

# GreenCharge: Managing Renewable Energy in Smart Buildings

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**Abstract** - Distributed generation (DG) uses many small onsite energy harvesting deployments at individual buildings to generate electricity. DG has the potential to make generation more efficient by reducing transmission and distribution losses, carbon emissions, and demand peaks. However, since renewables are intermittent and uncontrollable, buildings must still rely, in part, on the electric grid for power. While DG deployments today use net metering to offset costs and balance local supply and demand, scaling net metering for intermittent renewable to a large fraction of buildings is challenging. In this project, we explore an alternative approach that combines market-based electricity pricing models with on-site renewables and modest energy storage (in the form of batteries) to incentivize DG. We propose a system architecture and optimization algorithm, called GreenCharge, to efficiently manage the renewable energy and storage to reduce a building's electric bill. To determine when to charge and discharge the battery each day, the algorithm leverages prediction models for forecasting both future energy demand and future energy harvesting. We evaluate GreenCharge in simulation using a collection of real-world data sets, and compare with an oracle that has perfect knowledge of future energy demand/harvesting and a system that only leverages a battery to lower costs (without any renewable).

**Keywords:** GreenCharge, Renewable Energy, Smart Buildings.

## I. INTRODUCTION

The application of solar energy is more universal in daily now. In general, the solar power generation and solar illumination system are more popular for people. With regard to solar illumination system, which can be built while combined the charger and converter structure. It can charge the battery during the day, while lighting the LED module at night. In recent year, many charge methods have been widely used and discussed. For example constant current charging, constant voltage charging and reflex charging, etc. Reflex charging needs large input power, constant current charging is

easily overcharge and constant voltage charging is unable to determine the charge current during initial charge stage. So there are still some disadvantages and insufficient while use unique charge method. In other sides, common linear dimming methods include constant voltage dimming scheme and constant current dimming scheme. Among the existing power batteries, lithium batteries possess higher energy density, lighter weight, and compact size. However, the lithium battery is still suitable for lower power applications due to high cost, temperature rise, and lower output current at instant.

In order to overcome this drawback, a new system architecture and control algorithm called green charge for managing on-site renewable is proposed. Our system determines both the fraction of power to consume from the grid versus on-site battery based energy storage, as well as when and how much to charge battery based storage using grid energy.

### 1.1 Literature Survey

Since the 1980s, sustainability and environmental responsibility attracted considerable academic research (Deegan, 2002; Gray, 2002; Mathews, 1995). Research on voluntary disclosure has attempted to examine the nature and patterns of sustainability and environmental disclosure and investigates the determinants of these disclosure such as size, profit, and industry affiliation (Cormier and Magnan, 2003). The literature recognizes that sustainability and environmental practices across countries (Adams et al., 1998b) and between developed and developing countries (Imam, 2000). Further, the nature and patterns of sustainability and environmental disclosure vary between industry sectors (Gray et al., 2001). Surveys of sustainability and environmental disclosure practices in western developed countries reveal that companies place the greatest emphasis on human resources disclosures (Gray et al., 2001) such as employee numbers and remuneration, equal opportunities, employee share ownership, disability policies, and employee training. Moreover, the vast majority of disclosures are qualitative in nature.

In a study of 150 companies in the US, UK and Australia Guthrie and Parker (1990) found that 85% of US, 98% of UK,

and 56% of Australian companies made some social disclosures in their annual reports. This study indicated that more than 40% of these companies reported human resource issues, 31% reported community involvement, 13% reported environmental activities, and 7% reported energy and product related issues. It also revealed the average number of pages that organizations in these countries allotted for social disclosures. Companies in the US used 1.26 pages while 0.89 and .70 pages were used in the UK and Australia respectively.

## 1.2 Outcome of Literature Survey

Green Charge solves the problem at the beginning of each day to determine when to switch between grid and battery power, and when to charge the battery from grid versus renewable. Smart Charge uses a similar linear programming formulation without the constraints specific to renewable energy.

We explore how to lower electric bills using Green Charge by storing low-cost energy for use during high cost periods. We show that typical savings today are near 20% per home with the potential for significant grid peak reduction (20% with our data). Finally, we analyze Green Charge's costs, and show that recent battery advancements combined with an expected rise in electricity prices and decrease in solar panel prices may make Green Charge's return on investment positive for the average home within the next few years.

This project proposes methods for the currently faced issues by the solar power system. Before the start of each day the gateway server identifies the home's expected consumption and generated pattern, batteries array capacity and current SOC to determine when to switch home's power source between the grid and the battery array. Based on the weather condition (solar) the battery is charged from the grid or by on-site battery based energy storage.

## II. PROBLEM STATEMENT

Over the last few decades, a decline in fossil fuels reserves has been observed worldwide. Alternately, fossil fuels are not being newly formed at any significant rate, and thus present stocks are ultimately finite. If the current rate of energy consumption is continued, the limited reserves of coal, oil and natural gas may last only for 122, 42 and 60 years, respectively (BP 2009; Lior 2008).

The amount of uranium in the world is insufficient for massive long-term deployment of nuclear power generation (BP 2009; Lior 2008). Therefore, the sustainable development issue is more than ever raised, stimulating the need to search for a sustainable development path.

## 2.1 Uncontrollability and Unpredictability of Solar Energy

Solar power is one of the efficiently used renewable energy in most of the smart buildings. But it has significant drawback that has prevented its widespread of adoption. The generated electricity is intermittently based on uncontrollable and changing environmental conditions. Since the energy consumption density in kilowatt-hours (Kwh) per square foot, is higher than the energy generation density of solar deployments at most locations, buildings must still rely heavily on the electric grid for power. Another major drawback of DG is that large centralized power plants benefit from economies-of-scale that cause their generation costs; even accounting for T&D losses to be significantly lower than DG.

## 2.2 Lack of Net Metering

The DG deployments rely heavily on net metering, where building sell the unused energy they produce back to the utility company to offset their cost relative to grid energy. It is much less financially attractive where net metering is not available to measure the total production by solar panel and the consumption of generated power.

## 2.3 Reduction in Life Time of Battery

The batteries exhibit numerous limitations such as charging rate, capacity in-efficiencies such as energy conversion efficiency, self-discharge non-linear relationships like capacity, life time, depth of discharge, discharge rate etc. The life time of the battery is the most dominant drawback, which occurs due to abrupt switching between the electric grid and the solar energy. Due to this, the life time and the efficiency is reduced where maintenance of battery plays a major role which is not beneficial cost-wise.

## III. RESULTS AND DISCUSSIONS

Finally, this system can analyze Green Charge's costs, and show that recent battery advancements combined with an expected rise in electricity prices and decrease in solar panel prices may make Green Charge's return on investment positive for the average home within the next few years.

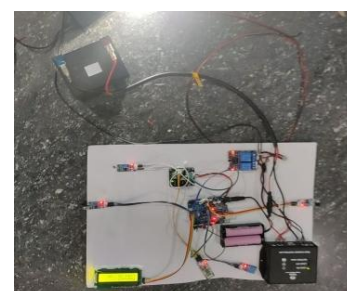


Figure 1: Prototype model of hardware design

#### IV. CONCLUSION

In this project, we examine how to lower electricity bills using Green Charge by storing low cost energy for use during high cost periods. Finally we analyze the green charge costs, the expected rise in electricity prices and decrease in solar panel prices may make Green Charge return on investment. and explore how to lower electric bills using Green Charge by storing low-cost energy for use during high cost periods. We show that typical savings today are near 20% per home with the potential for significant grid peak reduction (20% with our data). Finally, we analyze Green Charge's costs, and show that recent battery advancements combined with an expected rise in electricity prices and decrease in solar panel prices may make Green Charge's return on investment positive for the average home within the next few years. Both, RES and micro grids are tend to be solutions for improving existing grids in a future. Smart grids are able to transform the quality of whole distribution system thanks to dispersed RES. Variable character of these sources implicates a necessity to manage the load. Local micro grids will gain a better quality of energy, a stability of supply and energy independence. That is why a development of RES should be perceived at a local, commune level. RES can enhance power quality and reliability and potentially reduce the need for traditional grid expansion. The difficult RES' management process can be improved with an implementation of smart, local micro grids and – in a next phase – popularization of electric vehicles and their storage possibilities V2G. "Green charge renewable energy for smart buildings" improves the energy affiance and also improves the continuity of power supply. Here in this paper solar energy is used a renewable source because generation of solar energy is very easy and economical. Due to remote control of electrical appliances reduces the human effort and also time saving. In this paper we implemented hardware for switching on and off for two loads and we can also increase the number of loads as per our requirements. The on and off the loads using remote control is successfully implemented in this prototype. During the normal power supply also we can switch on and off using the remote control. The main advantage of this system is continuity of power supply without any breaks along with remote control of devices. The initial cost as well as maintenance cost of the system is very less. So it can be easily implemented for any domestic loads.

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