INDO-GERMAN CENTRE FOR SUSTAINABILITY (IGCS)

GRANTEE EXPERIENCE REPORT

Indo-German Centre for Sustainabilty (IGCS)
IGCS Research Exchange, Grant Period 2024

scholarship report

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Scholarship Report, IGCS Research Exchange Grants, Funding Period 2023

IGCS Grantee
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Research Topic
Air Conditioner Energy Efficiency within the New Academic Complex at IITM

Focus Area
Energy

Starting/End date of the student exchange period
25/12/2023 – 05/03/2025

As a beneficiary of the IGCS research exchange scholarship, the grantee has committed to share the outcome of their stay in the host institution. This report is containing a detailed summary of their work, findings and expected outcomes:

Part I: Research Brief

INTRODUCTION

As part of the energy transition in India, different measures are being taken throughout the country. To research the decrease in CO2 emissions and achieve carbon neutrality, the Indian Institute of Technology Madras (IITM) is setting up an experimental microgrid as a decentralized energy system that will provide electricity to different infrastructures, including the HVAC (Heating, Ventilation, and Air Conditioner). The New Academic Complex (NAC) at IITM was completed in 2020. In terms of energy optimization, to achieve thermal comfort, the reduction of the Energy Performance Index (EPI) by 50.21% from the GRIHA base case has been demonstrated through the integration of high-performance systems. NAC has faced certain challenges related to the HVAC installation and infrastructure. As part of the collaboration between TU Berlin and IIT Madras, this research proposal aims to elaborate a diagnostic on the current status of the Air Conditioner infrastructure and provide insight into the reduction in energy consumption and the increased efficiency.

RESEARCH

OBJECTIVES

The objective is to propose recommendations for improving the air conditioner infrastructure to enhance energy efficiency. To do so, the current status of the air conditioner infrastructure at the New Academic Complex (NAC) in IIT Madras was assessed. Then, the challenges faced by the NAC related to air conditioner installation and infrastructure were identified, and a diagnostic was elaborated. Analyzing energy consumption patterns and evaluating the air conditioner system helped during this objective.

LIMITATIONS

One primary limitation of this research project has been related to temporal constraints. Originally, the research proposal was centered on the mapping of the air conditioning infrastructure by the Geographic Information System (GIS). However, the focus shifted towards prioritizing the enhancement of energy efficiency within the Air Conditioning system at the New Academic Complex. This alteration in research scope constrained the depth and breadth of analysis achievable within the designated timeframe. .

METHODOLOGY

The methodology proposed for this research project was based on a multifaceted approach to gathering holistic insight into the HVAC infrastructure and its associated challenges. The methodology consisted mainly of data collection (visual inspection, survey administration, photographic documentation) and data analysis (data provided by the Administration Office). The first step involved a thorough visual inspection of the HVAC infrastructure at the New Academic Complex to identify any visible issues, anomalies, or areas of concern. Then, a structured survey was carried out to various stakeholders, including professors, workers, bachelor's, PhD, and research students utilizing the facilities. The survey was conducted during designated hours (Monday to Friday, 10:00 AM to 2:00 PM and 3:00 PM to 7:00 PM), ensuring

maximum participation. The survey consisted of open-ended questions to elicit responses regarding the challenges faced concerning the Air Conditioning system. Aphotographic report was carried out, documenting the observed conditions of the air conditioner infrastructure. Finally, the data provided by the administration office was interpreted and analyzed to extract relevant information regarding the air conditioning infrastructure and its usage patterns. However, certain limitations regarding limited accessibility/visibility and variation in occupancy were faced during the implementation of the methods. Due to concealed infrastructure or inaccessible areas, the accessibility and visibility for inspection and survey purposes were restricted. This limitation may have affected the comprehensiveness of the data collection process, as certain areas or components of the HVAC infrastructure could not be directly observed or assessed. Also, some rooms were unoccupied during the data collection period, which is attributed to the specific time of day. This variability in occupancy levels may have influenced the responses obtained from the survey participants and the overall assessment of the HVAC system's performance and user experiences within the New Academic Complex.

DIAGNOSTIC
The Administration Office provided plans for the whole New Academic Complex. These plans were used to carry out the interviews and identify the considerations regarding air conditioning on each room. A traffic light system was established, where green indicates that there are no issues or that any previous issues have been resolved. Gray indicates that the space was not interviewed because it was unoccupied or there was nobody present during the interview time. And red refers to any issues identified. .

DIAGNOSTIC
FINDINGS
Most of the issues in all the floors were related to the following problems:
- Most users complained about the temperature control not working.
- When it is too cold, users open the windows and/or doors to balance the temperature.
- AC is always running | Efficiency
- During the night (after 10pm) AC is too cold.
- Interconnected system with differentiated power (Some rooms get very cold and some very hot. And if the temperature changes in one, it affects its adjacent other).
- Certain rooms have condensation problems.
- Certainrooms would have similar issues throughout all the floors. This indicates a potential vertical structural problem.

DATA
ANALYSIS
The Administration Office provided an Excel file with diverse data on air handling units, rooftop heat pumps, and chillers. This data was categorized based on specific days and timeframes. However, as the survey was conducted recently, the Office's data only covered previous months, notably Autumn and Winter, compromising the accuracy for those seasons.

Through the selection of varied samples across floors, zones, and time slots, the analysis revealed the following finding: while temperature fluctuations of approximately 10°C were observed, the impact on energy consumption was minimal. This was particularly evident during late and early hours, from 11 p.m. to 6 a.m., despite lower occupancy rates. On average, the

energy consumption difference stood at 22 kWh, with the lowest discrepancy recorded at just 13 kWh, and the highest at 34 kWh.

RECOMMENDATIONS

The following recommendations aim to minimize energy consumption during periods of low occupancy, optimize HVAC system operation, and enhance overall energy efficiency in the NAC building. Recommendations include implementing Energy Saving Measures. Given that energy consumption remains consistent regardless of temperature and occupancy levels, consider implementing energy-saving measures during periods of low occupancy, particularly during late and early hours. This could involve adjusting HVAC system settings, such as temperature setpoints or ventilation rates, to minimize energy consumption while maintaining occupant comfort. Another strategy is to analyze the opportunities to optimize nighttime operation of the HVAC system. This may include scheduling equipment shutdown or reduced operation during periods of low occupancy, such as during late-night hours when energy demand is typically lower. Additionally, explore the feasibility of implementing occupancy sensors or automated controls to adjust HVAC settings based on occupancy patterns in real-time. Another strategy is to analyze the opportunities to optimize nighttime operation of the HVAC system. This may include scheduling equipment shutdown or reduced operation during periods of low occupancy, such as during late-night hours when energy demand is typically lower. Additionally, explore the feasibility of implementing occupancy sensors or automated controls to adjust HVAC settings based on occupancy patterns in real-time. Another relevant measure related with the previous one would be the exploration of energy management strategies. For example, to investigate further possibilities for reducing energy consumption during nighttime hours, such as implementing energy management strategies or upgrading HVAC equipment to more energy-efficient models. This could involve retrofitting existing systems with energy-saving features, optimizing equipment scheduling and sequencing, or investing in advanced control systems to maximize energy efficiency. Finally, it is recommended to conduct a Cost-Benefit Analysis. This could prioritize energy-saving measures based on a comprehensive cost-benefit analysis, considering factors such as initial investment costs, potential energy savings, and payback period. Evaluate the long-term impact of implementing energy-saving measures on energy consumption, operational efficiency, and overall NAC performance.

CONCLUSIONS

In conclusion, this research has shed light on the critical importance of optimizing air conditioner infrastructure to enhance energy efficiency, particularly within the context of the New Academic Complex (NAC) at the Indian Institute of Technology Madras (IITM). Through collaborative efforts between IIT Madras and TU Berlin, a comprehensive diagnostic was conducted to assess the current status of the NAC's air conditioner infrastructure. This investigation revealed significant challenges related to air conditioner infrastructure, which affect energy consumption and operational efficiency. By analyzing energy consumption patterns and evaluating the air conditioner system, valuable insights were gathered, highlighting the need for targeted interventions to improve energy efficiency. Despite facing diverse challenges, the NAC demonstrates a commitment to energy optimization, as evidenced by the notable reduction in the Energy Performance Index (EPI) achieved through integrating high-performance systems. However, there remains room for improvement, particularly in addressing issues related to HVAC installation and infrastructure and their energy

consumption. Moving forward, it is relevant to consider the recommendations aimed at enhancing the air conditioner infrastructure to achieve greater energy efficiency and contribute to the broader goal of carbon neutrality. By prioritizing energy-saving measures, optimizing nighttime operation, and exploring innovative solutions, the NAC can further advance its efforts towards sustainable energy management. This research serves as a foundation for future initiatives to foster energy resilience and reduce carbon emissions, thus paving the way for a more sustainable future.

Part II: Digital Media

Grantees are invited to share their experiences in digital media, encompassing photographs, illustrations, or graphics within the context of the IGCS scholarship.