Economical, Social, Environmental, and Technological Impacts of the Development and Implementation of Solar Powered Charge Stations

Larry Erickson[2], Aaron Burkey[1], Karla Morrissey[1], Matthew Reynolds[1], Jessica Robinson[1], Blake Ronnebaum[1], Parul Singh[1], Tyler Wagner[1]
[1]Earth, Wind and Fire Sustainability REU Student, [2]Professor of Chemical Engineering and Director of Center for Hazardous Substance Research

Economical

Pricing of Electric Vehicles

Electric vehicles have a high initial cost due largely to the batteries they require. This large initial cost can be returned by the fact that the consumer will not only save money on fuel costs, but hybrid and electric vehicles also require less maintenance month to month and year to year, thus further reducing the cost and returning on the initial cost.

Social Costs and Benefits to the Environment

We have to consider the social benefit as a source of revenue from electric vehicles. Implementing a large number of electric and hybrid vehicles will have a direct effect on lowering emissions which could have a large social benefit due to improved air quality, and thus reduced costs in health sectors.

Solar Powered Charge Stations

Solar powered charge stations provide a method to charge more electric and hybrid vehicles and can even generate profits through the selling of power to and from the grid. This will also increase air quality on campus, which will not only reap benefits for current campus life, but also increase the overall campus appeal for new students generating more revenue for the university.

Social

In addition to economical impacts, SPCS can also influence society in terms of whether these stations will provide benefits to electric vehicle owners as well as the general public . In a survey conducted this summer at K-State, several faculty, staff, and students were asked a variety of questions regarding their status as commuters/non-commuters, preferences towards SPCS being implemented at K-State, their willingness to invest in EVs if SPCS were available, and their thoughts on the environmental and social impacts of these charging stations.

Table 1. Comparison of survey results for KSU students, faculty, and staff respondents

	Students	Faculty	Staff
Most frequently drive to campus	43%	85%	90%
Travel 2-5 miles to campus	52%	51%	43%
Own electric cars	0%	3.60%	0.20%
Would like to reduce the cost of commute by using electric vehicles	73%	69%	58%
Are in favor of K-State installing SPCS	53%	82%	75%
Would like to own an electric vehicle	36%	52%	34%
Are more willing to invest in an electric vehicle if KSU has the infrastructure	26%	44%	26%
Believe SPCS on campus will encourage more people to purchase an electric vehicle	37%	47%	36%

Table 1. KSU students, staff, and faculty were surveyed using Qualtrics Survey Software. There were 759 respondents: 98 students, 451 staff, 192 faculty, 11 students and staff, 5 students and faculty, 2 staff and faculty.

Technological

Batteries

One major part of new and emerging technologies involved in solar powered charge stations are batteries. The lithium-ion battery is commonly used in electric vehicles in industry. Many batteries have different capacities, ranging from 4.4 kWh of the Toyota Prius to 60/85 kWh of the Tesla Model S. The next major topic involving batteries is the range and the amount of time it takes to charge. These all vary according to the capacity of the battery and can be seen in the table below.

Make/Model (2014)	Battery Capacity	All-Electric Range	Can it run on gas?	MSRP
Chevrolet Volt	16.5 kWh	38 miles	Yes	$34,995
Nissan Leaf	24 kWh	84 miles	No	$28,980
Toyota Prius	4.4 kWh	11 miles	Yes	$29,990
Tesla Model S	60 kWh / 85 kWh	244 miles / 265 miles	No	$69,900/ $79,900
Ford C-Max Energi	7.6 kWh	19 miles	Yes	$32,920

Information in table obtained from respective manufacturers' websites

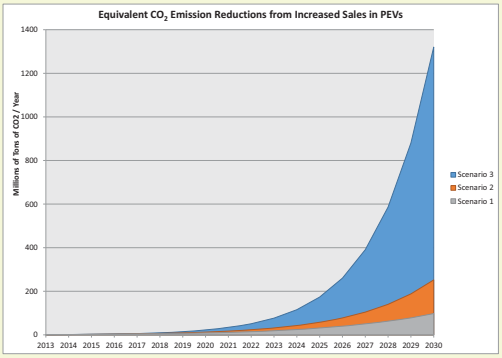
Smart Grid

The smart grid is the concept of combining the existing grid with information and communication technology that will allow the bi-directional flow of information and power. This will allow for many new applications, the most important being a stronger demand side of the power market and increased ability to integrate renewable energy into the grid.

This research has been partially funded by the National Science Foundation with REU Grant EEC-1166549, and by Black and Veatch.

Environmental

While advances in the research and development of SPCS are still in progress, a rise in the number of SPCS coupled with a continued growth rate in sales of electric vehicles could have significant environmental impacts, specifically in relation to reducing CO_2 emissions. The figure below shows resultant CO_2 emission reductions based on projected Plug-in Vehicle (PEV) sale growth calculated from previous years (33.9%) as well as a 25% increase and 50% increase in annual sales. With a continued 33.9% growth in PEV sales, the U.S. could reduce its current carbon dioxide emissions by 4.67% by 2030.



Scenario 1- 25%

Scenario 2-33.9%

Scenario 3-50%

References

Electric Drive Transportation Association
Environmental Protection Agency
Erickson, Larry. "White Paper on Solar Powered Charge Stations with Shaded Parking." Kansas State University. 27 Feb. 2012. Web. 2 Jul. 2014.
"Kansas State 2025 Sustainability Strategic Action Plan." Kansas State University. 11 Apr. 2014. Web. 2 Jul. 2014.