Optimizing Energy Usage for the IITGN Campus

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Introduction

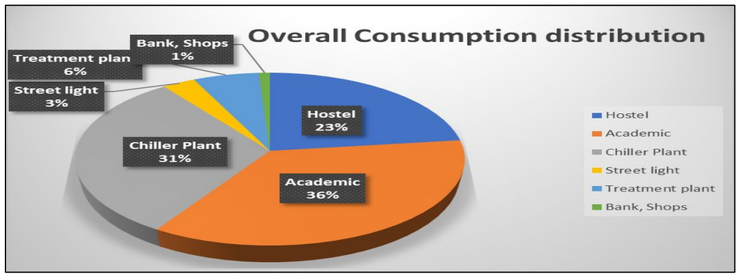

Figure: Overall Energy Consumption

- Our research focuses on optimizing campus electricity consumption as the student body grows. Our analysis indicates that **90% of total energy usage is driven by hostels (23%), academic buildings (36%), and the chiller plant (31%).** These areas are critical for achieving long-term sustainability and operational efficiency.

Objectives

- To analyze how different occupancy levels and room sizes impact cooling effectiveness, providing insights into optimizing energy usage.
- Detailed comparisons of different panel technologies inform optimal selection fo sustainable energy integration.
- To utilize predictive modeling to forecast energy consumption trends in the coming years.
- To explore how temperature settings influence energy usage and occupant comfort, highlighting opportunities for energy conservation.

Data & Methodology

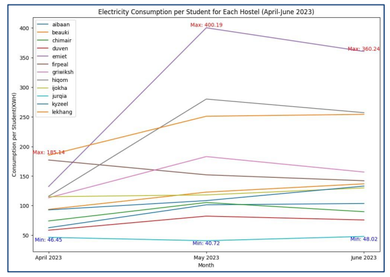

Figure: Per student Consumption for Each hostels

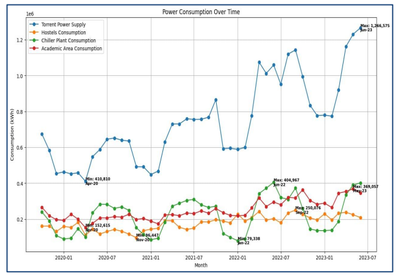

Figure: Power Consumption over Time

- **CAGR Modeling for Future Forecast of Energy Consumption:**
  Utilized the Compound Annual Growth Rate (CAGR) model to project future power consumption by assessing average growth rates from past trends, facilitating accurate predictions for upcoming years.
- **Energy Consumption Variation in Room Design:**
  Leveraged **EQUEST** modeling to assess energy consumption variations in different room types (single, double, and triple) across varying weather conditions, occupancy levels, and areas. This detailed analysis provides insights into optimizing energy efficiency in campus accommodations.
- **Occupancy with Room Painting Effects:**
  Utilized the heat model to simulate room temperature changes in response to varying occupancy levels.Explored the influence of room color changes on thermal comfort.
- **Heat Model Equation:** $$Cooling\ Efficiency = \frac{AC\ Power}{Total\ Heat\ Transfer\ Rate}$$

Conclusion

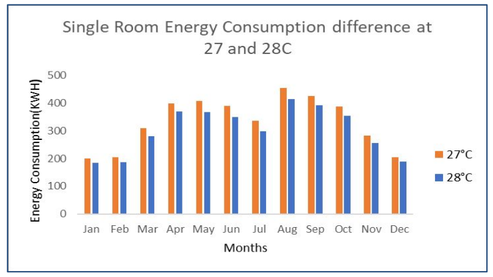

Figure: Analysis of Temperature difference for single room

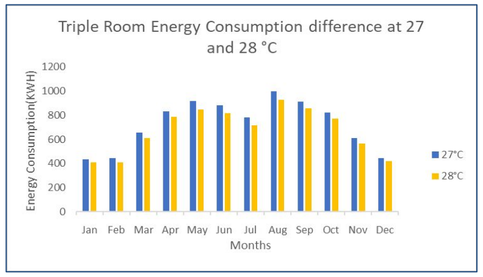

Figure: Analysis of Temperature difference for triple room

EQuest simulation model gives us the difference in per capita energy consumption when the set point of AC is changed from 27°C to 28 °C. Change shows a steady decrease in consumption.

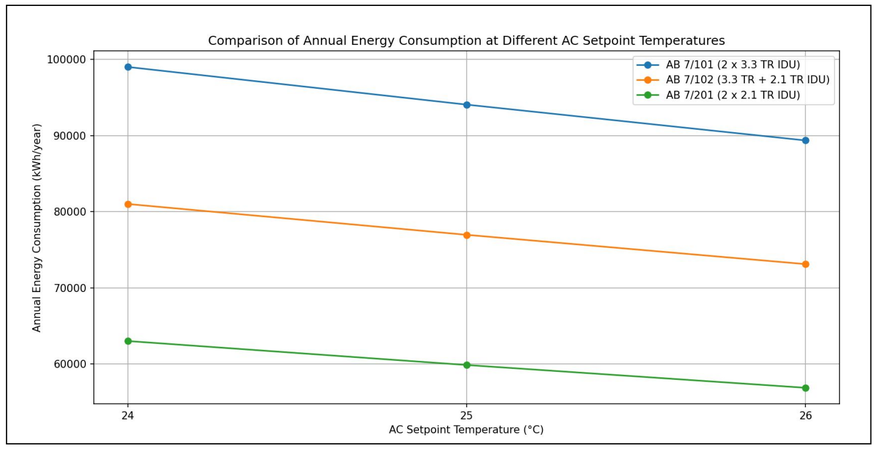

Figure: Analysis of Temperature difference for AB7 Block

Results

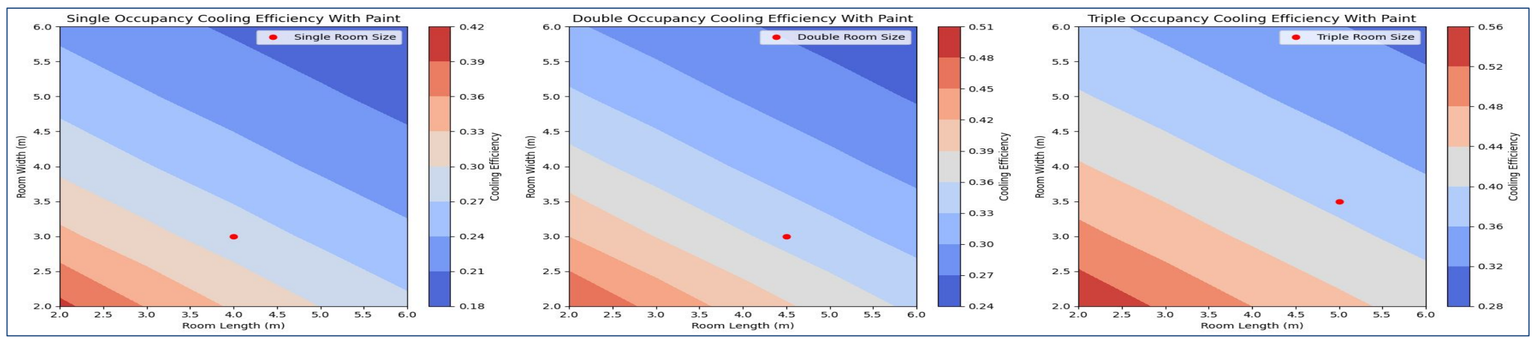

Figure: Cooling Efficiency Across Occupancy Scenarios and Room Sizes

Implementation of solar grids in hostels can yield an average current solar output of 2500 kWh, with potential for a **threefold** increase, offering a payback period of 5 to 6 years and a total lifespan of **25 to 30 years**, highlighting both the sustainability and financial benefits of solar energy integration.

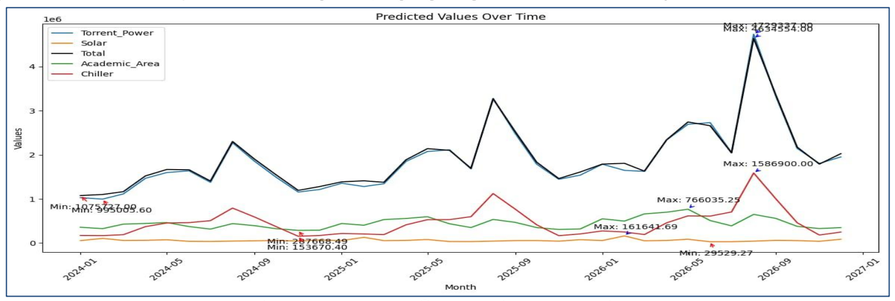

Figure: Future Years Energy Consumption Forecast

- Through the application of the CAGR model, it is evident that energy consumption experiences a growth rate ranging from 8% to 14% each month. Notably, Total and Torrent exhibit a significant spike of 44% in August, potentially attributed to the conclusion of the summer vacation period.
- Projected **Doubling** of Power Consumption in 6 Years, **Excluding** Growth in Student Population, Hostels, and Academic Facilities.

Policy Recommendations

- It is recommended to install additional solar panels on the roofs of hostels to support sustainability efforts.
- Consider revising the set points of air conditioning systems to 28°C within hostels, and between 25-26°C in academic blocks, aiming for improved energy efficiency.
- Implementation of programmable thermostats is advised to facilitate adaptive climate control, aligning temperature settings with occupancy and time of day.
- In future hostel constructions, priority should be given to incorporating triple rooms over single rooms to optimize space utilization and foster sustainable living arrangements.
- An evaluation of the effectiveness of reflective paint/surfaces in reducing heat gain through walls and enhancing overall energy efficiency is recommended.

Acknowledgements

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