Promoting Sdgs 7, 12, And 13: Strengthening Household Energy Conservation Practices in Ilocos Norte, Philippines for Sustainable Development

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ABSTRACT

Energy conservation is a critical global concern aligned with Sustainable Development Goals on affordable and clean energy, responsible consumption and production, and climate action. This study examined the energy conservation practices of households in Ilocos Norte, identified the challenges they face, and explored opportunities for improvement. A convergent parallel mixedmethods design was employed, combining quantitative surveys with qualitative focus group discussions and interviews to gather comprehensive data. The findings revealed that while households demonstrate some awareness and engagement in energy-saving behaviors, these practices are inconsistent and hindered by challenges such as limited knowledge, financial and technological barriers, behavioral resistance, and environmental factors.

Opportunities for improvement were identified, including the need to increase public awareness through education campaigns, provide financial support for energy-efficient technologies, and enhance access to renewable energy sources. Based on these findings, strategies were proposed in three key areas: renewable energy adoption, education and awareness campaigns, and energy efficiency improvements. These strategies provide a holistic framework to address barriers and promote sustainable energy practices at the household level.

The study highlights the importance of addressing individual and structural barriers to energy conservation through collaborative efforts among policymakers, communities, and stakeholders. While the study provides valuable insights, it is limited by its reliance on selfreported data, localized scope, and lack of a longitudinal perspective. Future research should address these limitations by including larger and more diverse samples, quantitative approaches, and long-term evaluations of the proposed strategies. This study contributes to the growing body of knowledge on energy conservation and offers actionable recommendations to support sustainable energy practices in households.

Keywords – Energy conservation, Sustainable Development Goals, Renewable energy, Household energy practices, Energy efficiency strategies

I. INTRODUCTION

Energy conservation plays a vital role in addressing the challenges of climate change, environmental degradation, and increasing energy demands. It serves as a key strategy for reducing greenhouse gas emissions, preserving natural resources, and fostering sustainable development. In the Philippines, the growing demand for energy, driven by urbanization, industrial growth, and population expansion, has placed significant pressure on the country's energy resources [18]. To address these challenges, the Philippine government enacted the Energy Efficiency and Conservation Act (Republic Act No. 11285), which mandates local government units (LGUs) to implement energysaving initiatives and promote a culture of conservation among communities [14]. However, despite these efforts, the adoption of energy-efficient technologies and practices remains limited, particularly at the household level [4].

Ilocos Norte, a province recognized for its leadership in renewable energy through its iconic wind farms and expanding solar power projects, occupies a unique position in the country's transition toward cleaner energy sources. While the province has made strides in renewable energy development, traditional household energy

consumption habits persist, contributing significantly to greenhouse gas emissions [17]. Changing these behaviors is critical to reducing emissions and meeting international climate targets [2].

Households in Ilocos Norte face challenges such as rising electricity costs and continued reliance on fossil fuels, which make energy conservation a pressing concern. Community-based programs, like "Energy Conservation Awareness Month," have been introduced to promote energy-saving practices, but there remains limited empirical data on how these initiatives are received and practiced at the household level. Furthermore, factors such as energy awareness, access to efficient technologies, and socio-economic conditions, including income and education, are known to influence energy conservation behaviors [1], [16]. However, little is understood about how these factors interact within the specific context of Ilocos Norte.

This study seeks to address this gap by providing a comprehensive analysis of household energy conservation practices in Ilocos Norte. It aims to identify specific behaviors, challenges, and opportunities that can inform effective strategies for promoting energy efficiency and sustainability. The findings of this study will serve as a foundation for practical recommendations that can empower households, guide local policy, and support ongoing efforts to build a more energy-efficient and sustainable community.

II. Conceptual Framework

Figure 1 illustrates a conceptual framework designed to enhance energy conservation practices among households in Ilocos Norte, with a focus on aligning these practices with global sustainability goals, particularly SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

Figure 1. Research Paradigm.

The framework begins with an assessment of Current Energy Conservation Practices, which serves as the foundation for understanding household behaviors and their alignment with the SDGs. It then identifies Challenges in
Implementation, which act as barriers to effective energy conservation. These challenges are followed by Opportunities to Improve Energy Conservation Practices, highlighting areas for intervention and improvement.

The final component, Strategies to Enhance Energy Conservation Practices, outlines actionable plans to address the challenges and leverage opportunities. The ultimate goal of the framework is to achieve alignment with SDG 7, SDG 12, and SDG 13, ensuring that households adopt sustainable energy practices that contribute to clean energy access, responsible consumption, and climate action.

III. RESEARCH METHODS

A. Research Design

The study employed a convergent parallel mixed-methods design, wherein both quantitative and qualitative data were collected and analyzed independently but concurrently to address the research objectives. This design allowed for the integration of diverse perspectives and comprehensive insights into energy conservation practices, challenges, opportunities, and strategies. Quantitative data provided a broad overview of household

practices and their alignment with SDG goals, while qualitative data offered deeper contextual understanding through thematic exploration of challenges, opportunities, and stakeholder-driven strategies. The findings from both methods were compared and synthesized to ensure a holistic interpretation and to develop actionable recommendations that align with SDG 7, SDG 12, and SDG 13.

B. Locale of the Study

The locale of the study was Ilocos Norte, a province in the northernmost part of Luzon, Philippines. Ilocos Norte is an ideal research setting for this study due to its unique combination of environmental, economic, and cultural factors that align well with the objectives of examining energy conservation practices and their alignment with Sustainable Development Goals (SDG) 7 (Affordable and Clean Energy), SDG 12
(Responsible Consumption and Production), and SDG 13 (Climate Action).

Ilocos Norte is recognized for its proactive efforts in renewable energy development, particularly in wind and solar energy. The province is home to the Bangui Wind Farm, the first powergenerating wind farm in Southeast Asia, and other renewable energy projects such as the solar farms in Currimao and Pasuquin. These initiatives demonstrate the province's commitment to clean and sustainable energy, making it a relevant and strategic location for studying energy conservation practices and their alignment with SDG 7.
Additionally, the local government has been actively promoting the use of renewable energy and encouraging sustainable practices among its residents, further supporting the relevance of Ilocos Norte as a research locale.

Moreover, Ilocos Norte's economy is heavily reliant on agriculture and tourism, industries that are significantly impacted by climate change and energy consumption patterns. As such, exploring household energy conservation practices in this province provides valuable insights into how energy efficiency and sustainability can contribute to SDG 12 and SDG 13. The province's vulnerability to climate-related risks, such as typhoons and droughts, also underscores the importance of studying energy conservation in the context of climate action.

Lastly, Ilocos Norte's diverse demographic profile, which includes urban and rural residents across various socioeconomic backgrounds, makes it an ideal setting for examining the challenges and opportunities related to energy conservation. This diversity allows for a comprehensive analysis of the factors influencing energy practices and the development of inclusive strategies that can be applied to other regions with similar characteristics.

In summary, Ilocos Norte's leadership in renewable energy, its economic and environmental context, and its demographic diversity make it a highly suitable locale for this study, aligning perfectly with the research objectives and the broader goals of sustainable development.

C. Population and Sampling Procedures

The population of the study consisted of various stakeholders involved in energy conservation practices in Ilocos Norte, including homeowners, local government officials, community leaders, energy providers, environmental organizations, and experts such as energy specialists and policymakers. These groups were selected based on their direct or indirect involvement in energy conservation efforts and their relevance to the study's objectives, which focus on alignment with Sustainable Development Goals (SDG) 7, SDG 12, and SDG 13.

Homeowners represented the primary population for understanding household energy conservation practices and challenges, while local government officials and energy providers were included to provide insights into policies, programs, and infrastructure related to energy conservation.
Community leaders and environmental organizations were involved to explore opportunities for improvement, and experts, including energy specialists and policymakers, were consulted to propose strategies for enhancing practices and achieving SDG alignment.

The sampling procedure employed purposive sampling to ensure the inclusion of participants who possessed relevant knowledge, experience, or involvement in energy conservation efforts. A total of 100 households were surveyed, representing both urban and rural areas across Ilocos Norte to capture diverse perspectives and practices. Ten semistructured interviews were conducted with local government officials, energy providers, and sustainability advocates to gather deeper insights into policies, infrastructure, and systemic challenges.

Additionally, three focus group discussions (FGDs) were organized, each involving 20 participants, to explore barriers such as financial constraints, lack of awareness, and infrastructural issues, as well as to collaboratively identify potential solutions.

Local government officials and community leaders were selected based on their roles in implementing or promoting energy-related policies and initiatives, while energy providers and environmental organizations were chosen for their expertise in renewable energy and sustainability. Experts such as energy specialists and policymakers were included for their ability to provide strategic recommendations. This sampling approach ensured representation across various sectors and stakeholder groups, providing a comprehensive understanding of energy conservation practices, challenges, opportunities, and strategies within the context of Ilocos Norte.

D. Research Instrument

The study employed a combination of quantitative and qualitative research instruments to address its objectives. A survey questionnaire was designed to collect data on household energy conservation practices in Ilocos Norte and their alignment with SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). The questionnaire included sections on respondents' demographic profiles (e.g., age, gender, household size, income) and energy conservation practices, measured using a 4-point Likert scale (4 = Always, 3 = Often, 2 = Sometimes, 1 = Never).

To supplement the survey data, focus group discussions (FGDs) and semi-structured interviews were conducted. FGDs with community members explored challenges in implementing energy conservation practices, such as financial constraints, lack of awareness, and infrastructural issues. Semistructured interviews with local leaders, energy providers, and sustainability advocates provided additional insights into systemic and contextual factors influencing energy conservation. Key informant interviews with experts in energy conservation and policymaking identified potential interventions and strategies to address these challenges.

The findings from the survey, FGDs, and interviews were synthesized to develop strategies for enhancing energy conservation practices and aligning them with the SDGs. These strategies underwent expert validation to ensure their feasibility and effectiveness.

To ensure validity and reliability, the research instruments were reviewed by a panel of experts in research methodology, energy conservation, and sustainable development. Feedback from the panel was used to refine the instruments, which were made available in both printed and digital formats for accessibility.

E. Data Gathering Procedures

Data collection followed a systematic process to ensure accuracy and reliability. Approval was sought from the local government of Ilocos Norte, and coordination with barangay officials facilitated the scheduling of activities.

Survey questionnaires were distributed to households in printed and digital formats, depending on respondents' preferences. Printed copies were delivered through barangay halls, community meetings, and house-to-house visits, while digital copies were shared via email or messaging platforms. Each questionnaire included a cover letter explaining the study's purpose, voluntary participation, and confidentiality assurances.

For the qualitative component, FGDs were conducted with community members to explore challenges in energy conservation, while semistructured interviews with key informants (e.g., local officials, energy providers, sustainability advocates) provided deeper insights into systemic issues. Community workshops were also organized to collaboratively identify solutions and strategies for improving energy conservation practices and aligning them with the SDGs.

The data collection process spanned several months to ensure sufficient participation and a high response rate. All collected data, including survey responses, FGD notes, and interview transcripts, were systematically organized and encoded into a database for analysis.

F. Statistical Treatment

The data collected from the study were analyzed using both quantitative and qualitative methods to systematically address the research questions and meet the objectives of the study. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were utilized to summarize and analyze the quantitative data obtained from the survey questionnaires. These measures provided insights into the current energy conservation practices of households in Ilocos Norte. To complement the quantitative analysis, thematic analysis was applied to the qualitative data gathered from focus group discussions (FGDs) and interviews. Using Braun and Clarke's six-phase framework, the researcher familiarized with the data, generated initial codes, identified themes, reviewed and refined these themes, and produced a detailed analysis of how these practices align with Sustainable Development Goals (SDG 7, SDG 12, and SDG 13), which focus on affordable and clean energy, responsible consumption and production, and climate action, respectively.

To identify the challenges faced by households in implementing energy conservation measures, thematic analysis was employed once again, following the same framework. This approach allowed for an in-depth exploration of recurring themes and specific barriers, such as financial limitations, lack of awareness, and systemic issues that hinder the adoption of energy conservation measures. Similarly, thematic analysis was used to explore opportunities for improving energy conservation practices and enhancing alignment with SDG 7, SDG 12, and SDG 13. Qualitative data from FGDs, interviews, and workshops were coded and analyzed to uncover potential opportunities, including policy reforms, technological innovations, and community-based programs, which were categorized into themes for further discussion.

To develop strategies for enhancing energy conservation practices and maximizing their alignment with SDGs, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted. This method was used to assess internal and external factors influencing energy conservation efforts. Qualitative data from FGDs, interviews, and workshops were synthesized to identify actionable strategies, which were further validated and prioritized based on their feasibility and potential impact, as reported by participants. Additionally, thematic analysis was used to identify recurring patterns and refine the proposed strategies.

All quantitative data, including survey responses, were encoded into a spreadsheet and analyzed using statistical software to ensure accuracy and reliability. Meanwhile, qualitative data, such as interview transcripts and FGD notes, were manually coded and organized for thematic analysis. To ensure the validity and reliability of the findings, triangulation was employed by crossreferencing data from multiple sources, including surveys, interviews, and FGDs. By combining descriptive statistics, thematic analysis, and SWOT analysis, the study ensured a comprehensive treatment of both quantitative and qualitative data, providing numerical insights and a deeper contextual understanding of the energy conservation practices, challenges, opportunities, and strategies in Ilocos Norte.

G. Ethical Consideration

The study adhered to strict ethical standards to ensure the protection of participants' rights and the integrity of the research process. Prior to data collection, the researcher sought approval from relevant authorities, including the local government of Ilocos Norte and barangay officials, to conduct the study within the community. Participants were provided with a clear explanation of the study's purpose, objectives, and procedures through a cover letter accompanying the survey questionnaire and during face-to-face engagements. Informed consent was obtained from all participants, emphasizing the voluntary nature of their participation and their right to withdraw at any point without any repercussions.

Confidentiality and anonymity were prioritized throughout the research process. Participants' identities were not disclosed, and all data were encoded and stored securely to prevent unauthorized access. Personal information collected in the demographic section of the survey was used solely for research purposes and was not linked to individual responses. For qualitative data, such as focus group discussions (FGDs) and interviews, participants were assured that their responses would remain anonymous and that any identifying details would be excluded from the final report.

The study also ensured that participants were not exposed to any risks or harm during their involvement. FGDs

and interviews were conducted in safe and comfortable settings, and participants were encouraged to share only what they were comfortable discussing. The researcher maintained a neutral and respectful stance to avoid influencing participants' responses and ensured that all interactions were conducted with cultural sensitivity, particularly given the diverse demographic backgrounds of the respondents in Ilocos Norte.

To uphold the validity and reliability of the findings, the study employed ethical research practices, including proper citation of sources and acknowledgment of contributions from participants and stakeholders. The researcher also ensured that the findings and recommendations were presented objectively, without bias or manipulation of data. By adhering to these ethical considerations, the study maintained the highest standards of research integrity while respecting the rights and welfare of all participants.

IV. RESULTS AND DISCUSSIONS

A. Energy Conservation Practices of Households

Table 1 shows the energy conservation practices of households in Ilocos Norte, with an overall mean score of 2.40, interpreted as "Sometimes." This result indicates that while households exhibit some awareness and engagement in energy-saving practices, these behaviors are not consistently applied in their daily routines. Among the ten listed practices, the highest mean score was 2.57, also interpreted as "Sometimes," for turning off lights and appliances when not in use. This suggests that this practice is relatively common due to its simplicity and lack of associated costs. However, the fact that it is not rated as "Always" implies that there is still room for improvement in making this behavior a consistent habit. This finding aligns with Abrahamse and Schuitema [1], who emphasized that awareness alone does not guarantee consistent energy-saving actions, as behavioral change often requires additional motivation or reinforcement.

The use of energy-efficient appliances, such as LED lights and inverter air conditioners, received a mean score of 2.45, also interpreted as "Sometimes." This indicates moderate adoption of energy-efficient technologies, likely influenced by financial constraints or limited awareness of their long-term benefits. Azimi et al. [3] highlighted that the high initial cost of energy-efficient appliances often prevents low-income households from adopting them, even when they recognize the potential for long-term savings. Similarly, Belaïd [4] argued that financial barriers remain a significant obstacle to achieving widespread energy efficiency, particularly in regions where household incomes are limited. These findings suggest that while there is some willingness to adopt energy-efficient technologies, targeted financial incentives or subsidies may be necessary to encourage broader adoption.

Another notable practice was the use of natural light during the day instead of artificial lighting, which scored a mean of 2.49. This relatively higher score can be attributed to the abundance of natural sunlight in Ilocos Norte, a tropical region. However, the practice of ensuring proper insulation or ventilation to reduce energy use for cooling or heating scored slightly lower, at 2.43. This suggests that while households may recognize the benefits of natural light, they may lack the resources or technical knowledge to implement structural improvements like insulation or ventilation. Huang et al. [9] noted that structural and environmental factors, such as building design and access to resources, significantly influence residential energysaving behaviors, particularly in rural and tropical areas.

The practice of unplugging devices and appliances when not in use to avoid standby power consumption scored a mean of 2.40, showing that this behavior is also only "Sometimes" practiced. This suggests that while households may understand the concept of standby power consumption, they might lack the discipline or motivation to consistently unplug devices. This finding supports the work of Abrahamse and Schuitema [1], who found that the effort required to consistently implement energy-saving practices can limit their adoption, even when individuals are aware of their importance. Monitoring and managing electricity consumption to reduce waste received the lowest score among the "Sometimes" practices, with a mean of 2.36. This indicates that households are not actively tracking their energy usage, which could hinder their ability to identify inefficiencies. These results corroborate Xu et al. [21], who argued that providing households with tools or feedback mechanisms to monitor their energy use could significantly enhance their ability to adopt energysaving behaviors.

The use of renewable energy sources, such as solar panels, also scored 2.45, indicating that households "Sometimes" adopt this practice. This relatively low score may reflect limited access to renewable energy technologies and the high costs associated with their installation. Reames [17] emphasized that financial and informational barriers often limit the adoption of renewable energy technologies, particularly in low-income areas. These findings highlight the need for targeted interventions, such as subsidies, community financing schemes, or awareness campaigns, to promote the adoption of renewable energy solutions in households.

TABLE I Energy Conservation Practices of Households in Ilocos Norte

No.	Statements	Mean	Descriptive Interpretation (DI)
1	I turn off lights and appliances when they are not in use.	2.57	Sometimes
2	I use energy-efficient appliances (e.g., LED lights, inverter air conditioners).	2.45	Sometimes
3	I unplug devices and appliances when not in use to avoid standby power consumption.	2.40	Sometimes
4	I monitor and manage my electricity consumption to reduce waste.	2.36	Sometimes
5	I use natural light during the day instead of artificial lighting.	2.49	Sometimes
6	I ensure proper insulation or ventilation to minimize energy use for cooling or heating.	2.43	Sometimes
7	I use renewable energy sources, such as solar panels, for household energy needs.	2.45	Sometimes
8	I participate in community programs or initiatives promoting energy conservation.	1.88	Rarely
9	I reduce water heating energy by using cold water for washing whenever possible.	2.39	Sometimes
10	I avoid overusing appliances that consume large amounts of energy.	2.54	Sometimes
Overall Mean Score	—	2.40	Sometimes

Note: Note: DI-Descriptive Interpretation; 3.50- 4.00 Always (A); 2.50-3.49 Often (O); 1.50-2.49 Sometimes (S); 1.00-1.49 Never (N)

The lowest-scoring practice, with a mean of 1.88 ("Rarely"), was participation in community programs or initiatives promoting energy conservation. This result suggests a lack of engagement with community-level efforts, which may be due to the limited availability of such programs or a lack of awareness among households. Keller et al. [12] emphasized the critical role of community-based initiatives in fostering collective action toward energy conservation, noting that their absence can significantly hinder the widespread adoption of energy-saving practices. This finding underscores the importance of developing accessible and well-publicized community programs to encourage greater participation and foster a culture of collective energy conservation.

In conclusion, the findings suggest that while households in Ilocos Norte demonstrate some awareness and engagement in energy conservation, their practices remain inconsistent and are limited by financial, structural, and informational barriers. These results align with previous studies, such as those by Azimi et al. [3], Belaïd [4], and Reames [17], which emphasize the role of financial constraints and access to information in limiting the adoption of energy-efficient practices. Similarly, the findings support Abrahamse and Schuitema [1], who highlighted that awareness alone is insufficient to ensure consistent energy-saving behaviors. Addressing these gaps requires targeted interventions, including education campaigns to raise awareness, financial incentives to promote the adoption of energy-efficient technologies, and the development of accessible community programs to encourage collective action. These strategies are essential for overcoming barriers and achieving sustainable energy practices aligned with SDG 7, SDG 12, and SDG 13.

B. Challenges in Implementing Energy Conservation Measures

Table II shows the challenges in implementing energy conservation measures among households, categorized into four main themes: Limited Knowledge and Awareness, Environmental and Climatic Factors, Behavioral and Social Barriers, and Financial and Technological Barriers. The data highlights the multifaceted barriers that hinder households from adopting energy-saving practices.

TABLE II Challenges in Implementing Energy Conservation Measures

Category	Codes	F	%	Rank
Limited Knowledge and Awareness	Lack of understanding of energy-saving practices	4	40%	1
	Difficulty understanding benefits of energy conservation	3	30%	2
	Lack of access to information on energy-saving methods	3	30%	2
Environmental and Climatic Factors	Weather conditions increasing energy use	4	40%	1
	Location affecting energy efficiency	3	30%	2
	Seasonal changes increasing energy needs	3	30%	2
Behavioral and Social Barriers	Difficulty changing daily habits	5	50%	1
	Lack of cooperation in the household	3	30%	2
	Resistance to new energy-saving practices	2	20%	3
Financial and Technological Barriers	Use of outdated appliances	4	40%	1
	High cost of energy-efficient solutions	4	40%	1
	Preference for convenience over saving energy	2	20%	2

Note: F-frequency; %-percentage

Limited Knowledge and Awareness

Under the theme of Limited Knowledge and Awareness, the most frequently cited challenge, with 40% of responses, is the "lack of understanding of energy-saving practices." This indicates that many households are unaware of practical actions to conserve energy. For instance, one respondent shared, “We don't know what specific actions can really save electricity, so we just do what we think is right.” Additionally, 30% of respondents mentioned "difficulty understanding the benefits of energy conservation," suggesting a lack of awareness of the long-term advantages of energy-saving behaviors. Another 30% cited the "lack of access to reliable information on energy-saving methods," which implies that limited dissemination of knowledge could be a major obstacle.

These findings are reflected in Table I, where the overall mean score for energy conservation practices is 2.40, interpreted as "Sometimes." For example, the practice of monitoring and managing electricity consumption to reduce waste scored the lowest among the "Sometimes" practices (mean = 2.36), indicating that households are not actively tracking their energy usage. This lack of monitoring may stem from insufficient knowledge about how to measure and manage energy consumption effectively. These results align with Ilham et al. [10], who emphasized the importance of awareness campaigns in bridging knowledge gaps and promoting energy conservation behaviors. Similarly, Keller et al. [12] argued that education and outreach are critical in fostering energy-conscious communities, particularly in areas where information about energy-saving methods is limited.

Environmental and Climatic Factors

Environmental and Climatic Factors were another significant challenge, with 40% of respondents citing "weather conditions increasing energy use" as a major barrier. For instance, one household noted, “We use more electricity during hot months because we have to run the air conditioner all day.” Another 30% of respondents cited "location affecting energy efficiency," reflecting the difficulties faced by households in remote or less-developed

areas where energyefficient infrastructure is limited. Seasonal changes, such as extreme heat or cold, were also noted by 30% of respondents as factors that increase energy consumption.

These challenges are consistent with the findings in Table I, where households reported only "Sometimes" ensuring proper insulation or ventilation to minimize energy use for cooling or heating (mean = 2.43). This suggests that households may be aware of the importance of structural adjustments but lack the resources or knowledge to implement them effectively. Huang et al. [9] highlighted the role of environmental conditions in shaping energy use patterns, particularly in rural areas, where climate and infrastructure challenges exacerbate energy inefficiencies. Similarly, Agrawal and Soni [2] noted that geographic and climatic factors significantly influence energy demand, making it difficult for households to adopt consistent conservation practices. Addressing these challenges would require region-specific interventions, such as promoting natural ventilation or providing incentives for energy-efficient home designs.

Behavioral and Social Barriers

Behavioral and Social Barriers emerged as the most significant challenge overall, with 50% of respondents citing "difficulty changing daily habits" as the most frequent issue. One respondent shared, “It's hard to change routines, like turning off the lights or unplugging appliances, because we've been doing it this way for years.” Additionally, 30% of respondents mentioned "lack of cooperation in the household," indicating that energy conservation is often not a shared responsibility among family members. Another 20% cited "resistance to new energy-saving practices," reflecting hesitation to adopt unfamiliar technologies or methods.

These findings are also evident in Table I, where certain practices, such as unplugging devices and appliances when not in use (mean = 2.40) and turning off lights and appliances when not in use (mean = 2.57), are only "Sometimes" practiced. While these behaviors require minimal effort, their inconsistent application suggests that ingrained habits and lack of cooperation within households hinder their adoption. Abrahamse and Schuitema [1] emphasized that behavioral change is one of the most challenging aspects of energy conservation, as habits are often deeply ingrained and resistant to change. Similarly, Xu et al. [20] noted that household energy-saving interventions often fail due to social dynamics and a lack of collective responsibility within families. Promoting behavioral change through nudges, reminders, or incentives could help households overcome these barriers and develop more consistent energy-saving habits.

Financial and Technological Barriers

The theme of Financial and Technological Barriers was another major challenge, with 40% of respondents identifying both "use of outdated appliances" and "high cost of energy-efficient solutions" as significant obstacles. One participant explained, “We want to buy energy-efficient appliances, but they are too expensive for our budget.” Another 20% of respondents mentioned a "preference for convenience over saving energy," suggesting that some households prioritize ease of use over energy efficiency.

These challenges are reflected in Table I, where the use of energy-efficient appliances, such as LED lights and inverter air conditioners, scored a mean of 2.45, indicating moderate adoption. While households recognize the potential benefits of energy-efficient technologies, financial constraints prevent them from fully transitioning to these solutions. Azimi et al. [3] and Belaïd [4] both emphasized that financial barriers are a major obstacle to adopting energy-efficient technologies, particularly in low-income households. Berkouwer and Dean [5] also noted that limited access to credit and financing options prevents households from investing in energy-efficient solutions, even when they recognize their long-term benefits. Addressing these barriers through subsidies, financing schemes, or bulk purchasing programs could make energyefficient technologies more accessible to households in Ilocos Norte.

These challenges highlight the interplay between knowledge gaps, environmental conditions, behavioral dynamics, and financial constraints in hindering energy conservation among households.

These findings are consistent with the results in Table I, where the overall mean score of 2.40 ("Sometimes") reflects the inconsistent application of energy-saving practices. For instance, the lack of knowledge and awareness directly correlates with low participation in community programs promoting energy conservation (mean = 1.88), while financial barriers are evident in the limited adoption of energy-efficient appliances.

These findings align with the broader literature, which underscores the importance of multi-faceted approaches to energy conservation. Abrahamse and Schuitema [1], Keller et al. [12], and Ilham et al. [10] all emphasized the need for awareness campaigns and education to address knowledge gaps. Similarly, Huang et al. [9] and Agrawal and Soni [2] highlighted the importance of addressing environmental and structural challenges, while Azimi et al. [3] and Belaïd [4] stressed the need for financial incentives to promote energy efficiency.

In conclusion, addressing these challenges requires a holistic approach that combines education, behavioral interventions, structural improvements, and financial support. By implementing targeted strategies, policymakers and stakeholders can promote sustainable energy practices and contribute to achieving SDG 7, SDG 12, and SDG 13.

C. Opportunities to Improve Energy Conservation Practices

Table III shows the opportunities to improve energy conservation practices. The results highlight three main opportunities: increasing public awareness on energy saving, providing financial support for energy efficiency, and enhancing access to renewable energy technology.

Each theme is further broken down into specific actions, with a total frequency of 10 distributed across the codes. The inclusion of sample quotes strengthens the qualitative analysis by providing direct insights from participants.

TABLE III Opportunities to Improve Energy Conservation Practices

Category	Codes	F	%	Rank
Increase Public Awareness on Energy Saving	Conduct workshops and seminars to educate people	5	50%	1
	Use social media and campaigns to promote awareness	3	30%	2
	Integrate energy-saving topics into school curricula	2	20%	3
Provide Financial Support for Energy Efficiency	Offer subsidies for energy-efficient appliances	4	40%	1
	Reduce the cost of renewable energy technologies	3	30%	2
	Provide affordable financing options for green energy solutions	3	30%	2
Enhance Access to Renewable Energy Technology	Improve access to renewable energy sources	6	60%	1
	Upgrade energy infrastructure for better efficiency	2	20%	2
	Develop affordable energy storage solutions	2	20%	2

Note: F-frequency; %-percentage

The first opportunity, Increase Public Awareness on Energy Saving, ranked as one of the most important themes, with a total frequency of 10 distributed across three codes. Among these, "Conduct workshops and seminars to educate people" received the highest frequency (5, 50%), indicating that education campaigns are seen as the most effective way to improve energy conservation practices. One participant stated, "We need more seminars to teach us how to save energy at home. I think many people are still unaware of the small actions they can take." This reflects a strong demand for direct, in-person learning opportunities to raise awareness about energy-saving practices. Similarly, "Use social media and campaigns to promote awareness" (3, 30%) highlights the need to leverage modern communication platforms to reach a wider audience. As one respondent noted, "Social media is a powerful tool. If we see posts or videos about energy saving, it could inspire us to try those practices." Lastly, "Integrate energy-saving topics into school curricula" (2, 20%) underscores the importance of educating the younger generation. A participant shared, "If children learn about energy conservation in school, they can teach their families and build good habits early on." These findings align with Keller et al. [12], who emphasized the importance of community-wide education and awareness campaigns in promoting energy-saving behaviors.

The second opportunity, Provide Financial Support for Energy Efficiency, also had a total frequency of 10, with "Offer subsidies for energyefficient appliances" receiving the highest score (4, 40%). This highlights the need for financial incentives to encourage households to adopt energyefficient technologies. One respondent stated, "We want to switch to LED lights and energy-efficient appliances, but they are too expensive for us to afford all at once." This sentiment reflects a common barrier to adoption, as the high initial cost of energy-efficient technologies often outweighs their perceived long-term benefits. Azimi et al. [3] found similar results, emphasizing that subsidies and financial support are critical for encouraging lowincome households to adopt energy-efficient appliances. Additionally, "Reduce the cost of renewable energy technologies" and "Provide affordable financing options for green energy solutions" both received a frequency of 3 (30%), highlighting the importance of reducing financial barriers to renewable energy adoption. As one participant explained, "Solar panels are a great idea, but the installation costs are way beyond what we can afford. If there were a loan or discount program, more people would consider it." This finding aligns with Belaïd [4], who argued that financial constraints are a key limitation to achieving energy efficiency goals.

The third opportunity, Enhance Access to Renewable Energy Technology, emerged as the most significant theme, with "Improve access to renewable energy sources" receiving the highest frequency across all codes (6, 60%). This indicates a strong need to make renewable energy sources, such as solar panels and wind energy, more accessible to households. One respondent remarked, "We live in a rural area, and renewable energy options are not available here. If we had access to solar panels, it would help us save more energy." This finding aligns with Agrawal and Soni [2], who emphasized that increasing access to renewable energy is critical for achieving SDG 7 and ensuring equitable energy availability. Furthermore, "Upgrade energy infrastructure for better efficiency" (2, 20%) and "Develop affordable energy storage solutions" (2, 20%) highlight the importance of modernizing energy systems to support a transition to renewable energy. A participant noted, "Our electricity supply is unreliable, and the infrastructure is old. If the government improved this, we could use energy more efficiently." These findings are consistent with Reames [17], who highlighted the need for investments in energy infrastructure to reduce disparities in energy access and support sustainable development goals.

In conclusion, the findings from Table III emphasize that improving energy conservation practices requires a multi-dimensional approach. Increasing public awareness through education and campaigns, providing financial support to make energy-efficient technologies affordable, and enhancing access to renewable energy technologies are critical steps toward aligning with SDG 7, SDG 12, and SDG 13. These opportunities are consistent with the literature, which highlights the importance of addressing both individual and structural barriers to promote sustainable energy practices [1], [2], [4], [6]. By addressing these opportunities, policymakers and stakeholders can create a more sustainable and energy-efficient future.

D. Proposed Strategies to Enhance Energy Conservation Practices

Table IV presents the proposed strategies to enhance energy conservation practices, categorized into three main themes: Renewable Energy Adoption, Education and Awareness Campaigns, and Energy Efficiency Improvements. These strategies were developed based on the challenges identified in Table II and the opportunities highlighted in Table III, providing a comprehensive approach to addressing barriers and leveraging potential interventions for energy conservation.

TABLE IV Proposed Strategies to Enhance Energy Conservation Practices

Strategies	Codes
Renewable Energy Adoption	Improve access to renewable energy sources
	Promote community-based renewable energy projects
	Develop affordable energy storage solutions
Education and Awareness Campaigns	Conduct workshops and seminars to educate people
	Use social media and campaigns to promote awareness
	Integrate energy-saving topics into school curricula
Energy Efficiency Improvements	Offer subsidies for energyefficient appliances
	Provide affordable financing options for green energy solutions
	Upgrade energy infrastructure for better efficiency

The first theme, Renewable Energy Adoption, focuses on improving access to renewable energy sources, promoting community-based renewable energy projects, and developing affordable energy storage solutions. These strategies address challenges related to environmental and climatic factors, such as weather conditions increasing energy use and geographic limitations affecting energy efficiency. By improving access to renewable energy, households in remote or underserved areas can transition to more sustainable energy sources, reducing their reliance on fossil fuels. As Agrawal and Soni [2] emphasized, equitable access to renewable energy is essential for achieving SDG 7 and promoting sustainable energy practices. Additionally, promoting community-based renewable energy projects fosters collective responsibility and reduces the financial burden on individual households. Heeter and Reames [8] highlighted that community-driven renewable energy systems are effective in achieving energy equity. Furthermore, developing affordable energy storage solutions complements these efforts by ensuring the reliability and efficiency of renewable energy systems. Reames [17] stressed the importance of energy storage in optimizing renewable energy use and reducing reliance on nonrenewable sources.

The second theme, Education and Awareness Campaigns, emphasizes the importance of increasing public knowledge and awareness of energy conservation practices. Strategies under this theme include conducting workshops and seminars to educate people, using social media and campaigns to promote awareness, and integrating energysaving topics into school curricula. These strategies directly address the challenges of limited knowledge and awareness, such as the lack of understanding of energy-saving practices and the difficulty in recognizing the benefits of energy conservation. Education campaigns and workshops provide practical knowledge and actionable steps for households. Abrahamse and Schuitema [1] argued that education is a key driver of pro-environmental behaviors. Similarly, leveraging social media and digital campaigns ensures a wider reach, enabling more households to access reliable information on energy-saving practices. This approach is consistent with Farghali et al. [6], who highlighted the effectiveness of social media in promoting energy conservation. Furthermore, integrating energysaving topics into school curricula ensures that younger generations are educated on sustainable practices, fostering long-term behavioral change. Ilham et al. [10] emphasized the importance of early education in building energy-conscious communities.

The third theme, Energy Efficiency Improvements, focuses on addressing financial and technological barriers to energy conservation. Proposed strategies include offering subsidies for energy-efficient appliances, providing affordable financing options for green energy solutions, and upgrading energy infrastructure for better efficiency. These strategies aim to mitigate the high costs of energy-efficient technologies and the prevalence of outdated appliances, which were identified as significant barriers in Table II. Offering subsidies and financing options can make energy-efficient technologies more accessible to low-income households. Azimi et al. [3] highlighted the importance of financial incentives in promoting the adoption of energy-efficient solutions. Additionally, upgrading energy infrastructure addresses systemic inefficiencies and ensures that households can maximize their energy savings. Xu et al. [21] emphasized the need for modernized energy systems to support sustainable development goals.

In this context, Figure 2 illustrates a comprehensive framework designed to enhance energy conservation practices among households. The framework consists of three interconnected strategies: Renewable Energy Adoption, Education and Awareness Campaigns, and Energy Efficiency Improvements, all symbolically represented within a light bulb, which signifies innovation and progress in energy conservation. These strategies aim to address existing challenges, explore opportunities, and align household practices with global sustainability goals, particularly SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), and SDG 13
(Climate Action).

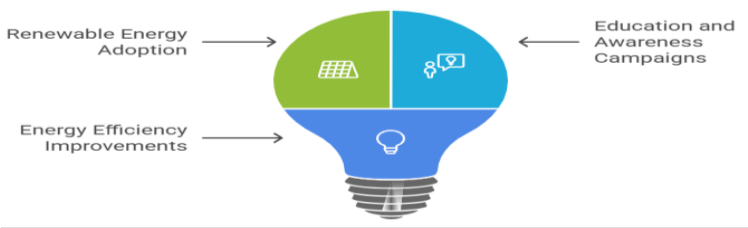

Figure 2. Energy Conservation Framework

The first component, Renewable Energy Adoption, focuses on integrating sustainable energy sources, such as solar panels, into household energy systems. This strategy reduces reliance on nonrenewable energy while contributing to SDG 7 and SDG 13 by promoting clean energy and reducing greenhouse gas emissions. The second component, Education and Awareness Campaigns, emphasizes the importance of informing households about energy-saving practices and their long-term benefits. By fostering behavioral change and encouraging community engagement, this strategy supports SDG 12 by promoting responsible consumption and production patterns. Finally, Energy Efficiency Improvements highlight the need for upgrading outdated appliances and implementing structural adjustments, such as proper insulation and energyefficient designs, to minimize energy waste. These actions ensure affordability and sustainability, aligning with both SDG 7 and SDG 12.

Figure 2 represents a holistic approach to addressing the barriers to energy conservation while maximizing opportunities for sustainable practices. By integrating these strategies, households can contribute to global efforts to achieve energy efficiency, reduce emissions, and foster a culture of sustainability.

In conclusion, the table outlines a set of strategies that comprehensively address the challenges and opportunities related to energy conservation. By focusing on renewable energy adoption, education and awareness campaigns, and energy efficiency improvements, these strategies aim to overcome barriers such as limited knowledge, environmental constraints, behavioral resistance, and financial challenges. These findings align with existing studies, which emphasize the importance of multi-dimensional approaches to energy conservation that integrate technological, educational, and financial interventions [1], [2], [6], [8], [10], [17], [21]. Implementing these strategies can help households transition to more sustainable energy practices, contributing to the achievement of SDG 7, SDG 12, and SDG 13.

V. CONCLUSION

Based on the findings of this study, households in Ilocos Norte demonstrate some level of awareness and engagement in energy-saving behaviors, with an overall mean score of 2.40 ("Sometimes"). However, these practices remain inconsistent and are not yet fully integrated into daily routines. Key challenges identified include limited knowledge and awareness, environmental and climatic factors, behavioral and social barriers, and financial and technological constraints. Despite these challenges, opportunities for improvement were identified, such as increasing public awareness, providing financial support for energy efficiency, and enhancing access to renewable energy technologies.

The proposed strategies to address these challenges and leverage opportunities were categorized into three themes: Renewable Energy Adoption, Education and Awareness Campaigns, and Energy Efficiency Improvements. These strategies emphasize improving access to renewable energy, fostering public awareness through education and outreach, and addressing financial and technological barriers to energy efficiency. Together, these strategies provide a comprehensive framework for enhancing energy conservation practices and aligning them with Sustainable Development Goals (SDG) 7, 12, and 13.

Based on the findings of this study, policymakers should prioritize the implementation of subsidies for energy-efficient technologies and the development of community-based renewable energy projects. Stakeholders can begin by organizing education campaigns and workshops to address knowledge gaps and promote behavioral change. By implementing the proposed strategies, stakeholders can help households adopt more sustainable energy practices, reduce energy consumption, and contribute to global efforts to mitigate climate change.

This study also acknowledges certain limitations, such as the reliance on self-reported data, which may be subject to biases, and the focus on a specific geographic location, which may limit the generalizability of the findings. Future research could explore the long-term effectiveness of the proposed strategies and assess their applicability in other regions with similar socio-economic and environmental contexts. Additionally, further studies could investigate the role of emerging technologies and innovative policy mechanisms in overcoming barriers to energy conservation.

In conclusion, this study underscores the necessity of addressing both individual and structural barriers to energy

conservation through a multi-dimensional approach. By implementing the proposed strategies, policymakers and stakeholders can foster sustainable energy practices, contributing to a more energy-efficient and environmentally sustainable future.

VI. Limitations of the Study

While this study provides valuable insights into the energy conservation practices of households in Ilocos Norte and proposes strategies to enhance these practices, several limitations should be acknowledged.

First, the study relied on self-reported data from surveys, interviews, focus group discussions (FGDs), and workshops. Self-reported data may be subject to biases, such as social desirability bias, where respondents might overstate their engagement in energy-saving practices to present themselves in a favorable light. This could affect the accuracy of the reported energy conservation behaviors.

Second, the study was limited to households in Ilocos Norte, which may not fully represent the energy conservation practices, challenges, and opportunities in other regions with different socioeconomic, cultural, or environmental contexts. The findings may therefore have limited generalizability to other areas, especially those with different energy consumption patterns or access to resources.

Third, the study primarily focused on qualitative data, which, while providing rich and in-depth insights, may lack the statistical rigor and generalizability of quantitative approaches. The small sample size used for interviews and FGDs may not capture the full diversity of household experiences and perspectives.

Lastly, the study did not include a longitudinal component to assess the long-term effectiveness of energy conservation practices or the proposed strategies. As a result, the findings reflect a snapshot of current practices and challenges, rather than the potential evolution of these practices over time.

Despite these limitations, the study provides a strong foundation for understanding energy conservation practices and identifying strategies to overcome barriers. Future research could address these limitations by incorporating larger and more diverse samples, including quantitative data for broader generalizability, and conducting longitudinal studies to evaluate the long-term impacts of the proposed strategies.

VII. RECOMMENDATIONS

Based on the findings and limitations of this study, several recommendations are proposed to enhance energy conservation practices among households in Ilocos Norte and beyond. First, policymakers and stakeholders should prioritize the implementation of the proposed strategies, particularly those focused on Renewable Energy Adoption, Education and Awareness Campaigns, and Energy Efficiency Improvements. This includes improving access to renewable energy technologies, such as solar panels, and providing financial incentives, such as subsidies and affordable financing options, to encourage the adoption of energy-efficient appliances and practices. These efforts can address financial and technological barriers while promoting sustainable energy use.

Second, targeted education and outreach programs should be developed to address the knowledge gaps identified in the study. Workshops, seminars, and community-based campaigns can be organized to improve public understanding of energy-saving practices and their long-term benefits. Integrating energy conservation topics into school curricula is also recommended to instill sustainable habits among younger generations and encourage them to influence household energy behaviors.

Third, it is recommended that local governments and energy providers collaborate to modernize energy infrastructure and expand access to renewable energy sources, particularly in rural and underserved areas. Investments in infrastructure upgrades and the development of affordable energy storage solutions will ensure that renewable energy systems are reliable and accessible to more households.

To address the limitations of this study, future research should include larger and more diverse samples from different geographic locations to improve the generalizability of findings. Quantitative approaches should also be incorporated to complement the qualitative data and provide statistical evidence of the effectiveness of energy

conservation strategies. Additionally, longitudinal studies should be conducted to assess the long-term impact of the proposed strategies on household energy conservation practices.

Finally, continuous monitoring and evaluation of implemented strategies are essential to ensure their effectiveness and adaptability to changing socioeconomic and environmental conditions. By following these recommendations, stakeholders can create a supportive environment for households to adopt sustainable energy practices, contributing to a more energy-efficient and environmentally responsible future.

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REFERENCES

1. Abrahamse, W., & Schuitema, G. (2020). Psychology and energy conservation: Contributions from theory and practice. In Energy and behaviour (pp. 19–44). Academic Press. https://doi.org/10.1016/B978-0-12-818567-4.00001-6
2. Agrawal, S., & Soni, R. (2021). Renewable energy: Sources, importance and prospects for sustainable future. In Energy: Crises, challenges and solutions (pp. 131–150). https://doi.org/10.1002/9781119741503.ch7
3. Azimi, S., Hon, C. K., Tyvimaa, T., & Skitmore, M. (2024). Adoption of energy-efficiency measures by Australian low-income households. Journal of Housing and the Built Environment, 39(2), 909–936. https://doi.org/10.1007/s10901-023-10104-3
4. Belaïd, F. (2025). The limits of energy conservation: Why doubling current energy efficiency progress is no easy feat. Energy Research & Social Science, 127, 104253. https://doi.org/10.1016/j.erss.2025.104253
5. Berkouwer, S. B., & Dean, J. T. (2022). Credit, attention, and externalities in the adoption of energy-efficient technologies by low-income households. American Economic Review, 112(10), 3291–3330. https://doi.org/10.1257/aer.20210766
6. Farghali, M., Osman, A. I., Mohamed, I. M., Chen, Z., Chen, L., Ihara, I., & Rooney, D. W. (2023). Strategies to save energy in the context of the energy crisis: A review. Environmental Chemistry Letters, 21(4), 2003–2039. https://doi.org/10.1007/s10311-023-01591-5
7. Gołębiowska, B., Bartczak, A., & Czajkowski, M. (2020). Energy demand management and social norms. Energies, 13(15), 3779. https://doi.org/10.3390/en13153779
8. Heeter, J., & Reames, T. (2022). Incorporating energy justice into utility-scale photovoltaic deployment: A policy framework. Renewable Energy Focus, 42, 1–7. https://doi.org/10.1016/j.ref.2022.04.003
9. Huang, Z., Liu, Y., & Wang, Y. (2022). Rural residential energy-saving in China: Role of village morphology and villagers' daily activities. Journal of Cleaner Production, 379, 134707. https://doi.org/10.1016/j.jclepro.2022.134707
10. Ilham, Z., Zulkifli, N. E. I., Ismail, N. F., Danik, A. S., Abdul Halim-Lim, S., Wan Mohtar, W. A. A. Q. I., & Jamaludin, A. A. (2022). Energy conservation: Awareness analysis among secondary school students. Environmental Education Research, 28(6), 925–947. https://doi.org/10.1080/13504622.2022.2031902
11. Jamaludin, A. A., Zulkifli, N. E. I., Bharin, S., Jani, R., Mokhtar, M. I., Abdul Halim-Lim, S., & Ilham, Z. (2023). Awareness on energy conservation: A case study of first-year undergraduate students in Malaysia. International Journal of Sustainability in Higher Education, 24(3), 678–699. https://doi.org/10.1108/IJSHE-03-2022-0084
12. Keller, S., Otjen, A. J., McNally, M., Wilkinson, T. J., Dockery, B., Leonard, J., & Southworth, H. (2021). Improving awareness of energy conservation: Rocky Mountain City. Journal of Ethics in Entrepreneurship and Technology, 1(1), 4–19. https://doi.org/10.1108/JEET-10-2020-0011

13. Meena, C. S., Prajapati, A. N., Kumar, A., & Kumar, M. (2022). Utilization of solar energy for water heating application to improve building energy efficiency: An experimental study. Buildings, 12(12), 2166. https://doi.org/10.3390/buildings12122166
14. Monteagudo, R. S., Manalac, S. J. A., Martin, A. Q., Liscano, J. S., Roman, A. N., Manalo, A. T., & Pampo, F. R. (2025). Design and development of a smart motion detection system geared towards energy conservation at a state university in Bacolor, Pampanga. Asian Journal of Applied Science and Technology, 9(2), 252–261. https://doi.org/10.38177/ajast.2025.9218
15. Perros, T., Büttner, P., Leary, J., & Parikh, P. (2021). Pay-as-you-go LPG: A mixed-methods pilot study in urban Rwanda. Energy for Sustainable Development, 65, 117–129. https://doi.org/10.1016/j.esd.2021.10.003
16. Rausser, G., Strielkowski, W., & Mentel, G. (2023). Consumer attitudes toward energy reduction and changing energy consumption behaviors. Energies, 16(3), 1478. https://doi.org/10.3390/en16031478
17. Reames, T. G. (2020). Distributional disparities in residential rooftop solar potential and penetration in four cities in the United States. Energy Research & Social Science, 69, 101612. https://doi.org/10.1016/j.erss.2020.101612
18. Santos, A. G. (2021). Forecasting residential electricity demand in the Philippines using an error correction model. Philippine Review of Economics, 57(1), 121–151. https://doi.org/10.37907/6ERP0202J
19. Trotta, G. (2021). Electricity awareness and consumer demand for information. International Journal of Consumer Studies, 45(1), 65–79. https://doi.org/10.1111/ijcs.12603
20. Xu, Q., Hwang, B. G., & Lu, Y. (2021). Exploring the influencing paths of behavior-driven household energy-saving intervention: Household Energy Saving Option (HESO). Sustainable Cities and Society, 71, 102951. https://doi.org/10.1016/j.scs.2021.102951
21. Xu, X., Yu, H., Sun, Q., & Tam, V. W. (2023). A critical review of occupant energy consumption behavior in buildings: How we got here, where we are, and where we are headed. Renewable and Sustainable Energy Reviews, 182, 113396. https://doi.org/10.1016/j.rser.2023.113396
22. Zheng, Q., & Lin, B. (2020). Achieving energy conservation targets in a more cost-effective way: Case study of pulp and paper industry in China. Energy, 191, 116483. https://doi.org/10.1016/j.energy.2019.116483