**Paper: SmartCharge: Cutting the Electricity Bill in Smart Homes with Energy Storage**

**Reviewer: Ye Xu**

**A SHORT SUMMARY OF THE PAPER:**

This paper mainly presents the following aspects:

1. It analyzed, based on the data about peak/unpeak powers and different charge prices from different areas, the problems of traditional fixed rate charge plan for electricity, as well as the new problem for consumers based on the new market based charge plan.
2. It presented SmartCharge, the core part of their intelligent charging system to manage battery charge and discharge schedule. The authors explained in detail how SmartCharge works, and how to mathematically model each part of the system, as well as the objectives.
3. Then the paper gave a couple of experimental results and evaluations. In particular, the authors used real data from some houses for couple of months to show the simulation results and the corresponding cost reductions.
4. Finally, the paper gave a cost and benefit analysis. In particular, the authors analyzed the return on investment (ROI) of the smart charge system, based on the installation fee of the hardware required for smart charge system.

**STRENTH AND CONTRIBUTIONS OF THE PAPER:**

This paper has three key contributions:

1. The solver of SmartCharge was mainly based on linear programming. Linear programming is a well-developed area, and the algorithms are available to solve various problems. Because of this general technique, as well as the whole SmartCharge architecture, future researchers are able to reuse this system without significant modification; only the Linear Programming modeling needs to be changed, either by modifying the battery modeling or adding more variables to control.
2. This paper really aimed to solve a practical problem, a.k.a, how to save cost. Since the recent growth in peak power usage caused quite a few environmental and social issues, many states changed their charging plan from the traditional fixed charging plan to a market based charge plan. But very few, if any, of home consumers paid attention to the management or scheduling of workload and energy source to make high benefit out of this plan change. Even if some of the home consumers did, they have to manually monitor the real time prices and then decide when to use which appliance. Via smartCharge, the authors made a positive prediction of huge electricity cost reduction.
3. The paper also discussed about the practical issue of the return on investment. Although through smartCharge home consumers are able to reduce electricity cost, the biggest requirement is the installation fee of the battery array, and other hardware. For battery array only, the price would be a couple of thousands of dollars. The paper analyzed in details about the tradeoff between the electricity cost reduction and this installation fee.
4. Regarding the data inputs to the smart charge system, unlike most of other paper with the similar topic, this paper used a Machine Learning technique to provide the next 24 hours’ power usage pattern. This ML-based method made the system more realistic, and technically easy to implement.

In general, the structure of the paper was clear; the overall technical explanations were easy to understand. However, the paper seems to miss an important fact that nowadays renewable energy source are more and more popular at homes, as will be discussed below

**WEAKNESS OF THE PAPER:**

1. Although the paper discussed in detail how smart Charge works, the paper ignores one important fact, that is, these days renewable energy source like solar and wind are more and more popular. Rather than buying battery array for storage, most of the home owners are more willing to invest their money on solar panels, and/or with battery array storage. Some home consumers only want to purchase solar panel only. So, rather than just considering about the battery array, which is unlike to be purchased alone, the author could have improved the practicality by offering the system with three options regarding energy source schedule: battery alone, solar only, and battery with solar.
2. Another issue is that a lot of workloads in a typical home can be defined as “deferrable workloads”, such as refrigerator, AC, wash machine, dryer, etc. As long as they have enough power in each working period, the total work can be done. So regarding the workload scheduling, the authors could also have improved the whole cost reduction by adding this deferrable workload scheduling, which is also very common in today’s home appliance usage.

In conclusion, this paper took advantage of a well-known technique to solve a practical problem in recent hot topic of “green” home building in both industrial and academic areas. It did raise research interests in the area of scheduling energy resource in “green” smart homes, although the technique and the algorithm used was nothing new. This paper might be improved if the authors took considerations about renewable energy source as well as deferrable workload scheduling.