Children Built This City

Co-Housing from a Child's Eye

AB316 Environmental Technology

Chloe Pimblett

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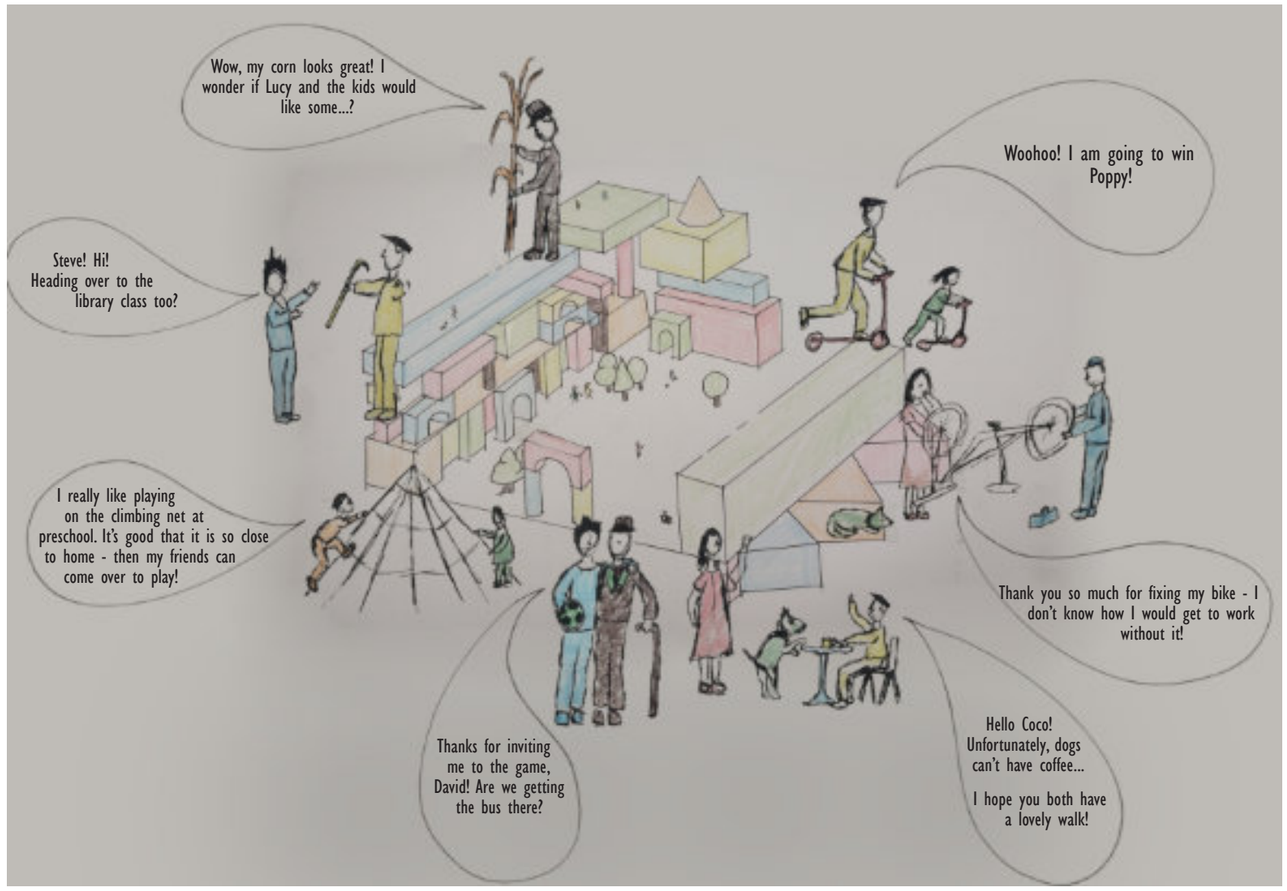
Introduction - Co-housing through a child's eye



Lucy, Steve, Charlie and Poppy

Lucy and Steve moved in just after they had Charlie, and Poppy came along not long after! They live in a 3 bed, and use lots of the shared facilities. Lucy says the best bit is the preschool being so close, but if you ask the children, they love to be able to play outside while their dad watches from the balcony!

David and Archie

David lives in a 1 bed duplex, and his friend Archie visits so often that his neighbours thought he had moved in!

Archie spends lots of time tending to his plants, so he loves that the house has a front garden, back garden, and access to the shared roofspace too.

Living near Charlie and Poppy really gave David a childish sense of life - sometimes he can even be seen having a go on Poppy's scooter!

Mel and Coco

Mel works in the city centre, and though it's only her and Coco at the moment, she is hoping to extend her family soon. She lives in a 2 bed flat, and can often be found sipping a vanilla latte at the community coffee shop (and Coco sniffing out pastry crumbs!)

On weekends, she picks up a shift or two in the store, where she sells any excess produce grown on the allotments, as well as some cakes that the lady on the third floor bakes.

My proposal helps create a sustainable community by…

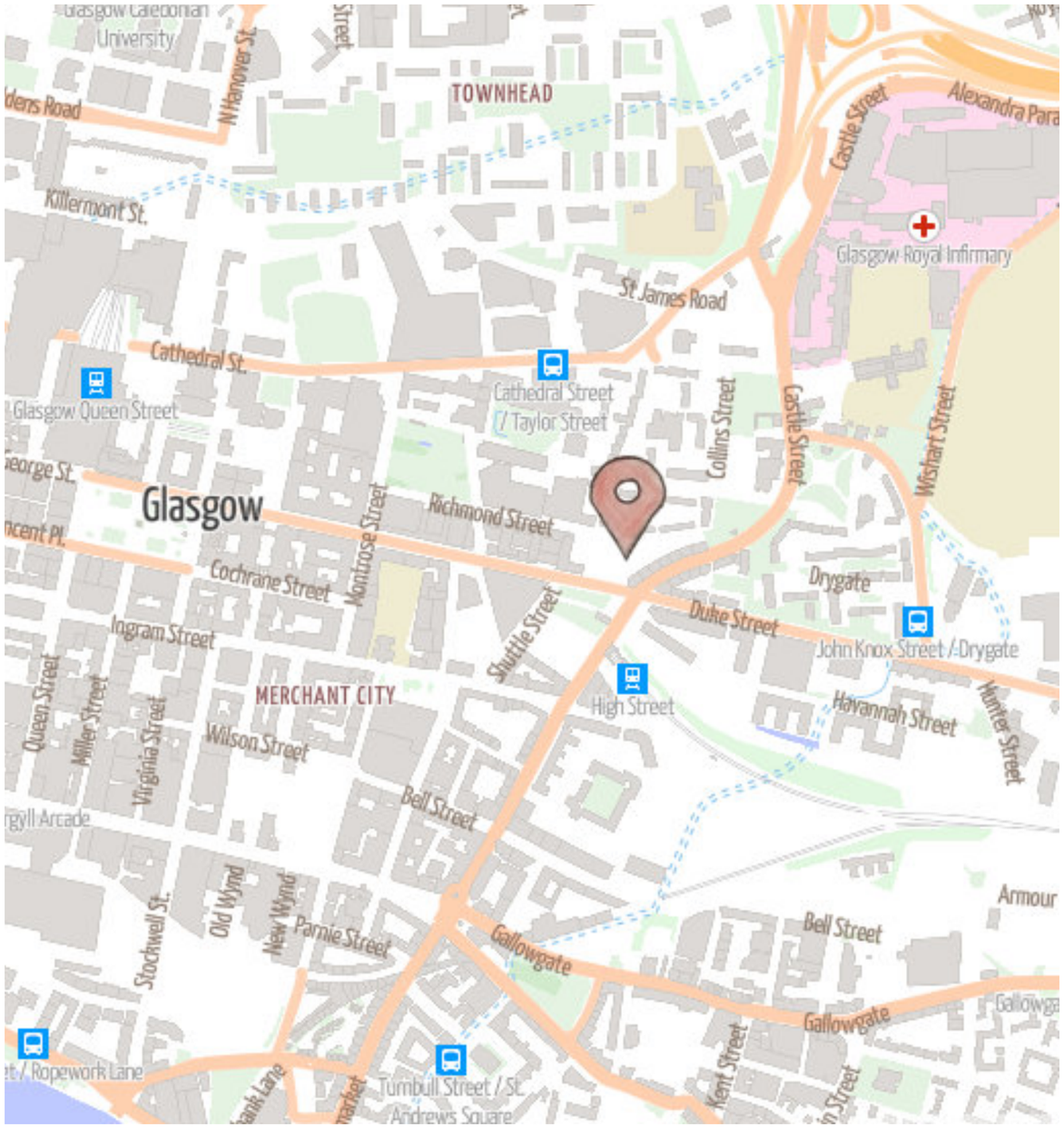
- Offering a range of housing suitable for all families

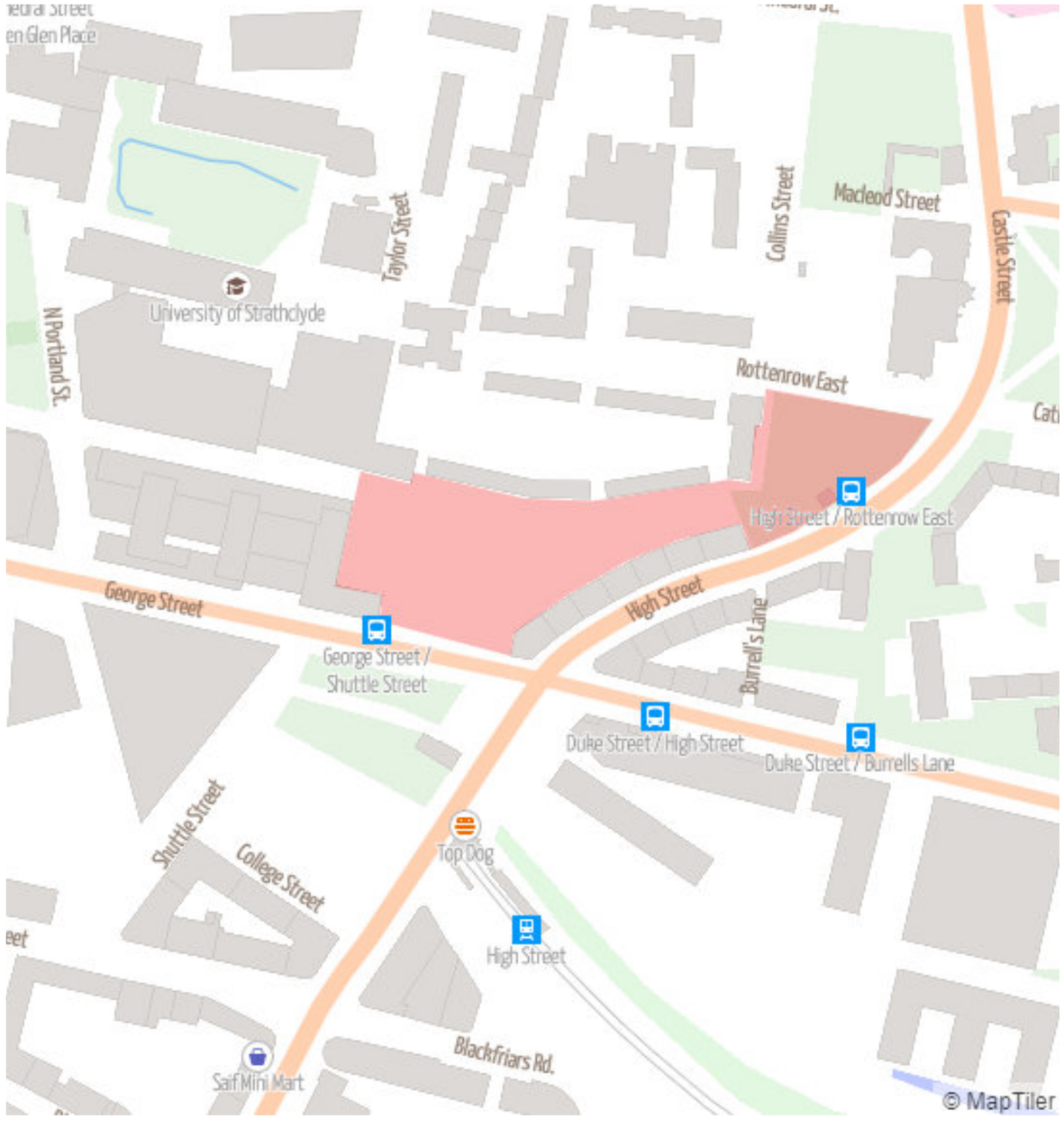
- Creating spaces where residents can learn

- Connecting to the wider community with commercial street facades that can be accessed via active travel routes

- Ensuring all residents have a variety of outdoor spaces, and access to the local economy via the community cafe/shop

Site Location





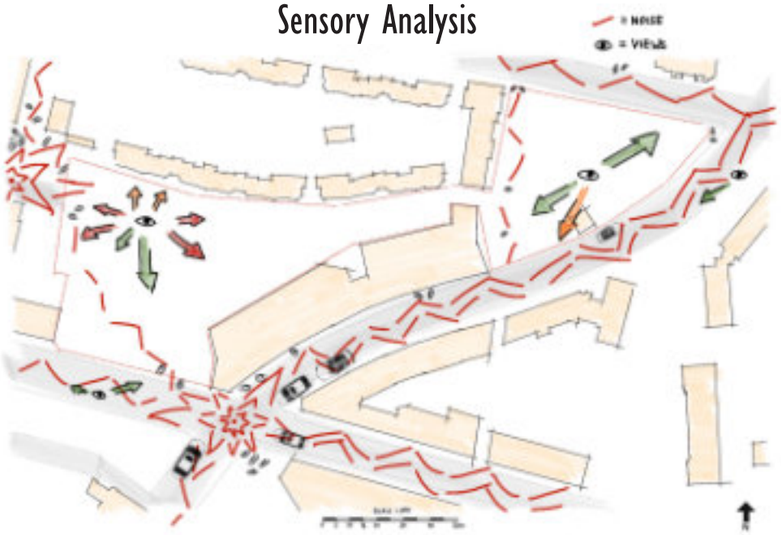
Site Analysis

Climate and Weather

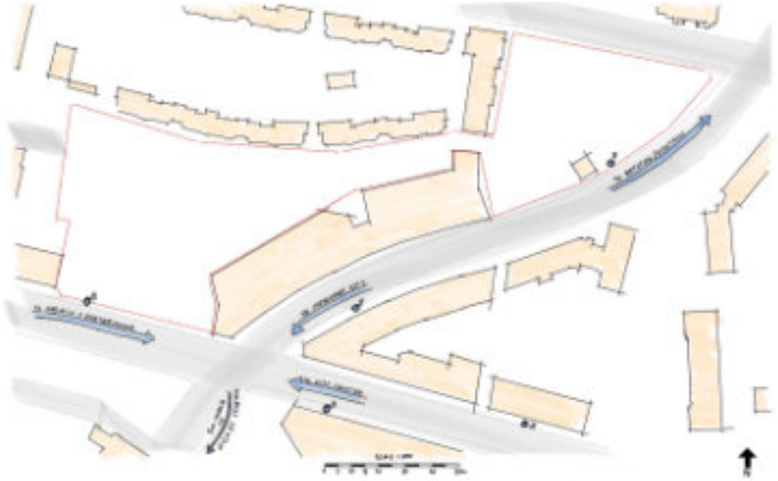
Natural Features

Manmade Structures

Sensory Analysis



Public Transport



Pedestrian Routes

Both sites have good potential solar gains, and minimal overshadowing. The slope of both sites could leave them at risk of flooding on the Southern edge.

The North site, at Rottenrow, is currently more "green" than the George Street site, but both have existing trees that could be maintained.

Man-made elements that impact the site include existing buildings, three murals, a bus stop and a large retaining wall.

The sites both have good views, but the George street site also has a more negative view into the back of the existing tenements.

Both sites have good connections, both with bus routes, High Street station, and a variety of pedestrian routes.

Housing Design

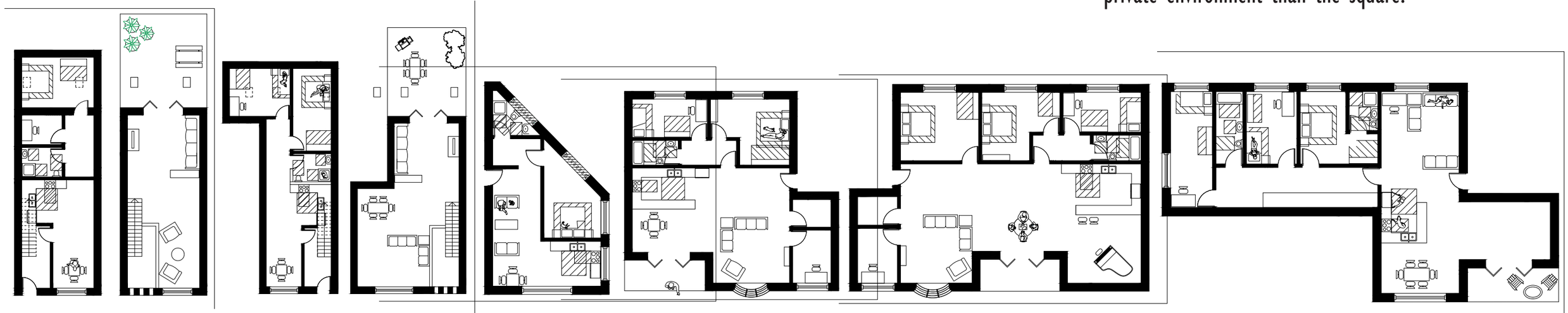
My design is an L shaped block of housing, creating a bright, green, semi-private square to it's South and private, intimate gardens to the North and East.

Along George Street, community-centred shops encourage passing members of the public to engage with the residents, which continue up to a second story that allows spaces such as cafes to spill out into the square.

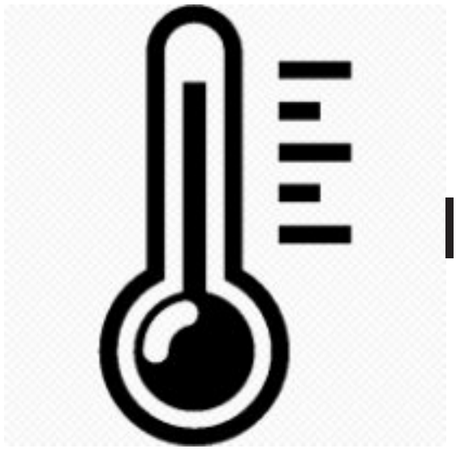
6 different housing typologies were included in my proposal:

- 1 bed duplex (with private garden to front and rear)
- 2 bed duplex (with private garden to front and rear)
- 1 bed flat
- 2 bed flat (with private balcony)
- Two versions of 3 bed flats (with private balconies)

All residents also have access to roof terraces and growing space, which allows them to interact in a more private environment than the square.



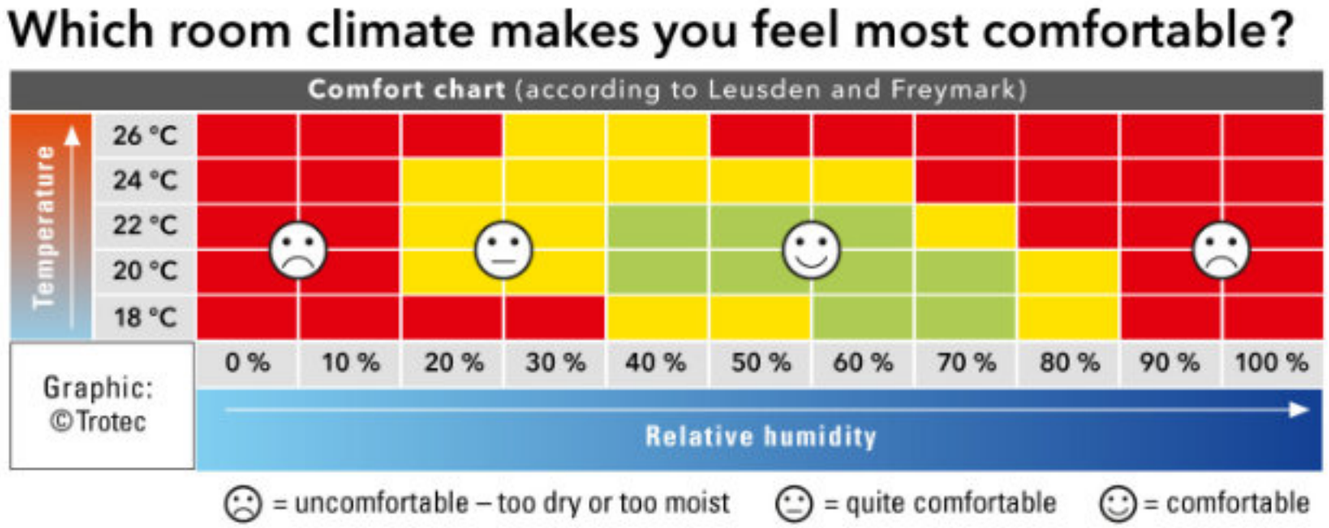
Ideal environmental conditions



18-21°C

40-60%

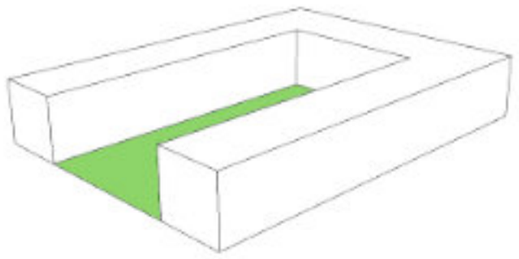
Varies per room - see right



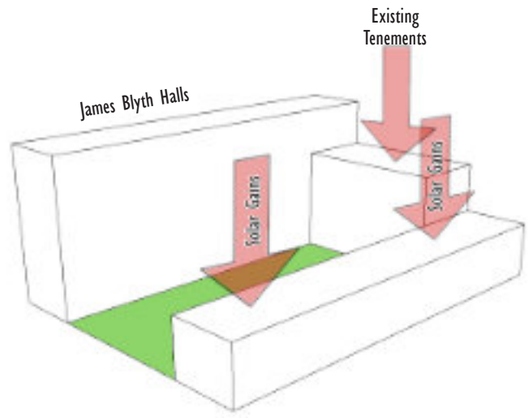
Room type	Air Change Requirement
Apartment	Ventilator with area 1/30th of floor area it serves
Kitchen	30l/l above a hob, 60l/s everywhere else
Utility room	30l/s
Bathroom or shower room without W/C	15l/s
Toilet	Either 1/30th of floor area, or 3 air changes per hour

Designing the Square

Public Square

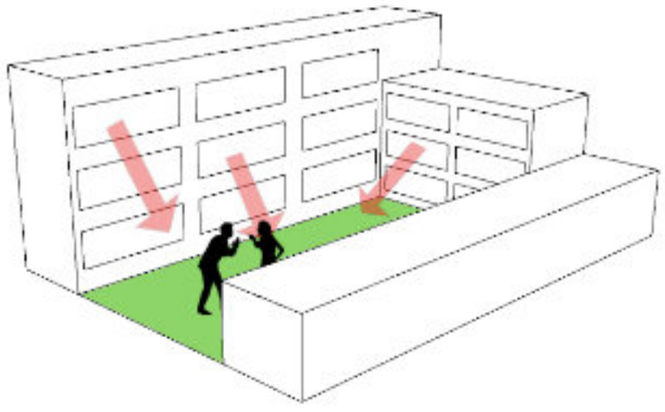


Protection

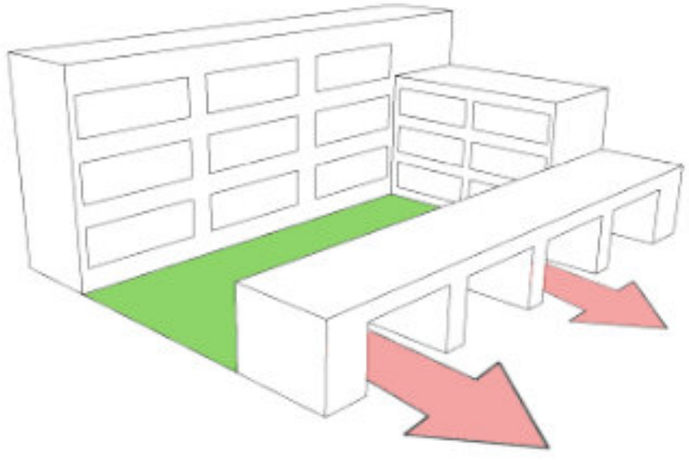


Levels

To reference context

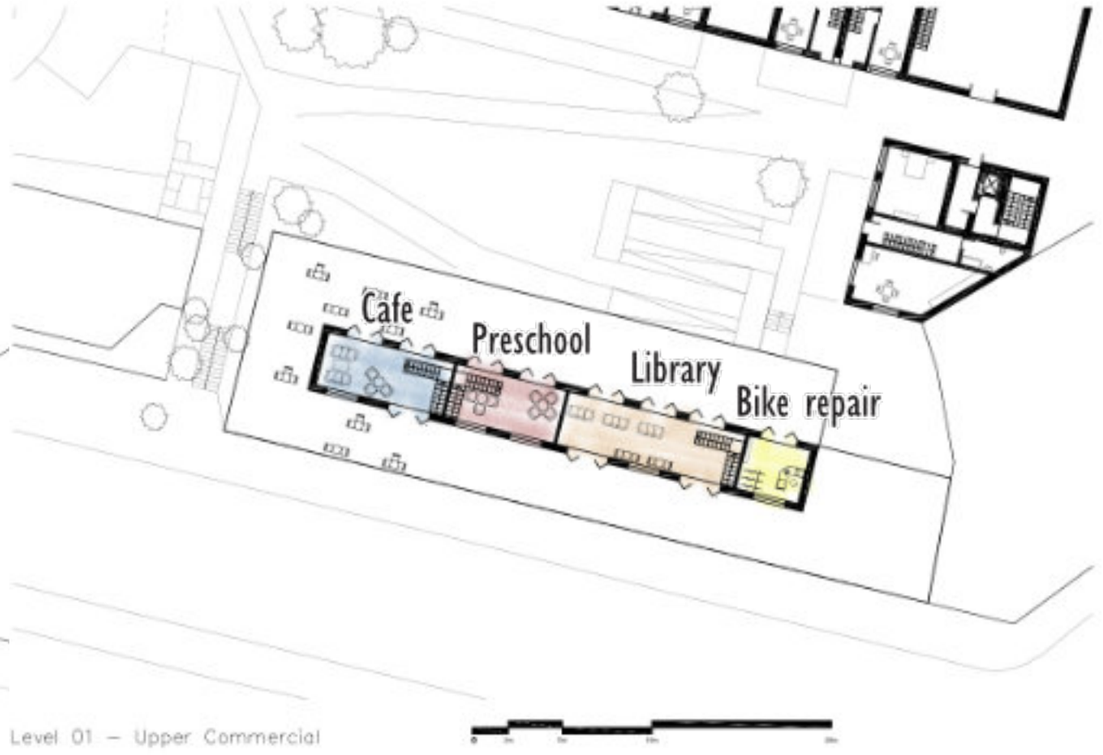


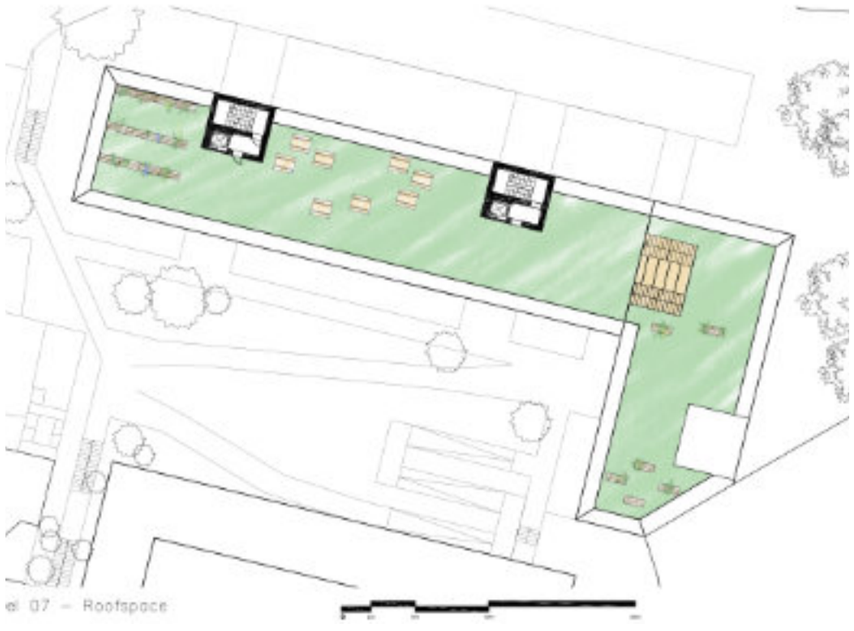
Self-policed

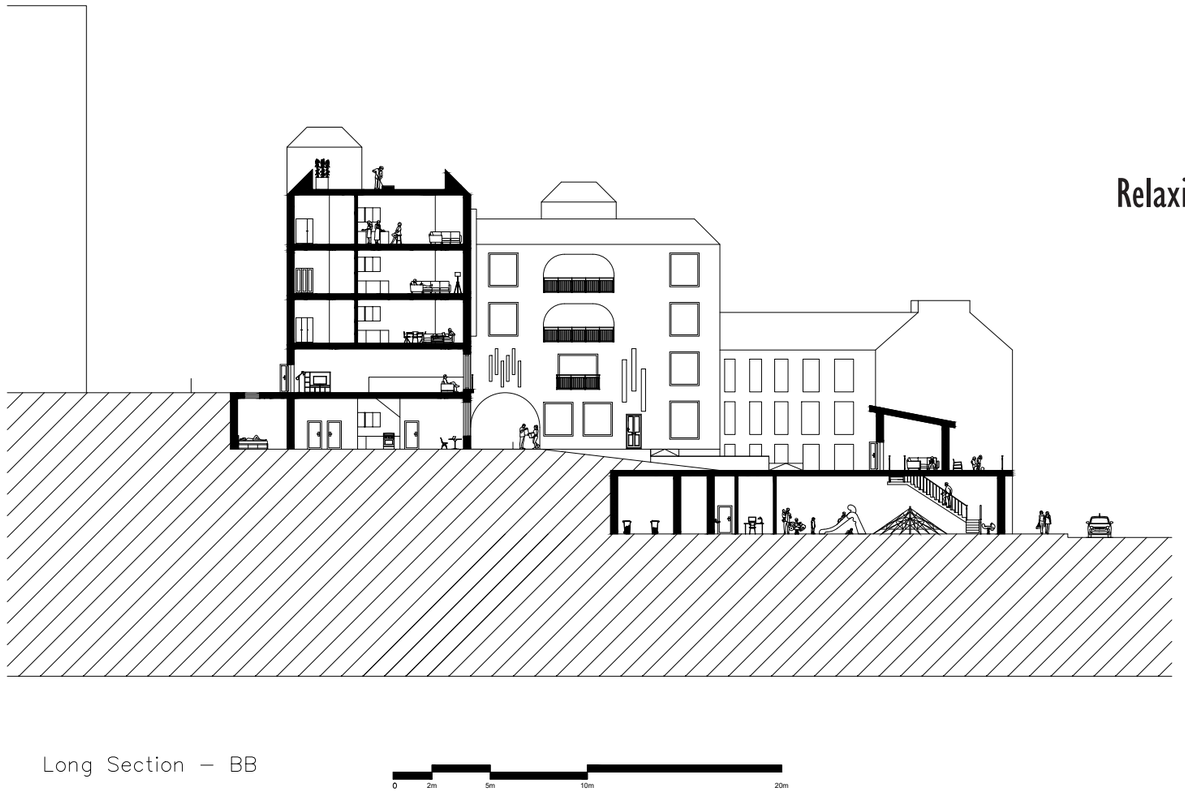


Activation

Sustainable Community







Bicycle Repair

Loanable tools (like the Library of Things)

Library/learning spaces

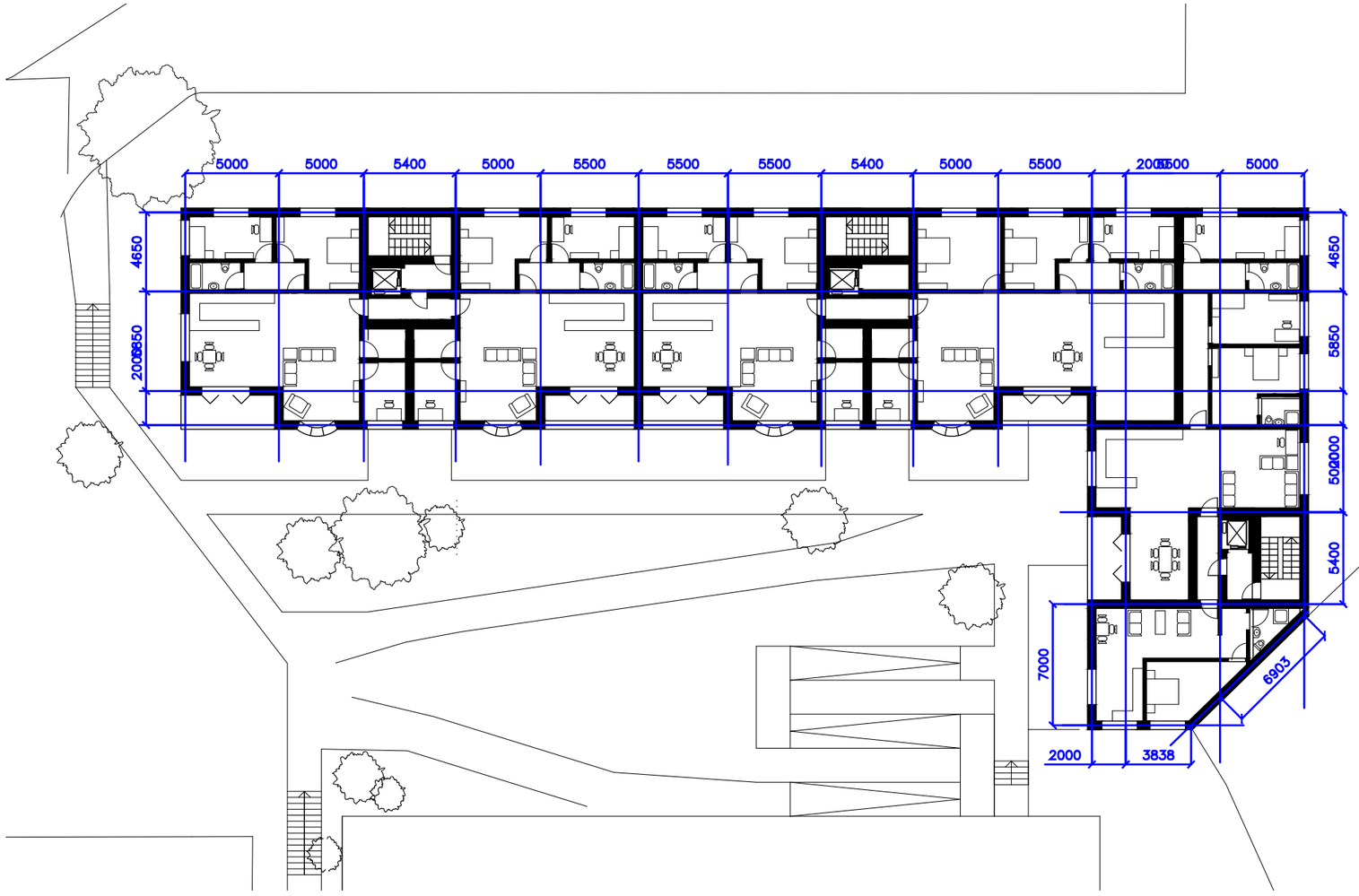
Preschool

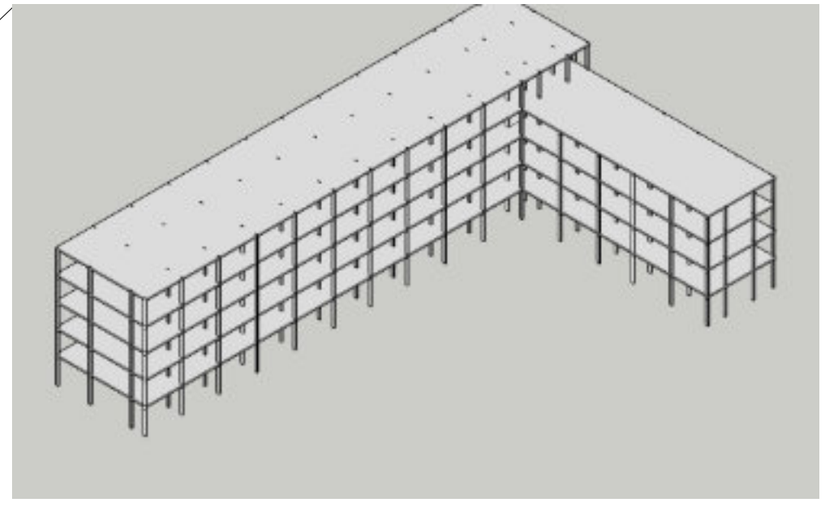
Relaxing Spaces (Ping pong/pool)

Community cafe

Community store

Construction Method

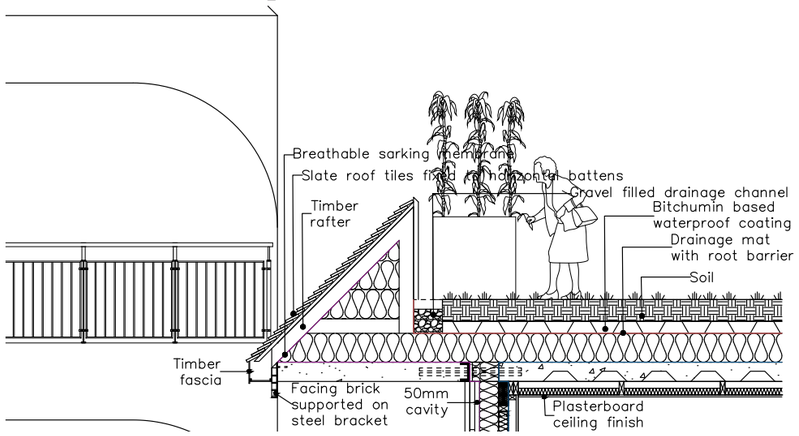


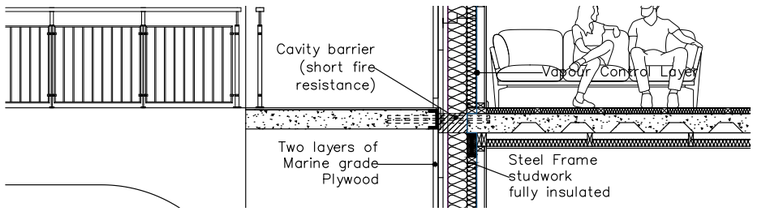


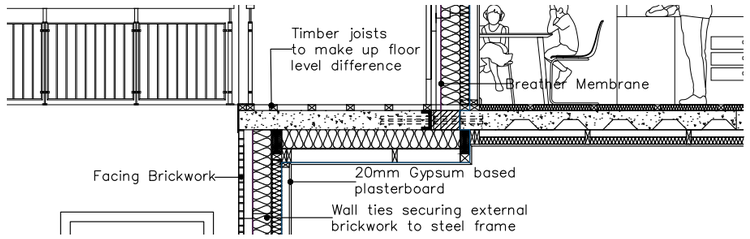
I decided to use steel frame construction, as I feel it is the most sustainable and economic choice for the size of my design. Because it is over 7.5m, the structure needs a medium fire resistance. I ruled out CLT due to its cost, and carbon impact during transportation. I then went on to decide on steel because of its ability to be deconstructed, reused and recycled with no losses. Furthermore, by choosing to use a steel frame as my construction method, the spacing to my structural grid is large and allows for maximum flexibility in the plan. This also means that residents can have open spaces that are adaptable to suit their own needs, without having to avoid large columns or low beams. This could also allow for the building to be reused in the future without being deconstructed, expanding it's lifespan.

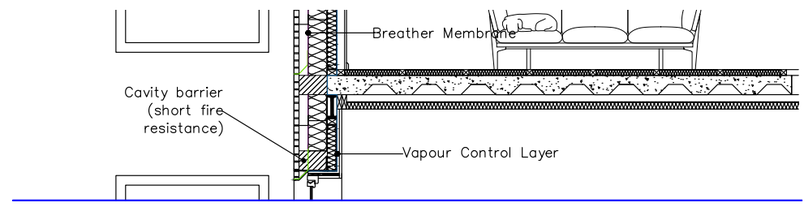
On a more personal level, my previous projects have all used timber as their primary structure, and I wanted to challenge myself with detailing an alternative.

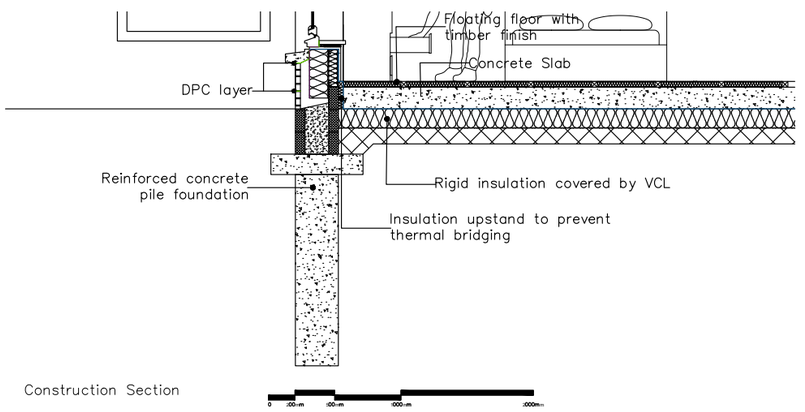
Materiality









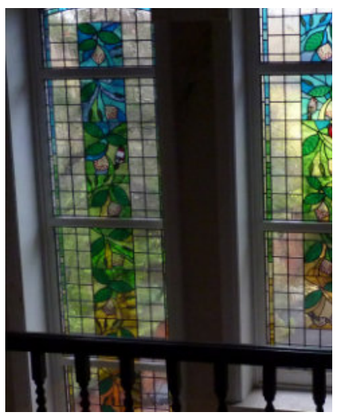


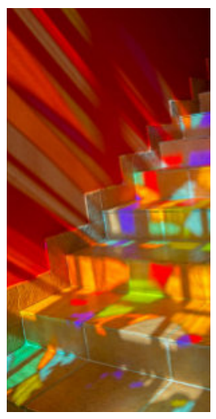
Construction Section

Referencing the immediate context with similar colour and texture

Playful, bright, details

Balconies gain a splash of colour by being tiled similarly to Glasgow tenement's closes



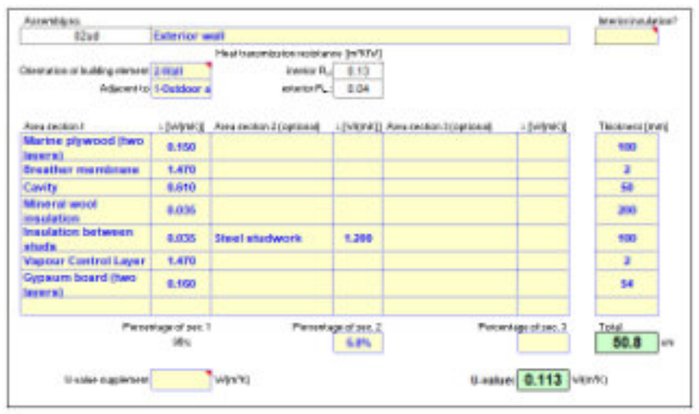


Stained glass on stairs adds interest and colour

Materiality

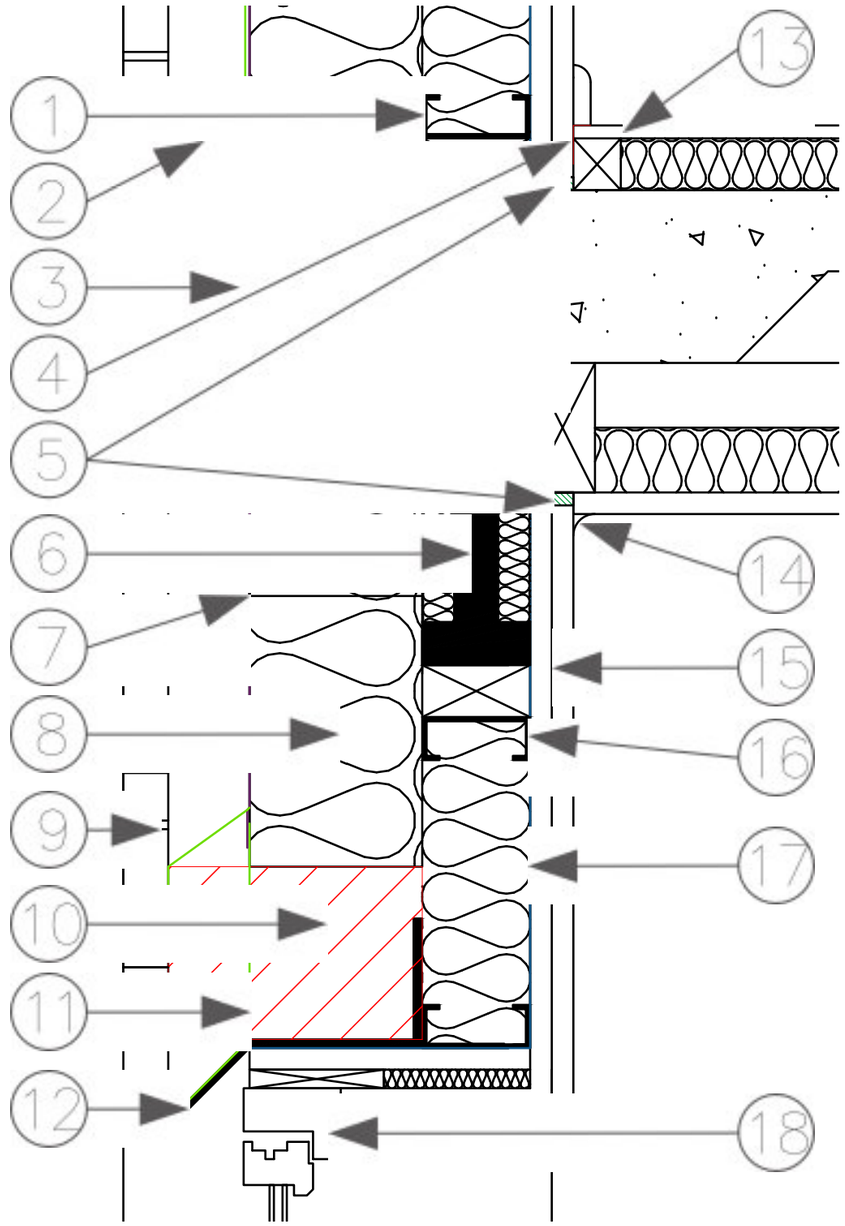
As you can see below, the U value of my external wall buildup is Passivhaus compliant, being under 0.12W/m^{2}K. However, my floors do not meet Passivhaus Standard. They should have an overall U-Value of 0.15W/m^{2}K, but unfortunately mine are 0.22.

This is due to the lack of insulation in my floors. My building's overall height sat at 17.9m, and I was keen to keep it under 18 to avoid having to incorporate a second escape stair. However, this meant I have tried to minimise the depth of my floor-plate, and as a result the floor does not meet the thermal requirements set by Passivhaus.



1:5 detail of an exterior wall/separating floor

1. 100mm Steel channels for studwork to sit in
2. 50mm cavity
3. Cavity barrier with short fire resistance
4. 2 layers of gypsum based board, 8kg/m^2 each
5. Acoustic Sealant
6. Steel Beam 356x127mm, surrounded by 25kg/m^3, 0.035W/mK mineral wool insulation (such as Knauf Omnifit Slab 35)
7. Wall tie securing facing brick to steel frame
8. 200mm 25kg/m^3, 0.035W/mK mineral wool insulation (such as Knauf Omnifit Slab 35)
9. Red facing brick (e.g. TBS Old Coach House)
10. Cavity barrier with short fire resistance
11. DPC Layer
12. Steel to support facing brickwork at window head
13. Floating floor with timber finish
14. Perimeter joints caulked with sealant
15. 2 layers of gypsum based board, 8kg/m^2 each
16. 100mm Steel channels for studwork to sit in
17. Low E Vapour Control Layer (R=0.68m^{2}K/W)
18. Window head, all joints caulked with sealant

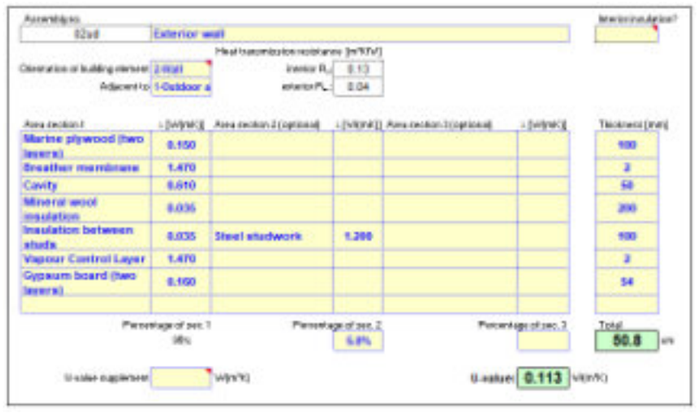


Materiality

I have also included this plan detail, to show how services can potentially run vertically up the void created between the steel stud walls.

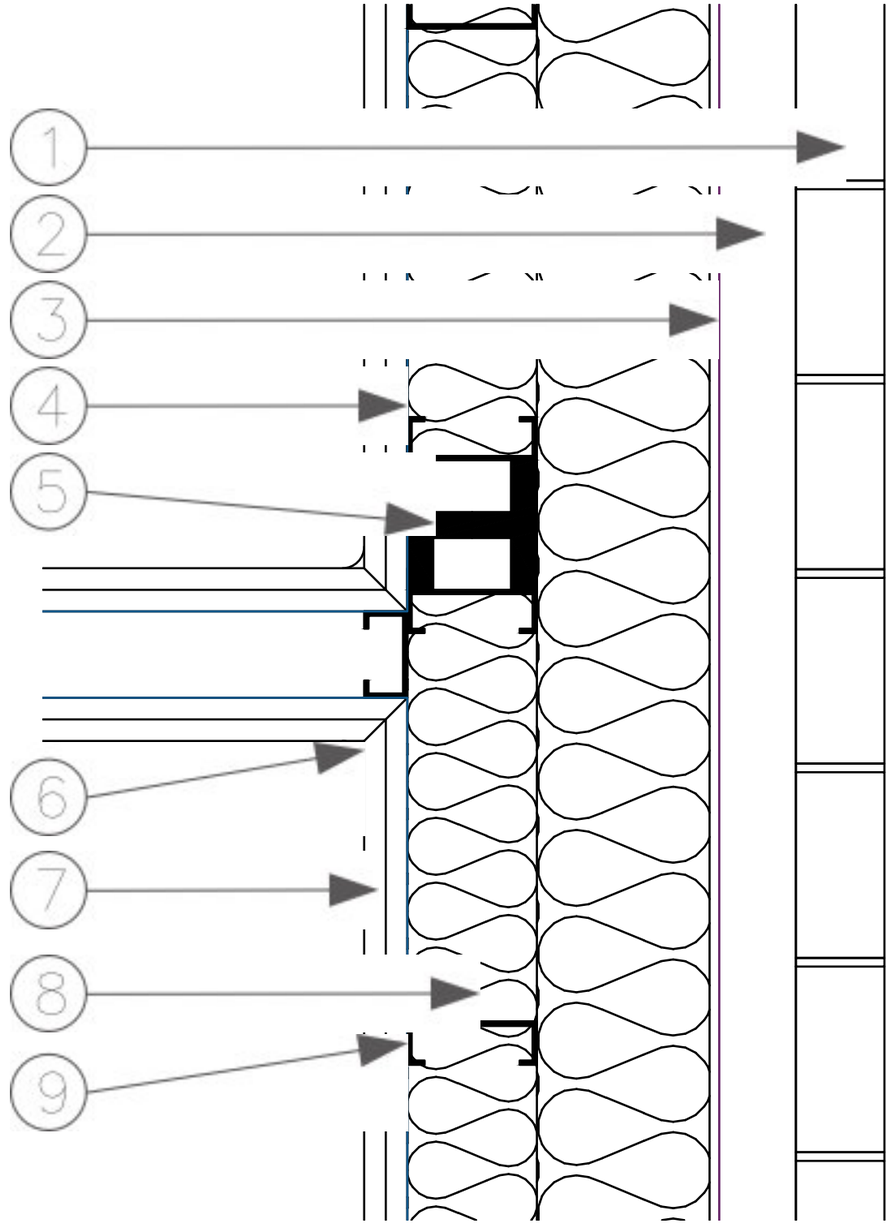
This 100mm void has the potential to run soil stacks, water pipes or even mechanical ventilation ductwork, but it is important to note that this was not taken into account when calculating the U-Value of the external wall.

Overall, I feel that my material choices were not as sustainable as they could have potentially been. There were some swaps I could have made, such as sheep's wool insulation. Furthermore, the bricks and plasterboard were the obvious material choice, but not the most sustainable. Instead, I could have used a sustainable cladding (wood, hemp, cork), and a finish of clay or lime.

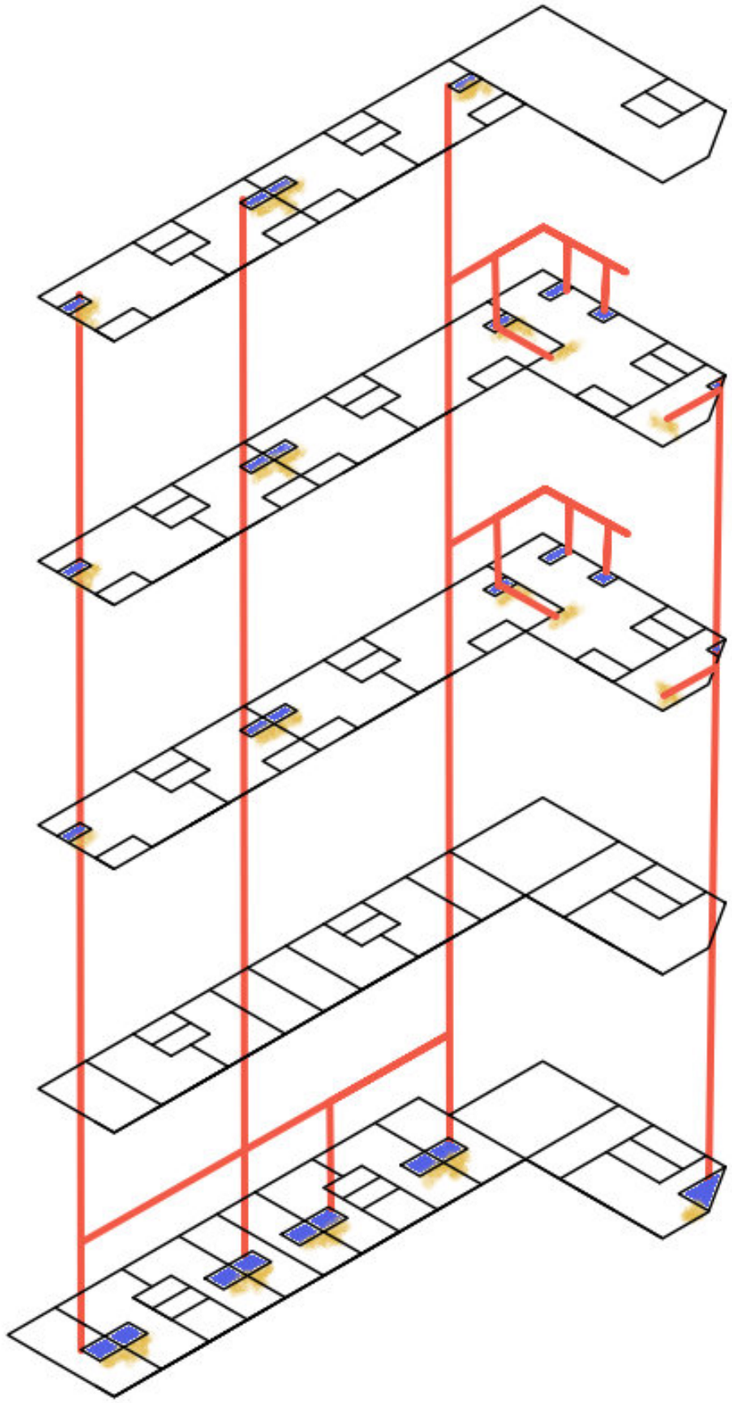


1:5 Plan detail of a steel column in wall

1. Red facing brick (e.g. TBS Old Coach House)
2. 50mm cavity
3. Breather membrane
4. Low E Vapour Control Layer (R=0.68m²K/W)
5. Universal column 152x152mm
6. Perimeter joints caulked with sealant
7. 2 layers of gypsum based board, 8kg/m² each
8. 100mm 25kg/m³, 0.035W/mK mineral wool insulation (such as Knauf Omnifit Slab 35)
9. Steel frame stud walls



Services and pipework



Bathrooms

Kitchens

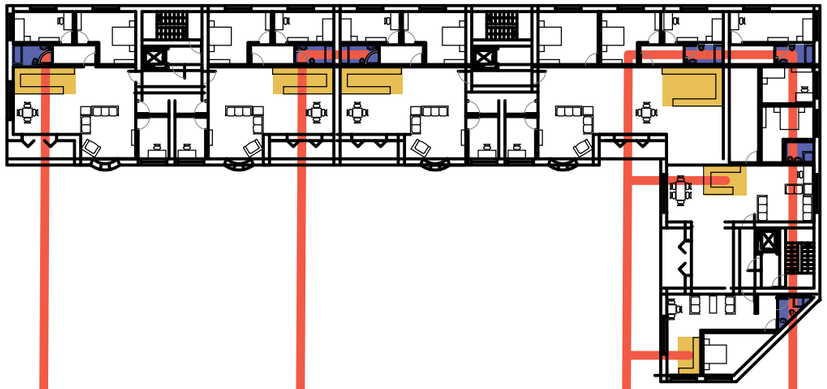
Waste Pipes

When designing my floorplans, I had put a lot of effort into ensuring that most of my flats had kitchens that were on the opposite wall to bathrooms, so that they could be served by one soil stack.

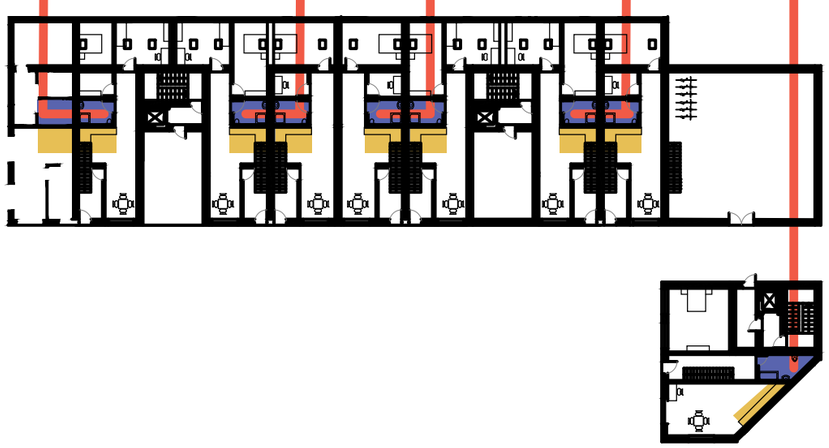
Unfortunately, it seems I was so preoccupied by this that I missed noticing how many flats do not actually neatly stack, which is a real issue! In the future, I need to take greater care to ensure that not only do kitchens and bathrooms work well together, but the scheme also stacks more efficiently to minimise the amount of horizontal waste piping.

My section leaves a service void that varies between 80-180mm. This should leave enough room for mechanical ventilation ductwork.

Third Floor



Ground Floor



Energy Supply

Due to the creation of the central square, it makes sense that the already disturbed land have ground source heat pumps added to it.

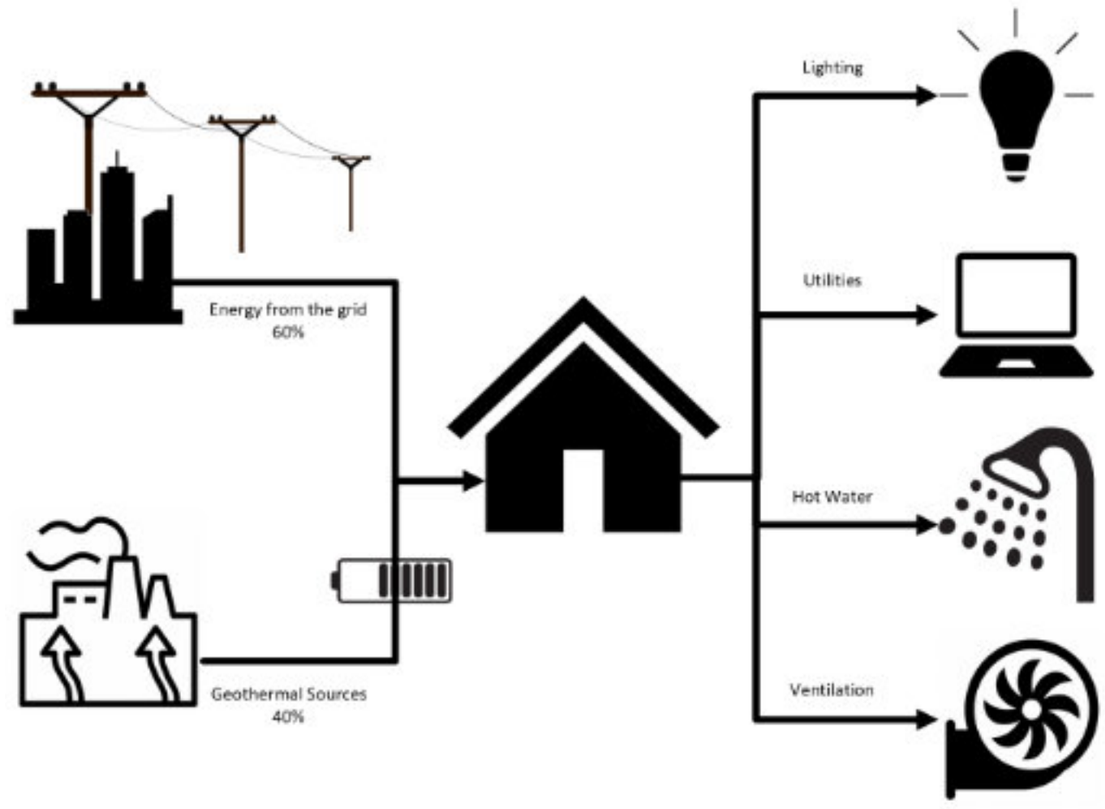
Homebuilding.co.uk states that "As a rule of thumb, an area of 50m2 is needed for each 1kW of heat output. So an 8kW heat pump will need 400m2, assuming damp clay soil." With the square measuring approximately 50m by 30m, it could potentially produce 30kW of energy. The average boiler for a standard UK house is 20kW, so the ground source heat pump will not be able to provide for many homes within the scheme.

For this reason, I propose that the centralised energy network is further supplemented by the Innovation District's "Climate Corridor" which runs up High Street, after sourcing clean energy from the tidal wier in the River Clyde.

I have primarily tried to utilise natural ventilation by designing dual aspect flats with operable windows. However, in places that require more air changes per hour, such as bathrooms and kitchens, mechanical ventilation would be required. These rooms are back to back, to make the extraction vents more efficient.

Similarly, by orientating the majority of my flats to face South, the large windows allow for solar gains throughout the year, as well as making the balconies warm and appealing!

As well as being a place for residents to interact, the allotment spaces on the rooftops of my scheme help to slow storm-water runoff, and may even help reduce the urban heat island effect.



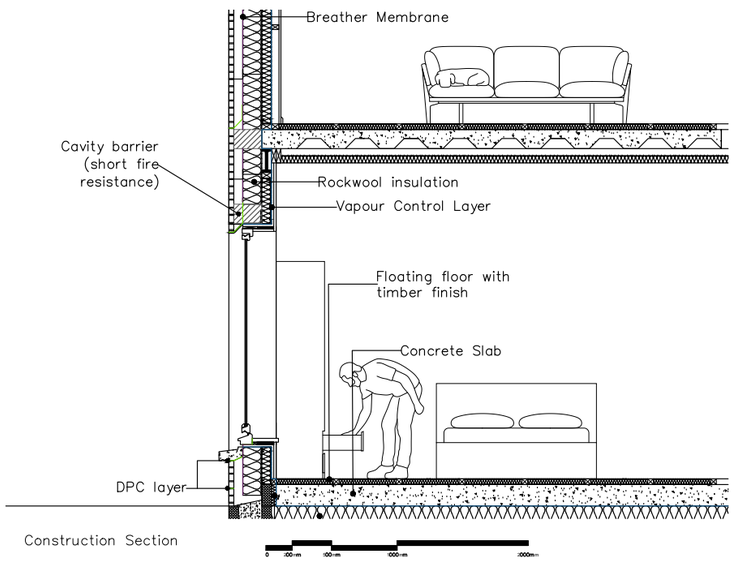
References: https://www.homebuilding.co.uk/advice/ground-source-heat-pumps accessed 21/02/2023 for "rule of thumb" as above

https://www.vaillant.co.uk/homeowners/advice-and-knowledge/what-size-boiler-do-i-need-2069848.html accessed 21/0223 for average boiler size

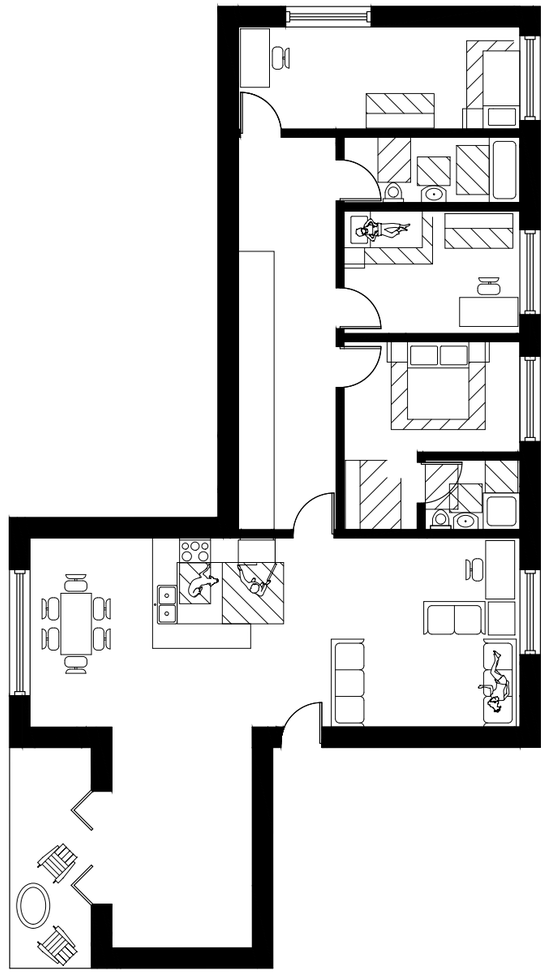
Chosen focus flats

1 bed duplex

132m²

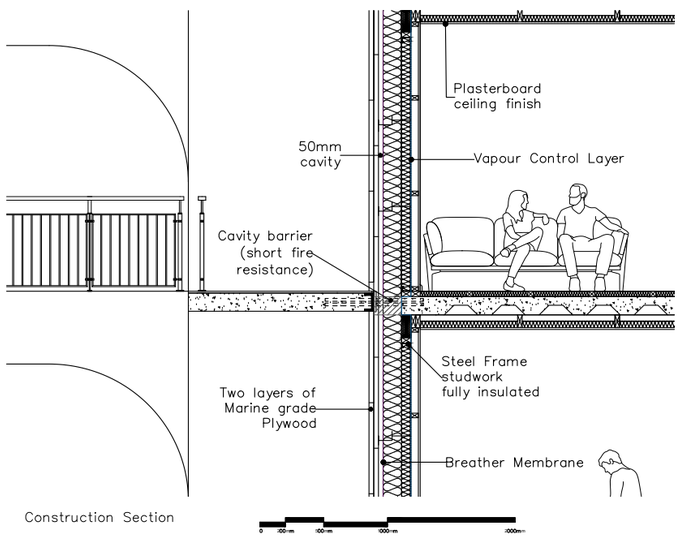


Construction Section



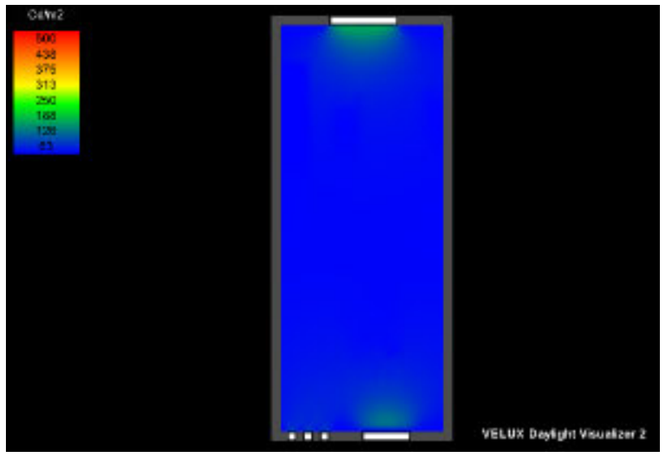
3 bed corner flat

159m²

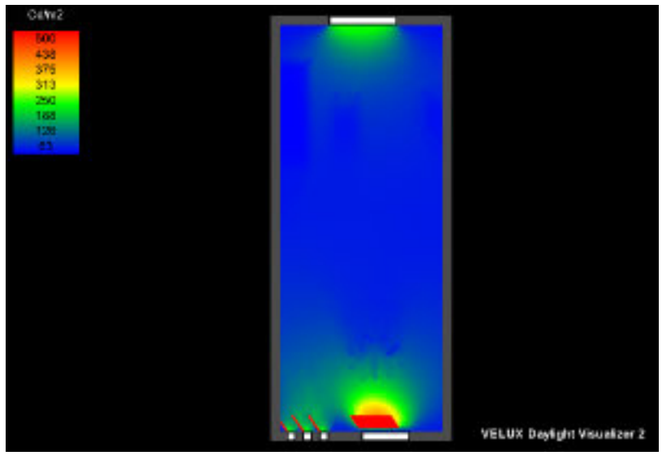


Construction Section

Lighting - 1 bed duplex



Overcast winter daylighting



Sunny summer daylighting

Looking South from downstairs corridor

Bedroom with roof lights

Looking North upstairs

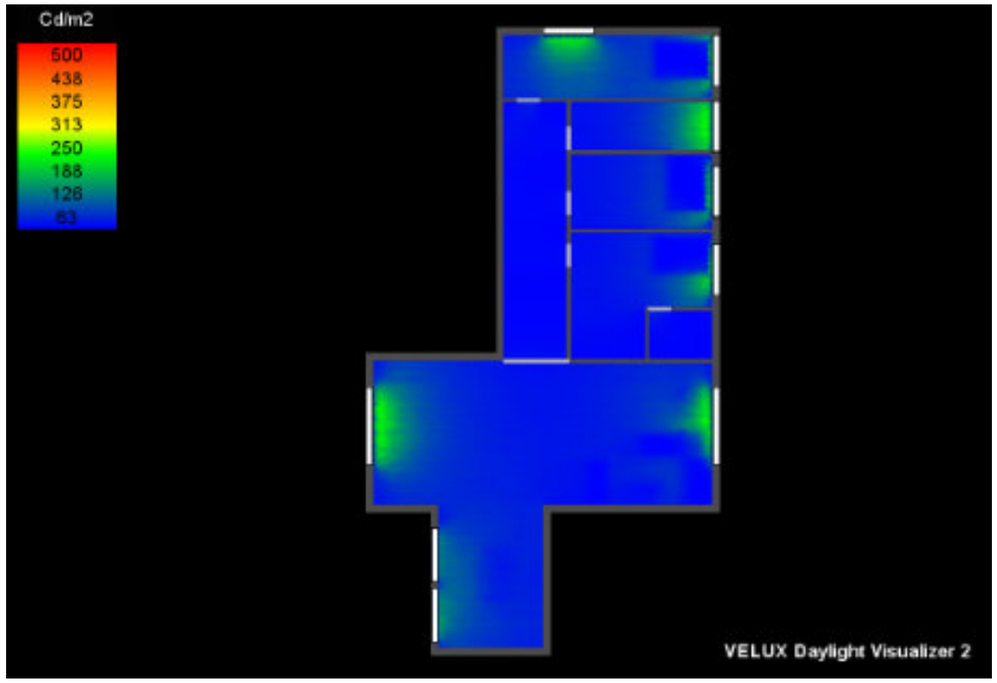
Looking South upstairs

Looking North from dining room downstairs

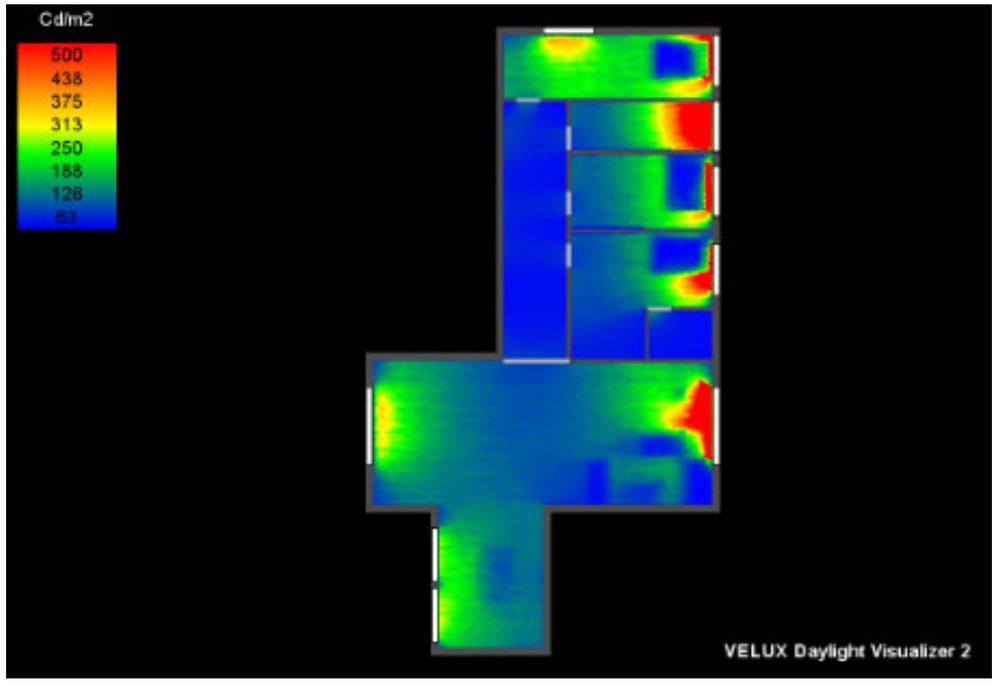
I was surprised at how little light the duplex received, especially with the large south-facing windows upstairs. I don't think that this natural lighting could be improved, as the window is already large and causing a lot of heat losses.

I was also surprised to see that the roof lights in the bedroom did not benefit the overall daylighting of the room, even in summer. As this part of the design was underground, I am not sure what I could propose retrospectively to improve natural light in this room.

Lighting - 3 bed flat



Overcast winter daylighting



Sunny summer daylighting

Looking towards the balcony

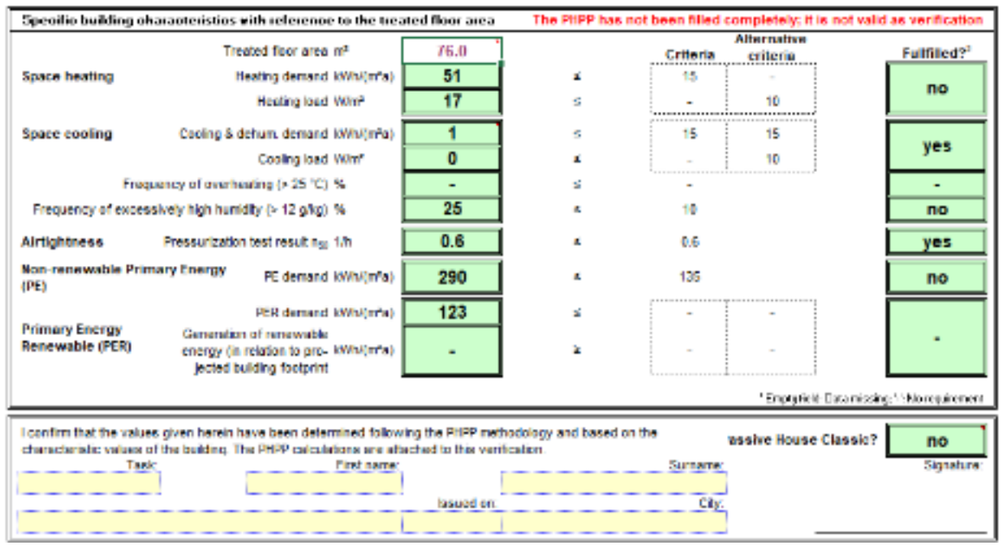
From the kitchen looking South East

From Northern bedroom into the corridor

This flat's natural light seems to be a lot better, especially in the bedrooms in summer. Making these windows any larger would result in overheating and glare in summer, so I feel that the overall strategy here is appropriate.

However, I did not model the tenement that is to the East of this flat, so it could potentially be overshadowed. Once again, the windows could not be much larger in the facade so I am not sure how I could retrospectively address this.

PHPP Passivhaus Spreadsheet - 1 bed duplex



Specific building characteristics with reference to the treated floor area — The PHPP has not been filled completely: it is not valid as verification

				Criteria	Alternative criteria	Fulfilled?
	Treated floor area m²	76.0				
Space heating	Heating demand kWh/(m²a)	51	≤	15	-	no
	Heating load W/m²	17	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	1	≤	15	15	yes
	Cooling load W/m²	0	≤	-	10	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	25	≤	10		no
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	290	≤	120		no
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	123	≤	-	-	-
	Generation of renewable energy (in relation to projected building footprint) kWh/(m²a)	-	≥	-	-	

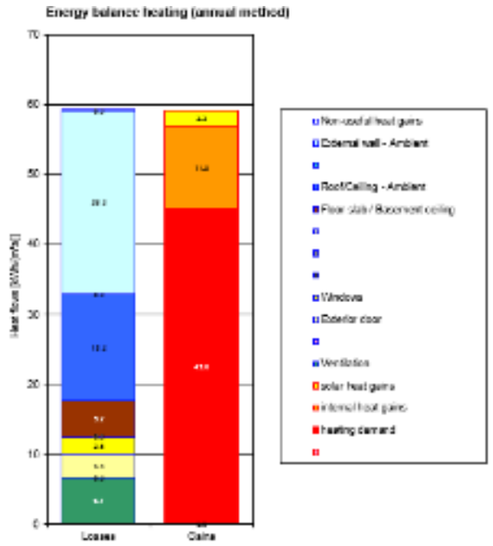
¹ Empty field: Data missing; ² - : No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? no

Task: First name: Surname: Signature:

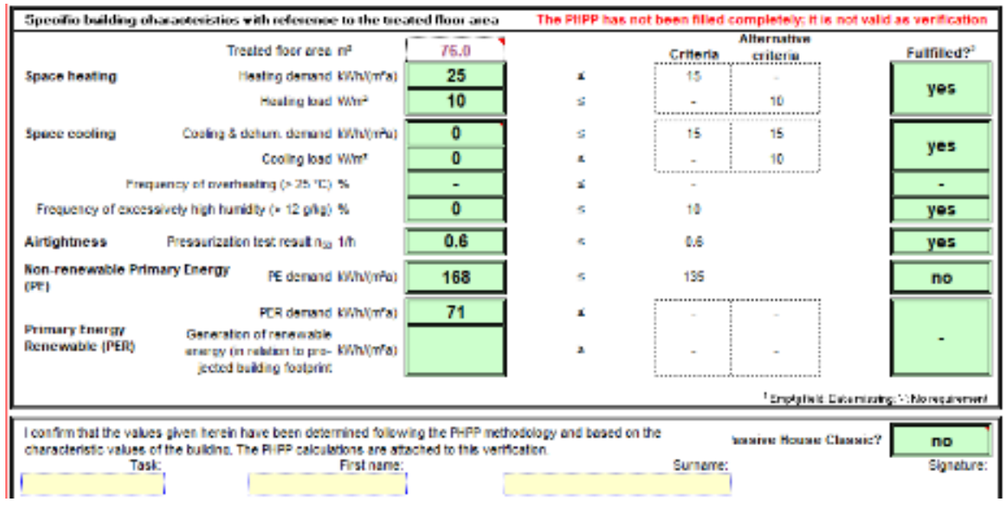
Issued on: City:



After initial input, my design did not meet passivhaus standard. I adjusted the U-Value tab so that all the elements had double the insulation. I also added 200mm of insulation to the seperating floor. I still could not manage to get the flat passive.

I think this was due to the renewable energy tab, which I did not really understand. I tried to adjust it but it still did not fulfil the Passivhaus requirements.

I did attempt to improve passive solar gains by increasing the size of the windows, but instead I ended up with thermal losses.



Specific building characteristics with reference to the treated floor area — The PHPP has not been filled completely: it is not valid as verification

				Criteria	Alternative criteria	Fulfilled?
	Treated floor area m²	76.0				
Space heating	Heating demand kWh/(m²a)	25	≤	15	-	yes
	Heating load W/m²	10	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	0	≤	15	15	yes
	Cooling load W/m²	0	≤	-	10	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	10		yes
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	168	≤	135		no
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	71	≥	-	-	-
	Generation of renewable energy (in relation to projected building footprint) kWh/(m²a)		≥	-	-	

¹ Empty field: Data missing; ² - : No requirement

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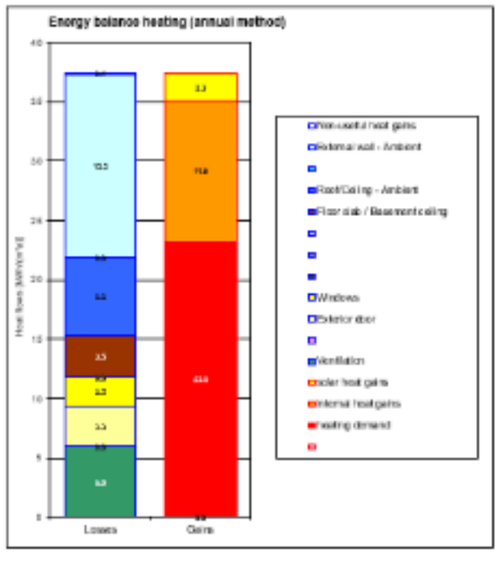
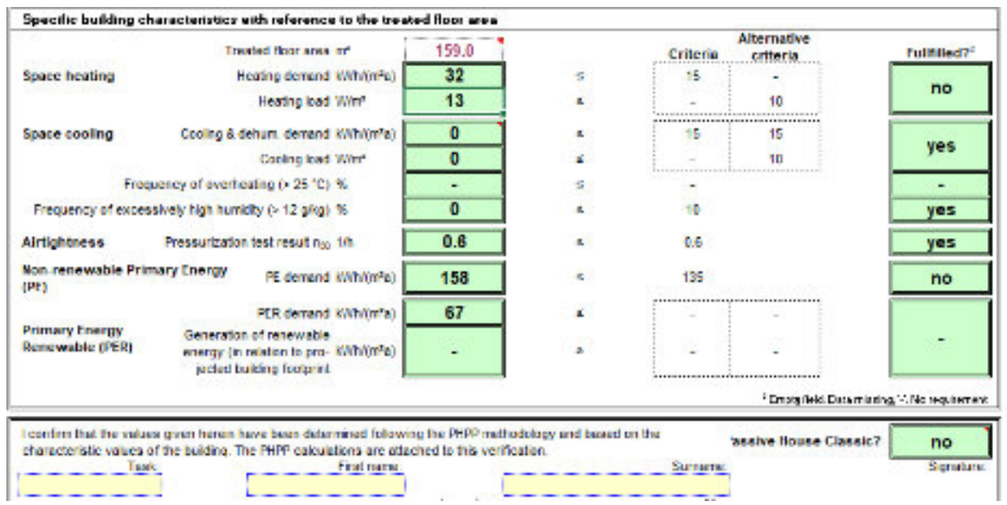
Passive House Classic? no

Task: First name: Surname: Signature:



PHPP Passivhaus Spreadsheet - 3 bed flat



Specific building characteristics with reference to the treated floor area

				Criteria	Alternative criteria	Fulfilled?
	Treated floor area m²	159.0				
Space heating	Heating demand kWh/(m²a)	32	≤	15	-	no
	Heating load W/m²	13	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	0	≤	15	15	yes
	Cooling load W/m²	0	≤	-	10	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	10		yes
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	158	≤	135		no
	PER demand kWh/(m²a)	67	≤	-	-	-
Primary Energy Renewable (PER)	Generation of renewable energy (in relation to pro-jected building footprint kWh/(m²a)	-	≥	-	-	

¹ Empty field: Data missing; "-": No requirement

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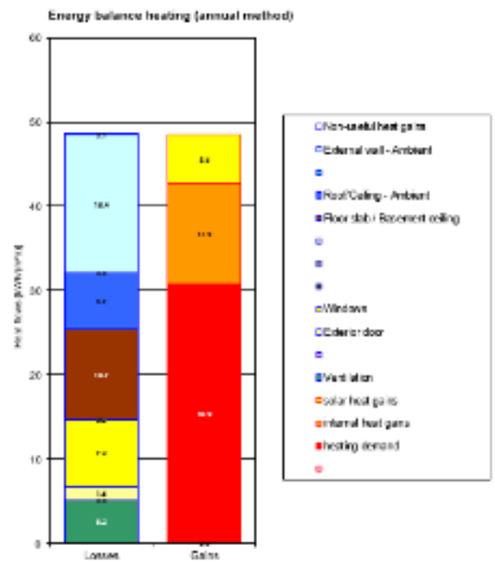
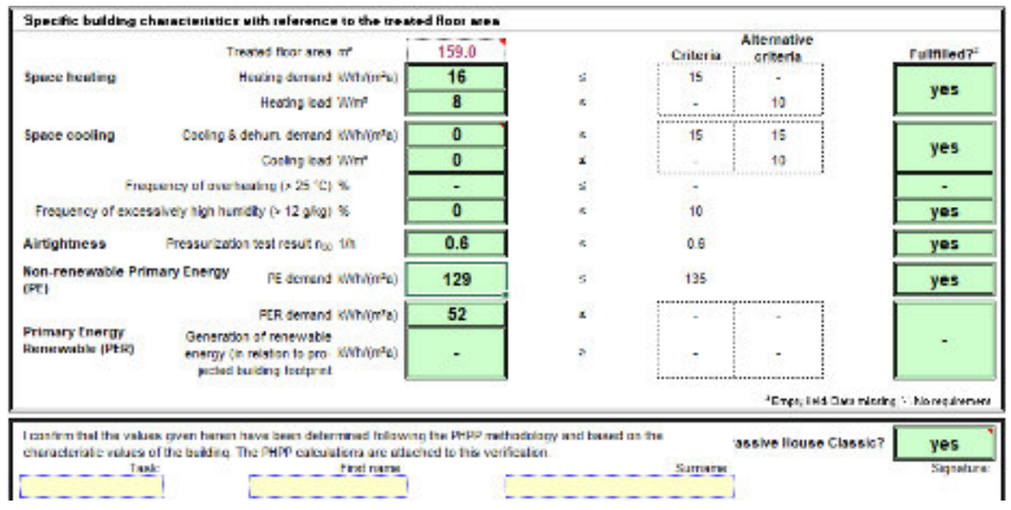
'assive House Classic? no

Task: First name: Surname: Signature:



After initial input, my design did not meet passivhaus standard. I adjusted the U-Value tab so that all the elements had double the insulation. I also added 200mm of insulation to the seperating floor. This then made the flat Passivhaus.



Specific building characteristics with reference to the treated floor area

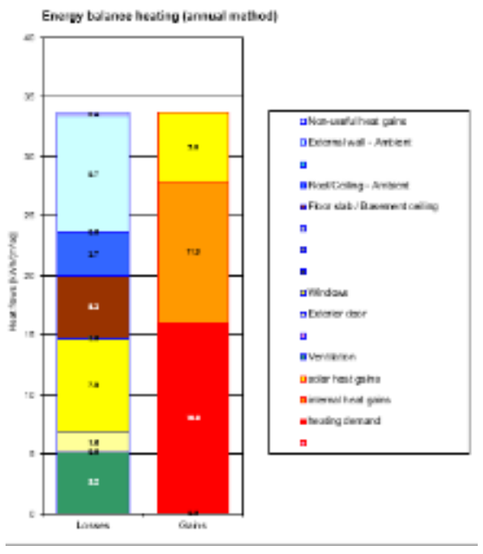
				Criteria	Alternative criteria	Fulfilled?
	Treated floor area m²	159.0				
Space heating	Heating demand kWh/(m²a)	16	≤	15	-	yes
	Heating load W/m²	8	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	0	≤	15	15	yes
	Cooling load W/m²	0	≤	-	10	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	10		yes
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	129	≤	135		yes
	PER demand kWh/(m²a)	52	≤	-	-	-
Primary Energy Renewable (PER)	Generation of renewable energy (in relation to pro-jected building footprint kWh/(m²a)	-	≥	-	-	

¹ Empty field: Data missing; "-": No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

assive House Classic? yes

Task: First name: Surname: Signature:



I did attempt to improve passive solar gains by increasing the size of the windows, but instead I ended up with thermal losses.

Supporting Statement

How is your building heated and ventilated and why did you choose these systems?

My building is heated via radiators, and naturally ventilated with mechanical assistance (extractor fans). I chose this strategy because I wanted the users to understand how to maintain their home without necessarily requiring external support. I also feel that heating via radiators gives the homeowner the most options aesthetically, with a variety of styles of radiators in comparison to electric heaters or MVHR systems. Radiators also allow for heated towel rails or warming items of clothing - a little luxury!

How have you exploited and integrated low carbon/renewable energy options into your scheme?

I proposed a ground source heat pump under the semi-public square of my development, as well as integration into the sustainable energy system sourced from the River Clyde. This renewable energy could have been further exploited by adding photovoltaic pannels to the small amount of roofspace of my scheme, or specifying gas boilers that have the potential to be used as hydrogen boilers if/when the gas network is decarbonised.

How have you ensured thermal comfort and 'healthy' indoor air quality?

When initially approaching the design of my housing, I considered what an ideal internal environment would be (as specified on page 7). Keeping this in mind, I designed a heating and ventilation system that ensured homes were at the required temperature, humidity, and air quality via natural solar gains, heating, natural cross-ventilation and mechanical extraction where required.

What factors did you take into account when selecting materials/structural systems?

As per page 10, I decided to use steel frame construction, as I feel it is the most sustainable and economic choice for the size of my design. Because it is over 7.5m, the structure needs a medium fire resistance. I then went on to decide on steel because of its ability to be deconstructed, reused and recycled with no losses. However, in detailing my design I felt I often chose the “obvious” choice, and I think I should have considered natural/sustainable alternatives. The studwork in my flats’ walls could have been made of timber, the insulation sheeps’ wool and hemp, or the plaster finish swapped out for a clay. Not only would these have reduced the carbon footprint of my design, but would have also reduced VOCs and improved air quality for the residents.