

# Electric Propulsion: a Game Changer

by MAJ Ryan Ressler, MAJ Brian Ottestad and Mike Smith

America's adversaries have closely studied our recent operations. They know the American way of war well. Simultaneously, emerging technologies – including artificial intelligence, machine learning, nanotechnology and robotics – are driving a fundamental change in the character of war. Strategic competitors such as China and Russia are deploying capabilities to fight the United States through multiple layers of stand-off in all domains: space, cyber, air, sea and land.

In an era of great-power struggle, the American way of war must evolve and adapt.

As the world changes, so must the Army change how it fights. Electric-powered vehicles offer the potential to double the ground forces' operational reach; increase lethality and survivability at the tactical and operational levels; and reduce the Army's logistics burden by half. The rapid and widespread adaptation of vehicle electrification, from hybrids to fully electric vehicles, has begun to alter the full spectrum of the automobile industry and will dramatically revolutionize the way we maintain and sustain vehicles.

A significant vulnerability of forward-deployed ground combat forces is their dependence on bulk-petroleum fuels. These traditional fuels are essential for maneuver forces; they power weapon-systems and command-and-control systems, and aid in gathering information and decision-making. Maneuver-force endurance and operational reach is determined by the ability to ensure open lines of communication, with a supply of bulk petroleum readily available.



**Figure 1. A Heavy Expanded-Mobility Tactical Truck fueler prepares to conduct refuel operations in an austere environment. (U.S. Army photo)**

Nearly “half of American deaths in Iraq and almost 40 percent of deaths in Afghanistan”<sup>1</sup> are attributed to roadside-bomb attacks. Fuel convoys are soft targets, yet they are a major line of effort during large-scale combat operations (LSCO).

Throughout modern history, there are many examples of military operations losing tempo due to disrupted and degraded supply lines. For example, during World War II, both the Allies and Axis powers were impacted by fuel shortfalls during their campaigns across North Africa. Also, GEN George S. Patton's Third Army's drive into Germany was at the mercy of bulk-petroleum requirements.

In today's Army, multi-domain operations (MDO) will further increase the time and space between units and drive increased power demands, causing strain on sustainment capabilities and highlighting the need for a more efficient vehicle fleet.

## **Sustainment advantages of electrification**

The U.S. Army must focus more effort and resources on increasing the endurance and ability of ground forces to operate semi-independently. Electric-powered combat vehicles will do this by overcoming the energy logistics challenges of future battlefields while providing increased reliability, survivability, lethality and cost-effectiveness. Electrification can double the operational range of vehicles and potentially reduce the logistical requirements of our current fleet by up to 45 percent.

Electric propulsion provides a means to address two of the most pressing challenges on the future battlefield: energy logistics and unit endurance. Fielding an electric-propulsion capability in combination with organic persistent-power-generation capabilities provides several distinct advantages over existing drivetrains. The most prominent of these advantages is the dramatic increase in the amount of time units can sustain operations without external logistical support. Electric-powered tactical and combat vehicles have significantly fewer moving parts and will be inherently more reliable than those with traditional drivetrains powered by internal-combustion engines.

Increased reliability directly translates into fewer maintenance manhours, a reduction in cargo space required to carry spare and repair parts, smaller logistic-support areas and an increased operational-readiness rate. These benefits allow our formations to operate longer and can better control tempo, providing commanders a competitive advantage over our adversaries.

## **Electric vehicles' tactical advantages**

Introducing electric propulsion to the tactical and combat vehicle fleet enables the Army to integrate capabilities that were once thought of as only science fiction. Many of these advantages ascend from electric-drive motors and embedded electric-energy storage and internal-distribution systems. Electrification enhances the tactical aspect of maneuver platforms in three distinct ways:

- First, it enables silent mobility. Silent mobility, a long-desired attribute, will increase lethality and survivability in all formations. Imagine a motorized-cavalry troop fitted with a light reconnaissance vehicle that can conduct its mission set virtually undetected. This – combined with extended range and duration – has a dramatic impact on the overall effectiveness of the future cavalry squadron.
- Second, electrification will extend the duration of silent watch, or the ability to sit in a hide position with all critical systems powered and the engine off. Through increased battery density, power-sharing and the ability to produce and prioritize onboard power, electrified vehicles will far outperform the current fleet in terms of power management.
- Third, electric-powered vehicles will dramatically reduce the thermal signature produced by vehicles, degrading adversarial detection capabilities. Reductions in both visible and acoustic detection will dramatically increase the element of surprise.

Further, platform electrification addresses the inevitable increase in high-demand future power requirements. Future ground-combat systems will be required to support a litany of high-energy systems such as advanced communications systems, directed-energy weapons and active/passive protection systems.

In addition, platform electrification will enable the concept of formation power. Formation power is defined as the ability to power all organic or habitually attached systems through the vehicle platform. This capability will allow Soldiers to ensure their mission-essential power demands are met.

As robotics and artificial-intelligence technology advances, electrification will facilitate adaptation of smart-power capabilities. Smart power optimizes power conversation and power sensing to ensure both the platform and Soldiers maximize their use of power resources.

Finally, electric-powered vehicles are well known for their ability to instantly deliver high torque and rapid acceleration. A commercial example is the Tesla S P90D, a mass-produced and mass-marketed four-door all-wheel-drive sedan, delivering 762 horsepower and 713 pounds-per-foot of torque, able to accelerate from 0 to 60 miles per hour in an astonishing 2.4 seconds.<sup>2</sup> Before the development of modern electric vehicles, this type of performance was found only in exotic high-performance vehicles, not production sedans.

The Army must leverage capabilities such as these to save lives and provide decisive lethality.

In addition to these performance advantages, electric-powered vehicles offer other benefits beyond traditional drivetrains. As the employment of electric-powered vehicles continues to expand, it is likely that their design and configuration will evolve. The use of conformable batteries will dramatically affect design considerations. By no longer designing a vehicle around heavy, bulky engines and transmissions, electric-powered vehicles can alter their shape and profile. This facilitates the ability to better design platforms and meet the ever-growing roles of the future ground fleet.

## Challenges

Compared to commercial industry, the Army has unique design challenges when adapting tactical and combat platforms to electrification.

The technology required for all-electric propulsion for light tactical vehicles exists today. However, the technology required to sustain these vehicles in an austere environment does not. In the future operational environment, formations employing MDO will be widely dispersed and may not have the ability for a daily logistics package to rearm/refit every unit. Semi-independent operations may last for days without external support.



**Figure 2. A Joint Light Tactical Vehicle convoy performs mounted-movement techniques in a desert environment. (U.S. Army photo)**

Specific challenges lie in battery density or the ability to store power for heavier platforms; the ability to produce and transport power on the battlefield; and rapid recharging. The Army has invested in a significant number of propulsion, power and battery initiatives to address these challenges. The Army must continue to leverage industry investments and expertise to help us solve these complex, but not insurmountable, challenges.

## Path to platform electrification

Based on current technology, the most viable path to electrification is through the light-tactical-vehicle fleet as the Army's entry point into electric propulsion. The near-term strategy should be centered on hybrid drivetrains.

It's been estimated that hybrid technology can produce up to a 45-percent reduction in Class III bulk petroleum. Applying this theory to an armored brigade combat team's (ABCT) light-tactical-wheeled fleet, the ABCT could save 36,000 gallons a day in LSCO.

The mid-term goal is to advance hybrid-electric-drive technologies to heavier platforms. Applying this theory to the entire ABCT fleet, the ABCT can save up to 133,000 gallons of Class III per day in LSCO.

The far-term goal is to transition the Army to an all-electric-capable ground force. As power and battery technologies mature, a transition to an all-electric force will dramatically enhance the effectiveness of our combat and tactical vehicles.



**Figure 3. Soldiers finalize camouflage in preparation for a mounted reconnaissance mission. (U.S. Army photo)**



**Figure 4. A fuel convoy moves to provide fuel to combat forces in support of sustainment operations. (U.S. Army photo)**

## **Conclusion**

The future is now. Traditional fuel is a high-demand commodity that is difficult to move and distribute on the battlefield. Limitations of fuel-capacity drive operational reach and will impact our influence in future contested environments. Adopting electric-propulsion alternatives while increasing power generation, storage and distribution capabilities will reduce our dependence on traditional fuels; increase the lethality and survivability of units; and enhance the overall effectiveness of the force.

The Army must be an electric-propulsion innovator and continue to strengthen ties with industry regarding propulsion, power and battery technologies. Through the right investments, programs, initiatives and resources, the Army can push these technologies and drive innovation that facilitates continued dominance in the ground domain.

*MAJ Ryan Ressler is a capability developer for the Maneuver Requirements Division (MRD), Maneuver Capabilities Development and Integration Directorate (MCDID), Maneuver Center of Excellence, Fort Benning, GA. Previous assignments included operational test officer, mission-command systems, U.S. Army Operational Test Command,*

Fort Hood, TX; assistant product manager, tactical programs, Product Manager Force Protection Systems, Fort Belvoir, VA; commander, Troop C, 1<sup>st</sup> Squadron, 61<sup>st</sup> Cavalry, 4<sup>th</sup> Brigade Combat Team (BCT), 101<sup>st</sup> Airborne Division, Fort Campbell, KY; and platoon leader/executive officer, 6<sup>th</sup> Squadron, 8<sup>th</sup> Cavalry, 4<sup>th</sup> BCT, 3<sup>rd</sup> Infantry Division, Fort Stewart, GA. His military schooling includes Command and General Staff College (CGSC); Defense Acquisition Workforce Improvement Act Program Management Level III; Maneuver Captain's Career Course (MCCC); Ranger, Airborne and Air-Assault schools; Mortar Leader's Course and Army Acquisition Basic Course/Army Intermediate Program Management Course. MAJ Ressler has a bachelor's of specialized studies degree in foreign affairs from Ohio University and a master's of science degree in business from the University of Kansas.

MAJ Brian Ottestad is the battalion operations officer (S-3) for 3<sup>rd</sup> Battalion, 21<sup>st</sup> Infantry, 1<sup>st</sup> BCT, 25<sup>th</sup> Infantry Division, Fort Wainwright, AK. Previous assignments include capabilities developer, MRD, MCDID, Fort Benning; task force S-3, Task Force II, Joint Readiness Training Center (JRTC), Fort Polk, LA; weapons-company team senior observer/coach/trainer, Task Force II, JRTC, Fort Polk; commander, heavy-weapons company, Company D, 3<sup>rd</sup> Battalion, 7<sup>th</sup> Infantry, 4<sup>th</sup> Infantry Brigade Combat Team (IBCT), 3<sup>rd</sup> Infantry Division, Fort Stewart; and plans officer, Headquarters and Headquarters Company, 3-7 Infantry, 4<sup>th</sup> IBCT, 3<sup>rd</sup> Infantry Division, Fort Stewart. His military schooling includes CGSC, MCCC, Ranger School and Airborne School. MAJ Ossestad holds a bachelor's of science degree in history from the University of Wisconsin-Stevens Point.

Mike Smith is a contractor serving as a capability developer at MRD, MCDID. Previous assignments include training developer, Directorate of Training and Doctrine, Fort Benning; senior drill sergeant, Fort Benning; platoon sergeant, Fort Hood; platoon sergeant, Fort Hood; and Bradley master gunner, "various assignments." Mr. Smith's military schooling includes Bradley Master Gunner School, Drill Sergeant School and Advanced Noncommissioned Officer School. His awards and honors include the Meritorious Service Medal.

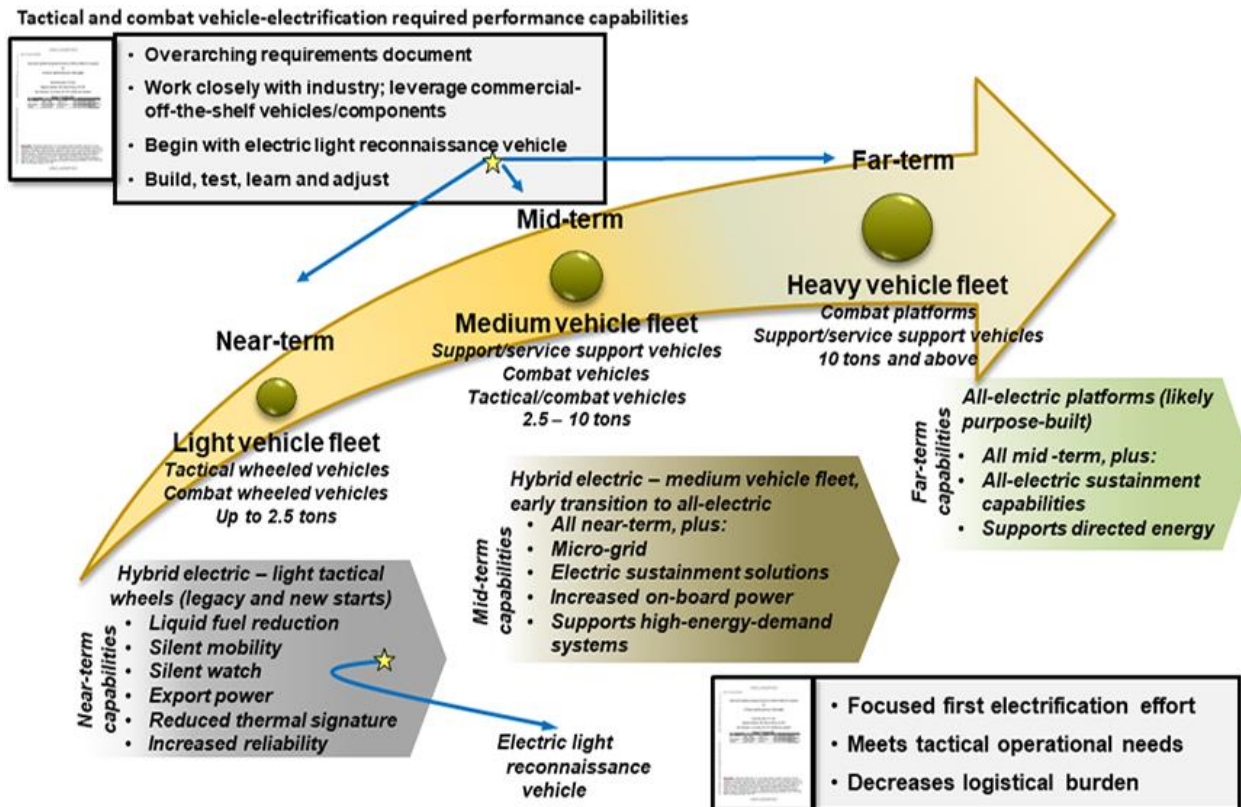


Figure 5. Possible path to tactical- and combat-vehicle electrification.

## Notes

<sup>1</sup> Christopher Helman, "For U.S. Military, More Oil Means More Death," *Forbes*, Nov. 12, 2009, <https://www.forbes.com/2009/11/12/fuel-military-afghanistan-iraq-business-energy-military.html#6e24e6064562>.

<sup>2</sup> Tesla, "Model S Performance," <https://www.tesla.com/models>.

## **Acronym Quick-Scan**

**ABCT** – armored brigade combat team

**BCT** – brigade combat team

**CGSC** – Command and General Staff College

**IBCT** – infantry brigade combat team

**JRTC** – Joint Readiness Training Center

**LSCO** – large-scale combat operations

**MCCC** – Maneuver Captain's Career Course

**MCDDID** – Maneuver Capabilities Development and Integration Directorate

**MDO** – multi-domain operations

**MRD** – Maneuver Requirements Division