



Finding a Place to Plug:

A Review of Factors Influencing Optimal Electric Vehicle Charger Locations

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Introduction to EVs

Electric vehicles (EV) are considered as a 'cleaner' alternative to fossil fuel powered cars. Electricity from renewable resources can be used to power the vehicle

Electric vehicle supply equipment (EVSE) or charging stations are points where drivers can recharge their battery, much like gas stations to traditional cars

Increases in EV infrastructure leads to increased interest and confidence in EVs leading to more users.

Research Questions:

Where can charging stations be located to be mutually beneficial to drivers and the stakeholders that will be funding them?

Can the utilization of renewable energy sources encourage EV adoption by lowering the financial costs, reducing strain on the grid, and further improving the environmental benefit of EVs compared to fossil fuel powered vehicles?

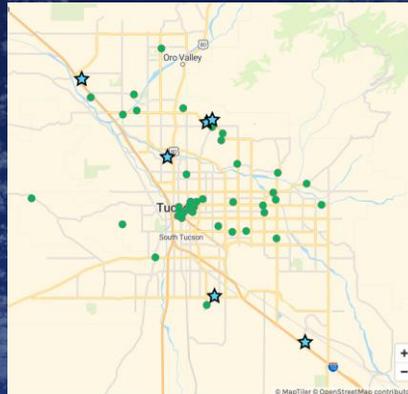
Methodology

Major findings from Literary Review studies and papers are applied to a dataset of existing EVSE locations in Tucson, Arizona

"When a country can increase one percent of renewable share in total electricity, it may sell 6% more EVs per 100 thousand people" (Li et. al, 2017).

Data Application

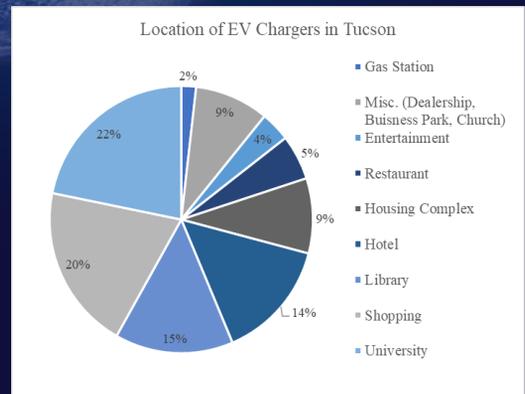
Arizona By The Numbers
 744 Public Chargers
 1,894 Charging Ports
 Tucson Area Chargers
 55 Level 2 Chargers
 6 DC Fast Chargers



According to records from the US Office of Energy Efficiency and Renewable energy

EV Charging Levels

	Level 1	Level 2	Level 3 (fast charging)
Power Supply	120 V @ 12-20 amps	240 V @ 30-80 amps	up to 600 V (DC) or 480 V (AC) @ 100 amps
Energy Use Characteristics	1-1.5 kW/hr	3-7 kW/hr	75-100 kW/hr
EV Range Boost	2-5 miles/hr	8-20 miles/hr	60-80 miles (< 30 minutes)
Bottom Line	Widely available, low cost (\$10 to \$1000). Ideal solution to provide EV owners with more range, and to gain experience in workplace charging.	Widely available, moderate cost (\$500 to \$6000). Many 3rd party equipment and service providers. Ideal solution to provide EV owners substantial boost in range in less time.	Limited availability, high cost (>\$15,000+ installation). As of late 2012, this solution is not practical for most workplace charging sites.



Notable findings from Literary Review

EVSE in locations with charging level options attract different users

Challenge is to balance high productivity of a charging station and reduced wait times for users

Areas with higher incomes and higher populations of college educated adults have 8% and 19% higher EV registrations

Range Anxiety is the concern the driving range of an EV is not sufficient to reach the driver's destination

To lessen range anxiety, -chargers should be located near popular driving routes to minimize deviation from original route

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Drivers want EVSE locations powered by renewable energy and are willing to pay more knowing the power came from renewables

Drivers are only willing to wait 10min before the start of a charging session.

Placing chargers near locations drivers want to go is critical in the success of new installations

Conclusion

Incorporating renewable sources of energy or shifting usage can offset or lower electricity costs. This is mutually beneficial to the energy provider and the EV owner.

The data set of existing EVSE in Tucson shows the real-world application of the conclusions of the research papers

Level 1 and level 2 chargers with cheaper energy and installation costs can be implemented more widely for frequent use by EV drivers.

Additional charging infrastructure gives drivers more flexibility and lessens driver's 'range anxiety.'

Successful EVSE must balance the desire for high utilization of chargers with low wait times for users

Providers of charging infrastructure are financially encouraged to install EV chargers in locations that will attract EV drivers and integrate into the energy system