Electric heavy-duty vehicles: The real 800-pound gorilla in the room

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When I joined E Source in 2010, one of my first responsibilities was to moderate a Forum session in collaboration with Michael Shepard, our president at the time. If my memory serves me correctly, Michael called our session something along the lines of "Electric vehicles: The 800-pound gorilla in the room."

For weeks leading up to our annual conference, I spent almost every day in his office preparing for our session. It would be the first time that E Source ever presented on electric vehicles (EVs). With nearly no EVs on the road then, Michael and I were a bit too optimistic in thinking that most utilities would be ready to get serious about planning for EVs.

Today, EV charging on the electric grid isn't a particularly scary thing for most utilities. But soon, having to serve large EV loads will be that big, hairy, audacious goal (BHAG) utilities must face. And we probably don't have nearly as much time to prepare as we might think.

Electric trucks need a lot of juice

There's plenty of talk surrounding the commercialization of big, heavy EVs, but they mostly don't exist on our roads right now. I'm referring to so-called commercial vehicles, often parts of fleets operated by public agencies and private businesses. In transportation circles, we sometimes refer to them collectively as medium- and heavy-duty vehicles (MHDVs), or even more specifically by their weight classes, where a Class 5 vehicle is something the size of a Ford F-550, while a Class 8 truck is the size of a fire engine.

As you might imagine, the heavier the vehicle, the more energy it needs to move. It will need a larger battery and more electricity to charge that battery. So even though there are more light-duty vehicles (LDVs or passenger vehicles) on the road, each individual heavy-duty vehicle represents several lighter vehicles. And that can present a real concern for meeting the grid's future demand and charging infrastructure needs as MHDVs electrify.

How are utilities preparing to meet these new challenges without adding considerably to the costs (and emissions) associated with serving these new loads?

To put this into perspective, an all-electric tractor trailer (those long-haul trucks you see moving freight on the interstate) would need a battery at least 15 times larger than the largest battery in all-electric LDVs today. However, the real kicker isn't just about how much energy these larger vehicle batteries store, but about how quickly we need to recharge them. For long-haul electric trucks to be financially and logistically viable, they need to be recharged fairly quickly in some cases—on the order of minutes instead of hours. The maximum allowable time to recharge for long-haul trucks is somewhat debatable, but 10 minutes is a number that gets thrown around occasionally as a performance goal. Fully recharging a large electric truck's battery in 10 minutes would require a megawatt-scale charger. In this example, we'd need about 9 megawatts (MW) of vehicle-recharging power. That much power is equivalent to the demand from thousands of homes!

From a utility planning perspective, this is essentially the worst-case scenario for MHDV charging and infrastructure needs, but that doesn't mean it won't happen. And it may happen sooner than we think. Several research groups around the world are developing megawatt-scale charging equipment and connectors right now (**figure 1**). In Bakersfield, California, the start-up WattEV intends to build the nation's first all-electric truck stop, hoping to serve 12,000 electric trucks by 2030. And of course, we all know about the thousands of electric delivery vans Rivian is building for Amazon, as well as the thousands of electric school buses President Biden intends to electrify, where fleet depot charging will present grid resource challenges of its own.

Figure 1: A researcher at the National Renewable Energy Laboratory tests the fit on a proof-of-concept megawatt-scale connector



Source: National Renewable Energy Laboratory

It all makes you wonder how utilities are preparing to meet these new challenges without adding considerably to the costs (and emissions) associated with serving these new loads.

How fast we can versus how fast we should

When it comes to refueling large EVs, timing is everything. If instead of charging that all-electric, long-haul truck in 10 minutes, we chose to recharge it in 30 minutes (the legally required break time a truck driver must take after 8 hours of driving in the US), the power requirements for recharging the truck would be cut to a third (about 3 MW). Or, if we assume the driver waits to charge the vehicle until after their 11 hours of total daily driving or 14-hour allowable duty period (when they then have 10 hours to sleep or rest before starting a new shift), we'd only need a 150 kW charger to refuel that same truck. That's a huge difference in grid demand—literally the difference between powering one Tesla Supercharger or thousands of homes.

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If the tech giants get their way, truck drivers will all be replaced by autonomous electric trucks in the years to come. And they'll likely require charging or refueling of zero-emission trucks to happen as quickly as humanly (or nonhumanly) possible. Elon Musk, Tesla, SpaceX … these are the modern poster children for futurism and industrialism. Harder, better, faster, stronger! You can just hear that Daft Punk song playing in the background, can't you?

No matter how impressed we may be by what Musk, Tesla, and others have achieved so far, utilities are a different breed than tech companies, and we shouldn't pretend they operate at the same pace (or that we should necessarily want them to). We also shouldn't give in to the demands of non-EV owners who loudly proclaim that they won't purchase the Tesla Model Y until there's a 350 kW fast charger on every street corner. That kind of infrastructure would be absurd and unnecessary, and it would wreak havoc on our distribution grids. We need more level-headed planning around where and how much EV charging infrastructure (and power) is really necessary. And this need is, ironically, rather immediate.

A BHAG bigger than any one of us

Contact us for more information on the electrification of MDVs:

When a BHAG—or an 800-pound gorilla—rears its ugly head, it's easy to throw up our hands and defer to the experts, hoping they'll solve the problem for you. And the experts tend to think that's a totally reasonable expectation. After all, we do call them the experts for a reason, right?

E Source is made up of true experts in utility programs and customer needs. It's what we do. When you're dealing with a challenge that's big, immediate, and entirely new, you shouldn't underestimate just how much effort will be required and how much coordination will be needed among all the various expert entities, assuming we hope to pull things off smoothly. Unfortunately, not every group of experts sees it this way.

Over the past few months, I've met with dozens of researchers, directors, professors, and graduate students from the University of California, Davis, and its Institute of Transportation Studies (ITS-Davis). If you read my previous blog post, Arguing about which clean mobility tech to support is slowing progress, you may recall that I'm a UC Davis alum and former ITS-Davis graduate student (go Aggies!). I also attended eight hours of presentations from these global leaders in transportation and energy technology and policy research. And I moderated a 90-minute discussion with two dozen folks from UC Davis and the California Mobility Center in Sacramento. I can say with a high degree of certainty that:

1. We have some of the best minds working on these problems.
2. We learn more every day about how to best solve these problems.
3. We still have a very long way to go before we'll have these problems solved.

Zero-emissions freight: An unsolved problem

One thing I failed to mention until now is that even designing a viable all-electric tractor trailer remains a formidable challenge that hasn't yet been fully solved. Marshall Miller, director of the Sustainable Freight research program at ITS-Davis, described in our recent meetings that there have been several technology demonstrations conducted so far, but these vehicles are still precommercial. The near-term prospects for zero-emissions solutions in short-haul and last-mile freight look more promising. But long-haul options present persistent and nontrivial challenges. And while some people might blame the lack of a robust refueling network for this holdup, the reality is that problems on the vehicle side have proven to be an equally tough nut to crack.

While the near-term prospects for zero-emissions solutions in short-haul and last-mile freight look more promising, long-haul options present persistent and nontrivial challenges.

I worked closely with Miller many years ago when he ran the battery and capacitor testing lab for Dr. Andy Burke. Miller and his team of brilliant researchers have been producing industry-leading research publications on topics related to freight and zero-emissions technologies for the past six years. But even Miller readily admitted that there's still a huge amount of uncertainty and many more obstacles to overcome before we've got our clean-transportation logistics issues all figured out. Maybe the best long-haul solution will turn out to be hydrogen. Or better batteries, or battery swapping, or a hybrid battery–fuel cell. Perhaps the solution is something else entirely. The reality is that no one really knows yet.

Using today's best commercial battery technologies, it's tough to build a heavy truck for long-haul shipping that makes sense in the market. Consider this ACS Energy Letters paper from 2017, Performance Metrics Required of Next-Generation Batteries to Make a Practical Electric Semi Truck, where researchers described just how difficult it is to optimize battery-pack size versus weight for the best available batteries. Our commercial batteries today are a bit better in terms of energy density but not by a whole lot. Battery swapping might eventually be viable for larger vehicles, but it's still a long-shot solution. Designing a battery-powered tractor trailer that can drive far enough without having to recharge, such that it's attractive to trucking companies, remains a not-yet-entirely solved problem. And in case you were wondering, delivering enough zero-carbon hydrogen cost-effectively to fuel a hydrogen-powered trucking fleet probably isn't going to be any easier. So what do we do?

How utilities can prepare

I won't sit here and tell you that I have all the answers or that I can solve these problems alone. To enable large EVs to recharge in a relatively short period of time on existing electric grids, a lot of planning and coordination is necessary. As we get there, remember:

- *You're not alone in addressing these problems.* A lot of us (myself included) have a tendency to put our heads down, focus on our own problems, and operate as if we have blinders on when there is a lot of hard work to be done. I see this with utilities attempting to start transportation electrification programs for the first time, but it happens outside of utilities as well. Someone working at a state transportation department recently expressed to me their concern about the possibility of having to get into the energy business—something neither they nor the logistics companies want to see happen. Meanwhile, they probably have little insight into all the great work happening in parallel at the electric utilities. We need to work together more closely to address these problems and not duplicate our efforts.
- *Find the expertise without relying entirely on the industry incumbents.* As I mentioned before, great minds have been working for years to try to solve some of our biggest transportation electrification challenges. They've made wonderful progress and produced incredible research, but they can't turn their models into reality without a whole lot of help from the rest of us. Look to well-established incumbents like ITS-Davis and others for inspiration and guidance, but don't expect them to solve the problems alone.
- *We can work together in a more coordinated fashion.* There's now a broad recognition that we need to coordinate more closely between transportation and energy planning to achieve our transportation electrification goals. The recent creation of the Joint Office of Energy and Transportation (with joint oversight from the US Department of Transportation and US Department of Energy) is just the latest signal that more close coordination is needed. We still don't know exactly what the new joint office will look like or how it will operate, but we're very excited to watch as new developments unfold.

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