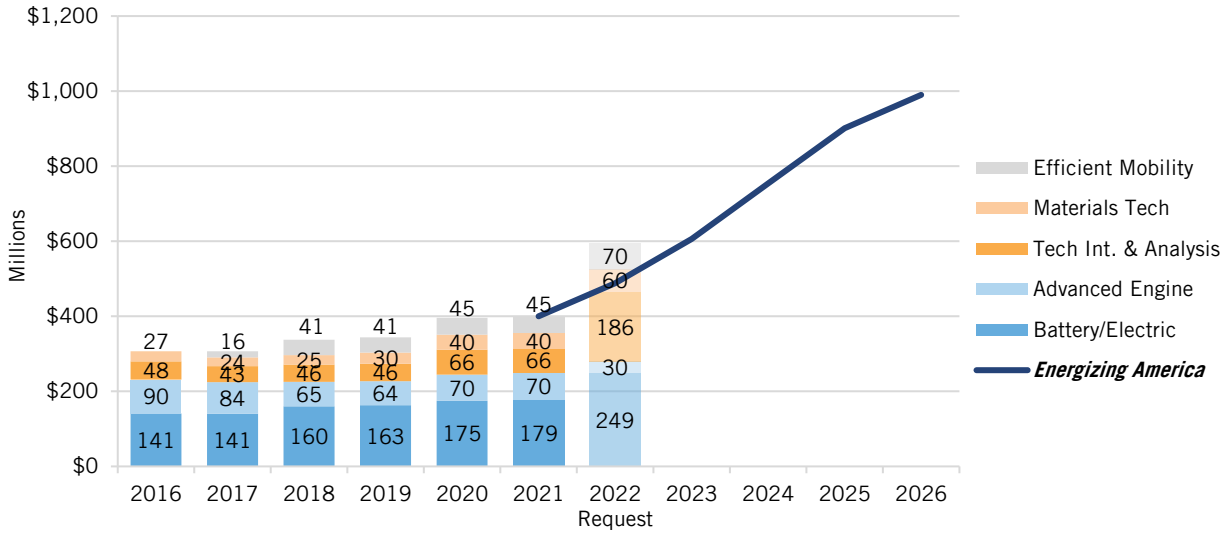
# Federal Energy RD&D: Vehicle Technologies

BY COLIN CUNLIFF AND LINH NGUYEN | JUNE 2021

The transportation sector is the largest source of U.S. greenhouse gas emissions, accounting for 29 percent of all carbon pollution in 2019.[1] The average U.S. household spends 16 percent of its total family expenditures on transportation, making it the most expensive spending category after housing.[2] By investing in research, development, and demonstration (RD&D) to use conventional fuels more efficiently and develop domestically produced electric vehicle (EV) technologies, the Vehicle Technologies Office (VTO) works to keep prices low for consumers, improve national energy security, and enhance environmental performance.[3] VTO also leads the Department of Energy's (DOE) research in autonomous and connected vehicles and intelligent transportation systems, which have the potential to improve transportation services while reducing greenhouse gas emissions.[4]

**Figure 1: *Energizing America* recommends increasing funding by 150 percent by FY 2026.[5]**




## What's at Stake

The world has begun the transition to EVs. Global EV sales reached over 3 million in 2020, up 40 percent from the 2.1 million sold in 2019, a record increase in new sales despite the economic contraction caused by the COVID-19 pandemic.[6] In the United States, EV sales were 4 percent higher than in 2019 in a car market that shrank by 15 percent.[7] Major automakers are rapidly increasing the range of EV models they offer. General Motors, the largest U.S.-based automaker, announced in January 2021 that it aspires to an "all-electric future [and] … to eliminate tailpipe emissions from new light-duty vehicles by 2035."[8]

To accelerate the transition to EVs and help domestic automakers capture this growing global market, VTO has set technology cost and performance targets for EVs and the batteries that

power them, including reducing the cost of batteries to 100 dollars per kilowatt-hour ($100/kWh), increasing their range to 300 miles, and decreasing charging time to 15 minutes or less, by 2028, with an ultimate cost goal of $60/kWh. These targets were chosen to make EVs competitive with internal combustion engine (ICE) vehicles. At a battery cost of $100/kWh, the total cost of ownership of an EV—purchase price plus maintenance and fuel costs over the lifetime of the vehicle—reaches cost-parity with ICE vehicles. And at a battery cost of $60/kWh, the upfront purchase price of an EV reaches parity with ICE vehicles.

But these targets may not be sufficiently aggressive: BloombergNEF's *Electric Vehicle Outlook* projects battery costs to reach $100/kWh by 2024, while IHS Markit anticipates reaching the $100/kWh milestone in 2023.[9] The National Academies of Sciences, Engineering, and Medicine found that batteries for EVs will reach $100/kWh in the 2023–2025 range, and could reach $60/kWh by 2030.[10]

DOE should set more-ambitious innovation targets—and Congress should appropriate commensurate funding levels—in order to help domestic automakers and battery manufacturers reclaim global leadership in EVs. China is currently leading the world in EV deployment, accounting for more than half of total global production and sales, while the European Union is moving quickly to catch up and secure its own EV supply chain.[11] Greater investment in battery and electrification RD&D is needed to help move the United States toward a similar track.

The SuperTruck II research activity set a target of doubling the freight-hauling efficiency of heavy-duty Class 8 long-haul trucks by 2020 over the 2009 efficiency level.[12] Long-haul trucking is a key "hard-to-decarbonize" transportation subsector that is more challenging to electrify due to the need for high-energy-density fuels. Improving efficiency is one of the few good near-term options for lowering energy costs and reducing carbon emissions in this sector.[13]

DOE has also established goals to improve mobility efficiency through connected, shared, and autonomous vehicles, and to identify novel high-strength structures that can reduce vehicle weight and improve fuel economy. The Energy Efficient Mobility Systems (EEMS) subprogram leads DOE's work in Connected and Autonomous Vehicles (CAVs), which integrate intelligence and sensing capabilities to enable vehicle operation with little human intervention and increased connectivity between vehicles and traffic signals. By optimizing traffic signaling and decreasing accidents caused by human error, CAVs have the potential to reduce congestion, fuel consumption, and emissions.[14]

The Energy Act of 2020 provides the first reauthorization of DOE's Sustainable Transportation program—which includes VTO, the Bioenergy Technologies Office, and the Hydrogen and Fuel Cell Technologies Office—in over a decade. The bill authorizes $830 million for FY 2021, $855 million for FY 2022, and $880 million for FY 2023 for Sustainable Transportation, but does not specify the amount to be allocated to each office.[15]

Figure 1 shows historical DOE investment in vehicles technologies RD&D by subprogram, for FY 2016 through FY 2021, and the FY 2022 budget request. The blue line shows recommended funding levels from the *Energizing America* report (see box 1). Because transportation makes up a disproportionately small share of the federal energy RD&D budget—transportation accounts for 29 percent of U.S. greenhouse gas emissions but only 16 percent of DOE's portfolio—*Energizing*

*America* recommends a fast ramp-up to 150 percent above FY 2020 levels over the next five years.[16]

## Box 1: An Innovation Agenda for Vehicles Technologies

The *Energizing America* report co-authored by the Information Technology and Innovation Foundation (ITIF) and Columbia University's Center on Global Energy Policy offers several recommendations to DOE and Congress to accelerate innovation in vehicles technologies. Similarly, ITIF's 2018 report "Innovation Agenda for Deep Decarbonization" makes recommendations for harder-to-decarbonize transportation sectors, include aviation, long-distance trucking, and marine shipping:

- Congress should ramp up investment in vehicle technologies RD&D by 150 percent over the next five years.[17] This increase is needed to rebalance the research portfolio and make up for historical underinvestment. Transportation is now the largest-emitting sector, producing 29 percent of U.S. greenhouse gas emissions, but accounts for only 16 percent of DOE's portfolio.[18]
- Congress should double investment in RD&D of artificial intelligence with energy applications across the federal government, including DOE programs in advanced grid RD&D and Information Technology and Services (ITS).[19]
- DOE should accelerate the ambition of its cost target for advanced batteries. DOE's current goal to reduce the cost of batteries for EVs to $100/kWh by 2028 is not ambitious enough. But multiple analyses from the National Academies, Bloomberg New Energy Finance, and IHS Markit suggests that this target could be achieved by 2023–2025.[20]
- DOE should increase RD&D of fast-charging EVs, as slow charging times have been a barrier in EV deployment.[21]
- DOE should launch a SuperTruck III program to double freight-hauling efficiency of heavy-duty Class 8 trucks by 2025.[22]
- DOE and the Department of Transportation should create new programs targeting shipping, aviation, and energy management and electrification at ports and airports, which have not been a focus in past federal transportation RD&D programs.[23]

## Vehicle Technologies RD&D Subprograms

RD&D in the Vehicle Technologies program is distributed across six subprograms:[24]

- **Battery and Electrification Technologies** explores new battery chemistry and cell technology to reduce the cost of EV batteries; supports work on EV integration with the electric grid; conducts RD&D to improve electric drivetrains; and explores fast-charging technologies.

- **Energy Efficient Mobility Systems** applies complex modeling and simulation to explore the energy impact of emerging disruptive technologies such as connected and autonomous vehicles, information-based mobility-as-a-service platforms, and advanced powertrain technologies in order to identify opportunities to improve efficiency.
- **Advanced Engine and Fuel Technologies Research and Development (R&D)** works both to develop advanced combustion engines and to co-optimize fuels and engines to improve fuel economy.
- **Materials Technology** supports vehicle lightweighting and improved propulsion (powertrain) efficiency through materials RD&D.
- **Technology Integration** supports cooperative agreements with Clean Cities coalitions, maintains the Alternative Fuels Data Center and the annual Fuel Economy Guide, conducts transportation data and systems research, and supports the collegiate Advanced Vehicle Technology Competitions (AVTC) and other workforce development programs.
- **Data, Modeling, and Analysis** provides technological, economic, and interdisciplinary analyses to inform and prioritize the Vehicle Technologies research portfolio.

## Key Elements of the FY 2022 Budget Proposal[25]

The budget proposal seeks $595 million for the Vehicle Technologies program, a 49 percent boost from FY 2021 enacted levels. Some highlights include:

- **A 39 percent increase in the Battery and Electrification Technologies subprogram,** including a $65.5 million increase in funding for battery R&D; funding for battery development work through the Battery500 R&D Consortium; a $2 million increase for electric drive R&D; and a $2.5 million increase for electrification R&D, focusing on developing smart charging, extreme fast charging, and wireless charging technologies.
- **A 57 percent reduction of the Advanced Engine & Fuel Technologies R&D subprogram,** including no funding for lightweight high-efficiency engine research projects; no funding to improve efficiency and reduce harmful emissions from off-road vehicles, including agricultural vehicles; the elimination of research on spark-ignited engines; and reduced funding for emission reduction of diesel engines.
- **A 56 percent increase in the Energy Efficient Mobility Systems subprogram,** including a $20 million investment in clean energy mobility solutions for underserved communities and a $4 million increase in computational modeling and simulation.
- **A 50 percent increase in the Materials Technology R&D subprogram,** including funding for a new research effort on non-exhaust emissions from tire wear, brake wear, road wear, and stirred-up dust, which contribute to particulate matter (PM2.5) pollution. Funding will also increase for research on electrical conductivity, thermal conductivity, magnetic materials, and high-temperature operations that limit advances in wireless charging and electric powertrains.
- **A 200 percent increase in the Technology Integration subprogram,** including funding for SuperTruck III demonstration projects; new funding for charging infrastructure

demonstration projects; and new funding for smart charging vehicle-grid integration demonstration projects.

- **No change to the Data, Modeling, and Analysis subprogram.**

## Further Reading


- Varun Sivaram et al., *Energizing America: A Roadmap to Launch a National Energy Innovation Mission* (ITIF and Columbia University SIPA Center on Global Energy Policy, 2020), http://www2.itif.org/2020-energizing-america.pdf.
- Colin Cunliff, Ashley Johnson, and Hodan Omaar, "How Congress and the Biden Administration Could Jumpstart Smart Cities with AI" (Information Technology and Innovation Foundation, 2021), 25, https://itif.org/sites/default/files/2021-smart-cities-ai.pdf.
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## About ITIF

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## ENDNOTES

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