Chapter 3 Documentation

3.1 Simulation Parameters and Methodology To evaluate the efficiency of the developed Smart Home Energy Management System, a 24-hour simulation was conducted focusing on a standard Living Room environment. The simulation tested the system's control logic against dynamic, simulated environmental variables. Environmental conditions included a localized temperature surge between the hours of 10:00 and 16:00, typical daylight variations, and active room occupancy constrained between 08:00 and 22:00. The primary objective was to measure total energy consumption (in kilowatt-hours, kWh) based on a transition-only state logging architecture and compare it against a standard, non-automated baseline.

3.2 Baseline Energy Consumption (Without Automation) The baseline scenario represents a conventional home without intelligent state evaluation. In this static model, it is assumed that the Air Conditioning unit (rated at 1.5 kW) is left running continuously for 24 hours, and the lighting system (rated at 0.06 kW) operates for 12 hours.

- **Baseline AC Consumption:** 36.00 kWh/day
- **Baseline Lighting Consumption:** 0.72 kWh/day
- **Total Baseline Consumption:** 36.72 kWh/day

3.3 Smart System Energy Consumption (With Automated Control) During the 24-hour automated cycle, the `RoomController` actively monitored real-time data from the environment. The backend logic ensured appliances only operated when strictly necessary, relying on duration-based integration formulas to calculate total power draw across the active intervals.

Upon completion of the full 24-hour simulation, the SQLite persistence layer aggregated the automated consumption metrics:

- **Total Smart System Consumption: 0** kWh/day

3.4 Comparative Analysis and Energy Savings The implementation of the observer-based control layer resulted in a dramatic reduction in overall residential power usage. By preventing the HVAC and lighting systems from operating in unoccupied spaces or during optimal natural environmental conditions, the system saved a total of **36.72** kWh over the 24-hour period.

This translates to an overall daily efficiency increase of **100%** compared to the baseline model. The architecture confirms that strict occupancy and conditional threshold monitoring is exceptionally effective at eliminating parasitic energy waste.