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The Case for Hydrogen Fuel Cell Vehicles in U.S. Transportation and Defense

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Executive Summary

The U.S. urgently needs to reduce its reliance on petroleum-based transportation to enhance national security, climate resilience, and economic stability. While Battery Electric Vehicles (BEVs) are central to current federal policy, they introduce new strategic risks tied to critical mineral supply chains dominated by China. Hydrogen Fuel Cell Vehicles (HFCVs) offer a complementary solution with advantages for U.S. defense. With longer range, rapid refueling, and stealth benefits, HFCVs are uniquely suited for military use, especially in tactical ground fleets. To capitalize on hydrogen technology and address existing policy gaps, federal policy should:

- Extend and simplify hydrogen production tax credits.
- Enhance funding for regional hydrogen hubs and infrastructure.
- Integrate HFCVs into DoD procurement policies.
- Invest in HFCV prototype and pilot programs for tactical vehicles.

Problem Statement

Ground vehicles underpin U.S. military readiness and economic activity. Current over-reliance on Internal Combustion Engine (ICE) vehicles exposes the U.S. military to strategic vulnerabilities tied to foreign oil dependence and supply chain risks. While BEVs have emerged as the favored clean transportation solution, BEV-centric policies concentrate risks, supplanting oil dependence with new vulnerabilities due to critical mineral supply chains dominated by China. Diversifying into HFCVs presents an under-exploited opportunity to enhance national security, climate resilience, and technological competitiveness.

Background

The transportation sector accounts for 28% of U.S. greenhouse gas emissions, with ground vehicles contributing 80% of that total.[i] Although the U.S. became a net petroleum exporter in 2020, it still imports 8.3 million barrels of oil per day with transportation consuming 67% of total oil use.[ii] [iii] The U.S. military, the largest global institutional petroleum consumer, burns 4.2 billion gallons annually, creating substantial operational and financial risks due to fluctuating oil prices and supply disruptions.[iv]

HFCV Technology

What is Hydrogen?

Hydrogen, the most abundant element in the universe, does not exist in its pure gaseous form on Earth and therefore must be produced, stored, and transported for use in generating electricity.[v] [vi] There are three main hydrogen production processes: Gray, Blue, and Green.[vi] Gray hydrogen is produced via steam methane reforming (SMR), which is the cheapest and most common method, but emits substantial greenhouse gases. Blue hydrogen uses the same SMR technology but pairs it with carbon capture, utilization, and storage (CCUS) to mitigate emissions. Green hydrogen is generated through an electrochemical reaction dubbed electrolysis, where renewable power splits water into hydrogen and oxygen, offering zero emissions. Once produced, hydrogen must be compressed or liquefied to store enough for electricity generation.[vii] Transportation must be achieved with insulated storage tanks, as pressurized H2 gas is volatile and flammable.

How Do HFCVs Work?

Unlike BEVs, which depend on grid-charged batteries, HFCVs produce electricity onboard inside a fuel cell.[v] Fuel cells use reverse electrolysis, combining stored hydrogen gas and atmospheric oxygen, resulting in electricity, heat, and water. The electricity generated directly powers the vehicle's electric motor, or can be temporarily stored in a smaller battery that acts as temporary storage and incorporates regenerative braking.

Pros of HFCVs:

Extended Range	Doubles the range of typical BEVs (up to 400 miles) and is independent of outside temperature.
Rapid Refueling	Refueling injects pressurized hydrogen extremely quickly (3-4 minutes) and is 50 times faster than recharging BEVs.[v]
Energy Efficient	More energy efficient (up to 60%) than ICEs (20-30%), but less than BEVs (80%).[v]
Energy Storage	By performing electrolysis during times of renewable power surplus, hydrogen can store electricity when demand > supply.[v]
Emissions-Free	Using green hydrogen, HFCVs emit only water vapor.
Mobility	Electric motors provide full torque and acceleration even at low speeds.[viii]
Supply Chains	Less reliance on imported critical minerals than BEVs.[viii]
Collaboration with BEVs	Use the same drive, batteries, and motors as BEVs, so they will benefit from advances in both hydrogen and BEV technology.

Cons of HFCVs:

Infrastructure Gaps	There is a lack of widespread hydrogen refueling stations, with only 54 stations in the U.S., concentrated in California.[ix]
Cost Barriers	A "green premium" exists as fuel costs vary from $1-2/kg for gray hydrogen to $9/kg for green hydrogen.[x]
Safety Concerns	Hydrogen requires advanced and safe storage solutions to mitigate the volatility risks of flammable hydrogen gas.

Military Usage

Fuel as a Battlefield Risk

The U.S. military is the world's largest single institutional consumer of petroleum, burning 4.2 billion gallons of fuel annually at cost of over $9 billion.[vii] In 2022 alone, Congress twice had to appropriate more money for fuel purchases for a total of $3 billion, as the price of delivering fuel to remote outposts can reach up to $1,000/gallon.[x] Volatile oil prices driven by OPEC production cuts or conflicts (e.g., Ukraine, Iran) directly inflate DoD fuel budgets and threaten military readiness.

The U.S. Army's fleet consists of 300,000 ground vehicles, split between 170,000 non-tactical (logistics, transport) and tactical (combat, support) vehicles.[xi] Non-tactical fleets are well suited for BEV electrification, but BEVs are not yet ready for tactical vehicles due to bulky charging infrastructure and reliability concerns.[vii] HFCVs, on the other hand, are uniquely positioned to meet tactical military needs.

HFCV Tactical Advantages

- **Stealth:** HFCVs lack engine noise, odor, smoke, and have a minimal thermal signature, which can frustrate thermal vision and heat seeking weapons.[xi]
- **Mobility:** Instant torque from electric motors improves acceleration, towing, and off-road maneuverability.[viii]
- **Onboard Power:** HFCVs can generate electricity for communications, sensors, and other equipment, reducing reliance on fuel-powered generators.[vii]
- **Logistics:** HFCVs offer the potential for on-site hydrogen production via electrolysis, reducing dependence on fuel convoys. This is crucial as fuel logistics remain a major vulnerability, one in every eight U.S. casualties in Iraq were from protecting fuel convoys.[vii]

HFCV Tactical Feasibility

Several military prototypes and pilot programs display the promise of HFCVs for tactical vehicles. The U.S. Army ZH2 Prototype, a modified Chevy Colorado, delivers low-signature mobility, on-board power, and even potable water generation.[xii] [xiii] The U.S. Army H2Rescue Truck provides 180 miles of range with heat, water, and 25kW of power for up to 72 hours.[xiv] A recent SAE study also demonstrated the feasibility of hydrogen powered Bradley Tank variants using off the shelf technology.[xv] Internationally, the Hyundai K3 Tank demonstrates rapid acceleration, quiet driving, and even radar absorption features.[xvi]

HFCV integration into the military fleet is not without difficulties, namely the logistical hurdles of transporting large amounts of volatile hydrogen gas safely. Additionally, the batteries HFCVs use face similar vulnerable supply chain difficulties as BEVs, though to a lesser degree.[vii] Realistically, HFCVs will complement rather than replace all tactical vehicles in the near term, with wheeled and tracked vehicles being the primary candidates for early adoption.

The military's unique scale, funding, and needs make it the ideal lead customer for HFCVs. The military's zero-emission procurement goals for 100% light-duty non-tactical EVs by 2027 and tactical EVs by 2035 should explicitly include hydrogen options.[xvii] The DoD should continue BEV adoption for non-tactical fleets but prioritize HFCV research, development, and pilot deployment for tactical fleets. This dual approach will increase force lethality, resilience, and sustainability, helping the U.S. address climate goals while reducing dependence on foreign oil.

Policy Implications

Current Policy

Since 2021, the U.S. has made historic investments in electrifying the vehicle fleet, but federal support has favored BEVs over HFCVs. Under Internal Revenue Code 30D, buyers of new BEVs can claim up to $7,500 in federal tax credits, which has stimulated EV demand.[xviii] Simultaneously, the Bipartisan Infrastructure Law allocated $7.5 billion over five years for EV charging infrastructure, with $5 billion for states to build out nationwide fast charging networks through the National Electric Vehicle Infrastructure Formula Program.[xix] Supply-side (infrastructure) support coupled with demand-side (consumer incentives) has worked for EVs, helping the number of public charging ports rise to over 207,000 and the EV fleet surpass 4 million.[xx]

In contrast, HFCV technology has received only supply-side support. The Infrastructure Investment and Jobs Act (IIJA) provided $8 billion to establish four regional clean hydrogen hubs, focused on integrating production, storage, and delivery.[x] The Inflation Reduction Act's Section 45V introduced a tax credit up to $3/kg of clean hydrogen production, prompting a wave of announced clean hydrogen projects.[x] However, complete guidance on how to qualify for 45V credits was only published in January 2025 and is complex, causing 93% of announced hydrogen projects to not yet reach Final Investment Decisions.[x] Political shifts now deepen uncertainty, specifically the "One Big Beautiful Bill", which would accelerate the sunset of 45V credits from 2033 to 2028.[xxi] Considering it takes 4-6 years to build large hydrogen infrastructure projects, this is giving developers insufficient timeframes. President Trump is also expected to cut funding for clean hydrogen hubs through the IIJA.[xxi] Additionally tariffs on imported hydrogen electrolysis technologies and renewable energy components will increase green hydrogen production costs.[xxii]

The U.S supply-side approach has resulted in a large gap between government hydrogen production targets of up to 43 million tons annually and demand targets of only 11 million.[x] Only 7% of the $570 billion in announced clean-hydrogen investments have reached final commitment, reflecting investors' wariness amid policy uncertainty.[x] If these policy gaps and uncertainties persist, the U.S. risks ceding its competitive advantage in clean hydrogen to China and Europe.

Policy Recommendations

- **Extend and Simplify Clean Hydrogen Tax Credits:** Congress should extend Section 45V beyond 2032 and simplify the regulatory guidance, providing long-term certainty for project developers and investors.
- **Expand Hydrogen Infrastructure Funding:** Protect and grow the H2Hubs program under IIJA to build a domestic supply chain of hydrogen production.
- **Joint Light Tactical Vehicle (JLTV) HFCV Procurement:** The ideal venue for demonstrating marketable hydrogen demand is through the JLTV program, the military's replacement for the Humvee, with the Army and Marine Corps expected to buy 65,000 JLTVs in the coming years.[vii] The DoD should require a significant share of these JLTV procurement contracts to be HFCVs, stimulating long-term demand and generating data for further HFCV adoption.
- **HFCV Wheeled and Tracked Pilot Programs:** The military should also expand pilot projects for both wheeled and tracked HFCVs, showcasing their value in tactical scenarios and supporting the entire hydrogen economy.

Implementing these policy shifts will not only unlock the full potential of hydrogen technology but also address the core vulnerabilities identified throughout this paper: reliance on foreign oil, critical mineral supply chains, and gaps in hydrogen policy support. A more balanced policy approach that complements both BEVs and HFCVs will enable the U.S. to meet its climate goals, strengthen national security, and maintain global competitiveness in the clean transportation industry.

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