Section 5.1 PEO LS S&T Focus Area

POWER AND ENERGY

PEO LS continues to address the challenge of increasing energy and fuel efficiency of Marine Corps vehicles. As the vehicles today are being equipped with a greater number of electronic devices, there is an increase in the demand for onboard power. Dependence on common towable power generator only adds to the logistics burden and increases fuel consumption. Additionally, the energy and fuel efficiency can be increased by:

- Lightening the load of the MAGTF
- Reducing the requirement for bulk fuel distribution and storage on the battlefield, thereby reducing the logistics footprint
- Saving millions of gallons of fuel and increase vehicle range
- Reducing total ownership cost

Within PEO LS, there is a two-pronged approach to address the needs and requirements of power and energy: **Fuel Efficiency projects and Intelligent Power and Thermal Management projects.**

- Fuel Efficiency projects focus on increasing the efficiency of mechanistic systems (e.g., the engine, drive train, vehicle aerodynamics) to increase the amount of energy that can be extracted from Marine Corps vehicles per every gallon of fuel used.
- Intelligent Power and Thermal Management projects concentrate on solutions that increase the efficient use of electricity and other sources of power once it has been generated. These two focus areas are inherently aligned and will continue to maximize the power and energy available for the Marine Corps vehicle fleet.

PEO LS is actively engaged with other agencies and technology partners to address the Marine Corps' current and future power and energy challenges. Working with ONR, MCSC, US Army Research Development and Engineering Command (RDECOM), Tank and Automotive Research, Development and Engineering Center (TARDEC), as well as various Industry partners, PEO LS S&T representatives continuously seek improvements in the areas of fuel efficiency and alternative solutions for generating on-board (and exportable) vehicle power.

5.1.1 Fuel Efficiency

The Challenge

Marines can expect to fight in austere environments in the future. Units will also be more dispersed than in the past. Fighting with more fuel-efficient vehicles allows the MAGTF to travel farther with less fuel. The existing tactical vehicle fleet and associated fossil-fuel-consuming end items will be in the Marine Corps inventory for quite some time. Multiple avenues are being explored to maximize the energy extracted from each gallon of fuel and to minimize losses to heat, friction, and other inefficiencies. When implemented together, these S&T investments, which are not limited to one vehicle or even one component, can minimize fuel use and maximize operational maneuver for each gallon of fuel used.

Potential Solutions

ONR Efforts

Fuel Efficient Medium Tactical Vehicle Replacement (MTVR) – Future Naval Capability (FNC)

This FNC will develop, optimize, integrate, and demonstrate at least 15% fuel efficiency improvement over the existing MTVR across a set of driving cycles representative of likely operational conditions, while maintaining MTVR affordability, current mobility, transportability, and survivability capabilities.

FNC - ACV Fuel Efficiency Improvements

This FNC will develop, optimize, integrate, and demonstrate a fuel efficiency improvement over the current ACV platform across a set of driving cycles representative of likely operational conditions, while maintaining affordability, mobility, transportability, and survivability capabilities.

TARDEC Efforts

Alternative Fuels Qualification (AFQ)

The purpose is to determine JP-8 fuel spec requirements needed for approval of alternative jet fuels (ATJ, DSH, HDC, & CH) as military ground fuel that enables DLA-Energy to source these fuels when they are commercially available at cost-competitive prices.

Advanced Thermal Management System (ATMS)

This effort will leverage current investments in combat vehicle cooling technologies to develop, mature and integrate an efficient and effective cooling system for the Combat Vehicle Program

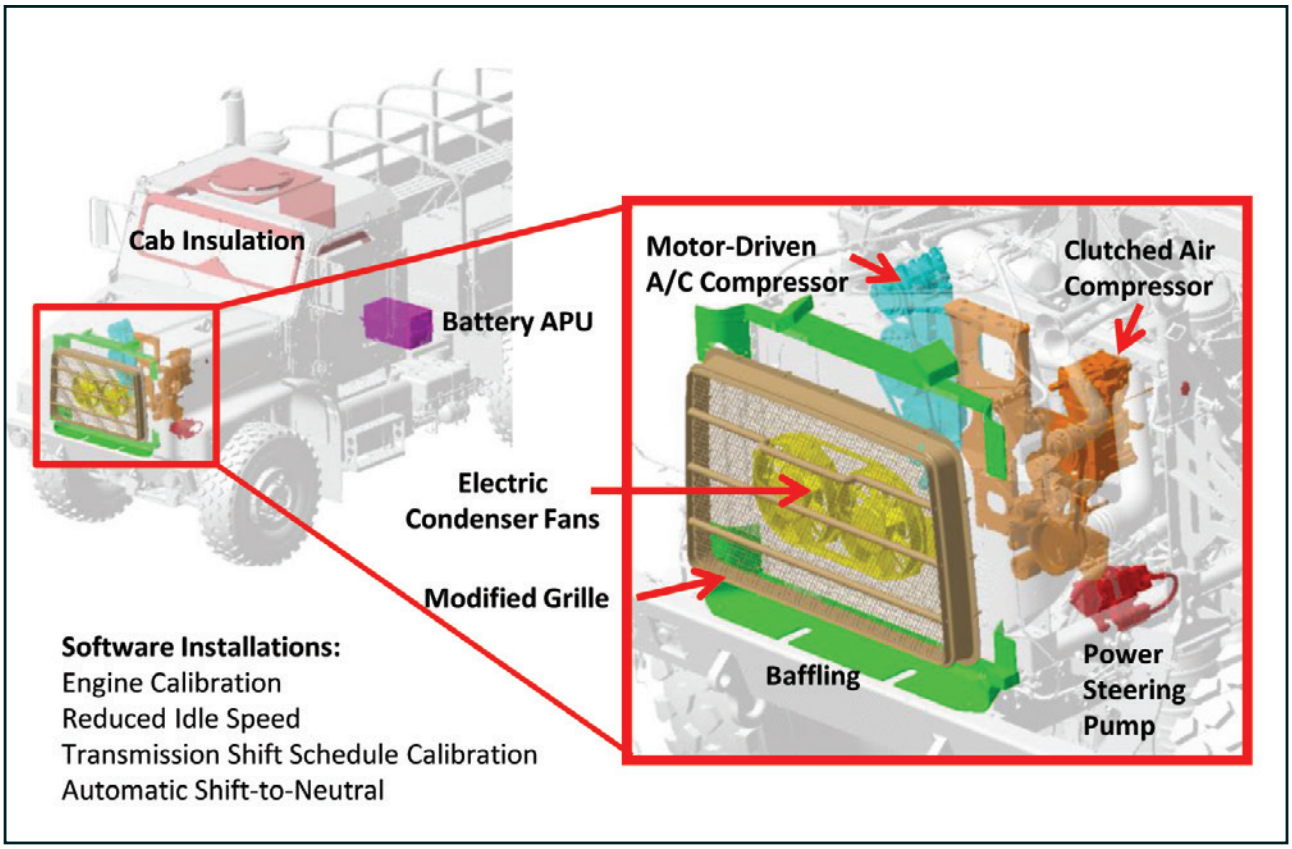


Figure 5.1-1. Fuel Efficient MTVR Components

Figure 5.1-2. MATV Operating in Southwest Asia

(CVP). It will optimize cooling system reducing parasitic power in all modes of vehicle operation for more range and mobility. Maturing advanced technologies will also integrate thermal solutions, while enhancing performance, decreasing weight, and minimizing cost.

Energy Efficient Hydraulic Fluids (EEHF)

Reduce energy (fuel) consumption in CE/MHE equipment by developing an energy-efficient hydraulic fluid formulation and hydraulic fluid efficiency models. The EEHF requirements will be documented in a performance specification with qualified products for DLA-Aviation to purchase. Project will verify hydraulic fluid efficiency models developed for CE/MHE to further understand the efficiency gains that can be attributed to hydraulic fluid formulations. Efficiency testing will be conducted via laboratory rig and vehicle level testing.

Fuel Efficient Gear Oils (FEGO)

This project will develop the necessary tools and methods to identify fuel-efficient gear oils that the DLA can competitively purchase.

Fuel Cell In-House

This effort will maintain and strengthen in-house technical knowledge and competencies through hardware testing, system integrations, collaborations with industry, government and academia. It will also manage technical research efforts that push the state-of-the-art and reduce system cost and complexity.

Advanced Combat Engine (ACE)

The intent is to design and develop a novel 1500 hp Military Engine to meet mobility needs for combat vehicles. It will meet the Army's need for enhanced protection and fuel efficiency as high power engines (800–1500 hp), which are needed to offset increasing combat vehicle weights (armor). The ACE will also address increased electrical generation needs (onboard and exportable power), improved fuel economy (cost & range), enhanced mobility (survivability), and reduced cooling system burden (size, heat rejection) in a smaller package (reduce under armor volumes).

Advanced Combat Transmission (ACT)

Development of a high-efficient cross-drive transmission for a track vehicle mated to a 1500hp high-power dense engine, while offering greater fuel economy (10–15%), improved thermal efficiency (15%), and lower heat rejection (20%) for use in future combat vehicles and demonstrated in the Combat Vehicle Program (CVP) platform.

Battlefield Fuel Reduction & Water Generation Analysis

The purpose of this effort is to demonstrate an analytical capability to quantify the fuel- and water-related logistics burden impacts of technology-related changes in a virtual battlefield.

Efficient Power Take Off (EPTO)

This will improve limited manufacturing capability of Efficient Power Take Off-geared fan drive technology and also provide affordable EPTO systems for Program Manager Bradley and other Army ground vehicles for fuel savings and improved mobility.

Fuel Cell Hybrid Systems for Extended Mission Capabilities

This will develop a semi-automated manufacturing process resulting in decreased production costs and increased production output for compact, silent, fuel cell hybrid systems for Unmanned Ground Vehicles (UGV), Unmanned Aerial Systems (UAS), and man-portable power systems.

Fuel Quality Surveillance

Petroleum fuel handlers at all levels (to include Petroleum Groups and Theater and Divisional Sustainment Brigades, and Brigade Support Battalions) lack the ability to rapidly verify the suitability for use of petroleum products prior to issuing. This project will develop algorithms and mature technologies that will provide a fuels quality surveillance in minutes. Technologies to be investigated include: light obscuration, light scattering and ultrasound for contamination detection, and Near Infrared Spectrometry for the portable fuel property monitor.

Small Business Innovation Research (SBIR) Efforts

Adaptive Diesel Engine Control via Variable Valve (Smart Lifter Technology) (Phase II)

The current use profile shows engine operating at two different and distinct load levels 400 BHP to climb slopes, accelerate under full payload, or traverse soft soils 10–20 BHP to support idle vehicle operation generating electricity and HVAC functions. Currently, the state of the art only allows engine optimization at a single operational point. This effort will demonstrate multi-operation point optimization thru the use of prototype Smart Lifters operating on a Caterpillar C-12 engine by the end of Phase II.

This project will demonstrate the benefit of cylinder deactivation and variable valve timing on Diesel/JP-8 engine fuel economy and power output. Estimates from Phase I suggest up to 31% fuel economy improvement during idle/surveillance mode and up to 15% fuel economy improvement during driving.

Parasitic Load Reduction to Improve Engine Efficiency (Phase II)

This SBIR program focuses on a combined software/hardware solution to reduce the volume of fuel consumed by the MTVR engine during mission operations, while increasing the power output of the engine. These goals will be reached thru modification of the Caterpillar C12 for full and independent control of diesel engine components, which will then enable the engine to operate at maximum efficiency across the full spectrum of engine loads.

Variable Speed Accessory Drives (Phase II)

The objective of this Phase II research is to develop a variable ratio cooling fan drive for the MTVR. The MTVR currently uses a clutch-style fan drive operated with air pressure. It is believed that the fuel economy of the MTVR can be improved by implementing a variable ratio cooling fan drive and controlling the cooling fan speed as a function of coolant temperature.

5.1.2 Intelligent Power and Thermal Management

The Challenge

The management, storage, and efficient use of vehicle power has led to developing a suite of power control programs that can effectively prioritize and manage between C4ISR, Hotel Services, and HVAC systems in an adaptive operational environment. Thermal management of electronics is vital to the successful tactical operation of a variety of military electronic systems. Vehicle thermal management is important as it can reduce thermal loads, efficiently remove heat, reuse waste heat, and integrate systems within the vehicle. This effort can improve operational effectiveness and have a reduced energy load. This can extend vehicle operations and can result in efficient electric generation and consumption. Managing the vehicles various thermal loads and supplies can also assist with power consumption and resourcefully manage the vehicle's output.

The projects described below address many of the needs associated with this challenge through management of thermal loads and energy consumption on Marine Corps tactical vehicles.

Potential Solutions

MWCL Efforts

Hybrid Energy ITV Trailer (HEIT)

The Hybrid Energy ITV Trailer combines ways to generate, scavenge, condition, store, manage and distribute power. HEIT is a standard ITV Ammo Trailer reconfigured to provide 3.5 kW Tactical Quiet Generator (TQG) capabilities with the primary system, the battery bank, providing silent operation. It harvests energy from renewable energy sources such as solar, shore power, or conventional energy provided by the on-board generator. With the primary power source being the battery bank, it provides auto-load balancing and an uninterruptable power supply to support the MAGTF.

Potential Solutions

Small Business Innovation Research (SBIR) Efforts

- Compact Auxiliary Power System for Amphibious Vehicles.

TARDEC Efforts

Integrated Starter Generator (ISG)

The Integrated Starter Generator will address onboard electrical power needs of Army Combat Vehicles (Stryker, CVP). Current Vehicle alternators provide 10-20kW, but the CVP baseline onboard power generation is 120kW; the CVP ISG will provide 160kW of high-voltage electrical power. The ISG buys back the power margin and allows for capability growth. This will increase efficiency (fuel savings), augment mobility, and allow export power.

Advanced Li-Ion Modular Batteries (AMB)

This effort will apply recent commercial advances in Lithium-ion based anode, cathode, electrolyte and separator battery materials to electrode, cell, and military-specific pack designs to:

- Significantly increase energy density vs. lead acid battery baseline from 36Whr/kg to >160Whr/kg, while increasing power desnsity by >50%
- Increase operating temperature range for the Li-ion batteries from (-20°C to +50°C) to (-46°C to +71°C)

Advanced Auxiliary Power Unit (AAPU)

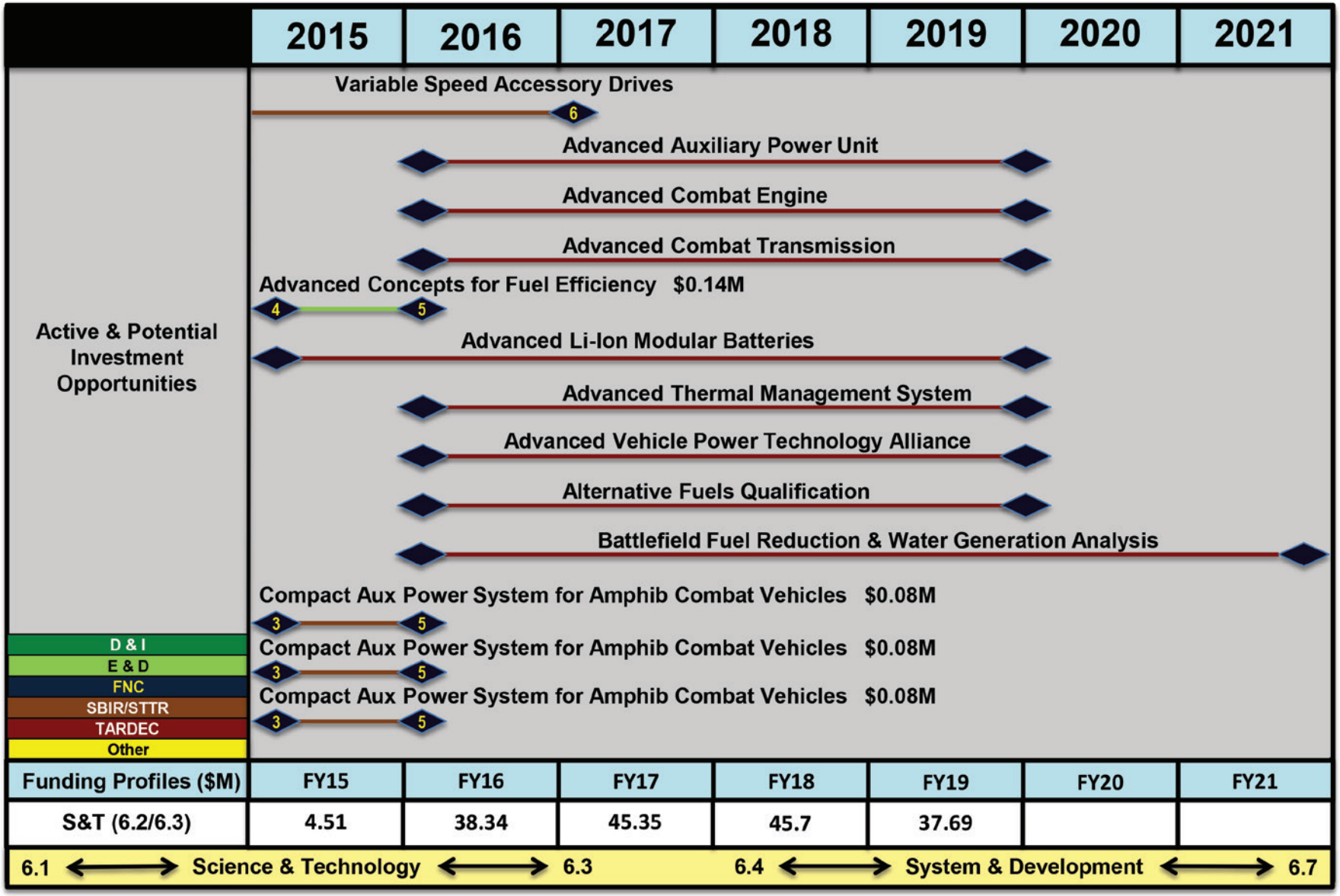
This effort will provide electrical power for ground vehicle main engine off operations. It will develop a compact, scalable Auxiliary Power Unit (APU) to provide sufficient power, while meeting space and weight requirements.

Additional TARDEC S&T Projects that are of Interest to PEO LS Include:

- Advanced Vehicle Power Technology Alliance (AVPTA)

The Power & Energy Focus Area charts on the following pages highlight critical efforts monitored and supported by the PEO LS S&T Director.

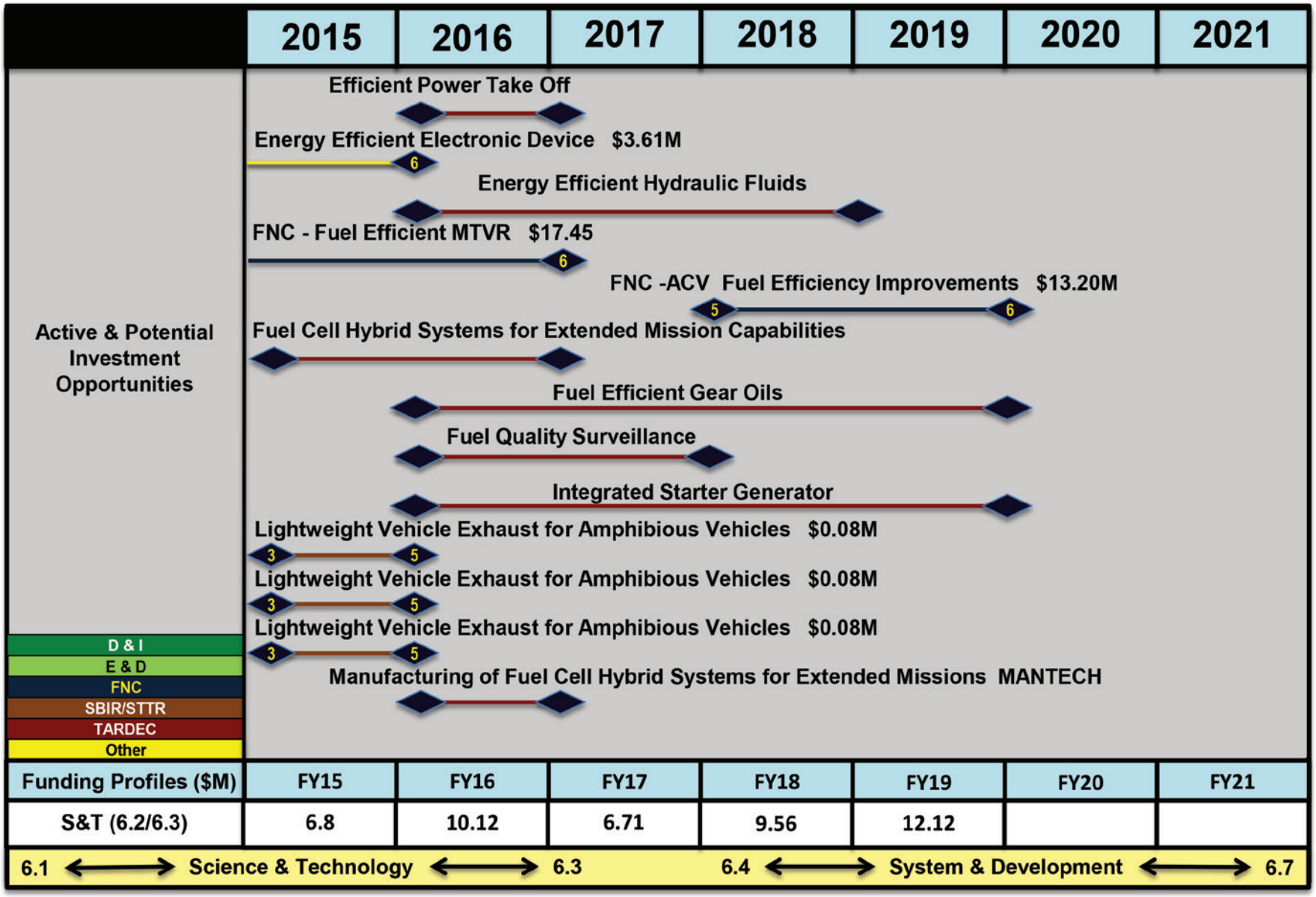
Power & Energy



Funding Profiles ($M)	FY15	FY16	FY17	FY18	FY19	FY20	FY21
S&T (6.2/6.3)	4.51	38.34	45.35	45.7	37.69		

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System & Development ⟷ 6.7

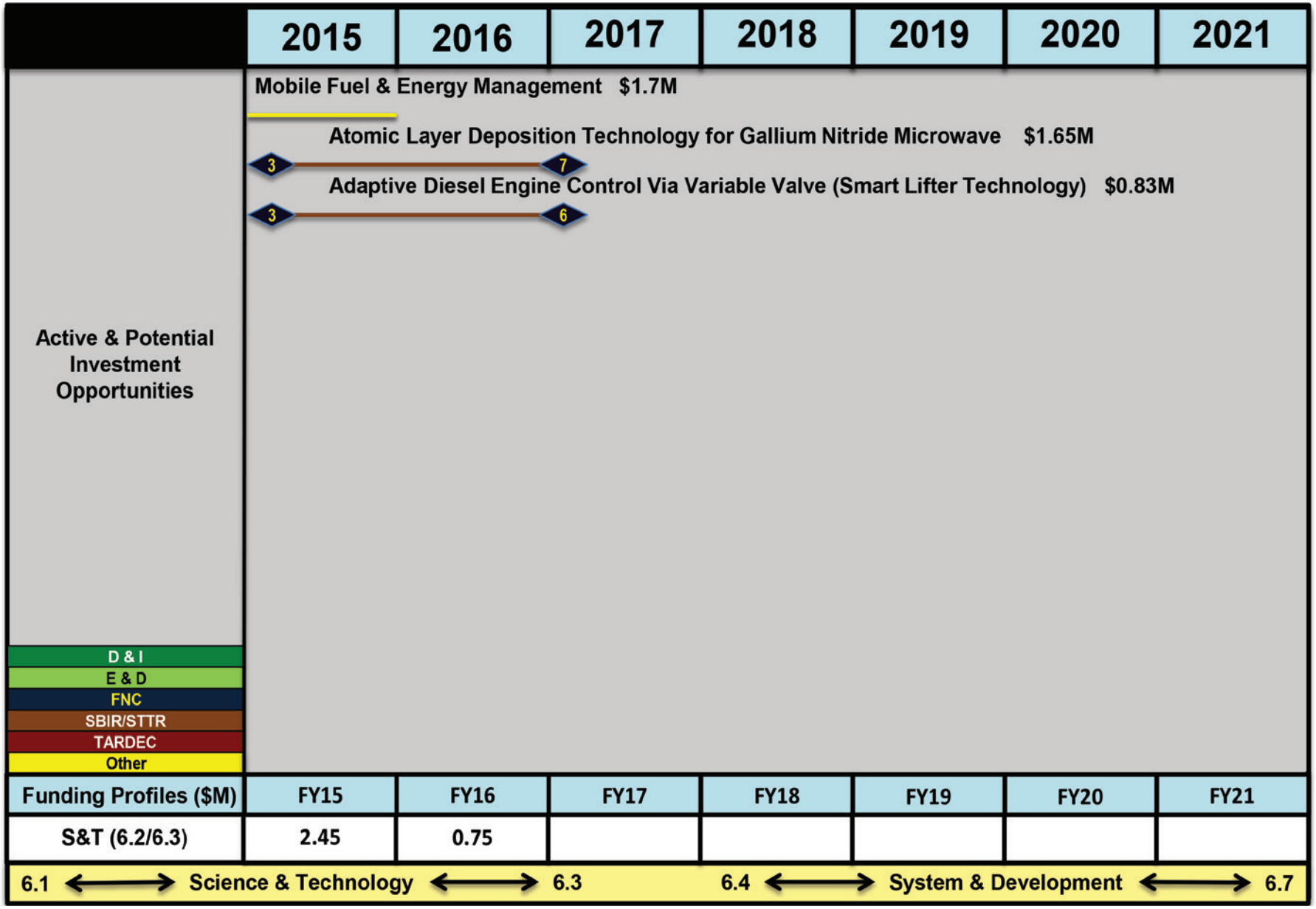
Power & Energy



Funding Profiles ($M)	FY15	FY16	FY17	FY18	FY19	FY20	FY21
S&T (6.2/6.3)	6.8	10.12	6.71	9.56	12.12		

6.1 ⟷ Science & Technology ⟷ 6.3 6.4 ⟷ System & Development ⟷ 6.7

Power & Energy



Funding Profiles ($M)	FY15	FY16	FY17	FY18	FY19	FY20	FY21
S&T (6.2/6.3)	2.45	0.75					