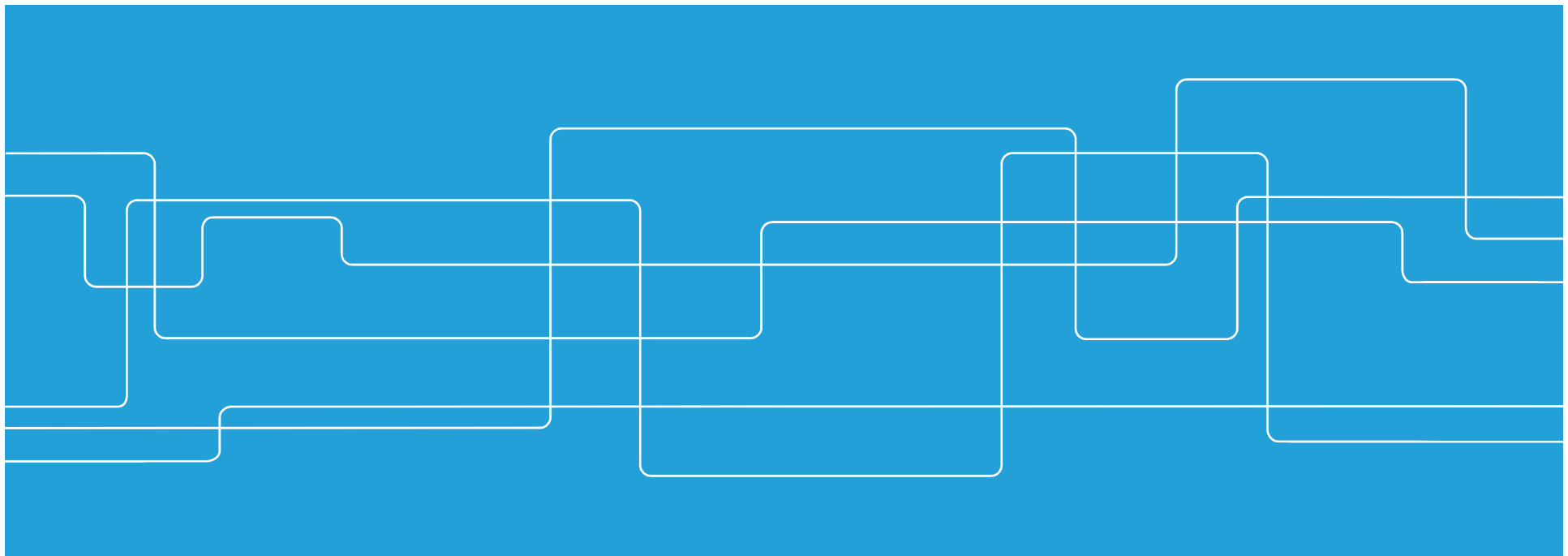




A Systematic Approach to Real-Time Integrated Energy Performance and Monitoring





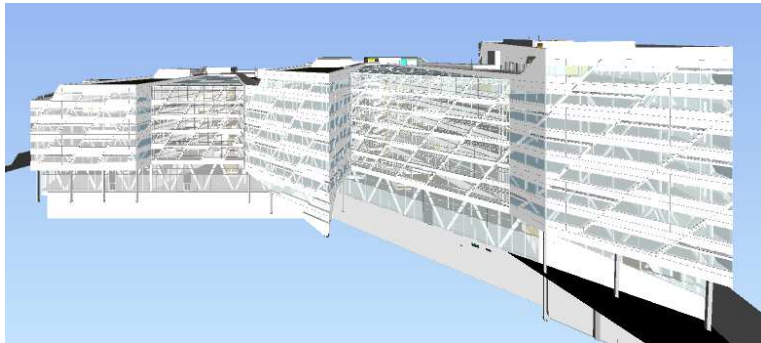
A little info about myself:

- MS in Sustainable Energy and Resource Recovery
- 3 years experience in HVAC design
- B.E. in Mechanical Engineering

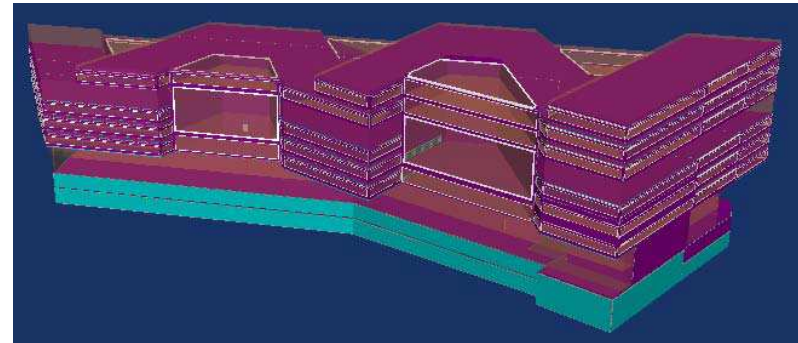


1. Introduction

- Humlegården Project – Swedbank HQ, Sundbyberg
 - Gross area 45,000 m²(offices, restaurants, etc...)
 - Miljöbyggnad Guld (50 kWh/m²)
 - Detailed measurements on a system & zone level
 - Real-time visualization Green Fingerprint



3D model



IDA model

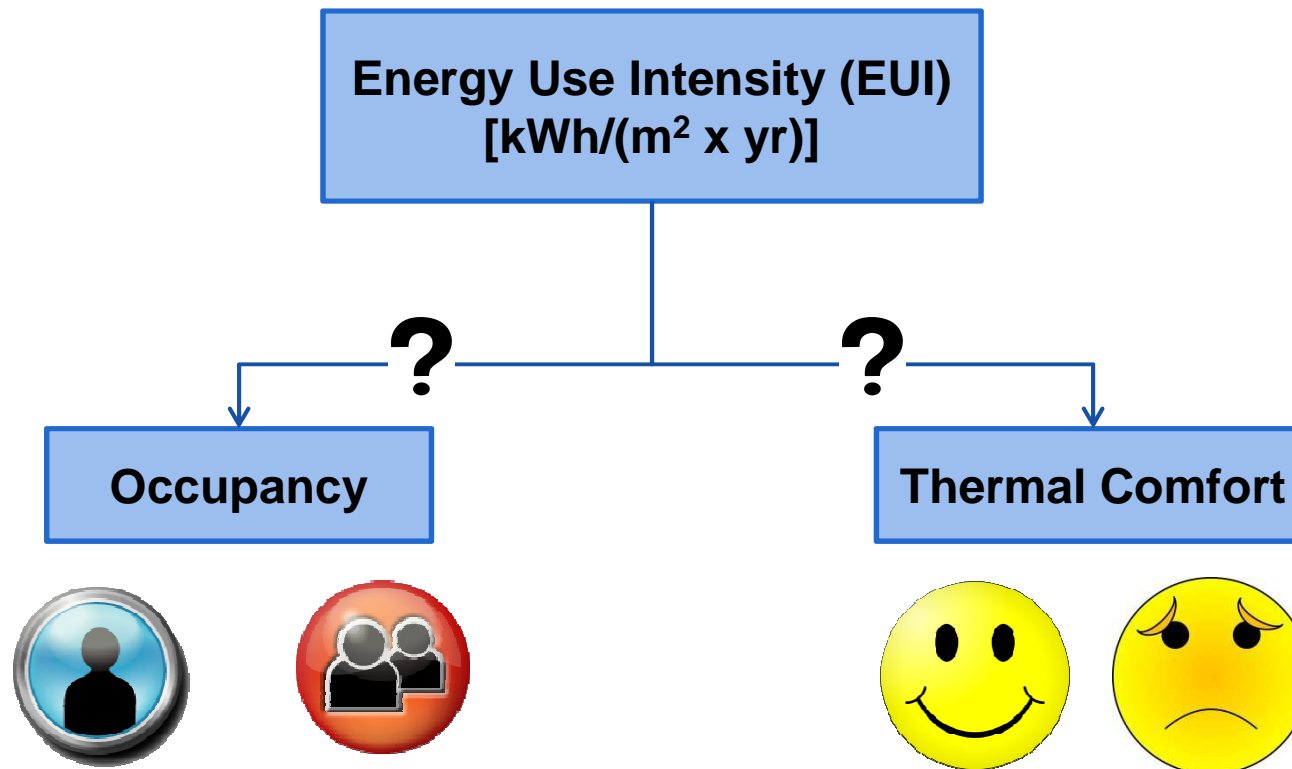


2. Objectives

1. Novel criterion for assessing buildings' energy performance; one that takes into account occupant satisfaction!
2. Key parameter selection for fault detection and diagnosis
3. Online auto-tuning simulation model
4. Real-time visualization
5. Off-line predictive control and optimization

2.1 Novel Criterion

How are buildings being assessed nowadays?

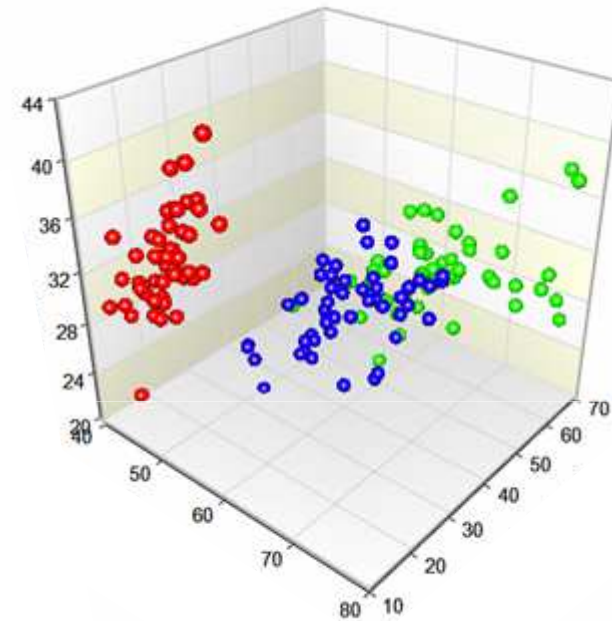




2.1 Novel Criterion

Need to consider:

- Quality of service provided
 - Thermal Comfort
 - Productivity
- Environmental Impact
- Performance
- Service Efficiency





2.2 Key Parameter Selection

A detailed simulation model of a building entails thousands of parameters

To obtain an accurate representative model these parameters need to be tuned

Brute-Force tuning of 156 such parameters (screened from 3k+, min-max) requires $5 \cdot 10^{52}$ simulations (roughly $2 \cdot 10^{28}$ lifetimes of the known universe!)

Solution: Experience helps!



2.2 Key Parameter Selection

Whole Building

- Windows U-Value
- Glazing Solar Heat Gain Coefficient
- Blind additional resistance

Zone

- Air Leakage
- Thermal Bridges
- Temperature setpoints
- CO₂ setpoints

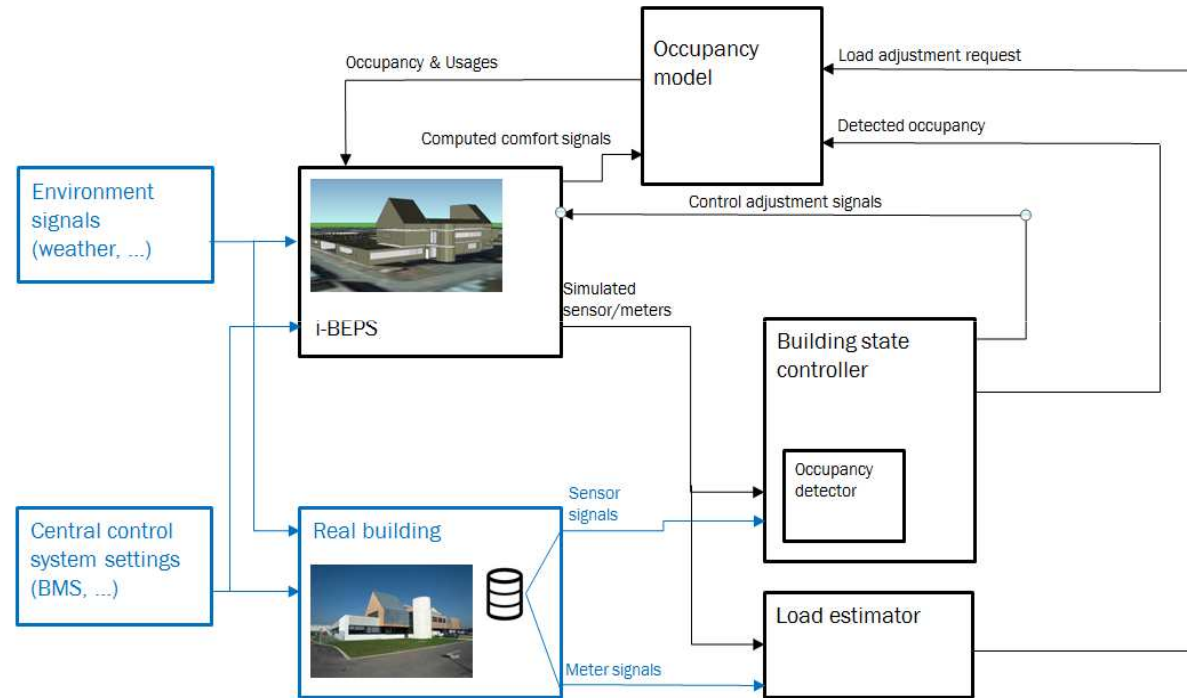
AHU

- Heating Capacity
- Cooling Capacity
- Heat Recovery Efficiency

2.3 Auto-Tuning

Layered approach:

1. Real-time state adjustment control



2. On-line key parameter optimization

3. Off-line model adjustments

2.4 Real-Time Visualization



Effects on energy consumption?



2.5 Predictive Control & Optimization

- Manual FDD
- Automatic alarm signaling
- Short-term and long-term forecasting
- What-if scenarios and retrofitting options
- Testing control strategies
- ...and more

Questions?

