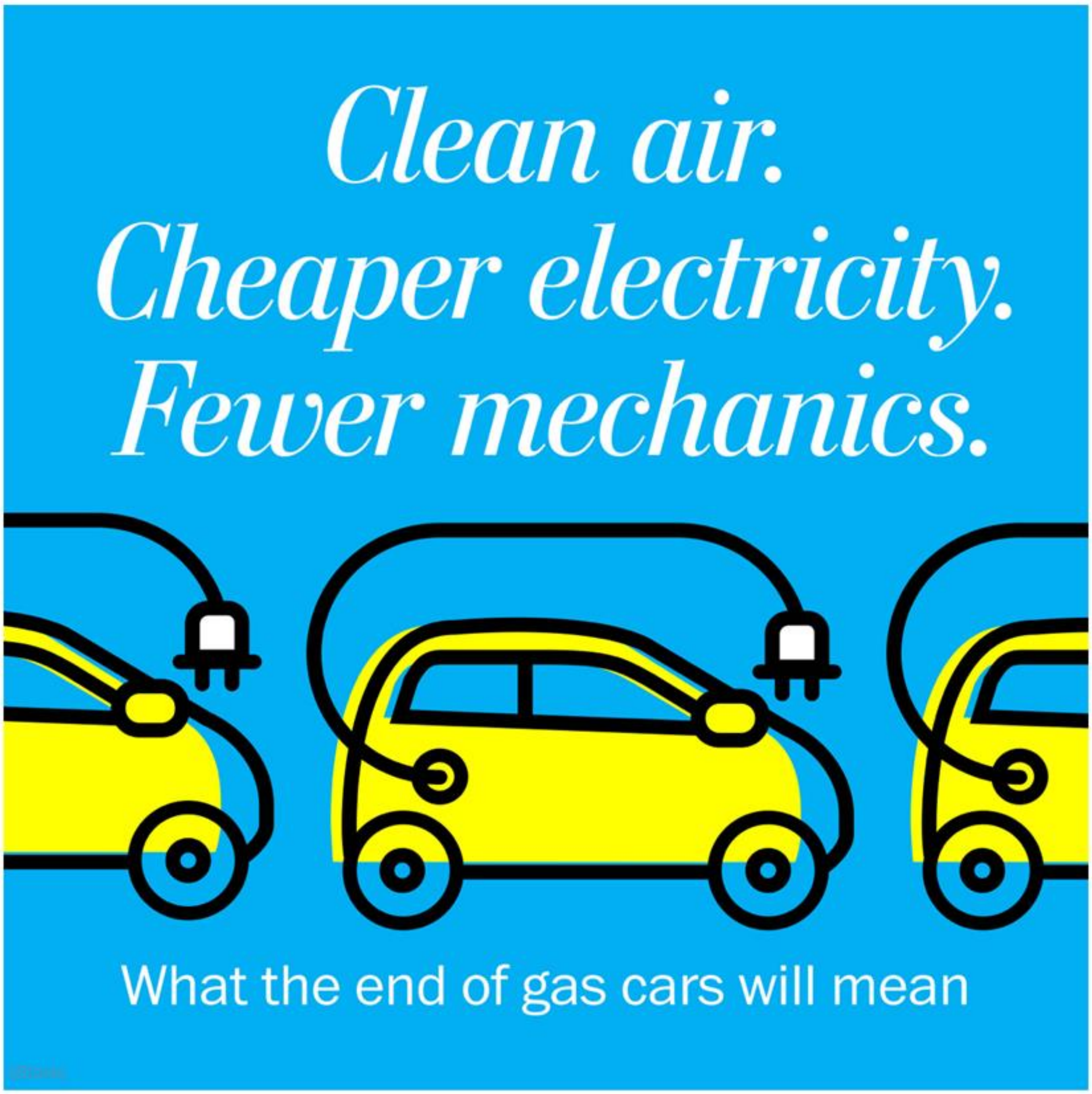
The electric car fever

12 October, 2017

In a national newspaper today. As if it were a done deal.



This dramatic title gives occasion to a few remarks.

1. **Cheaper electricity**: how electricity is to become cheaper if demand explodes and so-called renewable costs 20 times as much as conventional electricity is unclear. In the U.S., substituting electric for thermal engine cars would mean almost tripling the overall electrical capacity. If all of that were wind and solar, the bill would be 9 trillion U.S. dollars, plus another 5 to 10 trillion to replace existing vehicles. No wonder people with a financial interest in those industries slobber at the mere mention of the concept. However, the effort would be so enormous as to be unlikely to happen.

   For reference, if all the new installed power were wind powered, and windmills were erected along the, say, 100 ft offshore depth contour, with the commonly acknowledged safe distance between wind turbines being 3 to 10 rotor diameters, and if only the largest were installed, the entire oceanfront of the 48 contiguous states would be lined with between 130 and 360 rows of windmills, depending on the spacing, a 75 to 550 km wide belt (45 to 340 miles). That represents between 12 and 33% of the surface area of the 48 contiguous States. If all electricity in the U.S. came from wind power, the belt would have between 200 and 580 rows, and would be 120 to 900 km wide (75 to 560 miles), which would represent between 20 and 55% of the 48 contiguous States area. An absolute environmental nightmare, designed to counter the supposed nefarious effects of the invisible, odorless, and tasteless gas of life.

   There is no typo.

2. **All electric, end of gas cars**: filling a battery with the energy equivalent to that contained in a gasoline or diesel tank requires between 1,000 and 6,000 times as long. It is that fact, and that fact only, that has prevented electric cars from being the choice mode of road transportation since the 19th century. Apparently, the battery charging issue is consistently ignored.

3. **Clean air**: that would be welcome, as well as the silence electric cars come with. Unfortunately, thought needs to be given to the negative impact on the environment that windmills, solar panels, and batteries represent.

It seems considerations of perspective and proportion are quite discounted by the all-electric hopefuls.

There are other issues arising with the electric car.

An electric car would be a good choice for people going out for short errands a few days per week, likely in an urban environment. For that use, big powerful cars are quite purposeless, since urban speeds are usually limited to 50 or 65 km/h (30 to 40 mph).

For all other users the electric car looks like an improbable choice.

Take the much vaunted rear wheel drive Tesla Model S 85. It boasts a range of 426 km (265 miles) with an 85 kWh battery set. The powertrain delivers a combined 382 HP (285 kW), the top speed is 230 km/h (140 mph), and it accelerates from 0 to 100 km/h in 5.6 seconds. At 90 km/h (55 mph), it would take 4.73 hours to go the maximum distance, and the actual power would be 16 kW (22 HP), which, with a 2,108 kg curb weight seems a little skimpy. At top speed you would be discharged after 16 minutes and the distance covered would have been 62 km. Let’s assume a very good electric efficiency of 90%, and no overheating issues.

In fact, the EPA has measured a combined consumption of 24 kWh per 100 km. Assuming a 100% electric efficiency, that would make the range 354 km, not 426. If the car was diesel-fired, the equivalent fuel economy would be 7 l/100 km (33 miles per gallon), and such a car would go 1,000 km (600 miles) on one 70 l fuel tank (18.5 gal). The Tesla has a tank equivalent of 25 l (6.6 gal).

Although being marketed as a muscle car, the Tesla’s performance, when measured for the sake of fuel economy, is that of a small car. As soon as you use the real performance, the range drops steeply.

Another issue is the time taken to recharge the battery set. No matter how efficient the battery is, if charge time was the same as the time taken to fill a 25 l tank, which is 40 seconds at the regulation 10 gallons per minute for a car, and 10 seconds for a truck, the charging intensity from a 120 VAC outlet would be theoretically 85,000 A (amperes) resulting in 8 MW (8,000 kW, or 11,000 HP) of required power in comparison to a car dispenser, and 340,000 A with 32 MW of power in comparison to a truck dispenser. Those values are enormous and therefore quite impossible in real life (see note in the footer).

In reality, standard household outlets deliver 15 amps in the U.S., so charging time would be 63 hours, theoretically. In fact, according to the manufacturer, “*from a 120 volt/15 amp household outlet, the range increases by 3.75 miles (6 km) for every hour of charging*”, which means that the battery takes 71 hours (3 days) to charge at the manufacturer’s range. From another type of outlet, such as “*a 10 kW, NEMA 14–50 240 V/50 A outlet (like those used by RVs or standard cooking ranges), the charge rate is 28.75 miles (46 km) per hour*”, and the battery would take 9.5 hours to charge.

To charge the equivalent of a 70 l fuel tank, 8.3 days will be required from the standard household outlet, and 26.6 hours from a 50 A outlet.

Put in other words, for each hour driving the car at its meager economy performance, assuming an average speed of 60 km/h (37 mph), you would need to spend 10 hours recharging from your standard outlet. You cannot use the car more than 2 hours and 10 minutes per 24 h day, and cannot go further than 130 km (65 km one way). If you use 50 A outlets exclusively, you can use the car 10 hours a day (and recharge 14), and go 600 km every 24 hours.

If traveling cross country at a speed of 100 km/h (60 mph), you can probably drive a little less than 3 hours on a full charge and then you will need 9.5 hours to recharge, if you find a 50 A outlet. If not you’ll have a nice 3-day pit stop. In any 24 hours you wouldn’t be able to go further than 570 km (350 miles), at an average speed of 24 km/h (15 mph). The trip from New York City to Los Angeles would take you a lazy 8 days if 50 A outlets were deployed at least every 300 km (185 miles).

And no emergency rush to the hospital when the battery's flat. For that you would need another car, in spare.

There is one way to remedy those drawbacks, though. Buy a trailer and put a 25 kW diesel generator on it, together with a 70 liter fuel tank, and you get yourself a nice so-called hybrid car. Better still, you can remove all the batteries and electric motors and place the diesel engine directly under the hood and you get yourself a low-powered car that can go 2,400 km per day. Make sure to stop your engine every time the car is motionless, which, by the way, is the very cheap reason why electric and hybrid cars have a good fuel economy in the first place.

> *Note: the current intensity limitations have nothing to do with battery technology. They are inherent to electricity distribution systems. To carry 85,000 A you need a bundle of 400 4/0 or 0000 cables, each 13.4 mm in diameter (0.528 in). The overall diameter of such a conductor would be about 300 mm (1 foot), with insulation. Huge and impossible. The 340,000 A conductor would be 600 mm. That's on the mains side. Since a fully charged Tesla battery set potential is 400 V, the conductor on the car side would need to be rated for about 20,000 A (at full charge, but more at partial charge), with a diameter of 150 mm, still huge and impossible.*
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> *You can also say that to allow just one car in 1,000 to be recharging this fast at any given time, if all cars in the U.S. were electric, you would need to increase the current national electrical capacity by 160%, just to power charging stations. Cost if wind and solar powered: 9 trillion dollars, plus 6 to retrofit the existing, plus 10 trillion to replace the cars. Total: 25 trillion, one and a half times the U.S. gross domestic product.*
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> *Opportunists may see an opportunity.*