

Energy Conservation Behaviors in Greek Urban Districts: Investigating Practices to Reduce Energy Consumption in High-Density Areas

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Introduction

In recent years, high energy consumption has been one of the main problems that lead to increased environmental degradation, higher greenhouse gas emissions, and unsustainable urban living conditions [1,2]. Climate change is related to energy usage in buildings, because its effects cause adverse weather conditions that impacts the economy and society [3].

In December 2021, the European Union published a new revision of the latest directives concerning nearly zero-energy buildings (NZEB) for residential use and proposed guidelines for their transition into zero-energy buildings (ZEB) from the year 2030 [4]. Although the goal appears ambitious, the question raised here concerns the future of high energy consumption residential buildings which lack the capability to become zero-energy buildings or even undergo energy upgrades, particularly in low-income countries, where efforts to reduce energy usage are still emerging.

The current research examines practices to reduce energy consumption in high-density areas, using a questionnaire based approach.

Materials and Methods

The majority of this study was conducted through in person questionnaire distribution to residents in three distinct high-density neighborhoods in Athens, Greece (Nea Ionia, Nea Filadelfia, and Kifisia). These areas are characterized by dense urban development within the metropolitan city of Athens. In order to have direct interaction with residents in these areas, the door to door method was implemented [5]. Additionally, the questionnaire was distributed online to improve response rates and obtain a more representative sample.

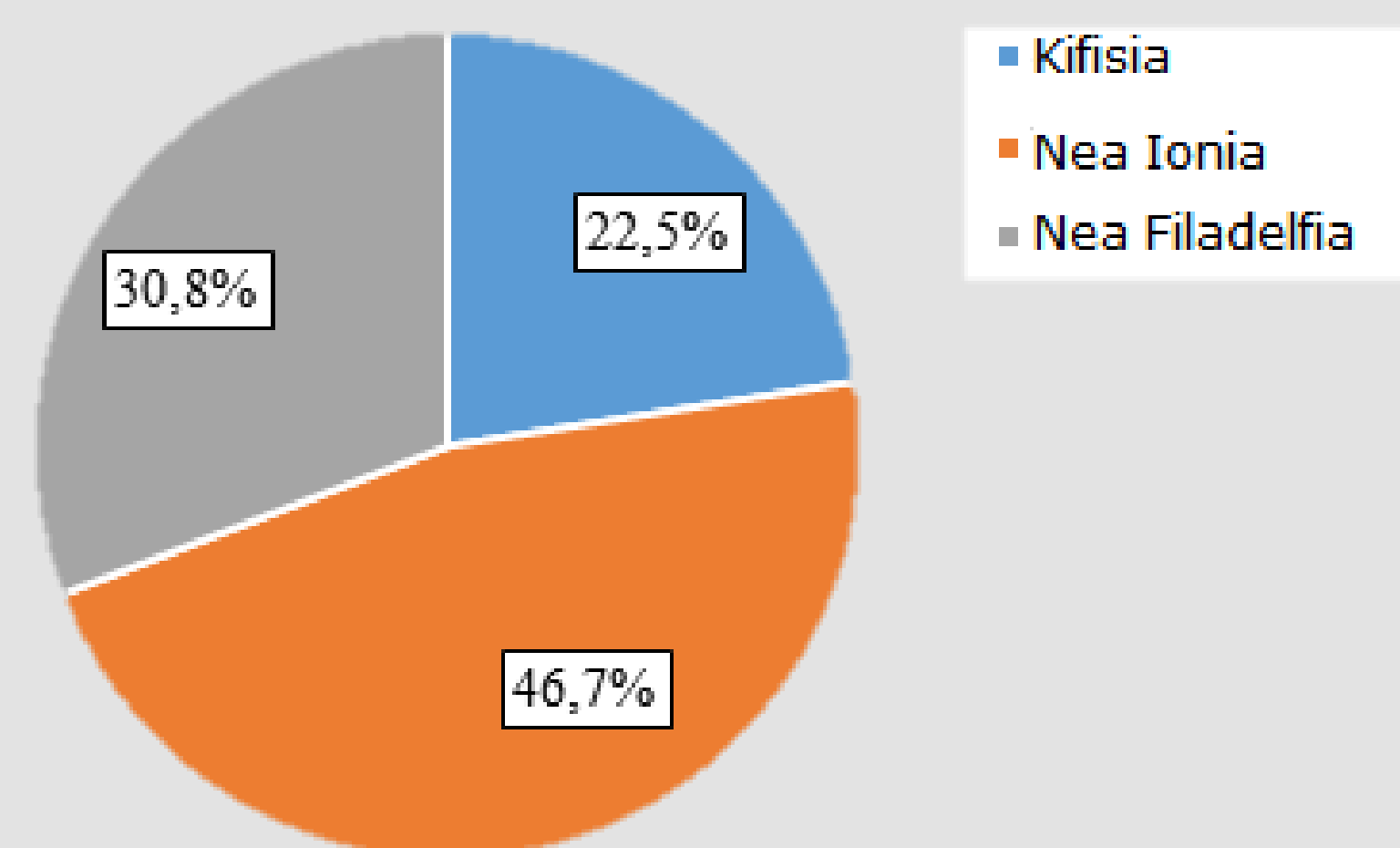


Figure 1: Residential area of residence of the respondents

For the data analysis, spreadsheet forms are used to enter the questions numerically, and generate basic charts. Subsequently, SPSS software is utilized for statistical processing, including the creation of tables and graphs. Additionally, a literature review was conducted to explore existing knowledge and gaps related to energy saving practices across the globe.

Results

To address the research question "To what extent do you implement good energy management practices in order to reduce your energy consumption?", results show that responders appear to adopt simple, everyday energy-saving practices such as using LED lights, utilizing natural light, and turning off lights more consistently. In contrast, more complex or financially demanding practices such as automations in the heating system, are less implemented (Table 1 and Figure 2).

| | | Very little | Little | Moderate | Quite a lot | Very much |
|---|---------------------|-------------|--------|----------|-------------|-----------|
| Q1. Automations in the heating system | Number of responses | 25 | 14 | 19 | 32 | 23 |
| | Percentage | 20,8% | 11,7% | 15,8% | 26,7% | 19,2% |
| Q2. I clean my air condition units | Number of responses | 6 | 9 | 21 | 52 | 32 |
| | Percentage | 5,0% | 7,5% | 17,5% | 43,3% | 26,7% |
| Q3. Tents are lowered during the summer months | Number of responses | 7 | 5 | 7 | 21 | 76 |
| | Percentage | 5,8% | 4,2% | 5,8% | 17,5% | 63,3% |
| Q4. I open the windows shutters for natural light | Number of responses | 2 | 3 | 6 | 19 | 90 |
| | Percentage | 1,7% | 2,5% | 5,0% | 15,8% | 75,0% |
| Q5. I use LED type lamps | Number of responses | 3 | 6 | 10 | 28 | 73 |
| | Percentage | 2,5% | 5,0% | 8,3% | 23,3% | 60,8% |
| Q6. Window gaps are sealed during winter | Number of responses | 7 | 19 | 29 | 25 | 40 |
| | Percentage | 5,8% | 15,8% | 24,2% | 20,8% | 33,3% |
| Q7. Lights are turned off when leaving a room | Number of responses | 2 | 14 | 15 | 18 | 71 |
| | Percentage | 1,7% | 11,7% | 12,5% | 15,0% | 59,2% |
| Q8. Electrical appliances are unplugged when not in use | Number of responses | 11 | 37 | 31 | 17 | 24 |
| | Percentage | 9,2% | 30,8% | 25,8% | 14,2% | 20,0% |

Table 1: Responses to the question "To what extent do you implement good energy management practices in order to reduce your energy consumption?"

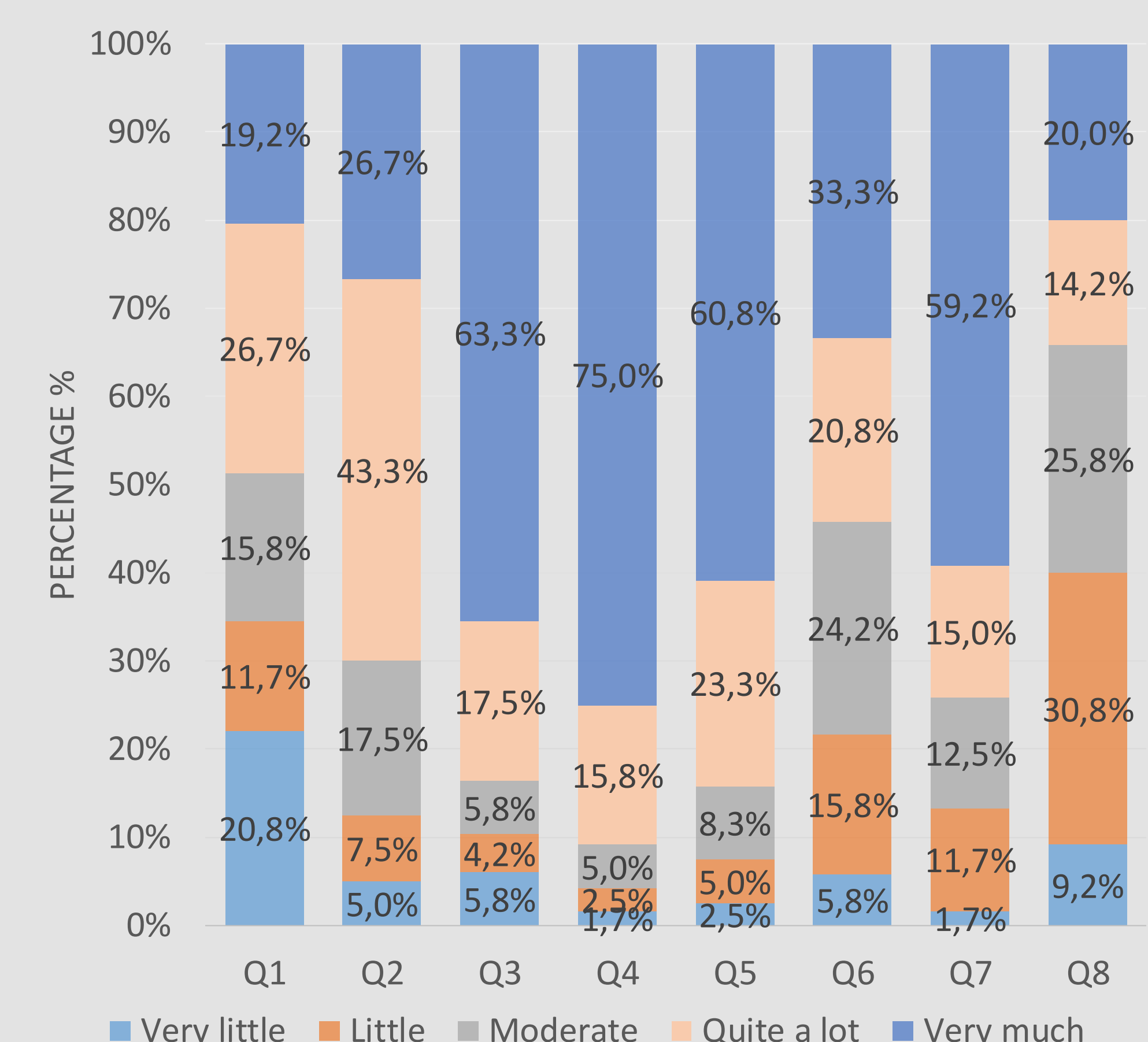


Figure 2: Responses to the question "To what extent do you implement good energy management practices in order to reduce your energy consumption?"

Table 2 presents in detail the statistical data derived from the software analysis of the questionnaire responses. Specifically, it includes values for the Mean, Standard Deviation, Skewness, and Kurtosis.

| | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|-----------|----------------|-----------|------------|-----------|------------|
| | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| Q1. Automations in the heating system | 3,12 | 1,452 | -,255 | ,227 | -1,315 | ,451 |
| Q2. I clean my air condition units | 3,79 | 1,076 | -,931 | ,221 | ,441 | ,438 |
| Q3. Tents are lowered during the summer months | 4,33 | 1,156 | -1,806 | ,225 | 2,277 | ,446 |
| Q4. I open the window shutters for natural light | 4,60 | ,834 | -2,488 | ,221 | 6,363 | ,438 |
| Q5. I use LED type lamps | 4,35 | 1,001 | -1,672 | ,221 | 2,265 | ,438 |
| Q6. Window gaps are sealed during winter | 3,60 | 1,260 | -,409 | ,221 | -,962 | ,438 |
| Q7. Lights are turned off when leaving a room | 4,18 | 1,145 | -1,119 | ,221 | -,070 | ,438 |
| Q8. Electrical appliances are unplugged when not in use | 3,05 | 1,276 | ,226 | ,221 | -1,075 | ,438 |

Table 2: Descriptive statistics for the question "To what extent do you implement good energy management practices in order to reduce your energy consumption?"

The preliminary data evaluation collected with the Likert scale, aimed to identify the correlation between sample characteristics and the type of question. Considering the correlation involves quantitative variables, a bivariate analysis was performed using the parametric Pearson correlation coefficient. Detailed correlations between energy management behaviors of the individuals and demographic variables such as gender, marital status, number of children, employment status, education, income, and age, are presented in Table 3.

| | | Correlations | | | | | | |
|----|---------------------|--------------|----------------|--------------------|-------------------|-----------|--------|-------|
| | | Gender | Marital Status | Number of Children | Employment Status | Education | Income | Age |
| Q1 | Pearson Correlation | -,008 | ,017 | ,196 | -,033 | ,048 | ,005 | ,069 |
| | Sig. (2-tailed) | ,931 | ,851 | ,033 | ,721 | ,603 | ,958 | ,455 |
| Q2 | Pearson Correlation | ,139 | ,027 | ,139 | -,055 | ,063 | ,029 | ,016 |
| | Sig. (2-tailed) | ,131 | ,768 | ,131 | ,550 | ,492 | ,756 | ,866 |
| Q3 | Pearson Correlation | -,085 | -,346 | -,017 | -,261 | -,137 | -,017 | -,053 |
| | Sig. (2-tailed) | ,356 | ,000 | ,856 | ,004 | ,136 | ,854 | ,565 |
| Q4 | Pearson Correlation | ,132 | ,075 | -,113 | -,128 | ,058 | -,111 | -,256 |
| | Sig. (2-tailed) | ,150 | ,414 | ,222 | ,165 | ,527 | ,229 | ,005 |
| Q5 | Pearson Correlation | -,022 | ,185 | -,274 | -,119 | ,133 | -,028 | -,189 |
| | Sig. (2-tailed) | ,810 | ,043 | ,003 | ,196 | ,149 | ,763 | ,038 |
| Q6 | Pearson Correlation | -,023 | ,108 | ,025 | ,014 | ,181 | -,043 | -,050 |
| | Sig. (2-tailed) | ,804 | ,241 | ,786 | ,878 | ,048 | ,645 | ,589 |
| Q7 | Pearson Correlation | -,183 | ,042 | -,068 | ,124 | ,233 | ,142 | -,053 |
| | Sig. (2-tailed) | ,045 | ,645 | ,460 | ,176 | ,010 | ,121 | ,565 |
| Q8 | Pearson Correlation | ,197 | -,034 | -,125 | -,009 | -,171 | -,212 | -,195 |
| | Sig. (2-tailed) | ,031 | ,710 | ,177 | ,923 | ,062 | ,020 | ,033 |

Table 3: Correlation analysis for the question "To what extent do you implement good energy management practices in order to reduce your energy consumption?"

Conclusion

The examination of energy usage practices in dense urban housing area shows that residents engage in basic activities, in order to decrease the daily energy usages. On the other hand practices that require additional effort or need extra financial investment are less frequently implemented.

Opening the window shutters for natural light, using LED lamps, lowering the tents in the summer months and switching off the lights when exiting a room, are the most consistently practiced energy saving actions. Moreover, practices like cleaning the air conditions and sealing the window gaps during the winter months are also implemented but through a moderate degree. On the other hand, practices like automation in heating systems, disconnection of electrical appliances when not in use, are less frequently adopted. To enhance energy efficiency, the findings show possible areas where awareness could be raised and where additional education and public information may be beneficial.

Additionally the analysis presented correlations between the demographic characteristics and the adoption of various energy management practices. Some groups are more likely to use methods such as LED lamps, unplugging the electrical appliances when not in use or opening the window shutters to maximize natural light, in order to reduce energy use. Personal background appears to play a significant role in shaping energy saving behaviors. Although these findings are specific to this sample and indicate correlations between various factors, similar patterns are commonly reported in global literature.

All in all, results indicate that while basic behavioral adjustments are widely adopted, there is a significant potential to increase engagement in the adoption of more advanced energy-saving practices.

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