

Assessing Awareness and Willingness of College Students to Participate in Demand-Side Management Strategies: A Survey-Based Approach

Patricia Guillante
Student Member ASHRAE

Jeonga Kang

Kristen Cetin, PhD, PE
ASHRAE Member

ABSTRACT HEADING

Buildings represent the largest contributor to energy consumption in electric grids of the United States, making them a significant focal point for energy improvements and sustainability efforts. The broad participation of residential buildings in demand side management (DSM) can support decarbonization goals and the use of power generated by clean energy sources. The purpose of this study is to assess awareness and potential factors that may influence college students' willingness for load flexibility to support DSM participation. An online survey was conducted among students majoring in civil, environmental, and applied engineering in two distinct classes. Preliminary findings suggest that enhanced awareness of the DSM strategies reduce levels of concern with participation in demand side management programs. The factors that appear to drive willingness to participate in DSM for this specific population are related to the potential reduction of electricity costs, helping the environment, and overall energy savings.

INTRODUCTION

Buildings, collectively, account for approximately 70% of total energy consumption on the electric grid, playing a substantial role in driving demand. Residential buildings specifically contribute approximately 35% of this total energy consumption (U.S. EIA, 2021). As substantial energy consumers linked to the electric grid, the active participation of buildings in demand side management (DSM) can support decarbonization of electric power, and in particular the use of power generated from clean energy resources, such as solar or wind (Koul et al. 2021). DSM or Demand Response (DR) programs are designed to encourage consumers to modify when they use electricity, which can be a mechanism to support balancing available electricity supply with grid loads, particularly under peak demand scenarios (Wijaya et. al, 2013). Therefore, increasing DSM participation can also enhance the reliability of electric power supply by mitigating power outages caused by grid overload.

Participation in DSM can be influenced by various factors, including socio-demographic characteristics, as well as occupants' behavior, level of awareness, and electricity-consuming end-use loads (Khan et al., 2021, Azar et al., 2017, Blight et al., 2013). Previous survey-based studies in this area have demonstrated that the socio-demographic profiles of occupants, including gender, age, educational level, household size, and income, are correlated with energy usage patterns and the potential for savings through DSM (Vogiatzi et. al, 2018). Other survey-based studies have indicated a significant potential to enhance home energy flexibility through behavioral changes. However, there is a need to provide adequate information and education to homeowners on how these changes can effectively improve energy consumption and flexibility. Additionally, increasing awareness about DSM/DR can also increase willingness among homeowners to adjust habits and decrease energy usage during

Patricia Guillante and **Jeonga Kang** are graduate research assistants in the Department of Civil and Environmental Engineering, Michigan State University, East Lansing, Michigan. **Kristen Cetin, PhD, PE** is an associate professor in the Department of Civil and Environmental Engineering, Michigan State University, East Lansing, Michigan.

peak periods (Tumbaz et al., 2018). Specifically for college students, most of whom are living in rental housing, these challenges can be compounded by additional factors such as shared living spaces, varying household sizes, and different schedules among individuals (Guillante et. al, 2024). Additionally, renters may not pay for their electricity bills directly, results in limited information on their energy usage and willingness to adjust the time they perform electricity consuming tasks (Macedo et. al, 2015). Despite the potential benefits of DSM/DR, the lack of knowledge and awareness from consumers, along with particular challenges of rental housing, are pontential barriers that can limit DSM participation. Due to these challenges, the purpose of this study is to assess awareness and potential factors that may influence college students' willingness for load flexibility to support DSM participation.

METHODS

This study employed a survey-based methodology. A cross sectional survey was designed on Qualtrics, a web-based survey tool that allows the development of survey research and other types of data collection (Qualtrics, 2020). The online survey was designed considering several types of questions and an anonymous link was provided such that participants could access the survey. Participants were selected from two different engineering courses (Course 1 and Course 2) consisting of students majoring in civil, environmental, and applied engineering. Students enrolled in Course 1 had learned and received background information about DSM/DR strategies, whereas students in Course 2 did not receive any background information during their course. A convenient sampling approach was used. A total of 33 students from Course 1 responded to the survey, while 55 students from Course 2 participated in the survey.

Participants from the two courses were asked to answer the same 50 questions, divided into three main sections in an effort to understand household occupancy schedules, awareness and willingness to participate in DSM, and demographic characteristics. The survey remained open for approximately 20 days and was completed in Course 1 during the fall semester of 2022 and in Course 2 during the spring semester of 2023. The demographic and household characteristics from the two groups of students are shown in Table 1.

Table 1. Demographic and household characteristics

| Category | Data Field | Sample (Course 1) | Sample (Course 2) |
|----------------------|--------------------------------|-------------------|-------------------|
| Gender | Female | 42.42% | 43.64% |
| | Male | 54.55% | 54.55% |
| Age | 18-24 years | 87.88% | 98.18% |
| | 25-34 years | 12.12% | 1.82% |
| Tenure | Rent | 78.79% | 84.91% |
| | Pay for electricity | 80.65% | 83.02% |
| Utility bills | Bills are included in the rent | 19.35% | 16.98% |
| | Average | 3.36 | 3.28 |
| Adults per household | 4 adults or more | 57.57% | 49.06% |
| | Friends or roommates | 65.63% | 83.02% |

The two surveyed student groups show similar demographic characteristics regarding gender and age, although overall, students from Course 1 are slightly older compared to those from Course 2. The majority of students rent their place of residence, and over 80% of respondents directly paying for their electricity bills across both courses. Nearly all students reside in single-family homes or apartments, while a small percentage (5.56%) from Course 2 live in dormitories. Most students shared their living space with friends or roommates, resulting in an average of 3.36 (Course 1) or 3.28 (Course 2) adults per household.

RESULTS

DSM awareness was assessed by inquiring about participants' familiarity with DSM/DR programs. Results show that 54.54% of students from Course 1 were unfamiliar with DSM/DR, whereas 88.90% of students from Course 2 lacked familiarity with these programs. These results were expected, as Course 1 participants received some background information about these programs throughout the course. The familiarity with DSM appears to influence participants' perceptions of concerns about DSM, as 55.55% of participants from Course 2 reported having or being unsure about concerns regarding DSM programs, compared to 39.39% from Course 1. This influence can also be observed through analysis of several factors that have the

potential to impact respondents' interest in participating in DSM. Figure 1 shows the results from seven factors.

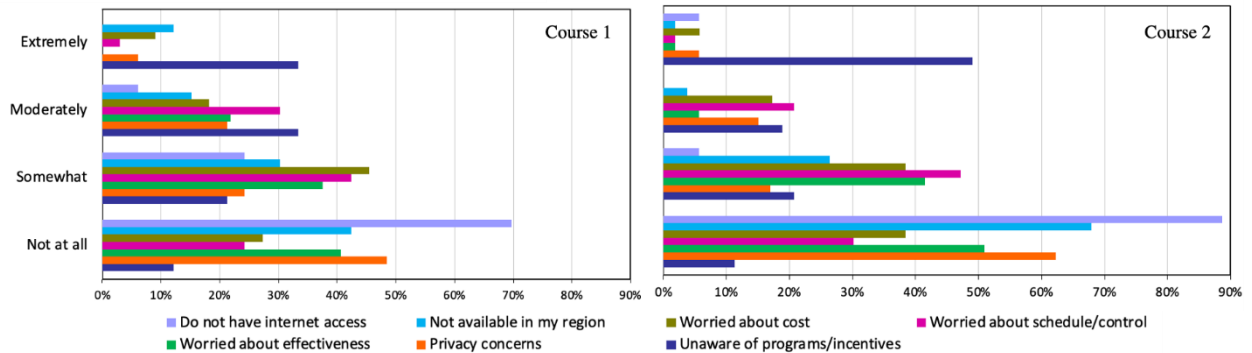


Figure 1 Factors that impact interest in participating in DSM programs for participants in Course 1 and Course 2.

The results indicate that for students from Course 2, lack of awareness about DSM programs or incentives had a significant impact on the interest of nearly 50% of respondents in participating in DSM (extremely impactful). Participants from Course 1 also demonstrated that lack of awareness could affect their interest, followed by concerns about scheduling or control. However, these concerns were to a lesser degree (moderately impactful). Similar results were found when participants were asked about their interest in participating in DSM in the future and their belief in the associated benefits. Regarding being interested in participating in DSM in the future, nearly 93% of students from Course 1 expressed interest in participating in DSM programs in the future, compared to 69% of students from Course 2. Students from Course 1 also demonstrated stronger evidence regarding the benefits associated with DSM, with 81% expressing belief in benefits, while only 55% from Course 2 held similar opinions. These findings reinforce the perception that raising awareness about DSM among households or energy consumers can enhance their interest and willingness to participate in these programs.

The willingness to participate in DSM strategies was also explored by asking participants if they would be willing to adjust the timing of performing certain energy-consuming tasks, such as running a dishwasher, washer, and/or dryer, among others to reduce peak demand on the electricity grid. Both groups of students reported being willing adjust the time they run their dishwasher (56% - Course 1, 59% - Course 2) and washer/dryer (70% - Course 1, 65% - Course 2). The factors that appear to drive willingness to adjust are related to reduction in energy bills and saving energy (Figure 2). For participants from Course 2, improving energy efficiency in the home is also a benefit that could increase willingness to participate.

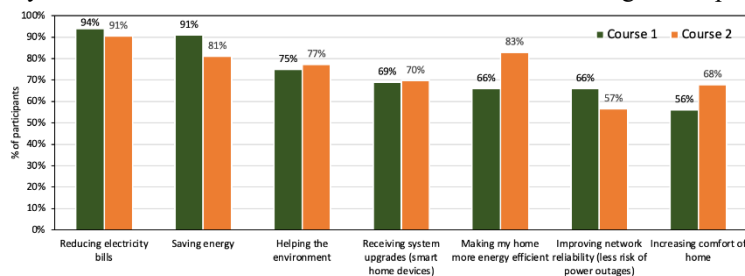


Figure 2 Factors or benefits that could influence willingness to participate in DSM

CONCLUSIONS

Based on the results from the two groups studied, increasing awareness about DSM among households or energy consumers can increase participants interest and willingness to participate in these programs. Findings regarding willingness to participate also suggest potential misconceptions about DSM/DR, as electricity bills may not change significantly unless participants are enrolled in time-of-use (TOU) tariffs or other DR type programs. TOU tariffs incentivize consumption during off-peak hours, leading to reduced electricity bills. This research is a part of an ongoing study. Further analysis will be conducted to better understand DSM potential for a variety of groups of people.

ACKNOWLEDGMENTS

This study was funded by the National Science Foundation under award # 2144468. The findings of this study do not necessarily reflect the views of the National Science Foundation.

REFERENCES

- U.S. EIA. 2021. "Electric Power Annual, Table 2.2: Sales and Direct use of Electricity to Ultimate Customers by Sector".
- Koul, Singh, K. B., Brar., Y.S. 2021. "An introduction to smart grid and demand-side management with its integration with renewable energy". *Chapter 4 in Advances in Smart Grid Power System*, p.73-101.
- Wijaya, T. K., Papaioannou, T. G., Liu, X., Aberer, K. 2013. "Effective consumption scheduling for demand-side management in the smart grid using non-uniform participation rate". *Sustainable Internet and ICT for Sustainability*. pp. 1-8
- Khan, I., Jack, M. W., Stephenson, J. 2021. "Dominant factors for targeted demand side management—An alternate approach for residential demand profiling in developing countries". *Sustainable Cities and Society*, v67, 102693
- Azar, E., Ansari, H. A. 2017. "Framework to investigate energy conservation motivation and actions of building occupants: The case of a green campus in Abu Dhabi, UAE". *Applied Energy*, v.190, p.563-573.
- Blight, T. S., Coley, D. A. 2013. "Sensitivity analysis of the effect of occupant behaviour on the energy consumption of passive house dwellings". *Energy and Buildings*, v.66, p.183-192.
- Vogiatzi, C., Gemenetzi, G., Massoua, L., Pouloupoulos, S., Papaefthimiou, S., Zervas E. 2018. "Energy use and saving in residential sector and occupant behavior: A case study in Athens". *Energy & Buildings*. pp 1-8.
- Tumbaz, M. N. M., Moğulkoç, H. T. 2018. "Profiling energy efficiency tendency: A case for Turkish households". *Energy Policy*, v.119, pp.441-448.
- Guillante, P., Fylak, N., Cetin, K. 2024. "Potential Factors Influencing Student Rental Housing Participation in Demand-Side Management Strategies". *Proceedings at the 2024 CI & CRC Joint Conference*.
- Macedo, M.N.Q., Galo, J.J.M., de Almeida, L.A.L., Lima, A.C. de C. 2015. "Demand side management using artificial neural networks in a smart grid environment". *Renewable and Sustainable Energy Reviews*, v. 41, pp.128-133.