# Commercial Trucks Are One Key to EV Adoption

## What's Holding Them Back?

**Battery trucks face hurdles that electric cars don't. Most prominently, they can cost more than three times as much as a similar diesel model.**

BY BART ZIEGLER

THE EFFORT to reduce carbon emissions by transitioning to electric vehicles isn't going as well as it might seem.

On the bright side, the adoption of electric cars is happening faster than some experts predicted, with sales in the U.S. soaring 65% to 800,000 last year. But the move to electric power for big commercial trucks is stuck in first gear, with only a few thousand on American roads.

Experts say it's vital to replace millions of diesel-engine tractor-trailers and other big rigs with green alternatives to tackle climate change. Medium- and heavy-duty trucks make up only about 5% of U.S. vehicles but spew about 23% of all greenhouse gases from transportation sources, according to the Environmental Protection Agency.

Now, with a push from billions of dollars in new federal and state subsidies and stricter regulations, some experts are optimistic that the transition to green-energy trucks will accelerate.

But getting there faces speed bumps. Several technologies (batteries, fuel cells or burning hydrogen in a modified internal combustion engine) are competing to replace diesel engines. That's a technological split that the car industry doesn't face, and it could make truck buyers hesitate to commit to any one path. It also could require massive funding to build two "filling station" networks—one with high-power chargers for battery trucks and another to replenish the hydrogen tanks of others.

Another big hurdle: Battery trucks can cost more than three times as much as a similar diesel model—a vastly greater premium than the 15% to 25% extra that consumers pay for many electric cars over nonelectric versions, not counting tax incentives that can reduce this added cost. And there are downsides with the battery trucks' weight, lengthy charging times and limited driving range.

All this means that the truck transformation could take far longer than that of passenger vehicles. "This is a transition that is a minimum of 15 to 20 years," says Bernd Heid, a senior partner at McKinsey & Co. who advises clients on carbon-free transportation.

Here's a look at what might speed up—or slow down—that transition:

### Sticks and carrots

In April, the EPA proposed increasingly stringent vehicle-emission rules that it says could require 35% of new short-haul and 25% of new long-haul tractor-trailers to be electric by 2032. Meanwhile, California requires that some trucking companies begin buying electric vehicles starting next January.

There are also positive incentives to make the move. Under the 2022 Inflation Reduction Act, buyers of electric and hydrogen-fuel-cell heavy commercial vehicles can receive a tax break of up to $40,000 per truck. The law also offers tax incentives to install electric charging and hydrogen filling stations. In addition, it provides funds to boost U.S. production of vehicle batteries—the most expensive part of electric trucks—which could reduce their cost.

### Customer demand

Pressure from some customers of trucking companies also is fueling the move to electric vehicles.

Katie Griley is president of Griley Air Freight, a family-owned company that moves freight in and out of Los Angeles International Airport. She says a client wanted a no-emissions truck used for its shipping business because one of its own customers specified it. So she bought a Volvo electric truck for about $470,000—compared with about $135,000 for a diesel model.

That's too rich a price for her relatively small company, even after government subsidies, so she says she plans to split the cost with the client. Still, she says of truck electrification: "This is coming. I'm not going to be left to the side."

Sysco, a food products distributor, has about 20 battery trucks from Daimler's Freightliner division and a letter of intent to buy a total of 800. So far, it uses them to deliver shipments to restaurants and other customers in Southern California. The company limits the trucks' daily routes to 130 miles or so to ensure they don't run out of juice. When they return to the depot at day's end they are plugged in and take about three hours to fully recharge.

Apart from their high cost, Sysco is pleased with the vehicles. "The biggest surprise is the truck holds its charge better than we assumed," says Marie Robinson, Sysco's chief supply-chain officer, who is overseeing the rollout. That's allowing the company to test routes longer than 130 miles.

Another upside: In an era when truck drivers are in short supply and frequently jump jobs, Sysco's drivers "love the truck," she says. Electric trucks are quieter and accelerate more smoothly and quickly than diesel ones.

Sysco plans to have one-third of its fleet converted to nondiesel by 2030. But the cost of the vehicles and the chargers makes them economically viable only with government subsidies. As Sysco plans to expand its use of electric trucks elsewhere in the U.S., "we anticipate some form of government assistance in all those places," Robinson says.

Moving to electrics also can require changes in driver habits. Performance Team, a distribution company owned by shipping giant A.P. Moller-Maersk, has told drivers of its Volvo electric trucks to look for "opportunity charges"—hooking up their rigs when they pause for a break at the company's depots, says Michael Gallagher, Performance Team's head of procurement, fleet and services in North America. One incident reinforced that practice—a truck got stuck along a road with a depleted battery and had to be towed.

### Getting the juice

Beyond the steep price of battery trucks, fleet operators face high expenses and other challenges in constructing charging stations at their depots. Among the hurdles: delays in government approvals, lead times of up to two years in procuring the electrical gear, and trouble getting the local utility to provide the vast amount of power needed.

"I've had a number of customer sites that I have worked with where we've got longer lead times getting the infrastructure in place than we do for our ability to deliver the trucks," says Keith Brandis, vice president of system solutions partnerships at Volvo Group North America.

Trucking firm Schneider National started work on charging stations at its Southern California sites about three years ago to service the 92 Freighliner electric trucks it ordered. "We thought we'd be done late last year," says Rob Reich, Schneider's executive vice president and chief administrative officer. But it didn't have a ribbon cutting for the installation until June. His advice to other trucking firms: "It's going to take a lot longer than you think."

Truck makers are trying to ease the issue. They are helping customers determine details such as how many chargers they need, where to install them and how much power they will use.

Unlike in the diesel world, where fuel delivery to truck depots is a well-established system, "we have to enter into the infrastructure space," says Rakesh Aneja, head of e-mobility for Daimler Truck North America. "That to me was one of the biggest surprises" about the move to electric.

### What about trade-ins?

Commercial-truck purchases are all about the total cost of ownership—what it costs to buy the truck, operate it and maintain it, and what it will be worth when it is traded in for a new model. "It's the only metric that counts," says McKinsey's Heid.

Calculating the trade-in figure—the residual value—is well-established for diesel trucks but a mystery for electric ones because there is no resale market yet to base it on. Plus, there's an added concern: The long-term viability and worth of the batteries aren't known. As with cellphones and laptops, truck batteries will lose their ability to hold a charge as they age.

All that makes it tough for truck buyers and companies that finance them to figure out the economics of purchases.

### The long haul

Designing battery trucks that could take nonstop trips of 500 or more miles—common for long-haul diesel routes—faces hurdles. The battery packs already are heavy. Adding more batteries could cut into how much freight a truck can carry, due to government weight limits. That could harm the economics of trucking. And charging bigger battery packs would increase the already-long charging times.

Many experts say fuel-cell trucks are the answer. These trucks carry compressed hydrogen that is fed into a device that converts the gas into electricity that powers the motors. Experts say a fuel-cell truck could travel 500 or more miles before its tanks need a refill. And that refill would take a fraction of the time it takes to charge an electric truck. But the technology is still at an early stage.

Most major truck makers are exploring fuel-cell models. Paccar has joined with Toyota Motor to develop fuel-cell trucks for its Kenworth and Peterbilt brands. Daimler is working with Volvo. In May, Hyundai announced a commercially available version of a fuel-cell heavy-duty truck.

"I'm excited about the option," says Schneider's Reich. "I don't anticipate [electric trucks] will be able to handle long haul."

But so far there are very few fuel-cell trucks in use—generally just test versions—and very few places to fill their tanks. Also, hydrogen is expensive and making it creates pollution.

Some 95% of hydrogen in the U.S. is produced by using steam to interact with natural gas. The process splits off hydrogen atoms, but emits carbon dioxide into the atmosphere—the very greenhouse gas that nondiesel trucks are supposed to eliminate.

Hydrogen advocates say "green hydrogen" could be created through an alternative method: using electricity from renewable sources to split water into hydrogen and oxygen. So far, production of hydrogen by this costly technology is minimal.

Volkswagen's Traton unit, which makes Navistar, Scania, MAN and other truck brands, is betting that batteries will advance enough to relegate fuel cells to a niche product. "There is so much research and money flowing into battery technology," says Michael G. Grahe, executive vice president of operations at Navistar.

Traton argues that battery trucks are much more energy-efficient when all the energy used to produce and transport green hydrogen and turn it into electricity in a truck's fuel cell is compared with the energy used to produce and transmit electricity to a battery truck.

### Splitting their bets

Truck manufacturers also are considering models that burn hydrogen in an internal combustion engine, similar to a diesel engine. But this technology faces the same hydrogen limitations as fuel cells—it's costly, and making it can produce greenhouse gases.

And these vehicles present another pollution concern. The high heat inside the engine creates nitrogen oxides, which can damage the human respiratory tract. So such trucks aren't considered zero emission.

Many big truck makers plan to split their bets by pursuing battery-electric, fuel-cell and, possibly, hydrogen-combustion options. And they say diesel could be around for many more years.

"We are likely to see a world in commercial vehicles where battery electric, diesel and hydrogen coexist for decades to come," says Brian Collie, Boston Consulting Group's global leader in the automotive and mobility sector.

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### Three Options
### The pros and cons of alternatives to diesel-powered trucks

**Battery-electric trucks**

**THUMBS UP:** Use proven technology perfected by electric cars; provide smoother, quieter power than diesel; may have lower maintenance costs; are totally green if charger electricity is from renewable sources.

**THUMBS DOWN:** Driving range too short for many trucking routes; charging takes too long; public truck charging stations are scarce; batteries are expensive and heavy; battery life is a question; the trucks cost too much.

**Hydrogen fuel-cell trucks**

**THUMBS UP:** Create electricity through a chemical process and emit nothing but water; should go substantially farther on a tank of hydrogen than a battery truck on a charge; filling a truck's hydrogen tank is vastly quicker than the 90 minutes to several hours to charge a truck battery; fuel cells are lighter than batteries.

**THUMBS DOWN:** Trucks projected to be more expensive than even costly battery ones; most hydrogen production creates greenhouse gas; few hydrogen filling stations exist; trucks won't be commercially available for several years.

**Hydrogen combustion engines**

**THUMBS UP:** Use engines based on diesel versions, simplifying the design process; eliminate weight of batteries needed in electric trucks; likely to cost far less than battery and fuel-cell trucks.

**THUMBS DOWN:** Don't qualify as zero-emission since they put out nitrogen oxides, which can harm lungs and create acid rain; face same issues as fuel-cell trucks of lack of hydrogen filling infrastructure and reliance on nongreen hydrogen production.


| | VNR diesel | Gross allowed weight (truck plus cargo) in the U.S. | VNR electric |
|---|---|---|---|
| | 80,000 pounds | | 82,000 pounds |
| | 15,000 pounds (weights can vary based on configuration) | Truck weight without cargo | 6x4 four-battery-pack 22,400 pounds<br>6x4 six-battery-pack 25,400 pounds |
| | 500 horsepower | Horsepower for top model | 455 horsepower |
| | The most common fuel-capacity configuration is 150 gallons. Using an average of 6.5 miles per gallon, that yields a range of about 975 miles. | Approximate driving range | With a six-battery-pack configuration the range is up to 275 miles. |
| | For every gallon of diesel fuel combusted there are 22.8 pounds of CO2 generated. | Carbon-dioxide emissions | 0 (provided the electricity comes from a green source) |


## Barriers to Going Electric

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down the electrification road for a host of reasons—nor should we want to. For one thing, it would place unnecessary limitations on other viable solutions to rising greenhouse-gas emissions. It also ignores existing technical, regulatory and strategic constraints on electrification.

None of this is to say the world shouldn't be shifting to new—and cleaner—electricity. And not just because of its role in fighting climate change. Among other things, electrification via renewable energy is playing a pivotal role in energy security for a variety of countries where oil and gas is scarce and expensive, and where volatile fuel prices threaten economic growth and fiscal stability. Clean energy helped Germany and other European countries cope with the loss of natural-gas imports from Russia last year. New clean energy is also helping key economies like China and India reduce air pollution.

But even with its environmental and strategic benefits, electrification won't be the be-all and end-all for the foreseeable future.

Here are five reasons why:

**• Some things can't be electrified.**
There are a lot of industries that are too difficult or expensive to be electrified for the foreseeable future. Do you want to know why there is no major commercial airline currently operating electric long-distance flights? It's because the battery weight needed to hold enough energy for a trans-Atlantic flight would be greater than that of the airliner itself.

The weight of the battery and driving range is also a barrier for electrifying 18-wheeler trucks, though that electrification technology is further along than that for large jets. Freightliner has a big rig called eCascadia, but its range is only 250 miles, recharging takes over 90 minutes, and the e-truck is two to three times more expensive than its diesel-fuel version.

That may change as the battery and charging-station technology develops. A new study by the Environmental Defense Fund says that long-distance battery electric trucks could be cost effective by 2030, but other solutions are also possible by then, such as hydrogen, waste-to-energy, biofuels and tailpipe capture. (More on that in a moment.)

High-heat industrial processes, such as those for blast furnaces, cement kilns and petrochemical plants, are another commercial activity that will be hard to electrify, because electric high heat can be challenging and expensive for some industrial applications.

One key problem is that any unplanned downtime or fluctuation in temperature levels—caused by electrical fluctuations or disruptions from weather, accidents or a failed circuit breaker—not only can ruin the end product but also possibly damage billions of dollars of industrial equipment. While that scenario can be averted with automated backup energy systems, as is done routinely for nuclear plants to prevent a meltdown, it's still an expensive add-on cost.

**• Cheaper alternatives may be coming for the most difficult-to-electrify areas.**
Electric power doesn't have a monopoly on innovation. As a result, it could be risky for some industries to invest in some electrical solutions at the moment, knowing there might be a superior, cheaper technical solution down the road. Alternatives such as biofuels, hydrogen or biogas and fossil fuels with carbon sequestration offer the potential to be superior sources of power.

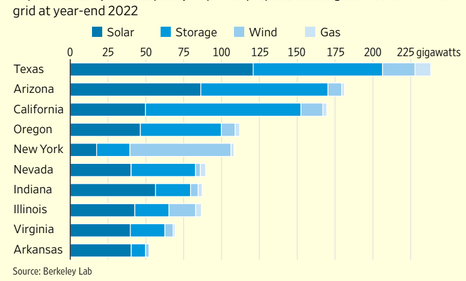
For instance, Remora, a startup based in Wixom, Mich., is designing a device that can collect tailpipe CO2 directly while a truck is in operation, compressing it for later sequestration or sale. Several airlines have started to use jet fuel made from purified biogenic waste that can be mixed with oil-based diesel fuel—so-called drop-in fuels that don't require special or new fuel-transport infrastructure. Hydrogen made from renewable energy also could eventually be a solution for fueling planes and trucks.

Heidelberg Materials, a global manufacturer of building materials, is studying carbon capture and storage for its Mitchell, Ind., operations that would allow it to continue to use a fossil-fuel energy source while adding equipment that would separate CO2 emissions from other waste gases before, during and/or after combustion activities. Heidelberg would then transport its waste CO2 to be permanently injected into deep geological storage or to be reused making other products in a way that it doesn't wind up back in the atmosphere.

These examples have the advantage of using existing energy infrastructure rather than retiring it before its end-of-life service.

### Gearing Up

Top 10 states by total capacity of power projects seeking connection to the grid at year-end 2022




Source: Berkeley Lab

**• Access to land, a surfeit of complaints.**
Yes, there is plenty of uninhabited land in many countries, and especially in the U.S. But uninhabited doesn't always spell accessibility.

For one thing, in highly urbanized regions or densely populated countries, it can be difficult to find sufficient empty land to support alternative-fuel installations. Around the world, in places as diverse as India and Africa, renewable-energy developers often have trouble getting permits to buy or lease the necessary acreage. And in many areas, including the U.S., local populations can object to living near wind and solar farms, or near the power transmission and distribution lines that they require.

Consider this: It would take a wind farm on about 100,000 acres to generate the same amount of electricity as a one-gigawatt nuclear plant that typically occupies less than 1 square mile, or 640 acres. Princeton University estimates in a high-renewable-energy scenario, where solar and wind would account for virtually all electricity generation for the U.S. in 2050, the number of wind turbines would require roughly 244 million acres of uninhabited land—even assuming efficiency improvements. The current U.S. electrical system only uses about 20 million acres for the power generation business, including fuel-source production (e.g. coal, natural gas, solar, wind, nuclear and hydro), and power plants. Today's power lines take up 4.8 million acres in the U.S., but that could increase sharply the more renewables that are added.

For a small country like Japan, that renewables-footprint requirement seems insurmountable, even if its nascent offshore wind business gets off the ground. But even for a large nation like the U.S., construction of wind and solar farms often gets held up by groups who want to use the land (or sea) for something else. In the entire U.S., there are two small offshore wind platforms currently in operation, with a third, larger one, nearing completion. The Biden administration is trying to change that at the federal level, but local factors are often hard to sort out.

Moreover, all that uninhabited U.S. land isn't necessarily contiguous with large energy-using metropolitan regions or located where the most commercial-scale resource of renewable energy is available. For instance, many large U.S. cities aren't contiguous with Midwest or offshore wind resources or Southwest solar.

**• Difficulty siting right of way for power lines and getting technical approvals for renewables to connect into the grid.**
Since the energy resource used for electricity generation often isn't located in populated areas, that means more transmission lines will be needed, and more lines means more permitting, which can be a time-consuming, multiyear process.

In addition to potentially requiring new transmission lines, new renewable projects also have to receive technical approval to be allowed to connect into existing grids to prove that adding more electricity won't destabilize existing service. Again, that can take years for regulators to study and approve. The U.S. Congress has talked about permitting reform, but a solution to the problem isn't currently on the horizon.

The U.S. isn't the only place with transmission-construction and grid-connection obstacles. In India, land permitting for solar energy can be a bureaucratic nightmare and remains a barrier. In Germany, local opposition to new high-tension transmission lines to carry offshore wind energy from the country's northern shores to its southern factories blocked projects for years before the Ukraine crisis. In Africa, governments that can access foreign aid for construction of wind and solar installations have had more difficulty financing the transmission lines to carry the power generated to populations and industry. All of this will continue to slow down electrification.

**• Electricity grids are highly interruptible.**
It isn't just the occasional squirrel that's the problem. In recent years, we have witnessed weather systems that knocked out power for huge swaths of the U.S. at once. The war in Ukraine is a reminder that cyberattacks against the grid could be catastrophic if too many aspects of daily life are tied to a singular infrastructure. Already, there are many vital services that cannot be conducted without access to electricity, like lighting, telecommunications, data centers and financial services. Broadening that to our *entire* fuel system and industrial operations seems risky, if not downright irresponsible.

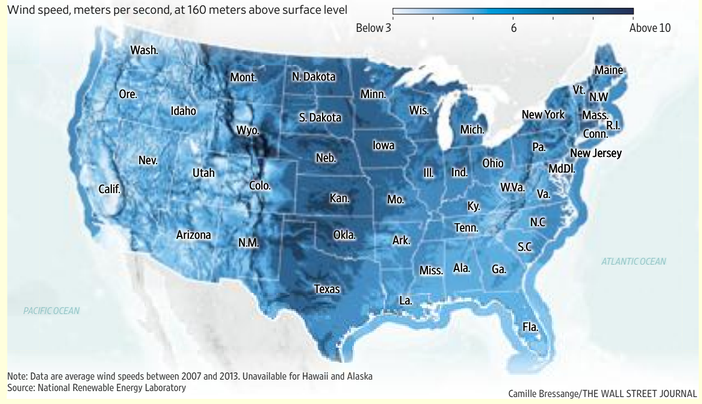
There will be technical solutions to the risks of electricity disruptions, but it will take time and money to implement them. Households, governments and regional grids will all have to invest in backup systems that can be turned on seamlessly using automation when the larger grid goes down. That could take decades—and an enormous amount of money. BloombergNEF estimates that it could take as much as $17.3 trillion to expand the grid and $4.1 trillion to maintain what is there now, for a total of $21.4 trillion.

Ultimately, there is little doubt that the world is heading for the electrification of a lot more things. And that's good—for energy security, stable economic growth and reduced greenhouse-gas emissions.

But it's also clear that a goal of electrifying *everything* is neither possible nor desired, and putting all our power eggs in one basket would be a fool's errand. Innovation is by no means isolated to the electric domain. Many forward-looking businesses are experimenting with new ways to squeeze emissions out of industrial processes, and to replace fossil fuels in transport and building applications, in some cases with assistance from governments. Power to them. Rather than naysay what's not electricity, let's hope they unlock superior solutions.

### Location Matters

The strongest wind resources in the U.S. are far enough away from many areas of major electricity demand to present transmission challenges, a problem also posed by solar energy.




Note: Data are average wind speeds between 2007 and 2013. Unavailable for Hawaii and Alaska
Source: National Renewable Energy Laboratory

Camille Bressange/THE WALL STREET JOURNAL