GREEN NUDGES ENERGY EFFICIENCY INITIATIVE

(NUDGING TOWARDS ENERGY CONSERVATION ON CAMPUS)

FINAL REPORT

(APRIL 2024)

Dr. Abdul Shakoor (PI)

Professor

Department of Mechanical Engineering

University of Engineering & Technology, Peshawar

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Green Nudges Energy Efficiency Initiative was a pilot project implemented by Adam Smith International UK, Sustainable Energy and Economic Development (SEED), and University of Engineering and Technology (UET) Peshawar from November 2023 to February 2024. It aimed to promote sustainable energy behaviours and achieve electricity savings in student hostels during winter months at UET's campus. The project utilised "green nudges" based on behavioural science insights to gently influence students' behaviours towards electricity savings and conservation actions. The project envisioned engaging students as partners in advancing sustainability efforts on campus and contributing empirical evidence on effective green nudges for electricity conservation.

The project's activities were executed through a phased approach including nudges design and implementation, monitoring and measurement, and data analysis. The project team implemented a mix of interventions, including default thermostat temperature nudges, social norms nudges (priming, information prompts, peer engagement), and infrastructural provisions. The team selected five student hostels for the study, implemented the designed nudges, and monitored electricity consumption during December 2023 to February 2024. After collecting the required data, the team analysed it to compare electricity consumption in the period after the nudges were implemented (December 2023 to February 2024; the post-nudge period) to the same months in the prior year (December 2022 to February 2023; the pre-nudge period).

The results revealed that total electricity usage dropped by 16.51% in the post-nudge period compared to the pre-nudge period in the five targeted hostels. Specifically, power consumption declined by 19.14%, 12.67% and 19.97% in December 2023, January 2024, and February 2024, respectively, compared to the pre-nudge months. Additionally, observational audits and post-nudge surveys and focus discussions demonstrated an increase in sustainable behaviours and awareness among students. Moreover, the results revealed gender-based differences in the effectiveness of the nudges, with female students showing greater reductions in consumption.

In conclusion, these results indicate that the study successfully used green nudges to achieve electricity savings in five targeted hostels, enhance student awareness of sustainable energy behaviours, and develop sustainable norms around thermal comfort practices and space heating within hostels. Essentially, the study demonstrated that nudging strategies are easy, economical interventions that induce environmentally beneficial outcomes. Moreover, although the study's narrow setting and target demographics means its scope is limited, the underlying behavioural framework of green nudges indicates that the study's outcomes may be applied to a variety of contexts.

Finally, the study's outcomes give rise to several policy recommendations, including tailoring nudges according to gender and culture, scaling nudges to other campus buildings to enhance energy conservation across the institution, and sustaining the project's impact through continued student advocacy and institutional mainstreaming of nudges.

1. INTRODUCTION

1.1 Global Energy Consumption in Buildings

Buildings account for 36% of global energy consumption and approximately 40% of carbon dioxide emissions. Optimising energy efficiency while ensuring occupant comfort remains a key challenge. Sustainable energy strategies have largely focused on technical interventions, such as retrofits, automation, and integration of renewables. However, the human dimension of energy use also requires equal emphasis, as user behaviours and habits significantly influence efficiency.

As people do not always make economically optimal or environmentally beneficial choices, technical solutions alone cannot fully address the energy impacts of their actions. Behavioural science offers key insights into driving sustainable energy use by understanding an individual's cognitive shortcuts, social motivations and thought patterns. It demonstrates how subtle tweaks in choice environments and decision-making contexts can prompt significant behaviour change towards environmentally beneficial actions. These small modifications are known as "green nudges."

1.2 Green Nudges

Green nudges use subtle cues based on behavioural design principles to gently influence an individual's behaviour towards more environmentally friendly actions. These nudges leverage cognitive biases and decision triggers to make sustainable options the easiest choice. Unlike regulatory measures, they preserve freedom of choice while making responsible energy actions effortless and socially rewarding. Well-designed green nudges can achieve considerable energy savings in various settings.

1.3 University Campuses as High-Impact Settings

University campuses provide ideal controlled environments to demonstrate how nudges promote sustainable behaviours. Students represent a high-impact population in a formative life stage where habits and identities are being developed. Pro-environmental behaviours shaped during college years tend to persist long after. Therefore, campuses offer valuable opportunities to pilot test green nudges.

The Green Nudges Energy Efficiency Initiative conducted a pilot test study aimed at harnessing green nudges to reduce electricity consumption in student hostels during the winter. In the following sections, this report presents an overview of the project including objectives, methodology, results, key outcomes, and recommendations.

2. PROJECT OVERVIEW

The Green Nudges Energy Efficiency Initiative is a joint effort by Adam Smith International UK, SEED, and UET Peshawar to reduce energy consumption through

innovative approaches engaging the student community. The Initiative conducted a pilot study from November 2023 to February 2024 to address the winter electricity consumption spike in student hostels at UET Peshawar using behavioural design principles.

2.1 Objectives

The project aimed to:

- Reduce electricity consumption in student hostels during the winter months of December, January, and February of 2024 compared with the same months in the prior year using green nudging strategies.
- Increase awareness of responsible energy use and build sustainable habits among students regarding thermal comfort practices and space heating in hostels.
- Demonstrate nudging strategies as easy, economical interventions that produce environmentally beneficial outcomes.

2.2 Scope of the Study

As an institutional case study, the results of this trial are specific to the implementation conditions and target demographics. As this study was conducted on a university campus with students as participants, its scope is restricted.

However, the mechanisms of behaviour change employed by this study can theoretically inform nudge design in other contexts. This is because the underlying behavioural science frameworks grounded in prospect theory, heuristics, and social proofs remain relevant across settings. Therefore, the initiative's strategies can be adapted to other settings, although replicability would require factoring different contextual variables.

3. PROBLEM ANALYSIS

UET Peshawar's student hostels experience a recurring seasonal spike in electricity consumption during the winter months when a drop in temperatures increases heating requirements. As these hostel buildings have poor insulation and lack centralised heating systems, individual room heater usage rises, and thermostat temperatures in common study rooms are raised beyond recommended setpoints. Moreover, increased occupancy during early mornings and nights for studying adds to the peak load.

This spike increases utility bills, straining institutional resources, while high demand overloads hostel distribution infrastructure like transformers and feeders, causing power breakdowns that disrupt student life and well-being. Moreover, higher fossil fuel-based electricity generation to meet seasonal spikes exacerbate the university's carbon footprint and greenhouse gas emissions.

Students tend to lack awareness regarding the consequences of high energy use and appropriate strategies to conserve power. They may feel that their individual increase in energy-consumption has a marginal impact on total use. However, other students feel the same and increase their power consumption, leading to a compounded overall increase. This multidimensional challenge needs more than a solely technical solution and may be effectively targeted with a people-centric solution tailored to the local context, i.e. with green nudges.

4. PROJECT METHODOLOGY

4.1 Project Inception

To establish a strong foundation for the project, the project team was designed to encompass diverse expertise, including representatives from the behavioural science, engineering, energy, student engagement, and facilities management departments. The team worked together to define the project's aims and determine timelines and a budget.

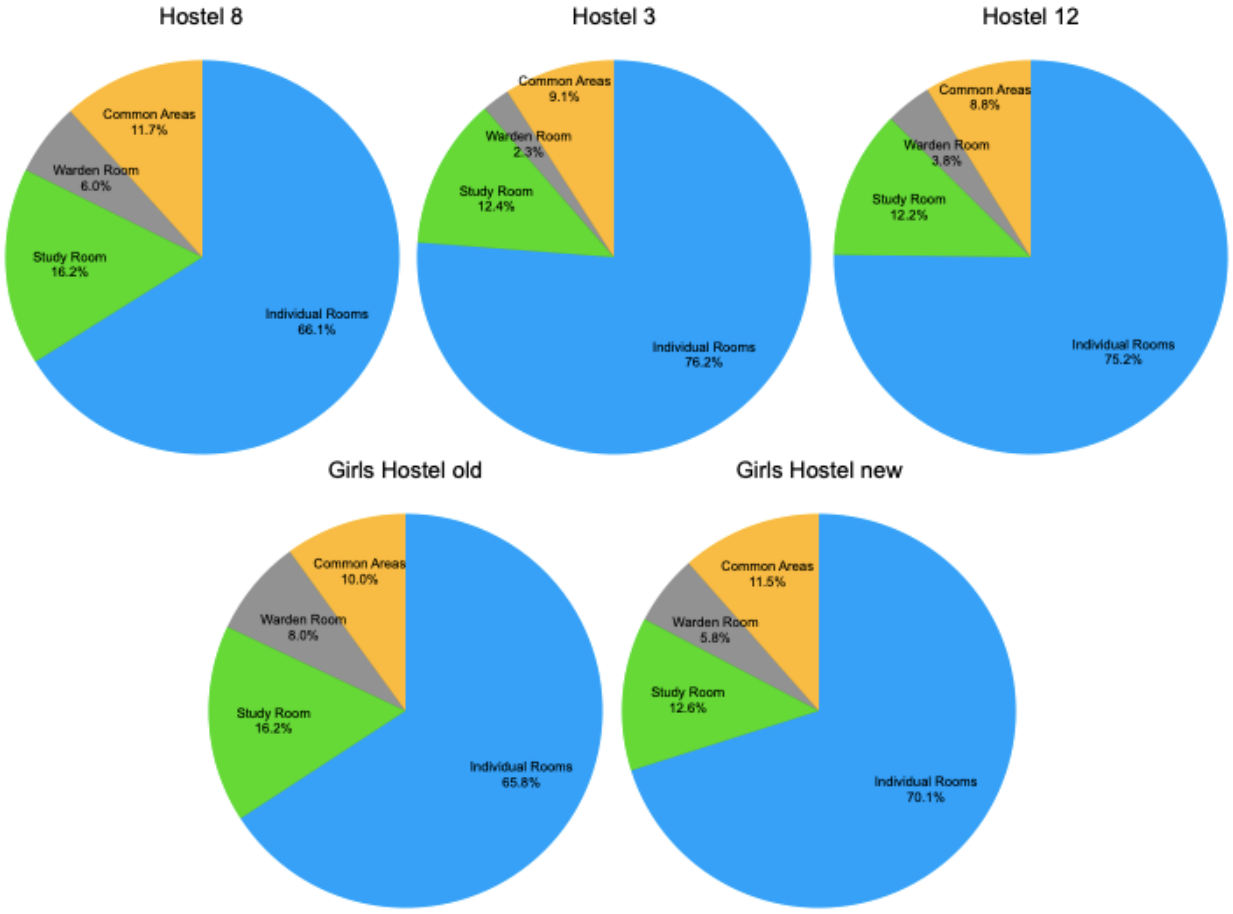
4.2 Planning

4.2.1 Context Analysis and baseline assessment

The team conducted context analysis and a baseline assessment to facilitate a comparative evaluation of the impact of the implemented nudges.

- **Electricity Usage:**
    - The team analysed annual and monthly electricity billing data for each hostel (November 2022 to November 2023). This data was used to develop monthly consumption profiles for the hostels and study rooms to determine benchmark consumption figures.
    - The data showed that winter electricity consumption in the five selected hostels (December to February) ranges from 16.9% in 'Girls Hostel (New)' to 26.2% in 'Girls Hostel (Old)' of total annual energy consumption.
    - Energy consumption rises in November, peaks in December-January with extended morning and night occupancy, and declines from February. In the summer, most students leave campus for the holidays, which leads to low consumption.
    - Students' rooms have the highest consumption, with study rooms coming in second (Figure 2).
    - The girls' hostels showed higher winter consumption, proportional to occupancy, compared to the boys' hostels.

Figure 1. Percentage Share of Energy Consumption Within Hostels (Baseline Consumption)



- **Observational Audits**: Physical audits documented hostel infrastructure, appliance usage, and space occupancy. The team found that thermostat settings exceeded the default temperature (at 27°C), portable room heaters were widely used, and most outdoor seating areas were minimally used.
- **Pre-Nudge Survey:** A survey of 201 students assessed students' heating practices, thermal comfort perceptions, and motivations during winter.
    - Only 16% of surveyed students were aware of energy conservation techniques.
    - Approximately half of surveyed students expressed that they were highly motivated to reduce energy consumption within hostels.
    - Although 58% of students said they preferred to study outdoors on sunny winter days, they cited key deterrents, which included poor WiFi

connectivity (68%), lack of power sockets (68%), and insufficient outdoor seating arrangements (52%).

- **Focus Group Discussions:** Students and facility representatives were asked in-depth questions regarding energy use behaviours and motivations. The initial default 20°C thermostat setting was considered quite uncomfortable during winter months by most students, which is why it was raised to 23°C.

4.2.2 Context Analysis Insights

The context analysis revealed several insights regarding students' energy consumption in hostels.

- The increase in demand for energy was primarily driven by the use of heating appliances in rooms, such as portable room heaters.
- Students support the idea of sustainability and energy conservation but lack awareness about the campus-level impacts of individual energy decisions and sustainable heating strategies.
- Students tend to use indoor common spaces for group studying, which raises room heater usage, as outdoor spaces lack charging points and WiFi.
- Thermal comfort needs, miscellaneous plug loads, and space usage behaviours vary significantly across social indicators (gender, culture, etc.), warranting tailored nudges.

4.3 Nudges Design, Implementation, and Assessment Strategy

The project team designed green nudging and other strategies to reduce students' energy consumption in hostels.

- **Default Thermostat Nudge:** A default thermostat temperature of 20°C (later raised to 23°C based on pre-nudge survey results) was set in hostel study rooms. Default thermostat temperatures are an effective green nudge because they use an individual's behaviour preferences to encourage energy conservation without needing active decision making. If a default temperature is set, users are more likely to maintain it because they prefer the status quo.

  The 20°C default temperature in the study rooms is based on global best practices for sufficient warmth at the lowest energy consumption. The National Energy Efficiency and Conservation Authority (NEECA)'s "Energy Conservation and Building Codes 2023" recommends 20°C and 26°C for maintaining indoor thermal comfort in winter and summer seasons, respectively.

- **Social Norms Nudge:** Social norms nudges are another effective mechanism that can steer individuals towards environmentally beneficial decisions. People tend to adopt practices that they believe are prevalent and valued in society. Therefore, presenting energy conservation as socially valued act can nudge people towards sustainable behaviours.
    - This study used informational posters and banners, some designed by students, depicting pro-environmental descriptive norms across campus to influence student behaviour.
    - Twelve students were chosen as Eco-Warriors, who provided regular energy conservation reminders and tips to students. This peer advocacy emphasized the social value of energy-saving behaviours by leveraging the influence of fellow students.
    - Competitions, workshops, and social media activities were organized to encourage 'green' behaviour.
    - Incentives, such as recognition, certification, and discount vouchers, were offered for active participation. This was aimed to encourage students to participate in conservation efforts.

- **Infrastructure:** Outdoor study areas were facilitated with device charging and WiFi. This aimed to encourage students to use outdoor study areas instead of indoor ones, thereby cutting down on power consumption.

After finalizing nudging strategies, impact assessment approaches, including metering, surveys, focus groups, observational audits, and feedback, were finalised.

4.4 Nudges Implementation and Monitoring

The designed green nudges were implemented in five hostels from December 2023 to February 2024. The project team monitored their impact through smart metering, student surveys and focus groups, energy use audits, and thermostat setpoint records.

- **Hostel Selection:** Five student hostels were selected for the study. Three were male ('Hostel 3', 'Hostel 8', and 'Hostel 12'), and two were female ('Girls Hostel New' and 'Girls Hostel Old'). To ensure a representative sample, the hostels were chosen based on electricity metering infrastructure, space layouts, student gender mix, student capacity, and a mix of student seniority.

- **Treatment Group:** The study rooms in three hostels ('Hostel 3', 'Hostel 12', and 'Girls Hostel New') had the default thermostat nudge implemented, with the temperature initially preset to 20°C and later raised to 23°C.

- **Control Group:** Two study rooms, one each in a male and female hostel ('Hostel 8' and 'Girls Hostel Old') were designated as control rooms without the default nudge. In these control rooms, the thermostat was not preset to a specific temperature, allowing students to adjust the settings freely. The inclusion of these control rooms enabled the project team to isolate and evaluate the impact of the default thermostat nudge on electricity consumption.

- **Monitoring**: Continuous monitoring was conducted from December 2023 till February 2024 to track the green nudges deployment, electricity consumption patterns, user engagement levels, and responses. The data allowed the project management team to identify trends, correlations, and emerging insights for refinements.

Table 1: Project Monitoring Plan

Monitoring Mechanism	Data Acquisition Frequency/Time	Responsible Team Members
Electricity Metering (study rooms and hostels)	• Study rooms (weekly consumption) • Hostels (monthly consumption)	Eco-Warriors + Hostel Lead Persons + Project Coordinator
Temperature Logbooks and Weather Website	Study rooms (hourly) and outdoor temperatures (weekly)	Eco-Warriors + Project Coordinator
Pre- and Post-Nudge Surveys	Students input and feedback (pre- and post-nudges)	Project Coordinator + Hostel Lead Persons + Eco-Warriors
Focus Group Discussions	In-depth attitudes and responses (Month 2 and Month 5)	Principal Investigator + Project Manager
Observational Audits	Hostels space usage and energy conservation behaviours (at intervals throughout the day)	Hostel Lead Persons + Project Coordinator + Eco-Warriors

4.5 Impact Analysis

The team used monitoring data to analyse the nudges' impact through comparative analysis of pre- and post-nudge electricity consumption data, surveys, and focus group discussions as well as observational audits to assess changes in space usage and habits.

4.6 Dissemination

The dissemination phase focused on communicating the study's insights through workshops. seminars, and social media. Key dissemination activities conducted during the project period include a workshop conducted in January 2024 and two seminars in February 2024. Additionally, a project website has been developed and launched

(https://www.ecopushcampus.pk/). Targeted social media engagement is also underway with dedicated handles created on Facebook, LinkedIn, and Twitter.

5. RESULTS

5.1. Total Electricity Consumption in Hostels

For the five hostels selected for this study, total consumption in the pre-nudge period (December 2022 to February 2023) was 84,232 kWh, while total consumption in the post-nudge period (December 2023 to February 2024) was 70,323 kWh. This reflects a total reduction of 13,909 kWh or 16.51%, as shown in Table 2.

Specifically, students cut energy use by 19.14%, 12.67%, and 19.97% in the post-nudge months of December 2023, January 2024, and February 2024, respectively, compared to the pre-nudge months of December 2022, January 2023, and February 2023, as shown in Table 3.

With regard to individual consumption, the results shown in Table 2 and Table 4 reflect a reduction for all hostels except for 'Hostel 8', which experienced a rise of 9.86% in the post-nudge period. This suggests that the study's interventions largely succeeded in compelling students to cut electricity usage.

Table 2: Total Electricity Consumption in Pre- and Post-Nudge Periods

Hostel Name	Occupancy		Total Consumption (kWh)		Consumption/person (kWh)		Percentage Decrease/person
	Dec22-Feb23	Dec 23-Feb24	Pre-nudge	Post-nudge	Dec22-Feb23	Dec23-Feb24	
Hostel 8	300	300	18,102	19,887	20.11	22.10	**+9.86**
Hostel 12	277	274	9,583	8,537	11.53	10.39	**- 9.94**
Hostel 3	660	650	28,437	19,667	14.36	10.09	**- 29.78**
Girls Hostel Old	94	126	14,095	13,002	49.98	34.40	**- 31.18**
Girls Hostel New	151	151	14,015	9,230	30.94	20.38	**- 34.14**
Total	1482	1501	84,232	70,323	18.95	15.62	**- 17.57**
Change in total consumption (kWh)	**-13,909**						
Change in total consumption (%)	**-16.51**						

Table 3: Total Monthly Electricity Consumption (Pre-Nudge vs Post-Nudge)

Hostel Name	Total Consumption (kWh)					
	Dec 2022	Dec 2023	Jan 2023	Jan 2024	Feb 2023	Feb 2024
Hostel 8	5,507	5,617	8,576	9,715	4,019	4,555
Hostel 12	2,504	2,247	4,400	4,497	2,679	1,793
Hostel 3	11,921	7,707	10,698	8,286	5,818	3,674
Girls Hostel Old	4,140	4,620	7,296	6,037	2,659	2,345
Girls Hostel New	4,750	3,114	5,650	3,446	3,615	2,670
Total	**28,822**	**23,305**	**36,620**	**31,981**	**18,790**	**15,037**
Change in total consumption (kWh)	**-5,517**		**-4,639**		**-3,753**	
Change in consumption (%)	**-19.14**		**-12.67**		**-19.97**	

Table 4: Total Electricity Consumption Per Person

Hostel Name	Total Consumption Per Person (kWh)					
	Dec 2022	Dec 2023	Jan 2023	Jan 2024	Feb 2023	Feb 2024
Hostel 8	18.36	18.72	28.59	32.38	13.4	15.18
Hostel 12	9.04	8.20	15.88	16.41	9.67	6.54
Hostel 3	18.06	11.86	16.21	12.75	8.82	5.65
Girls Hostel Old	44.04	36.67	77.62	47.91	28.29	18.61
Girls Hostel New	31.46	20.62	37.42	22.82	23.94	17.68

5.2 Total Electricity Consumption in Study Rooms

The default thermostat temperature setting was set to 23°C in the study rooms of three hostels (‘Hostel 3’, ‘Hostel 12’, and ‘Girls Hostel (New))’. Meanwhile, two study rooms (‘Hostel 8’ and ‘Girls Hostel (Old)’) were designated as control rooms without the default nudge.

The actual recorded monthly electricity consumption of the study rooms after the nudge was implemented, in December 2023, January 2024 and February 2024, was compared with the estimated pre-nudge consumption in December 2022, January 2023, and February

2023. The pre-nudge estimate was calculated based on the study room's percentage share of total hostel consumption during that period (baseline), as shown in Table () and ().

Here is how the pre-nudge estimate was determined for December 2022 in the 'Hostel 3' study room:

- The actual recorded electricity consumption (Dec 23) equaled 913.16 kWh.
- Estimated electricity consumption (Dec 22) @12.4% baseline equaled 1478.20 kWh. The 12.4% baseline is drawn from the baseline consumption figures presented in Figure 1.
- This shows that electricity consumption (Dec 23) decreased from electricity consumption (Dec 22).
- Meanwhile, the share of the actual recorded electricity consumption of the 'Hostel 3' study room as a percentage of the total electricity consumed (7707 kWh) in 'Hostel 3' in December 2023 equals 11.85%
- Therefore, the predicted electricity consumed by the study room in December 2022 at 11.85% would be 1412.64 kWh, which is still more than the actual electricity consumed by the study room in December 2023.

The other estimates for each hostel study room were calculated using the same method as above.

Table 5: Electricity Consumption in Study Rooms (Dec 22 baseline vs Dec 23 actual)

Hostel Name	Study Room Consumption (kWh) Dec23 (actual)	Study Room Consumption (kWh) Dec22 (baseline)	Change in Study Room Consumption (kWh)
3 (Treatment)	913.6	1,478.20	-564.60
8 (Control)	837.2	892.13	-54.93
12 (Treatment)	289.4	305.49	-16.09
GH old (Control)	763.2	714.42	+48.78
GH new (Treatment)	348.1	598.50	-250.40
Total	**3,151.5**	**3,988.74**	**-837.24**

Total Change in Consumption kWh of Study Rooms in December 2023 (%)	**-21.00%**

Table 6: Electricity Consumption in Study Rooms (Dec 22 estimate vs Dec 23 actual)

Hostel Name	Total Hostel Consumption (kWh) Dec23 (actual)	Study Room Consumption (kWh) Dec23 (actual)	Study Room Consumption (%) Dec23 (actual)	Total Hostel Consumption (kWh) Dec22 (actual)	Study Room Consumption Dec22 (kWh) (As a % of the actual study room consumption of Dec23)	Decrease in Study Room consumption (kWh)
3 (Treatment)	7,707	913.6	11.85	11,921	1,412.64	-499.04
8 (Control)	5,617	837.2	14.9	5,507	820.54	+16.66
12 (Treatment)	2,247	289.4	12.88	2,504	322.52	-33.12
GH old (Control)	4,890	763.2	15.61	4,410	688.40	+74.80
GH new (Treatment)	3,114	348.1	11.18	4,750	531.05	-182.95
Total Consumption kWh of Study Rooms (actual) in December 2023		**3,151.50**				

Table 7: Electricity Consumption in Study Rooms (Jan 23 baseline vs Jan 24 actual)

Hostel Name	Study Room Consumption (kWh) Jan24 (actual)	Study Room Consumption (kWh) Jan23 (baseline)	Change in Study Room consumption (kWh)
3 (Treatment)	1,034.2	1,326.55	-292.35

8 (Control)	1,542.7	1,389.31	+153.39
12 (Treatment)	527.8	536.8	-9
GH old (Control)	961.3	1,225.69	-264.39
GH new (Treatment)	486.5	711.9	-225.4
Total	**4,552.5**	**5,190.25**	**-637.75**
Change in Consumption (kWh) of Study Rooms in January 2024 (%)	**-12.29%**		

Table 8: Electricity Consumption in Study Rooms (Jan 23 estimate vs Jan 24 actual)

Hostel Name	Total Hostel Consumption (kWh) Jan24 (actual)	Study Room Consumption (kWh) Jan24 (actual)	Study Room Consumption (%) Jan24 (actual)	Total Hostel Consumption (kWh) Jan23 (actual)	Study Room Consumption Jan23 (kWh) (As a % of the actual study room consumption of Jan24)	Decrease in Study Room consumption (kWh)
3 (Treatment)	8,286	1034.2	12.48	10,698	1,335.11	-300.91
8 (Control)	9,715	1542.7	15.88	8,576	1,361.87	+180.83
12 (Treatment)	4,497	527.8	11.74	4,400	516.56	+11.24
GH old (Control)	6,307	961.3	15.24	7,566	1,153.06	-191.76
GH new (Treatment)	3,446	486.5	14.12	5,650	797.78	-311.28
Total		**4,552.50**				

Table 9: Electricity Consumption in Study Rooms (Feb 23 baseline vs Feb 24 actual)

Hostel Name	Study Room Consumption (kWh) Feb24 (actual)	Total Hostel Consumption (kWh) Feb23 (actual)	Change in Study Room Consumption (kWh)
3 (Treatment)	533.7	721.43	-187.73
8 (Control)	759.1	651.08	+108.02
12 (Treatment)	246.5	326.84	-80.34
GH old (Control)	397.3	474.5	-77.20
GH new (Treatment)	363.5	455.49	-91.99
Total	**2,300.1**	**2,629.34**	**-329.24**
Change in Consumption kWh of Study Rooms in February 2024 (%)	**-12.52%**		

Table 10: Electricity Consumption in Study Rooms (Feb 23 estimate vs Feb 24 actual)

Hostel Name	Total Hostel Consumption (kWh) Feb24(actual)	Study Room Consumption (kWh) Feb24(actual)	Study Room Consumption (%) Feb24(actual)	Total Hostel Consumption (kWh) Feb23(actual)	Study Room Consumption Feb23 (kWh) (As a % of the actual study room consumption of Feb24)	Decrease in Study Room consumption (kWh)
3 (Treatment)	3674	533.7	14.53	5,818	845.36	-311.66
8 (Control)	4555	759.1	16.67	4,019	669.97	+89.13
12 (Treatment)	1793	246.5	13.75	2,679	368.36	-121.86
GH old (Control)	2615	397.3	15.19	2,929	444.92	-47.62

GH new (Treatment)	2670	363.5	13.61	3,615	492	-128.5
Total Consumption kWh of Study Rooms (actual) in January 2024		**2,300.1**				

Overall, the analysis revealed that total consumption in study rooms where the default thermostat nudge was implemented declined by 21%, 12.29%, and 12.52% in December 2023, January 2024, and February 2024, respectively, compared with the pre-nudge months of December 2022, January 2023, and February 2023.

6. DISCUSSION

6.1 Electricity Savings

For the five chosen student hostels, the analysis revealed a significant decline in total electricity consumption. Except for 'Hostel 8', all hostels recorded a decrease in electricity consumption in the post-nudge period. Moreover, electricity consumption in study rooms with the default nudge declined compared with pre-nudge estimates.

However, the results for consumption in control study rooms were mixed. For Hostel 8, which had a control study room, consumption increased in two months but decreased in one. Similarly, for 'Girls Hostel (Old),' consumption increased in one month but decreased in two.

Nevertheless, overall, the results suggest that the initiative's green nudging strategies, especially the default thermostat temperature nudge, were effective in cutting total power consumption in hostels as well as specifically in treatment study rooms.

6.2 Gender Differences

In the pre-nudge period, female hostels had higher winter monthly consumption per person than male hostels. However, female hostels also had higher reductions in per person consumption post-nudge compared to male hostels. 'Girls Hostel (New)' recorded a reduction in consumption of 34.44%, 39.01% and 26.14% in December 2023, January 2024, and February 2024, respectively, while 'Girls Hostel (Old)' recorded a reduction of 16.75%, 38.27%, and 34.21%.

Moreover, thermostat compliance improved significantly in female hostels, as evidenced by the 52.56%, 63.98%, and 35.35% reduction in electricity consumption of study rooms in 'Girls Hostel (New)' in the three study months. Female students also showed greater adoption of outdoor studying post-provision of facilities, as shown through observational audits and post-nudge surveys.

This data suggests that the study's nudging strategies were more impactful among female students than among male students. However, just as in the pre-nudge period, female hostels still consumed more electricity than male hostels. This difference may be because female students use electrical devices, such as hair dryers, straighteners, and irons, more than do male students, raising their per person consumption. Additionally, female students tend to spend more time indoors than male students, which results in higher electricity consumption.

6.3 Student Engagement and Norms

Post-nudge survey results showed increased awareness of energy saving and conservation strategies among students across genders. Additionally, focus groups revealed an enhanced understanding of linkages between individual behaviours and campus-level power demand. The project team also observed the development of positive social norms relating to sustainable behaviours. For example, observational audits showed increased adaptive behaviours like adding extra clothing layers before turning up thermostats. Additionally, focus groups revealed that students were more likely to switch off unused appliances because of peer accountability. Moreover, the post-nudge survey data showed more compliance with the default thermostat nudge and a higher willingness to continue energy-saving behaviours beyond the project duration.

These developments suggest that the study's social norms nudging strategies were successful in changing social norms, raising awareness, and nudging students toward adopting energy saving behaviours. This shift in norms may be attributed to how the posters and banners displayed across campus, workshops and seminars, and peer advocacy by the Eco-Warriors symbolised a descriptive norm that saving energy is socially valued, thereby influencing student behaviour.

Surveys also indicated that efforts to actively involve students as partners through initiatives like volunteer programs and competitions allowed students to feel invested in the project's success. The experiential engagement deepened learning compared to didactic instruction alone. Thus, the engagement nudges successfully activated students as empowered change agents based on the psychological principles of autonomous motivation and social diffusion.

6. CONCLUSION AND RECOMMENDATIONS

The Green Nudges Energy Efficiency study used green nudges to achieve electricity savings in five targeted hostels, enhance student awareness of sustainable energy behaviours, and develop sustainable norms around thermal comfort practices and space heating within hostels. The project's effectiveness demonstrated green nudges as a valuable sustainability strategy that integrates social and behavioural factors.

The study's outcomes give rise to several policy recommendations:

- Given the effectiveness of the default thermostat temperature and social norms nudges in encouraging energy conservation, the study demonstrated that nudging strategies are easy, economical interventions that induce environmentally beneficial outcomes. Therefore, policymakers should employ nudging strategies to induce power savings and pro-environmental behaviours.

- Additionally, the study revealed differences in the effectiveness of nudges between male and female hostels, suggesting that nudges should be tailored to account for gender and cultural differences.

- The study's setting at a university campus indicates that academic institutions, especially student hostels, are ideal spaces to target nudging strategies to encourage environmentally beneficial behaviour and cut electricity consumption in buildings. This also suggests that other locations where people reside and work, such as apartment buildings and offices, may be viable settings for future studies and interventions.

- The study's results offer an opportunity for scaling nudges in university buildings other than hostels, which could significantly enhance energy conservation institution wide. However, a stage-wise scaling approach through periodic pilot testing across contexts like academic areas, offices, residential blocks should be implemented, as this allows for contextual adaptations. In fact, periodic optimisation is more prudent than an ambitious singular scale-up, and potential challenges to scale-up like technology integration across legacy campus technology systems would need to be evaluated. Scaling nudges through systematic pilots can multiply sustainability benefits compared to one-off isolated pilots in some buildings.

- Continued efforts should be made, such as by student advocates who offer regular reminders and reinforcement of sustainable values, to maintain energy savings. Sustaining the project's impact would require the institutionalisation of critical nudges within mainstream campus operations through policies and engagement programs.

- Deeper technological integration, such as smart default settings connected to occupancy and climate patterns, can enhance the effectiveness of nudges. Therefore, basic automated controls should be prioritised when designing such interventions.