

# Compliance vs Performance modelling

*Repurposing a certification model for better design stage performance estimates*

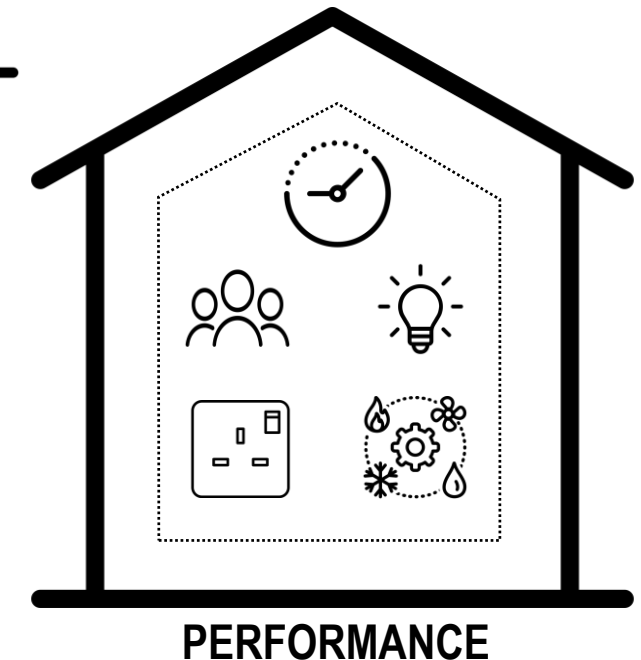
(as per CIBSE TM54)

Nishesh Jain

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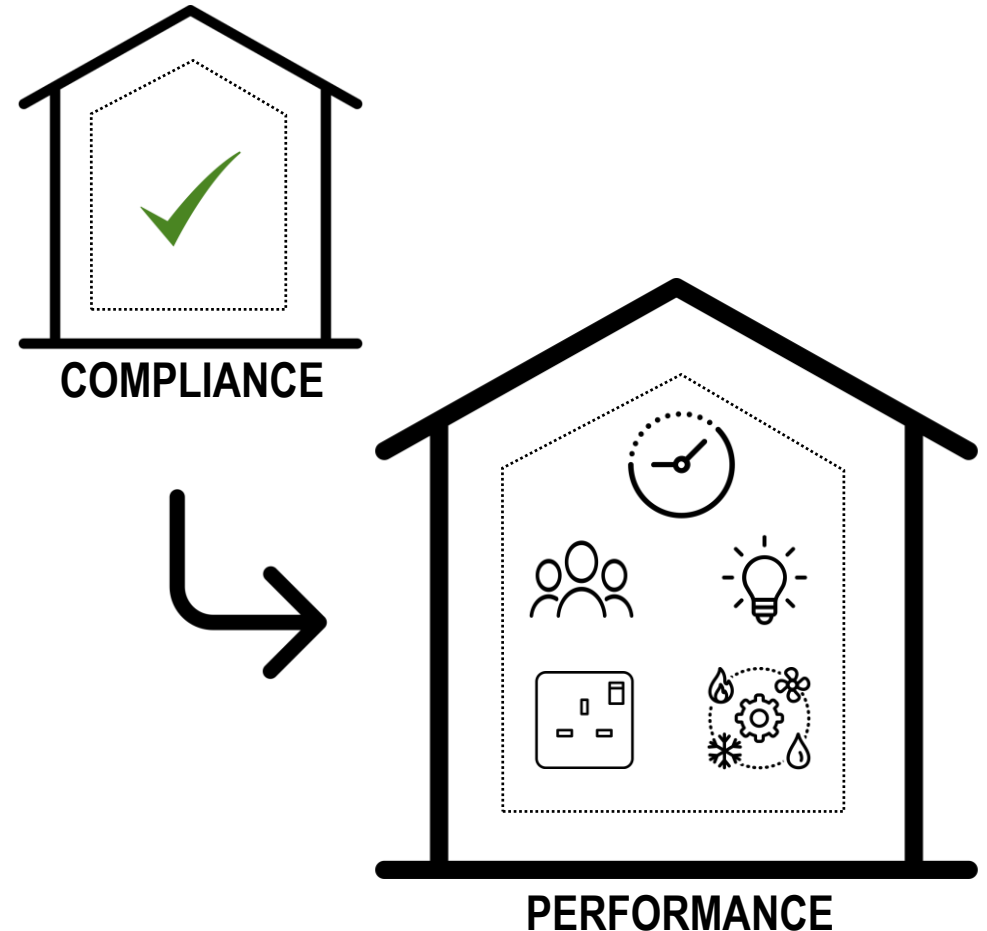
[n.jain@ucl.ac.uk](mailto:n.jain@ucl.ac.uk)

23<sup>rd</sup> June 2020



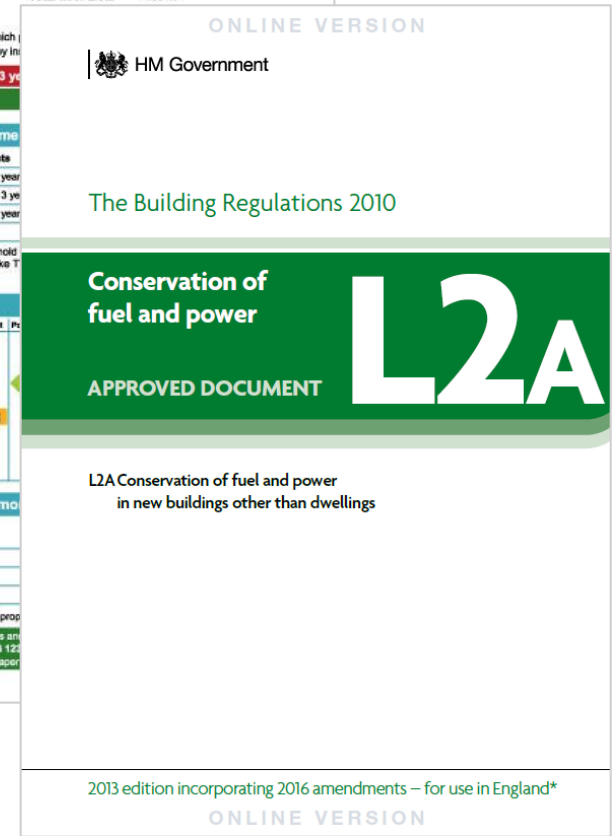
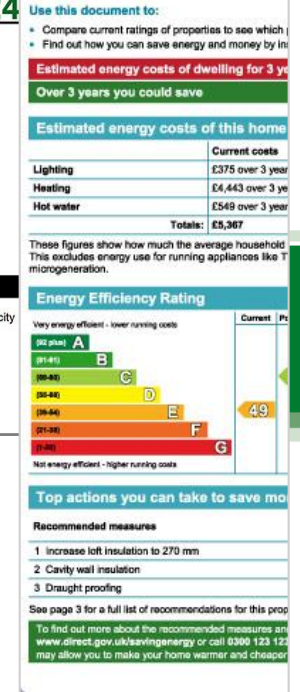
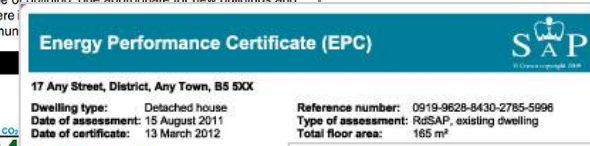
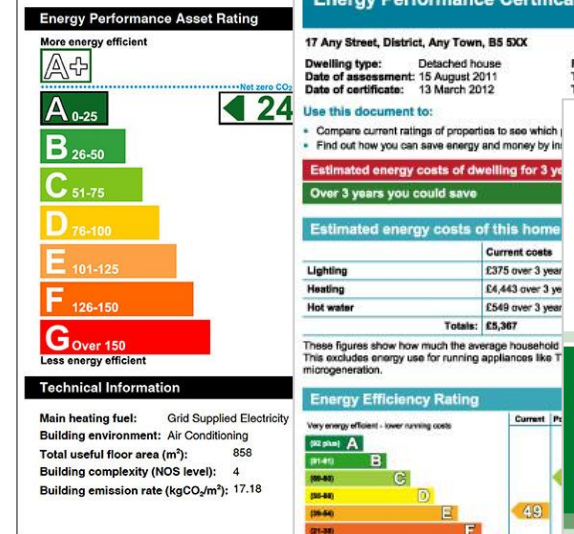
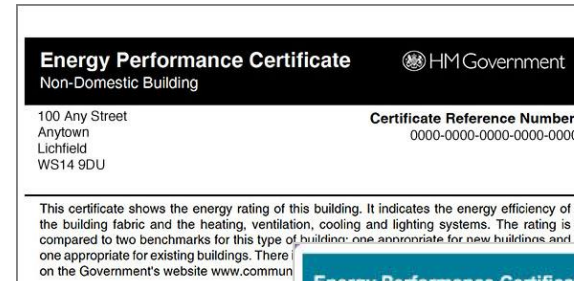
# Content

1. Background on compliance vs performance modelling
2. TM54 approach and requirements
3. Repurpose a certification model to a performance model, in accordance with TM54
4. TM54 recommended calculations and results

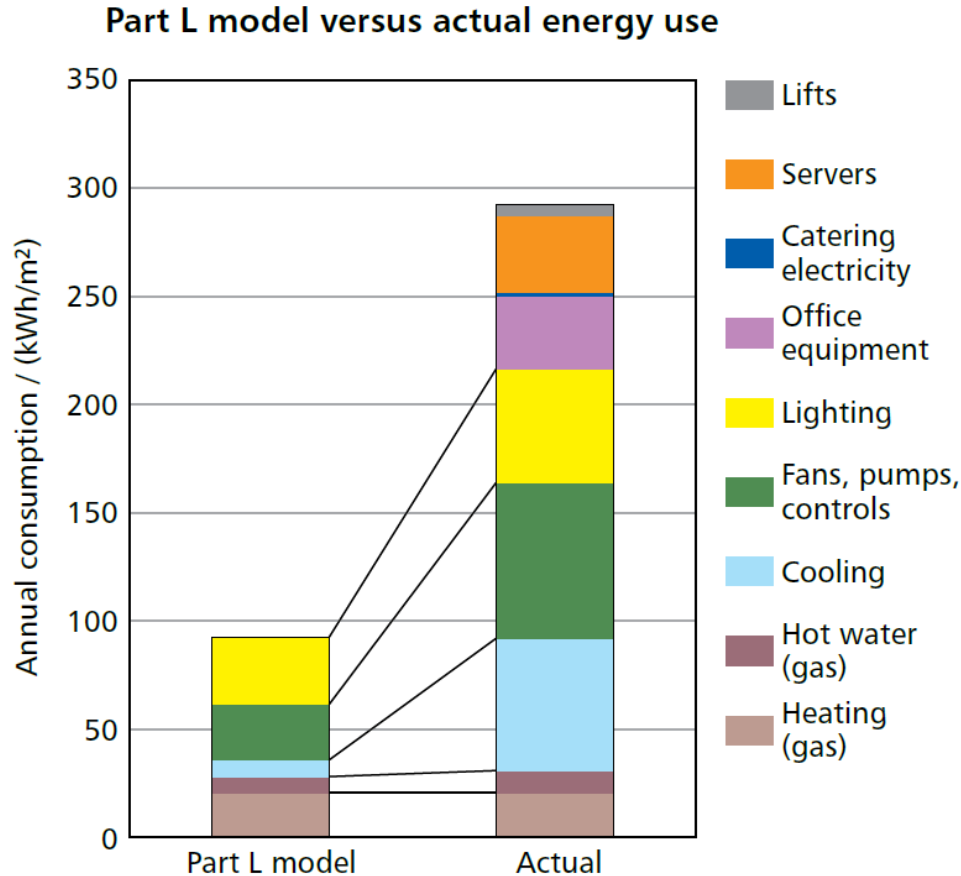


# Compliance Modelling

- Created for comparative assessments and benchmarking
- Major driver for energy modelling of buildings in the UK
- Compliance calculation results often mistakenly interpreted as predictions of energy use



# Compliance Modelling

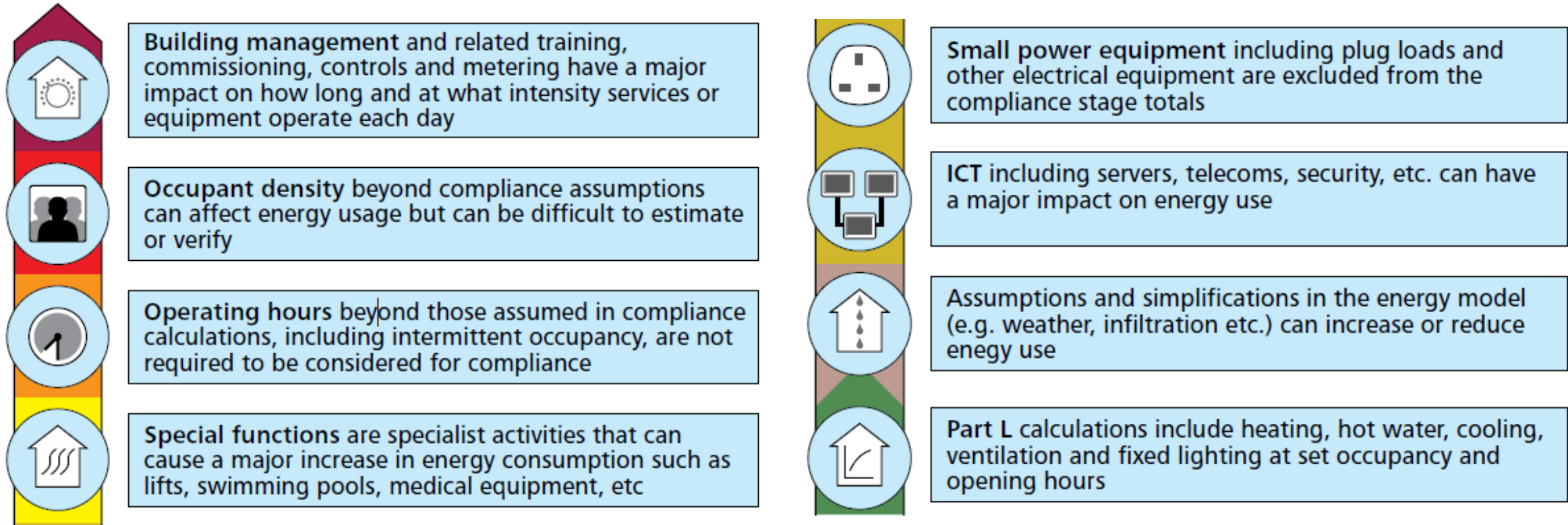


## Why Part L calculations are not suitable for energy projections:

- Totals only report on fixed building services, heating, hot water, cooling, ventilation, lighting only.
- Calculations use standardised assumptions and schedules (NCM based)

Using Part L calculations as the design baseline can lead to a perception of an inflated performance gap

# Reasons why Part L calculations differ from operation energy use (CIBSE TM54 / CarbonBuzz)



# CIBSE TM54



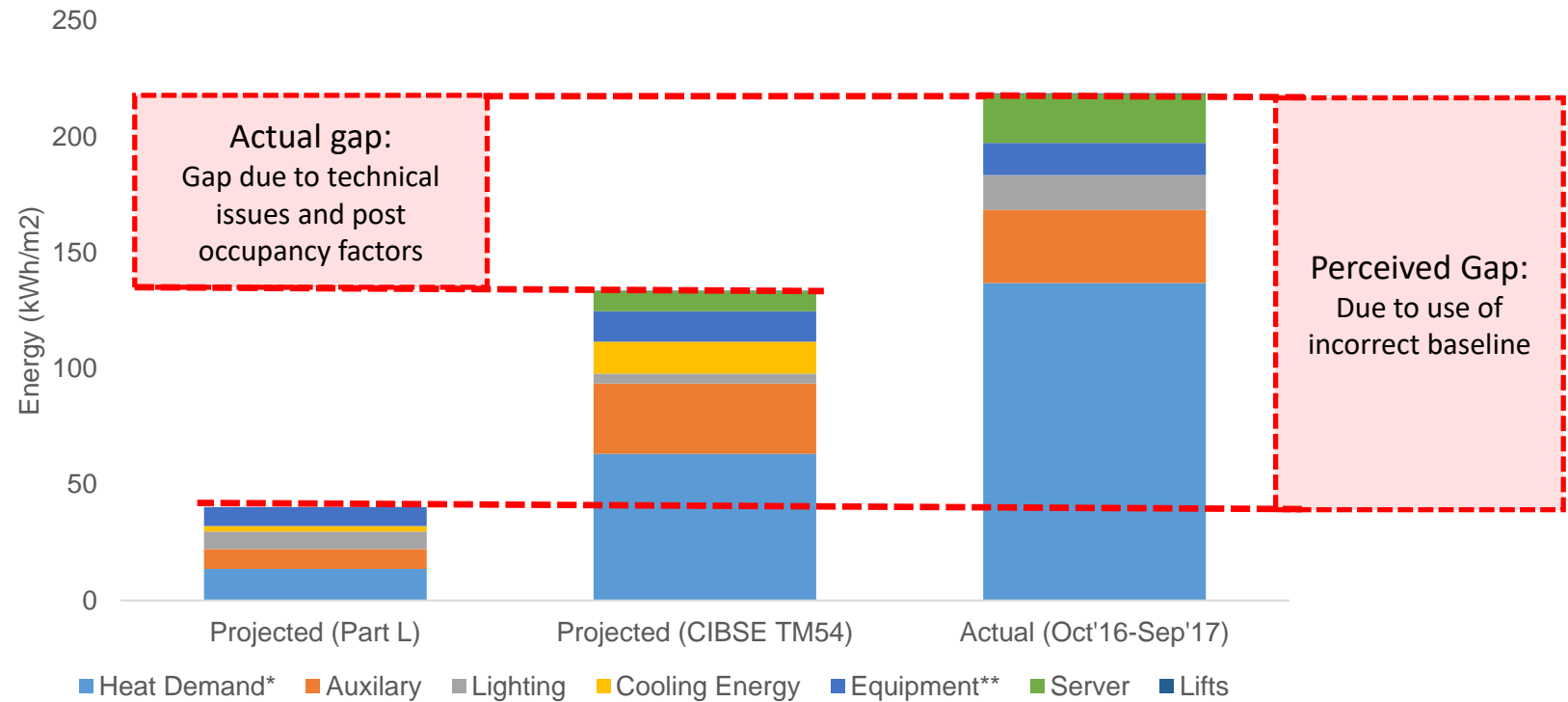
## Guidance on performing predictive energy modelling during the design stage

- Uses building specific model data and operational parameters such as occupancy, schedules, lighting power, and plug loads
- Results include unregulated energy end uses such as plug loads, servers, security, external lighting, lifts

# Perceived Performance Gap



Case study school



\*Heat demand used instead of heating energy; \*\*Equipment includes cooling and heating energy use of VRF system in some zones

# CIBSE TM54



Primary recommendations of CIBSE TM54 are:

- Better calculations
  - Use Dynamic Simulation Models (like DesignBuilder)
  - Source complete and accurate data for operational parameters.
- Better presentation and explanations
  - Explore multiple scenarios by determining high and low estimates for inputs
  - Undertake sensitivity analysis
  - Compare results against existing benchmarks

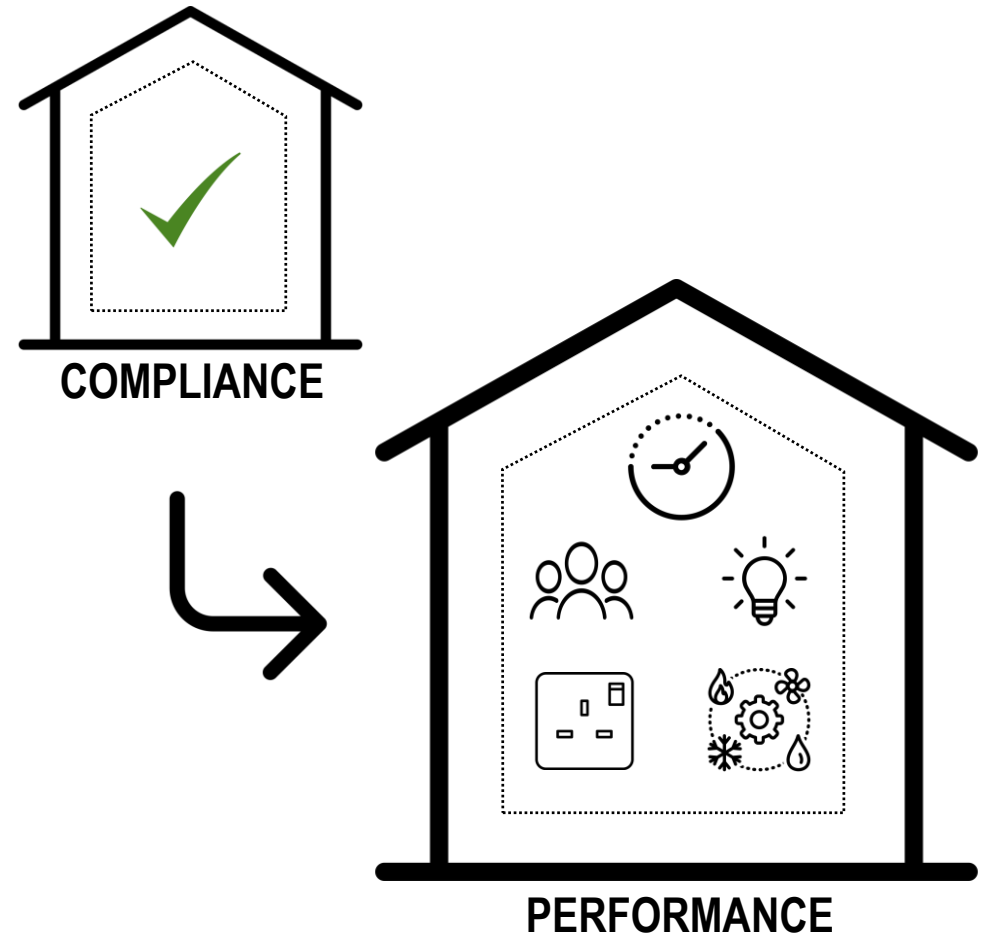


# Modelling

Overview of the compliance model

Repurposing in accordance with TM54

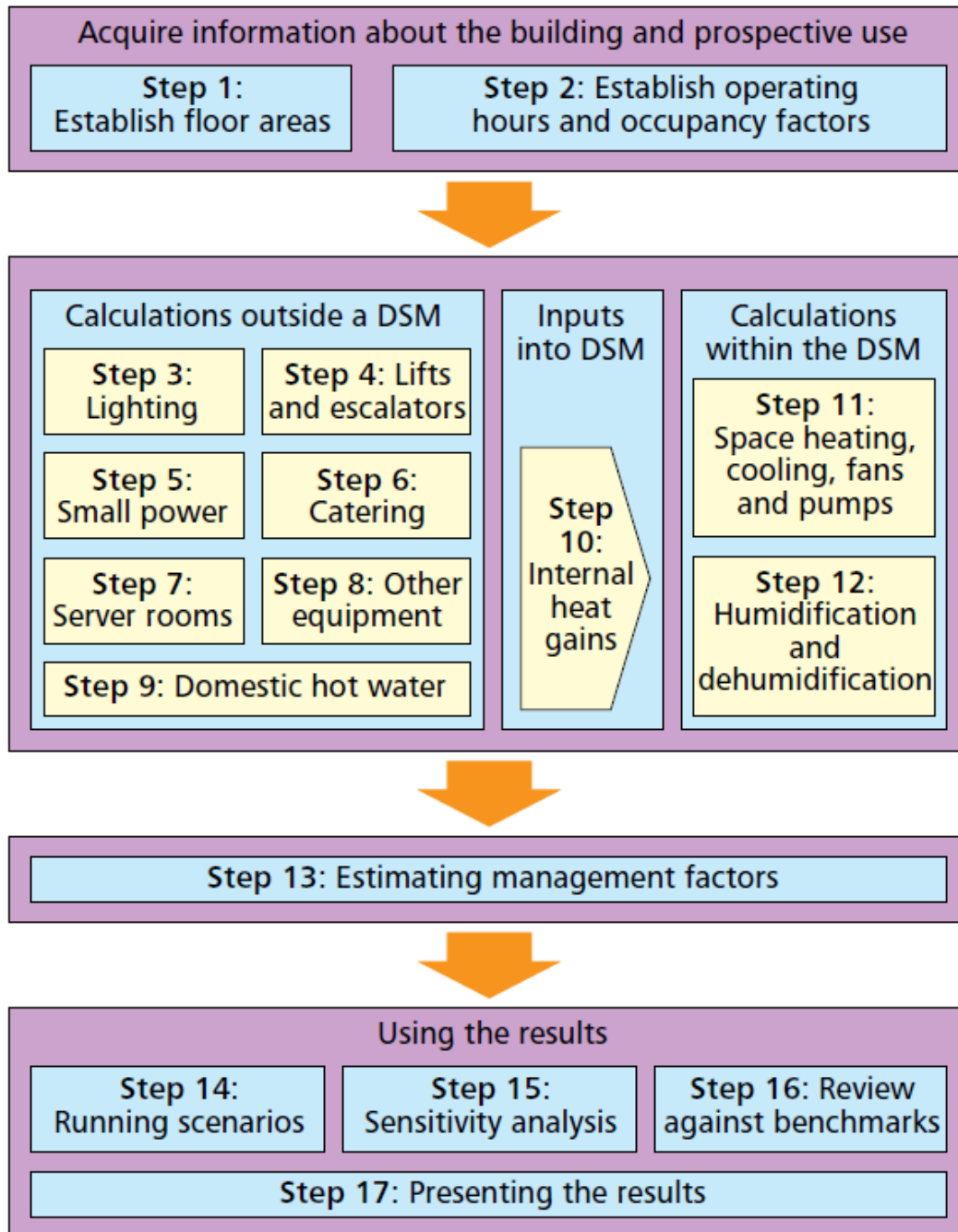
Calculation results



# TM54 modelling prerequisites



- Full dynamic thermal simulation software, e.g. DesignBuilder Software
- Information from stakeholders about likely operations and management regimes
- List of probable high and low energy use changes for scenarios and sensitivity analysis
- Identified benchmarks for relevant building type



# TM54 Methodology

# My TM54 Checklist

## TM54 baseline

- Location (weather) data
- Operating hours and occupancy
- Lighting (load and operation)
- Small power (load and operation)
- Lifts, escalators & other equipment (load and operation)
- Server (load and operation)
- Heating and cooling system operation
- Fan power and operations
- Hot water consumption
- Detail HVAC system design (optional)

- Overall management quality
- HVAC system efficiency
- Control inefficiency in HVAC system (e.g. heating when windows open)
- Hours of operation
- Loads (occupancy and equipment)
- Future weather data

## Scenario/Sensitivity

- CIBSE Guide F: Energy Efficiency in Buildings
- CIBSE TM46: Energy Benchmarks
- Other building specific guides

## Benchmark

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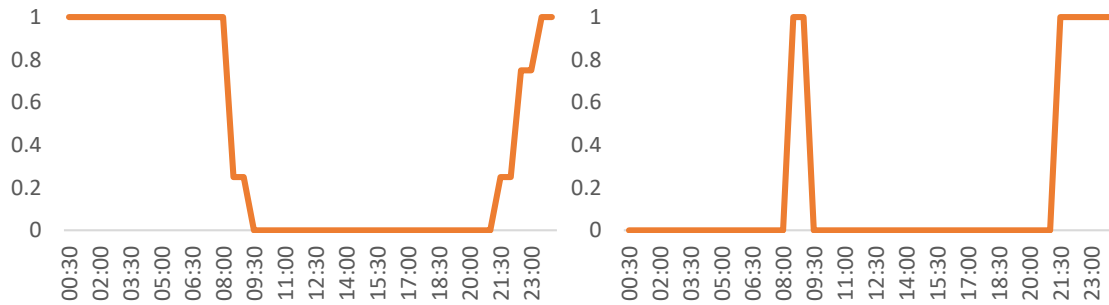
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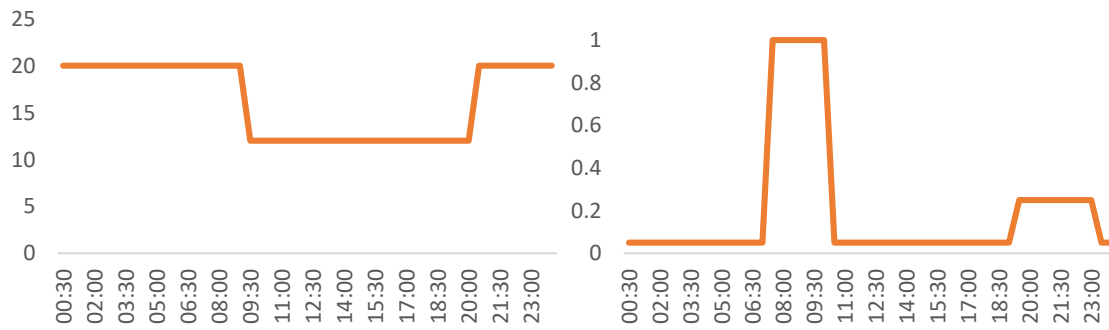
# NCM vs Actual

NCM Schedules for University Bedroom (majority area)



Occupancy Schedule

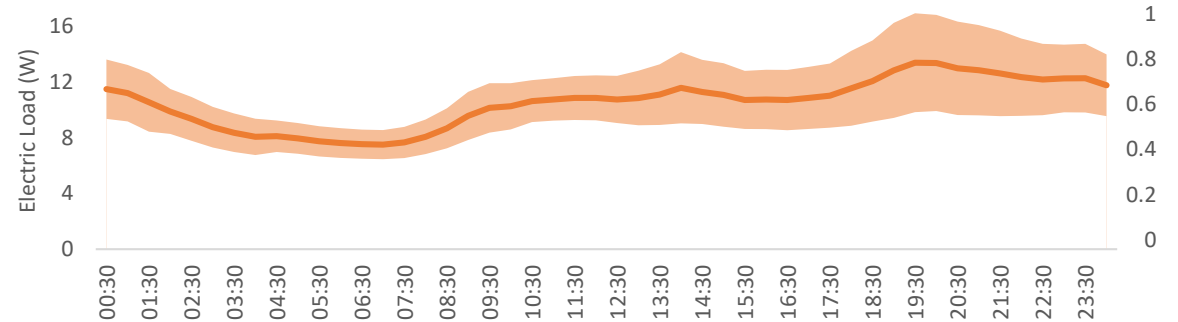
Lighting Schedule



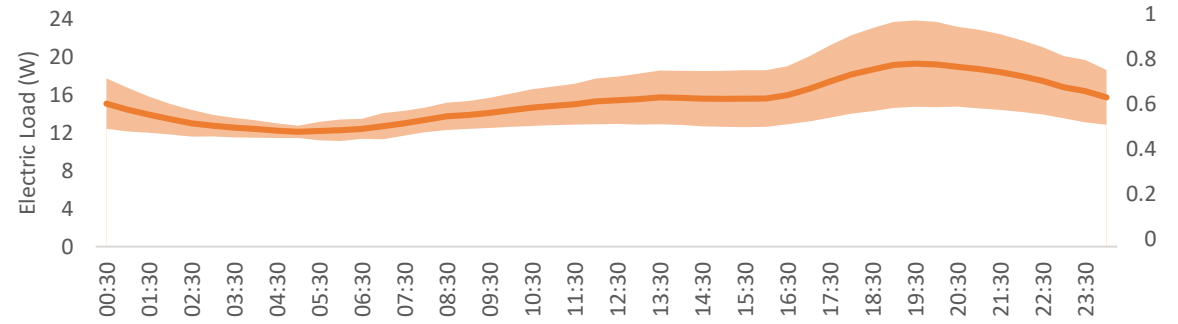
Heating Schedule

Equipment Schedule

Actual load profiles from student accommodation



UCL Student Residence 1 (2017)



UCL Student Residence 2 (2017)

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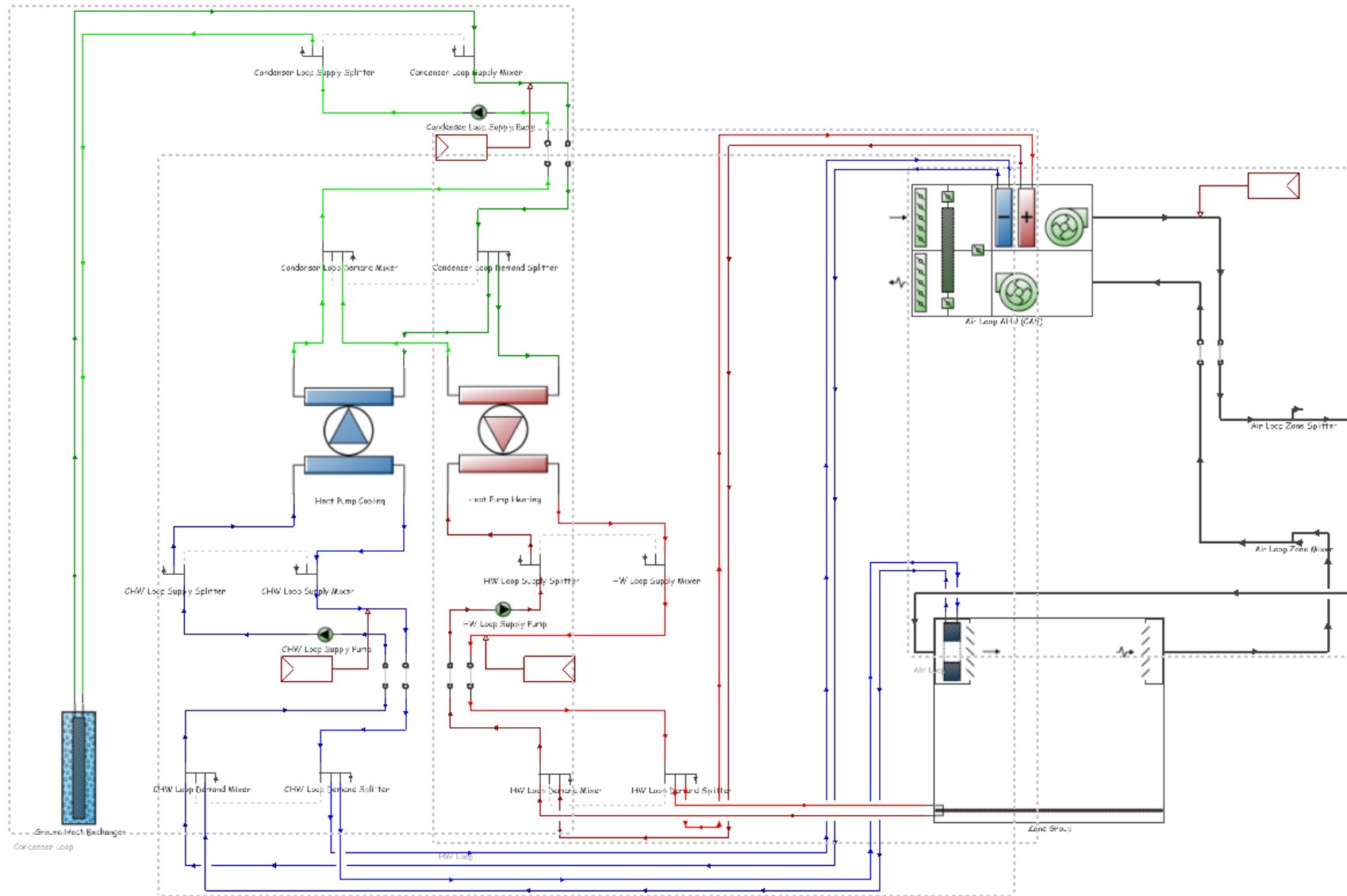
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## Detailed HVAC system design

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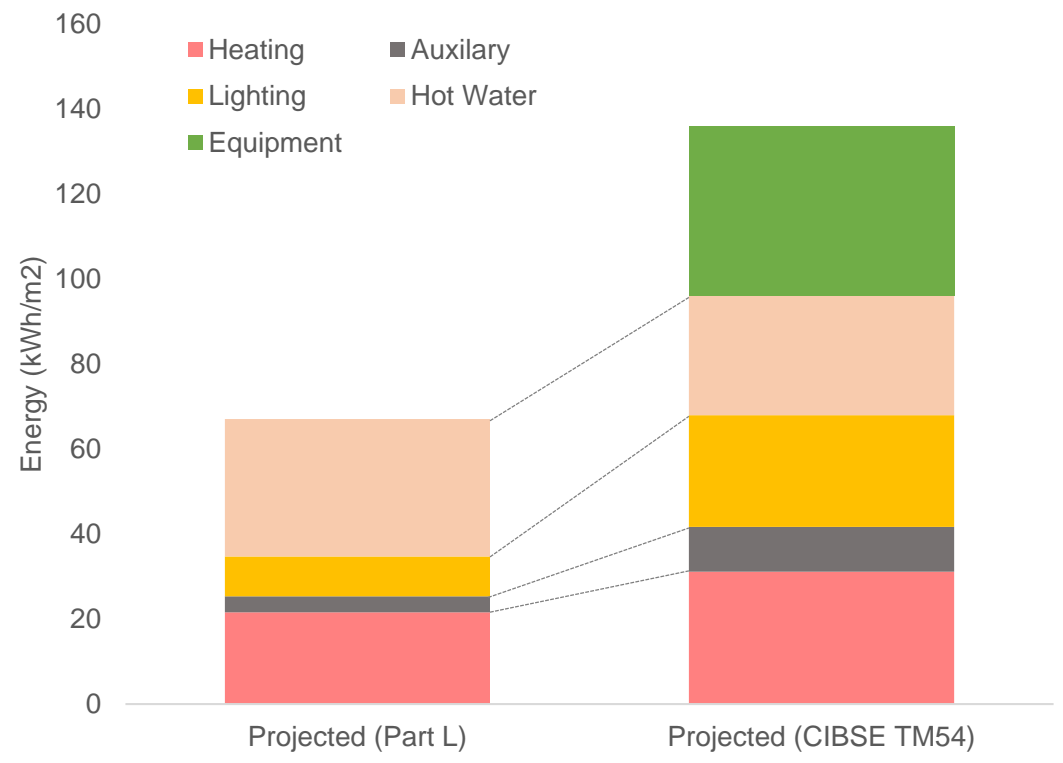
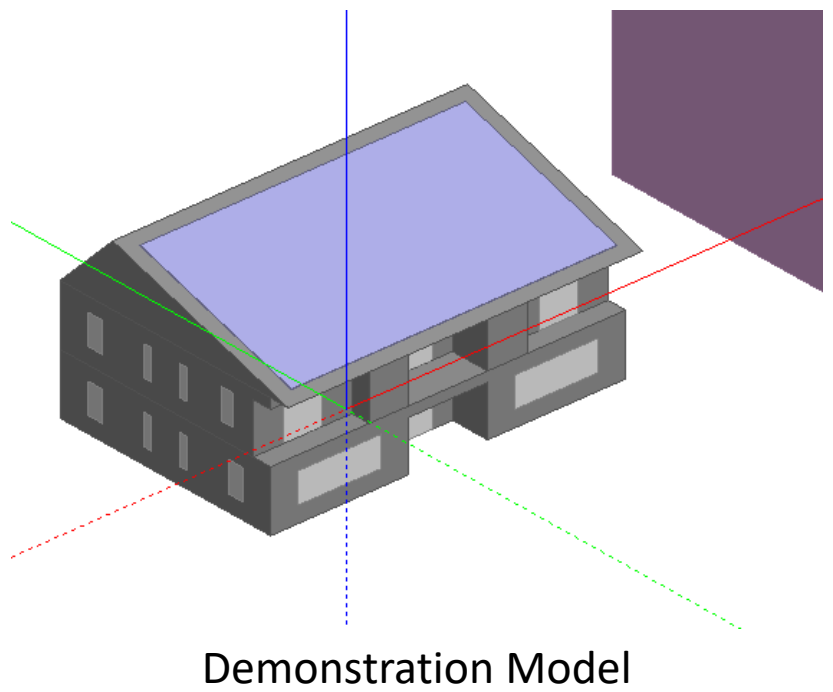
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## Scenario/Sensitivity

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## Benchmark

# Projected energy use, Part L vs TM54



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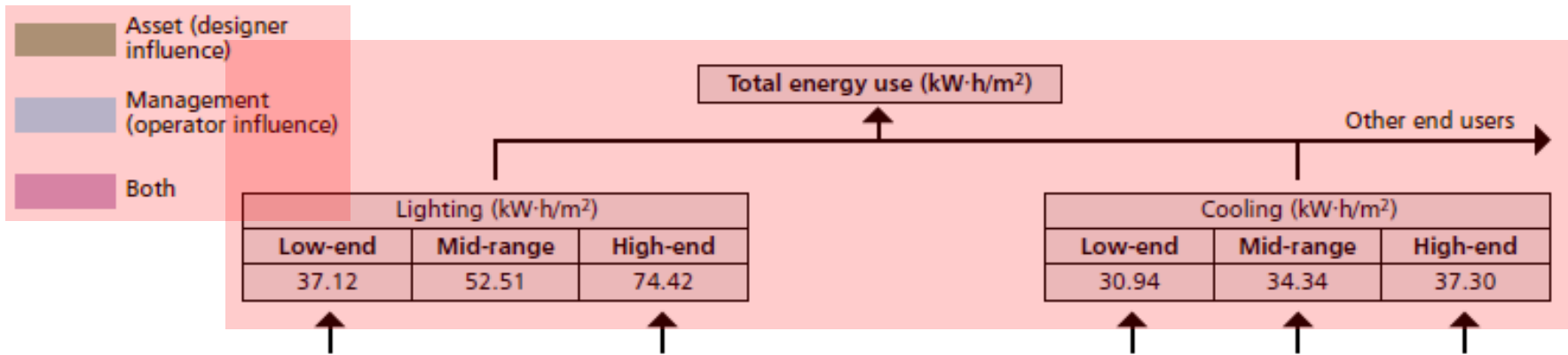
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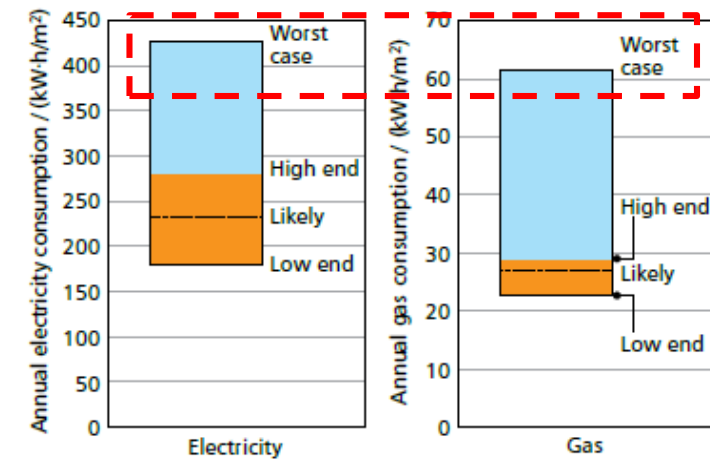
## Benchmark



Assumptions			
Scenario	Low-end	Mid-range	High-end
	Fully functional controls, excellent management and no weekend operation	Partially functional controls, average management and weekend operation	Non-functional controls, poor management and extended hours of operation
Total installed power (kW)	366	366	366
Constant illuminance factor	1.0	1.0	1.0
Occupancy dependency factor	0.90	0.95	1.00
Daylight dependency factor	0.90	0.95	1.00
Daylight time usage (h)	2620	3504	4346
Non-daylight time usage (h)	500	500	750
Parasitic control energy (kW·h/m²)	5.00	5.00	5.00
Parasitic emergency energy (kW·h/m²)	1.00	1.00	1.00
Management factor	1.00	1.05	1.10

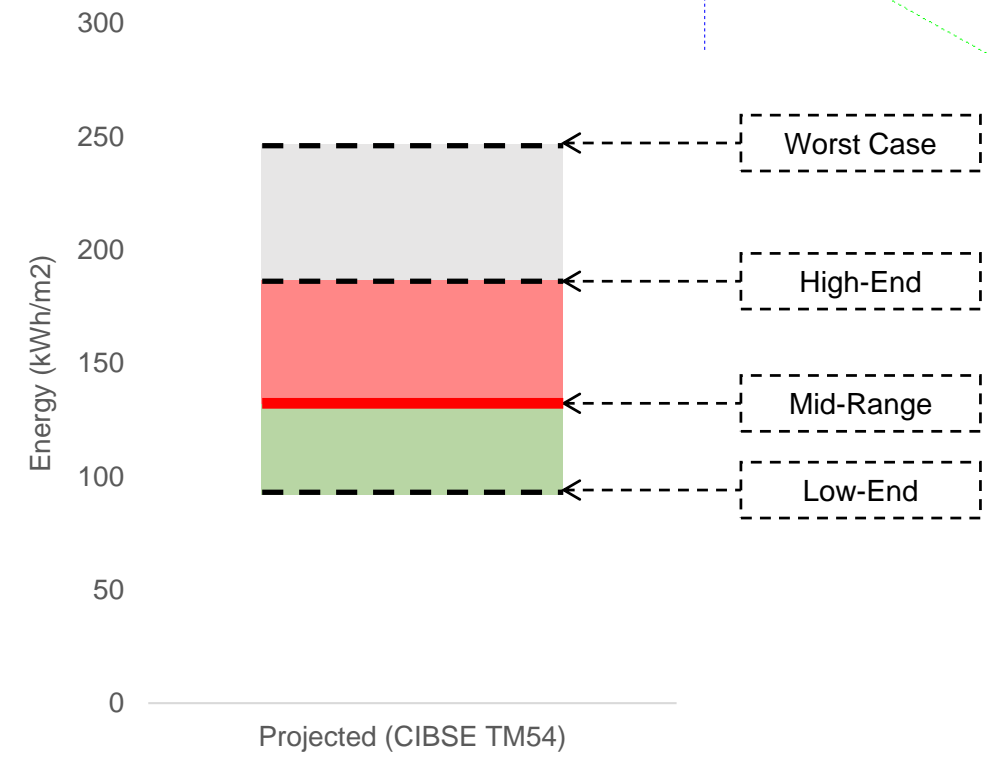
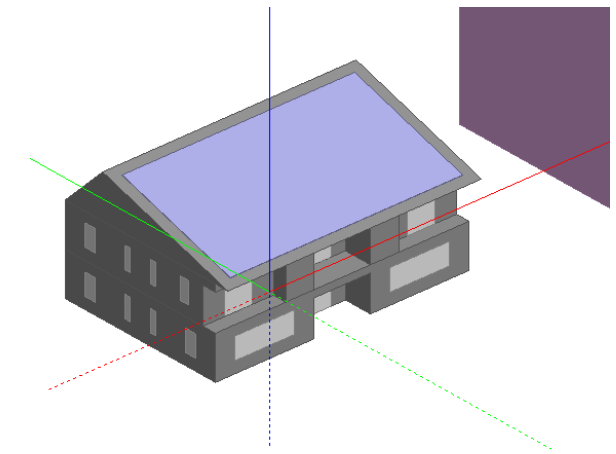
Assumptions			
Scenario	Low-end	Mid-range	High-end
	Excellent management, no weekend operation and low internal gains	Average management, weekend operation and average internal gains	Poor management, extended hours of operation and high internal gains
Chiller cooling capacity (kW)	1450	1450	1450
SEER	3.5	3.5	3.5
Lighting gains (W/m²)	0.0	0.0	0.0
Small power gains (W/m²)	13.5	15.0	17.0
Small power gains (out-of-hours) (W/m²)	1.5	2.5	5.0
Fan coil unit gains (W/m²)	6.8	6.8	6.8
Servers gains (W/room)	1500	1500	1500
Occupant gains (m² per person)	6.0	6.0	6.0
Occupancy hours	3120	4004	5096
Management factor	1.00	1.05	1.10

## Table for scenarios



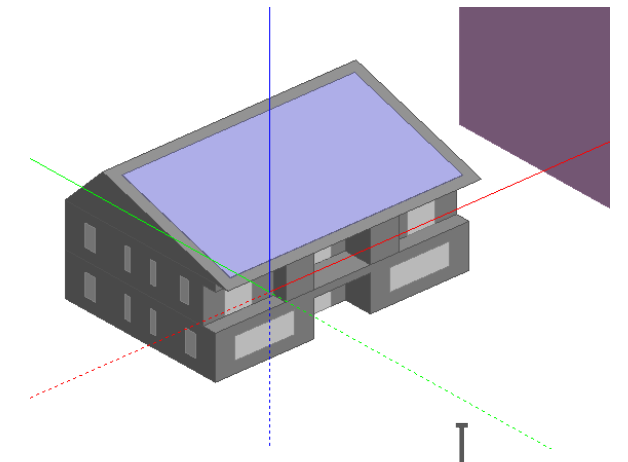
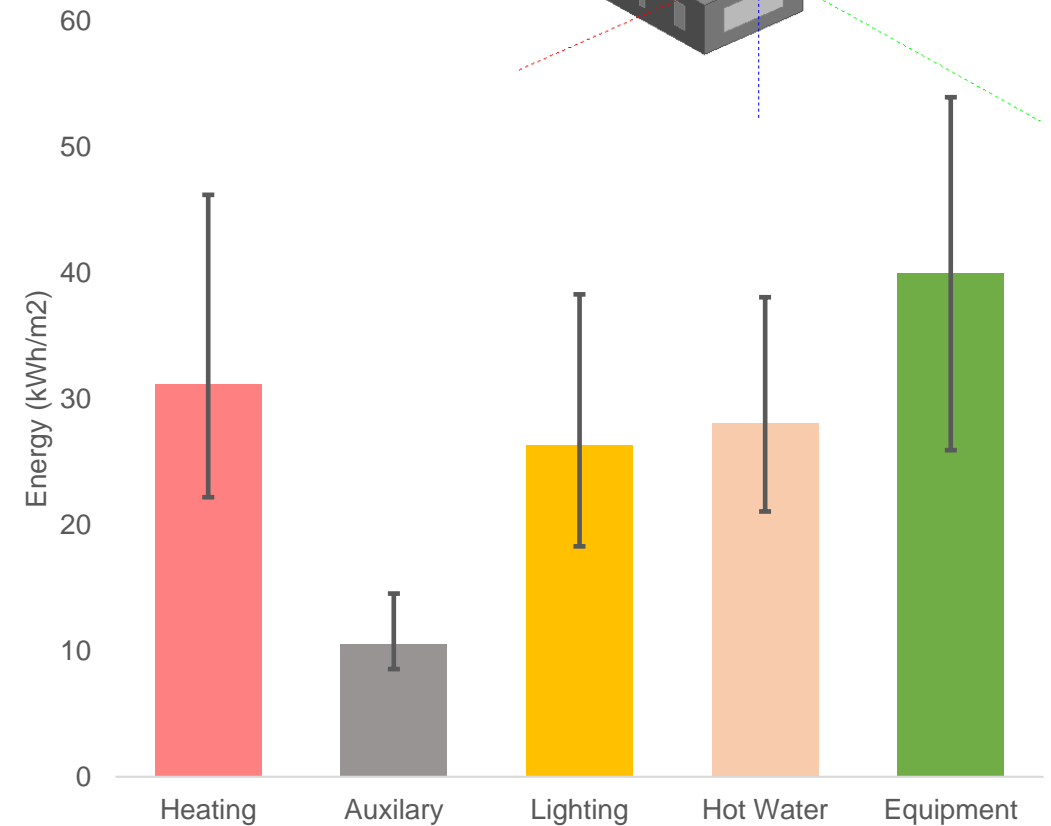
# Scenario analysis of the demonstration model

Category	Low	Medium	High
Occupancy number	1	2	3
Occupancy hours	8-10	12-14	16-18
Heating EER	3.5	3.5	2.5
Heating set-point (°C)	20	22	24
Lighting load (W)	800	1200	2500
Lighting operating hrs	6-8	6-10	10-12
Equipment Load (W)	2500	3200	6000
Equipment operating hrs	6-8	6-10	10-12
Parasitic Load (W)	1500	2000	4000
Weather (2020/2050 CIBSE future emission scenarios)	Low	Medium	High

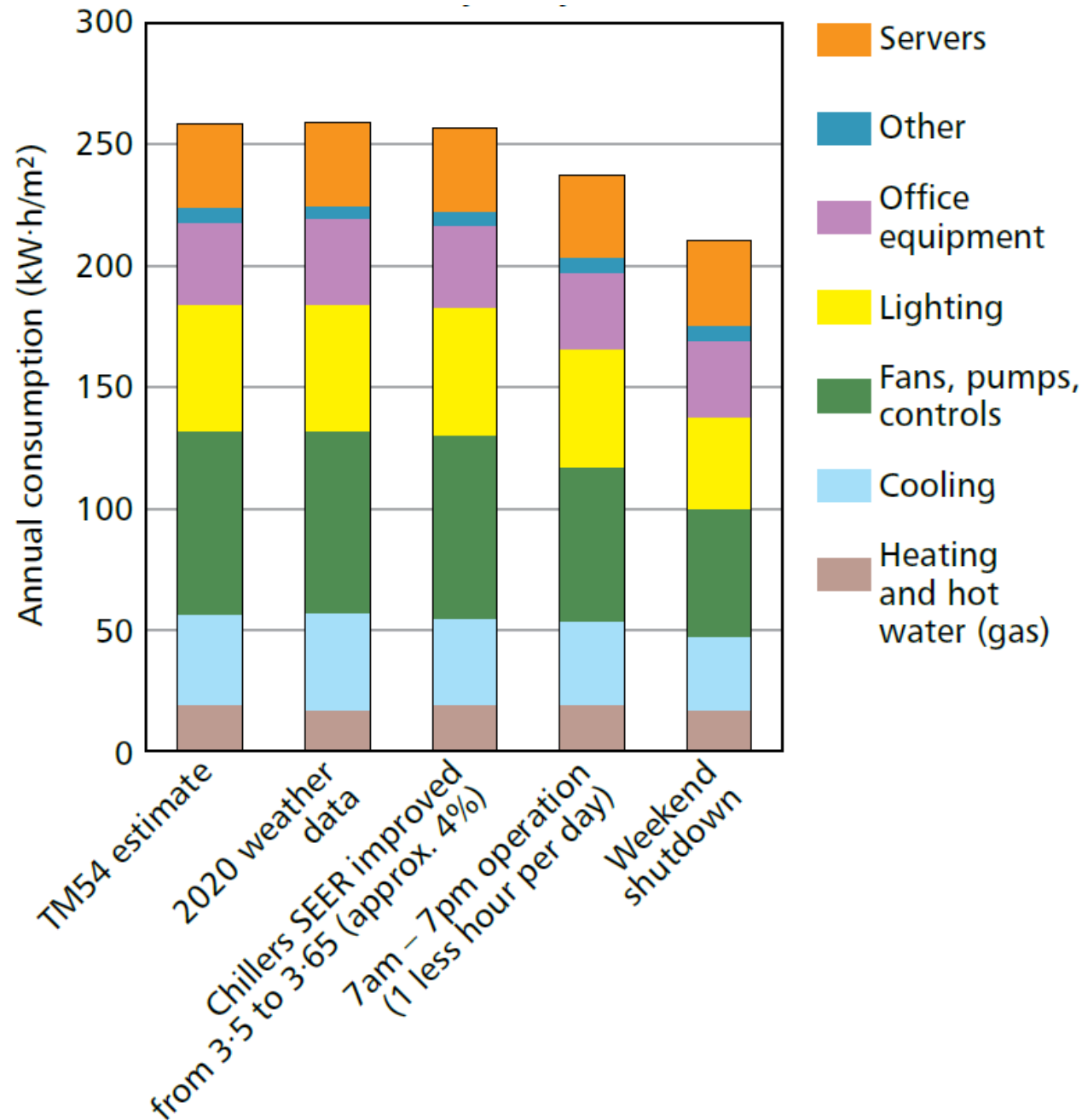


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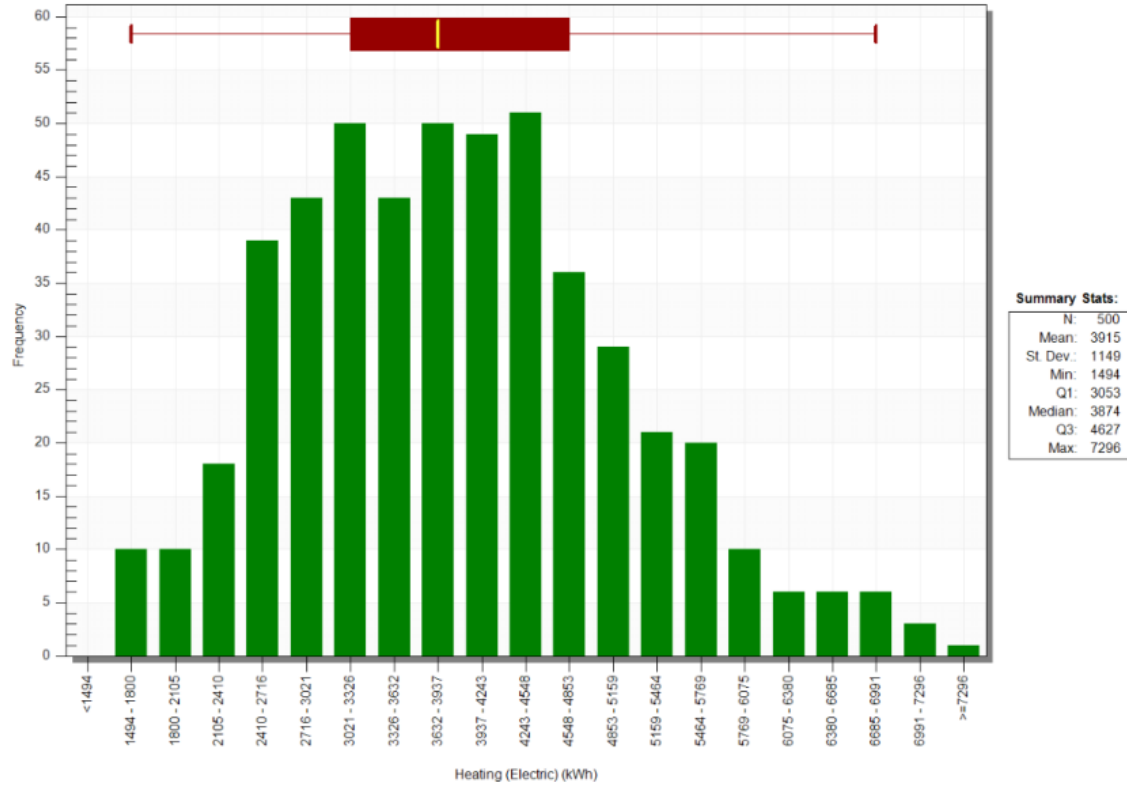






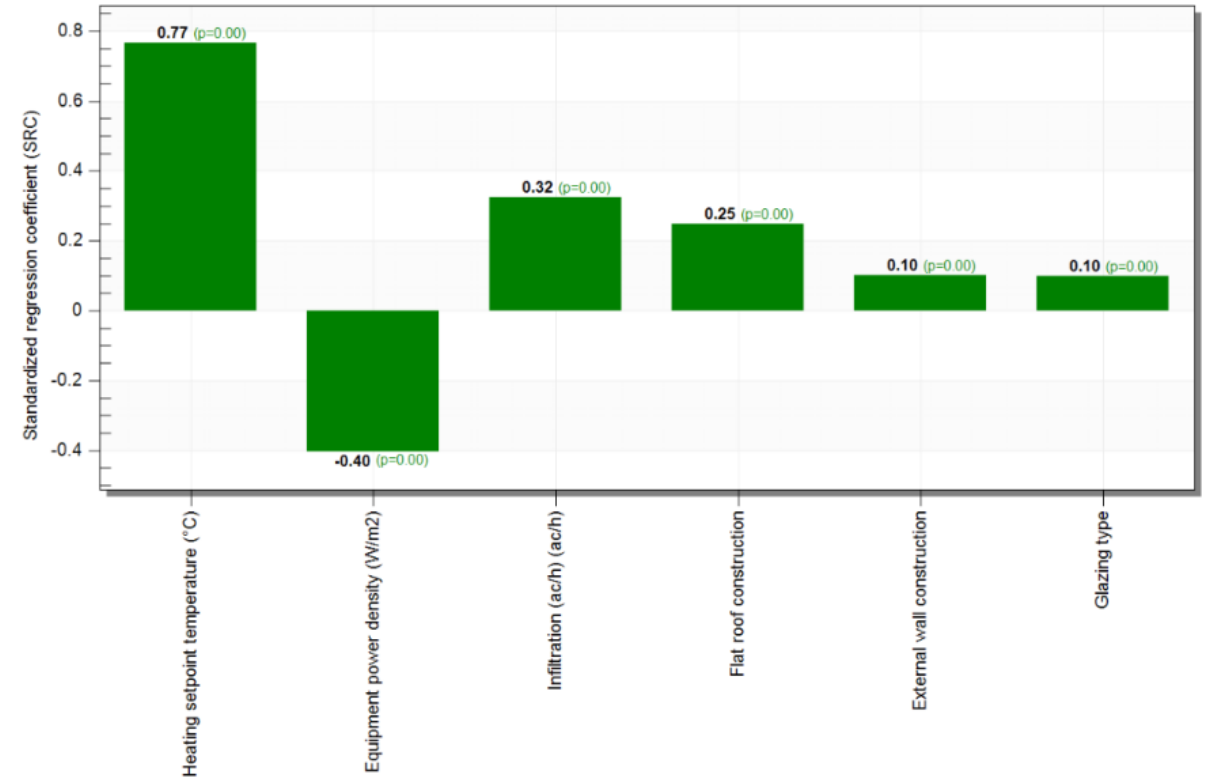
# Sensitivity Analysis

Uncertainty Analysis - Distribution of Heating (kWh)



Uncertainty Analysis

Sensitivity Analysis - Distribution of Heating (kWh)

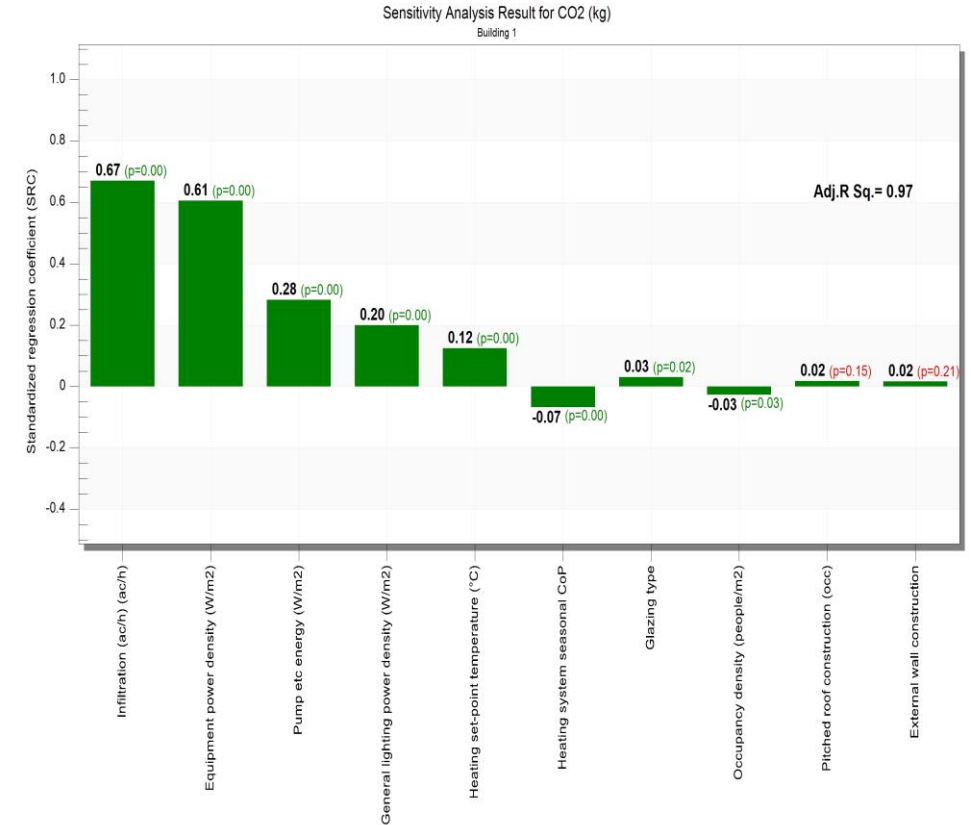


Sensitivity Analysis

# Sensitivity Results

- Fabric Infiltration
- Small power equipment load density
- Load requirement of pumps and vents
- Lighting equipment load density
- Setpoint temperatures
- Efficiency of Heating System
- Windows and vents thermal performance
- Occupancy density
- Thermal performance of roof
- Thermal performance of wall

Decreasing order of importance



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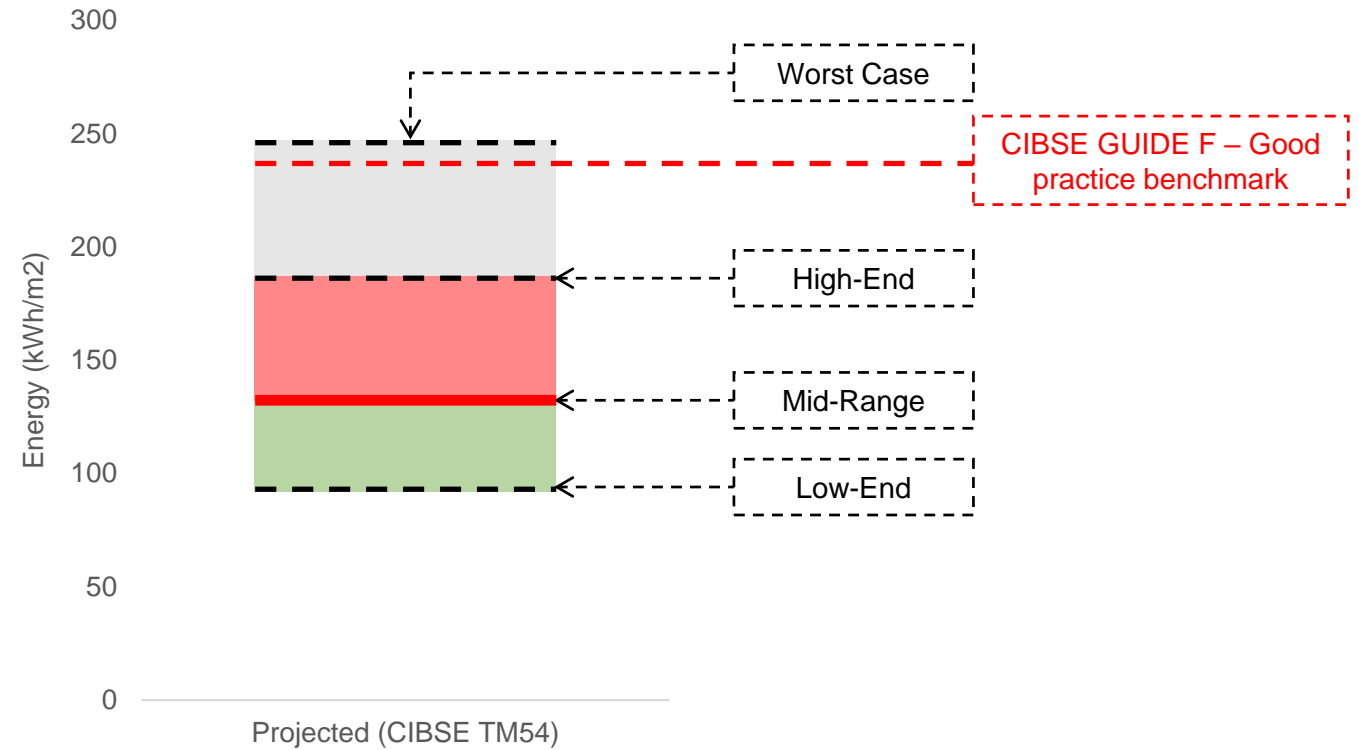
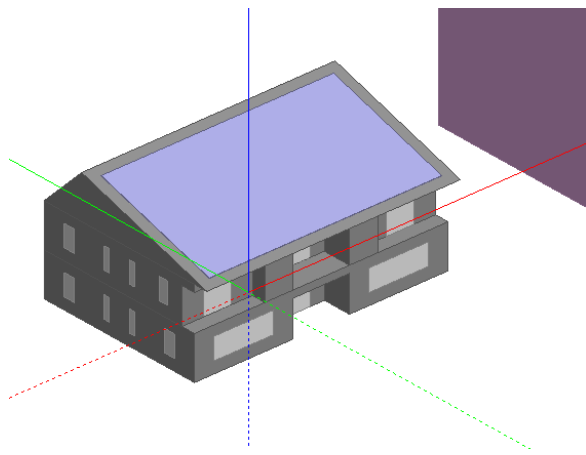
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## Scenario/Sensitivity

- CIBSE Guide F: Energy Eff. in Bldgs.
- CIBSE TM46: Energy Benchmarks
- Energy Eff. Best Practice Programme (ECON Series)

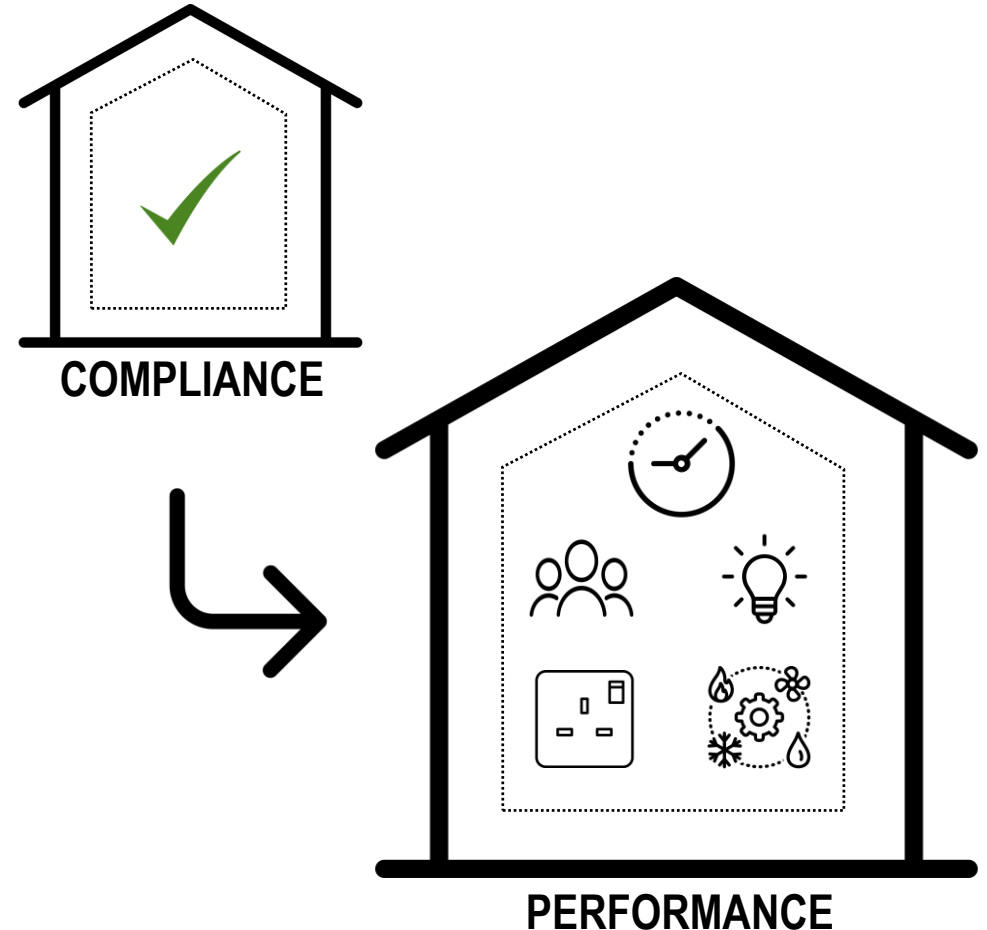
## Benchmark

# Benchmarking of the demonstration model



# Conclusion

- Compliance models and performance models serve different purposes
- Repurposing compliance model as per TM54 requires changes to NCM defaults
- Scenario and sensitivity analysis can provide information for more informed decisions
- Comparing against the benchmark data contextualises the building performance



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