Characterization and determinants of energy poverty disconnections using smart meter data

Zheyu Zhang [a], Yueming (Lucy) Qiu [a, *], Destenie Nock [b,c]

[a] School of Public Policy, University of Maryland, College Park, MD, USA

[b] Engineering and Public Policy, Carnegie Mellon University, PA, USA

[c] Civil and Environmental Engineering, Carnegie Mellon University, PA, USA

[*] Corresponding author. E-mail addresses: yqiu16@umd.edu

Energy poverty remains a significant issue in developed countries, exacerbated by social inequalities. In 2020, 27% of households in the United States experienced energy poverty, with 12% of households experiencing disconnections (U.S. Energy Information Administration). Recent research has leveraged smart meter data to characterize and study energy poverty through the analysis of disconnection durations reflected in household electricity consumption data (Barreca et al., 2022; Longden et al., 2022). This study aims to determine energy poverty disconnections from household electricity consumption data, analyze the characteristics of total disconnections and energy poverty disconnections, and examine their influencing factors. The study uses hourly electricity consumption data recorded by smart meters from 5,318 households provided by a power company in the southwestern United States over a 34-month period, both before and during the pandemic, to calculate the duration and frequency of disconnections. Total disconnections were categorized by type, excluding regional power outages, temporary disconnections, and voluntary disconnections during absences, to identify energy poverty disconnections. Characteristics and differences between total disconnections and energy-poverty disconnections were compared in terms of time distribution, temperature variations, electricity consumption differences, household characteristics, housing type, and energy usage methods. Furthermore, fixed-effects models were used to study the differential impacts of temperature variations, household characteristics, and housing types on total disconnections and energy poverty disconnections. Finally, the study

focused on energy usage methods, including types of heating and cooling, pre-cooling, home energy management systems, and their relationships with both types of disconnections, alongside heterogeneity analysis by race and income. The study found that disconnections significantly increased after the pandemic, with energy poverty becoming more severe. An increase in temperature reduced total disconnection duration, though the impact was minimal. There was an inverse relationship between household electricity consumption and energy poverty disconnections. Disconnection risk varied significantly by race, with American Indian and Alaska Native households having the highest risk. The lower the income, the longer the energy poverty disconnections. Mobile homes had the highest probability of energy poverty disconnections, while townhouses had the lowest. Older energy managers had a higher likelihood of experiencing disconnections. In terms of energy usage methods, heat pumps helped reduce disconnections, while unified gas heating and AC cooling had a greater impact on energy-poor households. Decentralized gas heating and decentralized AC cooling were both highly effective in alleviating energy poverty. For energy-poor households, pre-cooling exacerbated their burden, while home energy management systems effectively alleviated disconnection issues. By distinguishing disconnection types directly from utility companies, this study facilitates efficient identification of energy-poor households. Furthermore, analyzing the characteristics and influencing factors of energy poverty assists governments and utility companies in providing appropriate energy policies to energy-poor households more precisely.

Keywords: energy poverty disconnections, smart meter data, power outage

References

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