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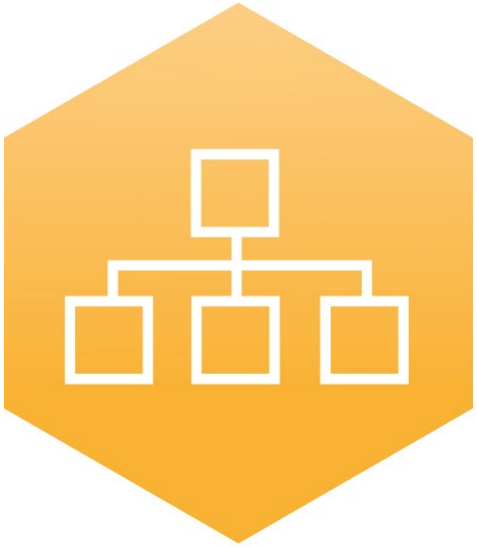
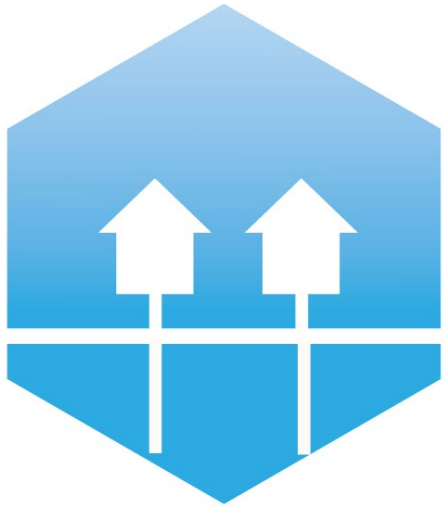
Building Energy Investigation: Understanding Our Buildings From An Energy Perspective

Ahmad Said Galadanci, Anton Ianakiev, Rolands Kromanis and Julian Robinson





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4th Generation District Heating Technologies and Systems

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Introduction

2050 Climate Change Act: Reducing greenhouse gas emission by 80-95%

Building are the largest energy users, accounting for 25-40% of the total energy demand (Mayer et al 2014)

Buildings are designed based on

- Safety
- Economy
- SUSTAINABILITY

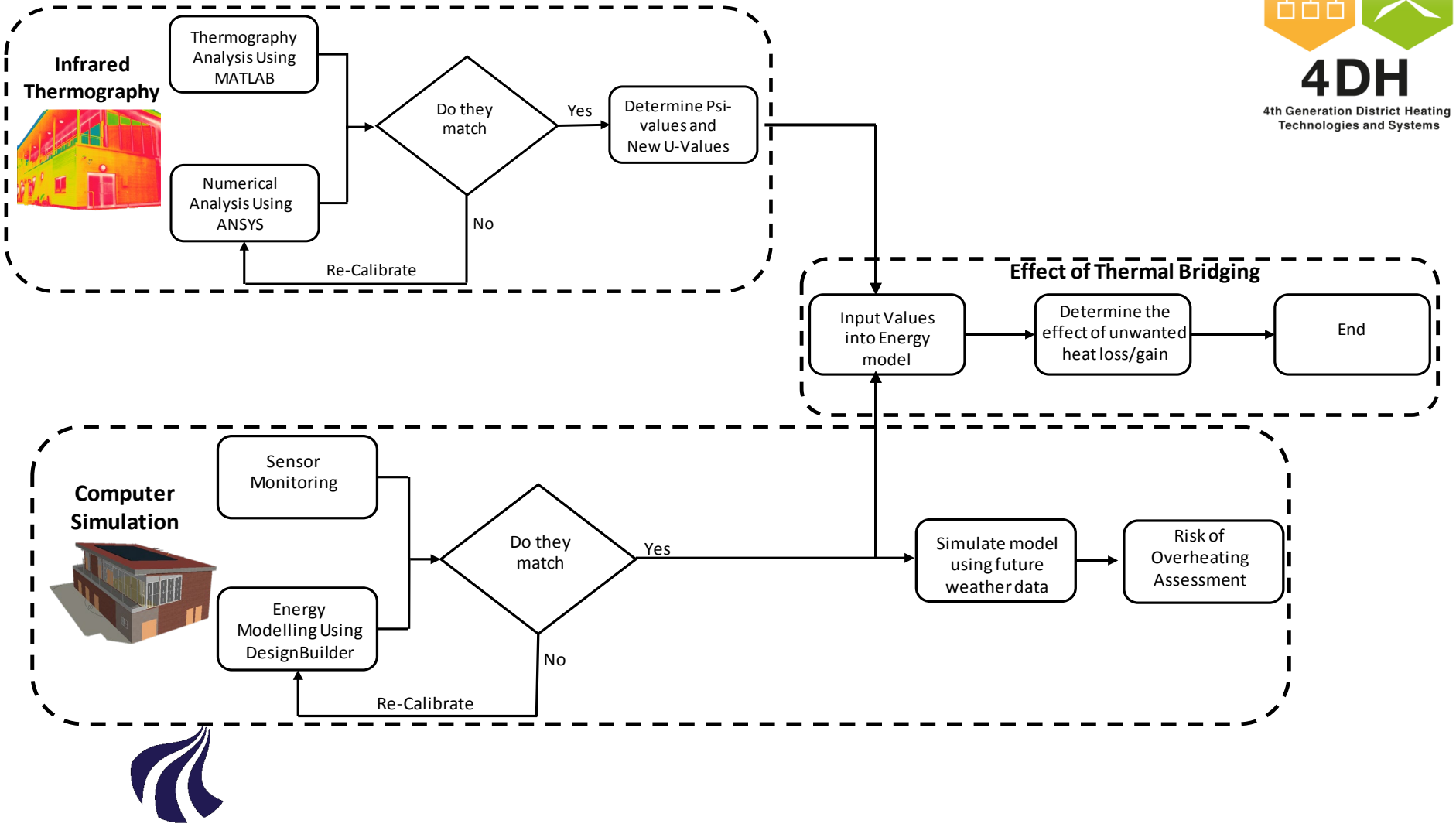
Motivation

With the climate change and effect of fossil fuels, buildings are required to reduce their energy

Therefore buildings are designed as low energy or zero energy buildings using smart energy systems

A low energy building with both passive and active energy measures was not performing as expected

Methodology Framework



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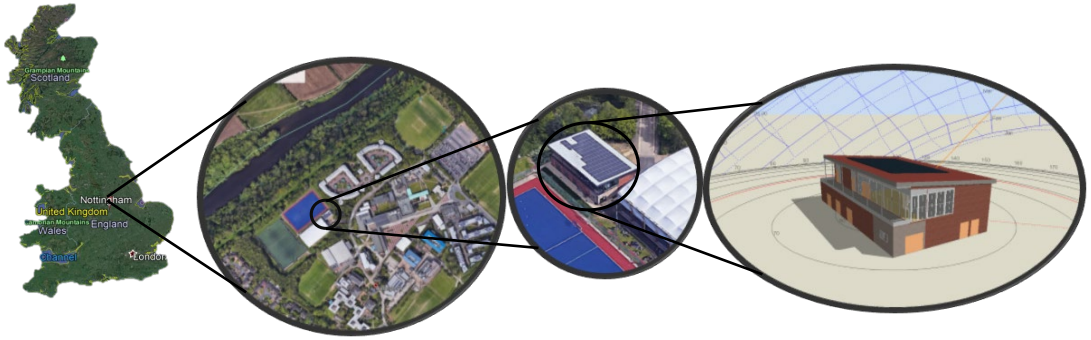
Case-Study

- Location: Clifton, Nottingham
- Facility: Sports changing facility
- Dimension: 468m^2 floor area
- Equipment:
  - Boilers
  - Radiators
  - Heat recovery unit



United Kingdom | Nottingham Trent University, Clifton Campus | Sports Centre | DesignBuilder Model of the Clubhouse

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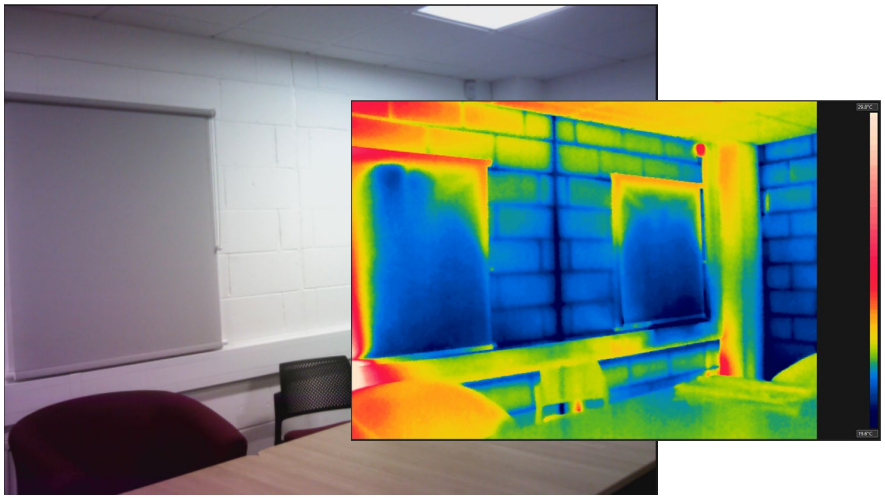
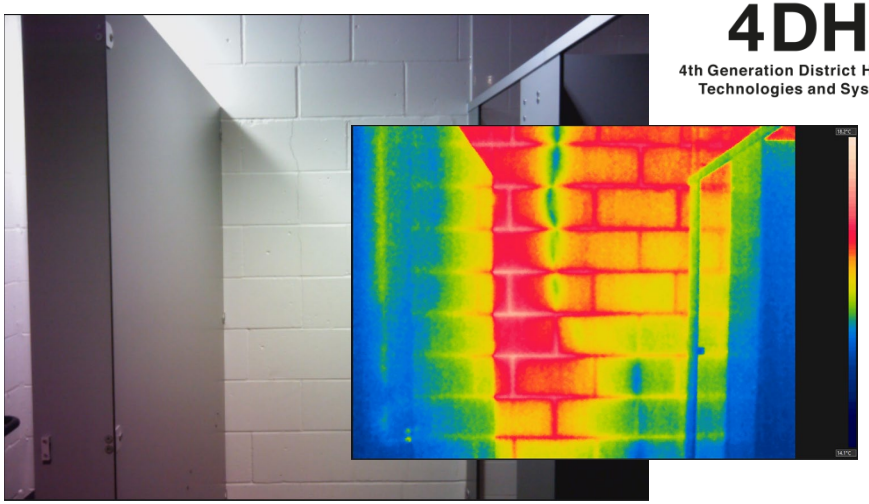
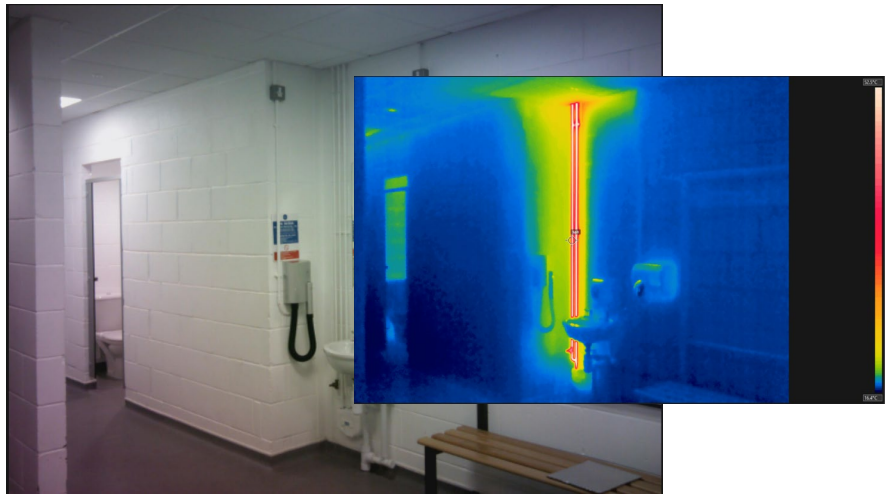
Thermography of Case Study

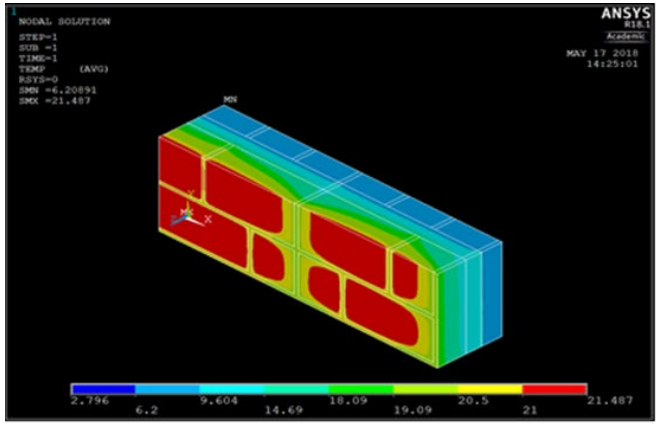
- Cracks creating heat sinks
- Pipes becoming radiators
- Mortars joints cooling the lounge

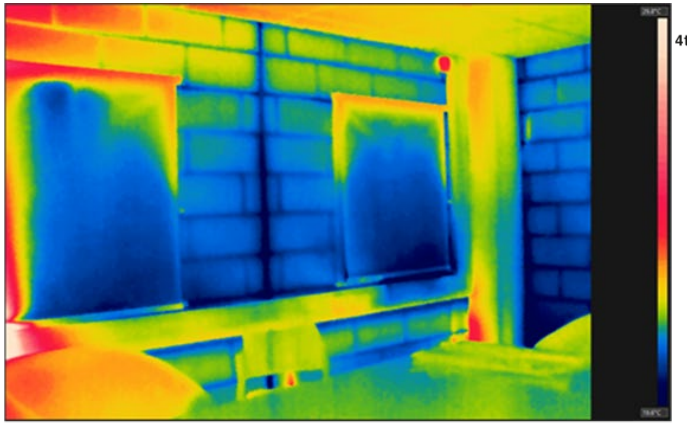


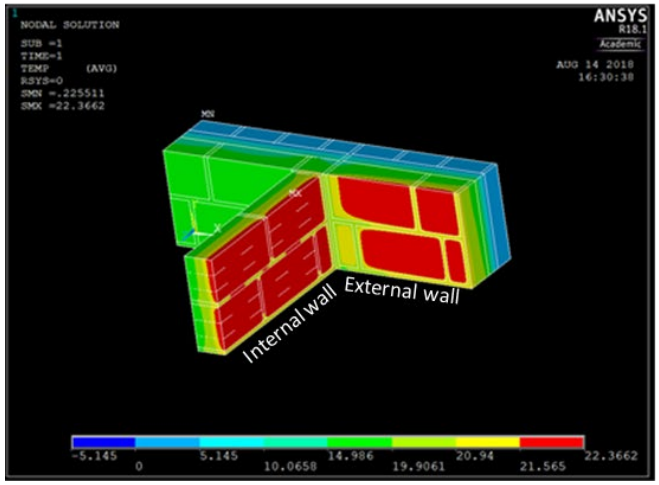


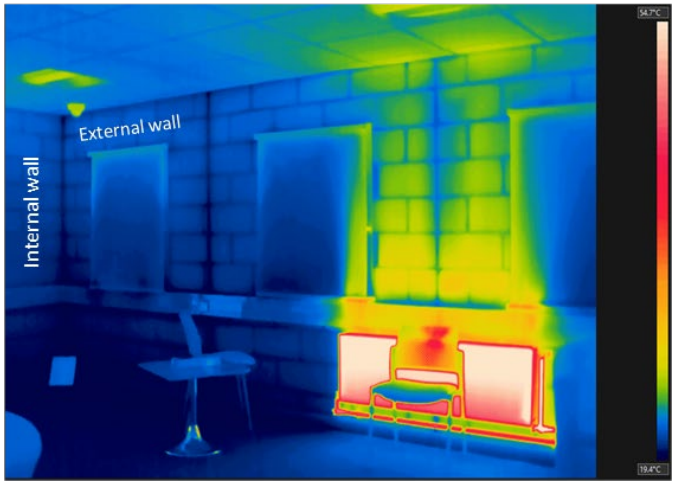


Numerical Analysis









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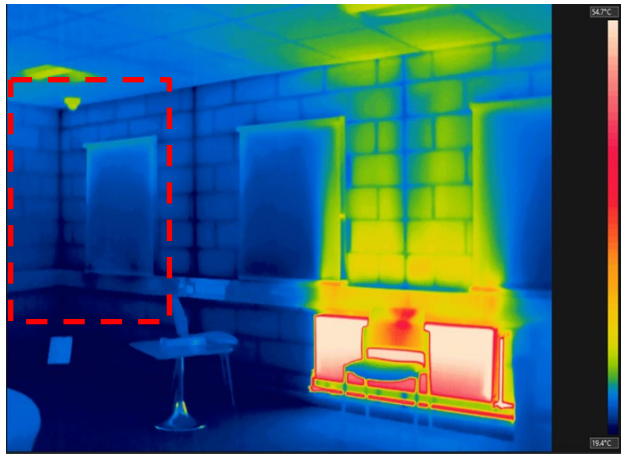
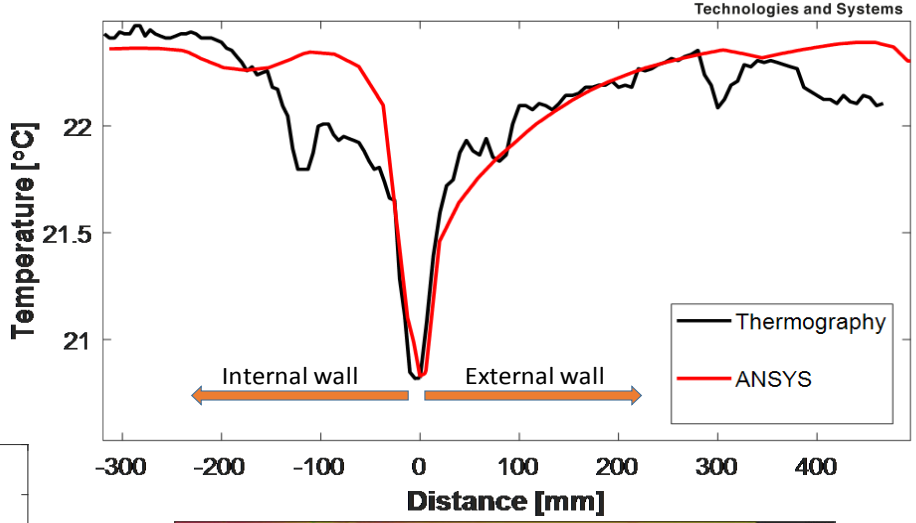
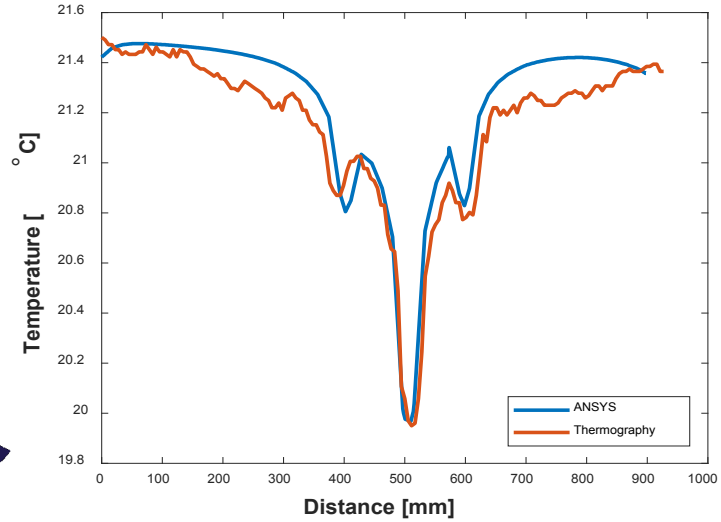
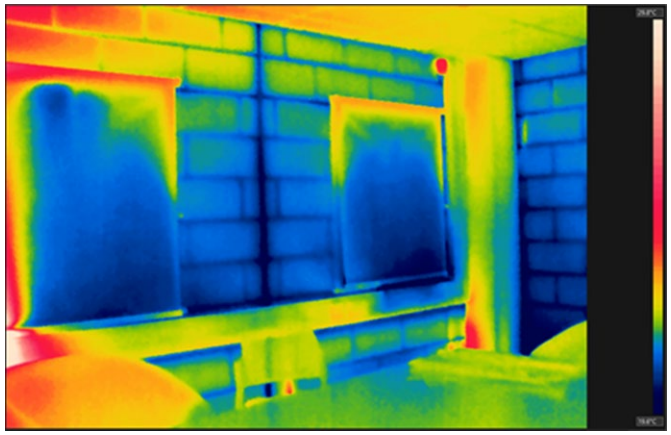
Comparison between numerical and thermography analysis









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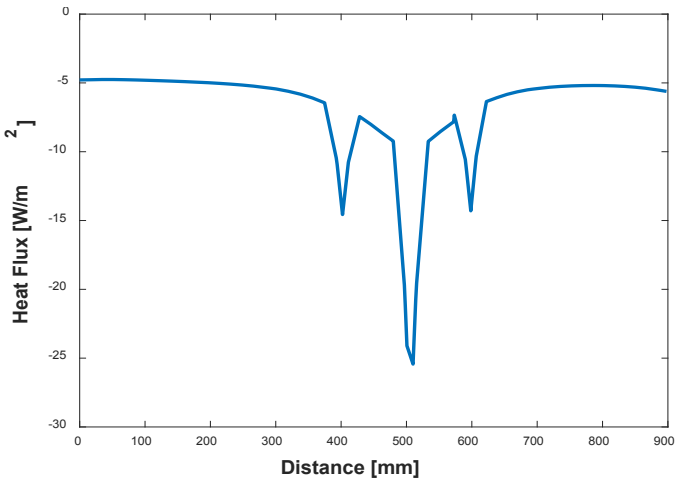
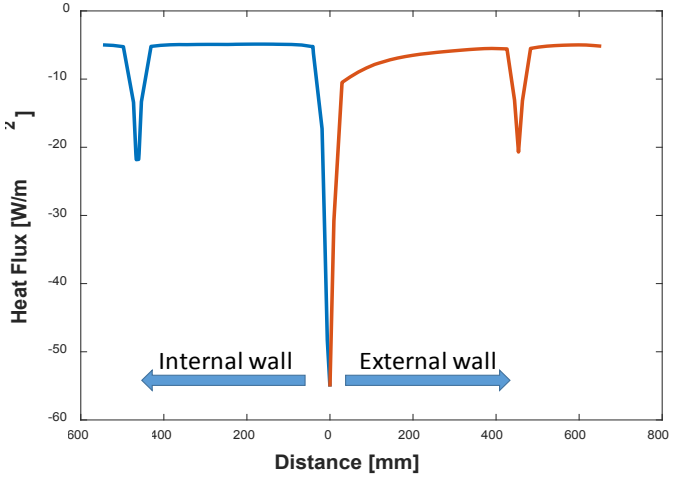
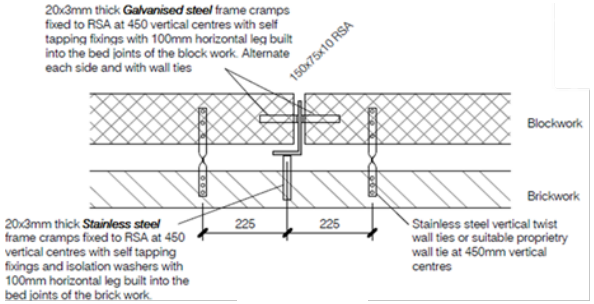
What is the Effect of the Thermal Bridge





Thermal Bridge Location	U-Value	New U-Value	Psi-Value
Thermal bridge created by Steel frame	0.32	0.52	0.256
Thermal bridge created by junction	0.32	0.32	0.678



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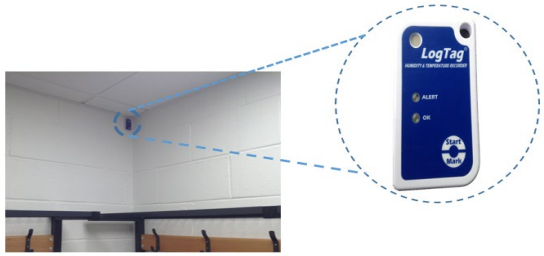
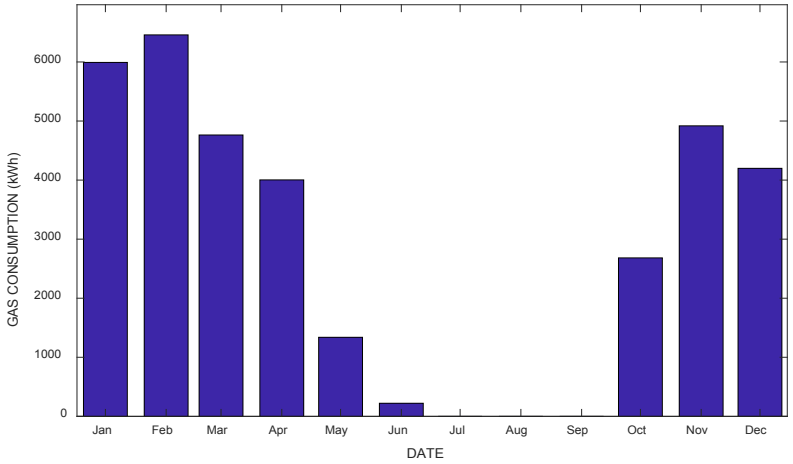
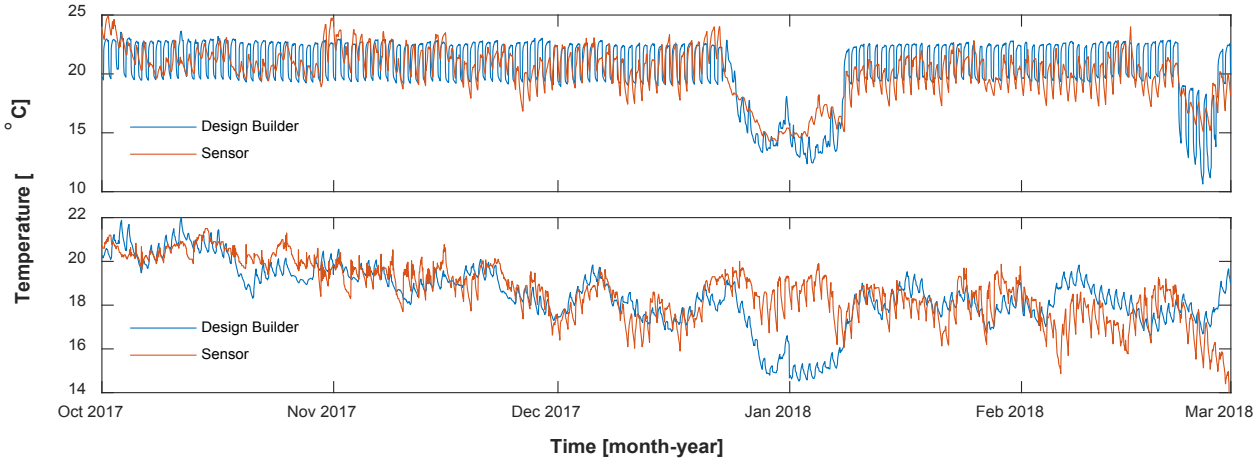
Energy Simulation of Case Study

- DesignBuilder Software
- Whole building modelling
- Results validated with data from temperature and humidity sensors







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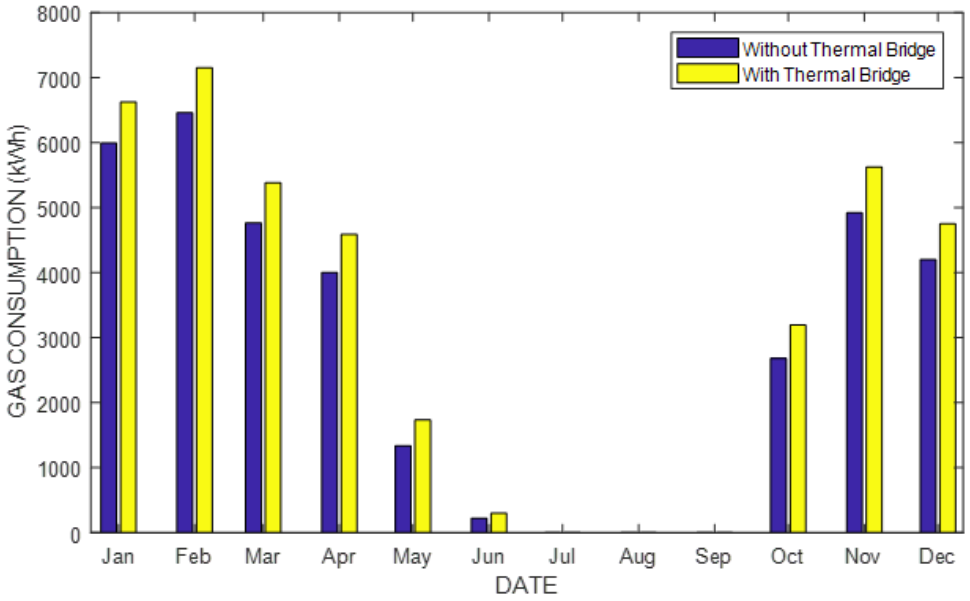
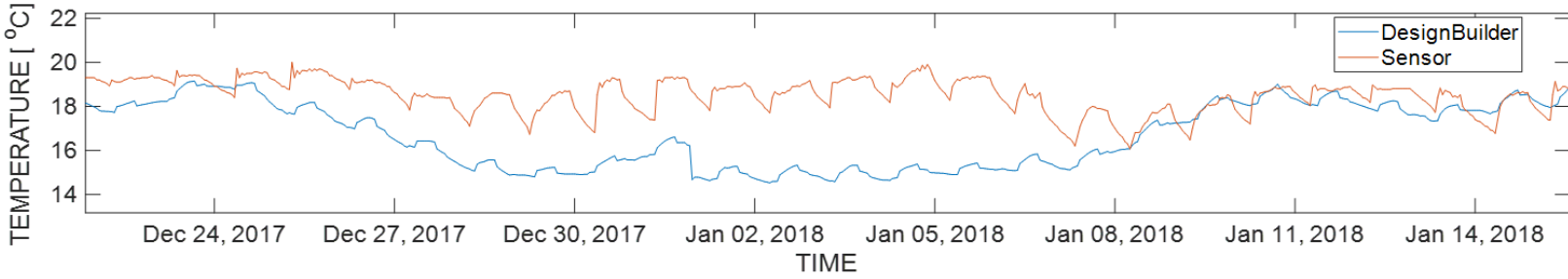
Effect of Thermal Bridge on Gas Consumption

- 15% increase in gas consumption during winter
- 5% increase in gas consumption during summer
- Influence of hot water pipe left on during the holidays to avoid frosting





Overheating Risk

- Using TM52 the risk of overheating was assessed
- Future weather data (from Prometheus Project)was used to predict the performance

CIBSE TM52 OVERHEATING ASSESMENT FOR THE CLUBHOUSE (YEAR 2030-50TH PERCENTILE)					
Block	Zone	Criterion 1 (%)	Criterion 2 (Khr)	Criterion 3 (hr)	Pass/Fail
First Floor	Changing Room 5	0.00	0.00	0.00	Pass
First Floor	Changing Room 6	0.00	0.00	0.00	Pass
First Floor	Main Lounge	3.08	22.50	0.00	Fail
Ground Floor	Changing Room 1	29.98	23.75	0.00	Fail
Ground Floor	Changing Room 3	0.00	0.00	0.00	Pass
Ground Floor	Changing Room 4	57.32	22.00	0.00	Fail
Ground Floor	Entrance Main	0.88	2.25	0.00	Pass

CIBSE TM52 OVERHEATING ASSESMENT FOR THE CLUBHOUSE (YEAR 2050-50TH PERCENTILE)					
Block	Zone	Criterion 1 (%)	Criterion 2 (Khr)	Criterion 3 (hr)	Pass/Fail
First Floor	Changing Room 5	0.00	0.00	0.00	Pass
First Floor	Changing Room 6	0.00	1.00	0.00	Pass
First Floor	Main Lounge	9.31	46.50	3.00	Fail
Ground Floor	Changing Room 1	52.66	26.25	0.00	Fail
Ground Floor	Changing Room 3	0.00	2.50	0.00	Pass
Ground Floor	Changing Room 4	77.17	33.75	3.75	Fail
Ground Floor	Entrance Main	7.26	8.50	0.00	Fail

Conclusion

- Unwanted energy gains and losses (thermal bridges) affect the energy performance of buildings. *Therefore to have the optimal use of our smart energy systems, thermal bridges have to be **eradicated!!***
- There is substantial risk to overheat in the future. *Therefore smart energy systems (cooling systems) have to be incorporated in a way to reduce the risk of overheating*

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Thank you

Any Question?

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