107 NIDDRIE ROAD, GLASGOW

Project Description: 107 Niddrie Road is a pre-1919 red sandstone tenement in Govanhill in the south side of Glasgow owned by Southside Housing Association (SHA). Like most traditional Scottish tenements, it consists of eight flats and a communal close and back court. Each flat includes one bedroom, a living room / kitchen, bathroom, hallway and store. This project was designed to EnerPHit standard (the equivalent of Passivhaus for retrofit) and has high levels of insulation and airtightness combined with new heating and ventilation systems. These energy efficient measures drastically reduce energy bills for the tenants while providing them with the healthiest possible internal environment. As well as the energy efficient measures, there was cleaning, repairing and repointing of the sandstone front elevation, improvement of the internal layouts and installation of new kitchens, bathrooms and finishes throughout.

Overall energy demand
20.9 kWh/ m^2.a
(as monitored)

Annual running costs vary between flat types

Construction costs
£2,502 / **m^2**

Standards met: designed to EnerPHit

Location: Glasgow, G42 8PR

Construction: Red sandstone, traditional pre-1919 construction. Timber floor and roof structure

Occupied since: October 2022

Certification Date: n/a

Gross Internal Area: 439m^2

Treated Floor Area: n/a

Form Factor Ratio: n/a

Heat Source(s): 4no flats air source heat pumps, 4no flat gas boilers

TEAM CREDITS:

- **Client/ Developer:** Southside Housing Association
- **Architect:** John Gilbert Architects
- **PH Consultant:** Passivhaus Associates
- **Contractor:** CCG
- **Certifier:** WARM
- **Other Consultants:** Design Engineering Workshop, NBM Construction Cost Consultants

PHPP screenshot awaited from consultant

The heating demand has been reduced by 90%. This was calculated through PHPP as 25.9 kWh/m2/year. The monitoring of these flats has confirmed they are actually performing better than this and achieving 20.9 kWh/m2/year.

CO2 emissions summary: 70% reduction in CO2 produced per m2 (average across the 8 flats)

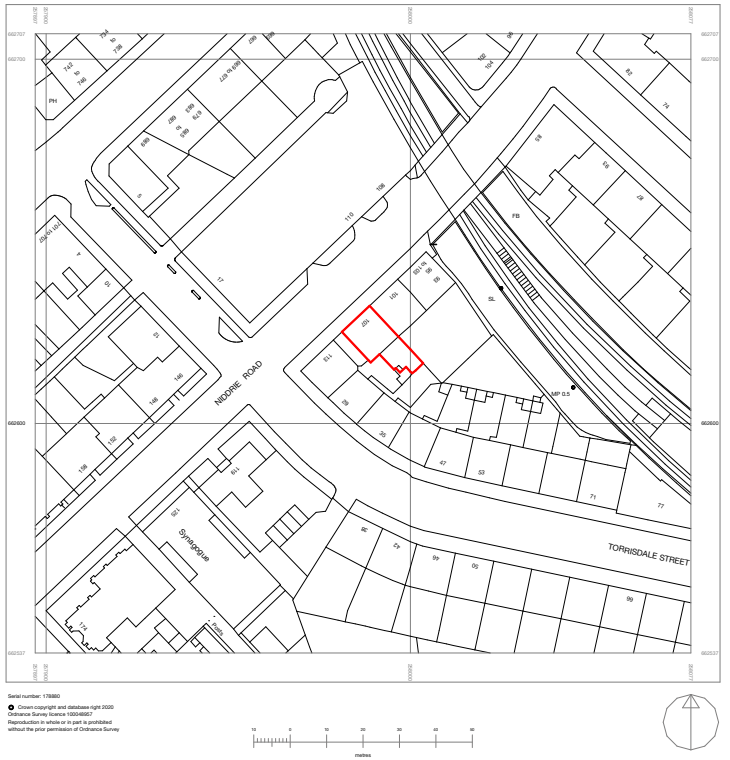
Before - CO2 production per m2 per year = 39 kgCO2e/m2/year

After - CO2 production per m2 per year = 11.9 kgCO2e/m2/yr

Four of the eight flats are ‘net zero’ utilising ASHP technology. It was originally proposed to retain the existing gas boilers, but the funders were keen to see a demonstration of renewable technologies. However, it was not possible to agree with the Planning department a fully renewable solution, so a compromise was reached where Air Source Heat Pumps (ASHPs) were located to the rear gardens and supply heat to the four lower flats, while gas boilers supply the upper flats.

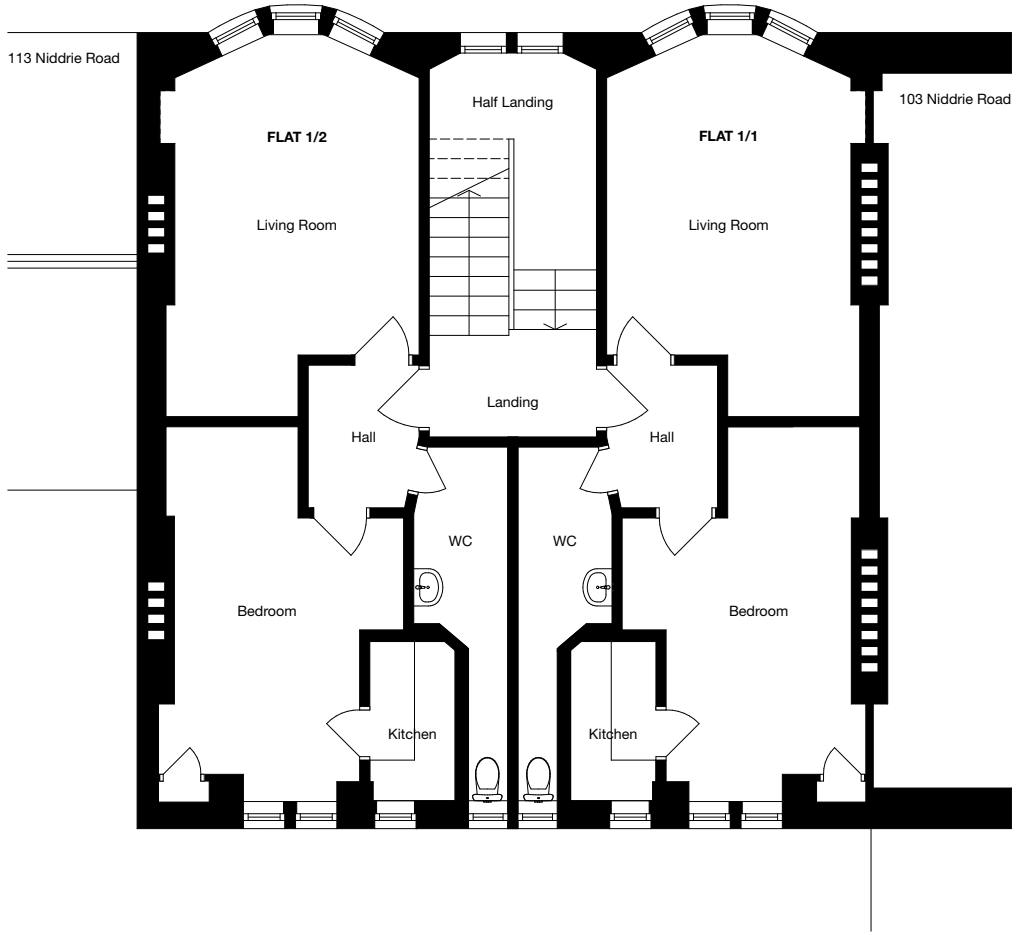
In addition to recovering heat from the outgoing air, we also specified Waste Water Heat Recovery technology to recover heat from the outgoing hot water because with space heating demand low, the hot water would become the largest component of any future heating bills.

Site aerial and location plan below. Site constraints: i) heavily overshadowed by adjacent tenement buildings and mature trees, ii) limited south east facing windows (limited solar gain), iii) large areas of north west facing glazing and iv) significant unavoidable thermal bridging (due to traditional construction materials and methods) - all of these are bad for Passivhaus!

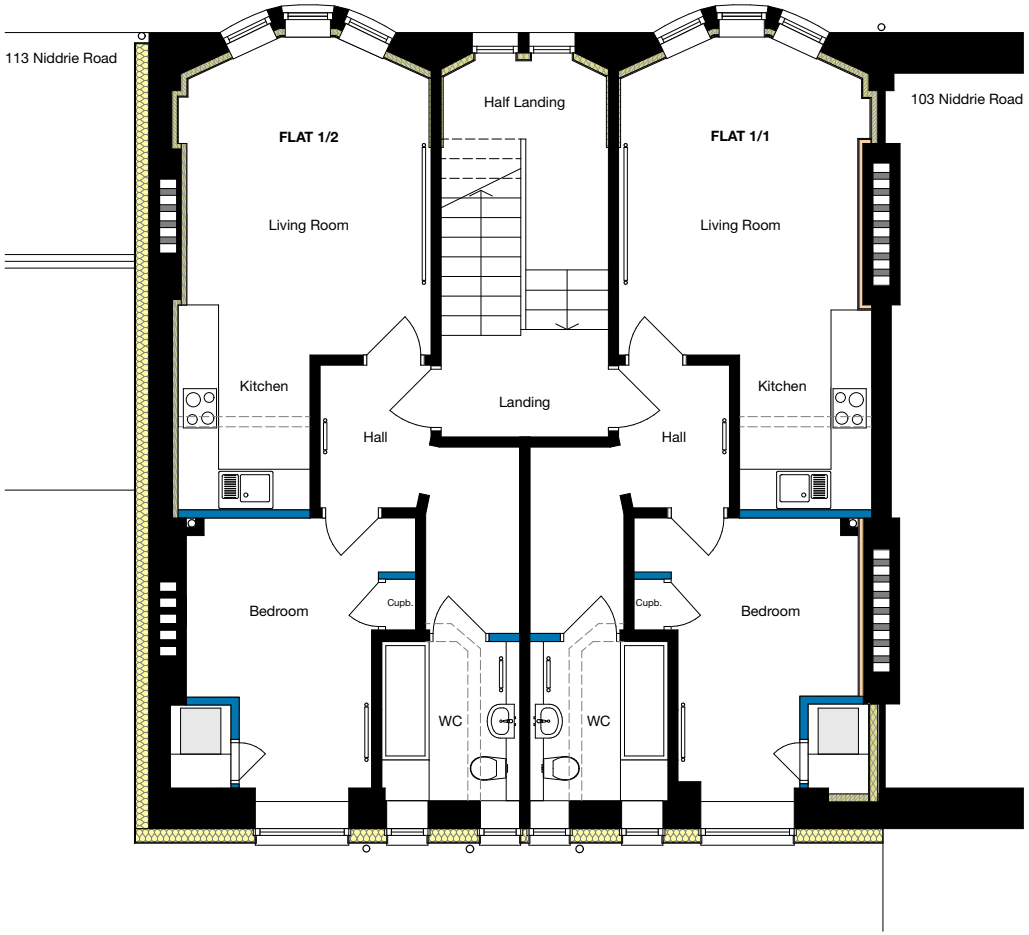


DESIGN PHILOSOPHY & SITE PLAN

Plans

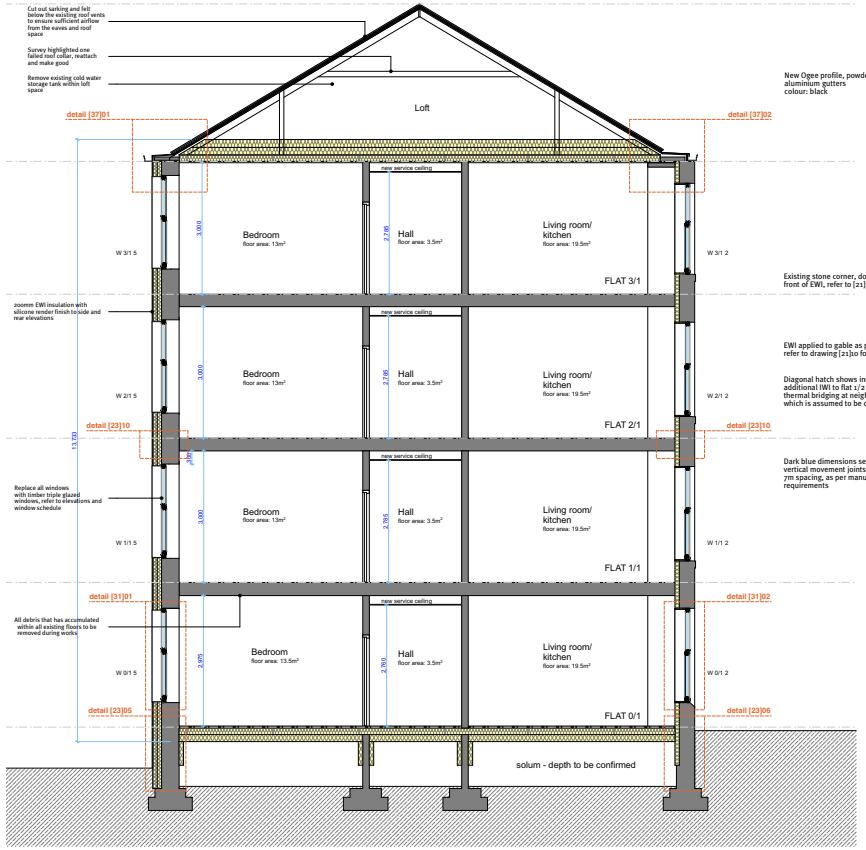


Typical existing upper floor plan

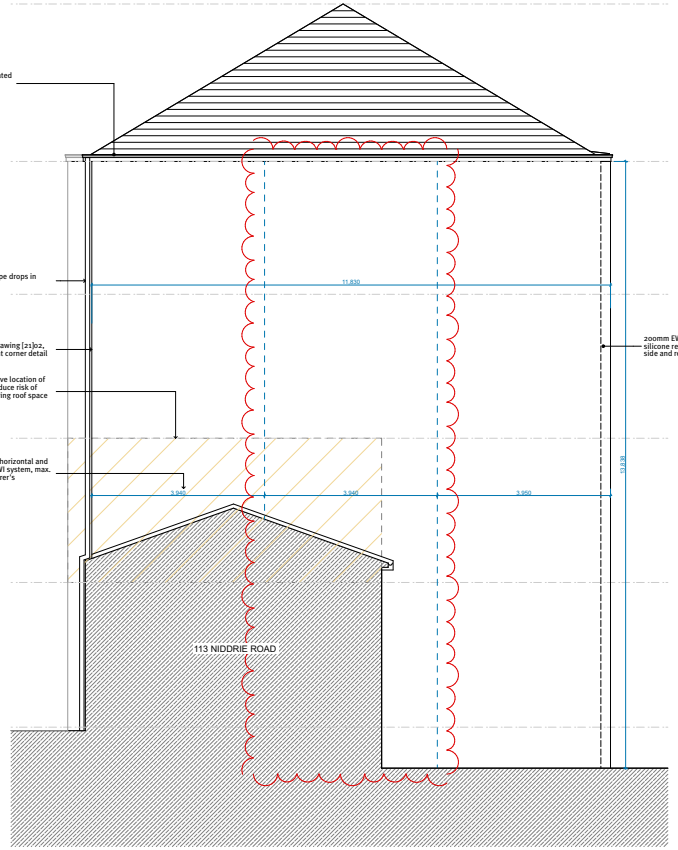


Typical proposed upper floor plan

Key sections & elevations



Proposed cross section



Proposed gable elevation

Rear elevation with EWI complete

107 Niddrie Road is a pre-1919 red sandstone tenement in Govanhill in the south side of Glasgow owned by Southside Housing Association. Like most traditional Scottish tenements, it consists of eight flats and a communal close and back court. Each flat includes one bedroom, a living / kitchen, bathroom, hallway and store.

This project was designed to EnerPHit standard (the equivalent of Passivhaus for retrofit) and will have high levels of insulation and airtightness combined with new heating and ventilation systems. These energy efficient measures drastically reduce energy bills for the tenants while providing them with the healthiest possible internal environment.

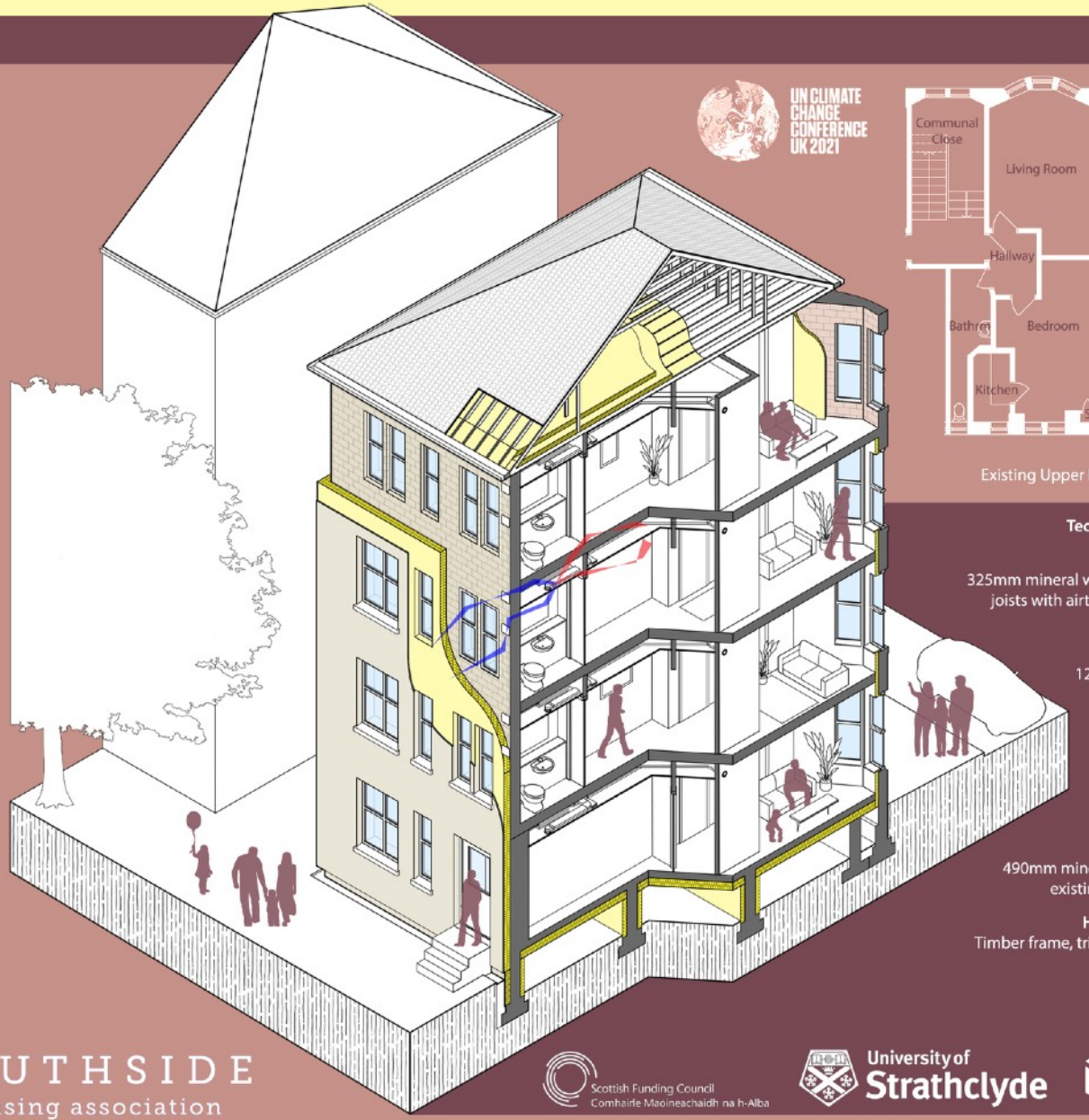
As well as the energy efficient measures, we will be cleaning and repairing the sandstone front elevation, improving the internal layouts and installing new kitchens and bathrooms.

'Fabric First Approach'
We have to improve the building fabric in order to minimise the heating demand and we have done this by ensuring the whole envelope is wrapped in high levels of insulation, minimising thermal bridging and ensuring there is a continuous airtightness line. The insulation and airtightness lines are continous at all key junctions (eg. at eaves level, windows, doors etc.) General building improvements have also been carried out.

Heating and Domestic Hot Water
The lower four flats will be heated by individual air source heat pumps (ASHP) which take heat from the external air and uses it to provide hot water for new radiators and domestic hot water. The four upper flats will be heated by new efficient combi condensing gas boilers which provide hot water for new radiators and domestic hot water.

Mechanical Ventilation Heat Recovery
All eight flats will have their own mechanical ventilation heat recovery unit (MVHR) installed above the ceiling in the bathrooms. These will extract moist / stale air from kitchens and bathrooms while bringing in fresh air from the outside. The heat exchanger transfers the heat from the stale air to the fresh to minimise heat loss which reduces the heating demand.

Wastewater Heat Recovery
The upper six flats will have wastewater heat recovery units installed to the bath / shower so heat can be recirculated back into the hot water system which reduces the heating demand.



UN CLIMATE CHANGE CONFERENCE UK 2021

Existing Upper Plan

Proposed Upper Plan

Technical Data - insulation and airtightness

Ground Floor 0.11 W/m²K
325mm mineral wool insulation fixed between and below joists with airtightness membrane above and breather membrane below

External Walls (front) 0.38 W/m²K
120mm wood fibre internal wall insulation with two layers of natural lime parge

External Walls (rear) 0.18 W/m²K
200mm mineral wool external wall insulation with silicone render and a layer of natural lime parge internally as the airtightness layer

Loft Insulation 0.07 W/m²K
490mm mineral wool packed between and on top of existing timber joists and breather membrane

High Performance Windows 0.89 W/m²K
Timber frame, triple glazed Passivhaus certified windows from Green Building Store

CCG

John Gilbert ARCHITECTS

SOUTHSIDE housing association

Scottish Funding Council
Comhairle Maoineachaidh na h-Alba

University of Strathclyde

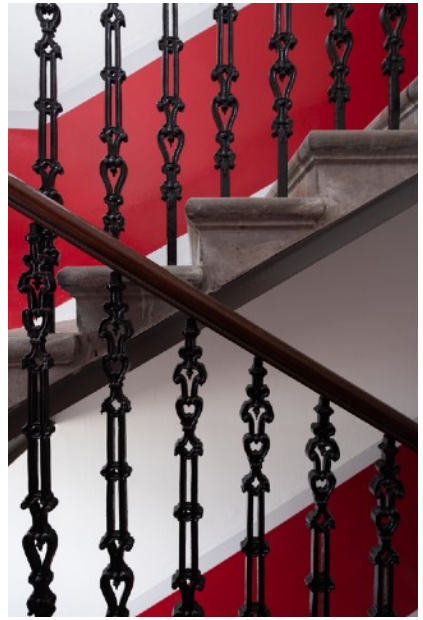
UK COLLABORATIVE CENTRE FOR HOUSING EVIDENCE

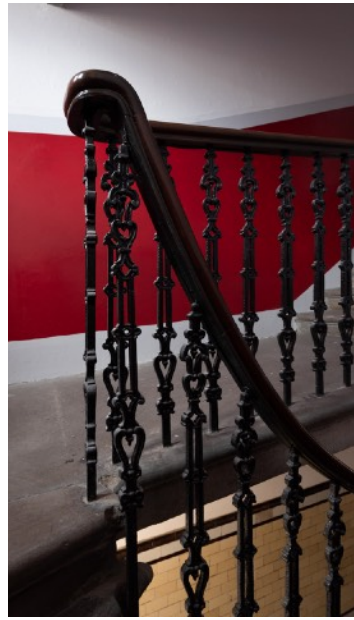
Glasgow CITY COUNCIL

Internal & external images

Front and gable elevations

Bay window internally





Summer comfort strategy:

No. Occupants:
8no 1 bedroom flats

Overheating/year:
0%

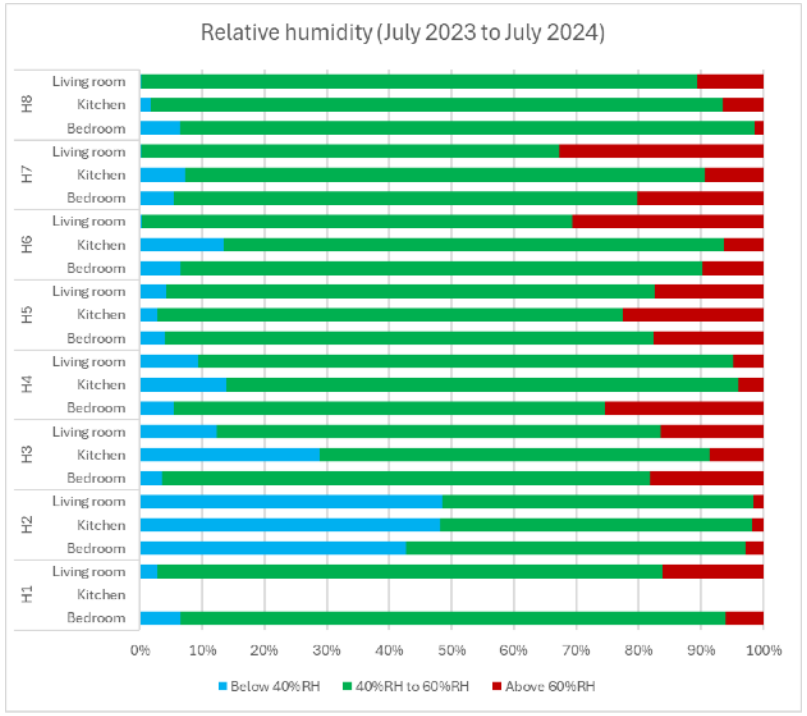
Risk management & mitigation approach (based on measured data) to:

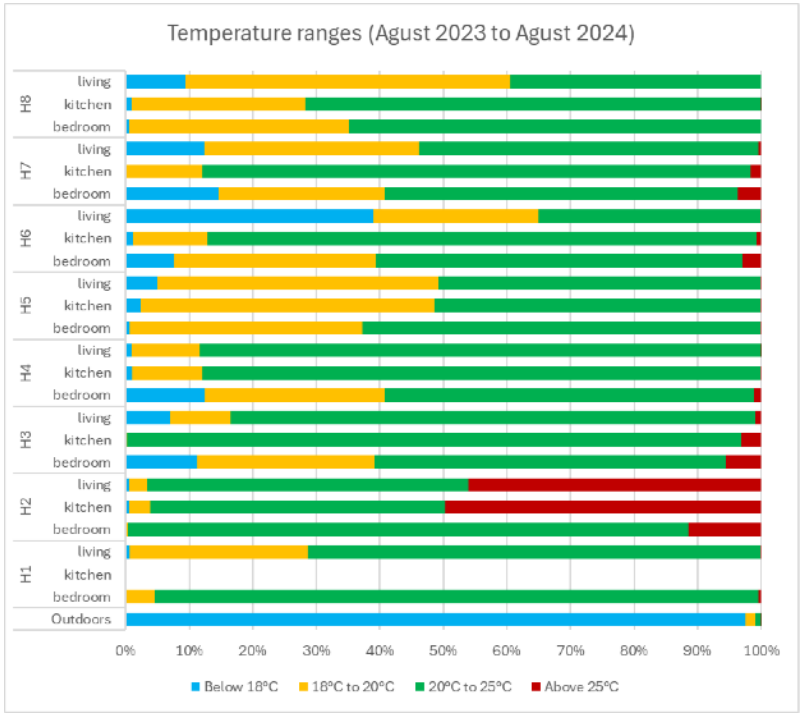
- Ventilation - openable windows throughout, MVHR units to each flat with summer bypass function
- Shading - the building is naturally shaded due to its orientation, neighbouring tenements and mature trees, refer to site aerial and location plan.
- Glazing - triple glazed Passivhaus certified windows throughout
- Services design - MVHR units concealed above bathroom ceilings with summer bypass setting. Location and concealment to minimise any background noise internally

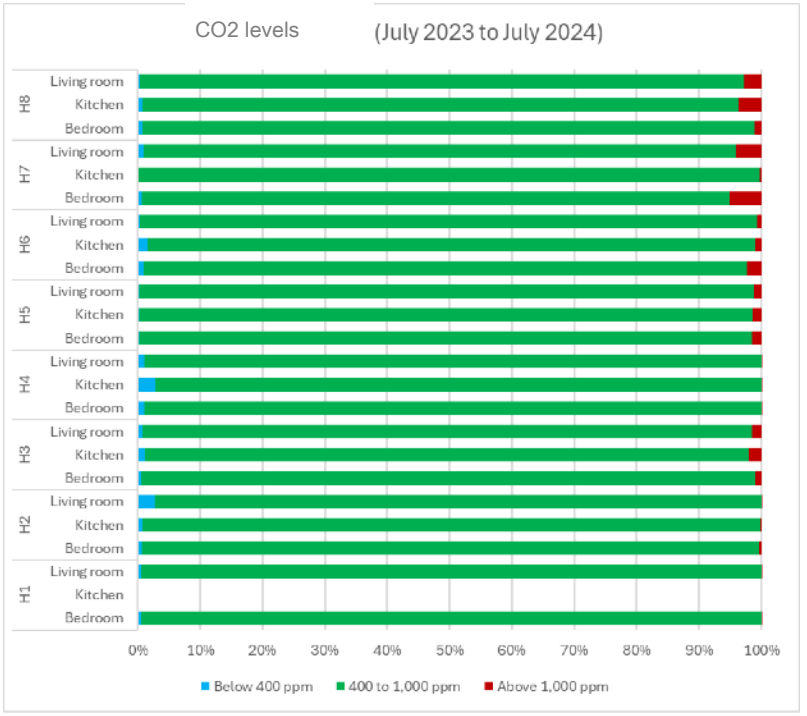
Monitored data graphs / charts

Occupant feedback: Occupants reported overall satisfaction with all the aspects of the home, particularly the low energy bills. Several of the occupants reported not having to pay for electricity during the period of the energy rebate from the Government between October 2022 and March 2023. From a fuel poverty and affordability perspective, this was very positive for occupants as this suggests that the monthly energy bills were below £66.00 even with particularly high energy prices and that some of this credit may have even rolled out to further months. Some quotations from the interviews are below in blue.

Monitoring data for summer 2023 to summer 2024 is also summarised for the eight flats below (provided by Strathclyde University who are conducting the monitoring and research).





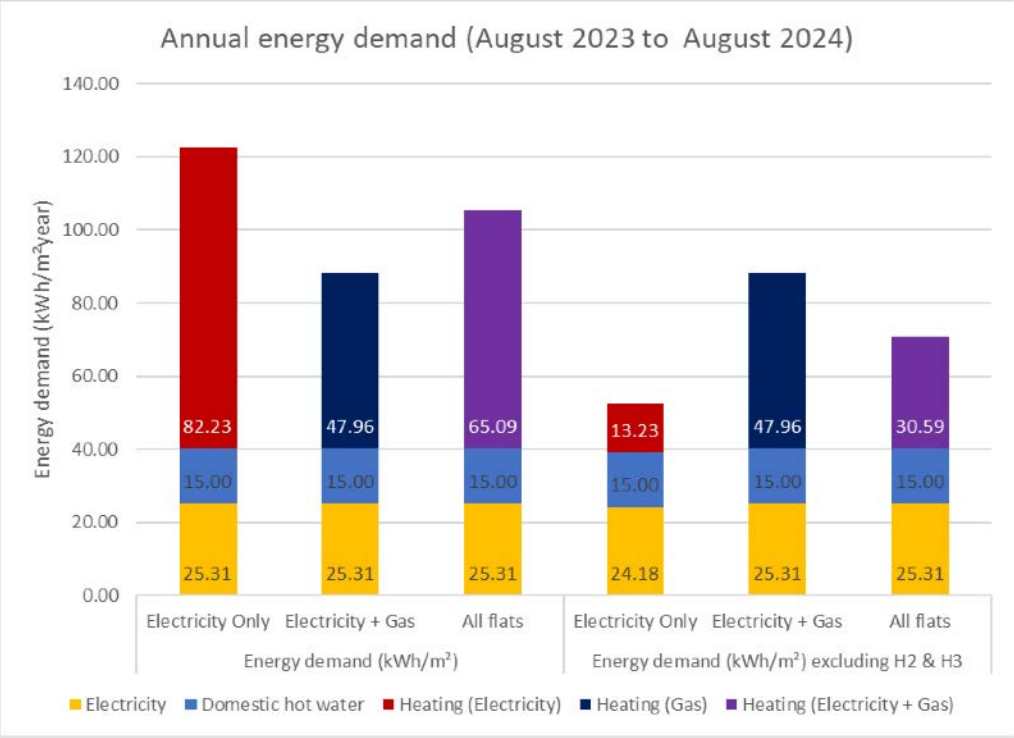


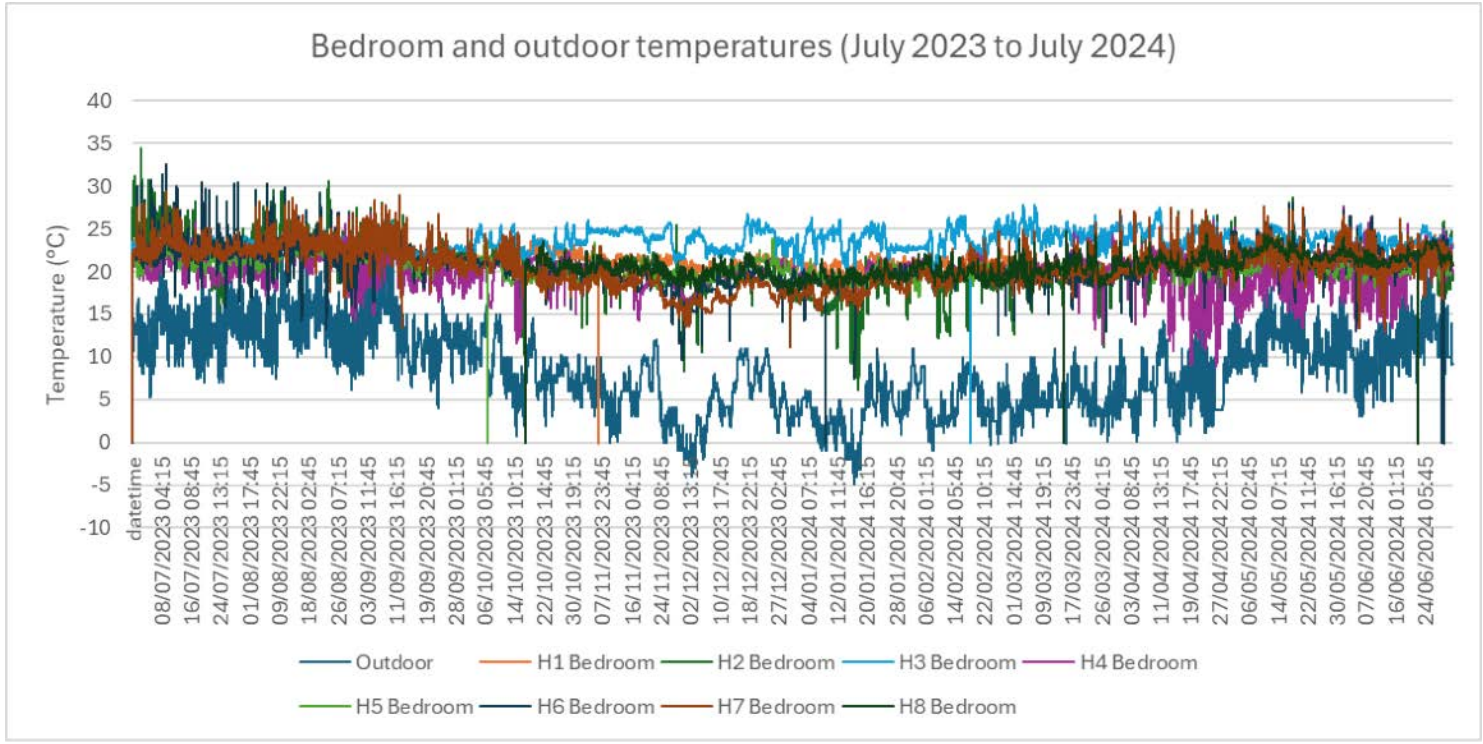
"I wish all the homes were like this one. I have been very happy since I moved in and I don't need to worry about the energy bills"

"The house was too warm during winter, but after a visit from the engineers to look out to my boiler, everything was good. I haven't had any problems since then"

"My house is comfortable and cheap to heat"

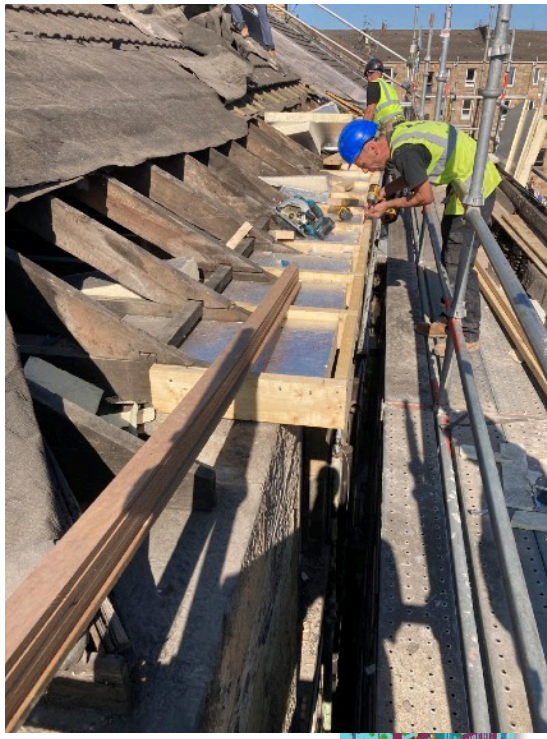
Monitored data graphs / charts





Note: flat ‘H2’ has been excluded in some of the data due to issues with the tenant. This tenant has serious mental health issues and internal temperatures have been kept extraordinarily high using plug in electric heaters, even during summer, and this has skewed some of the data.

- Natural materials - natural hygroscopic materials were used where possible. Natural lime parge coat applied to stonework internally throughout to provide airtightness layer and minimise use of sheet membranes. Internal wall insulation (IWI) fixed at front elevation was natural wood fibre board, see image on the right. External wall insulation (EWI) fixed at rear and gable elevations was mineral wool insulation. This was chosen for its ease of install and high performance and non-combustible qualities (required) due to building height.
- Embodied carbon - this was not calculated as part of the project.
- Petrochemical materials - some PIR insulation was used in specific areas where high performance insulation was required but where depth / thickness had to be kept to a minimum (around window reveals for example). Natural insulation depths would not have worked or reduced thermal bridges enough. PIR was also used at wall heads to ensure insulation continuity from wall (EWI or IWI to loft insulation) where the traditional timber rafters and roof tiles constrained the space we had to work with, see image on the right..
- Avoiding chemical treatments - a number of structural repairs were made and decayed timber was repaired. While a conventional chemical company quoted around £20,000 to spray the timbers of the building with chemical fungicides and biocides, JGA opted instead to engage a building pathologist to advise. Heritage & Design Ltd. helped us specify suitable specifications which meant none of those chemicals were needed while ensuring the long term durability of the timber and the health of the occupants.
- Detailing - it was felt that even though the building is not in a conservation area, that external insulation to the stone facade would not be appropriate, so an internal wall insulation solution was designed. Internal wall insulation is tricky though because it can cause increased risks associated with moisture, but we were also keen to trial the technique we had seen abroad where the insulation is installed directly against the masonry, relying not on air movement, but on the vapour permeability and hygroscopicity of the insulation to manage the moisture risk. Great care was taken and the whole element tested using WUFI hygrothermal calculations. The WUFI calculations carried out by Greengage demonstrated that all elements were safe, except the timbers in the street side, internally insulated wall and so it was decided to remove these. Removing joists increased costs but ensured firstly that no future decay could come back to haunt the client. It also simplified the forming of the airtightness layer. Instead of being buried in the wall, a new perimeter beam was installed with insulation behind which also ensured that the otherwise tricky floor-to-wall detail was wholly thermal bridge-free. One of aspects of the push towards energy efficient retrofit that concerns us as a practice is that both planning / conservation and cost pressures are driving many towards, in some cases, poorly conceived internal insulation solutions and we worry about the long term effects this will have on moisture and maintenance of these retrofitted buildings, as well as the possible knock-on effects on occupant health.



CONSTRUCTION APPROACH

Throughout the construction works at 107 Niddrie Road we accommodated dozens of building visits from people from all walks of life. There are approx 80,000 tenements in Glasgow and more than double that in Scotland so there was a great deal of interest. Patrick Harvie (The Minister for Zero Carbon Buildings, Active Travel and Tenants' Rights) and several other MPs visited the building as well as several local councillors. There have been multiple visits from members of other housing associations and students from various Glasgow institutions, some of whom were writing essays on the project.

During the project and since completion we have given a number of talks in person and online to help spread the knowledge gained on the project. There was a documentary made about the project which is free to view on YouTube and there have been several journalists that have covered the project (link: https://youtu.be/Klysx_-qmy4?si=pIuViza_y7R6abMh). The project also featured in the international COP26 'Virtual Pavilion' and it was the only project from the host city to feature. It is crucial that those not involved in construction also know about the project and its basic principles.

An extensive research and information dissemination project has followed on, and is still on going, from completion. A dedicated research team at Strathclyde University are closely monitoring the building performance and sharing the learning so professionals can use this and apply it on future projects. During the project we have conducted three Matterport 3D visual scans showing the building once stripped back, midway through and at completion. These 3D models can be explored on screen or with a VR headset and will form the basis for an app being developed by the university which demonstrates the retrofit principles and steps by overlaying them on these 3D models.
Link below: https://my.matterport.com/show/?m=j5WgEdowQpu

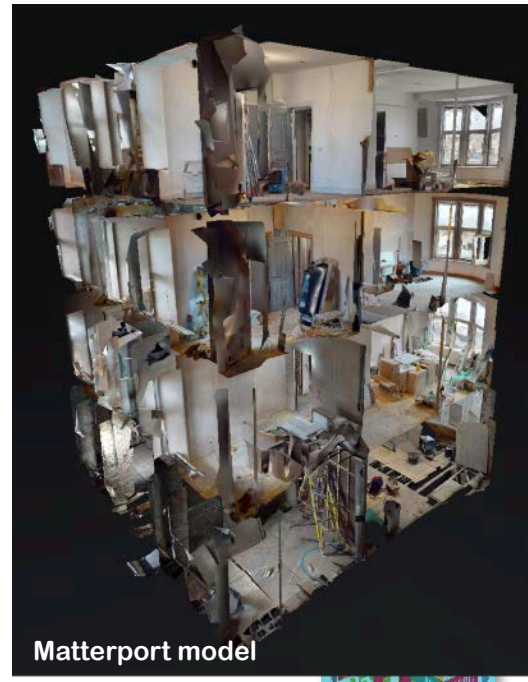
Prior to tenants moving in there was an introductory session where installers came out to talk the tenants through the operation of the technologies such as ASHP, MVHR and boilers. We also attended this to give the tenants some background on the principles of insulation and airtightness and the most efficient way to live in the flats. As with most of our housing projects we also provide tenant Quick Start Guides which gives an overview of the flats and the most efficient way to live in them.

Applicable at scale - this project is unique in that all eight flats were in the same ownership and has been vacant for a couple of years prior to the project going on site. This allowed a very intrusive approach which took most finishes back to the sandstone internally and opening up of ceilings and floors. Most tenements are mixed tenure and in several different ownerships which would complicate the process. However, testing of this innovative approach has been well worthwhile and the whole team learnt a great deal about tenements and how best to retrofit them. This learning is not confined to Niddrie Road and can be applied to future projects whether or not they are single flats, whole tenements or deep whole house retrofit such as this.

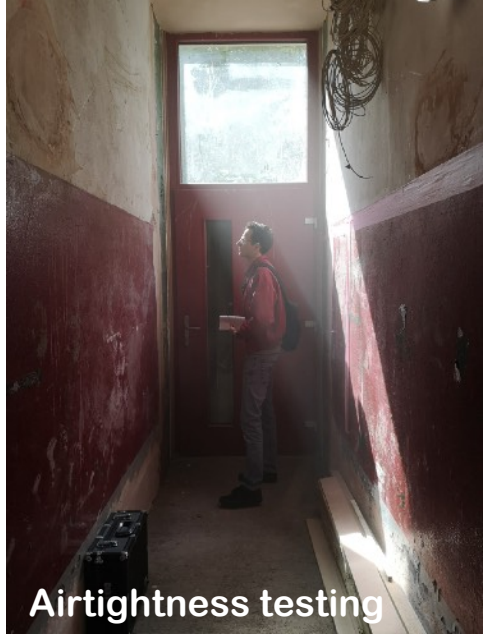
What would you do differently - two areas which proved tricky on site were: i) the ground floor works and ii) existing chimneys. The suspended timber ground floors (with solum below) was fully opened up to allow for insulation install to dwarf walls and to underside and between timber joists. This was a particularly difficult install with confined working conditions and the varying conditions of the masonry dwarf walls was a concern. In hindsight, a simpler solution would have been to remove the existing floor fully and install a well insulated ground bearing slab. This would have made the insulation and airtightness install easier but also more effective. The building originally had two chimneys, one which was previously lowered (on the gable) and one which remained in place (on the party wall) with all fireplaces already being covered over. Each flue was a shaft of cold air within the masonry walls which meant we had to utilise some intricate insulation and airtightness solutions to minimise the risk of thermal bridges and draughts. A more robust solution would be to lower the chimney so it sat fully within the insulation and airtightness line. The gable chimney flues were filled with EPS beads and capped at the head but this was not possible at the party wall due to the unknown condition of the masonry flues and the neighbouring fireplaces.

Lessons - the site start was begun prior to the pandemic but then the site was shut until the situation improved. During this period the building had deteriorated in several areas meaning the scope of work (and costs) grew. At this point a reassessment of the proposed solutions would have saved time on site and given the chance to improve on some of the proposed solutions. We are already using details developed and applying learning from this project in future tenement projects and other retrofit projects of heritage buildings.

Bay window lead works


Matterport model

Opened up ground floor bay window


Airtightness testing

Ground floor airtightness membrane

Improved layout

Conservation of masonry

EWI works to rear

IMAGES

Completed front and gable elevation

Retained / repaired finishes in close

IMAGES