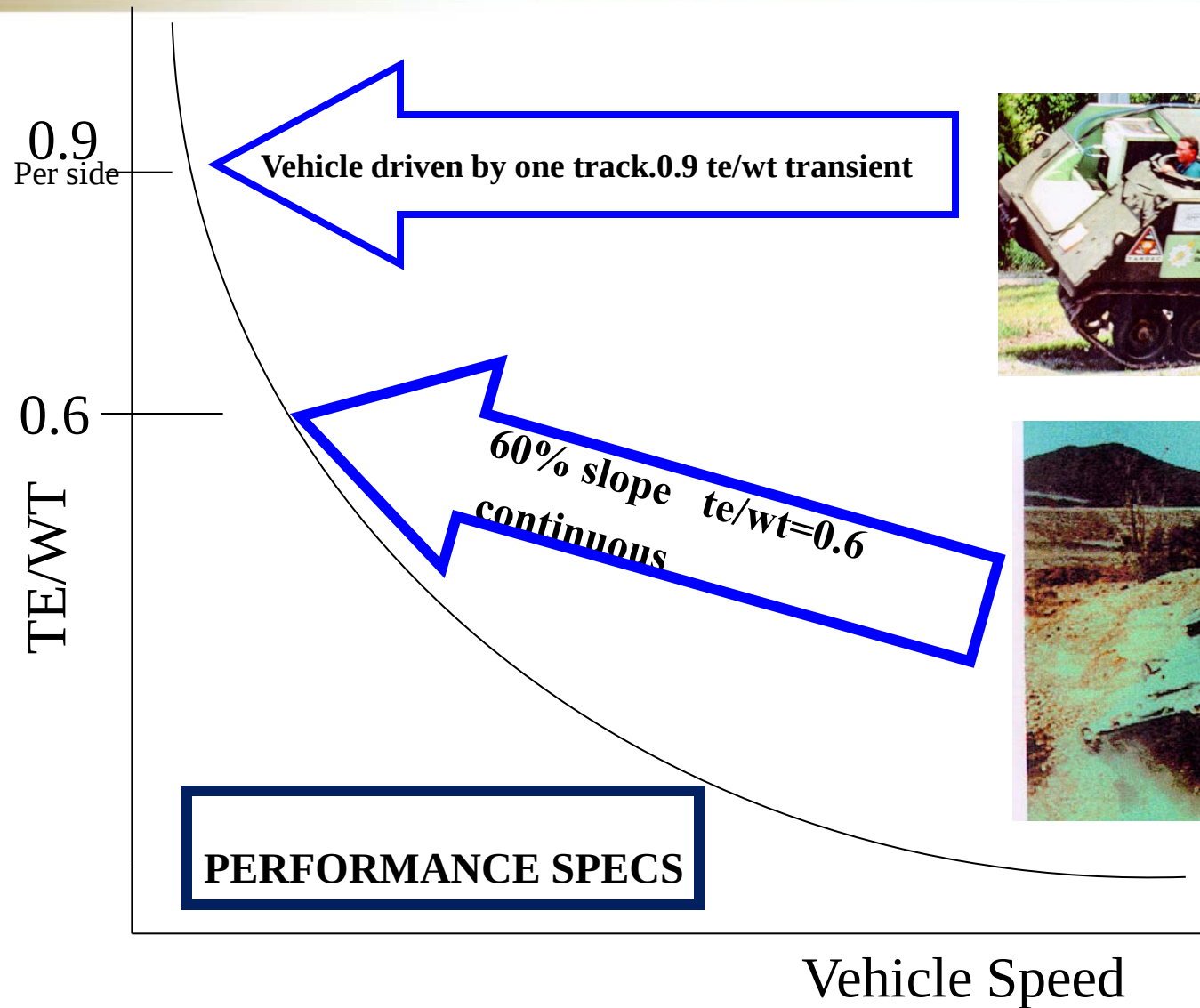
FMTV HE



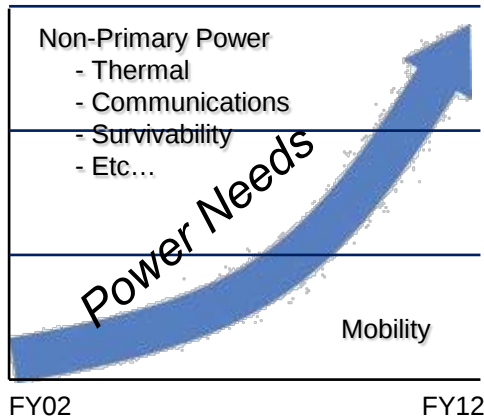
RSTV



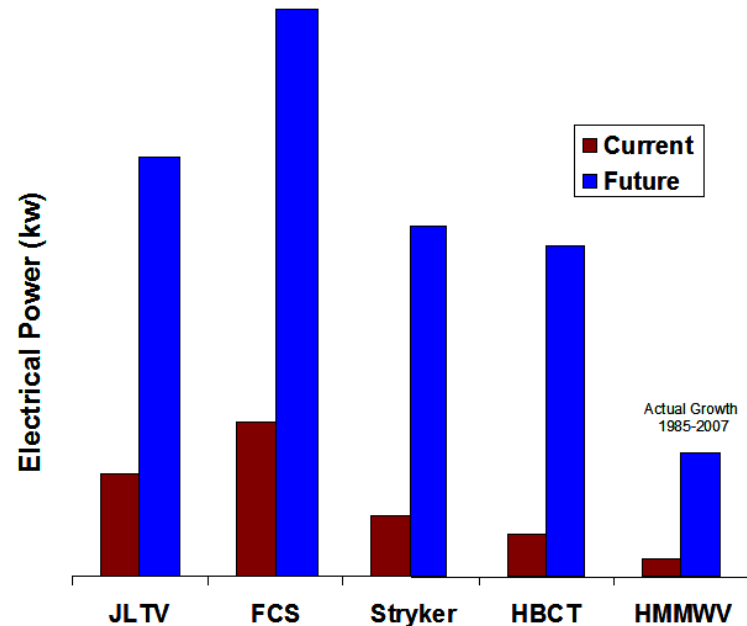
FTTS



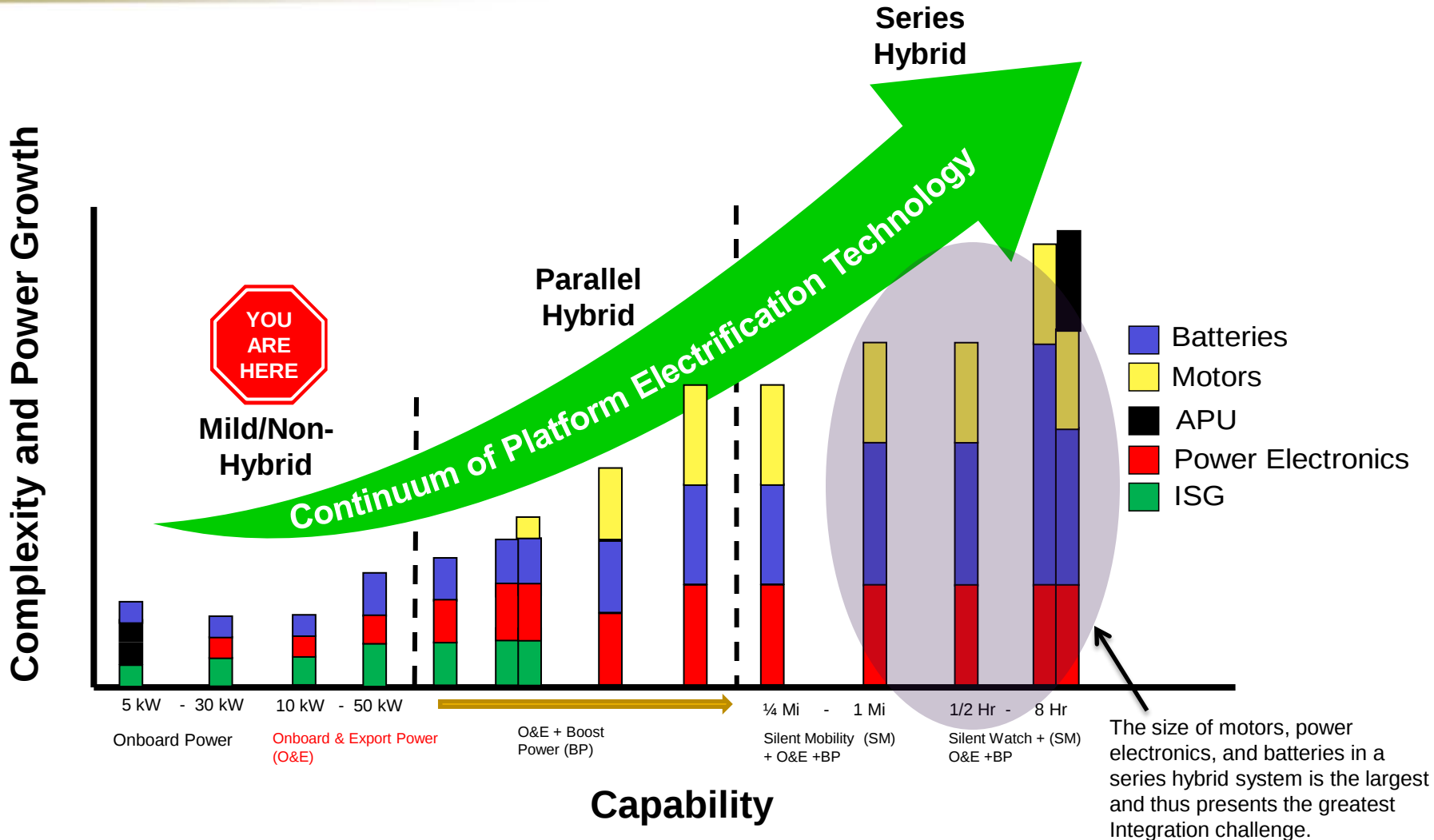
Ground Vehicle Power Needs



**Non-Primary Power
Estimated Electrical Power Growth**



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Hybrid Electric Drive Configurations Can Vary to Fulfill Desired Capability

Hybrid Vehicle Challenges

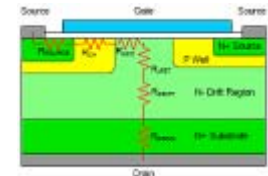
Unprecedented use of emerging technologies never proven in battle field scenarios

- 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

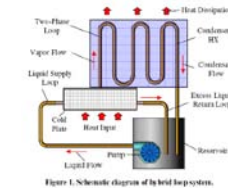
High Power density motor



SiC MOSFET



Phase change cooling



Li-Ion Battery Pack



Tactical Operation Center (TOC)



Hybrid Electric Component Program

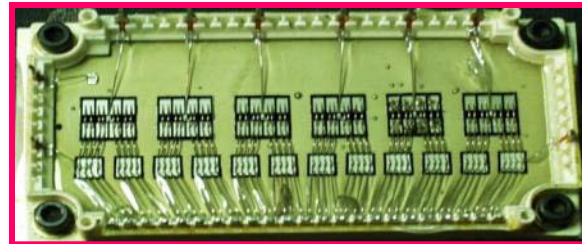
- Traction Motors



- Energy Storage
Li-Ion



- Power Electronics/cooling



- Vehicle tests:
 - ATC
 - AAEF

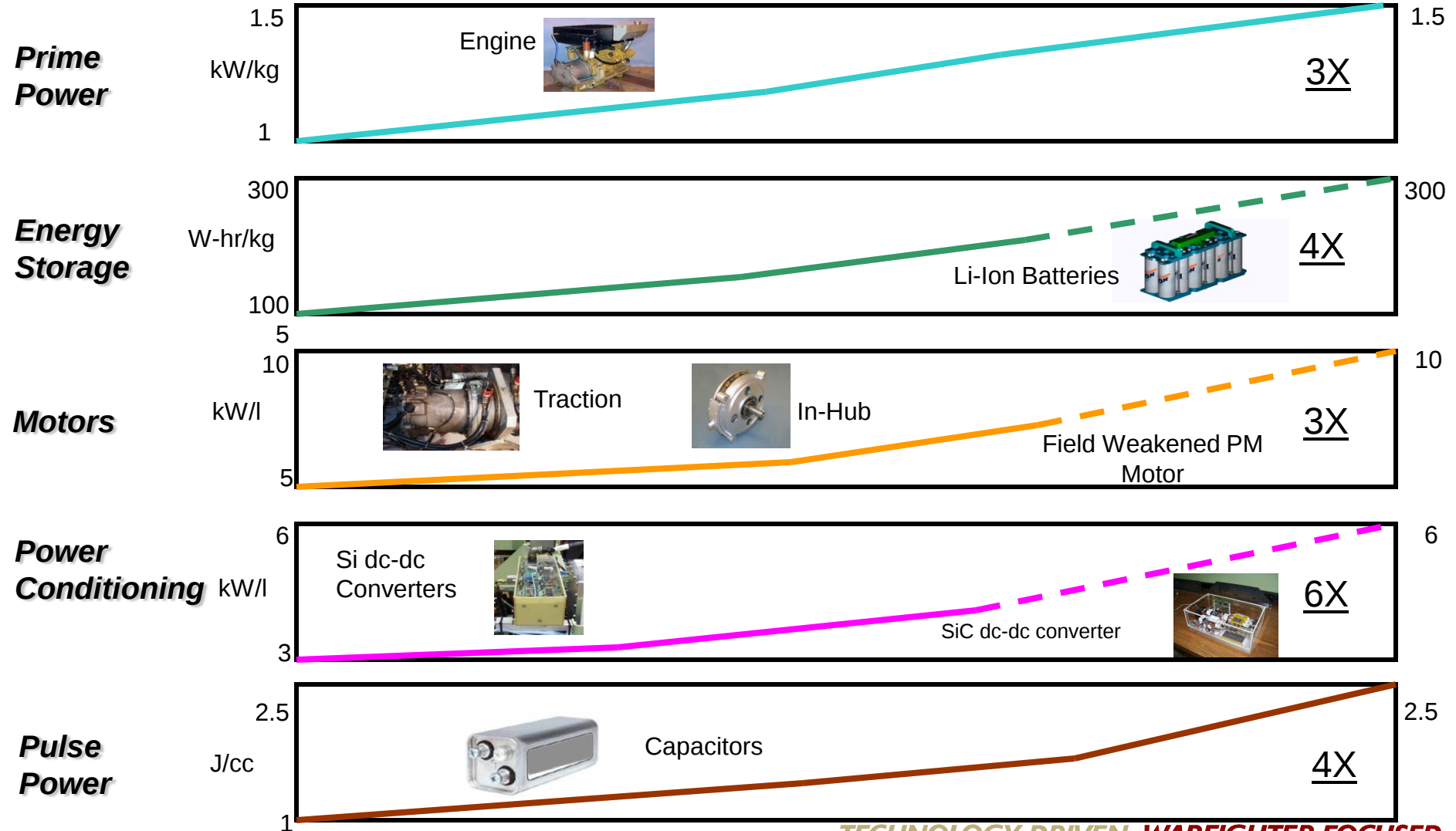


Thermal Management

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Technology Goals

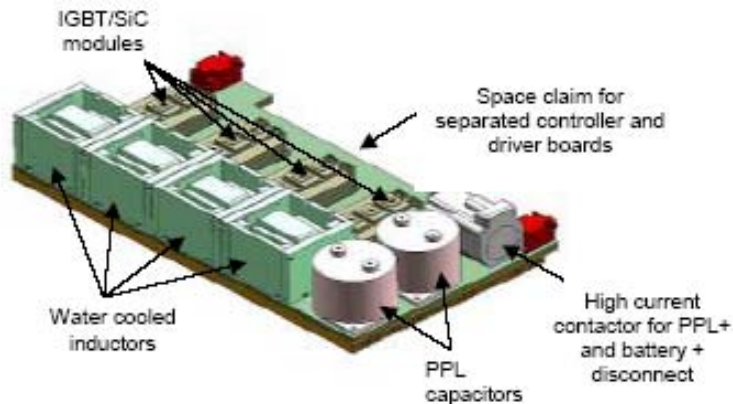
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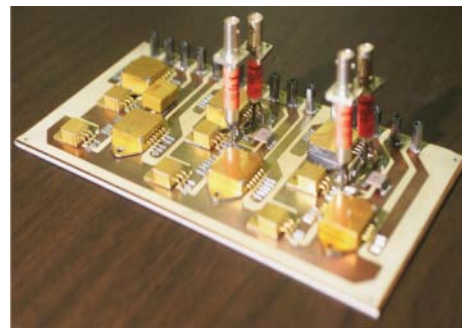
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- Thrust is SiC to overcome:
 - Thermal issues
 - Efficiency
 - Low frequency requiring large capacitors
 - Low power density

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



100 kW Si/Si-C hybrid
DC-DC converter

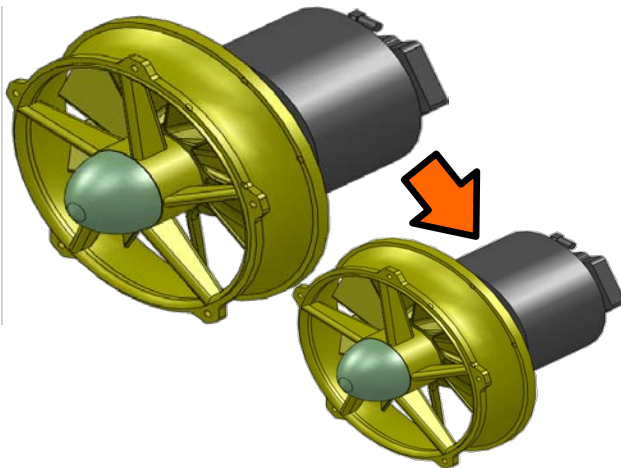
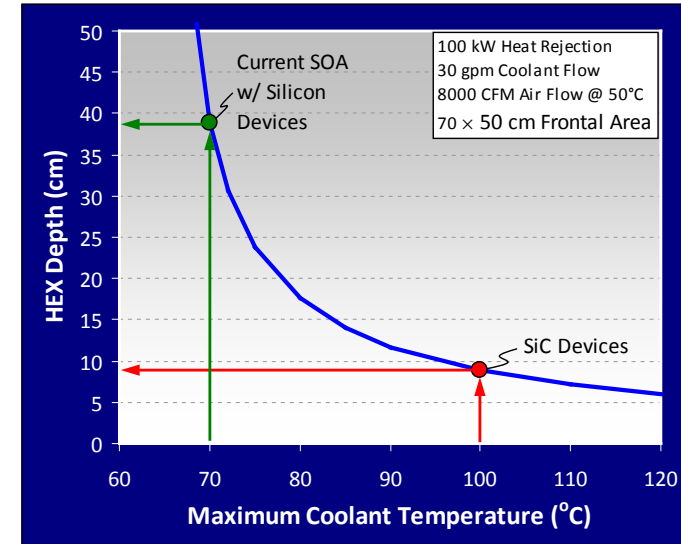


All-Si-C motor-drive
inverter

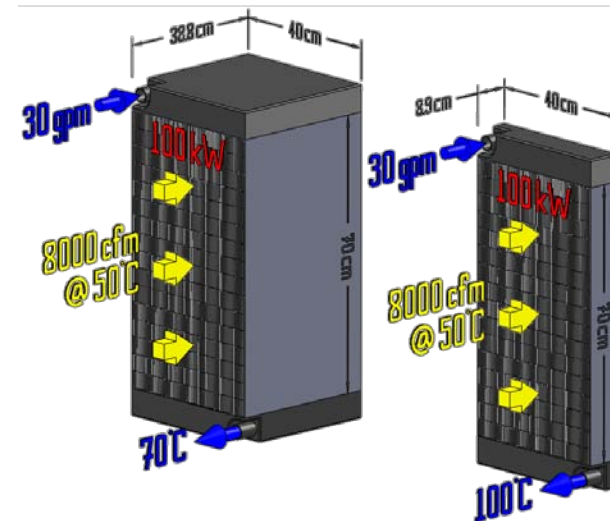


SiC PiN Diode Module

- 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 $\geq 100^{\circ}\text{C}$ thus reducing the size of The cooling system by half



Advanced SiC Components will Reduce the Power Electronics Cooling Burden



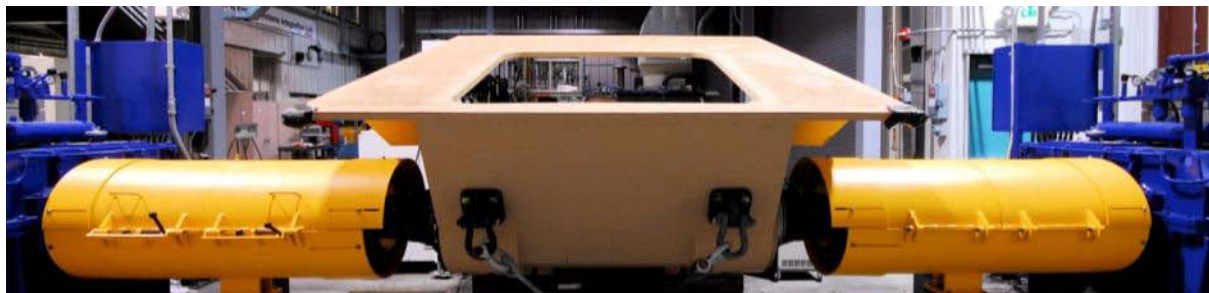
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The SIL provides capability to accelerate the integration and maturation of critical FCS MGVS system technologies in order to meet FCS Performance within the weight and volume constraints



System Integration

System integration into vehicle platform



HOTBUCK platform with FCS hardware

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Hybrid Electric Vehicle Experimentation and Assessment (HEVEA)

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



HMMWV Series HE



RSTV Series HE

B. Hybrid Electric:

- 1 – HMMWV
- 1 – RSTV
- 1 - UV
- 1 – UV
- 1 – AH/SS MSV
- 1 – FMTV
- 1 – HEMTT A3



Parallel Hybrid MSV



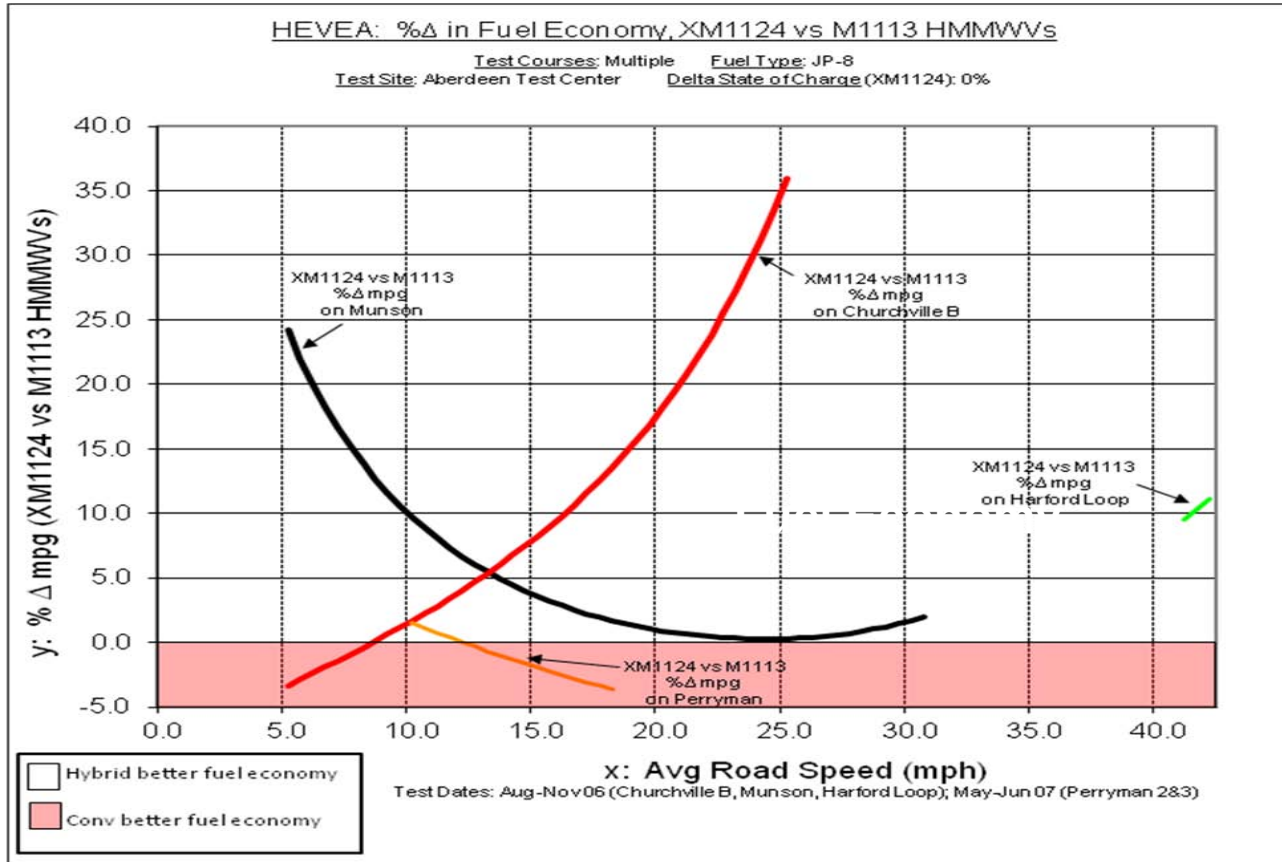
2 Parallel hybrid UVs



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Improved Fuel Economy

Hybrid Electric Vehicle Experimentation and Assessment (HEVEA) Program



HMMWV Series HE



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



HTUF Industry Contact Point for Dual-Use Heavy Hybrid Technologies

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