Electric Vehicle Charging Stations Partially Powered by Solar Energy

Solar-Powered Battery Installations for Home Use

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

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4/3/2022

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Intro/General Problem

How can innovations in solar power help to make solar energy a primary energy source?

One of the most discussed problems in society today is the implementation of clean and renewable sources of energy. Solar energy is a promising energy source that could be the answer to this problem due to it being on the rise lately. For example, in 2020 solar energy accounted for 10.7% of all renewable energies in the United States (U.S). Next to wind energy, solar energy is one of the fastest growing renewable energy sources (”U.S. renewable energy factsheet”, n.d.). One of the more recent innovations pertaining to solar energy are electric vehicle (EV) charging stations that are partially solar powered at the commercial level as well solar-powered battery installations for home use. These two innovations could help further the push to use solar energy more often in society and make it a primary energy source.

In terms of the solar EV charging station, this paper will dive into the technical aspect of this innovation by discussing the overarching problem of redesigning these charging stations to be used as a renewable energy source in addition to the power grid. The overall goal of this redesign would be to have a clean and alternative source of energy for EV chargers at the commercial level. The methods, software, and equipment needed to develop this technology will be talked about in this section to give a sense of how it will be designed and created.

Looking at the STS portion of the paper, the policies and economic incentives that are shaping the sociotechnical system surrounding solar-powered battery installations for home use will be examined. Specifically, this paper will seek to identify how society has impacted this sociotechnical system in the past, currently and what it could be faced with in the future. The first factor that will be examined for this shaping of society is how a lack of regulations looking to be passed as well as regulations currently in place have limited large scale companies from

selling/installing these installations. The second factor is the economics problems as well as incentives that are restricting consumers who are looking to buy the installations.

Technical Research Problem – Electric Vehicle Charging Stations Partially Powered by Solar Energy

How can electric vehicle charging stations be redesigned to operate off the power grid as well as by solar technology?

The technical topic for this paper would be designing an EV charging station that is partially solar powered instead of solely from the power grid. Although using electrical vehicles is seen as a benefit to the environment, having an alternative power source for the charging stations would further the cause of using solar energy more frequently in society. Currently, several companies make EV chargers for home use capable of being charged by solar power, but little to none at the commercial level. The design for these chargers would be used at the commercial level and be capable of storing solar power into a battery until it was needed for a charge. However, if the weather conditions proved unfavorable and would not allow for the sun to hit the panels, the station would be able to access the grid for power.

To design this innovation, I will first investigate how the power grid is set up in general with EV chargers and compare this with how EV chargers with solar power capability for home use are connected. The next step would be to incorporate this same setup at the commercial level. The largest difference for EV chargers for commercial and home use is that the commercial ones can use much higher voltages. Despite this being different, having higher voltage capability is seen as positive because it allows for faster charging (Martin, 2019). The main constraint for this design would be trying to find the best place to put the solar panels needed for the charger. The

solution that makes the most sense would be to put the panels on top of the charger itself. Another would be trying to route the panels far away in an open area, but this may prove to be very costly.

In terms of making a model for the design, I will gather all the necessary parts needed to create the innovation. From here, coding languages used in embedded systems such as C++ and Python would be used. When looking into the hardware of the design, NI Multisim and Ultiboard will be used to test circuit simulations. Once it passes all the tests electronically, it will be manufactured onto a PCB prototyping board and soldered with the components. In essence, this plan will ultimately allow me to design an efficient as well as cost effective EV charger capable of solar power use that will hopefully help to end the energy crisis. Any future work based on the research conducted in this section will aid in creating even more cost efficient as well as over effective EV chargers at the commercial level.

STS Research Problem –Solar-Powered Battery Installations for Home Use

How are policies and economic incentives shaping the sociotechnical system surrounding solar-powered battery installations for home use?

In theory the design of a partially solar-powered EV charging station, as well as solar-powered battery installations for home usage, will lead to the advancement of solar power. This type of technology is still being developed more and more currently to where it'll hopefully be a common technology in society at some point. Overall, this paper will primarily focus on how this innovation was hindered in the past by various factors, such as policies and economics, to where it currently stands in society as well as speculate to where it could be at in the future. In the past, solar-powered battery installations for home use have been hindered by various regulations

preventing companies from breaking into this industry as well as extremely high costs for the materials, installing, and upkeep for an individual. Currently, these regulations are being fought to be overturned and the overall costs of equipment relating to solar energy have become significantly cheaper.

As of now, there are many regulations in place limiting the use of these companies' technology and if this technology is to spread, these regulations will need to be dealt with. For example, in the U.S. there are many outdated regulations at the federal, state, and regional levels that prevent people from installing these systems (Pearce, 2016). This aspect will be investigated by examining these regulations at each level of government to identify where the bigger regulatory lag exists. In terms of the local level, various city, and town regulations in the state of Virginia will be discussed. For the state and federal level, the regulations that are currently mandated for Virginia as well as the country will be identified and talked about. These installations are mostly limited in largely populated areas due to building restrictions based upon various factors, such as safety, noise, and height systems (Beck & Martinot, n.d). Based on this a really populated area such as Northern Virginia will help to show how these policies have shaped this sociotechnical system. Soon, these regulations could change if planning departments in cities were to update their policies for the dealing and sitting for this technology. The resources needed to explore this dilemma will require speaking to legislators at each level to better understand the problems currently associated with this technology as well as what is currently being done to fix it.

In addition, the lack of specific regulations has also contributed to the halting of this technology (Beck & Martinot, n.d). For instance, there has been a lot of confusion created for companies and individuals in several aspects. One of which being the uncertainty when it comes

to code requirements for installing this technology. Companies that have employees in charge of installing this technology may not do enough or too much to be properly installed. Anything that is being contracted to a company to be constructed on or around a home requires certain health and safety codes that need to be followed. If there is not a specific set of regulations put out by localities there is always going to be a threat to safety as well as liability concern for this technology. Here research will be conducted to see where in the country this lack of regulation is the biggest. This research involves looking up scholarly articles that have explored this area as well as interviewing with companies that supply this technology such as Tesla, EVBox, and Blink to identify where this is a significant problem. Overall, the altering of regulations as well as need for new regulations has led to utility companies being able to still have a monopoly over the energy distribution (Meraay, 2019). A vast majority of these laws were set up long before inverters were invented. Currently, there are many people everywhere lobbying to get these laws and regulations amended due to this.

Not only companies but as well as individuals who are homeowners and consumers of the power grid would be affected by these changes. Solar-powered battery installations can be seen as a long-term investment due to having to pay upfront for this technology ("Benefits of Residential Solar Electricity", n.d.). The cost in 2021 ranged from $11,000 to $15,000 for the entire system which includes solar panels along with the inverter. However, over time one will end up paying significantly less for utility bills to use solar energy partially or entirely to power their home (Riley, 2021). Previously, the cost was even higher making it hard for the average person to utilize this type of equipment. Over time, researchers were able to improve upon solar technology making it more efficient and more cost-effective ("How Did Solar Become The Cheapest Energy", n.d.). The issue of the overall costs of the system will be another basis for

research in this paper. Specifically, it will be explored how cost has affected the sociotechnical system of solar-powered battery installations in homes. In order to dive into this aspect, research will be conducted to look up current prices of the available technology as well what is being done to improve upon current innovations to reduce cost even further. The biggest issue with any technology is lowering the energy consumption and if this can be reduced even further then in turn the cost to buy this technology for the average consumer will go down.

In order to offset the expenses associated with the system and installation, the federal government as an incentive has put in place a 26% tax credit for systems installed between 2020-2022 and a 22% tax credit for systems installed in 2023 (“Homeowner’s Guide to the Federal Tax Credit for Solar Photovoltaics", n.d.). In addition, consumers who own this system can sell electricity that is generated by their solar panels to utilities through a “net metering” plan. Essentially, this is when residential consumers are credited for the electricity they add to the grid when the rate of generation from their solar system is greater than the rate of utility consumption (Riley, 2021). Although this is a great addition to owning this technology for the user, utility companies may think differently about this aspect (Net Metering, 2017). This section will also dive into the various reasons as to how and why utility companies will try to prevent these plans as well what other incentives the federal government is putting into place to counteract the high prices currently facing the markets with this technology.

In closing, to further support these claims evidence will be gathered from resources that describe the problems that home solar-powered battery installations were previously faced with compared to where they stand now in society. This evidence includes articles and statements from well-known sources such as Harvard Business Review and the Department of Energy. In addition, interviews with various companies in this field will be conducted to identify any new or

current problems that may exist for them. Implementing this plan of research for this paper will allow for the comparison of limitations relating to this technology that have occurred in the past and currently in today's time. Solar powered battery installations for home usage have come a long way in society, but there is still much left to do make them readily available for anyone to own, use and even sell. By the end of this paper, the problems associated with solar powered battery installations for home use will be fully examined and discussed. Specifically, the regulatory lag as well as overall costs for this technology and how this effects companies and individuals in society. This knowledge will be useful for anyone who is interested in up-and-coming technology in addition to people looking to understanding how solar energy has been progressing.

Conclusion

Essentially, this paper is broken into two separate sections that focus on the importance that solar power can have on society. The technical section of this paper discusses the importance of how commercial level EV charging stations can be incorporated to push to make solar energy a primary energy source in society. In addition, it elaborates on the steps that will be taken to design and create an EV charger that can use solar power as well as energy from the power grid at the commercial level. The STS section will analyze how policies as well as high costs associated with solar battery powered installations at the home level have affected many groups, such as companies and individuals. In theory, this research will look to address and inform on how certain innovations pertaining to solar energy can be improved upon to shape society for the better. Hopefully, this work will be inspiring others to improve upon this technical design, STS topic, or even another innovation or aspect pertaining to solar power.

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