

CS 6300 Location Project - Final Report

"EcoCampus: Tech-Driven Sustainability"

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Abstract—This report presents an innovative project at our team aimed at reducing energy wastage due to the simultaneous use of ACs and open windows in classrooms. We developed a cost-effective solution combining smart switches and a user-friendly app. The switches, installable on windows and integrated with AC systems, communicate via TCP to the app, providing real-time updates on the status of windows and ACs. The app, designed with a user-friendly interface, processes this data to prompt immediate action from users through a multi-channel notification system. Priced under \$3 per unit, the system is economically viable and scalable, marking a significant step towards institutional energy conservation and sustainability.

1 BACKGROUND AND MOTIVATION

In an era prioritizing sustainability, energy conservation is a key concern for global institutions. Educational establishments like ours are pivotal in this effort. Efficient electricity usage, a significant financial and environmental issue, is especially relevant at GTSI, where air conditioning (AC) is the primary electricity consumer. The frequent scenario of running ACs in classrooms with open windows leads to substantial energy wastage.

Our aim is to minimize this energy wastage by ensuring the timely closure of windows in AC-operated rooms. Specifically, we choose two scenarios:

Open Windows and Running ACs Scenario: Often, due to oversight, air conditioners are left running while windows are open, leading to significant energy wastage. This scenario often occurs due to oversight or a lack of awareness among building occupants.

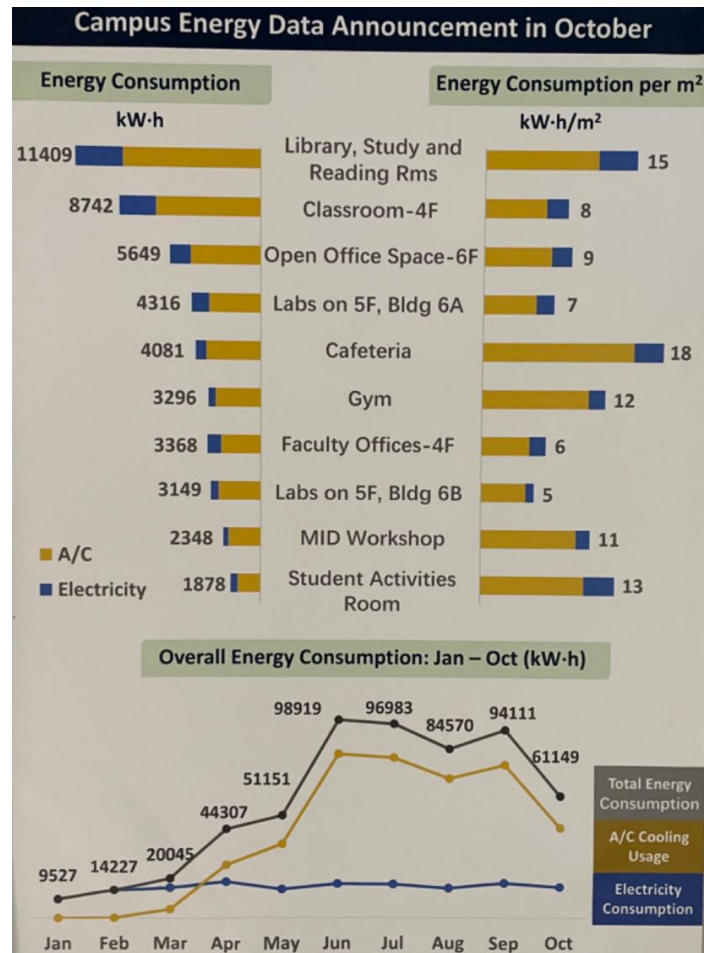


Figure 1—Campus Energy Data Announcement in October

The current reliance on manual interventions, such as students or staff adjusting the air conditioners or closing windows, has proven to be ineffective. There is a pressing need for an automated solution that can intelligently detect and address these inefficiencies.

2 HARDWARE PART - SMART SWITCH SOLUTION

Our innovative solution involves smart switches that can be installed on windows and integrated into air conditioning systems. These switches are designed to trigger signals based on their open or closed state, corresponding to the status of windows and air conditioners. When the status of a switch changes, it communicates this information to the app via TCP.

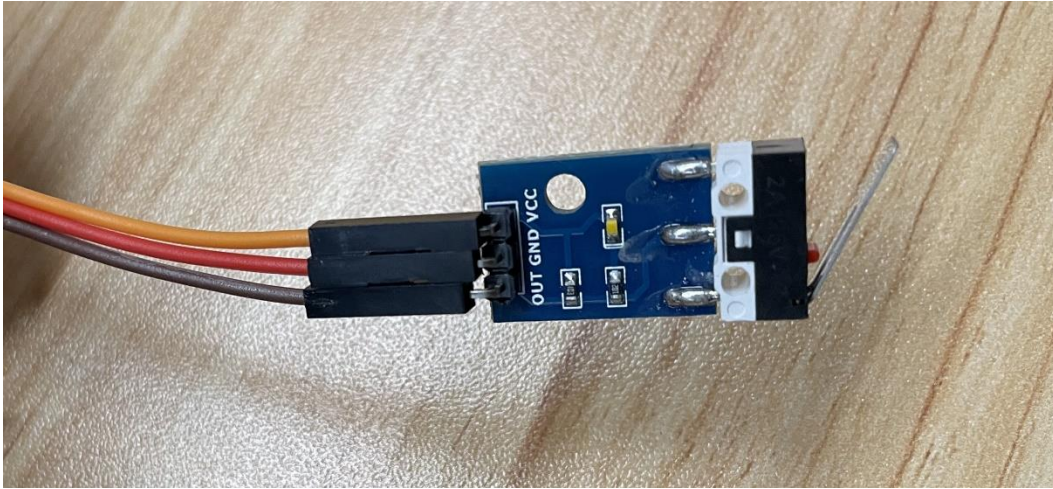


Figure 2—hardware switch device

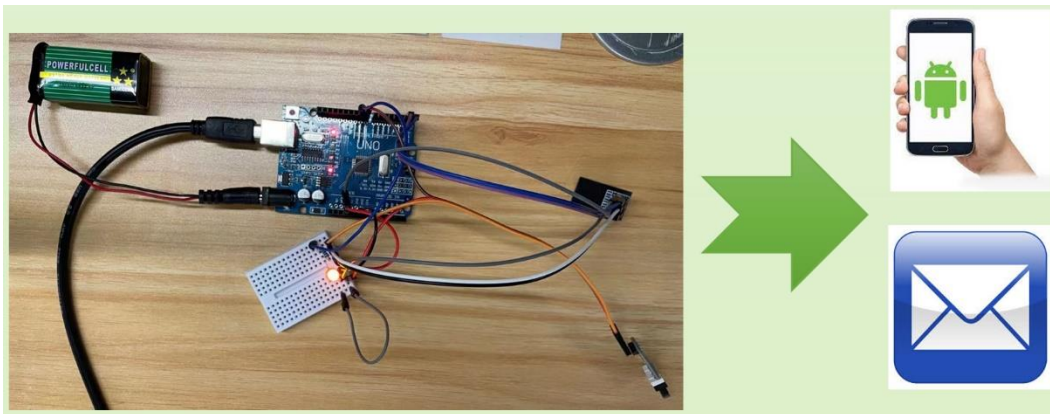


Figure 3—Monitor the switch status in real time and send notifications to the user's APP and email

3 SOFTWARE PART - SEAMLESS APP INTEGRATION

3.1 Real-Time Data Processing

The app receives and processes data from the smart switches, enabling informed and immediate action. The app's core functionality lies in its ability to analyze the status of windows and air conditioners in real-time. If it detects that both a window and the air conditioner are open simultaneously, it triggers an alert. This alert system sends notifications and emails to all users, prompting immediate action to rectify the situation. This integration not only ensures efficient energy management but also enhances user engagement and awareness.



Figure 4—email alerts

3.2 User Interface and Interaction

3.2.1 Classroom List Feature

This key feature of the app displays a list of classrooms with open windows, based on signals from the hardware switches. Users can easily identify which classrooms require attention and select up to three tasks to close the open windows.

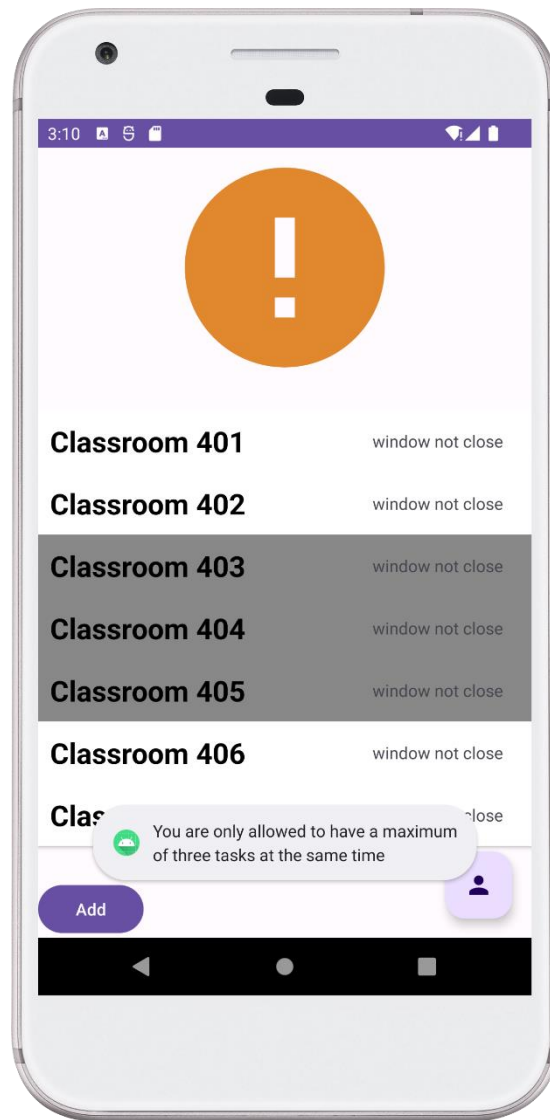


Figure 5—Classroom List

3.2.2 Tasks Management

Once a task is selected, it appears on the 'Tasks Page' with a countdown timer, emphasizing the urgency of the action. This feature is designed to encourage users to promptly close open windows, thereby preventing energy wastage.

The app dynamically updates task status. When a window is closed, and the switch signals this change, the app automatically marks the task as 'Completed'. Conversely, if the window remains open past the countdown, the task is marked as 'Incomplete' in the user's history.

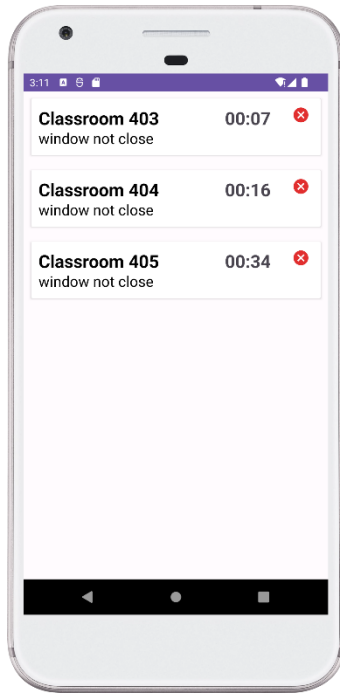


Figure 6—Tasks Page

3.2.3 Task History and Profile

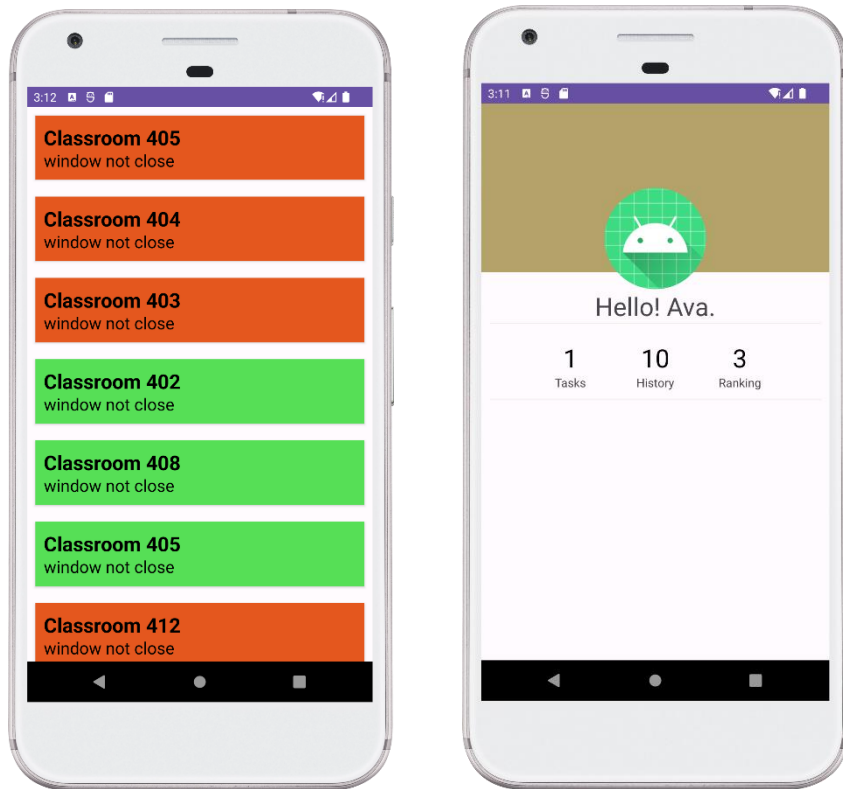


Figure 7—Task History and Profile

Users can view their pending tasks, completed and incomplete task history, and personal ranking within the app. This feature provides a comprehensive overview of individual contributions and achievements.

3.2.4 Ranking System

To further engage and motivate users, the app includes a ranking system. This system calculates user rankings based on the number of completed versus incomplete tasks, gamifying the process and encouraging community participation.

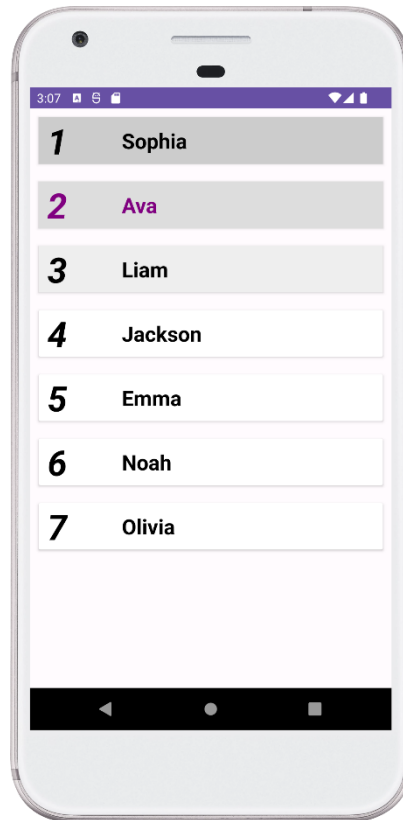


Figure 8—Ranking

The integration of this software with our smart switch hardware not only streamlines energy management but also actively engages users in energy-saving efforts. It raises awareness about energy usage and instills a sense of responsibility, ultimately fostering a culture of sustainability at GTSI.

4 BUDGET

Table 1 — Budget details

Category		Details	Total Projected Budget
Equipment and Installation	Switch Button	¥2.24 per unit	¥21.44 (<\$3)
	WiFi Module	¥5.2 per unit	
	Arduino	¥14 per unit	
	Installation Costs	¥0 (As part of students' project)	
App Development		¥0 (As part of students' project)	
Maintenance and Operations		¥0 (As part of students' project)	

All labor-related costs are set at ¥0, as tasks such as development, installation, maintenance, and operations can be incorporated into student projects like this local project. And the current cost **per set of components stands at 21.44 CNY, which is less than \$3**. However, for future large-scale deployments, the average cost per kit is expected to decrease significantly.



Figure 9 — Budget details

5 ADVANTAGES OF OUR PROJECT

1. **Cost-Effective Solution:** By using a single switch device to address both the open window and running AC scenarios, we've created a cost-effective solution. This not only saves on the budget but also simplifies implementation.
2. **User-Friendly Interface:** Our application boasts a clear and user-friendly interface, employing intuitive icons and notifications. This design ensures that users can easily understand the issue and its location at a glance.
3. **Multi-Channel Notifications:** We've implemented a multi-channel notification system, delivering alerts through the app and email. This approach guarantees that users receive timely updates, encouraging immediate action.
4. **Broad Compatibility:** Developed from scratch, our app is compatible with a wide range of devices and operating systems. Its versatility allows easy integration into various platforms, including popular ones like WeChat Mini Programs.
5. **Ease of Adoption:** The app's straightforward and intuitive design makes it easy for new users to adopt and integrate into their daily routines, enhancing its overall effectiveness and user engagement.
6. **Scalability and Potential for Future Development:** The design of our system allows for easy scalability, offering potential for future enhancements such as integrating more sensors or expanding to other energy management scenarios.

6 CONCLUSION

This project showcases an advanced and integrated approach to solving the significant issue of energy wastage at our institution. By combining smart switches and a multifunctional app, we're harnessing the power of modern technology to achieve substantial energy savings, reduce operational costs, and contribute to environmental preservation. The project stands out for its economic feasibility, ensuring scalability and long-term applicability.

Involving students in the development and maintenance phases not only adds educational value but also fosters a sense of community responsibility towards sustainable practices. This initiative is more than just a response to a current problem; it's a stepping stone towards ongoing energy conservation and sustainability efforts, setting a precedent for future initiatives within the institution.

7 EXPLORE OUR PROJECT ON GITHUB

For a more detailed insight into our project, including source codes, documentation, and updates, we invite you to visit our GitHub repository. You can explore our work and even contribute to its ongoing development. Find us on GitHub at: <https://github.com/Farengon/6300Local.git>.