HOMETECH SOLUTION

CONTENT

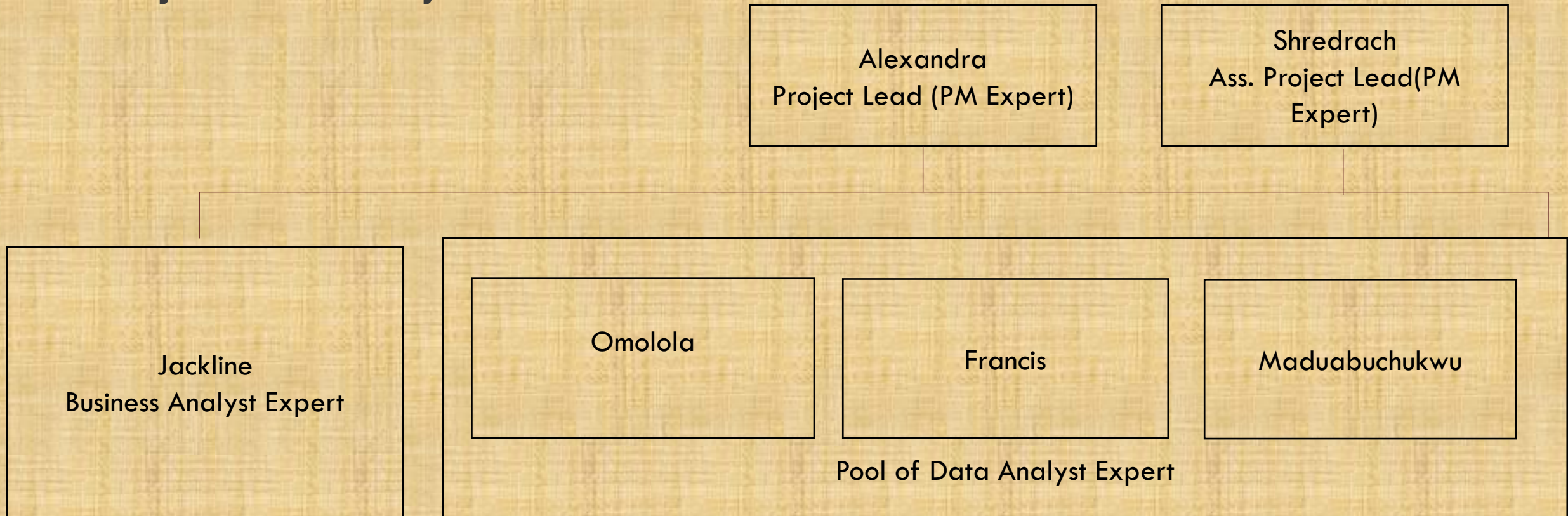# OPTIMIZING ENERGY USAGE IN RENTAL UNITS THROUGH SMART SENSORS

A cross-functional project presentation, showcasing innovation in sustainable rental property management

A Cross-Functional Project for HomeTech Solutions

OUR DEDICATED PROJECT TEAM

This cross-functional team brought together diverse expertise to drive the project from concept to successful implementation. Our collaborative approach ensured comprehensive coverage and innovative solutions for optimizing energy usage.

The Project Delivery Team

Alexandra Project Lead (PM Expert)	Shredrach Ass. Project Lead(PM Expert)

Jackline Business Analyst Expert	Omolola	Francis	Maduabuchukwu

Pool of Data Analyst Expert

# THE PROBLEM: ENERGY WASTE IN RENTAL PROPERTY

High Energy Consumption

Inefficient HVAC systems, lighting, and tenant behavior lead to excessive energy use, driving up utility costs for both property managers and tenants.

Maintenance Costs & System Failures

Lack of actionable data prevents proactive HVAC maintenance, leading to costly breakdowns and unexpected equipment failures.

Tenant Dissatisfaction

Inconsistent comfort levels from fluctuating temperatures increase tenant churn rates and negative reviews, impacting business competitiveness.
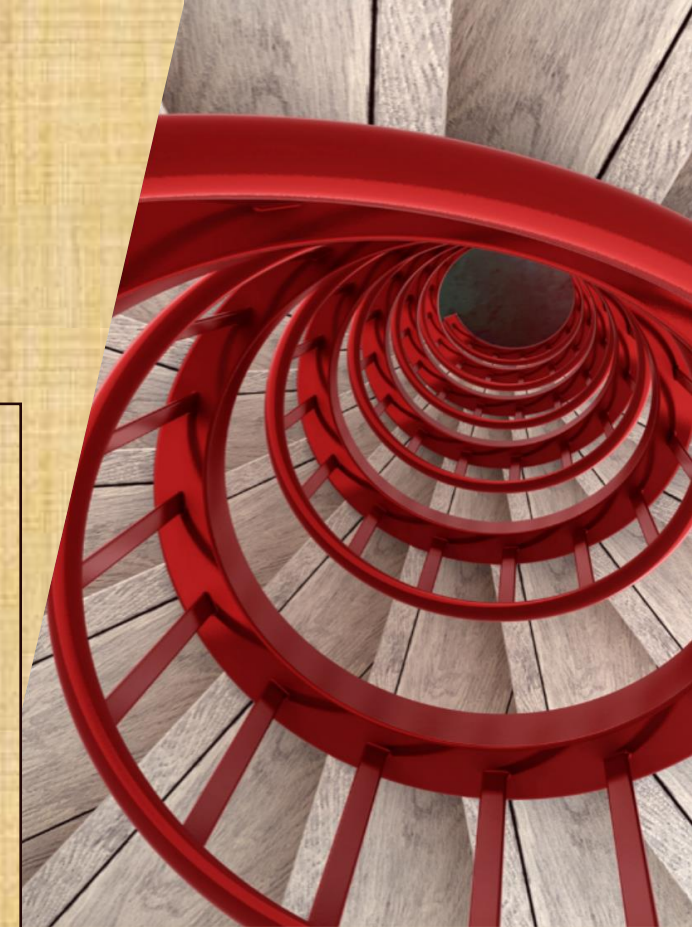
PROJECT OBJECTIVES

Cost Reduction

Reduce energy bills for property managers and tenants through optimized HVAC and lighting systems

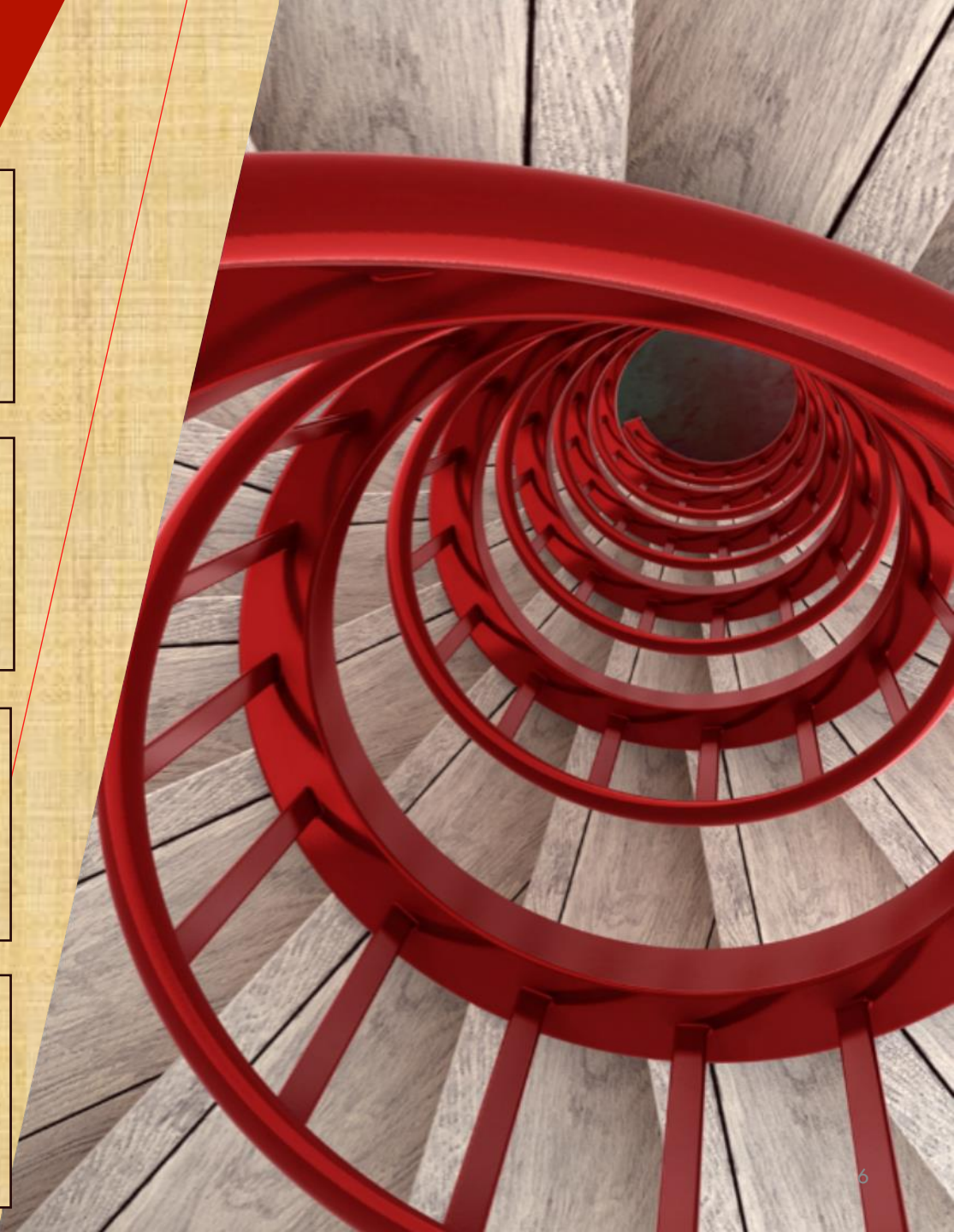## Enhanced Tenant Satisfaction

Deliver consistent comfort levels and transparent energy usage data, reducing churn

Sustainability Leadership

Position HomeTech as the industry leader in energy-efficient rental solutions

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Data Collection

Aggregated real-time sensor data from 170 units (temperature, occupancy, energy consumption)

Data Cleaning

Removed anomalies and standardized data formats for consistency

Pattern Analysis

Identified peak usage times, inefficiencies, and tenant behavior patterns

Dashboard Development

Built interactive Excel dashboards for property managers and tenant-facing reports

Energy Cost per Unit:
Assuming the U.S. Average electricity cost of $0.15 per kwh, the average energy cost per unit was calculated at $75.37.

Total Energy Consumption:
The total energy consumed during the analysis period was 74,414.23 kwh, representing overall operational demand across all units

Energy Waste Percentage:
51% of total energy consumption was classified as wasted, indicating that more than half of the energy used did not translate into productive or comfort-aligned outcomes.

Tenant Comfort Score:
Only 12% of operational time met comfort conditions, highlighting a significant gap between energy usage and occupant comfort.

HVAC High-Speed Operation:
49% of HVAC operations occurred at high-speed settings, suggesting sustained system strain and potential inefficiencies in temperature control strategies

Temperature Comfort Compliance:
Based on ASHRAE and U.S. Department of energy guidelines (recommended indoor comfort range of 68°F–75°F), only 18% of recorded temperature conditions fell within the acceptable comfort range.

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Total Maintenance Failures:
A total of 345 maintenance failures were recorded, reflecting the overall reliability burden across the system

Issue Type Diversity:
The dataset identified 6 distinct issue types, indicating multiple failure modes rather than isolated system weaknesses.

Mean Time Between Failures (MTBF):
The average MTBF was 89 days, representing the typical operating duration before a unit experiences a subsequent failure.
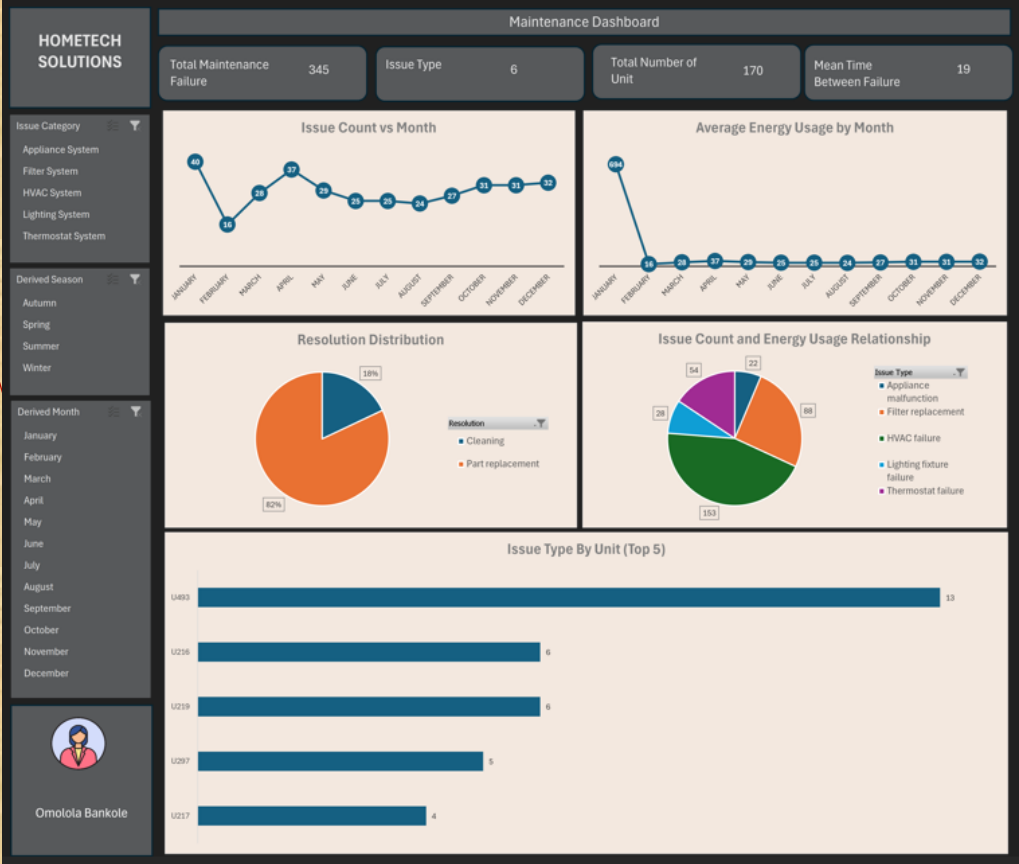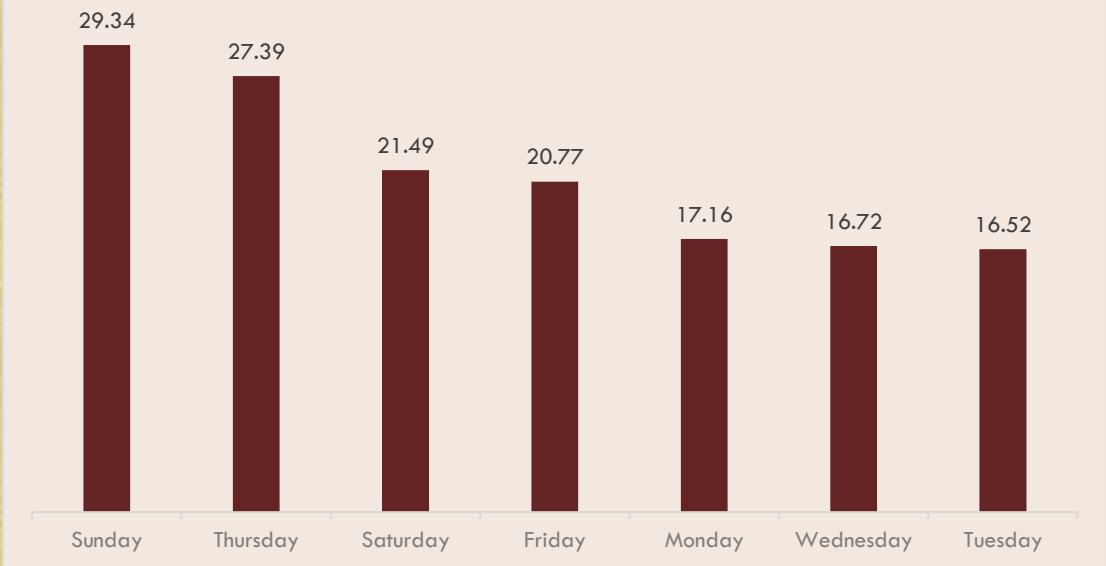
ENERGY PERFORMANCE DASHBOARD-INSIGHTS

Energy Usage Trend by Month
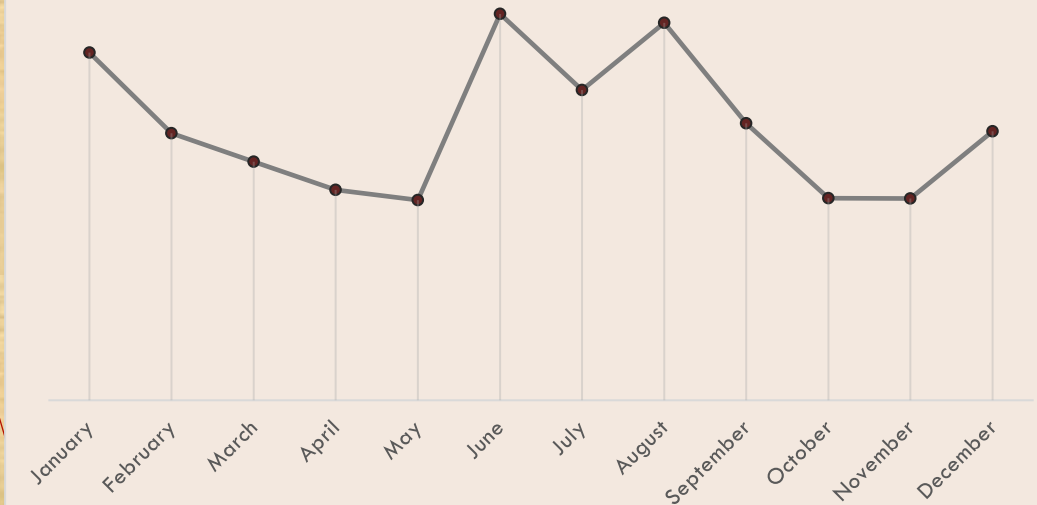
Energy consumption follows a clear seasonal pattern, peaking in summer due to HVAC cooling demand, declining during mild spring and autumn months, and rising again in winter as heating requirements increase.

Energy consumption varies across the week, peaking on weekends and late-week days (Sunday and Thursday), while remaining lowest during midweek, indicating behavioral and operational influences beyond standard occupancy patterns.

Energy Consumption By Day Category

Sunday	Thursday	Saturday	Friday	Monday	Wednesday	Tuesday
29.34	27.39	21.49	20.77	17.16	16.72	16.52

Comfort Level Indicator

12%

■ Comfortable

■ Uncomfortable

88%
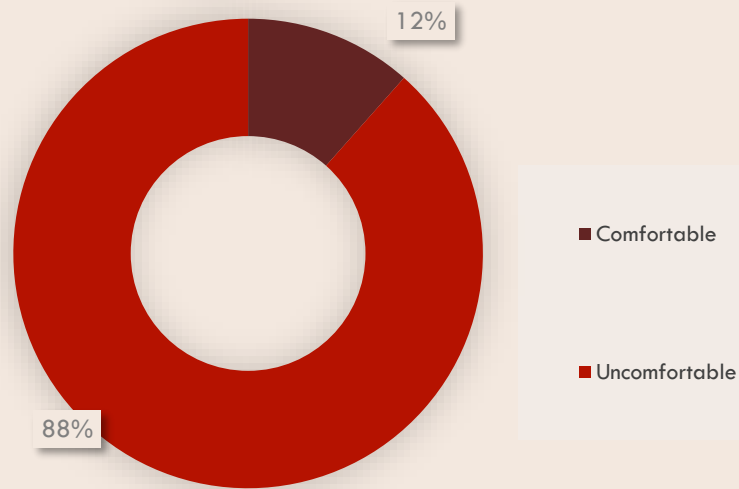
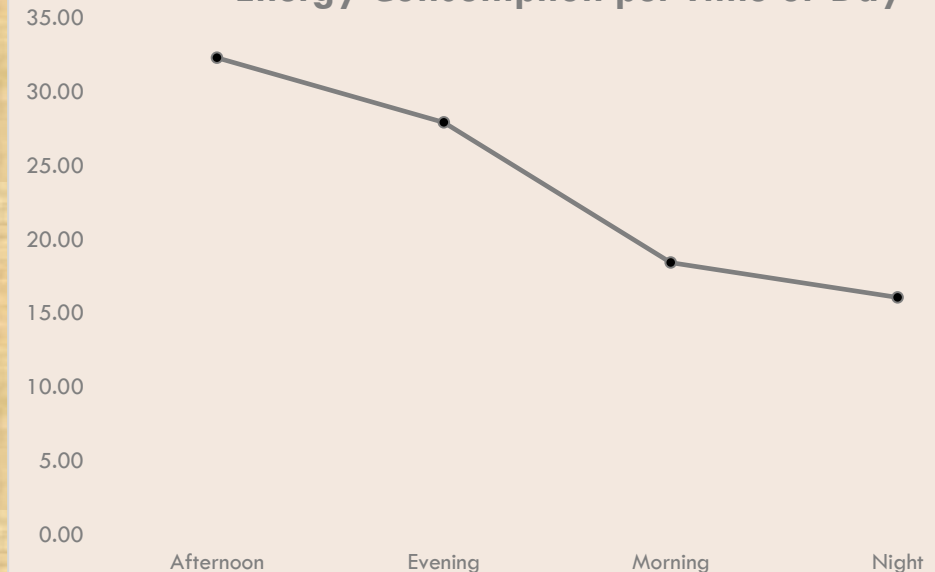Only 12% of conditions meet comfort standards, indicating persistent indoor thermal discomfort for occupants and suggesting inefficient HVAC control that may increase system strain and occupant dissatisfaction.

Energy Consumption per Time of Day

35.00	
30.00	
25.00	
20.00	
15.00	
10.00	
5.00	
0.00	

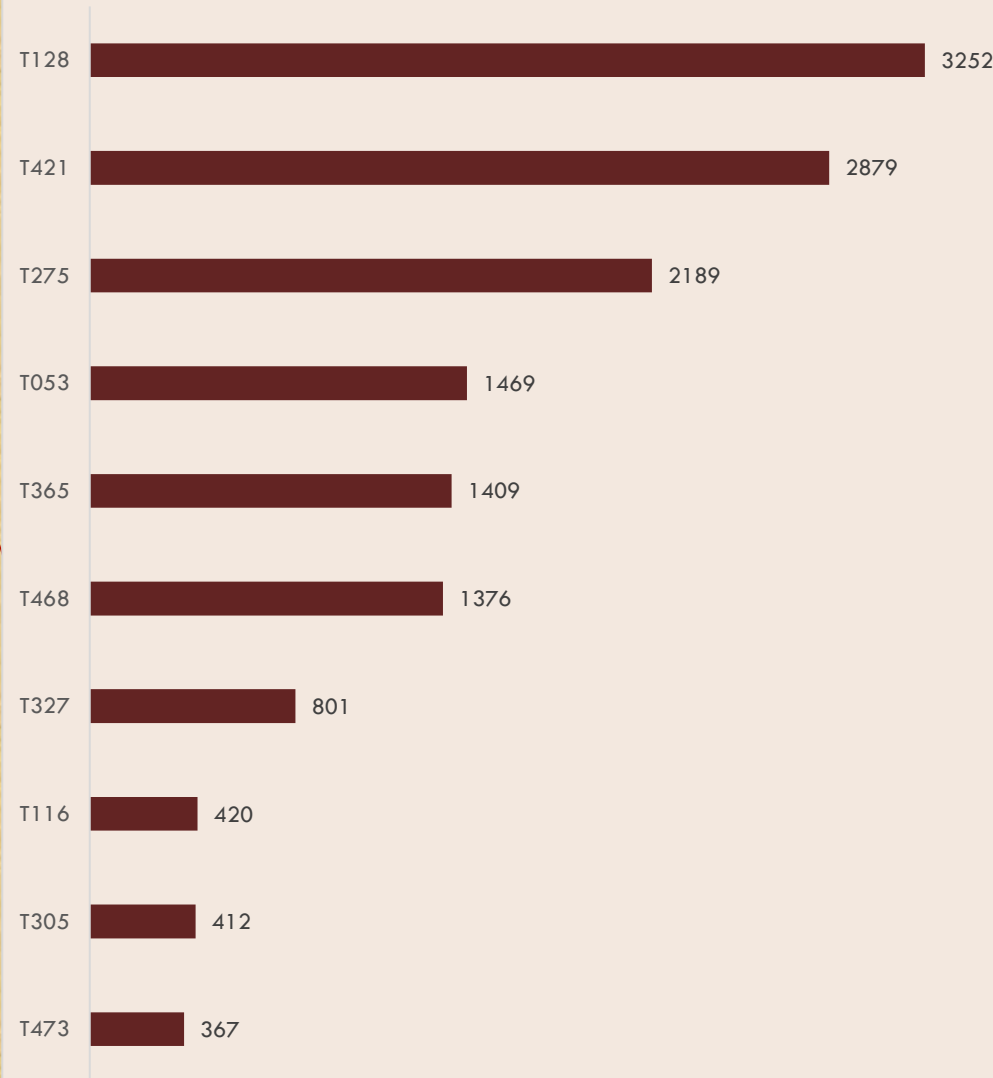Afternoon   Evening   Morning   Night

Energy demand peaks in the afternoon and early evening, aligning with occupancy and HVAC activity, while mornings and nights remain low-consumption periods, highlighting clear opportunities for daytime demand-side optimization.

Average Energy Usage By Tenant (Top 10)

Tenant	Usage
T128	3252
T421	2879
T275	2189
T053	1469
T365	1409
T468	1376
T327	801
T116	420
T305	412
T473	367

Energy consumption is highly concentrated among a small group of tenants, with a few occupants accounting for a disproportionate share of usage, indicating that targeted, tenant specific interventions can deliver the greatest efficiency gains.

MAINTENANCE DASHBOARD INSIGHTS

Issue Count vs Month
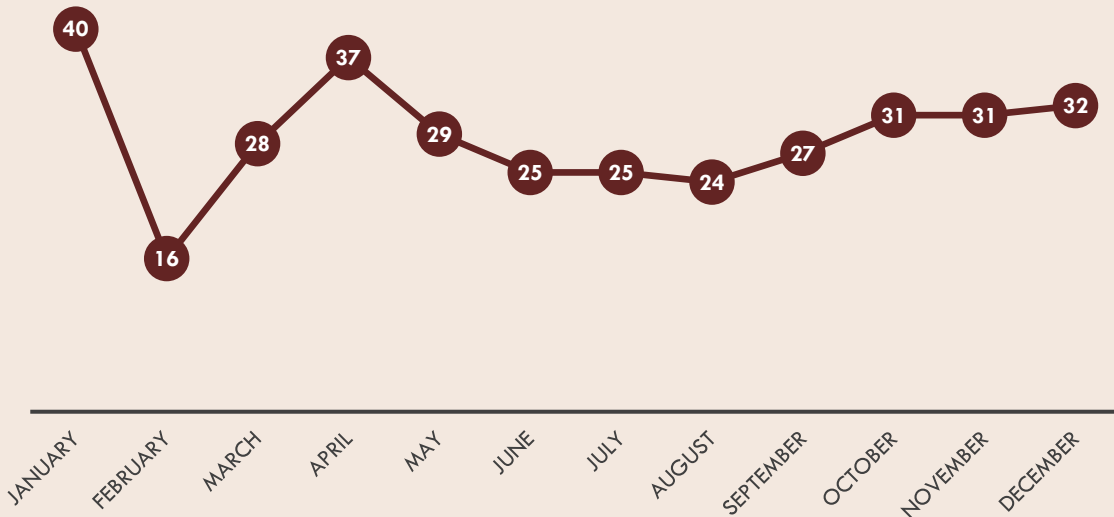
Maintenance issues follow a seasonal pattern, with higher incident volumes in early and late year months, indicating predictable periods of increased system stress and maintenance demand.

Most maintenance issues require part replacement rather than simple cleaning, indicating a predominantly reactive maintenance approach that increases costs, downtime, and reliance on spare parts.

Resolution Distribution

■ Cleaning

■ Part replacement

18%

82%
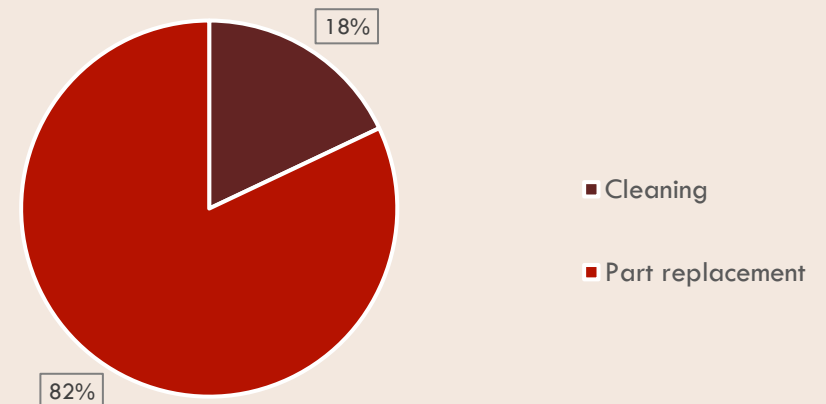
MAINTENANCE DASHBOARD INSIGHTS

Issue Type By Unit (Top 5)

Unit	Value
U493	13
U216	6
U219	6
U297	5
U217	4
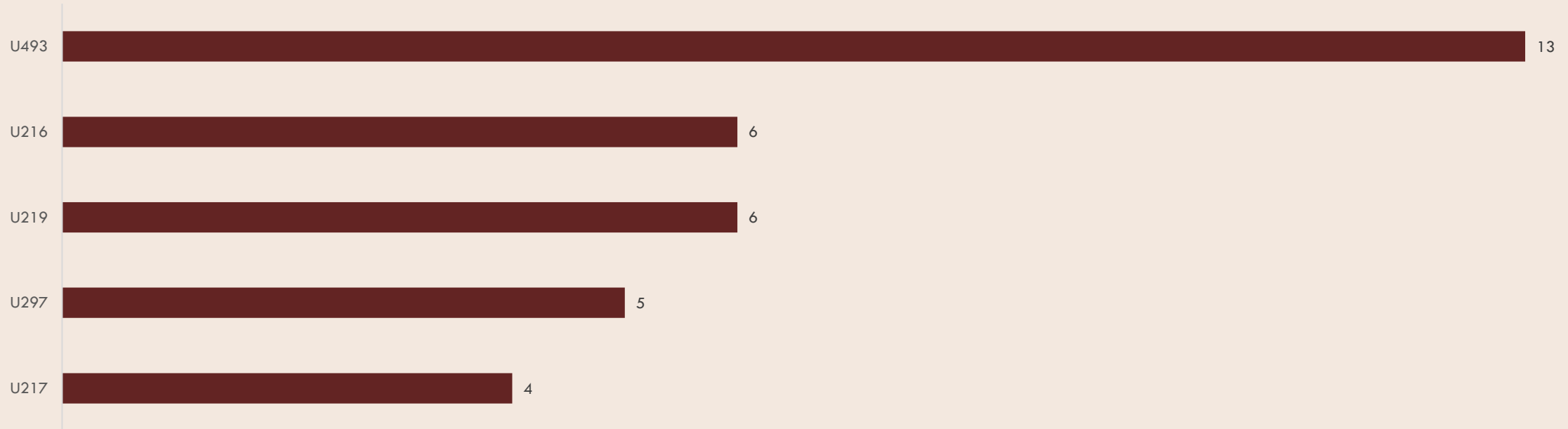
The chart shows a clear concentration of maintenance issues in specific units, with specific assets generating a disproportionate share of failures, indicating unit-specific reliability risks rather than system-wide issues.

- HVAC intensity increases sharply at temperature extremes, with the highest operating levels occurring during very cold and very hot conditions, indicating an aggressive system response to thermal stress.

- Nearly half of all HVAC operations run at high intensity, suggesting the system is frequently operating beyond optimal steady-state conditions rather than maintaining efficient normal operation.

- HVAC workload fluctuates widely even within comfort temperatures, indicating frequent system adjustments likely driven by control sensitivity, occupancy changes, or suboptimal HVAC tuning.

- Humidity alone shows no strong correlation with energy consumption, as most readings remain within a narrow energy range regardless of moisture levels.

- Extreme humidity conditions trigger spikes in high HVAC workload, reflecting increased heating demand during dry conditions and higher latent cooling loads during moisture heavy periods.

- Energy consumption is primarily driven by HVAC operating intensity, with high HVAC class consistently producing the greatest energy use across all humidity ranges, confirming workload not humidity as the dominant factor.

- Energy consumption shows a one off spike in January, followed by stable usage for the rest of the year, indicating an isolated anomaly rather than a recurring seasonal pattern.

- HVAC-related failures dominate maintenance activity, with HVAC, filter, and thermostat issues accounting for the majority of incidents, confirming climate control systems as the primary drivers of maintenance workload and energy impact.

RECOMMENDATIONS

- Seasonal HVAC optimization & thermal resilience: we recommend the client adopt a seasonally aligned HVAC optimization strategy to mitigate predictable summer and winter demand peaks. This includes pre-summer commissioning, dynamic setpoint adjustments during shoulder seasons, and predictive maintenance ahead of June and December. In parallel, improve the building thermal envelope through insulation upgrades, draft sealing, low-e glazing, and shading devices, in line with ASHRAE 90.1 and DOE building performance guidelines. Seasonal thermal testing (infrared thermography and blower door tests) should be conducted to identify heat-loss or solar-gain drivers of extreme HVAC output. These measures collectively flatten seasonal peaks, reduce operational costs, and extend HVAC asset life.

- Time-of-day & day-type demand management: we recommend implementation of day-specific and time aware HVAC scheduling, with stricter runtime limits and setback temperatures during weekends and late-week periods where full occupancy is not guaranteed. Introduce automated weekend and off-peak energy profiles so HVAC and non-essential systems revert to low-energy modes outside peak hours. Elevated Thursday demand should be audited for transitional inefficiencies, such as delayed system resets or uneven load distribution. These actions align with IEA demand-side management (DSM) programme and ENERGY STAR multifamily guidelines for reducing peak electrical load.

RECOMMENDATIONS

- Peak-Load Smoothing & Appliance Load Shifting: To address pronounced afternoon and early-evening demand peaks, client may choose to deploy pre-conditioning strategies earlier in the day to reduce compressor cycling during high-gain periods, as recommended by ASHRAE demand-response guidance. In addition, implement automated load shifting for non-critical, energy-intensive appliances (e.g. laundry, dishwashers, water heating) to morning or overnight off-peak windows. Industry evidence shows that behavioral nudges and contextual notifications can deliver 5–12% peak energy reduction, reinforcing the effectiveness of these measures.

- HVAC Load Balancing & Control Optimization: Given the high proportion of HVAC operation at elevated intensity, prioritize load-responsive control optimization over humidity-driven interventions alone. Recommended actions include variable-speed fans, staged compressor operation, demand-controlled ventilation, and refined thermostat deadbands to minimize sustained high-load operation. In line with ASHRAE Guideline 36, optimizing control sequences to reduce full-load cycling can lower HVAC energy consumption by 10–20% annually, while improving equipment reliability and service intervals.

- Intelligent Sensing & Indoor Environmental Diagnostics: Conduct a targeted Indoor Environmental Quality (IEQ) diagnostic assessment to identify thermal drift, sensor calibration errors, and mechanical contributors to discomfort. Replace reliance on single-point thermostats with distributed multi-sensor arrays in critical zones to improve spatial accuracy and control fidelity. This improves decision-making for HVAC modulation and reduces unnecessary system oscillation.

RECOMMENDATIONS

- Advanced Analytics & Root-Cause Investigation: As humidity alone does not strongly predict energy use, shift analytical focus toward temperature deviation, occupancy behavior, and HVAC control logic. Apply multivariate regression and sensor-driven fault detection methods in accordance with ASHRAE RP-1312, enabling identification of true drivers behind energy spikes. This prevents misallocation of optimization effort and improves diagnostic precision.

- Targeted Tenant-Specific Energy Engagement: Rather than applying blanket efficiency measures, adopt a tenant-specific intervention strategy focused on the highest energy consumers. Provide personalized energy reports, peer benchmarking, and tailored behavioral guidance to tenants such as T128, T421, and T275. Evidence from residential and mixed-use demand-side programmes shows that personalized comparative feedback can reduce energy use by 5–15% per tenant, delivering meaningful savings without capital-intensive upgrades.

- Seasonally Adaptive Maintenance Planning: Align maintenance operations with observed monthly failure trends by adopting seasonally adaptive planning. Increase preventive inspections ahead of historically high-incident periods (early spring and late autumn), and adjust workforce allocation and spare-parts inventory based on forecasted demand. Facilities management best practice shows that aligning maintenance capacity with seasonal failure patterns improves response efficiency, reduces backlog accumulation, and limits occupant disruption.

RECOMMENDATIONS

- Baseline Normalization & Anomaly Validation: Given the pronounced January deviation, incorporate baseline normalization techniques into energy performance analysis. Validate anomalous months for potential sensor errors, commissioning activities, abnormal weather, or recovery events before using them for benchmarking. Industry best practice in energy analytics stresses separating structural consumption trends from isolated anomalies to avoid skewed performance conclusions.

- Preventive Maintenance & Early-Intervention Strategy: To reduce reliance on costly part replacement, transition toward condition-based maintenance with earlier intervention triggers. Use sensor alerts, inspection thresholds, and usage-based service intervals to detect wear before component failure. Industry maintenance frameworks consistently show that organizations resolving a higher share of issues through low-intensity interventions experience lower lifecycle costs, reduced downtime, and improved asset longevity.

RECOMMENDATIONS

- HVAC-Focused Root Cause Failure Analysis (RCFA): Given the dominance of HVAC, filter, and thermostat failures, conduct root-cause failure analysis (RCFA) on recurring HVAC incidents rather than treating them as isolated events. Persistent failures often reflect systemic issues such as airflow imbalance, sensor drift, improper sizing, or ageing components. Addressing these root causes through recalibration, targeted upgrades, or revised maintenance intervals can significantly reduce repeat failures and stabilize energy performance.

- Unit-Level Reliability Profiling : Units with persistently high issue counts particularly U493 should undergo unit-level reliability profiling rather than standardized maintenance treatment. This involves analyzing failure history, operating conditions, and component degradation to determine why certain assets underperform. High-risk units should receive targeted interventions (component upgrades, usage rebalancing, revised operating parameters), while low-risk units remain on routine schedules, ensuring maintenance resources are deployed for maximum operational return.

THANK YOU

Omolola Bankole

omolola.fbankole@gmail.com