Chapter 14
All-Electric Trucks Using Batteries or Overhead Wires

Since trucks are the chariots driven by the Gods of Stuff, in a fossil-free world it would sure be divine to have all-electric trucks.

Trucks don't have a lot in common with Tesla. The Tesla gets some of its high mileage from low aerodynamic drag (0.24), not the battery. Nothing personal here, but a truck is not a sleek beauty queen of the road. Trucks will always be a blocky mass of air resistance (0.60–0.65) and lose 20 % of fuel energy or more to drag when they travel over 50 miles per hour.

Hybrid diesel-electric (battery) trucks that capture regenerative braking will save some fuel, but are best for trucks that stop and start frequently like garbage trucks and buses, not the trucks on highways that don't stop often enough to recharge a hybrid battery.

It is much harder to develop hybrid systems for trucks than cars, since they are expected to last 15 years or travel 1 million miles (compared to an auto lifetime of <10 years), and travel in more extreme conditions of temperature, vibrations, and corrosive agents (NRC 2015).

Trucks are like postal carriers: Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds. A truck would have a problem living up to that creed if powered by a Li-ion battery. Li-ion, the state of the battery art, does not function well in cold and hot temperatures, which can shorten their lifespan, or even ruin them (AAA 2014; Calstart 2013a; Pesaran 2013).

Battery-Electric (BEV) Trucks

Batteries capable of moving a big truck would be behemoths, far too heavy and large to be practical. One European study calculated that a truck capable of going 621 miles hauling a maximum payload of 59,525 pounds would need a battery weighing as much as 55,116 pounds, which is 93 % of the legal road weight limit there, and take up a quarter of the space in a 40 ft. container (den Boer et al. 2013).

Another study found that the battery to move a 33,000 pound truck would weigh 17,500 pounds, have a 500 mile range with an efficiency of 23 %, and cost so much

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it would never pay for itself. An improved diesel truck using the technology available today could go 1300 miles with an efficiency of 39 %, and pay for itself within a year (DOE 2011).

The Port of Los Angeles explored the concept of using an all-electric battery drayage (short-haul) truck to transfer freight between the port and warehouses, but rejected them because they could go at most 100 miles a day before needing to be recharged, half of the minimum 200 miles needed. The short range was due to the need for a 350 kWh battery that weighed 7700 pounds and reduced payload too much. The 12 h or more to recharge the battery was another deterrent. Ultra-fast 30 min recharging was considered too risky since this might reduce battery lifespan, and bearing the cost of replacing these expensive batteries was out of the question (Calstart 2013b).

WAAAAY Too Expensive

For all trucks, with current battery technology, not enough fuel is saved to justify the cost of an expensive battery pack. A diesel delivery truck costs $65,250 now, which is $35,000–$182,000 less than an all-electric battery truck, and $207,000 less than a hydrogen fuel cell (FCHEV) delivery van. If you add in the infrastructure cost of electric or hydrogen service stations, the cost difference is even higher. Clearly BEV and Hydrogen fuel cell (FCHEV) delivery, drayage, and long haul trucks cost too much to be competitive with diesel trucks now (Table 14.1).

Calstart also looked at $234,090 drayage trucks running on compressed natural gas (CNG) aided by a 150 kWh battery ($47,250). Since a used drayage truck can cost as little as $3000, this is clearly not economic. Plus there is an additional cost of $8400 per truck for the CNG fueling station (Calstart 2013b).

Typical e-truck battery warranties now are just three years but need to be a minimum of six years to be acceptable. Cold and hot weather, ultra-fast charging, overcharging, discharging beyond recommended depth, damage to delicate battery

Table 14.1 Comparison of costs for different types of trucks using three types of propulsion systems, Delivery & Long haul costs in 2010 US$ (den Boer et al. 2013, Tables 15–18, 21). Drayage and infrastructure cost (Calstart 2013b, Tables 4.7, 4.11, 4.20). FCHEV are far from commercial both in cost and technology

Type of truck	Diesel	BEV $400–800/kWh	FCHEV
Delivery	$65,250	$100,000–247,000 250 kWh battery	$272,260
Drayage	$104,360 Used: $3000	$307,890 350 kWh Battery $110,880	$226,361 60 kWh Battery
Long Haul	$107,610	$1,000,000–2,000,000 2500 kWh battery	$598,678
Infrastructure cost per vehicle	N/A	$25,000	$3350

management systems and other electronics from rugged roads can decrease battery life as well.

Despite massive local, state, and federal subsidies, many medium-duty electric truck and battery companies have gone out of business. Smith Electric received a $32 million grant for 500 Newton e-trucks, but went bankrupt in late 2013 despite a $66,402 subsidy per vehicle (Chesser 2013, 2014; Cassidy 2014). Navistar received $39.4 million for 950 electric delivery trucks but is in financial trouble and discontinued its electric van in March 2013 (Truckinginfo 2013). A123 made batteries for Smith Electric, but went bankrupt in March 2012 despite a $263 million dollar grant (Cohan 2012). Eaton has discontinued sales of diesel-electric hybrid drive systems as well (Eaton 2014).

Additional Costs

There is an alternative to a truck driver twiddling his thumbs, waiting for his electric truck to be recharged. Why not battery swapping stations? The problem is money. A truck battery swapping station might cost over $4 million, based on a $3 million cost for a car station (Berman 2011). The swap stop for trucks would need more storage and operating space for hundreds of large battery packs and for many large trucks to pull into. And perhaps a little more elbow room for the truckers!

Added electric generation might also be needed. Consider this frame of reference. The entire Los Angeles Metropolitan Transportation Authority light and heavy rail system consumed 489,000 kWh/day. But just 2500 BEV trucks that go 100 miles a day would need 625,000 kWh/day (250 kWh battery * 2500 BEV).

To charge just one 25 kWh battery pack in five minutes requires a power flow rate of 300 kW, equal to the peak power demand of a 100,000 square foot office building (NPC 2012).

Trucks Running on Overhead Wires (Catenary)

Since the battery-electric trucks the Port of Los Angeles was considering for drayage were impractical and could only go half of the required 200 miles, the port looked at using an overhead wire (catenary) system on the I-710 highway.

Trucks running on catenary systems are expensive, because they need equipment to use the catenary as well as a second propulsion system to deliver cargo after leaving the overhead wires. That is on top of the catenary system capital cost of $5–$7 million dollars per mile (Carpenter 2012) (Fig. 14.1).

A catenary is not just for any truck. It is hard to imagine putting wires over the 360 million acres of U.S. cropland for electric tractors, or the cost of doing so. Likewise many other trucks operate off the grid for logging, maintaining transmission lines, pipelines, railroads and dams.

Fig. 14.1 I-710 Siemens demonstration project with one mile catenary system. Cost $13,500,000. *Source* AQMD (2015)

Catenary systems do exist. In San Francisco, they are used by 273 trolley buses and 200 tramcars powered by overhead lines spaced about ten minutes apart. A great deal more power would be needed for the more than 40,000 drayage trucks that travel the 24 miles of the I-710 corridor every day, just seconds apart.

Conclusion

Trucks don't yet ride the roads on battery power. That day remains down the road, and indeed, over the horizon.

The very best batteries today are far too heavy, expensive, short-ranged, and take too long to recharge to be adopted by medium and heavy duty trucks. It would take decades to replace or alter millions of diesel trucks to run on overhead wires, and we do not know whether today's electric grid, or a future renewable grid, can produce enough electricity to power them. Our quest for battery-powered trucks must keep going, and going, and going …

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