First Wessex

Innovate UK
Technology Strategy Board

Tassos Kougionis

Technical Manager

LABC
Delivering building control through local authorities

SAINT-GOBAIN

Homes & Communities Agency

Taylor Wimpey

NHBC FOUNDATION

ZERO CARBON HUB

Introduction to the project

North-East Elevation

South-West Elevation

- Two identical block of flats – 12 flats each (mirrored floor plan layouts)
- Two different energy efficiency targets (CSH L3, FEES)
- No renewable energy generation systems installed
- Modern Method of Construction (Thin-Joint Masonry)
- Mechanical Ventilation Heat Recovery (MVHR) in all flats

Introduction to the project

Block B - CSH

External wall	U = 0.24 W/m2K
Party wall	E-WM-15 Cavity, partial fill

Block C - FEES

External wall	U = 0.18 W/m2K
Party wall	E-WM-17 Fully insulated and sealed

Phase I – Design and Construction

- Designed to meet the 2006 version of the Building Regulations, Housing Quality Indicators and Lifetime Homes standards.

- Skills and knowledge of the team members reviewed

- Audit trail of designs and relevant documents

- Interviews with design and construction team members

Testing to evaluate as-built performance:

- Staged airtightness tests
- MVHR commissioning
- In-site U values
- Coheating test
- Thermal imaging

Phase I – Design and Construction

- Design and construction teams unfamiliar with Thin-Joint Masonry system
- No clear documentation on the continuity of the air-tightness and thermal barriers
- Issues noted with the installation of the MVHR ductwork layout
- Testing showed additional thermal bridges, and slightly higher in-situ U values
- The coheating test calculated Heat Loss Coefficient (HLC) was almost 2.5 times higher than predicted in the case of the flat in the FEES block and 1.5 times higher than predicted for the flat in the CSH L3 block

The whole house heat loss coefficient test and other associated investigations, including heat flux tests and thermography, were carried out at the end of what would be typically considered as the winter heating season. Because of unusually warm weather, the test conditions were not ideal.

Phase II – Post Occupancy evaluation

First Floor Plan – Flat Types 1-3

THREE FLAT TYPOLOGIES ON SITE

1. Two bedroom, single aspect flat
   Floor area – 68m²
2. One bedroom, small single aspect flat
   Floor area – 46m²
3. Two bedroom, multi-aspect flat
   Floor area – 70m²

FLAT REFERENCE KEY

B-GT (1-3)
Block B, Ground floor – Types 1-3

B-FT (1-3)
Block B, First floor – Types 1-3

B-ST (1-3)
Block B, Second floor – Types 1-3

C-GT (1-3)
Block C, Ground floor – Types 1-3

C-FT (1-3)
Block C, First floor – Types 1-3

C-ST (1-3)
Block C, Second floor – Types 1-3

Monitoring Programme

Energy and water consumption

- Meters to monitor mains gas, electricity and water consumption in all 24 flats.
- Sub-meters in 2 identical flats (one in each block)

I. For all electricity circuit rings
II. For electricity consumption and air temperature in supply and extract ducts of the MVHR units
III. Energy meters in flow and return circuits of the space heating and hot water circulation systems connected to the boiler

Conditions review

- Temperature and relative humidity (RH) sensors in the living room and main bedroom in 2 pair of flats (two of each block)
- CO2 sensors in the living rooms of the sub-metered flats
- Window sensors attached to all windows recording open/close in previous four flats
- External weather station measuring temperature and humidity levels of the location

Supporting monitored data

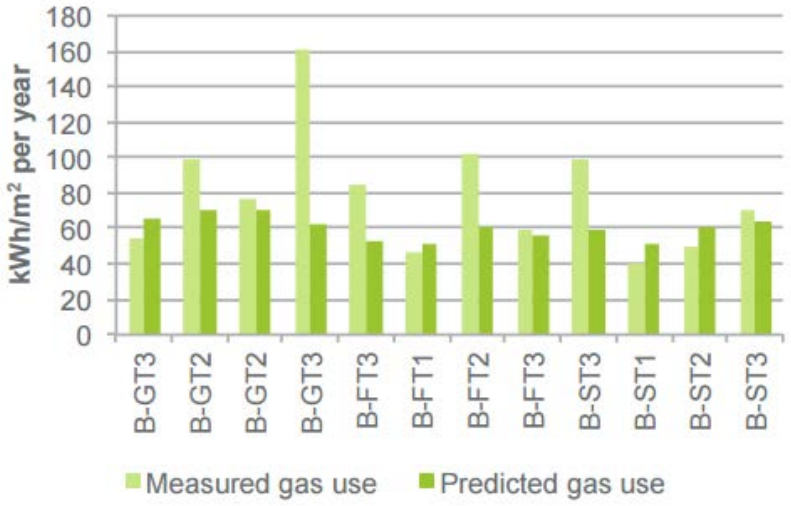
- Airtightness testing of 8 properties after almost two years of occupation
- Spot checked the flow rates of 3 MVHR units
- Second round of Building User Satisfaction surveys – almost two years after occupation

	At completion ($m^3/m^2.h$ @50Pa)	Post-occupancy ($m^3/m^2.h$ @50pa)	Deterioration (%)
B-GT2	3.99	4.73	18.55
B-FT3	-	4.98	-
B-FT1	3.95	5.49	38.99
B-ST3	3.33	4.95	48.65
C-GT1	3.70	5.23	41.35
C-FT1	3.73	5.44	45.84
C-FT3	-	5.95	-
C-ST3	3.84	5.90	53.64

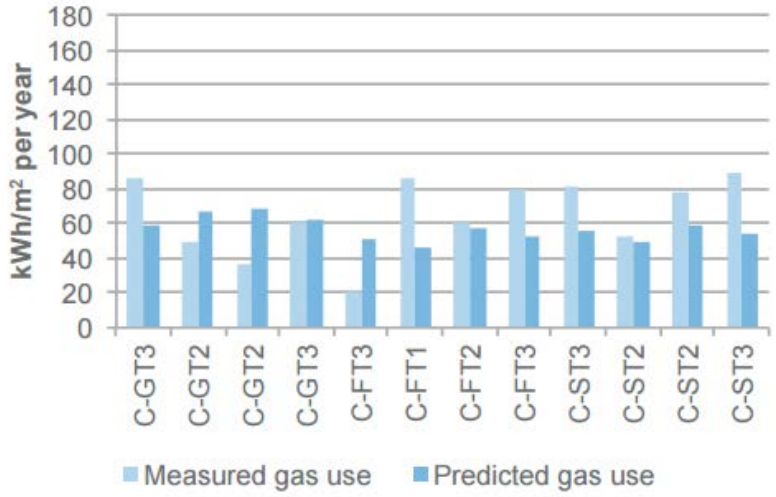
The MVHR flow rate checks identified problems in all tested units, varying from low flow rates to unbalanced systems.

Phase II – Post Occupancy evaluation

BLOCK B



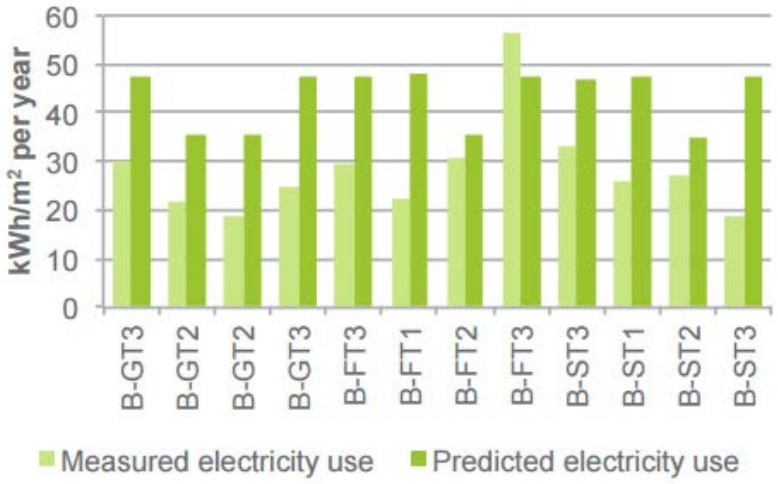
BLOCK C



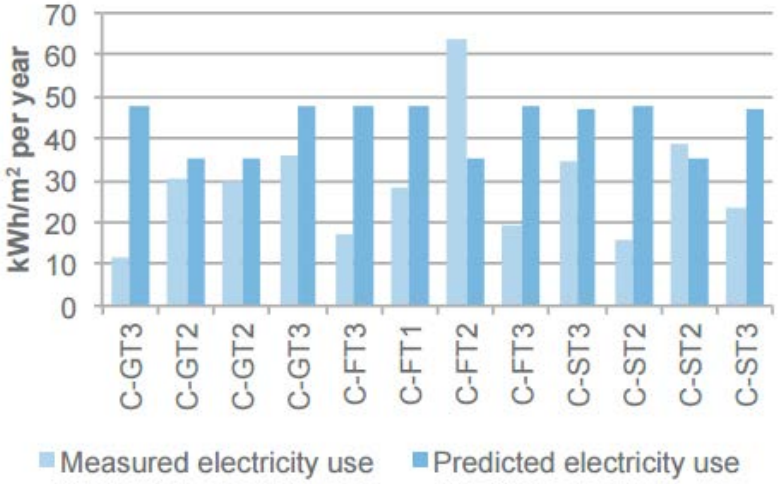
The measured annual gas consumption of the flats in both blocks showed great variations, even when compared between flats of the same typology located within the same block

Phase II – Post Occupancy evaluation

BLOCK B



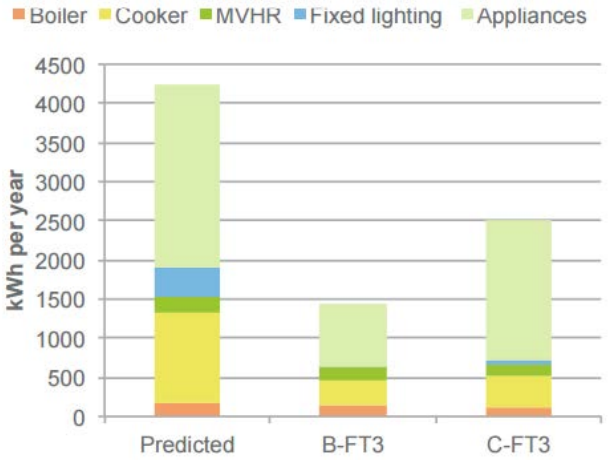
BLOCK C

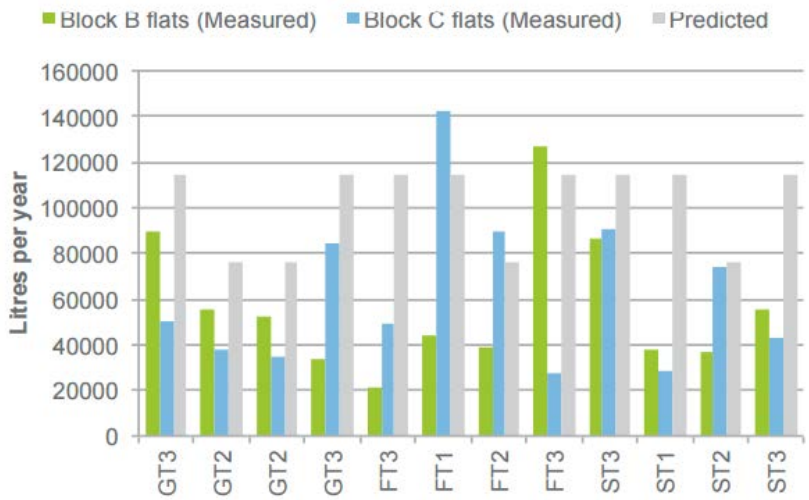


- The average electricity use was generally lower for all the flats than the predicted demand
- Minimal inter-seasonal variations in the electricity use were observed in the two blocks

Phase II – Post Occupancy evaluation

- Most of the electricity was used for appliances
- Both flats showed very little energy use for lighting
- The measured electricity demand of the installed building services was close to SAP predictions



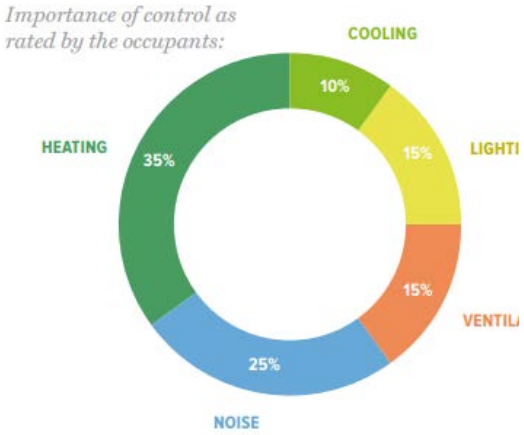


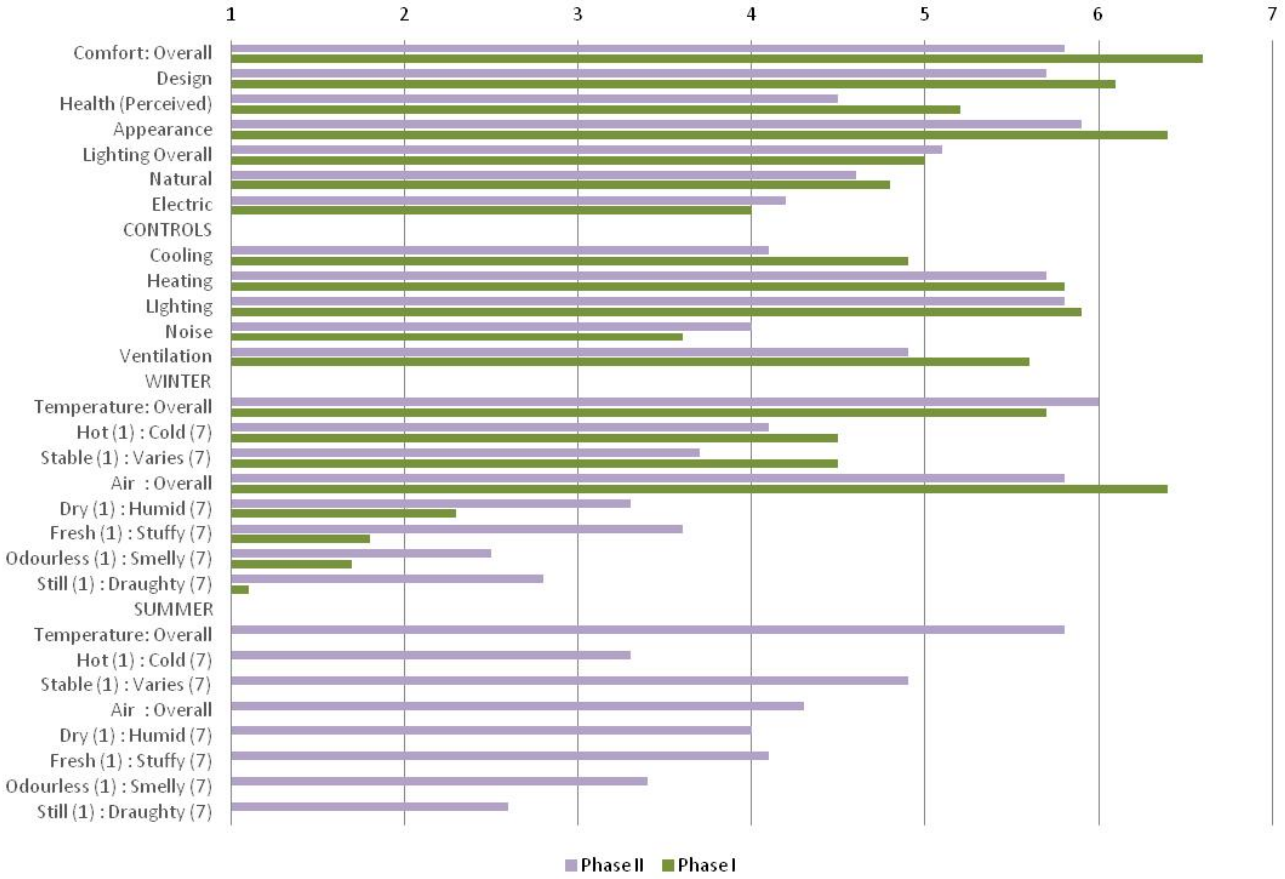
All the flats in the development were designed to comply with level 3 of the CSH, predicting the daily use of potable water to be 105 litres per person

Phase II – Post Occupancy evaluation

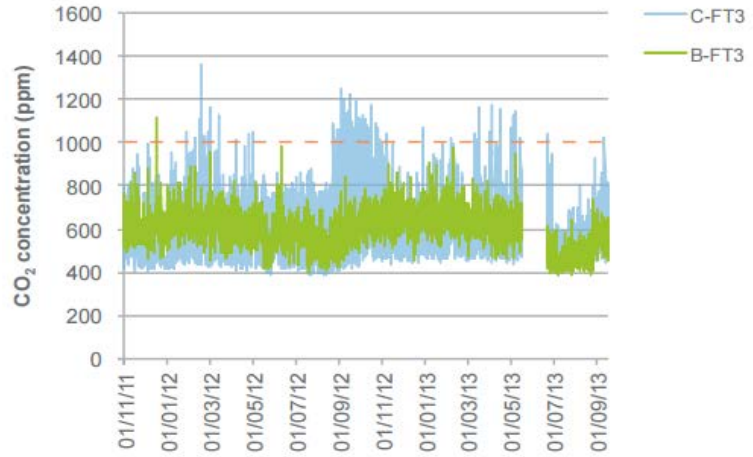
BUS Survey	
Phase I	Phase II
There was generally a high level of satisfaction reported by the residents in regards to quality of construction and comfort experienced in their new homes. There was a general lack of understanding of user manuals for the services	The overall scores for the various parameters were generally slightly lower in the second survey Flats were considered comfortable after a cold winter, however, there were signs of dissatisfaction with the air quality, with it being regarded stuffy and stale. The flats have been generally noted to be not as comfortable during hot weather

Phase II – Post Occupancy evaluation

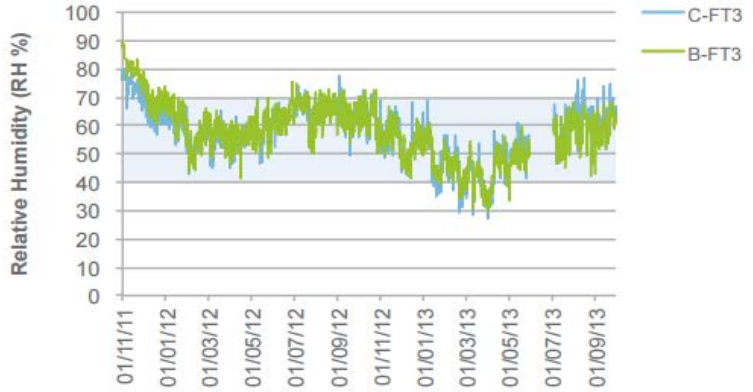




Phase II – Post Occupancy evaluation



Measured CO_2 concentration levels were below the 1000ppm limit for most of the project's duration.



The humidity levels in both sub-metered flats were within the acceptable range for most of the project's duration.

Phase II – Post Occupancy evaluation

• The problems identified with the MVHR units and the low air-tightness levels measured pointed to the fact that the contribution of the MVHR to reducing gas consumption of the flats may have been less than expected.

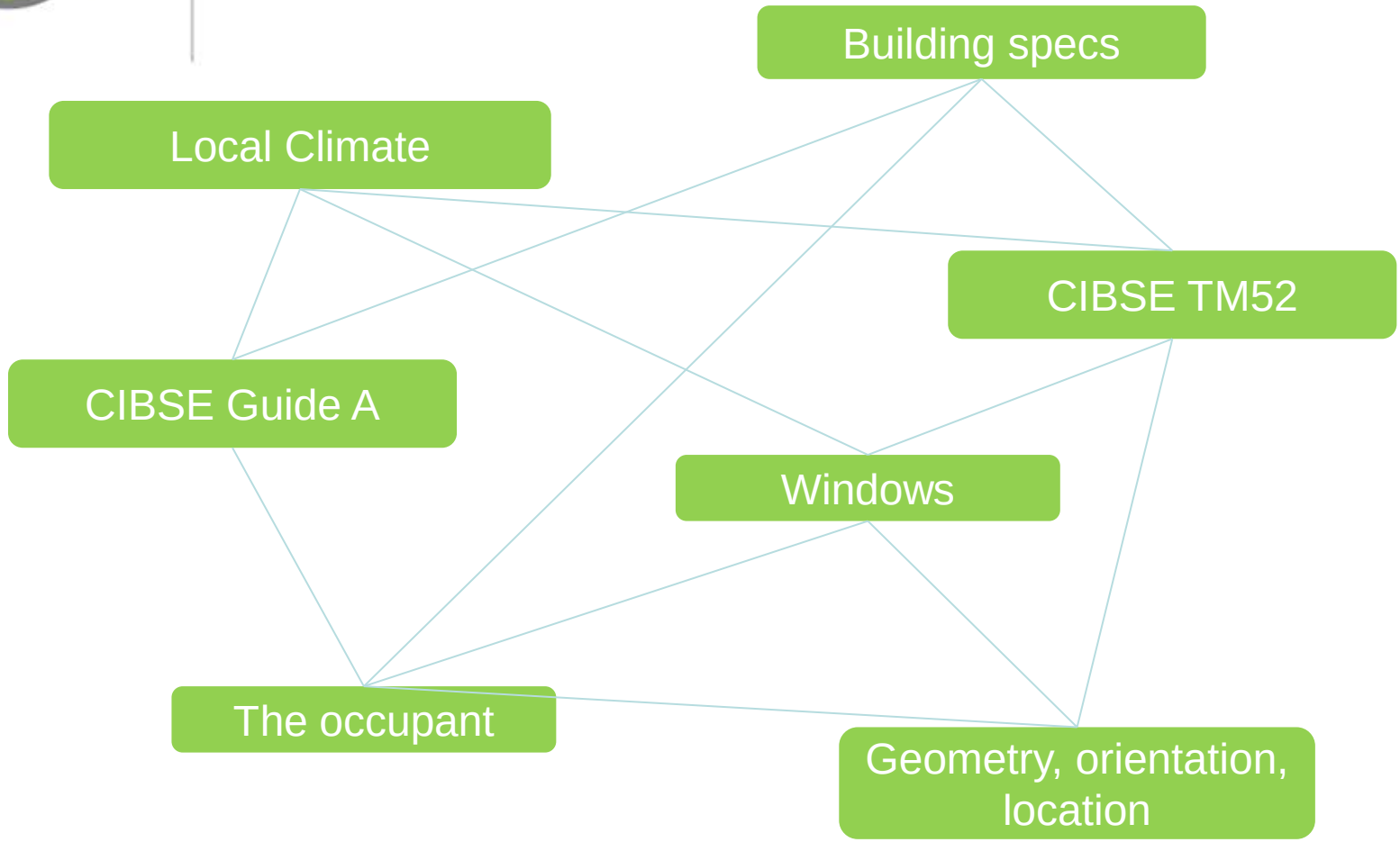
• Some occupants were high gas consumers while others seemed to use very little, irrespective of the flat specifications.

• The difference in the two block specifications appeared to have a small impact on the thermal performance of the units. This difference was more obvious during the winter period.

• Occupants first impressions of the flats remained positive but it was noted that many occupants had difficulty understanding aspects of their heating and ventilation systems.

• Some overheating comments received

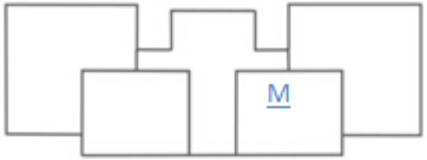
Phase III – The Overheating Study



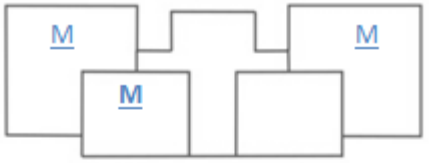
Phase III – The Overheating Study

Monitoring programme

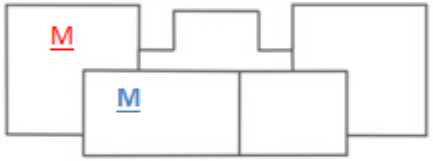
- Temperature and humidity sensors
- Window opening sensors
- External conditions
- All other sensors from Phase II



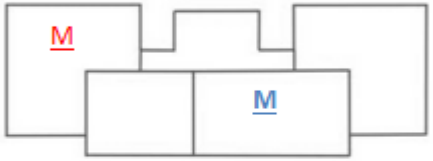
Block B – Ground floor



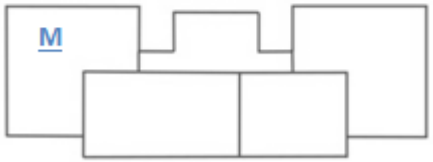
Block C – Ground floor



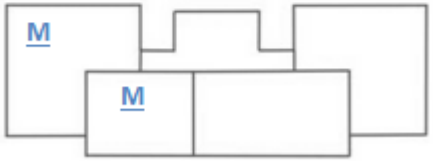
Block B – First floor



Block C – First floor



Block B – Second floor

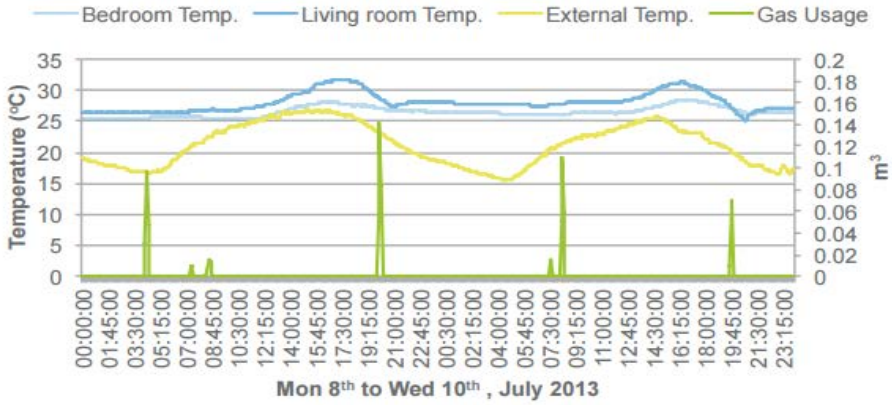


Block C – Second floor

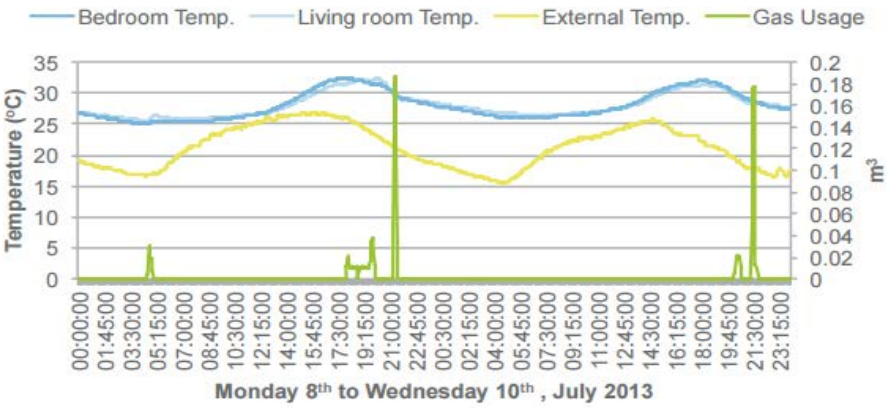
Methodology

- CIBSE Criteria used
- Block B (CSH) compared to Block C (FEES), side to side flat conditions
- Flats type and location within the block evaluated
- Occupants experience, feedback reviewed

YOUNG ADULT, WORKING LATE HOURS.
ONE BEDROOM SINGLE ASPECT FLAT



YOUNG FAMILY OF THREE.
TWO BEDROOM SINGLE ASPECT FLAT



• The impact of the advanced fabric of Block C (FEES) on the internal air temperatures was not clear, potentially because of the small difference in the two blocks specification and other contributing factors that would have had a higher impact on measured temperatures as explained earlier.

•The impact of the ventilation could not be evaluated as MVHR summer mode was not enabled, there were identified issues with the MVHR systems and airtightness deteriorated two year after construction.

• Single aspect flats showed difficulties managing internal temperatures even with windows fully open.

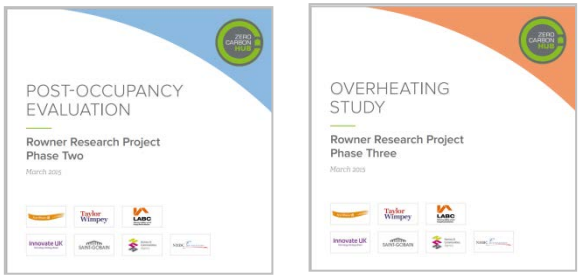
• Smaller single aspect flats and those located on the top floor seemed to be the most susceptible to higher internal temperatures.

• Occupant responses indicated that they felt the temperatures were high during summer

Stay in touch:

www.zerocarbonhub.org

tassos.kougionis@zerocarbonhub.org



Thank you !