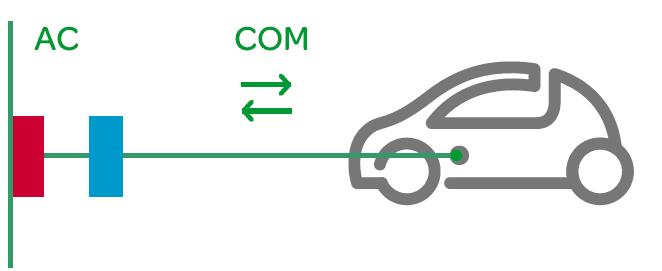
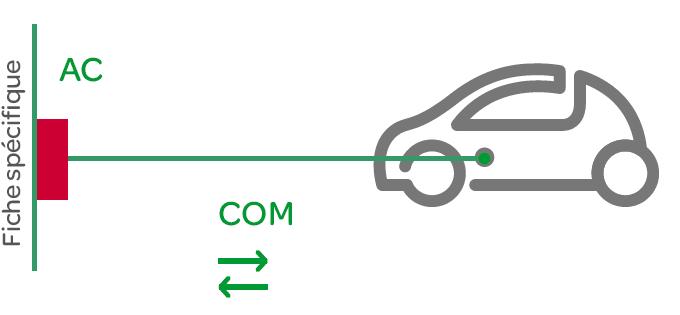
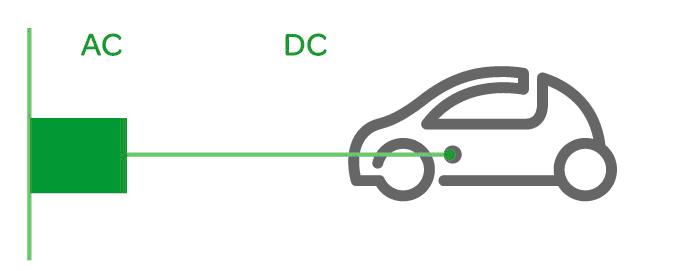
Technology review notes.



Connection types.



**Charging stations fall into 4 basic contexts:**

1. Residential charging is the most common charging method, and generally involves upgrades to existing wiring or a faster custom charging station. An EV owner plugs in when they return home, and recharges their car overnight.
2. Charging while parked (including public charging stations) - a commercial venture charged or free, offered in partnership with the owners of the parking lot. This charging may be slow or higher speed, and encourages EV owners to recharge their car while they take advantage of nearby facilities. It can include parking stations, parking at malls, small centres and train stations (and for a businesses own employees).
3. Fast charging at public charging stations > 40 kW, delivering over 60miles (100 km) of range in 10–30 minutes. These chargers may be at rest stops to allow for longer distance trips. They may also be used regularly by commuters in metropolitan areas, and for charging while parked for short or longer periods. Common examples are CHAdeMO and SAE CCS chargers, and Tesla Superchargers.
4. Battery swaps or charges in under 15 minutes. A specified target for CARB credits for a zero-emission vehicle is adding 200 miles to its range in under 15 minutes. In 2014 this was not possible for charging Electric Vehicles, but it is achievable with EV battery swaps and Hydrogen Fuel Cell vehicles. It intends to match the refueling expectations of regular drivers.

**Standarts**

The [International Electrotechnical Commission](http://en.wikipedia.org/wiki/International_Electrotechnical_Commission) [*modes*](http://en.wikipedia.org/wiki/IEC_62196#Charging_modes) definition (IEC 62196):

* *Mode 1* - slow charging from a regular electrical socket (1- or 3-phase)
* *Mode 2* - slow charging from a regular socket but which equipped with some EV specific protection arrangement (e.g., the [Park & Charge](http://en.wikipedia.org/wiki/Park_%26_Charge) or the PARVE systems)
* *Mode 3* - slow or fast charging using a specific EV multi-pin socket with control and protection functions (e.g., [SAE J1772](http://en.wikipedia.org/wiki/SAE_J1772) and [IEC 62196](http://en.wikipedia.org/wiki/IEC_62196))
* *Mode 4* - [fast charging](http://en.wikipedia.org/wiki/Charging_station#Fast_charging) using some special charger technology such as [CHAdeMO](http://en.wikipedia.org/wiki/CHAdeMO).

There are four plug *types*

* *Type 1* - single phase vehicle coupler - reflecting the [SAE J1772](http://en.wikipedia.org/wiki/SAE_J1772)/2009 automotive plug specifications
* *Type 2* - single and three phase vehicle coupler - reflecting the [VDE-AR-E 2623-2-2](http://en.wikipedia.org/wiki/IEC_62196#Type_2:_VDE-AR-E_2623-2-2) plug specifications
* *Type 3* - single and three phase vehicle coupler equipped with safety shutters - reflecting the [EV Plug Alliance](http://en.wikipedia.org/wiki/EV_Plug_Alliance) proposal
* *Type 4* - fast charge coupler - for special systems such as [CHAdeMO](http://en.wikipedia.org/wiki/CHAdeMO)

Charging times

The battery capacity of a fully charged electric vehicle from electric vehicle automakers (such as Nissan) is about 20 kWh, providing it with an electrical autonomy of about 100 miles. [Tesla Motors](http://en.wikipedia.org/wiki/Tesla_Motors) released their Model S with battery capacities of 60 kWh and 85 kWh with the latter having an estimated range of approximately 480 km.

* Use the vehicle's built-in charger, designed to charge from 3 to 43 kW at 230 V single-phase or 400 V three-phase.
* Use an external charger, which converts AC current into DC current and charges the vehicle at 44 kW (e.g. [Nissan Leaf](http://en.wikipedia.org/wiki/Nissan_Leaf)) or more (e.g. 120 kW [Tesla Model S](http://en.wikipedia.org/wiki/Tesla_Model_S)).

|  |  |  |  |
| --- | --- | --- | --- |
| **Charging time for 100 km of**[**BEV range**](http://en.wikipedia.org/wiki/Electric_vehicle_battery#Travel_range_before_recharging_and_trailers) | **Power supply** | **Voltage** | **Max current** |
| **6–8 hours** | [Single phase](http://en.wikipedia.org/wiki/Single_phase) - 3.3 kW | 230 VAC | 16 A |
| **3–4 hours** | [Single phase](http://en.wikipedia.org/wiki/Single_phase) - 7 kW | 230 VAC | 32 A |
| **2–3 hours** | [Three phase](http://en.wikipedia.org/wiki/Three_phase) - 10 kW | 400 VAC | 16 A |
| **1–2 hours** | [Three phase](http://en.wikipedia.org/wiki/Three_phase) - 22 kW | 400 VAC | 32 A |
| **20–30 minutes** | [Three phase](http://en.wikipedia.org/wiki/Three_phase) - 43 kW | 400 VAC | 63 A |
| **20–30 minutes** | [Direct current](http://en.wikipedia.org/wiki/Direct_current) - 50 kW | 400 - 500 VDC | 100 - 125 A |
| **10 minutes** | [Direct current](http://en.wikipedia.org/wiki/Direct_current) - 120 kW | 300 - 500 VDC | 300 - 350 A |

<http://www.andromedapower.com/>

<http://www.evtronic.com/page7/page9/index.html>

<http://www.eaton.com/Eaton/ProductsServices/Electrical/Markets/AlternativeEnergy/ElectricVehicle/index.htm?wtredirect=www.eaton.com/plugin#tabs-2>

**Electric vehicle hyper charger**

The DC hyper charger for electric vehicles is scalable from 250 KW to one MW. It has the highest energy density in its class. On a recent demonstration route, the charger recorded an average of eight charges and 240 miles per day utilizing 100 percent on–route charging. Designed to provide fleets of all sizes, including mass transit vehicles, with reliable and efficient off-board charging, making the DC hyper charger more practical for governments and companies to meet the transportation needs of a changing world in a sustainable way.

<http://www.eesi.org/briefings/view/16th-annual-congressional-renewable-energy-and-energy-efficiency-expo-forum?/expo2013>

**Battery swaping**

The companies [Better Place](http://en.wikipedia.org/wiki/Better_Place), [Tesla Motors](http://en.wikipedia.org/wiki/Tesla_Motors), and [Mitsubishi Heavy Industries](http://en.wikipedia.org/wiki/Mitsubishi_Heavy_Industries,_Ltd.) considered working in integrating battery switch technology in their electric vehicles to extend their driving range.[[41]](http://en.wikipedia.org/wiki/Charging_station#cite_note-SwapModelS-41)[[42]](http://en.wikipedia.org/wiki/Charging_station#cite_note-42) In a battery switch station, the driver does not need to get out of the car while the battery is swapped. Battery swap depends on at least one [electric car](http://en.wikipedia.org/wiki/Electric_car) designed for "easy swap" of batteries. However, electric vehicle manufacturers that are working on battery switch technology have not standardized on battery access, attachment, dimension, location, or type.

[Tesla Motors](http://en.wikipedia.org/wiki/Tesla_Motors) introduced a proprietary charging station service to support owners of [Tesla Model S](http://en.wikipedia.org/wiki/Tesla_Model_S) automobiles in the summer of 2013. The growing network of [Tesla stations](http://en.wikipedia.org/wiki/Tesla_station) will be able to support both battery pack swaps for the Model S, as well as the more-widespread [fast charging](http://en.wikipedia.org/wiki/Fast_charger) capability for both the Model S and the [Tesla Roadster](http://en.wikipedia.org/wiki/Tesla_Roadster).

Battery swapping has the following benefits:

* Fast battery swapping under five minutes.
* Unlimited driving range where there are battery switch stations available.
* The driver does not have to get out of the car while the battery is swapped.
* The driver does not own the battery in the car, transferring costs over the battery, battery life, maintenance, capital cost, quality, technology, and warranty to the battery switch station company.
* Contract with battery switch company could subsidize the electric vehicle at a price lower than equivalent petrol cars.
* The spare batteries at swap stations could participate in [vehicle to grid](http://en.wikipedia.org/wiki/Vehicle_to_grid) storage

**Related technologies**

**Smart grid communication**

Recharging a large battery pack presents a high load on the electrical grid, but this can be scheduled for periods of reduced load or reduced electricity costs. In order to schedule the recharging, either the charging station or the vehicle can communicate with the [smart grid](http://en.wikipedia.org/wiki/Smart_grid). Some plug-in vehicles allow the vehicle operator to control recharging through a web interface or smartphone app. Furthermore, in a [Vehicle-to-grid](http://en.wikipedia.org/wiki/Vehicle-to-grid) scenario the vehicle battery can supply energy to the grid at periods of peak demand.

<http://www.plugincars.com/tesla-motors-introduces-free-app-model-s-sedan-126356.html>

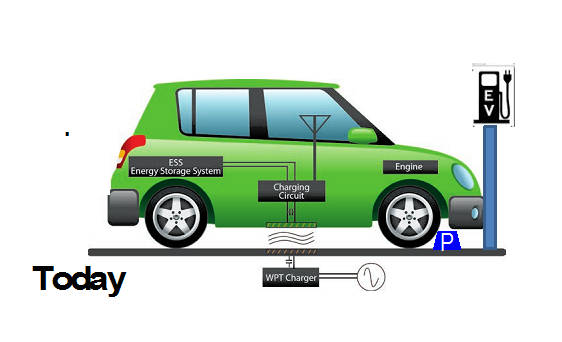
**Wifi Power Transfer**

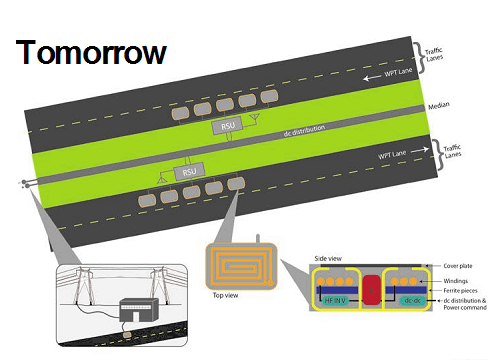
Wireless charging systems following the principle of inductive resonant energy transfer can achieve the best energy transfer rates and efficiency rates with increased coil distances, reduced electromagnetic inference risks and more compact geometrical dimensions in the (lower) kHz frequency band.

 It is important to keep the geometrical alignment of primary and secondary within certain tolerance values in order to ensure a sufficient efficiency rate of the energy transfer.

With quasi-dynamic wireless charging the energy is transferred from the road-side primary coil system of limited length to the secondary coil of a slowly moving or in stop-and-go mode moving vehicle (with passengers).

With dynamic wireless charging (see fig. 3) the energy is transferred via a special driving lane equipped with a primary coil system at a high power level to a secondary coil of a vehicle moving with medium to high velocity.



[**http://electricvehicle.ieee.org/2014/06/26/overview-wireless-charging-electrified-vehicles-basic-principles-challenges/**](http://electricvehicle.ieee.org/2014/06/26/overview-wireless-charging-electrified-vehicles-basic-principles-challenges/)

<https://www.youtube.com/watch?v=Gw6XtzEOlyI> (Wifi, active caharging)

<https://www.youtube.com/watch?v=h6jKvZgkSFE>

**EV Battery Technology**

With suitable power supplies, good battery lifespan is usually achieved at rates not exceeding "0.5*C*" or so, taking two to three hours for a full charge, but faster charging can be done.

Charging time is often limited by the capacity of the [grid](http://en.wikipedia.org/wiki/Electrical_grid) connection. A normal [household](http://en.wikipedia.org/wiki/Household) [outlet](http://en.wikipedia.org/wiki/Electrical_outlet) delivers 1.5 [kilowatts](http://en.wikipedia.org/wiki/Kilowatt) (in the US, Canada, Japan, and other countries with 110 [volt](http://en.wikipedia.org/wiki/Volt) supply) and 3 kilowatts (in countries with 240 V supply).

Many European countriesfeed domestic consumers with a 3 phase system fused at 16-25 amp allowing for a theoretical capacity around 11-17 kW. At this higher power level charging even a small, 7 kilowatt-hour (14–28 mi) pack, would require less than an hour. This is slow compared to the effective power delivery rate of an average petrol [pump](http://en.wikipedia.org/wiki/Pump), about 5,000 kilowatts. Ultimately, even if the supply power is increased, batteries cannot accept charge at greater than their maximum charge rate (usually "2*C*" or "3*C*"), giving a recharge time of 20 to 30 minutes to 80%, with slower charging usually recommended for the remaining 20%.

In 2005, [handheld](http://en.wikipedia.org/wiki/Handheld) device battery designs by [Toshiba](http://en.wikipedia.org/wiki/Toshiba) were claimed to be able to accept an 80% charge in as little as 60 seconds. Scaling this [specific power](http://en.wikipedia.org/wiki/Power_density) characteristic up to the same 7 kilowatt-hour EV pack would result in the need for a peak of 340 kilowatts of power from some source for those 60 seconds. It is not clear that such batteries will work directly in BEVs as heat build-up may make them unsafe.

Many BEV drivers prefer refueling at home, avoiding the inconvenience of visiting a [fuel station](http://en.wikipedia.org/wiki/Fuel_station). Some workplaces provide special parking bays for electric vehicles with charging equipment provided.

**Battery Cost Estimate Comparison**

| **Battery Type** | **Year** | **Cost ($/kWh)** |
| --- | --- | --- |
| Li-Ion | 2014 | 200-300[[23]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-morganstanley-23) |
| Li-Ion | 2012 | 500-600[[24]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-mckinsey-24) |
| Li-Ion | 2012 | 400 [[25]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-autoblog2-25) |
| Li-Ion | 2012 | 520-650 [[26]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-plugincars.com-26) |
| Li-Ion | 2012 | 752 [[26]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-plugincars.com-26) |
| Li-Ion | 2012 | 689 [[26]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-plugincars.com-26) |
| Li-Ion | 2013 | 800-1000 [[27]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-forbes.com-27) |
| Li-Ion | 2010 | 750 [[28]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-autoblog3-28) |
| Nickel Metal Hydride | 2004 | 750 [[29]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-29) |
| Nickel Metal Hydride | 2013 | 500-550 [[27]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-forbes.com-27) |
| Nickel Metal Hydride |  | 350 [[30]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-ev1.org-30) |
| Lead Acid |  | 256.68 [[31]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-31) |

**Battery Longevity Estimate Comparison**

| **Battery Type** | **Year of Estimate** | **Cycles** | **Miles** | **Years** |
| --- | --- | --- | --- | --- |
| Li-Ion |  |  | 100,000 [[32]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-auto.howstuffworks.com-32) | 5 [[32]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-auto.howstuffworks.com-32) |
| Li-Ion |  |  | 60,000 [[33]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-en.wikipedia.org-33) | 5 [[33]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-en.wikipedia.org-33) |
| Li-Ion | 2002 |  |  | 2-4 [[34]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-U._Kohler.2C_J._Kumpers_2002-34) |
| Li-Ion | 1997 | >1,000 [[35]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-I._Uehara.2C_T._Sakai_1997-35) |  |  |
| Nickel Metal Hydride | 2001 |  | 100,000 [[36]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-Akihiro_Taniguchi_2001-36) | 4 [[36]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-Akihiro_Taniguchi_2001-36) |
| Nickel Metal Hydride | 1999 | >90,000 [[37]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-37) |  |  |
| Nickel Metal Hydride |  |  | 200,000 [[30]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-ev1.org-30) |  |
| Nickel Metal Hydride | 1999 | 1000 [[38]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-Tetsuo_Sakai_1999-38) | 93,205.7 [[38]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-Tetsuo_Sakai_1999-38) |  |
| Nickel Metal Hydride | 1995 | <2,000 [[39]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-39) |  |  |
| Nickel Metal Hydride | 2002 | 2000 [[34]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-U._Kohler.2C_J._Kumpers_2002-34) |  |  |
| Nickel Metal Hydride | 1997 | >1,000 [[40]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-40) |  |  |
| Nickel Metal Hydride | 1997 | >1,000 [[35]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-I._Uehara.2C_T._Sakai_1997-35) |  |  |
| Lead Acid | 1997 | 300-500 [[35]](http://en.wikipedia.org/wiki/Electric_vehicle_battery#cite_note-I._Uehara.2C_T._Sakai_1997-35) |  |  |

<http://www.eenews.net/stories/1059984950>