Occupant-Dependent Residential End Use Load Profiles for Demand Response Under High Renewable Energy Scenarios

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ABSTRACT

With increased penetration of renewable energy resources, such as wind and solar, in the generation mix servicing the electric grid moving forward, there is a need for added flexibility to account for the high variability in the electricity supply that can occur with the use of these resources. Current market reports and industry surveys suggest that residential buildings are projected to be able to contribute significantly more to Demand Response (DR) and more broadly in grid flexibility services in the future, with the growth of enabling technologies that will help to support this transition from static to grid-responsive loads. Various behind-the-meter energy technologies such as smart meters, energy storage, electric vehicles, and smart appliances have the potential to accommodate these grid needs. This overall study aims to formulate electric load profiles for residential loads and quantify their ability to provide grid services, including capacity services, spinning reserves and/or voltage regulation at different times of the day. In this research, the REFIT and American Time Use Survey (ATUS) datasets are used to develop data-driven models to determine the state of use of different end-uses and their corresponding load profile when they are in operation. The results of this work will be used as input into grid-level models to assess the impact of the use of use end-use resources on transmission and distribution (TD) capital investment and reliability.

INTRODUCTION

By 2050, electricity generation due to renewable sources, including solar and wind, is projected to represent 20% and 11% of the generation mix respectively (US EIA 2018); this percentage is projected to increase further in the future. The electricity generation from these sources is dependent on variables such as solar irradiation and wind speed, which are highly variable, and often unpredictable. This variability in electricity supply can be addressed through various grid-based flexibility services (FS). However, these services are dependent on mostly non-renewable sources; with reduction in non-renewable sources in the generation mix, these FS may not be economically feasible options in the future. However, Demand Response (DR) programs have the potential to provide similar load flexibility with minimal investment, using loads in existing building. Currently, a significant portion of DR resources implemented are from large industrial and commercial customers (FERC 2018). While, by DR's original definition, it is used for load shifting and peak shaving, recent industry surveys suggest that DR's definition is expanding to include load flexibility capabilities at any time of day. these studies also suggest that residential buildings are projected to contribute significantly more to DR in the future, with the growth of enabling technologies (SEPA 2019). This study is focused on developing electric

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