Test Plan for Efficient ADU Design Simulation

CS 4632 - Modeling & Simulation
Milestone 4 - Model Implementation
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1 Introduction

This document outlines the **test plan** for the **Efficient ADU Design Simulation**, ensuring that the **discrete-event simulation** correctly evaluates **ADU feasibility, energy efficiency, and cost-effectiveness** while adhering to zoning regulations.

Objectives:

- Ensure that **ADU placement validation** accounts for property constraints
- Validate **energy efficiency computations** against theoretical values
- Test **cost estimator accuracy** using standard material and labor costs
- Verify that the **optimization module** correctly suggests **improvements**

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2 Test Cases and Validation Criteria

Test Case 1: Property Constraint Validation

Test Objective: Ensure that the simulation correctly identifies **valid and invalid** ADU placements.
- **Input:** Property size, slope, zoning restrictions
- **Expected Output:** ADUs should only be placed in areas meeting zoning laws.

Pass Criteria: The simulation correctly rejects ADUs placed on **steep slopes** or in **restricted zones**.

Test Case 2: Energy Efficiency Calculation

Test Objective: Validate energy efficiency calculations based on **insulation, solar exposure, and HVAC systems**.
- **Input:** ADU floor plan, insulation type, HVAC system specs, and climate data
- **Expected Output:** The simulation should match theoretical energy consumption predictions within a **5% margin**.
 Pass Criteria: Energy model outputs are consistent with **EnergyPlus/OpenStudio benchmarks**.

Test Case 3: Construction Cost Estimation

Test Objective: Ensure that the cost estimator correctly calculates ADU construction costs.
 - **Input:** Material costs, labor rates, ADU square footage
 - **Expected Output:** The cost estimator should output accurate **total construction costs** within **industry-standard margins**.
 Pass Criteria: Estimates align with **real-world ADU cost data**.

Test Case 4: Optimization Module

Test Objective: Confirm that the **optimization module** suggests **optimal ADU configurations**.
 - **Input:** Multiple ADU designs, cost vs. energy trade-offs
 - **Expected Output:** The optimizer should **recommend the best ADU design** for a given property.
 Pass Criteria: The module ranks ADUs based on **cost, energy, and feasibility metrics**, favoring **high-efficiency, low-cost solutions**.

Test Case 5: Simulation Performance Testing

Test Objective: Measure **run-time performance** for different simulation sizes.
 - **Input:** 10, 100, 1000 simulation iterations
 - **Expected Output:** The simulation should scale **efficiently** and complete within reasonable execution times.
 Pass Criteria: Execution time remains within acceptable limits for large simulations.

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3 Testing Tools & Frameworks

Unit Testing: pytest (for function-level tests)
Performance Testing: time and cProfile (for run-time analysis)
Data Validation: Matplotlib (for result visualization), OpenStudio (for energy calculations)

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4 Summary & Next Steps

This test plan provides a **structured framework** for validating the **accuracy and efficiency** of the ADU simulation model. Future work includes **fine-tuning energy calculations, expanding test cases, and refining the optimization algorithm**.

Next Steps:

- Implement **automated test scripts**
- Expand dataset for validation
- Improve optimization heuristics