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EV Charging Technology wars: The platform economics of Charging Standards

The transportation sector is one of the largest contributors to greenhouse gas emissions in the world, accounting for 29% of all global greenhouse emissions in 2017. Emissions from light-duty vehicles are expected to contribute to the largest share of carbon dioxide emissions from this sector. Electric vehicles (EVs) pose one of the most effective solutions to decreasing emissions. In this article, we take a deep dive into the network economics of public EV fast-charging and how we may be locked in a scenario where the dominant charging standard may be dominant because it had a pre-existing market size and not because it is the best technology.

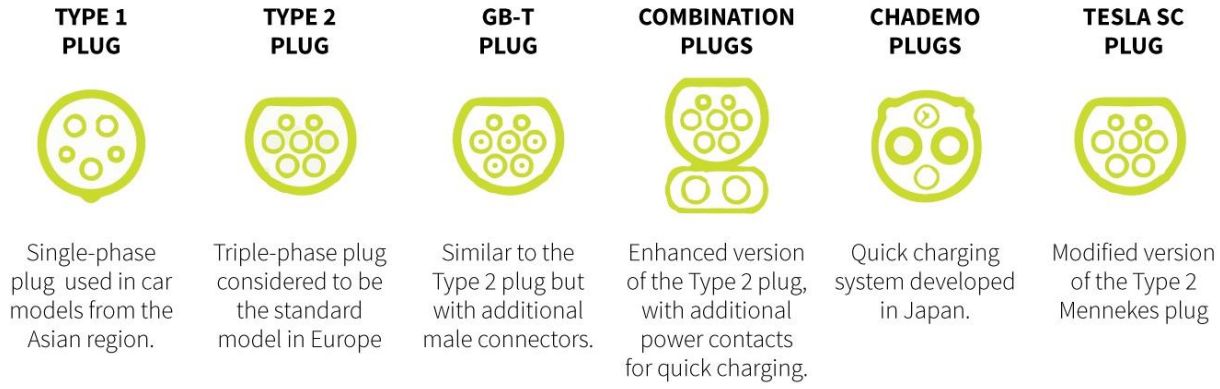
Introduction to charging standards: Present and Future

As EVs charge faster, the choice of publicly available charging technology becomes important. As of now, there are seven major standards to charge light duty vehicles (LDV) operating in four major markets of US, China, Europe and Japan.

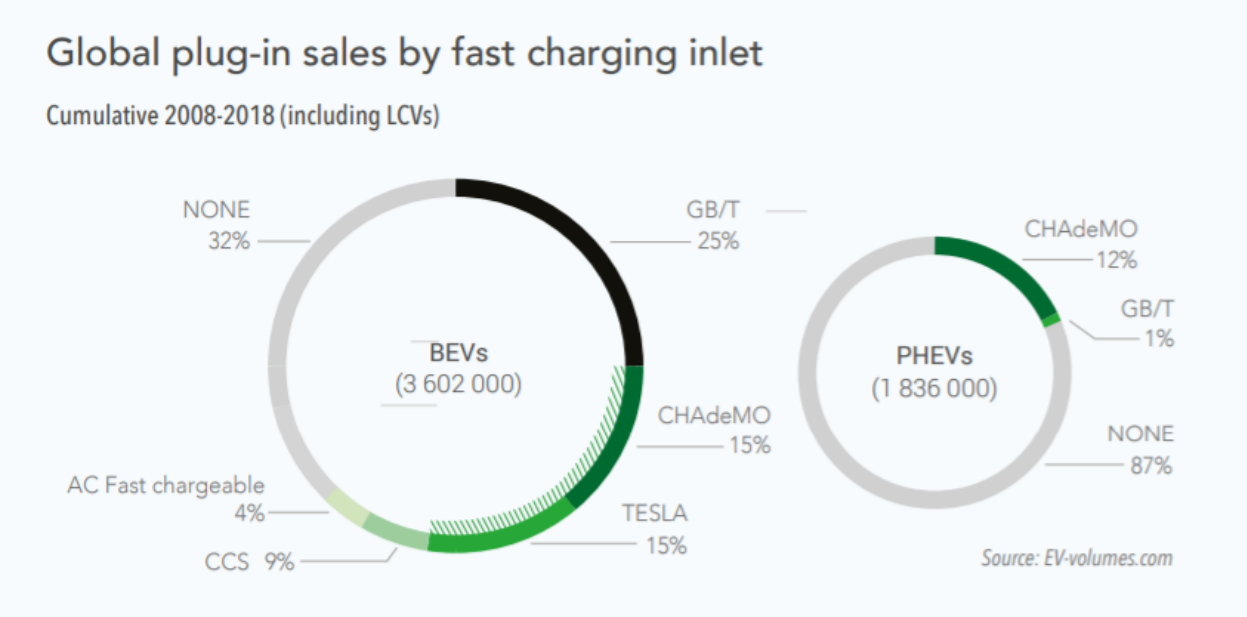
Charging for electric LDV is divided into three levels where Level 3 has the highest power output and can charge a vehicle the fastest. Level 1 charging (1.4 kW) can be facilitated by a household outlet, and is the slowest charging method requiring 17-25 hours to charge a car with a 100 mile range. Level 2 charging, has higher power output (7.2 kW) which can provide a full charge four to five hours, but requires a 240 Volt power supply. Level 3 charging is currently the fastest (and most expensive) charging option available and can charge the average car within 30 minutes, with a power outputs above 50 kW.

Level	Standard	Countries	Interoperable with	Output power
3	CHAdeMO	N. America, S. America, EU, AU, Asia & Africa	None	25kW - 100kW, 400kW
3	GB/T	China	None	100kW
3	CCS SAE Combo1	N. America	None	36-80kW
3	CCS SAE Combo2	EU, AU, S America, Africa, Asia	None	60-200kW
3	Tesla Super Charger	N. America, CN, JP, AU, EU	Everything (with adapters)	135kW
2	AC Fast - SAE J1772	All	Universal	~20kW
1	AC Level 1	All	Universal	2kW

The lack of interoperability between the level 3 chargers is characterized by their plug sockets as characterized in the picture below. Only CHAdeMO and CHAdeMO 2.0 are perfectly interoperable. Tesla can be interoperable with all chargers, but only with the use of adapters.



GB/T charging standard holds the largest share of EVs sold compatible to it and all its sales are made in China. CHAdeMO comes second in popularity and EVs compatible with it are spread all over the world, reportedly in 71 countries. CCS SAE Combo 1 is only deployed in the N. American markets and CCS SAE Combo 2, is primarily developed in Europe. Tesla Super Chargers are the only proprietary level 3 charger and is deployed in N. America, Asia, Australia and Europe. Why are some technologies adapted more successfully than others? The answer lies in the platform economics of these charging standards.



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Platform Economics of Charging Standards

Like other networked industries, the utility of the good (EV) to the consumer (EV driver) depends on the number of consumers also using the good. In a reality where different EVs adhere to different charging standards which are not interoperable, each charging standard is a networked platform economy. Consumers choose an EV only if there is a sufficient market size using that Charging Standard. This choice may be independent of which is the best technology standard and we may be locked in a scenario where the dominant charging standard may be dominant because it had a pre-existing market size and not because it is the best technology.

Once the incumbent lays their networks and customers come on board, a challenger with better technology must make an enormous capital bet to establish its own network. And even if it did make that bet, the dominant business could credibly threaten to drop its prices at the first sight of competition with a better technology. This is the first mover's advantage. Once a telephone network achieved scale, it made little sense to build a competing telephone network, and, as a result, the telephone network operator would have monopoly power, making such markets 'winner-takes-all'. For example, the battle between Betamax and VHS in 1980s provides an example of how network size is more important than network quality when it comes to locking in standards. Sony's Betamax standard was considered better, but the VHS standard, developed by a consortium of other Japanese companies had the first-mover advantage. Content creators catered towards the platform with more subscribers, which led to VHS becoming the leading standard. The first-mover advantages in industries with network effects magnifies the slightest of leads. Similarly, Blu-ray and HD DVD had a similar trajectory as Toshiba's HD DVD had the first mover's advantage. However, Sony's Blu-ray won the standards war by shifting business alliances including decisions by major film studios and retail distributors and Sony's decision to include a Blu-ray player in the Play station 3.

Electric vehicle charging standards are similar as consumers want to buy cars adaptable to the standard which has a wider infrastructure accessibility, car manufacturers want to manufacture the car targeting more consumers and charging infrastructure providers want to cater to the larger fleet. As CHAdeMO claims to offer its technology without any licensing fee, incentivizing car manufacturers to produce more CHAdeMO compatible cars. If consumers and manufacturers settle on a standard, the currently free standard could charge extravagant royalty for future innovations or discriminate against competing auto manufacturer as the market gets locked in, also known as the 'hold up problem'. The paid standard is the better technology for the future, free licensing today could shift charging infrastructure towards second best technology, as it may reduce EV prices and EV charging prices for the short term.

CHAdeMO and GB/T are expected to join forces to introduce a faster, bidirectional charging standard, called ChaoJi. As ChaoJi and SAE CCS Combo are expected to compete to be the best technology for Vehicle to Grid charging and integration, how can we make sure the market reaches its true potential?

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Addressing and preventing lock-ins

Here are three things we want to encourage:

- One way to address lock-in prevention and reduce switching cost is to encourage interoperability between different charging standards. ChaoJi is a right step towards interoperability, and policymakers should incentivize future standards to become more compatible with onanother.
- Legally binding commitments for consistent and non-discrimination license policy could also help prevention of abuse of monopoly power in the future.
- However, competition should be central to technology. Encouraging firm level competition in specific functionalities of the standard rather than the whole standard, creates an equitable market rather than one “winner takes all.” Telecom and smartphone standards have been successful in implementing this as gains from widespread adoption has been equitably distributed.