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ARMY TACTICAL WHEELED VEHICLE PROGRAM UPDATE AND REVIEW OF ELECTRIFICATION

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES,
Washington, DC, Thursday, May 27, 2021.

The subcommittee met, pursuant to call, at 3:00 p.m., via Webex, Hon. Donald Norcross (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. DONALD NORCROSS, A REPRESENTATIVE FROM NEW JERSEY, CHAIRMAN, SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES

Mr. NORCROSS. Welcome. I would like to call this hearing to order.

Welcome, everybody, to this hearing of Tactical Air and Land Forces Subcommittee. Perhaps more than any other appreciates the attention to military trucks and utility vehicles. It might not be glamorous but—as some other weapon systems, but it is essential, and certainly we need that mobility in anything we do as a service.

I would like to welcome the members who are joining us today remotely. I have to read this script, but, hopefully, we are not going to have to do it too many more times. Members who are participating remotely must be visible on screen for the purposes of identity verification, establishing and maintaining a quorum, participating in the proceeding, and voting. Remote attending members must continue to use the software platform's video function the entire time while in attendance, unless they experience connectivity issues or other technical problems that render them unable to participate on camera. If a member experiences technical difficulty, they should contact the committee's staff for assistance.

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If members will be absent for a significant period or depart to join different proceedings, they should exit the software platform entirely, then rejoin it when they return. Members may use the software platform chat feature to communicate with staff regarding only technical or logistical issues. I have designated a committee staff member to, if necessary, mute unrecognized members' micro-

phones to cancel any inadvertent background noise that may disrupt the proceedings.

With that, I would like to welcome our panel of witnesses for taking the time to come before us and discuss the Army's current and future tactical wheeled vehicles.

Mr. Tim Goddette, Deputy Assistant Secretary of the Army for Acquisition Policy and Logistics, and who until just this month was a PEO [program executive officer] of combat support—combat services support at the Detroit [inaudible] procurement programs. Welcome.

And Mr. Michael Cadieux, Director of Ground Vehicle Systems Center, that is our science and technology laboratory for combat and tactical vehicles.

As I mentioned earlier, the truck and utility vehicles, particularly those necessary to support field operations, are essential to the success of any modern military. We have all seen the pattern of the increasing risk of the Army's management of these vehicles over the last few years by cutting modernization and production funding to generate more money for the higher priority weapons programs, the 31–4 piece that the Army has been going through night court for several years.

We look forward to the witnesses addressing this increased risk and its implementation for truck and utility fleets today. We will also talk about risks to our industrial network, incredibly important, especially when we start talking about minimum sustaining rigs. We also noted over the last couple of months increased public awareness and interest in accelerating pace and scope of electrification. This is certainly nothing new to the automotive industry, but the military application of electrification, particularly, in the field environment has very different challenges.

Our witnesses today will help us understand where the Army has been and where it is going for tactical wheeled vehicles. More importantly, they will help us understand and the operational technical challenges that make the commitment to vehicle electrification perhaps uncertain at best at this time.

With this, I want to recognize the stand-in for our Ranking Member Mrs. Hartzler, Mr. Don Bacon from Nebraska, for his opening statement. Don.

[The prepared statement of Mr. Norcross can be found in the Appendix on page 29.]

STATEMENT OF HON. DON BACON, A REPRESENTATIVE FROM NEBRASKA, SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES

Mr. BACON. Thank you, Mr. Chairman. I appreciate the spirit in which you lead the subcommittee, and I am grateful to you. I appreciate your leadership in holding this hearing so that we may gain a better understanding of the Army's current and future plans for its tactical wheeled vehicle programs.

As we await the delivery of the President's budget request, I am concerned about proposed fiscal year 2022 defense top line and what that could mean for both our Nation's defense, for soldiers. In recent years, the Army's tactical wheeled vehicle programs have been funded at or below minimum sustaining rates—just as the

chairman says—and have at times been used as bill payers for the Army's higher priorities. This appears to be the likely case for fiscal year 2022 budget request as well. With over 200,000 tactical wheeled vehicles, we cannot afford to fall behind in recapitalization.

I am particularly interested in gaining better understanding for today's hearing of what impacts these funding and prioritization choices are having on the Army's wheeled vehicle programs. From a strategic and operational risk management perspective, I expect the witnesses to address how tactical wheeled vehicle modernization procurement fits under the Army's priorities and what they see as the most significant challenges to modernizing and sustaining a ready tactical wheeled vehicle fleet.

I also want to know what strategic risks and additional future costs the Army may be imposing on the wheeled vehicle programs and the industrial base needed to produce and sustain them.

As we all know, cutting plans and funding for development and procurement programs creates vendor uncertainty and a lack of predictability over time. Doing so also increases unit costs and risks for loss of industrial capacity, capability, and resilience. So I expect our witnesses today to help address these concerns.

Finally, I also look forward to today's discussion on the future of electrification in combat and tactical vehicles and the Army's initial efforts to collaborate with the electrical vehicle industrial partners to explore potential options. I understand that there are some potential benefits the electrification may provide, but there are also significant integration obstacles to achieving and maintaining operational capability in the dangerous and austere environments in which these vehicles will be depended on.

So I expect our witnesses to provide a realistic assessment of the potential practicality, the operational value, costs, and technical development challenges of these tactical wheeled vehicle electrification. We just want to ensure that what is fielded improves combat capability and is technically ready.

So I want to thank our witnesses for testifying before us today and for all you do to support America's soldiers.

Mr. Chairman, I yield back.

Mr. NORCROSS. Thank you, Mr. Bacon.

We have your statement. It is a joint statement from the two of you. But Mr. Goddette, you are recognized for opening remarks. Good to have you here.

STATEMENT OF TIMOTHY G. GODDETTE, DEPUTY ASSISTANT SECRETARY OF THE ARMY FOR ACQUISITION POLICY AND LOGISTICS

Mr. GODDETTE. Good afternoon, Chairman Norcross. Chairman Norcross, Representative Bacon, distinguished members of the Tactical Air and Land Forces Committee, on behalf of our Acting Secretary, the Honorable John E. Whitley, and our Army Chief of Staff General James C. McConville, thank you for the opportunity to discuss Army's tactical wheeled vehicle fleet and electrification of Army vehicles. Along with my colleague, Mr. Mike Cadieux, I ask that our joint witness statement be entered into the record.

Today, I offer my perspective based on my recent experience as a program executive officer for combat support and combat service support over the last 3 years. Today's Army tactical wheeled vehicle fleet consists of portfolio of over 200,000 light, medium, and heavy trucks.

While our vehicles rely heavily on commercial industry investments and components, they differ from commercial vehicles in three important areas: severe off-road mobility, crew protection, and the ability to burn JP8 [jet propellant 8] or jet fuel in austere environments.

In our environment of constrained resources, the Army's priority is the Joint Light Tactical Vehicle or the JLTV. We plan to buy approximately 49,000 JLTVs over the next 20 years. At that time, we will have a mixed fleet of roughly the same number of High Mobility Multipurpose Wheeled Vehicles also known as Humvees.

The Army's next priority is to maintain a warm production base for the Family of Medium Tactical Vehicles, or FMTV, and heavy tactical vehicle fleet. The FMTV and the HTV fleet have met their respective acquisition objective and are currently between 65 and 70 percent modernized. FMTV will focus on meeting the low velocity air drop capability in our airborne community. And the heavy fleet will continue to recapitalize the oldest trucks that are approaching or exceeding their economic useful life through 2023.

With the heavy fleet having reached its design maturity, the Army's exploring the concept of replacing the Heavy Expanded Mobility Tactical Truck, the Palletized Load System, and the M915 and M1088 tractors with the Common Tactical Truck or CTT. The CTT would be a commercial-based truck with a modular platform that leverages the best commercial practices, new mature technologies, and the potential to shift the cost curve, saving 15 to 30 percent.

In regards to electric vehicles, there are a number of advantages that include fewer moving parts, fuel efficiency, reduced emissions, and lower heat signatures that come with these technologies.

There are significant number of light commercial trucks in the pickup class that will be entering the market in fiscal year 2022 and 2023 timeframe. We see the light reconnaissance mission in our scout units as a possible early opportunity to field the electric vehicle, or EV, by leveraging that development and mature commercial industry.

An area of particular challenge to fielding a full electric vehicle on the battlefield is the weight of the batteries and the lack of mobile recharging capability. As a result, the initial electric vehicle solution is likely to be a hybrid drive with combustion engines and batteries due to the range and payload requirements.

The Army will continue to pursue incremental solutions such as anti-idle technology, powertrain modernization, and the ability to provide off-board power to reduce the need for separate tactical power generation.

In closing, Mr. Chairman, and members of the subcommittee, I sincerely appreciate your time today to discuss the Army's tactical wheeled vehicle fleet and opportunities for electrification. I look forward to your questions.

[The joint prepared statement of Mr. Goddette and Mr. Cadieux can be found in the Appendix on page 31.]

Mr. NORCROSS. Thank you. Mr. Cadieux, you are now recognized for any opening remarks.

STATEMENT OF MICHAEL CADIEUX, DIRECTOR, U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND GROUND VEHICLE SYSTEMS CENTER

Mr. CADIEUX. Chairman Norcross, Ranking Member Bacon, distinguished members of the House Armed Services Subcommittee on Tactical Air and Land Forces, thank you for your continued support and enduring commitment to our soldiers, our civilians, and their families. I appreciate the opportunity to testify today alongside my former Army program executive office counterpart, Mr. Timothy Goddette, and to discuss vehicle electrification.

I would like first like to take a moment to recognize the nearly 1,800 team members that make up the Ground Vehicle System Center family. Like all Americans, they were personally and professionally impacted during the pandemic. However, their ability to meet the challenge continues to be an inspiration as they keep our work on track to support America's soldiers.

The United States Army Combat Capabilities Development Command, Ground Vehicle Systems Center, GVSC, located at the Detroit Arsenal, Michigan, is proud to serve as part of the larger Army Futures Command [AFC] team. AFC leads a continuous transformation of Army modernization in order to provide future warfighters with the concepts, capabilities, and organizational structures they need to dominate a future battlefield. At GVSC, we develop, integrate, demonstrate, and sustain the capabilities of the Army's ground vehicle systems in support of Army modernization priorities and improved Army readiness.

Put simply, the GVSC team explores the art of the impossible across relevant technologies, evaluates and invests in order to mature technologies that meet Army program needs, and collaborates with Army acquisition partners using soldier touchpoints, when applicable, to transition technology into programs of record.

The Army's and GVSC's electrification efforts are shaped and informed by over 30 years of progressive research. Electrification to the Army represents a means to achieving many different capabilities that enhance soldier's effectiveness in multi-domain operations. Specifically, it means the use of electric power to augment vehicle performance.

Electrification-related technologies will mature and apply differently across the spectrum of light, medium, and heavy tactical wheeled vehicles as well as the Army's combat vehicle fleet based on each platform's unique needs and design considerations. Across the spectrum, electrification has the potential to provide the ability to operate at longer distances without refueling, extended silent [inaudible], and silent mobility through reduced acoustics and thermal signatures, and improved dash speeds. Additional onboard electrical power and energy storage required for advanced sensors, integrated tactical networks, and other future mission payloads, and exportable power generation and distribution.

We recognize, especially from our location in the Detroit area, the significant commercial automotive focus and investments in electrification. We work closely with commercial partners to foster collaboration and leverage industry's investments in electrification technology development.

While there are certainly some similarities in commercial and military requirements, we are mindful that the Army faces unique operational challenges compared to those in the commercial market. These challenges include the need to operate in extreme combat environments, widely ranging temperatures, and requirements for heavy armor and add-on mission packages.

In assessing the operational usability by the military of commercially available solutions in various hybrid, hybrid plug-in, and all electric vehicles, we recognize two significant challenges: the need for a mobile and deployable recharging infrastructure, and greater battery energy density and endurance.

To complement commercial automotive research and investment in technology for tactical wheeled vehicles, GVSC's funding for electrification focuses on developing capabilities for combat systems with specific military-unique requirements. For combat vehicles, our work is conducted under a platform electrification and mobility project, although the architecture and some of the component technologies are also applicable to tactical wheeled vehicles.

GVSC's current efforts, specific to wheeled vehicles, focus on vehicle electrification kits which have demonstrated up to 25 percent fuel savings through reduction in engine idle time for some platforms. We are continuing to pursue fuel demand reduction options like this with the Army program offices.

On behalf of our Army and especially the Ground Vehicle Systems Center team, I would like to thank the subcommittee for your continued support. Electrification offers the Army multiple operational benefits, and GVSC continues to conduct relevant transformative research that will help bring hybrid and all-electric vehicle capabilities to the warfighter.

We look forward to working with Congress to deliver the critical research, technology, and engineering that enables the Army's multi-domain transformation. I look forward to your questions.

Mr. NORCROSS. Thank you for your testimony. I just want to set the stage here; we have our existing structure, and then in many ways the future, particularly with the electrical. You talked about, Mr. Goddette, the three major capabilities. And certainly one of those is JP8 that we talked about. Unlike many of our other programs where industry follows what we develop, we work so closely with the existing industry, and the vehicle in particular. So the health of that industry is critical to what we do.

You talked about two new partners, GM [General Motors] and Mack [Defense], but you also talked about a warm production line. Minimum sustaining rate. Why don't you explain to us what a warm production line means to the industry? And is that across the board? Because the long-term health of those waiting or keeping a warm production line going is critical for our industrial base moving forward.

So if you could explain what do you mean what you say warm production line?

Mr. GODDETTE. So, Chairman Norcross, I will start by addressing what I mean by a warm industrial base. It is—the fact that we do have a very strong industrial base at the component level, the engines, the transmissions, the axles. Regardless of whether we have military vehicles, those particular components are going to be producing. And that is really the heart of what we do.

The importance of a warm industrial base is that if we have to surge, we have the ability to work with our vendors and react. And if we have an open contract, that makes that much easier.

The second-order effect of warm production base is that because the production is requiring the subtier suppliers to provide parts for manufacturing, it is also providing that part base for our sustainment, those systems that have already been fielded and may need replacement parts.

So the importance of a warm industrial base is really twofold. It lets us adjust in terms of production quantity, but it also allows us to sustain our systems over time.

Mr. NORCROSS. Let me follow up. So the minimum sustaining rate, typically, for building a helicopter, that is one set. Are you suggesting that the warm industrial base is kept warm with the private sector, or that we are demanding a minimum sustaining rate so they keep that line open and——

Mr. GODDETTE. Sir, sometimes it means both. Sometimes it means that the particular manufacturer that we have also produces commercial products. And so from a workforce perspective, they can—they can ebb and flow back and forth between military and commercial. For those manufacturers that are maybe more in the military side, then the risk is a little bit higher.

But I would also point out that over the last 20 or 30 years, maybe even going back further, we have manufacturers in the 1990s, Freightliner, BAE, Stewart & Stevenson, to name a few, that aren't in our business today.

So depending upon the requirement, depending upon the system that we are buying, I think sometimes our manufacturers may change, but almost always our engine, axle, brakes, et cetera, our component manufacturers take advantage of that strong U.S. industrial base.

Mr. NORCROSS. Great. Now, I will follow up with that on the second round, but I want to get to our members.

Mr. Bacon, you are recognized.

Mr. BACON. Thank you, Chairman Norcross, and thank you both to our panelists. I have enjoyed talking to you before. I appreciate your expertise here and your leadership.

I understand that JLTV may offer utility in the special operations realm. [Inaudible] the services have relied on the U.S. Army to select these kind of wheeled vehicle solutions, such as the Humvee, but those vehicles are aging. Has there been any interest in the special operations community in the JLTV?

Mr. GODDETTE. So, Representative Bacon, I can answer that, in fact, many of the systems that we have already fielded have gone to SOCOM [United States Special Operations Command] and the Special Forces. Of the roughly 4,000 that we fielded today, plus the other 3,000 we plan to field by the end of the year.

So the answer is, yes, it is truly not only a joint program in name, but we share that particular system with our other service partners and joint partners as well.

Mr. BACON. So have the Marines also procured?

Mr. GODDETTE. Yes, they have. In fact it is—we have the Marine Corps as part of the program office. And the program began by the Marine Corps actually being in charge of writing the requirement, and the Army being in charge of running the program. But we actually have Marine civilians and officers as part of our program office.

Mr. BACON. It sounds like a win-win there. That is great. I understand that the energy efficiencies and the electrification programs are a priority. I just want to verify that we are moving at a pace that is commensurate with the testing success. Do you feel like you are being pressured at all to field any of these systems before the testing or the validation warrants?

Mr. GODDETTE. Congressman, I don't feel any pressure at all. Basically, I think this technology has great potential, great promise. But I know one of the things that we ensure is that as we take advantage of technology, we are very conscious of the operational capability that we field. And one of the things that we pride ourself not to do is to reduce the capability that we already have.

There are some challenges. And as you have heard, the tactical wheeled vehicle fleet depends very heavily on where the commercial marketplace goes, both in terms of investment in technology as well as the components that make up our system.

So I think our strategy in most cases is follow fast, if you will, and take advantage and leverage everything that the commercial industrial base is doing.

Mr. BACON. Now, you both made a compelling case, I believe, in the hybrid MFS [Modular Fuel System], where the technology has us at right now for fielding and maintaining our capability. One last series of questions. You know, some of the defense industry are worried or they are relaying to me anyway that the JLTV build-to-print recompete favors the incumbent given the scheduled access to needed information of part components regarding the JLTV technical data package.

So how is the Army working with industry to ensure there is a fair and open competition? I just want to provide some confidence on both sides of this compete.

Mr. GODDETTE. Yes, that is a great question. What we did before we started to develop our acquisition strategy is we worked very closely with industry. We asked them what are those areas that you are concerned about? To date, we have had multiple industry days and engagements with all of the manufacturers, our potential manufacturers. We go back and forth, and we share the request for proposal and all of the requirements that we have.

In one case, we were going to run about an 18-month competitive effort, and industry came back to us and said that they felt that wasn't enough time. So we engaged to develop a strategy that met as many of the vendors as possible. I think where——

Mr. BACON. I——

Mr. GODDETTE [continuing]. Yes, sir.

Mr. BACON. Go ahead. I am sorry. So I will just close with this question. So do you think the current schedule is feasible for true competition?

Mr. GODDETTE. Yes, we do. We very much believe that we have taken all the feedback from the potential field and all of the vendors that have shown interest. And we have laid out a schedule that they can meet. And we believe that the—that the TDP itself, the technical data package that you referred to—typically, a barrier to entry of competition is that the incumbent does have an advantage.

But the Army has done a great job over the last 6 or 7 years ensuring that our biggest programs, the JLTV and the FMTV, which represent 80 percent of our fleet, 160,000 vehicles, we have bought the TDP so that the potential offerers have as much of a level playing field as we could possibly give them.

Mr. BACON. Thank you very much. I yield back, Mr. Chair.

Mr. NORCROSS. Thank you. So we have Carbajal, Wittman, Horsford, and Turner.

Mr. Carbajal, you are recognized for 5 minutes.

Mr. CARBAJAL. Thank you, Mr. Chair.

Mr. Goddette, we are all eagerly awaiting the President's budget release tomorrow, and hopefully it means good news on many fronts. Given the likelihood of flat or nearly flat defense budgets, how important is tactical wheeled vehicle modernization and resources to the Army?

Mr. GODDETTE. Representative Carbajal, thank you so much. We all live in constrained resources. We recognize that. I think what I would point out is when I look at the tactical wheeled vehicle fleet and the 200,000 vehicles that we have, we look at the medium and the heavy fleet, and that particular fleet, there are no holes in our motor pools, in our units.

Our units have the trucks. And 65 to 70 percent of them are modernized. When we look at the light tactical fleet, that is not quite the case. While we have the vehicles in the motor pool, as we experienced in Iraq, in Afghanistan, we didn't necessarily have the protection we needed in the smaller vehicles. And so that is where we are putting our priority.

And the reason why we have taken the time to prioritize the light fleet is because we understand there may not be resources. So when the Army looks at where the gaps are, and they put a priority on the "31 plus 4," that is because we recognize we need to fill that gap.

I think trucks are in a situation where we can accept and slow down a little bit to make sure that the Army can fight as a complete, a complete team.

Mr. CARBAJAL. Thank you. Mr. Cadieux, the electrical energy demands on tactical and combat vehicles have increased steadily and will continue to grow in the coming years. Both legacy and next-generation ground vehicles must provide sufficient electrical power to effectively operate a variety of equipment and payloads, including electronic warfare, active protection systems, radios, and directed energy weapons, just to name a few.

I understand that currently onboard vehicle power can be supplemented using auxiliary power units, but that existing APUs are so

large and so heavy that they can be difficult to integrate with many vehicles which must say below certain size—must stay below certain size and weight threshold. How is the Army working to address these power generation needs with solutions that present an acceptable size and weight footprint?

Mr. CADIEUX. Congressman Carbajal, absolutely, we do see those integration challenges for those auxiliary power units. And as we look towards electrification, that is really where we see the operational benefits of creating that onboard power to power those advanced warfighting functions.

Counter UAS systems, directed energy weapons, those items that are using lasers, microwave systems, that is really where we are seeing—the push towards electrification is to achieve those operational benefits. And to that end, we are closely working with partners across our Army Futures Command Team as well as the program executive office and Mr. Goddette and his team to identify what components of electrification can we take advantage of today and closely follow commercial industry.

And when the technology, especially in the hybrid, the plug-in hybrid space is available, and it is affordable and it is mature, and we can integrate it onto our system, be in a position to do so.

We certainly see there is some capability that is available today to reduce fuel consumption as well as to increase some available power. And as the investments in industry continue to occur over this decade and next, ensuring that those systems—we monitor them, we communicate with industry on what our gaps are, how those gaps align to their investment, and then we make sure that they are ruggedized and they can support our systems. That is our strategy to achieve the challenge that you described.

Mr. CARBAJAL. Thank you.

Mr. Goddette, commercial companies with large fleets of trucks of all sizes routinely buy customizable solutions from vehicle manufacturers rather than custom-made vehicles. Why doesn't the Army procure commercialized—commercial truck variants as opposed to custom-built vehicles like the JLTV or FMTV? What would be the cost difference from the current plan to procure custom-made vehicles rather than purchasing customizable vehicles?

Mr. GODDETTE. Yeah, so I think, Congressman Carbajal, it comes down to looking at the requirement. And in some cases when I talked about our military vehicles have a different requirement for mobility, payload, and protection, on a JLTV, there are no light items available in the commercial marketplace, which is why we buy the technical data package to compete, so that we can continue to give those capabilities to the soldier.

As you move into the heavy tactical vehicle fleet, those more align with the commercial-like programs. A Line Haul tractor that you might see going up and down the road with UPS [United Parcel Service]. And so then that is where the situation where the Army can add an armored cab to it, or we can do something with the tires that make it a little bit more off-road mobile. And that is where we would want to target an opportunity to use commercial, is when the requirements look more like the commercial industry.

Mr. CARBAJAL. Thank you. I am out of time, Mr. Chair, I yield back.

Mr. NORCROSS. Terrific, thank you. Mr. Wittman, you are recognized.

Mr. WITTMAN. Well, thank you, Mr. Chairman. I would like to thank our witnesses for joining us today. Mr. Cadieux, I would like to start with you. Listen, I appreciate the great work that is going on at the Ground Vehicle System Center. You know, we normally see military technology driving technology on the civilian side. This is actually one of those times where it is the opposite. We see technology that has been developed on the civilian side with electrical vehicles now being looked at on the military side.

I wanted to ask this, if you look at electric vehicles, it does appear that they have a potential role in a first-strike capability. But we all know that our adversaries are going to look at what happens in sustainment, and we know that there are vulnerabilities, tactically, for those vehicles in sustaining them; that is, recharging them with the power necessary in order to be able to do that.

Let me ask you, do you see that the vehicles have more than just a limitation of use for sort of a in-the-rear-with-the-gear sort of capability? And are there considerations that are given to what kind of percentage of combination in the fleet that we would have with internal combustion engines versus electric vehicles versus hybrid vehicles?

Mr. CADIEUX. We certainly see a role, actually, across the entire spectrum for electrification, both in tactical wheeled vehicles as well as combat systems. And as we look at what commercial industry is doing today and where they are headed, and then as we look and close those gaps and integrate them onto our systems, we see the opportunities to increase.

So right now and today, and actually it is an effort that Mr. Goddette is actively working today, is an electronic light or electric light reconnaissance vehicle. That is a specialty niche kind of activity that we see capability, perhaps today.

And then as the maturity of those systems occur over time, especially as we close gaps on the combat systems, and that will take a while, we see opportunity to leverage that again across that entire spectrum and not necessarily behind, if you will, but really right into the deep fight.

To your point, there are several challenges that we need to overcome.

Mr. WITTMAN. Sure.

Mr. CADIEUX. How we do mobile recharging and an infrastructure to support that as one example.

Mr. WITTMAN. Very good. Well, listen, I appreciate your thoughtfulness in that. And I want to follow up, Mr. Cadieux, with that. You know, I do see a world where these electric vehicles can complement our fleet. But I am not sure we that we are at a point where the internal combustion engine doesn't serve an outsize combat role. And as you point out, some of the limitations, namely, the size and weight of batteries, the inherently unstable nature of lithium ion batteries.

We all know the ability to be able to control the heating of those, especially if they are quickly discharged, which we know in combat

situation many times may be the situation. And also, as we both pointed out, charging in the field does become an issue.

So, realistically, how far out do you think we are from having an electric vehicle in the field that has overcome all of these technical hurdles? I understand that it can be a complement, and I think there are specific roles for electric vehicles, but how far off in the future do you think a scaled implementation of these vehicles might occur?

Mr. CADIEUX. From a technology perspective, especially when we think about hybrid or hybrid plug-in, we suspect the commercial industry technology will begin to mature over the next—within this decade. And then we can start to leverage and truly integrate it onto some of our platforms.

In terms of an all-electric platform, you know, the ability to overcome and close all of the gaps that were discussed a moment ago, we more than likely would see the technology being mature within the—in the next decade, not necessarily in this one.

Mr. WITTMAN. Gotcha. Give me a little more of your perspective on hybrid technology. That to me seems to have the greatest potential to provide greatest capability in the field and does give you the ability to overcome some of the tactical hurdles, but also give you some flexibility that, I think, can be to our tactical advantage also. So kind of give me your perspective on how you see the development of hybrid technology in the development of combat vehicles?

Mr. CADIEUX. First, as we look at electrification components, we see some technology that is available very soon, such as anti-idle technology on our systems.

Tim Goddette and ourselves have been partnered to look at the Joint Light Tactical Vehicle and anti-idle technology. So that way—and it is similar to my vehicle, when I am at a stoplight, my engine shuts off. When I am ready to go and that light turns green, it turns back on. The application of that, but it is in a much greater impact because we idle a lot with our vehicles. And we start to see some significant fuel savings, 25 percent in some cases, when we do that and apply some of those technologies. Those are very near in terms of maturity today.

When we start to think of hybrid where we have maybe a larger battery pack in a smaller internal combustion engine, we certainly see some capability there as well. An area that we just noted as we took delivery of robotic combat vehicle lights, prototype systems. In those instances, we see a hybrid package there where you have a larger battery pack coupled with a smaller internal combustion engine.

Mr. WITTMAN. Very good. Thank you, Mr. Cadieux.

Mr. Chairman, I yield back.

Mr. NORCROSS. Thank you. And we are also talking about things and issues of how does EMP [electromagnetic pulse] affect electrical vehicles. That is very important.

Mr. Horsford, welcome to the subcommittee. It is good to have you here. You are recognized for 5 minutes.

Mr. HORSFORD. Well, thank you very much, Mr. Chairman.

First, I want to thank you very much for the warm welcome. I am excited to be joining as the newest member on HASC [House

Armed Services Committee] and very delighted to be a part of this Subcommittee on Tactical Air and Land Forces.

Just by way of introduction, I have Nellis and Creech Air Force Bases in my district as well as the Nevada Test and Training Range, and the Hawthorne Army Depot all located in my district. So this is a very important committee, subcommittee, for the work of our military constituency and everything that they do each and every day.

I also want to thank our witnesses today. And, obviously, right now I am listening and learning more than anything. And I really appreciate your expertise and insight on the Army's tactical wheeled vehicle program.

I will just ask if I could, Mr. Goddette and Mr. Cadieux, the Nevada Army Guard recently took steps to revamp the training program for its drivers so that vehicle operators can be more prepared for future combat missions. This is taking place simultaneously with the State's effort to optimize the maintenance plan for the Nevada's approximately 1,500 ground vehicles and reduce maintenance expenditures.

As you may know, Nevada Guard vehicles have not been transported or driven in a combat area in more than a decade. So I am aware the Army resumed product verification testing for the last variant of its Family of Medium Tactical Vehicles. But can you bring me up to speed and provide a status update on where the Army is with the testing of FMTVs, please?

Mr. GODDETTE. Congressman Horsford, I would be glad to talk about that. As you know, we use the term family of tactical wheeled vehicle—I am sorry, the FMTV. In 2018, we awarded a new competitive contract which resulted in a much more capable system. So our systems are getting better over time.

As we brought that vehicle to test, we started the reliability testing. And we got about one-third of the way into the test, and we were seeing results that led us to believe that we weren't on the proper reliability growth curve to get to where we needed to be.

So I decided to stop that test. We went back and talked to our vendor, and the vendor made all the necessary fixes, brought it back to their own facility to test. And then recently here in the January, February, timeframe that they return the vehicles to the Army so that we could do our own independent testing. That is going extremely well. They have made a huge difference compared to where they were about a year ago, and we are very confident that they are on the right path.

Mr. HORSFORD. Thank you. And also the Army, apparently, plans to keep its tactical wheeled vehicles in the fleet for 30 or more years and it buys these vehicles over an extended period, which leads to concerns about obsolescence in the fleet and difficulties in manufacturing as suppliers struggle to provide vehicles and parts that are out of sync with the commercial market.

So what strategies will the Army pursue to help solve this problem? And why are manufacturers in some cases not interested in producing military vehicles? And what can be done to address the issue of sole source over competitive bid process?

Thank you.

Mr. GODDETTE. Congressman Horsford, three very good questions. In terms of the 30 years, what we do is we work with our producers, our manufacturers when we have issues with a certain supplier that we think may not be able to produce anymore. We also buy—when we think we are going to buy for the life cycle, and we stock those critical parts. And then we are also getting into advanced manufacturing and using our organic industrial base to be able to do that.

In terms of the sole source question, we, as I mentioned before, we buy the technical data package so that we can improve competition, and we think we have made great progress in doing that. And the biggest barrier to the manufacturer is usually volume. When most of the auto manufacturers, you think about, they make hundreds of thousands of vehicles a year. And on average, we buy maybe 3,000, maybe 4,000 vehicles a year. So I would say that is probably the biggest barrier to getting the more traditional manufacturers.

Mr. HORSFORD. Thank you, Mr. Chairman, I yield back.

Mr. NORCROSS. Thank you. I understand Mr. Turner is no longer here.

So, Mr. Green, you are recognized for 5 minutes. I just saw him. There you are. You are still muted.

Dr. GREEN. Can you hear me okay?

Mr. NORCROSS. You are good.

Dr. GREEN. Thank you, Mr. Chairman. And I want to thank our witnesses for being here. I really appreciate both the chairman and the ranking member for their leadership on this issue. And I certainly appreciate our witnesses and their lives of service to the country.

And I, of course, am very appreciative of cutting-edge technology. I get enamored with it, just the next gadget that comes out. Clearly, the private sector is making some big transitions to electric. And I am excited about that too. Like everybody else, I think CO2 is an issue, and we've got to decrease both its production and find a way to get rid of it.

But just because something is new and exciting doesn't necessarily mean it is the right choice for our warfighters, because in the end it is about them having the very best thing to fight with, piece of equipment. And having, you know, of course, deployed, myself, to combat, you know, I came in the Army it was the—and I don't even know if our witnesses will remember the Gama Goat or clearly the M113 which is still, you know, an armored vehicle but in the inventory. But the Gama Goat and the CJ7 were actually in the inventory when I came in the Army back in 1982. So I have been around and seen a lot of transition myself.

My big concern with the electric vehicles is like a lot has already been discussed, but something as a physician that hasn't been raised is toxicity. And I would like to hear from you guys as you all contemplate batteries, what are we doing to address the toxicity to soldiers if, you know, some of the equipment that are in these batteries is, you know, aerosolized in an explosion, in a fire, or whatever, are we preparing for that as we prepare to deploy these things?

Mr. CADIEUX. Congressman Green, from a technical perspective, a couple of thoughts. First, we have been doing, we have extensive partnerships with the Department of Energy and their national labs as they work and really look at battery research and battery storage that includes safety and how do we do it smartly to your point of toxicity and ensure that it is a safe system.

Additionally, we have efforts underway ourselves over the last 5 years where we have been looking to say how do we ensure that we have safety testing standards for these systems, especially when we start to put these capabilities and they are transported on Navy ships or aircraft.

To ensure that they are safe, because to your point, if they catch on fire, it is very hard, right, how do we ensure that we extinguish it and how can you? And so we put a lot of effort towards how do we ensure we have standardized testing so as these batteries come online, we can each time test them to ensure that they are safe. Those are the areas that we have been spending most of our efforts.

Dr. GREEN. I appreciate you guys saying that, but on the medical side of the military, you know, we oftentimes have physicians that are—you know, an OB [obstetrician] doc winds up in a flight surgeon's position, and he is downrange. And does that individual understand, you know, the—I mean, I am an ER [emergency room] physician, so I got extensive training in toxicology. We just have to make sure that we are prepared for that.

One of the other questions I have, and I am shifting gears a little bit, because I am probably only going to get a chance for one more question, is a lot of rare earth metals find themselves in these electronic systems. And the vast majority of the rare earth metals, we are getting them from China. So what is our plan? If we are going to rely on these batteries, what is our plan for rare earth metals and the other things that go into the batteries and the systems that support them?

Mr. CADIEUX. You are absolutely correct. And one of the concerns that—or the factors that we have been looking at is especially in the case of rare earth magnets. That is something that is present in a lot of the electric motors. And so that is certainly a concern.

The other concern that we also have is looking at lithium ion battery production, domestically, and is that going to be available when necessary, especially when industrial scales and when we can take advantage of it in the future as well, ensuring that we have that capability here.

Dr. GREEN. So you guys are taking that into consideration as you look to develop these systems?

Mr. CADIEUX. Yes.

Dr. GREEN. Okay. Well, that is real important. It would be great next time we talk to maybe get a little more detail on what the plan is.

Mr. Chairman, I think I am out of time. I yield.

Mr. NORCROSS. Mr. Brown, you are recognized for 5 minutes.

Mr. BROWN. Thank you, Mr. Chairman. You have gone from Mr. Green to Mr. Brown, I appreciate it. I am going to pick up where he left off, and first of all, thank him for really honing in on safety

aspects of, you know, kind of pivoting, converting, transitioning to electric power vehicles. I think it is really important.

And, Mr. Cadieux, on the battery-related research, and you just recently mentioned what kind of a partnership with the DOE [Department of Energy], can you just flesh out in as much detail as you can, what is the trend line for the Army budget when it comes to research, development on battery capacity safety? What are the relationships with our research universities and with private industry? If you can kind of be, you know, as specific as possible. I just want to get a feel for, you know, how comprehensive the effort is of the Army to develop the kinds of batteries that are safe, they have the capacity, they can withstand the rigor of the battlefield? Can you talk in detail about that R&D [research and development] program?

Mr. CADIEUX. Absolutely. And thank you, Congressman Brown, for that question.

Two activities, significant activities, that I would like to point to first. The first one is the Advanced Vehicle Power Technology Alliance. What that is that is a co-led activity between our center and the Department of Energy that allows us to co-invest and partner with industry and academic institutes. And I can share a lot more details with you on that.

The other one I would like to point out too as well, though, is our Automotive Research Center. The Automotive Research Center is really our flagship activity where we partner with the University of Michigan and eight other premier institutes, three DOE national labs as well as over 20 automotive industry partners. And they are all about doing the basic research with significant lines of effort into battery and battery technology and doing the modeling and simulation and analysis to ensure that, frankly, we get it right, we get it safe, and it is reliable over time. Those are two primary efforts that we are leveraging that hit universities, industry, as well as government partners.

Mr. BROWN. And how would you characterize the trim line of the Army's budget that goes into battery-related research and development?

Mr. CADIEUX. For the Ground Vehicle System Center, from which I can speak to, over the last 5 years, we have spent $75 million, roughly, in battery or electrification-related technology across five lines of effort.

Mr. BROWN. Yeah, what is the trim line, though? $75 million? Is it up, down, or flat?

Mr. CADIEUX. I would have to take that question for the record to really understand that, sir.

[The information referred to can be found in the Appendix on page 43.]

Mr. BROWN. Okay. I appreciate that.

Mr. Goddette, a question for you. And I thank our committee staff for teeing this question up for me. The tactical wheeled vehicle, my understanding is that there is an acquisition strategy that was produced in 2014, and that the Army is currently working on an updated comprehensive strategy. Is that accurate?

Mr. GODDETTE. Congressman Brown, that is accurate. We had an original one in 2010 followed by the 2014. Right now, the Army is

looking at a tactical wheeled vehicle plan based on multi-domain operations. So another element of the Army is studying the effects of how we are going to fight in the future against the systems that we have today versus the mix and quantity that we might need in the future. And that has been going on for about a year. And I believe the emerging results are being briefed out here shortly.

Mr. BROWN. Okay. As you mentioned, 2010, 2014, I think you mentioned 2000. What is the status of the strategy, and when are you going to release it?

Mr. GODDETTE. Yeah, sir, I believe the emerging results of the plan are being briefed out internally to the Army now. And once the Army plan has been briefed out, then we will start to develop the strategy. So I wouldn't expect the strategy this year in fiscal year 2021, but sometime next year, probably.

Mr. BROWN. Yeah. A great former Secretary of Defense once said, without a strategy then, you know, you may be throwing good money at the bad money. So let's come up with a strategy and make sure that Congress can get a good look at it.

Thank you, Mr. Chairman, I yield back.

Mr. NORCROSS. Thank you, Mr. Brown. Mr. Kahele, you are recognized for 5 minutes.

Mr. KAHELE. All right. Mahalo, Mr. Chair. And aloha, everyone, from Hawaii. Thank you so much for having this hearing today. I have two questions. One is for Mr. Cadieux. Based on the testimony, how are battery-related science and technology research efforts being factored into the Army's approach to electrification? And what Army and industry initiatives, if any, are showing considerable potential or promise?

Mr. CADIEUX. As we look at our tactical wheeled vehicle fleet and the electrification technologies, by and large, we look to leverage the investment that commercial industry is making. Recognizing that battery and battery energy density is critical in order to effectively integrate and provide operational value for our systems.

So to that end, we have done significant partnerships in creating electrification forums where we are bringing dozens of industry partners together across the country so they can share with us where they are at. And then we are able to express, here is the conditions by which our systems operate in, and we can have that dialogue. So we have awareness of where we believe industry will be meeting our needs and where those gaps then remain.

In the case of a gap then, what we will look at is we will partner whether it be with additional industry partners, universities, or non-traditional entities as well.

One particular area that is interesting and exciting to us is a cooperative research and development agreement with the University of Maryland that is looking at solid-state battery technology, and that is something that has us interested as we move forward.

Mr. KAHELE. Yeah, I saw a news report this morning. One of America's largest vehicle manufacturers is expecting a 40 percent increase over the next 10 years in electric vehicles and electric trucks. And so I think this is a step in the right direction. And partnering with those industry leaders and the sharing of critical information as the technology is developed, I think is very important. So thank you for that.

The second question for Mr. Goddette. The Army apparently plans to keep its tactical wheeled fleet vehicles, excuse me, in the fleet for 30 or more years and buys these over, as you as well know, an extended period. This can lead to an obsolete fleet and difficulties in manufacturing parts and the supply chain as they struggle to provide vehicles and parts that are out of sync with the commercial market.

Can you maybe talk a little bit about what the Army's future plans will be for the maintenance of the fleet over this extended period of time and especially as it relates to replacement parts and maintenance and how we are planning the O&M [operations and maintenance] component of the tactical wheeled fleet?

Mr. GODDETTE. I would be glad to, Congressman. We do keep our vehicles for a very long time, 30 years. But because of the quantity, the over 200,000 tactical wheeled vehicles that we have, we tend to be in production for a very long time too.

So the first area that helps us in the sustainment is if we are in production, then our manufacturers maintain relationships with the second-, third-, and fourth-year suppliers. And when somebody decides not to make a part, they find an alternative source.

When we go out of production, oftentimes we will do what is called a lifetime buy where we recognize there is a critical component, and then we buy enough of those to take us through what we think will be the rest of the life of that system.

And I think the third one that is newer, but one that we are putting energy into, is advanced manufacturing in our own organic industrial base, where they have the ability that if we have the technical data, we can actually use that technology and produce the part with our organic capability. So a combination of those three is how we address that issue.

Mr. KAHELE. Okay. Thanks, Mr. Goddette.

Mahalo to the chair for the opportunity, and I will yield back the rest of my time.

Mr. NORCROSS. Thank you.

Mr. Veasey, are you with us? You are recognized.

Marc? All right.

Is there anyone else that we haven't recognized from the first round? If Marc comes back, we are going to yield to him.

So for those of you who want to question for a second round, I am going to start by following up with that next generation. I mentioned EMP. Those pulses that we are looking throughout our services and our programs, for vulnerabilities. Gee, electric vehicles seem to be a place.

Have you looked into those potential issues that might come up? EMP, you think of the nuclear blasts, but there are other ways to disrupt the electrical. How have you calculated those issues into your research so far?

Mr. CADIEUX. As we are working with industry and we are looking at where we have gaps, we are looking at it from a whole perspective of where are the vulnerabilities. Chairman, to your point, EMP. Another that comes to mind is cyber and how do we protect against cybersecurity threats as well.

So as we work with these vendors and we work and we try to understand, we put them—we have robust testing, and we look and

we start to say, what are the requirements that are necessary. And we have to do that upfront. And then if we see those gaps, that is where we have deliberate activities to try to close those gaps.

And in some cases, we see that there is certainly an overlap with industry and where industry needs to go. Certainly, from a cybersecurity perspective, they care about that as well. And then for those that remain, we ensure that we are partnering and leveraging the mechanisms that we have to engage with universities and research institutes to close the remainder of the gaps that we have.

Mr. NORCROSS. So electric vehicles, no pun intended, is a hot item out there in the commercial world, and so we get many questions. Are we going to look at our fleet, and you discussed much of that today. But just because it is available doesn't make it right [inaudible] to that.

You talked about being quiet, the power, the heat signature, that burst power, but also when you start building those requirements. And the way they are right now I would say that there is quite a gap in those requirements. You talked about over the next decade that changing. What is the primary area of concern in those requirements? Is it the battery weight, size, availability, what everybody wants as it wants? You know, can you address those major concerns?

Mr. GODDETTE. Yeah.

Mr. CADIEUX. Chairman——

Mr. GODDETTE. Go ahead, Mike.

Mr. CADIEUX. Tim, go ahead.

The first concern that we see is battery energy density, ensuring that the batteries have enough energy and then can fit and integrate onto our systems, and that problem becomes amplified as the weight of our vehicles. On the lighter end, it is easier and that problem gets worse over time.

The other is the environmentals. We have to operate in extremely high temperatures in the desert down to the Arctic, and then we have to have components and we wrap them in—that have to operate in that environment, and then as we wrap them into armor and integrate them into very tight systems, how do we keep them cool, how do we ensure that those electronics also work in very high temperatures. Those are the two that jump right to mind in terms of the challenges that we have.

Mr. NORCROSS. Thank you. We will go to Don Bacon and then, Marc, I will flip it over to you, all right.

Mr. BACON. Thank you there, Mr. Chair. Two follow-ups. I heard yesterday, researchers on electrification, if you go with a full battery for these vehicles, can you tell us the amount of added weight you will be putting on these devices? If you could give us a little background on that, I think it is useful to have that on the record. Thank you.

Mr. GODDETTE. Yeah, Congressman Bacon, I would be glad to. The example, I guess, I would use, as Mike mentioned, it is easier on the light vehicles, so I will start with the Joint Light Tactical Vehicle. That has right now a capability of 350 miles of range so that our soldiers, sailors, and Marines can do their mission, and it has got about 5,000 pounds of payload.

If we were to take that range and the energy needed, we would need about 10,000 pounds of batteries, and we only have 5,000 pounds of payload. So if I took half of that and put all the payload with batteries, I would cut my range in half to 175 but I would have no payload left. And so that weight that you mentioned is significant. The other little fact is that 1 gallon of fuel weighs about 8 pounds. That would equate to about 140 pounds of batteries.

Mr. BACON. I appreciate that, because that is a compelling background, and I think that is why you are going to the hybrid. That makes sense, because we have the technology now where you can maximize the capabilities of electrification now and yet still maintain your combat capability.

My second question is, you know, I served four tours in the Middle East myself and had to look through the explosively formed penetrator at all these IEDs [improvised explosive devices] that the Iranians pumped over into Iraq, as well as Afghanistan. Your new vehicle as well, has it been looked at from that perspective, a hardening for these kind of munitions?

Because we had to do that with the Humvee with our follow-on there, with the—I just got a brain freeze but the vehicle we had to put in to help secure our troops better.

Mr. GODDETTE. Congressman Bacon, you are talking about the MRAP [Mine-Resistant Ambush Protected] was the vehicle that we had to respond to——

Mr. BACON. Yeah, the MRAP.

Mr. GODDETTE. And, quite frankly, that is why JLTV is our top priority in the Army——

Mr. BACON. Right.

Mr. GODDETTE [continuing]. Is because we recognized that particular capability was needed. The MRAP did exactly that, it provided the protection, but we lost the mobility and we lost the payload. So the JLTV was an attempt to rebalance those three military requirements——

Mr. BACON. Fantastic.

Mr. GODDETTE [continuing]. And so we believe that that is the biggest area that we need to focus on, which is why JLTV is the Army's number one priority in TWV [tactical wheeled vehicles].

Mr. BACON. That makes sense. I didn't understand that a lot of those requirements came right out of the EFP [explosively formed penetrator] and the IED scenario, so thank you.

Mr. Chair, I yield back. Those are all my questions.

Mr. VEASEY. I think we lost the chairman.

Mr. BACON. Mr. Chairman, you are on mute.

Mr. NORCROSS. I am here. Marc, you are recognized.

Mr. VEASEY. Okay. Mr. Chairman, thank you very much.

Mr. Goddette, your example of the payload and the weight reminds me of the stories in school we used to hear about the computers that used to take up an entire room and now they nicely fit in our hands, in many cases, and as technology evolves it will be very interesting to see how the Army utilizes it.

Given the likelihood—and this is for Mr. Goddette. Given the likelihood of constrained budgets and competing priorities, I am concerned about how our tactical wheeled vehicle fleets will remain

relevant in a future fight against a near-peer competitor without many long-term modernization efforts.

I am very interested in hearing about what the Army's near- and long-term plans are for the High-Mobility Multipurpose Wheeled Vehicles and that fleet since it is going to continue to be in service for quite some time. Have you considered the potential of modifying existing unarmored HMMVWs to an all-electric configuration?

Mr. GODDETTE. So that is a very good question. Consistent with where we are with modernization, the medium and the heavy fleets are in pretty good shape. They are 65 to 75 percent modern. As the light fleet, that is the area that we are focused on and why we are going after replacing as many Humvees as possible with the Joint Light Tactical Vehicle, because it does have protection. It has superior off-road mobility and superior safety as well.

We are starting to look at those opportunities where electrification, whether it be a hybrid solution, may be able to be modified on our existing vehicles, but we are just starting to look at that based on the maturity of the technology and the crossover into our more austere ruggedized needs. There would be a degree of integration and ruggedization to make that technology applicable to our military vehicles.

Mr. VEASEY. For traditional internal combustible vehicles or engines that the Army currently uses, does the military refine their own fuel, or do they get their fuel—they do refine their own?

Mr. GODDETTE. So, Congressman, what we do, our military vehicles have a unique requirement, unlike the commercial vehicles, to burn JP8, which is jet fuel, and that is primarily because we fight on the same—in the same areas as our Air Force partners who use a significant amount of fuel. And the Army is responsible for providing fuel for the Department of Defense, so therefore we have come up with a policy, a single fuel on the battlefield, which requires us to work with our engine manufacturers to modify engines so they can burn the jet fuel.

Mr. VEASEY. Because you are already doing that, do you think that the military would need their own mines in order to be able to, you know, replenish batteries for all electric vehicles in the future? Would they need to be able to source their own materials to build their own batteries or do you think that the batteries would just be part of the supply chain?

Mr. GODDETTE. So we tend to follow the commercial investment. The amount of money that our commercial automotive industry is putting into many technologies, not just batteries, oftentimes dwarfs the amount of money that we have. And so we try to follow fast. We try to make sure that those technologies are mature, then ready, and then we integrate them into our more unique platforms.

Mr. VEASEY. Okay. Thank you very much. Mr. Chairman, I yield back.

Mr. NORCROSS. Thank you. Mr. Wittman, do you have another question for us?

Mr. WITTMAN. Yes, Mr. Chairman.

I wanted to go to Mr. Goddette and ask a question about the tactical elements of electric vehicles and the sustainment of them. You know, listen, I think that there is capability with those vehicles. The question becomes tactical vulnerabilities.

As you look at an internal combustion engine, when you are transporting fuel around, as you said, using jet fuel creates a dual utility or a multi utility for that fuel. And the refueling operation for an internal combustion engine can take place pretty quickly. Even on the biggest of vehicles there, refueling opportunity is fairly short; not the same for electric vehicles.

And as we know, if you have a vehicle that stays in one spot for an elongated period of time or your adversary knows that it is going to be there for an extended period of time, it makes their calculus for tactical advantage much, much easier.

Can you speak to any of the tactics? We talk about the technology side, but you also, I think, have to look at the tactics side. Are there any elements of tactics?

And, Mr. Cadieux, I would point to you too. Any thoughts on the tactical elements of electric vehicles and what that—challenges that poses to the Army?

Mr. GODDETTE. So, Mike, let me just start with maybe a 20-second answer, which is that the amount of time it would take to charge a JLTV that I mentioned earlier is probably around 10 minutes for fuel. And it could be in excess of about 2 hours right now in one location to refuel or recharge, if we even had a recharging capability that was mobile, not fixed, as we would see here in the United States.

Mr. CADIEUX. Additionally, within the Army Futures Command we are leveraging multiple activities, we have been pursuing soldier touch points, and so getting that soldier feedback. And so that soldier feedback is key.

And in this particular case, the Army Applications Lab, which is an AFC [Army Futures Command] component, recently engaged with six industry partners that have unique capability that have some promise for mobile and tactical recharging.

And as they work through their process, we are going to get soldier feedback and that soldier feedback will go a long way to informing the tactics, as you mentioned.

Mr. WITTMAN. Sure. Yeah, listen, those are great observations. I think, you know, looking at the full battlefield scenarios, listen, I think mobility is critically important. If you can move, you obviously lessen the risk there in the battlefield.

The challenge then though is a complex one by moving a—whether it is a stored energy vehicle to transfer power to a battery pack on another vehicle or whether it is a power generation facility that is actually generating power through a generator to transfer, when you put that on the move as well as the vehicle, as you know, the complexity increases significantly.

While it does reduce the vulnerability, the physics of doing that and keeping both those systems functional also gets a little more complicated, especially if you are in very, very challenged environments. Maybe you would have some tactical limitations as far as roadways or terrain, those sorts of things.

So just as you point out, I think it is incredibly important to get out there with the soldiers on the ground. As you know, I think the most compelling and thoughtful, insightful observations don't necessarily come from people up in the acquisition chain. They come from soldiers that will tell you, sir, this won't work, or, sir, have

you thought of this, or, you know, we can do these things but we can't do those things.

So I think that is incredibly important. I applaud you for doing that because that practical knowledge of what our junior enlisted, our senior enlisted, as well as our junior officers who are going to have to deal with this, their observations, I think, are going to be critical going forward. So thank you for doing that. I think that will fully inform the pathway forward for electric vehicles and hybrid vehicles.

So thank you, Mr. Chairman. With that, I yield back.

Mr. NORCROSS. Mr. Wittman, you know a little bit about the electric ships, right? They used to be under water with old batteries, right?

Mr. WITTMAN. That is right. That is exactly right, yes.

Mr. NORCROSS. And you didn't want to get them wet.

Mr. WITTMAN. That is right. That is right. That is right.

Mr. NORCROSS. Mr. Horsford, you are recognized for a second round. Well, Steve? You are recognized for another round if you need. Are you good? Okay.

Mr. Brown, you are recognized.

Mr. BROWN. Thank you, Mr. Chairman. Just a question, a follow up on batteries prompted by that last exchange with Representative Wittman. Are we looking at battery replacement technology versus battery charging? I know that there is an Israeli company that has been working on that technology, the idea a vehicle pulls into a station, they drop a battery, they put another battery in and off they go.

Certainly, you know, there is logistical requirements there as well, additional batteries, stuff like that, but in terms of like time on station in a tactical refueling setting, et cetera, et cetera, that technology I think would probably provide greater survivability for units.

Is battery replacement something that is on the radar?

Mr. CADIEUX. As we are looking at the technologies from our perspective, everything is on the table, to include the scenario that you just outlined, Congressman Brown.

Mr. BROWN. Yeah. Okay. Thank you, Mr. Chairman.

Mr. NORCROSS. Mr. Kahele, you can wrap us up with the second round. Do you have a question?

Mr. KAHELE. Sure, why not, Chair? You know, always like the chance at a second question. And this would be a broad one for the Army, and I guess it would be—can be directed to either Mr. Goddette or Mr. Cadieux. But this has to do with, you know, as we have this broad discussion about increasingly looking at the military electrifying its fleet, its tactical fleet, do you have any thoughts on whether or not or how the DOD [Department of Defense] would be reassessing its long-term fuel storage?

Obviously, fuel is a big deal for our current fleet, and as we electrify that fleet, is there any thoughts on what the DOD would be doing in terms of fuel storage? You know, we all saw how, you know, the oil industry was affected, you know, in the last few weeks.

And so as the world moves towards clean and renewable energy and the DOD invests in the electrification of our tactical fleet, do

you think that large fuel storage facilities might become obsolete in our military and at our DOD facilities?

For me, this is significant in Hawaii because, you know, we only have so much room here and we have a lot of military bases, and so I am thinking about the future bases and fuel storage and if the Army would be cutting back on its fossil fuel consumption in the future as we electrify the fleet.

Mr. GODDETTE. So, Congressman Kahele, I would just take probably that question for the record, because from my perspective, my charter kind of sits in buying tactical wheeled vehicles, which is for those units that would deploy into a theater.

And the part that I think you are mentioning is more on the installation side of the house supporting a lot of the non-tactical vehicles and some of the military vehicles as well.

But from a storage perspective, on a tactical battlefield we tend to store in blivets and other things that, based on where we have to do the power generation to recharge batteries, would determine how we might change our doctrine. But I think your question was probably related to the installation side of the house, and we could take that for the record.

[The information referred to can be found in the Appendix on page 43.]

Mr. KAHELE. Yeah, that sounds great. It was just a broad question as we, you know, have this discussion, but thanks for giving it a shot. I appreciate it.

Thank you, Chair.

Mr. NORCROSS. So for those of you who haven't seen his unique storage ability out in Hawaii, next time you are out there, remarkable what they have up in the mountains.

With that, Mr. Bacon, any last words?

Mr. BACON. No, Mr. Chair. Appreciate both panelists, and I appreciated talking to them earlier as well. They did a great job. Thank you.

Mr. NORCROSS. So we appreciate it. It was a great discussion. Obviously, you are keeping your eye on the ball in the future, but more importantly, you are making sure we get there where we are now. We appreciate your time and your service to this country.

With that, we are adjourned. Thank you.

[Whereupon, at 4:21 p.m., the subcommittee was adjourned.]

A P P E N D I X

MAY 27, 2021

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MAY 27, 2021

Statement of the Honorable Donald Norcross
Chairman, Subcommittee on Tactical Air and Land Forces
"Army Tactical Wheeled Vehicle Program Update and Review of Electrification"
May 27, 2021

The hearing will come to order.

I want to welcome everyone to this hearing of the Tactical Air and Land Forces subcommittee. This subcommittee, perhaps more than any other, appreciates that our attention to military trucks and utility vehicles is not glamorous compared to other weapons systems, but essential to our military's success no matter where our forces may operate. This is, therefore, an important hearing.

I would like to welcome the members who are joining today's hearing remotely. Members who are participating remotely must be visible on-screen for the purposes of identity verification, establishing and maintaining a quorum, participating in the proceeding, and voting. Remote attending Members must continue to use the software platform's video function the entire time while in attendance, unless they experience connectivity issues or other technical problems that render them unable to participate on camera. If a Member experiences technical difficulties, they should contact the committee's staff for assistance.

Video of Members' participation will be broadcast via internet feed. Members participating remotely must seek recognition verbally, and they are asked to mute their microphones when they are not speaking.

Remote Members may leave and rejoin the proceeding. However, if remote Members depart our hearing for a short while, for reasons other than joining a different proceeding, they should leave the video function on. If Members will be absent for a significant period, or depart to join a different proceeding, they should exit the software platform entirely and then re-join it when they return. Members may use the software platform's chat feature to communicate with staff regarding only technical or logistical support issues.

I have designated a committee staff member to, if necessary, mute unrecognized Members' microphones to cancel any inadvertent background noise that may disrupt the proceeding.

That said, I welcome and thank our distinguished panel of witnesses for taking the time to come before us to discuss the Army's current and future tactical wheeled vehicle fleets.

- **Mr. Timothy Goddette,** Deputy Assistant Secretary of the Army for Acquisition Policy and Logistics, and who, until just this month, was Program Executive Officer, Combat Support & Combat Service Support at the Detroit Arsenal, Warrant, Michigan, where he was responsible for all the Army's truck and utility vehicle procurement programs; and,
- **Mr. Michael Cadieux,** Director, Ground Vehicle Systems Center, that is our science and technology laboratory for combat and tactical vehicles.

As I mentioned, trucks and utility vehicles, particularly those necessary to support field operations, are not glamorous but essential to the success of any modern military.

We've all seen, however, the pattern of increasing risk in the Army's management of these vehicles over the last few years by cutting modernization and production funding to generate more money for higher priority weapons programs.

We look forward to our witnesses addressing this increased risk and its implications for our truck and utility fleets today and tomorrow, as well as increased risk in the industrial base.

We have also noted over the last couple months increased public awareness and interest in accelerating the pace and scope of vehicle electrification. This is certainly nothing new in the American automotive industry, but the military application of electrification, particularly in a field environment, has very different challenges.

Our witnesses today will help us understand where the Army has been and where it wants to go with tactical vehicle electrification. More important, they will help us understand the operational and technical challenges that make commitment to vehicle electrification perhaps uncertain at this time.

With that, I recognize our Ranking Member, Mrs. Hartzler.

RECORD VERSION

STATEMENT BY

MR. TIMOTHY G. GODDETTE,
DEPUTY ASSISTANT SECRETARY OF THE ARMY FOR
ACQUISITION, POLICY, AND LOGISTICS

AND

MR. MICHAEL CADIEUX
DIRECTOR
ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND
GROUND VEHICLE SYSTEMS CENTER

BEFORE THE

SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES
COMMITTEE ON ARMED SERVICES
UNITED STATES HOUSE OF REPRESENTATIVES

FIRST SESSION, 117TH CONGRESS

ON TACTICAL WHEELED VEHICLES AND ELECTRIFICATION

MAY 27, 2021

NOT FOR PUBLICATION UNTIL RELEASED BY THE
COMMITTEE ON ARMED SERVICES COMMITTEE

INTRODUCTION

Chairman Norcross, Ranking Member Hartzler, and distinguished Members of the Tactical Air and Land Forces Subcommittee, thank you for your continued support and commitment to our Soldiers, our Civilians, and their Families. On behalf of the Acting Secretary of the Army, the Honorable John E. Whitley, and the Army Chief of Staff, General James C. McConville, thank you for the opportunity to speak before your committee on the topics of the Tactical Wheeled Vehicle (TWV) Fleet and the Electrification of Army Vehicles.

TACTICAL WHEELED VEHICLE FLEET

The Army's portfolio of over 200,000 Tactical Wheeled Vehicles (TWVs) consists of Light, Medium, and Heavy trucks from primarily three Original Equipment Manufacturers (OEMs), which include Oshkosh Defense, AM General, and Navistar Defense. The three major capabilities that make our military vehicles different from a straight commercial off-the-shelf vehicle are severe off-road mobility, crew protection, and the ability to burn JP8 or jet fuel. Two of our newest OEM partners are GM Defense, who is building the Infantry Squad Vehicle (ISV), and Mack Defense, who builds our Heavy Dump Truck.

The Army's priority for the Tactical Wheeled Fleet is the Joint Light Tactical Vehicle or JLTV. We currently have 4,142 in the inventory and expect to field another 2,797 this year. The Army's Procurement Objective is to buy a total of 49,099 JLTVs by 2041 with the next opportunity for competition in TWVs being the JLTV follow on contract with target award at the end of Fiscal Year (FY) 2022. However, given resource constraints, the Army recognizes it will continue to have a mixed Light Tactical Vehicle (LTV) fleet

that will include just over 50,000 High Mobility Multipurpose Wheeled Vehicles (HMMWVs), even after all of the JLTVs are purchased. Sustaining the entire LTV fleet through 2050 would benefit from limited procurement of new HMMWVs and retrofitting other HMMWVs with the Anti-Lock Brake System/Electronic Stability Control (ABS/ESC) kits to insure spare parts are available and we continue to improve safety.

The Army's second priority, with regard to the Tactical Wheeled Vehicle fleet, is to maintain a warm production base for the Family of Medium Tactical Vehicles (FMTV) and the Heavy Tactical Vehicle (HTV) fleets. The FMTV fleet has met its Acquisition Objective and is currently 66 percent modernized. Despite some reliability issues with the FMTV A2 over the past year, we have corrected those problems and testing has resumed. The phased approach we are taking will extend level production to approximately 1.5 vehicles a day.

As for the heavy fleet in the near term, the Army will continue to recapitalize (RECAP) heavy trucks that are approaching or exceeding their Economic Useful Life (EUL) through 2023. The RECAP program is critical to modernizing the aging fleet. RECAP will remanufacture and upgrade the 20+ year-old Heavy Expanded Mobility Tactical Truck (HEMTT) A0 and HEMTTA2 vehicles to the current A4 configuration. The RECAP also applies to the Palletized Load System (PLS) vehicles also approaching their EUL. The Army recently awarded a 3-year extension to the current Family of HTVs IV production contract. The contract extension will enable the Army (as well as other Services and Foreign Military Sales) to RECAP and procure new production vehicles. Lastly, United States Army Europe and Africa (USAREUR-AF) had a need to fill a capability gap to transport heavy tracked vehicles. As a result, the Army is fielding

modified M1070A1 tractors and procuring customized commercial-based trailers to achieve European road permits for 75 tons.

With the HTV fleet having reached its design maturity, the Army is exploring the concept of replacing the HEMTT, PLS, and the M915/M1088 Tractors with the Common Tactical Truck (CTT). The CTT would be a commercial based truck designed with a modular truck platform that leverages best commercial practices, lowers procurement costs (commercial economies of scale) and optimizes available and emerging technologies. This has the potential to "shift the cost curve," saving 15 to 30 percent.

VEHICLE ELECTRIFICATION

Electrification provides land forces in Multi-Domain Operations (MDO) the ability to operate at longer distances without refueling and provides extended silent-watch capability. In addition, the combination of silent mobility, reduced thermal signature, and improved sprint speeds will allow greatly improved convergence of lethal and nonlethal effects. Finally, electrification provides the on-board electrical power and energy storage required for the sensors and mission payloads envisioned for land forces in MDO.

Under the auspices of Army Futures Command (AFC), the United States Army Combat Capabilities Development Command (DEVCOM) Ground Vehicle Systems Center (GVSC) is focusing its Science and Technology (S&T) funding for electrification primarily on addressing combat systems capabilities, conducted under the Platform Electrification and Mobility (PEM) project. PEM is aimed at technical gaps that commercial industry is not addressing as they develop electrification solutions for on-road, commercial, wheeled systems. The combination of tractive forces, operating temperatures, and duty cycles associated with combat vehicles prevent direct adoption

of commercial solutions. Although PEM is focused on combat systems, the architecture and some of the component technologies are also applicable to tactical vehicles, including anti-idle and hybrid electric architecture, high voltage modular battery design, and quiet JP-8 fuel cell range extender technology, generators, and electric drive motors.

GVSC is also leveraging the Office of the Secretary of Defense's Operational Energy Capability Improvement Fund, which funded the Tactical Vehicle Electrification Kit (TVEK), for an FY 2021 project. This jointly funded project by both Project Manager-JLTV and Marine Corps Systems Command will demonstrate a JLTV anti-idle system that is expected to achieve up to 25 percent fuel savings through reduction in engine idle time. TVEK retrofit illustrates progression toward an electrified ground vehicle fleet. In addition to significantly reducing fuel consumption, TVEK provides 80 percent reduction in idle time and nearly 60 percent reduction in engine run-time in some operational scenarios.

As an example of a potential utilization, there is also growing support for using the niche Scout mission to enter the Electric Vehicle (EV) market and field a capability quickly. There are a significant number of commercial production vehicles, in the pick-up truck class, that will be entering the market in the FY 2022-2023 timeframe. The Army's intent is to leverage the development and maturity of the commercial industry to field a capability. The ability to field a Mobile Recharging capability is a critical element to realize a full electric vehicle. As a result, the initial electric vehicle solution is likely to be a Hybrid drive (EV with range extender (generator)) due to the range requirement and concern with tactical edge recharging.

Finally, from a commercial sector standpoint, some of the opportunities from which the Army can leverage modified products include: common components, autonomy "ready," standard Vetronics architecture for interoperability, and electric or hybrid-electric vehicles. With minimal government research and development investments in this area, the Army will need to closely align with industry's timeline for introducing these capabilities while insuring conditions for competition. The best way for the Army to manage the modernization/readiness risk associated with a constrained budget is to maintain open contracts with warm production so the ability to surge is readily available when needed.

CONCLUSION

The Army would like to thank the committee for today's opportunity to discuss the current TWV fleet and the potential for incorporating electrification technologies. We look forward to your questions.

Mr. Tim Goddette
Deputy Assistant Secretary of the Army Acquisition Policy and Logistics
Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Army Pentagon, Washington, D.C

Mr. Timothy Goddette was selected for the Senior Executive Service in January 2014. He is responsible for the formation, implementation and execution of Army Acquisition, Life Cycle Logistics, Industrial Base policies, processes and procedures providing oversight to protect weapon systems' supply chains from cyber-attacks. He also serves as the lead for the Army's Corrosion Protection Program. Mr. Goddette is a member of the Army Acquisition Corps and is certified at the highest level in Program Management.

CAREER CHRONOLOGY:
May 18-May 21: Program Executive Office Combat Support and Combat Service Support, Detroit Arsenal, Warren, MI
Aug 17-May18: Acting Deputy Assistant Secretary of the Army Acquisition, Policy and Logistics, ASAALT, Pentagon
Jan 14-Aug 17: Deputy Program Executive Officer Soldier, Fort Belvoir, VA
Jul 07 – Dec 13: Director Combat Support Systems, Office of the Assistant Secretary of Army, Acquisition Logistics and Technology (ASAALT), Pentagon
Jun 04 – Jul 07: Project Manager Force Projection, PEO Combat Support and Combat Service Support, Warren, MI
Jul 03 – Jun 04: Director Joint Precisions Strike Demonstration Office, PEO Intelligence Electronic Warfare Systems, Fort Monmouth, NJ
Jun 99 – Jul 02: Product Manager Construction Equipment and Material Handling Equipment, PEO Combat Support and Combat Service Support, Warren, MI
Mar 98 – Jun 99: Department of the Army Systems Coordinator, Office of the Assistant Secretary of Army, Acquisition Logistics and Technology (ASAALT), Pentagon
Jul 96 - Mar 98: Assistant Product Manager for Countermine Vehicles, PEO Ammunition, Picatinny Arsenal, NJ
Mar 93 – Jun 95: Research and Development Coordinator, Tank Automotive Research Development and Engineering Center (TARDEC), Warren, MI
Sep 90 – Sep 91: Combat Developer, Army Engineer School, Fort Leonard Wood, MO
Oct 85- Oct 88: Research and Development Coordinator, Cold Regions Research Engineering Laboratory, United States Army Corps of Engineers, Hanover, NH

COLLEGE:
MS, National Resource Strategy, National Defense University, Wash DC, 2003
MS, Industrial Engineering, Georgia Institute of Technology, Atlanta, GA, 1992
BS, Engineering, University of Vermont, Burlington, VT, 1982

SIGNIFICANT TRAINING:
Program Managers Skills Course, Defense Systems Management College, 2004
Industrial College of the Armed Forces Senior Acquisition Course, 2003
Advance Program Management Course, Defense Systems Management College, 1997
United States Army Command and General Staff College, 1996
United States Army Combined Arms Service Staff School, 1989

CERTIFICATIONS:
Level III in Program Management
Level II in Systems Research Development and Engineering
Level II in Test and Evaluation

AWARDS AND HONORS:
Senior Executive Service Appointment (January 2014)
Superior Civilian Service Award in 2012 and 2021
Legion of Merit Medal (one oak leaf cluster)

Meritorious Service Medal (four oak leaf clusters)
Silver DeFleury Medal, Engineer Association
Order of Saint Martin, Quarter Master Association
Order of Saint Christopher, Transportation Association
Order of Saint Maurice, Infantry Association
Order of Samuel Sharpe, Ordnance Association

PROFESSIONAL MEMBERSHIPS AND ASSOCIATIONS:
Member of the Army Acquisition Corps
Member of the Association of the United States Army
Member United States Army Engineers Association

Mr. Michael Cadieux
Director, U.S. Army Combat Capabilities Development Command's
Ground Vehicle Systems Center

Mr. Cadieux serves as the Director for the U.S. Army Combat Capabilities Development Command's Ground Vehicle Systems Center, a position he has held since April 11, 2021. He leads a workforce of over 1,800 engineers, scientists, researches and support staff in delivering advanced technologies as required by the Army's strategic priorities and support to its Cross Functional Teams. Mr. Cadieux also provides life cycle engineering solutions to the Army's Ground Combat Systems and Combat Support & Combat Service Support PEOs, the Tank Automotive Life Cycle Management Command, and the broader Department of Defense.

In his capacity as the Director, Mr. Cadieux ensures the Ground Vehicle Systems Center is Forging the Future by developing world-class engineering talent in the areas of survivability and protection, autonomy and robotics, propulsion and mobility, electronics and power management, fuels and lubricants, and ground system design and optimization. The Ground Vehicle Systems Center is the Army's primary organic engineering talent to develop the Next Generation Family of Combat Vehicles and thus deliver land dominance in the future fight.

CAREER CHRONOLOGY:
2021 – Present: Director, U.S. Army GVSC
2020 – 2021: Executive Director, SIE, DEVCOM GVSC
2019 – 2020: Associate Director, Software Engineering Center, CCDC GVSC
2018 – 2019: Deputy Project Manager (Acting), Joint Light Tactical Vehicles, PEO CS&CSS
2017 – 2018: Assistant PEO Operations, PEO CS&CSS
2014 – 2016: Deputy Program Executive Officer (Acting), PEO CS&CSS
2012 – 2014: Assistant PEO Systems Engineering, PEO CS&CSS
2007 – 2012: Chief Information Officer, PEO CS&CSS
1996 – 2007: Various Positions, Tank Automotive Research, Development & Engineering Center

COLLEGE:
Master of Global Leadership and Management – Lawrence Technological University, 2019
Master of Science – Computer Information Systems, University of Detroit Mercy, 2006
Bachelor of Science – Computer Science, Kettering University, 2000

SIGNIFICANT TRAINING:
S. Army Senior Service College Fellowship, Defense Acquisition University, 2018

CERTIFICATIONS:
S. Army Acquisition Corps, 2005

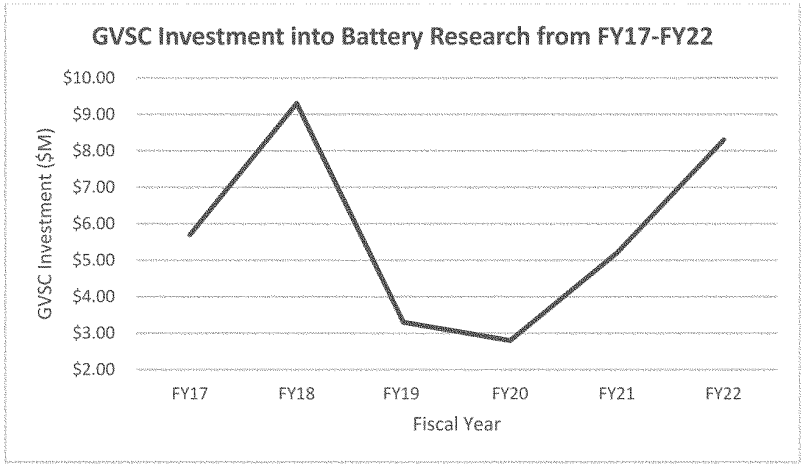
AWARDS AND HONORS:
Superior Civilian Service Award, 2018
Meritorious Civilian Service Award, 2017
Commander's Award for Civilian Service, 2014

WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING

MAY 27, 2021

RESPONSE TO QUESTION SUBMITTED BY MR. BROWN

Mr. CADIEUX. The trend line for GVSCs investment in battery research from FY17–FY22 is depicted below. Over the past 2–3 years, GVSC has seen a positive trend in investments into battery research.



Fiscal Year (FY)	Funding ($M)
FY17	$5.70
FY18	$9.30
FY19	$3.30
FY20	$2.80
FY21	$5.20
FY22	$8.30

[See page 16.]

RESPONSE TO QUESTION SUBMITTED BY MR. KAHELE

Mr. GODDETTE. The Military Services, like the Army, are customers of the Defense Logistics Agency (DLA). In Hawaii, the Army has an installation storage mission but it is very small (like filling stations). DLA runs a major fuel storage mission focused primarily on the Navy. [See page 24.]

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

MAY 27, 2021

QUESTIONS SUBMITTED BY MRS. HARTZLER

Mrs. HARTZLER. How do vehicle-based electrical power generation technologies (such as the On Board Vehicle Power system demonstrated by THAAD and the Army GVSC/C5ISR Teams in March 2021) fit into the Department's operational energy framework and how is the Department evaluating these technologies to meet weapon and vehicle energy requirements for expeditionary operations?

Mr. GODDETTE. The on board power generation technologies demonstrated by a system such as Theater High Altitude Air Defense, or THAAD, have served to inform the feasibility and application for increase power generation on tactical wheeled vehicles. The goal is to increase mobility and survivability of the platforms by enabling more rapid emplacement and displacement of a weapon system in a future Multi-Domain Operation. The Army is also evaluating On Board Vehicle Power (OBVP) technologies through the Secure Tactical Advanced Mobile Power (STAMP) Joint Capability Technology Demonstration (JCTD) scheduled to run through 2nd Quarter, Fiscal Year 2023 (2QFY23). The STAMP JCTD will demonstrate the flexible application of mobile and stationary power sources, and inform energy requirements for expeditionary operations in Army missile defense systems and Mobile Command Post Integrated Infrastructure, as well as tactical wheeled vehicles. One example from work on THAAD is the Joint Light Tactical Vehicles (JLTV) program is currently leveraging the Tactical Vehicle Electrification Kit (TVEK) hardware generated for that program to introduce an anti-idle capability to reduce overall fuel consumption by up to 20 percent.

Mrs. HARTZLER. Major weapon systems, command and control systems, and combat vehicles are forecasting additional electrical power needs, 30kW–300kW, in the future. What is the Department's plan to evaluate and implement vehicle-based power technologies to meet these energy needs? Will these electrical generation technologies be incorporated into the Army's vehicle electrification plan?

Mr. GODDETTE. The Army is evaluating vehicle-based power technologies through demonstrations, evaluations, and ongoing research and development efforts throughout the U.S. Army Development Command (DEVCOM). One example of On Board Vehicle Power (OBVP) evaluation is the Secure Tactical Advanced Mobile Power (STAMP) Joint Capability Technology Demonstration (JCTD) scheduled to run through 2QFY23. The STAMP JCTD will demonstrate the flexible application of mobile and stationary power sources, and inform energy requirements for expeditionary operations in Army missile defense systems and Mobile Command Post Integrated Infrastructure, as well as tactical wheeled vehicles. These evaluations will help the Army to better understand the capabilities and limitations of emerging technologies and inform requirements and system design. The Joint Light Tactical Vehicle currently has the ability to export 10kW with an installed export power kit. To meet future needs, the program is investigating various hybrid or full electric concepts that would facilitate improvements to fuel consumption, silent mobility, silent watch and provide increased export power ability to meet future energy demands. Implementation of these technologies will be dependent on how the demonstrated capability impacts trade-offs in requirements and funding.

QUESTIONS SUBMITTED BY DR. DesJARLAIS

Dr. DESJARLAIS. The ISV original equipment manufacturer has developed an all-electric military concept demonstrator vehicle based on the ISV platform in just 12 weeks. What are your thoughts on the potential or possibility to grow the ISV into a family of vehicles with different configurations, to include electric powertrains?

Mr. GODDETTE. The current F24/DF2 (diesel) powered Infantry Squad Vehicle (ISV) serves an excellent example of what commercial industry can do to tailor existing commercial product to meet our warfighter needs. A key enabler to the ISV success and in general, any commercial adaptation is the alignment of requirements with capabilities that allows adequate flexibility and trade space. The current ISV Original Equipment Manufacturer (OEM) is heavily invested in vehicle electrification and was able to quickly adapt their commercial technologies due to the flexibility inherent with the ISV body on frame architecture and the modularity of their electric vehicle technologies. The ISV is designed to a very specific set of approved requirements. The platform has the potential to be highly adaptable, to include elec-

trification, if Army requirements continue to align with respect to key performance parameters such as weight, range, mobility, payloads and survivability.

Dr. DESJARLAIS. Would you please elaborate on the steps you are taking to ensure the acquisition and research communities are leveraging commercial best practices and significant internal research and development investment by the commercial automotive industrial to support the development of and inform operational requirements for electric tactical and combat vehicles and their associated infrastructure?

Mr. GODDETTE. I can only speak for the tactical vehicles, but being co-located at the Detroit Arsenal, we work closely with the Army Futures Command Ground Vehicle Systems Center (GVSC) and the Ground Combat Systems Program Executive Office to leverage and share advances in automotive Science and Technologies, including vehicle electrification. As stated in their response, GVSC has extensive engagement with the commercial automotive industry to leverage commercial electrification investment. Recent examples within my previous tactical vehicle portfolio include a closely coordinated industry day with Maneuver Capabilities Development and Integration Directorate, Army Futures Command to assess eLRV requirements as well as sending multiple eLRV market questionnaires to industry to continually inform our acquisition strategy and requirements. The program offices are taking all critical steps together with our partners to understand electrification as we plan out near and long term path to leverage this technology to benefit the Army.

Dr. DESJARLAIS. Would you please elaborate on the steps you are taking to ensure the acquisition and research communities are leveraging commercial best practices and significant internal research and development investment by the commercial automotive industrial to support the development of and inform operational requirements for electric tactical and combat vehicles and their associated infrastructure?

Mr. CADIEUX. Located in Southeastern Michigan, GVSC is optimally positioned to work closely with the commercial automotive industry. GVSC leverages its proximity to automotive technical centers through Cooperative Research and Development Agreements with many of these automotive partners to leverage commercial efforts and investments in electrification. To-date, we have established 11 CRADAs and Test Service Agreements with automotive Original Equipment Manufacturers and suppliers of electrification components. Additionally, GVSC has held 5 Electrification Forums attended by dozens of companies working in electrification in order to share information on the unique Army operational environment and to gain their input on our electrification plans and architecture. This forum allows GVSC to share the Army's unique electrification needs and challenges with commercial industry partners. GVSC also has an established track record of working with America's research universities and leveraging groups such as the Automotive Research Center (ARC), partnering with 15 industry organizations and 9 Universities from around the country to conduct modeling and simulation research in areas such as vehicle electrification. The collaborative efforts that the Army has had across the commercial automotive sector have directly helped to shape and inform the emerging Tactical and Combat Vehicle Electrification (TACV-e) and Electric Light Reconnaissance Vehicle (eLRV) requirements documents. In the case of eLRV, the requirements enable the Army to leverage current and emerging commercial electric vehicle SUV/Pick-up truck offerings. Finally, GVSC has partnered with the Army Applications Laboratory (AAL) to find industry solutions for Army electrification challenges such as mobile charging infrastructure needed to support future military electric systems. As part of this effort, the Army has received technical input and solutions from over 70 different non-traditional partners, ensuring that commercial best practices are being leveraged to address the military unique challenges with vehicle electrification.

The collaborative efforts that the Army has had across the commercial automotive sector have directly helped to shape and inform the emerging Tactical and Combat Vehicle Electrification (TACV-e) and Electric Light Reconnaissance Vehicle (eLRV) requirements documents. In the case of eLRV, the requirements enable the Army to leverage current and emerging commercial electric vehicle SUV/Pick-up truck offerings.

Finally, GVSC has partnered with the Army Applications Laboratory (AAL) to find industry solutions for Army electrification challenges such as mobile charging infrastructure needed to support future military electric systems. As part of this effort, the Army has received technical input and solutions from over 70 different non-traditional partners, ensuring that commercial best practices are being leveraged to address the military unique challenges with vehicle electrification.

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