Electric Vehicle Charging Solutions

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In many countries in the world Electric Vehicles (EV) are now becoming an accepted alternate to internal combustion engine cars that burn fossil derived fuels, which are finite and not sustainable. Registrations of battery only powered EV's in USA in the month of July 2014 were an amazing 5693, and 2014 YTD there are now 66,406 plug in EV's registered in USA. Cumulative plug in EV registrations in USA is now over 235,000 vehicles. European countries are now setting about achieving the 20/20 target – 20% of all urban cars to be alternate fuels to fossil derived by the year 2020.

In Australia the take up by motorists has been very poor when compared to other countries. The national actual registrations to June 2014 are just 748 which represent less than 0.6% of the total new vehicle sales.

One of the concerns of potential EV buyers is "where and how can I charge my EV?"

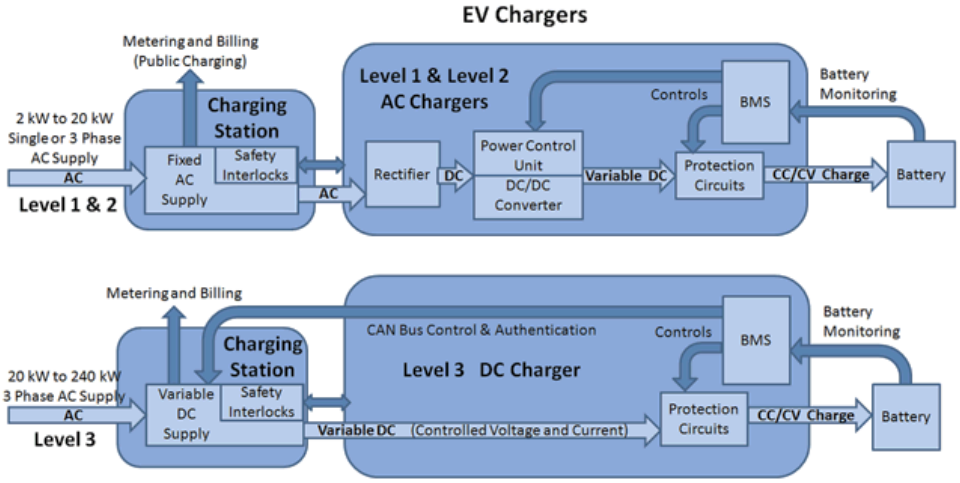
The charging of a pure Electric Vehicle can be done in a number of ways;

- At home via a 10 or 15 amp rated wall socket that is on a dedicated circuit from the home electricity distribution board. Using the floating cable as supplied with the EV.
- At home via a Level 2 EV home charger unit.
- At the office via a dedicated Level 2 EV charger
- In the street via a dedicated Level 2 EV charger
- In the street via a Direct Current (DC) fast charger
- Regeneration of charge by the EV itself
- In an emergency via the Auto Clubs mobile EV charging facility.

The other concern to potential EV buyers is what time it may take to recharge an EV. The table below outlines the three globally accepted charge regimes and Standards with the potential times to recharge – based on a depleted HV battery of around 16KwH.

Charge Regime	Operation	Time to charge
Level 1	Home 240VAC rated at 15Amps	10-13 hours
Level 2	240VAC – 15-30A. Home or office / street charge EVSE facility	3-4 hours
Level 3	360VDC-128A. DC fast charger. Public access in street locations	12 mins to 50%, 28 mins to 80%. CHAdeMO protocol.

The diagram below indicates the structure and charge controls incorporated into a Level 2 & 3 EV charger. Notice the Battery Management System that manages the actual charge energy transferred to the EV high voltage battery pack.



There are Standards for recharging that have been developed within the industry. These Standards cover the connectivity requirements as well as the actual charge profile employed. The more advanced EV charger systems (Level 2 & Level 3) also "talk" to the EV high voltage battery pack and the on-board EV charger and deliver a regulated and controlled charge that manages the level of charge in terms of voltage and current, thus delivering a full charge in a far reduced time when compared to the regular home 240 volt outlet socket.

Typical home / office level 2 EV charger

The Level 2 & Level 3 chargers take in information from the EV in regard to ambient temperatures, HV battery pack temperatures, battery cooling systems status and operation, State of Health of the HV battery pack, State of Charge of the battery pack, State of Fitness of the battery pack (ability to cycle fully) and the "fuzzy logic" algorithms associated with the last driver EV operation habits. Once all these sensory data is captured then the EV actually tells the EV Charger what voltage and current levels to deliver.

There are a number of versions for connectivity for Level 2 chargers around the world, however in Australia the Standard is currently being drawn up around the SAE J1772 Standard.

The DC Fast Chargers for EV's have an internationally set re-charge Standard called the CHAdeMO protocol from Japanese technology (Mitsubishi i-MiEV, Nissan LEAF,

Toyota and Subaru) and the European and some USA EV's are now adopting the SAE developed COMBO charge protocol. Although differing in some sensory and safety control characteristics the both DC Fast Charger protocols are very similar in regard to the delivery of recharge energy to the EV.

Some car makers of EV's (such as BMW for the i3) have developed options for charging such as the CHAdeMO or the SAE Combo inlet sockets.

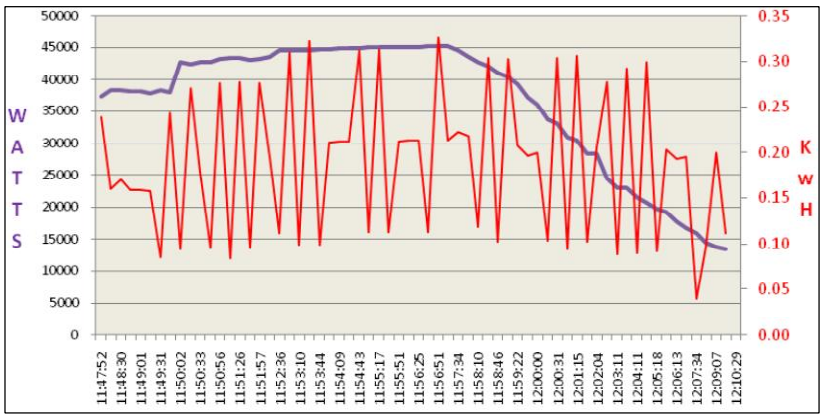
Typical DC Fast Charger installed in Sydney by NRMA Motoring Services

In Australia at this time there are only the CHAdeMO DC Fast chargers installed in the public environment. The DC Fast Chargers that are installed in public access locations operate 24 X 7 and there are no fees imposed for the EV charge top up.

The most popular DC Fast charger charge capacity is 50Kw, which requires a very intricate installation and cabling to ensure full compliance.

If an EV only uses the DC Fast Charger for re-charge, then it is expected that the high voltage EV battery pack may lose 20% capacity over the planned lifetime (around 8 years) of the battery pack.

The chart shown indicates the CHAdeMO charge protocol in use over the regular and controlled 28 minute charge cycle to 80%SOC. The pause of the charging cycle is clearly shown when the EV and the charger communicate to assess the capability of the battery pack to continue to accept a charge.



Current EV's all have a capability of on-board regeneration of energy. When the driver recognises this EV capability and adapts the driving technique to take advantage of this function, then range of travel is extended quite considerably.

Some forward thinking businesses such as shopping malls, libraries and convenience stores are now installing Level 2 EV chargers as an additional service for their customers. Many Local Government Councils are also considering the

installations of EV chargers to demonstrate to their constituents that the Council is looking to the future to make available sustainable energy use.

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