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HOW HYBRID ELECTRIC TECHNOLOGY IS SHAPING THE FUTURE OF COMBAT VEHICLES

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The positive probe of a multimeter tests volts on a Light Medium Tactical Vehicle's Electronic Control Module (ECM).

HOW HYBRID ELECTRIC TECHNOLOGY IS SHAPING THE FUTURE OF COMBAT VEHICLES

By: Korie Wilkins

Hybrid electric technology is challenging gas-powered vehicles for market supremacy, and the U.S. military is poised to take advantage of this change by embracing technology and looking toward a future that doesn't rely on fossil fuels.

In 2021, President Joe Biden announced his [Build Back Better Agenda](#) with a target of 50% of all vehicles sold commercially by 2030 to be zero emissions (battery electric, plug-in hybrid electric or fuel cell) — to drive innovation, create technological advantages over adversaries like China and help tame the climate crisis.

Following along, the military also announced its vision of a fleet of emissions-free vehicles, with the U.S. Army setting a goal to field a fully-

electric tactical vehicle by 2050. In February 2022, the Army published its Climate Strategy, a document outlining how it is addressing climate change.

"The Army will lead by example," said [Christine E. Wormuth](#), Secretary of the Army.

These are lofty goals, yet both the government and military appear to be well on their way. Challenges remain, and partnerships with private sector companies will be needed — including continued research and development spending to drive innovation.

"One of the biggest challenges in introducing hybrid or fully electric vehicles is their novelty," said Jensen Chew, product director for electrification and 4x4 vehicles at ST

Engineering. "And new very often frightens people. They aren't sure why you are building it."

Hybrid electric vehicles can offer many tactical and practical advantages to the military, in a war zone and beyond. As the world moves beyond gasoline-powered engines and into cleaner technology, the Department of Defense needs to waste no time in adopting these technologies as well.

"The department is committed to meeting the challenge by making significant changes in our use of energy and increasing our investments in clean energy technology," [Deputy Secretary of Defense Kathleen Hicks](#) said.

The DoD has a sustainability plan,

SGT. 1ST CLASS CLINTON WOODY, U.S. ARMY RESERVE

focused on a zero-emissions non-tactical vehicle fleet. As of 2021, there were more than 170,000 non-tactical vehicles in the fleet — a considerable number of vehicles to change over. Hicks has said the DoD will be relying on U.S. automakers and other suppliers to attain this goal. Companies like [General Motors](#) and [Ford](#) have invested billions into EVs on the commercial side, with plans to have dozens of EVs in their product lineups within a decade.

Other companies are also creating vehicles that the U.S. military should consider as it works toward its goal. Chew said [ST Engineering](#), for example, announced the hybrid-ready Terrex s5 8x8 Infantry Fighting Vehicle at the Singapore Airshow this year.

“ST Engineering went into electrification as a need and not a choice,” he said. “And the reason for that is that it offers operational benefits to our customers — and the environment.”

Timeframe for electrification

In the last few years, the electrification of commercial vehicles has accelerated, with companies ranging from startups to established legacy automakers driving innovation and change. This shift hasn't gone unnoticed by the military, with the U.S. Army announcing in 2022 its [Climate Strategy Implementation Plan](#) — which includes the goal of attaining net zero emissions by 2050. To do so, the Army plans to increase fuel efficiency, transition to more hybrid electric vehicles and more.

Secretary of Defense Lloyd Austin has made it a focus to look at how climate change impacts the military, taking policy actions and considerations.

“Climate change is an existential threat to our nation's security, and the Department of Defense must

act swiftly and boldly to take on this challenge and prepare for damage that cannot be avoided,” [Austin](#) said. “Every day, our forces contend with the grave and growing consequences of climate change, from hurricanes and wildfires that inflict costly harm on U.S. installations and constrain our ability to train and operate, to dangerous heat, drought, and floods that can trigger crises and instability around the world.

“The Climate Adaptation Plan will be our guide for meeting the nation's warfighting needs under increasingly extreme environmental conditions — and for maintaining force readiness and resilience well into the future.”

Suppliers and automakers are responding, pushing forward with innovative solutions to these goals. Chew said ST Engineering is poised to offer Hybrid Electric support vehicles and Hybrid Electric Kit solutions now to the military in advance of upcoming offerings in the way of combat vehicles, which he noted are moving forward quickly.

“We could transition to combat vehicles by the end of 2025,” Chew said.

The technology is there, experts say — it's the changing of hearts and minds to adopt a cutting-edge solution that remains a challenge. Budget considerations also remain a key point, as changing over entire fleets that may not yet be obsolete from an operational standpoint will be a massive expenditure.

However, there is a compelling case for tactical advantages of zero-emission vehicles in the military.

Tactical advantages of zero-emission vehicles

The environmental advantages of zero-emission vehicles such as better fuel economy, lower fuel costs and reduced

emissions are [well-documented](#) — but EVs also have considerable tactical advantages as well.

Something that battery-powered vehicles — whether they are hybrid or full EV — offer is more options for meeting the electrical needs for high-power computing and high-energy payloads. And the military of the future is moving toward a more high-tech fighting force that needs technical support.

At the October 2022 Association of the U.S. Army's Annual Meeting and Exposition, Assistant Army Secretary for Acquisition, Logistics and Technology Doug Bush said the EVs of the future will allow for the use of cutting-edge tools, such as directed energy weapons. Over the past 30 years, the electrical demand from onboard power systems has increased for command and control, communications, intelligence and weapons systems. These things need power — and EVs are one way to fuel this need.

“We'll have the ability for the Army to [have] vehicles with enough electric power not just to be silent watch and use less fuel, but also to have things like directed energy weapons on them, lasers, high-powered microwaves and electronic warfare kits, all across the battlefield,” Bush said.

The demand for more technology and computing support in the field is only going to increase, and vehicles powered by batteries can support a silent watch for hours — up to two days in some cases — with air conditioning or heat, Chew said. And that power can allow for other high-energy systems like drone use, making hybrid or electric vehicles an outstanding choice for any military operation that requires a command station. Chew said one battery-powered EV can replace three towed-in generators, which is a win for logistics, training, maintenance and

time, reducing the manpower needed to operate and maintain this system.

“Those personnel could be deployed to a different role,” Chew said.

EVs also offer other advantages, such as allowing the military to be more resilient and sustainable, which is a top priority for the DoD. [Rachel Jacobson](#), assistant secretary of the Army for installations, energy and environment said at the AUSA meeting that barracks are being built at Joint Base Lewis-McChord, Washington using sustainable materials.

“Everything we are doing on the climate front will make us better warfighters while reducing our carbon footprint,” Jacobson said.

Timing for changeover

The U.S. Army maintains a fleet of more than 220,000 vehicles, so changeover is no small task. Chew and others have said that from a business perspective, the Army will need to change over vehicles like commissary support vehicles first before switching over to larger vehicles or track vehicles like tanks. Right now, there is no timeframe to transition every single military vehicle — including tanks — to EVs.

However, the Army’s climate strategy is clear. It will add:

- An all-electric light duty nontactical vehicle fleet by 2027
- An all-electric nontactical vehicle fleet by 2035
- Hybrid-drive tactical vehicles by 2035, and
- Fully electric tactical vehicles by 2050.

To get all of these vehicles changed over by these dates, “the timeframe is now,” Chew said, noting that ST Engineering and other manufacturers



An instructor looks at an electric vehicle (EV) engine cabin during an EV maintenance training course that teaches key components and safety requirements of electric and hybrid vehicles.

have production-ready models now.

While the climate strategy does not mention tanks, the consensus among experts is that tanks weigh too much to be on full battery power for now, although hybrid might be an option — it is just a matter of time and technology catching up.

In its Climate Strategy, the Army stated its desire for non-tactical fleet electrification with plans to modernize its NTV fleet with commercially available vehicles like sedans, trucks, vans and buses, which will cut emissions and help the Army reach its net-zero goal. By the end of 2020, the Army had already removed 18,000 NTVs from its fleet and increased its inventory of hybrid vehicles by 3,000 — slashing fossil fuel consumption by 13 million gallons a year.

In addition, Army Materiel Command set a mandate in 2021 that all new vehicle leases and purchases must

select all-electric NTVs first, hybrids if electric are not commercially available and gas-powered only if nothing else is available.

The end goal is to have an all-electric fleet by 2027, with hybrid options as a bridging solution.

When it comes to hybrid or fully electric track vehicles, the industry is still lagging. However, they are on the horizon. The issue with track vehicles is that you need large batteries capable of delivering the power, which poses concerns relating to weight.

There are no all-electric combat vehicles currently in use, as the military is waiting for battery technology to improve on the commercial side, as well as technology advances for charging larger batteries.

“Ideally, we would be able to go to a full electric vehicle, but currently the technology does not exist to

generate, store, and distribute power in a tactically relevant amount of time for the frontline troops,” said [Lt. Gen. Ross Coffman](#), who heads up the Army Futures Command’s next generation combat vehicle team.

While moving to EV or hybrid support vehicles has already happened, the amount of battery power needed to run large, heavy vehicles like tanks is not there yet — and neither is the ability to quickly charge up.

So, for now, the focus remains on hybrid-electric or fully electric support vehicle changeover — which the commercial sector can currently source.

“Meeting demand won’t be an issue,” Chew said.

Challenges and charging

When it comes to tactical challenges the military may face with zero-emission vehicle changeover, the technology is there — and being

refined constantly. Military vehicles need to operate in extreme conditions: Heat, cold, humidity, snow and ice, and rough terrain, to name a few.

Chew and others have said those challenges can be met — ST Engineering, for example, has been building military vehicles for more than 50 years, so they are aware of the requirements.

Batteries, however, don’t always work in extreme environments, so that will also need to be considered so the vehicle can operate optimally, as well.

Charging the vehicles is a major hurdle, both for the military and in the civilian world. As it stands today, there simply aren’t enough charging stations to handle the civilian need — and in the military, you add in the challenge of charging in remote or inaccessible areas. And then, you must consider how long it takes to fully charge a vehicle — and how do you make high-speed charging available

and accessible?

In February 2024, the U.S. Army announced a master planning initiative for [EV charging facilities](#) and support equipment. The initiative will “bridge the gap between planned EV fleets and the required charging infrastructure to support it.”

The Army is already rolling out chargers at Army Reserve-funded installations, with several at Fort Buchanan in Puerto Rico and Fort McCoy in Wisconsin.

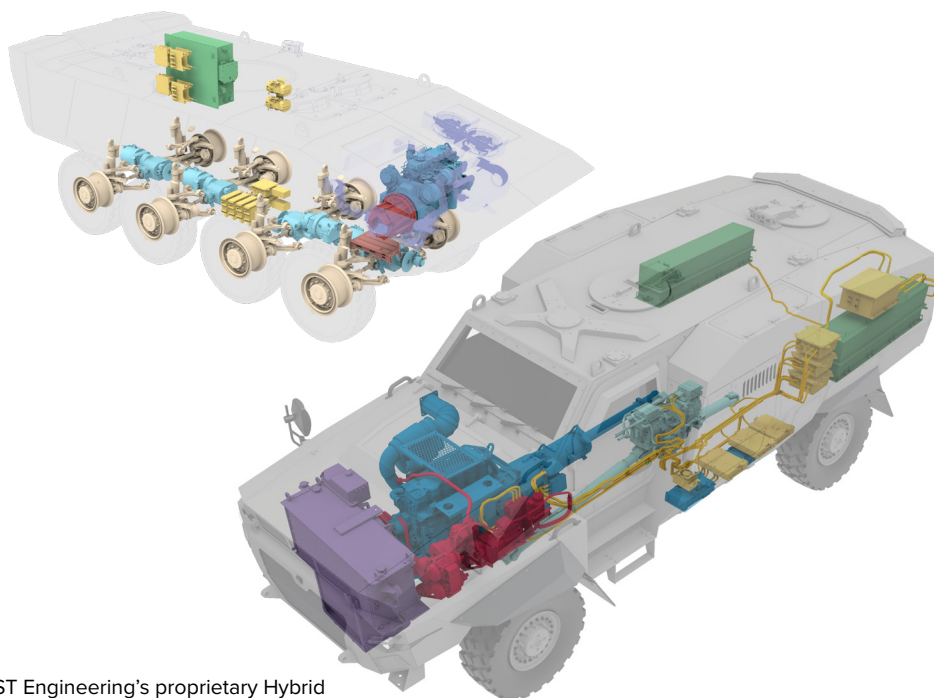
“Funding has been identified to support this effort and we are excited to earmark it for specific EV projects,” said [Joseph Foriska Jr.](#), who serves as a contract program manager for the Army Reserve Installation Management Directorate. “We are not building a plan to sit on a shelf. This will be actionable thanks to the confidence the data will provide us. The Army Reserve will be ready to implement the right solution for any given site as we modernize to meet future mission requirements.”

Having charging units in place is needed, but the technology to charge EVs faster is also evolving. Currently, there is research ongoing for a 1000-volt architecture that would allow for faster charging — meaning instead of a few hours to “fuel up,” it would take minutes. Today, direct current fast charging ([DCFC](#)) is available at public charging ports and can charge a battery in 20 minutes to an hour.

The military has a need to carry fuel rations into inaccessible areas. Whether they carry tanks of fuel or generators is a logistics issue, Chew said.

“It’s the same basic principle as cell phone charging,” he said. “We need to develop and mature the technology.”

The industry is moving forward and technology is advancing. Experts say if



ST Engineering’s proprietary Hybrid Electric Drive kit enables hybridization of 4x4, 6x6 and 8x8 vehicles.

research dollars keep being funneled into electric vehicles, the changeover will happen.

The future

Electrification is the future of vehicles for both the military and civilians. Automakers in the U.S. and abroad have embraced this technology and have either halted or slowed production on gas-powered vehicles. So, the question remains, what will the future look like on the battlefield when it comes to zero-emission vehicles? As in the commercial sector, Chew said the holy grail is the development of solid-state batteries — which engineers are experimenting with now for auto use, including companies such as

Toyota — with estimates of them being ready in the next two to five years.

“So much is being done to make batteries safer and more stable,” Chew said.

Solid state batteries, for example, have little risk of fire and aren’t as heavy or large, meaning less payload loss for military vehicles.

Balancing all these factors — including making the battery part of the protection package in a military vehicle, is on the horizon — and, in some cases, ready for production. Chew said the National Guard could conceivably change over now to electric vehicles with little to no issues.

“The infrastructure is there, or nearly so,” he said.

The technology is there; the development is coming.

“We should be fast followers,” said [Timothy Goddette](#), Deputy Assistant Secretary of the Army for Sustainment. “We should be looking at the technologies and looking at the opportunity where we can bring it in — not just because the technology is ready — but because it’s affordable, because it’s reliable, and because we’re taking advantage of the great industrial base that we have ... that is very closely aligned with what we do with tactical wheeled vehicles.” **DN**

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About ST Engineering:

ST Engineering is a global technology, defence and engineering group with a diverse portfolio of businesses across the aerospace, smart city, defence and public security segments. Headquartered in Singapore, it has operations spanning Asia, Europe, the Middle East and the U.S., serving customers in more than 100 countries.

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