

# White Paper on Solar Powered Charge Stations with Shaded Parking

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## Introduction

There are several reasons to develop the concept of solar energy and shaded parking in conjunction with newly needed charge stations for plug-in electric vehicles and plug-in hybrid vehicles. For the past three years NSF supported undergraduate students have participated in visioning efforts to investigate the potential feasibility of using parking lots as locations to generate electric power with solar panels, charge plug-in electric vehicles, and enjoy the social benefits of shaded parking (Erickson, 2011). In this paper, social value, environmental considerations and economic aspects will be included in order to look at several aspects that are important for good decisions. The cost of petroleum now and in the future, the air quality impacts of combustion on health in urban centers, greenhouse gas emissions, the dynamics of electrical power, the transmission costs associated with electrical power, the desire to have full employment, the balance of payments with other countries, the value of shade, and the value of a positive image will be considered below.

## Solar Powered, Shaded Charge Stations

The cost of gasoline for transportation by car is about \$0.10/mile while the cost of electrical energy for an electric vehicle is much less. There is an opportunity now for individuals to use plug-in electric vehicles to come to work at K-State and other locations and save on operating costs. For an individual that has a 100 mile round trip commute, the cost of gasoline is of the order of \$10/day. For 250 days/year, the cost of the gasoline is about \$2500/year for coming to work. With a plug-in electric vehicle, there is a need to charge the batteries while at work and at night at home. A reserved stall with solar panels, shaded parking, and a charge station can serve the needs for a place to park, battery charging, and a shaded car. If one adds \$50/month to the current cost of \$600/year for a reserved stall, one has \$1200/year or \$100/month for the income to pay for the charge station, which may cost between \$10,000 and \$20,000. An hourly charge may serve the needs of those wanting to plug-in without having a reserved stall. These numbers are intended to be illustrative. These charge stations would be connected to the K-State electrical grid so power produced can be delivered to K-State if it is not needed to charge vehicles.

The situation for plug-in hybrid vehicles differs from all electric vehicles because the size of the battery is smaller and the all electric range is less. The amount of charge needed is of the order of 3 to 6 kilowatt hours, sufficient to travel about 15-20 miles electrically. These vehicles can best be served by having solar powered charge stations at many locations so individuals can plug in at work, shopping centers, restaurants, grocery stores, home, etc. Because the amount of power needed is often small, free charging with free parking may be the most efficient way forward in many locations. The cost can be paid by businesses that serve the drivers and by sales tax.

## Petroleum Supplies and Cost

It is well known that petroleum supplies are limited and that the cost of crude oil production has increased over the last 50 years. There is a need to make use of solar and wind power for transportation. One benefit of using electrical energy for transportation is that it will reduce the amount of crude oil that is used. The current generation of students will benefit greatly from efforts that are made to reduce petroleum use because of the impact that will have on gasoline prices. A 50% shift to electrically powered vehicles would have a significant effect on petroleum use and future prices of gasoline.

## Urban Air Quality

There are many urban communities in which reduced emissions from vehicles would help the community to meet air quality standards. There is a cost associated with meeting air quality regulations. The health of citizens is impacted by air quality and emission requirements depend on being in compliance. Coal burning power plants impact air quality, and there are many citizens that do not support additional coal burning power plants. Solar powered electric vehicles have the potential to reduce emissions compared to other alternatives that depend on combustion.

## Health Effects of Vehicle Emissions

In two recent studies by Wellenius et al. (2012) and Mills et al. (2011), investigators found that the risk of heart attack and stroke increases with an increase in concentration of air pollutants associated with vehicle emissions, and that small particulates from combustion induce vascular effects. Kunzli (2011) points out that there is significant public health value to efforts to further reduce small particulates related to combustion of vehicle fuels. Thus, the electrification of transportation will improve air quality and public health.

## Greenhouse Gas Emissions

Vehicles powered by gasoline, coal burning power plants, and natural gas powered vehicles and power plants release carbon dioxide into the atmosphere. Climate change associated with increased concentrations of carbon dioxide in the atmosphere is a major concern. The future cost of climate change is expected to be very great and a major reason why it is important to develop solar powered charge stations (Stern, 2007). Nicholas Stern advocates action now to reduce future costs of climate change. Developing and installing solar powered charge stations with shaded parking will reduce future costs associated with climate change.

## Transient and Dynamic Aspects

There is a need to supply electrical power on demand in most applications such as lighting. This makes electrical power more expensive during peak power periods, which often occur in the late afternoon in support of air conditioning. There is some potential to manage vehicle charging and avoid charging vehicles during peak power times; however, there is a need to charge vehicles prior to returning home after work. Fortunately, the vehicle charging at work sites and the

generation of power using solar panels fits well together. This is one of the excellent reasons to develop solar powered charge stations with shade. At night there is sufficient power that can be used for charging batteries. The time when power is produced using the sun fits very well with the daily vehicle charge that is needed.

### Transmission Costs

The cost of transmission of electrical energy from the location where it is produced to where it is used has a cost associated with it. Because the power at the charge stations is being produced close to the location where it is used in this system, the transmission costs are very small. With millions of electric vehicles being charged, the impact on transmission could become important if transmission distances are larger. This is another reason to develop solar powered charge stations.

### Employment and Charge Stations

Employment in the United States will be positively impacted by the installation of solar powered charge stations. The electrical power that is generated using the solar panels will be produced where people work. Local jobs will be created to install the solar powered charge stations, service them and manage them.

### International Aspects and Balance of Payments

With the growth of the number of electrical vehicles, there will be a reduced use of motor fuels and reduced flow of dollars to petroleum producing countries. The solar powered charge station has the potential to be installed in many locations in the world. It can be used with a local grid in locations where power transmission lines have not been connected to a larger grid. Growth in use of electric vehicles in other countries will reduce the cost of petroleum in the world relative to not having alternative sources of energy for transportation.

### Value of Shade

The shading that is provided by the solar panels has social value when one gets into a vehicle on a hot sunny day. When purchasing a new vehicle, the trade value is higher if the vehicle has been parked in a shaded location each day.

### Positive Image for Individuals and the University

Those individuals who make the decision to drive an electrical vehicle and use a charge station will have the benefit of knowing that they are helping to advance a new technology and contributing positively to the environment. There will be social value of being an owner of a plug-in electric vehicle or a plug-in hybrid vehicle. Kansas State University will also benefit from the installation of solar powered electric vehicle charge stations with shade by providing a needed service and by moving a step closer to being a sustainable university.

## Research, Education and Engagement

There are many research, education, and extension aspects associated with solar powered electric charge stations with shade. Moving ahead with the plan will be beneficial to the university with respect to research, education, and extension.

## Conclusions

There are many reasons to move forward with the installation of solar powered charge stations for plug-in electric vehicles. The initial number of stations can be small. We should go forward and get started.

## References

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Larry E. Erickson  
Professor of Chemical Engineering and  
Director, Center for Hazardous Substance Research  
Kansas State University  
lerick@ksu.edu