Why Electric Vehicles do *not* need a 400 mile range

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I have argued before that 250-300 miles of range is all that's needed to allow the use of electric vehicles for most of the population. The charging requirements for electric cars are slightly different for city driving and long distance travel, so let's look at the details.

City driving consists of a high number of short distances, and long times in between when the car is parked. I'd like to base my arguments on data, so I'll use a study of Seattle drivers[1]. 75% of participants drove 39 miles/day or less. That is 195 miles Mon-Fri.

How can you charge a car to cover 195 miles? Assuming 3.5 miles/kWh and a 6 kW charger, it takes less than 10 hours. And electric vehicles have one advantage compared to any other fuel (gas, diesel, hydrogen, CNG, or LNG), and that is that very little new infrastructure has to be built to get electricity, because electricity is available almost everywhere already. This means charging station can be build almost everywhere, and electric cars can be charged almost everywhere. This allows a shift of how electric cars will be fueled compared to other cars. And if you can charge almost everywhere, slow charging speed does not matter (110V to standard Level 2 with 6-7 kW are all slow). Everybody owning an electric car today and charging at home knows that. The car gets plugged in when you get home, and is fully charged when you need it again in the morning. However, not everybody can charge at home, and the fraction of people unable to do so will increase with increasing numbers of electric cars. But because the requirements for charging slowly are not very high, charging electric cars will soon happen every time the car is parked, not just at night. It can already be done. I charge at the bank (Huntington), at the pizza restaurant (Donatos), at the zoo, at the mall (Easton). Charging at work becomes more common, too. I had no problem finding an available charger for all of these, and it seems that the build up of chargers keeps pace with the increase of electric cars. Keep in mind that not all electric cars need to be charged at the same time, just as all gas cars do not need to be refueled at the same time. The recommened ratios of charging stations to cars vary between 1:8 to 1:27[2]. This

[1] https://www.sciencedirect.com/science/article/pii/S0191261516309067

[2] https://theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf

means that adding charging to 12% of the parking spots is sufficient to charge electric cars for the all private use. And it might become even more convenient in the future if a wireless charging standard is adopted and you just have to park in a designated parking spot and everything else happens automatically.

This means that 200 miles of range is sufficient for city driving for a work week without charging for 75% of the people. To account for decreased range in winter, the range might have to be 250 miles. Assuming 50% of the range can be recovered by charging where you park, that means that only 125 miles of range are needed for a work week of city driving!

Long distance travel is a little bit more complex, because it involves range and fast charging speed. Some data first: 50% of long distance car trips are 194 miles or less[3]; this distance can already be travelled with a 250 mile range car. However, 75% of long distance trips are 500 miles or less one-way[4]. I usually stop every 3 hours, but some recommend stopping more frequent, e.g. in risk cases of thrombosis. Assuming 3 hours at 70 mph, that requires a range of 210 miles. To be able to drive that after a 80% fast charge, the total range needs to be 263 miles. To account for winter, this probably needs to be 290 miles.

How do you charge to cover 210 miles (231 miles in winter[5]) as fast as possible? Level 2 charging is too slow (10/11 hours at 3.5 miles/kWh and 6 kW). Depending on how long you take a break (e.g. restroom, meal), a more or less powerful charger is needed. A 100 kW charger will need 36/40 minutes, probably fast enough if you eat a meal. A 200 kW charger will cut these times to 18/20 minutes, which might or might not be fast enough for a restroom break and a drink[6].

Based on all this data, 250-300 miles of range is sufficient for long distance trips with fast charging. Of course you can simply make batteries big enough that you do not need to charge all day, the Tesla Roadster is an example, but it seems wasteful to built a 200 kWh battery into every car.

Summary All in all, 250-300 miles of range is enough for city driving and long distance travel, and 400 miles are not necessary. For Level 2 charging and city driving, I see a shift of how and when cars are fueled, and I expect a lot of gas stations to close, because they are not needed if you can charge where you already go. Think of all the possibilities what can be done with the space that gas stations occupy now, cities can become a lot more attractive!

PS. Yes, I have based the numbers to cover what 75% of people drive. Given that electric vehicles are 2% of new cars today, we have a long way to go before we have covered 75%.

[3] https://www.bts.gov/statistical-products/surveys/national-household-travel-survey-long-distance-travel-quick-facts

[4] http://www.princeton.edu/~alaink/Orf467F16/NTS_Entire_16Q1.pdf, Table 1-42, Personal use vehicle-miles, roundtrip distance

[5] I have used a smaller factor for long distance driving than for city driving, because the car does not need to be heated up repeatedly.

[6] Estimated charging times depend on the assumed vehicle efficiency of 3.5 miles/kWh.