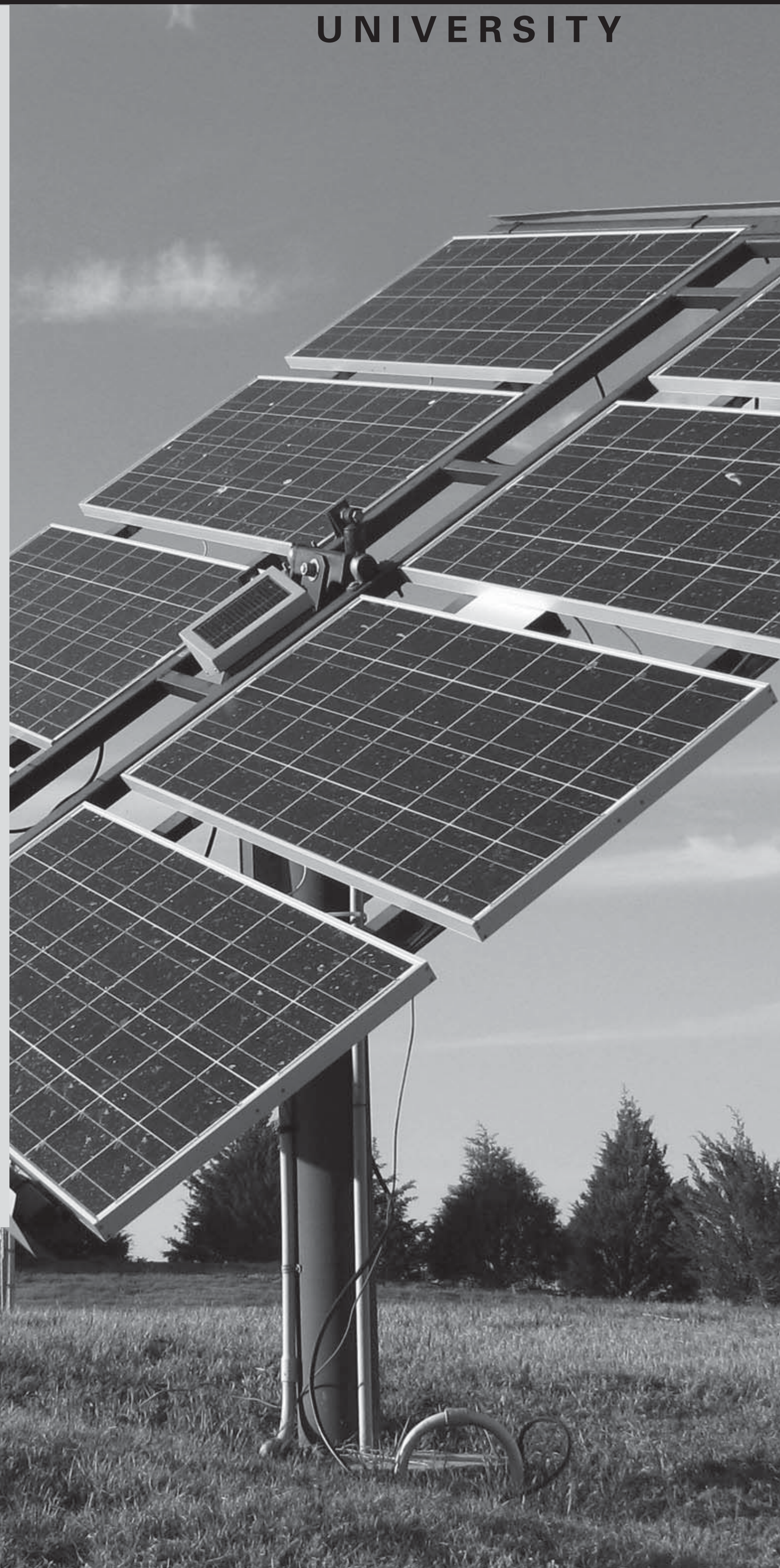
Final Report

Smart Residential Energy Management System

Drexel
UNIVERSITY



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1. Executive Summary

1.1. Purpose and Scope of Project

The Smart Residential Energy Management System began as a project for the proper management of energy within the Drexel Smart House. From this initial design, we expanded the project to a general idea of designing for the effective storage and use of energy. With this in mind, we have been able to consider the ability of this project to assist some of the challenges currently being faced by PECO and other utilities. Aside from benefiting PECO, this project also contains benefits to an everyday consumer in terms of electric bills by trying to avoid consuming power from the grid during the times of higher cost.

Although the project was first presented from Drexel Smart House, this has been a concern within the power industry for a much longer period. With energy demand on the rise, optimization of renewable energy generation and its storage has become not only a popular topic, but also a very important one. Harnessing these sources spreads from not only the ability to power homes but also to the ability to inject power back to the grid to relieve the demand on the utility. In general, the load experienced by the utility is a “double-humped” curve. One of the secondary abilities of the system is creating a flatter profile over the course of a day.

To reach these ends, our system is designed to utilize a combination of lead acid and/or lithium ion batteries as a storage medium. As a source of renewable energy, our main focus has been on solar panels as suggested by Drexel Smart House. In order to properly designate how to utilize the power, we have developed a control algorithm which takes historical data in order to decide the best course of action. Our solution is the proper combination of these elements.

1.2. Methods and Results

Preliminary simulations involving the solar panels and the lead acid battery they are connected to, have shown significant savings. These savings were also seen in the physical experiment that was run in the Drexel Center for Electric Power Engineering (CEPE) Laboratories using our algorithm to control the equipment. The similarities between simulation and experiment confirmed a working, successful product. One of the major setbacks was the lack of a load profile for the Drexel Smart House as the house is still in its design phase. Without this information we were unable to provide the Smart House a product tailored to their needs, in terms of suggested battery and solar panel sizing. However, our product’s algorithm could still be utilized, if the Smart House is still interested in pursuing this project.

The implementation of our real life testing platform included solar technology and a lead acid storage system. However, we were unable to integrate the Lithium Ion battery as the vendor failed to deliver the battery by the promised date.

The final control algorithm was capable of executing the commands offered by communications through the MATE digital monitor and control. This limited our ability to send specific commands such as the amount of power to send from the battery to the load. Instead, we were only able to tell the system when to turn on/off certain switches and components. Despite this limitation we were still able to get successful results.

The majority of our budget was spent on the Lithium Ion battery. The only additional hardware we had to purchase were cables to connect our computer to the MATE system controller. The rest of system, in terms of hardware and software, was already available in the CEPE Laboratories. CEPE also covered the costs of the cables.

1.3. Future Recommendations

Our recommendation for this project is to refine the control algorithm into a more user friendly and graphic based interface that will enable easier operation for the everyday consumer. Having an easy to use interface would also benefit the Drexel Power Department by allowing future courses the opportunity to easily integrate the system into their curriculum.

2. Abstract

Energy management is crucial in the modern day, with rising energy demands and a depleting supply of fossil fuels. One of the main challenges faced by utilities today is catering to an ever changing generation need, which renders it impossible for them to maintain a constant overall load profile.

We have designed a smart energy management system for residential use in the Drexel Smart House project to relieve the strain on the grid and utilities of high generation needs. Our final product includes a control algorithm that enables the integration of a renewable source and chemical energy storage devices with the grid. The system will be used to store generation from solar panels in batteries and supply the load or inject the generation back to the grid depending on load consumption of the house, price signals, power generation and charge on the battery.

The final testing of the system was performed in the Drexel Power Labs. With use of our algorithm, the validity of the simulations we ran in Fall and Winter terms were verified. When comparing the results, it was observed that those obtained from the hardware test were very close to those from the simulations.

The greatest challenge faced by our team was making enhancements to the existing system. One of the major goals as the project progressed was to add an additional storage medium to the lab. Even though the purchase was made and we were given a delivery date of late April/early May, we are still waiting at this point to receive the Lithium Ion Battery.

Overall, we were able to complete the tests we had originally set out to perform. The only issue at this point is the requirement of technical skill for the user. Without further adaptation, the product requires the end user to understand the intricacies of the program and thus makes it difficult for residential use.

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