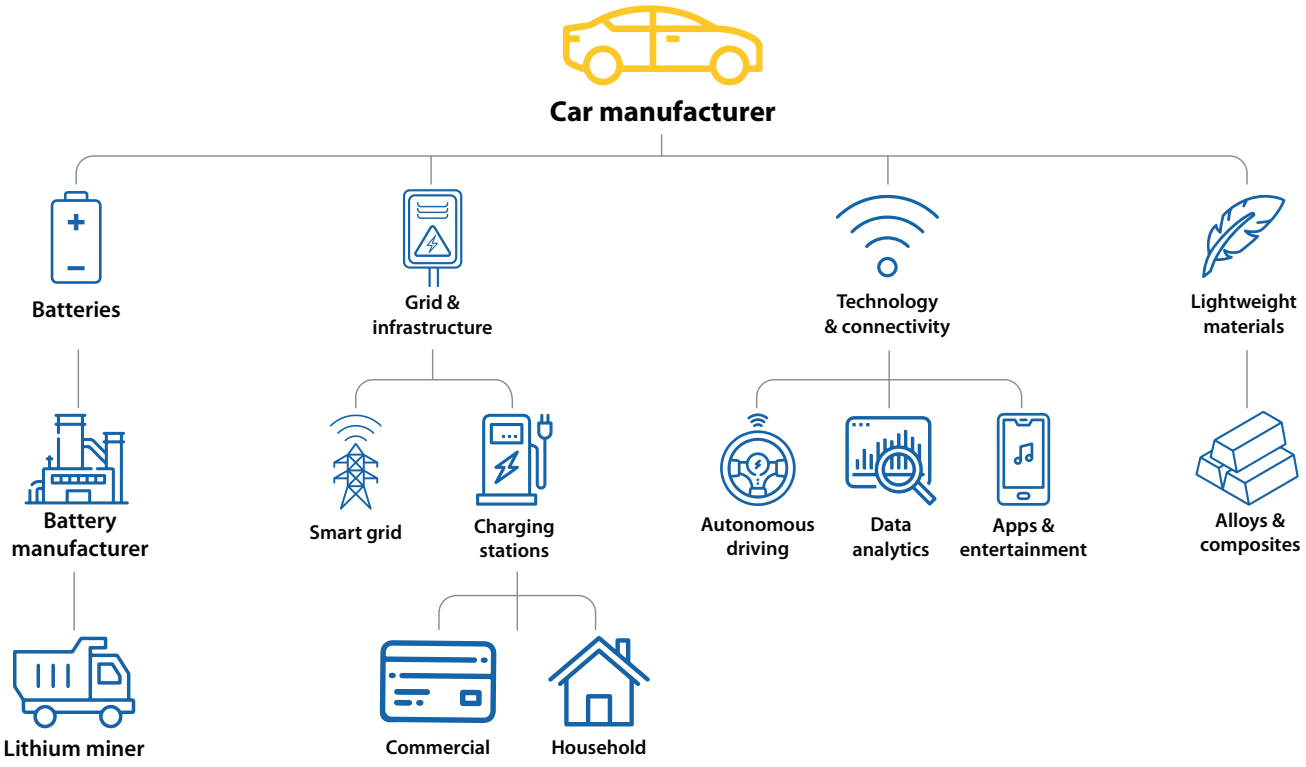
PHEV and EV are the Future
What does that mean to you?

Electric Mobility is the Future, but what exactly do I need to do?

The EV industry is set to boom in a big way, you have likely heard this 'n' number of times by now. As a supplier you may have been thinking, how exactly am I going to benefit from this, given the vast application area and complex value chain among many other variables? This paper will focus on clarifying the EV space for panel builders, OEMs, machine builders and provide the driving factors, areas to focus on, and how to make the most out of this new trend.

Let us start with understanding the scope first.



The electric mobility ecosystem consists broadly of three components:

1. **Car manufacturer:**
   These are large established consumer facing firms making EVs, yes Tesla rules here. (Although there are others entering the market.) This will include their Tier 1, 2 and 3 suppliers as well.

2. **Battery manufacturer:**
   This is probably the most important vertical in this space. It will not just include battery manufacturers, but also involves key raw material suppliers such as Lithium miners.

3. **Grid and Infrastructure enablers:**
   This is not an integrated part of this ecosystem, but actually, without this our Electric Vehicle will just be a piece in a museum. Apart from power generation and transmission companies, this vertical includes charging station providers — a super-important component in the whole EV space as well as for OEMs. This is the segment where the real opportunity lies.

So, let's take a deep dive into charging stations.

Charging Stations

Charging stations can be summarized in the following categories:

- **Level 1:**
  EV manufacturers provide a charging accessory that can be used to charge the EV through standard household power outlets. This is the slowest method of charging an EV.

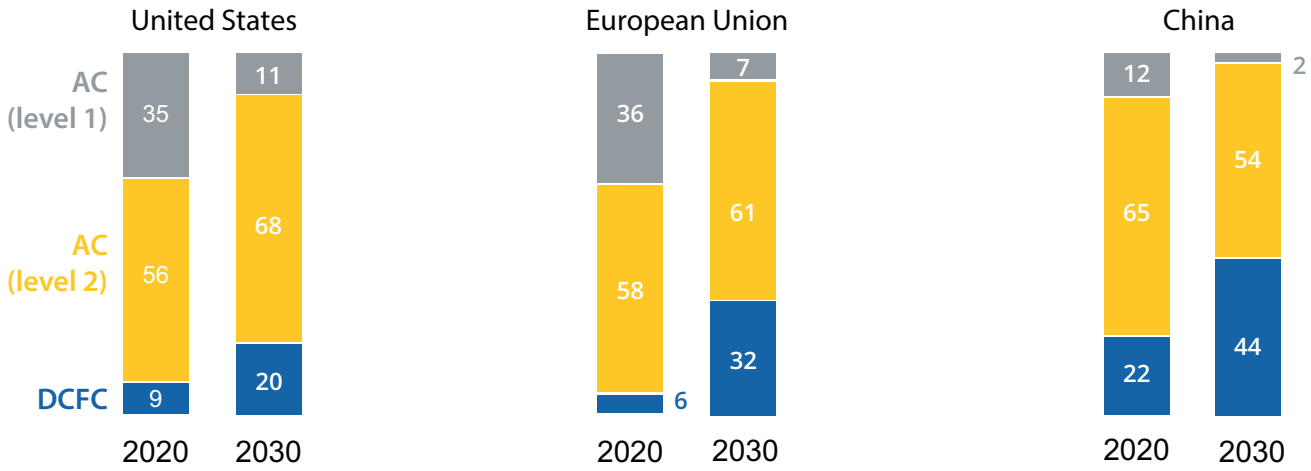
- **Level 2:**
  This is an AC charging station placed mostly in commercial establishments with higher output voltages and current. They utilize an On-board charger of the EV to convert this AC input to DC to charge the battery, same as the Level 1 charging method. It operates at powers up to roughly 20kW and requires a few hours to charge the battery.

- **Level 3 DC Fast Charger (DCFC):**
  These are the super chargers, which directly feed DC supply to the battery bypassing the on-board converter. It operates at power from 25 to 350kW and charges the vehicle in around 30 minutes.

Wireless charging & Battery swapping:
These are also some other techniques to power up your EV, but they are still emerging and may not be viable, considering challenges such as energy wastage in wireless charging or requirement of battery standardization across the industry for making battery swapping possible.

The question is where the largest market opportunity is. Per McKinsey analysis, significant share will be the Level 2 AC charging stations. The reason is quite obvious, most of the time, a vehicle will be off road, parked, whether at the workplace or home.

Energy demand by charging technology, % of kilowatt-hours, home-centered scenario



Another important factor which contributes to rapid adoption of Level 2 charging stations is the low upfront cost, which is often less than $5,000. Whereas the DCFC costs range from anywhere between $25,000 to $200,000, depending upon the power capacity.

Now comes the interesting part — volume and number of chargers. It is estimated that the US alone will have 13 million chargers by year 2030. Referring to the above graph, Level 2 charging stations will keep on increasing their share across the US and EU.

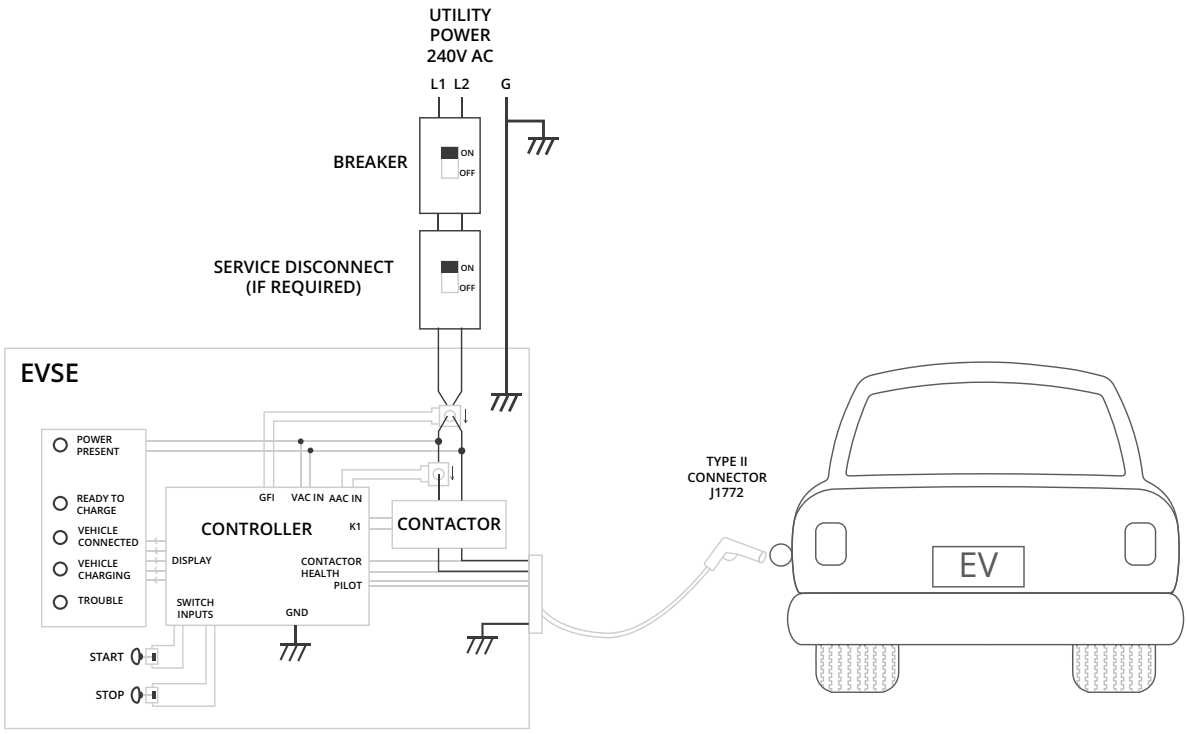
Is this really going to happen on such a large scale? It looks very possible. Electric is the future, thanks to the push from climate change. Governments are heavily subsidizing and incentivizing this space. For example, a recent announcement by US President Joe Biden, proposes spending of $174 billion for EV push, out of which $15 billion would be allocated for setting up 500,000 charging stations.

The above should have provided you with a basic understanding of the commercial considerations in this space. Now, let's look at the technical aspects of Level 2 charging stations.

Level 2 AC Charging Stations

Level 2 charging stations operate with an AC input voltage of 240V (typical in residential applications) or 208V (typical in commercial applications). This charging station can pump up to 80A or 19.2kW. However, most Level 2 charging stations operate at much lower power, i.e., up to 30A or 7.2kW of power.

Below is an example of how a simple level 2 charging station looks internally.



Due to the requirements of various standards, such as UL 2594, IEC/EN 61851-22, charging stations not only include control devices but also protection components (apart from J1772 connector).

Charging Station Components

- **Miniature Circuit Breakers:**
  Since Electric Vehicle charging stations need to be supplied by a dedicated branch circuit, protective devices such as Miniature Circuit Breakers are essential in case of adverse effects of overload and short-circuit.

- **Residual Current Circuit Breaker:**
  A charging station installed outside can be exposed to snow, dust, rain, and various temperature and humidity levels. Since it is handled by users every now and then, standards such as IEC 60364-7-722 requires a 30mA residual current circuit breaker for protection against fibrillation and electrocution which can be caused due to the earth's leakage current.

- **Disconnect Switch:**
  Per Canadian standard 86-304, if the charging station is being operated at 60A or above or more than 150 Volts-to-ground, a separate disconnecting means is required per installation. Additionally, it should be capable of being locked in the Off position.

- **Surge Protection Devices:**
  To protect sensitive components against lightning and over-voltages, charging stations use Type 2 surge protectors as well.

- **Contactors:**
  Contactors with General purpose current rating up to 115A are mainly used for switching the power to the EV On or Off.

- **Energy Meters:**
  If the charging station is to be used for commercial purpose, then there has to be a measurement of energy consumed, based on which customers would be charged. A digital energy meter with a maximum of 80A capacity is used here for this purpose.

- If a charging station is a networked one, then it would need high-tech devices such as gateways, controllers, etc. to power them all. It would also include a DC power supply requiring single or three phase input voltage. Terminal Blocks, Wire Duct, DIN Rail, etc. would also be there for ease of wiring.

We hope the information provided in this paper has helped you better understand the Electric Vehicle market. c3controls offers most of the products required to build a charging station. We are just a phone call away, ready to assist you in your journey in EV.