

# Plant Engineering Consultants' White Paper: Implementing Electric Vehicle Charging Stations



## Electric Vehicles

### A Bit of History.....

**The first crude electric vehicle** was developed in the 1830's, and it took until the 1870's before electric cars became "practical". Much development ensued, and by the turn of the century electric vehicles accounted for roughly a third of all vehicles on the road at that time. Thomas Edison is attributed to having worked on improving battery performance for electric vehicles of the day.

**The world's first hybrid electric car** was invented by Ferdinand Porsche in 1901. But before the EV and Hybrid EV could become mainstream, Henry Ford came along with the Model T. In 1912 the electric starter was introduced helping to increase the popularity of gasoline powered vehicles. With the discovery of cheap Texas crude accelerating the demise, by 1935 electric vehicles all but vanished.

**In 1973 General Motors** displayed a prototype EV at the EPA's first symposium on low pollution power systems development. American Motors introduced an electric powered version of the Jeep that was used by the USPS in a 1975 test program. Even with the oil shortages of the 70's, the range of ~40 miles between charging, and a top speed that couldn't even reach the 55mph national limit, further development was shelved.

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## EV Charging

### The Process.....

**Most of us are in the know** to some degree with EV's now. Starting with Toyota's Prius hybrid, advancements in EV technology and consumer acceptance has resulted in nearly every car manufacturer offering an electric version of their popular models. And we have Tesla, a fully electric car company that has never offered a gas powered car. Motivationally we have the US government investing heavily in green energy through incentives to ensure EV charging stations are no more than 50 miles apart. And many States have or are initiating legislation to eliminate new gas or diesel powered car sales in the foreseeable future.

If you are thinking about adding EV charging capability at your facility, and don't know where to start? You've found the beginning!

**As the Client/Owner** it is best to start with a bit of research. There are many questions that need to be answered.....

How many vehicles do you want to charge simultaneously?

Do you want/need level 1, 2, and/or level 3 type charging?

Is this to be public charging or charging limited to residents/employees?

Does your facility currently have capacity of available power to add charging stations?

Does the power for EV charging need to be metered separate from the building's power?

All of these answers factor in to the overall cost of implementing EV charging capabilities.

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## Charging Levels

### Level 1 Charging.....

**This is the simplest** form and is the type of charging included as standard with the electric vehicle when purchased. Level 1 is the slowest type of charging, ~ 4 miles/hour charged. The cord that came with the vehicle supplies 110VAC to the on-board converter. Charging time can vary but a typical overnight charge will add ~40 miles of driving to the battery. Typically, no modifications to the home or office AC circuits are required, unless multiple vehicles want to be charged simultaneously from the same circuit. Level 1 chargers typically deliver 1.2kW.

## Charging Levels

### Level 2 Charging.....

**Level 2 charging** is still an AC type charge, but instead of 110VAC it uses 208-240VAC and can charge at a rate of ~32 miles/hour charged, or about 8x the rate of a level 1 charger. The reason is the Level 2 charger can deliver anywhere from 6.2kW to 19.2 kW. So the benefit of faster charging time comes at a cost of requiring more power to be delivered to the charging station. This can and most often does require significant changes to the building's electrical system depending on how many vehicles will be simultaneously charged.

## Charging Levels

### Level 3 Charging.....

**This provides a huge change** in both charging speed and potential infrastructure costs. Level 3 charging is supplying 400-900VDC power directly to battery in the electric vehicle. Some sources cite level 3 charging speeds to be approximately equivalent to the time it takes to fill up a gas powered vehicle. With speed comes cost. This would be the highest priced level of charging that can be implemented, and requires the most infrastructure changes in most facilities.

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### Budgets.....

The chart below shows comparable estimates for various charging station implementations. These are based on recent projects we've completed, and based on assumptions of typical power available for various facility types.

	Equipment	Infrastructure	Design & Engineering	Permitting	Construction
Low	\$1,200 / port	\$2,000 / project	\$1,500 / project	150 / project	\$1,200 / charger
High	\$3,500 / port	\$40,000 / project	\$5,000 / project	\$500 / project	\$3,500 / charger

As you can see, the budget required to implement EV charging at your facility can vary significantly based on the available power, number of charging stations and the mix of levels of charging.

The actual charging stations costs are per charging port as some equipment can contain multiple ports and/or a mix of charging levels.

Infrastructure costs include things like needed electrical panels, high current breakers, additional power feeds to handle the added power requirements and safe distribution of that power.

Design & Engineering costs include any architectural design requirements, as well as engineering of the added electrical systems. Also included are any subconsultants such as structural or environmental engineering services.

Permitting is a fee, and issued after engineering design is complete.

Construction costs can vary based on the actual equipment required and any parking facility changes required, ADA requirements, etc.

It is recommended to talk with your energy supplier to get the latest on what rebates, government programs, etc. may be available that can be used to offset some of the costs of implementing EV charging at your facility. Tax incentives are typically available as well. Again, talking with your energy supplier will probably get you the latest information that applies to your state and local vicinity.

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## EV Charging

Where to Locate.....

## EV Charging

Time to Consult an  
Experienced  
Engineering Firm

**This is somewhat simple** but can impact costs.

Most charging stations are actually parking stalls, that may exist or may have to be added. Another consideration is the distance between the building's electrical infrastructure and the charging stations. The longer the distance, the higher the cost of implementation. If there is need to rearrange a parking lot to accommodate EV charging stations this may require architectural changes as well which adds cost. Another consideration is handicap spaces to comply with the latest municipal, state and federal ADA regulations.

**By now**, what seemed like a simple and timely addition to your facility has turned into a headache inducing swarm of questions and concerns causing a nightmare of "ka-chings" to your budget. Time to get an estimate from those who have done it before, multiple times. An MEP Engineering firm is a great place to start. Once contacted, they may ask some basic questions, and will want to schedule a time to visit to get a clear understanding of 1) what you have in mind regarding level and quantities of charging stations 2) what power is currently available from the facility and what can be available from your energy supplier 3) where the charging stations are to be physically located and 4) what if any budget has been discussed or made available.

With this information, an engineering firm can generate a firm fixed-price written proposal to complete the engineering required for a contractor to get building permits and construct the design. Until the design is complete any estimate of construction costs would be wide ranging. Rough order of magnitude (ROM) estimates can be provided but will come with no expressed or implied level of confidence, until the engineering is completed. It is not unusual if requested/required for the engineering effort to include an 'engineering estimate of probable costs' and that estimate be provided with the design deliverables. In addition to the engineering effort, if requested, costs for Bid and Construction Admin services can be included in the project proposal.

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Plant Engineering  
Consultants, Inc.

Plant Engineering Consultants, Inc. has engineered over a hundred charging stations across Colorado and into neighboring states since 2018. From commercial businesses such as numerous Phil Long car dealerships, to State Agencies including the Colorado Department of Corrections and the Department of Military and Veteran Affairs, we are well versed with all aspects of implementing EV charging capabilities, and can guide you throughout the process, from initial contact through construction administration.

We are licensed in Colorado, Wyoming, Utah, Arizona, New Mexico and Texas.

