Dynamic Modeling of Community Energy Storage for Lifetime Estimation During Islanding

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INTRODUCTION AND MOTIVATION

With the rapid development of electrochemical energy storage and the ongoing implementation of smart-grid metering and automation technologies, retail electric providers have started exploring applications for community-level battery energy storage systems [1]. Energy storage located at the distribution transformer level can provide vital control services, isolate and island during grid anomalies, and reduce utility costs associated with peak-demand periods [2]. In order to "island" a residential community during an electric outage, community energy storage (CES) must carefully follow downstream loads and discharge at a power level that is exactly equal to local electric demand at every moment in time. Our objective is to model the state of a CES unit during islanding to show how long a standard CES unit can power downstream loads at various times of day.

METHODS AND ANALYSIS

It is difficult to gauge how long a CES unit can island because electric demand downstream from the CES varies widely based on ambient temperature, time of day, and other random factors. Furthermore, the rate of discharge demanded from a battery affects its available capacity [3, 4]. In order to assess how long a standard CES unit can island a community, information must be known about the instantaneous load on the battery, and the dynamic nature of the battery itself. To estimate the instantaneous load on a CES unit, we utilize one-minute electric demand and rooftop photovoltaic (PV) generation data collected by Pecan Street Inc. (PSI) of Austin, Texas as part of their ongoing smart grid demonstration project [5]. In order to describe the dynamic state of a CES unit, we implement a dynamic model which describes the state-dependent voltage and capacity of the battery [6]. Using the model developed in [6], CES specifications outlined in [2] and data collected by PSI [5], we simulate a CES unit used to island downstream homes with and without rooftop PV panels installed. We consider a number of different homes from PSI's smart-grid study and simulate outages at various times of day over many months to show the islanding capabilities of CES specified in [2].

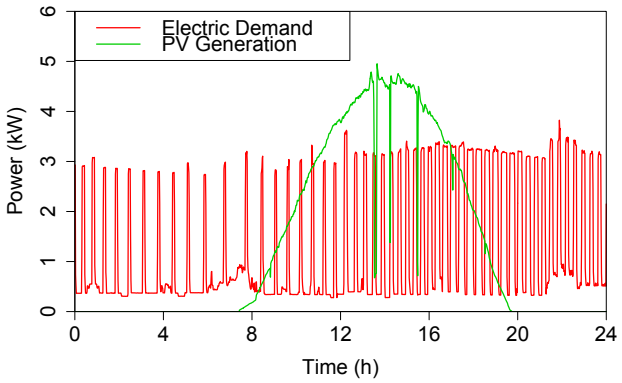

Figure 1: Pecan Street Inc. is collecting one-minute electric demand and photovoltaic generation data from hundreds of homes in Austin, Texas as part of a smart grid demonstration project. Sample data for a single home is shown here.

REFERENCES

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