# Problem Definition & Design Thinking

**Title:**

Holistic Building Performance Intelligence for Sustainable Design & Operations

## Problem Statement

Buildings contribute roughly 40% of global energy use and nearly one-third of $CO_2$ emissions. Yet, many projects underperform their sustainability targets because performance insights are siloed between design and operations. The core challenge is to deliver an end-to-end intelligence platform that guides architects, engineers, and facility managers to design, commission, and operate truly high-performance buildings—optimizing energy, comfort, and indoor environment across the full lifecycle.

### Target Audience

- **Design Teams:** Architects & MEP engineers crafting high-efficiency buildings
- **Operations Teams:** Facility managers driving day-to-day energy and comfort optimization
- **Sustainability Advisors:** Consultants and certification bodies (LEED, BREEAM, WELL)
- **Urban Innovators:** Planners and smart-city developers integrating building data at scale
- **Academia:** Students and researchers in civil, environmental, and architectural engineering

## Objectives

1. **Predictive Simulation:** Embed powerful, rapid energy-thermal-lighting models early in design to flag inefficiencies before construction.
2. **Lifecycle Feedback Loop:** Bridge the gap between as-designed and as-built through commissioning and ongoing validation.
3. **Real-Time Intelligence:** Fuse IoT sensor feeds with AI analytics to continuously monitor and auto-tune systems.
4. **Actionable Insights:** Surface prioritized, cost-benefit–ranked recommendations for both designers (e.g., façade tweaks) and operators (e.g., setpoint adjustments).
5. **Seamless Integration:** Leverage BIM workflows and open APIs to plug into existing tools and data streams.

## Design Thinking Approach

**Empathize :**

- **Pain Points:** Steep learning curves on simulation software; fragmented handoff between design and facilities; high energy bills from missed performance assumptions.
- **User Interviews:** Collected stories from architects who had to redo designs after discovering thermal comfort issues in mockups, and from facility teams scrambling to troubleshoot chronic HVAC faults.

## Define:

A unified “Digital Twin” platform that couples rapid parametric simulations with live sensor data—providing a continuous performance dashboard and an AI coach that speaks the language of each stakeholder.

## Ideate:

- **3D + IoT Hub:** Connect Rhino/Ladybug or Revit models to real-world sensor feeds in the cloud.
- **AI Performance Coach:** Natural-language alerts like “South-facing windows are causing overheating—consider adding shading fins.”
- **Scenario Compare:** Toggle between design alternatives to see energy, daylight, and comfort trade-offs in seconds.
- **Certification Mode:** Auto-generate LEED/WELL scoring projections and documentation.

## Prototype:

- **Tools:** Integrate Ladybug Tools for climate analysis, IES VE for detailed HVAC runs, Grafana for live dashboards.
- **Features:**
    - Rapid “what-if” slider for envelope and glazing parameters
    - Live energy use and comfort index plots
    - AI-driven fault detection and setpoint optimization

## Test:

Pilot with three firms on two project types (office tower and school building) over 8 weeks:

- **Metrics:** Simulation vs. field measurement deviation; time saved in analysis; user satisfaction scores.
- **Feedback Focus:** Clarity of recommendations; ease of model updates; integration pain points.