Southill Road
Fabric Improvement Strategy

19th October 2022 – Rev 01

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ENERGY ANALYSIS – OUTLINE APPROACH

This report aims to outline the findings of initial heat loss calculations and site inspections and provide a coordinated, and achievable range of energy reduction strategies. There are four elements of the approach.

1 – Baseline - We establish an energy baseline by using the records and references available.

2 - Demand –The baseline model is used to inform the efficacy and value of heat demand reduction measures. Demand reduction simultaneously broadens the options for heat supply and reduces the overall use of energy.

3 - Supply – The supply of heat is focussed on the successful implementation of heat pumps. In some instances, the practical challenges impose constraints on the options available and in practice would require some level of fabric improvement.

BASELINE - FABRIC HEAT LOSS MODEL

To determine the buildings heat loss and allow for initial sizing of the equipment, drawn survey information and a visual site inspection was utilised to build a heat loss model.

A fabric heat loss model utilises the known properties of a building (physical layout, dimensions, materials, and construction composition) as well as several necessary but logical assumptions to determine the buildings static heat loss.

The methodology employed follows BS EN 12831:2003 and CIBSE Guide A.

By determining the existing fabric heat loss of the building, it is possible to understand the effect of specific fabric improvements and the implications for the size of the heat pump, space heat emitters and other possible improvement strategies.

Existing Condition

Utilising the methodology described above the resultant peak heat loss for the existing condition is estimated to be 36.2kW [1]. This is in line with the installed boiler capacity of 2 number 26kW[2] condensing boilers – these are both combination boilers and provide domestic hot water in addition to heating. The Table below list the design assumptions.

Design Condition		
Internal Temperature Set Point	21°C 18°C	Occupied Spaces (MIS 3005 Table 1) Secondary Spaces (MIS 3005 Table 1)
External Temperature	-1.7°C	CIBSE Guide A Table 2.5
Ground Temperature	10°C	MIS 3005 Appendix B Table B1
U - Values		
Glazing	2.2 W/m²K 4.8 W/m²K	Double Glazing to the front of the property assumed to meet 2006 Part L requirements. Single Glazing to rear and sides of property.
External Door	3.9 W/m²K	Part L1A - Table 4 semi-glazed door
External Walls	1.7 W/m²K	Brick wall with 50mm cavity.
Party Wall	2.0 W/m²K	Solid Brick wall.
Floor	0.35 W/m²K	Solid insulated floor (R = 0.5 m²K/W)
Roof	1.7 W/m²K	Typical flat roof construction for property of this type / age.
Air		
Infiltration	0.75 ACH	CIBSE Guide A Table 4.19 Leaky building <4 stories.
Minimum Vent Rate	0.30 l/s	Part F - table 5.1b

[1] This value excludes Hot Water Use
[2] The boiler for the main house notes 35kW, however the model number indicates a 26kW output.

DEMAND - THERMAL IMPROVEMENTS

There are three possible strategies to reduce heat demand:

- *Improve Insulation* – low thermal conductivity materials applied to reduce heat losses through the fabric.
- *Improve Air tightness* – reducing unwanted infiltration of cold air through the building envelope.
- *Control Ventilation* – providing mechanical systems to recover heat from outgoing air and control the volume of air needed to adequately ventilate the buildings.

The application of these strategies is not additive. Rather, they require application simultaneously towards the same aim so as the maximise the contribution of each. i.e. a highly insulated building with poor air tightness will perform less well than a building with reasonable insulation and moderate air infiltration.

The table below shows the calculated fabric heat loss for individual building elements as each is improved. The aim for each upgrade step is to target specific, increasingly ambitious fabric improvements.

The improvement measures have been driven by:

- Technical feasibility
- Level of disruption

BUILDING SPECIFIC CONSIDERATIONS

As the existing building has constrained floor to ceiling heights and is part of a listed terrace, there are several constraints that need to be taken into consideration if the below strategies were to be implemented.

The focus should be on the relatively low risk improvements that meet the following criteria:

- No specific planning concerns (although planning permission would still be required in some circumstances given the Grade of the property)
- Reasonable financial payback of <10 years
- Low technical risk, i.e. established approaches without the need for further surveys or analysis.

MODELLING APPROACH

The following section details each of the changes that will be assessed in the thermal model, how the improvement might be achieved and any further considerations.

New Second Floor Flat

This is the estimated heat loss if the second floor flat was built to modern standards and no further improvements were undertaken to the lower floors. This will have a reasonable impact on the total heat loss as it replaces the existing extension as well as bringing first floor rooms within its thermal line.

	Peak Heat Loss
Existing Total	36.2kW
Lower Ground to First Floor House	23.3 kW
Second Floor Flat	6.4 kW
New Total	**29.7 kW**

This is the case against which each of the fabric improvements will be compared against.

Windows

As the building forms part of a listed terrace there are restrictions on the visual appearance of external building elements. We understand that discussions are being held with the other residents regarding the replacement of all the road facing windows for each home. This would maintain visual continuity and would likely be approved by the Heritage Officer. To assess the impact of this the following options were considered, with the later two taken after other improvements due to cost and relative impact.

- Modern Double Glazing to all windows
- Modern Double Glazing to front windows and Triple Glazing to all other windows
- Triple Glazing to all windows

As the building has a significant amount of glazing at the front and back, high specification glazing is likely to have the largest impact as the existing glazing is a mixture of single and older double glazing. An additional benefit of re-glazing would be a substantial improvement to airtightness.

Floors

The existing floor makes up a very small proportion of the total external area of the building and has been refitted to include underfloor heating. However, as we understand that the reconciliation of levels, and floor finishes is under consideration this has been taken as the next most likely measure.

Walls

The client has indicated their desire to maintain the exposed brickwork within the building, so two approaches have been considered.

- External insulated render system
- The above with cavity fill insulation.

For the external cavity walls, cavity fill insulation has only been considered at the Enhanced level and above, as the cost benefit is likely to be relatively low. Furthermore there is some evidence to suggest the effectiveness of the insulation decreases over time as it settles.

Internal insulation could be considered to further improve both the thermal performance and acoustics between the property and its neighbour.

Example of an external insulation system with rendered finish.

Example of EPS beads than have been blown into a cavity wall.

Mechanical Ventilation

One of the improvements that could be incorporated is the provision of a Mechanical Ventilation and Heat Recovery (MVHR) unit. These units have a typical heat recovery efficiency of 80%. The advantages of an MVHR unit are;

Advantages

- Reduces the peak heat loss
- Provides enhanced ventilation rates, reducing odours and humidity and improving the indoor air quality.
- Minimum ventilation rates don't need to be met via window vents.
- Allows for secure ventilation.

Disadvantages

- Additional cost
- Ducts require coordination.
- Filters require regular changing.
- Technically difficult to achieve with existing floor to ceiling heights
- Would require spatial concessions to achieve

The following system from Zhender may be suitable as it utilises low profile ducts and a proprietary manifold system that keeps ductwork runouts as small as possible.

Zhender Comfowell MVHR Unit – Note duct manifold to to right and individual ducts to spaces.

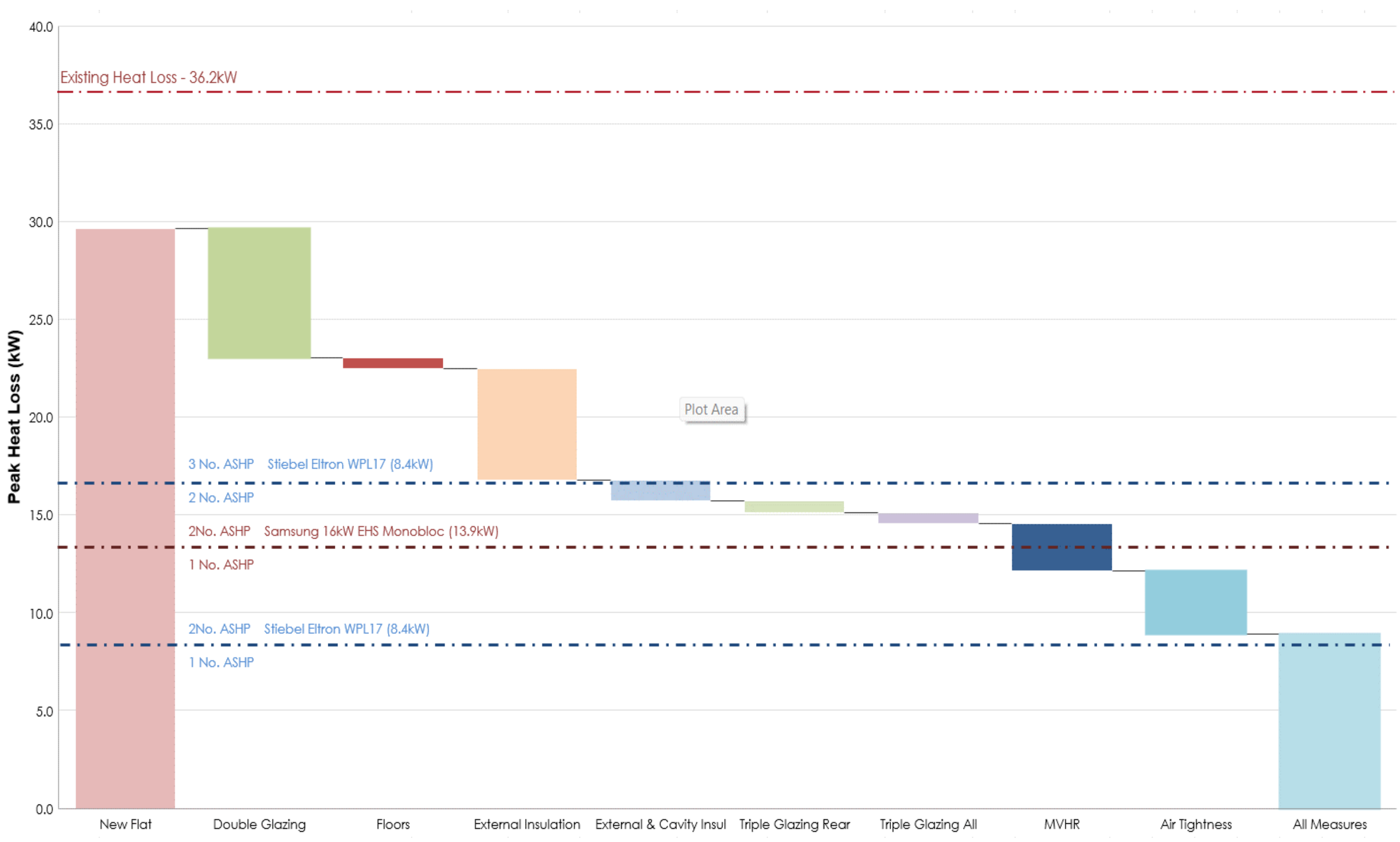
Zhender flat ductwork system.

MODELLING RESULTS

Element	Base Parameter	Improved Parameter	Peak Heat Loss	% Change	Notes
New Flat, no other improvements	-	-	**29.7 kW**	-	Upper flat to 2021 notional building performance. No other improvements
Double Glazing to all Windows	2.2 W/m²K 4.8 W/m²K	1.4 W/m²K 1.4 W/m²K	**23.0 kW**	22%	
Floor Improvements	0.35 W/m²K	0.25 W/m²K	**29.1 kW**	2%	Refinishing of floors incorporating small amounts of insulation.
External Wall Insulation	1.7 W/m²K	0.6 W/m²K	**24.0 kW**	19%	A U-value of 0.6 W/m²K is achievable with a 60-100mm system and reduces the risk of damp / condensation.
External and Cavity wall insulation	1.7 W/m²K	0.4 W/m²K	**22.9 kW**	23%	Achievable minimum U-value. Detailed analysis would be required to determine if there a damp / condensation risk
Double Glazing to front windows, Triple Glazing to all other windows	2.2 W/m²K 4.8 W/m²K	1.4 W/m²K 1.0 W/m²K	**22.4 kW**	24%	
Triple Glazing to all windows	2.2 W/m²K 4.8 W/m²K	1.0 W/m²K 1.0 W/m²K	**21.9 kW**	26%	
Mechanical Ventilation with Heat Recovery	Extract and Natural ventilation	80% Efficient MVHR to all spaces	**27.2 kW**	8%	Either through wall or centralised units.
Further Measures improving Air Tightness	0.75 ACH	0.20 ACH	**26.4 kW**	11%	Replacing of doors, installation of new windows, re-finishing of internal walls and junctions.
It should be noted that the Peak Heat Loss values are for the ENTIRE property, the heat loss for the second floor flat ranges from 6.4 kW down to 5.8 kW. To run both the second floor flat and main house of individual ASHP, the measures taken would need to get the total heat loss below 20kW. See graph below for further information.					

HEAT LOSS GRAPH

The graph below shows how each of the improvements described above reduces the overall heat loss. The dashed lines indicate where single, double or triple domestic heat pumps would be required to meet the peak heat loss. Two heat pumps have been chosen as these represent a typical domestic heat pump (Samsung) and a higher end unit (Steiibel Eltron) which has a higher efficiency and is significantly quieter.



Key observations:

- Moderate improvements, focusing on windows, floor, roof and airtightness could achieve a reduction in heat loss sufficient to run both flats on domestic ASHP's
- Enhanced improvements utilising higher specification glazing and cavity wall insulation could lower the heat loss to utilise smaller and quieter units.

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OVERHEATING

Overheating is an increasingly prevalent issue as heat waves increase in both frequency and severity. The most effective strategy for mitigating overheating risk is to reduce solar gains and warm external air entering the building during the day and utilise passive or active cooling methods when appropriate.

Solar Gains

Solar gain is the dominant factor in overheating. High specification glazing with low G-values can cut out up to 60% of the incoming gains. Further external shading measures should always be considered as unlike internal blinds or curtains these eliminate the gain outside of the building fabric.

External brise solai. Similar shading can be achieved with balconies.

External roller blinds

Ventilation

The conventional UK approach to mitigating the impact of heat waves relies upon the unintentional 'leaks' in the building fabric allowing air to move freely and securely through the building. As the air tightness is improved this aspect of the orthodox behaviour is lost and buildings become more susceptible to overheating.

To address this, it is very important that purposeful ventilation routes are provided. To be successful these must address the following:

- Privacy
- Security
- Rain ingress
- Pest ingress

An ideal arrangement allows air to move through the building whilst it is unoccupied without risk of water damage or an invasion of pests (insects/birds). Similarly, when occupied, the openings should allow occupants to sleep feeling secure and without privacy concessions.

This can be achieved by secure ventilation openings or by mechanical ventilation.

Active Cooling

Active cooling utilising external heat rejection equipment and internal cooling units can be used as a supplementary solution. Passive cooling methods are generally preferable as it results from pragmatic and effective design strategies. Should active cooling be a desirable addition some concessions on space and noise are likely.

SUPPLY

As the building has no access to open water, and limited available land there is only one option:

AIR SOURCE HEAT PUMPS

Air source heat pumps use ambient air as a heat source. These tend to be small to medium scale for domestic applications and can generate LTHW flow temperatures of around 45-55°C. Although most models have a secondary mode to generate higher temperatures for domestic hot water, with a commensurate reduction in COP.

Due to the inherent variability of the ambient air temperature throughout the year, values of COP tend to fluctuate and are typically lower in winter when compared to other heat sources when the ambient air drops below 10°C.

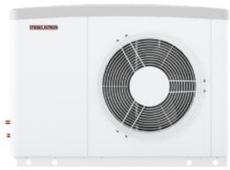
Table 1 - Summary of the advantages and disadvantages associated with domestic scale ASHPs.

Advantages	Disadvantages
• Lower capital expenditure • Ease of installation and integration • Extensive range available on the commercial market.	• Lower COP values in winter • Work efficiently up to LTHW temperatures of 45 °C maximum • Noise generated by equipment in an external setting • Aesthetic considerations

Figure 1 - Simplified diagram of an air source heat pump system. Values of COP typically range from 2-3 for an ASHP delivering 45-55°C LTHW. Note that most models have a secondary mode to generate higher temperatures for domestic hot water, with a commensurate reduction in COP.

At a target LTHW temperature of 45°C heat pumps will generally provide 3kW of heat output for every 1kW of electrical energy consumed this is known as the Coefficient of Performance (COP). The small difference in efficiency between air and ground is not a driving factor in the decision.

The table below shows an indicative selection for a domestic air source heat heat pump.

	Samsung	Stiebel Eltron
Peak Heat Loss	< 27.8 kW	< 16.8 kW
Model	2 No. Samsung 16kW EHS Monobloc (13.9kW)	2 No. Stiebel Eltron WPL17 (8.4kW)
Sound Pressure (max)	69 dB(A)	60 dB(A)
		

It should be noted the sound pressure is at the maximum output and by having a greater capacity of heat pump in comparison to the peak heat loss, the units can be run at lower outputs less often so would be quieter in operation.

From the layout of the building and its surroundings, the most suitable location for the outdoor unit will be on the roof or below the external staircase.

HEAT EMITTERS

Radiators

Heat pumps operate most efficiently at a lower flow temperature of 45°C or less. They therefore require larger heat emitters than traditional systems, which can lead to coordination issues. However, by improving the fabric performance of the building the size increase can be offset, allowing for similar size or smaller radiators.

Stelrad K2 – Standard LTHW Radiator

Dimplex Smartrad - Fan assisted LTHW radiator

The Stelrad K2 is a standard radiator and the Dimplex Smartrad utilises an internal fan to drive air over the heating fins to boost the output. These two radiators have been selected as they are known to be good quality, cost effective radiators[3].

The advantages and disadvantages to radiator-based systems are:

Advantages

- Reduced cost when compared to Underfloor Heating (UFH)
- Simple to replace.
- Fan boost systems can allow for smaller radiator sizes.

Disadvantages

- Reduced flexibility with room layouts.
- Fan boost systems can be noisy if not suitably selected.

Underfloor Heating

An alternative to radiators is underfloor heating, however this may or may not be possible with the existing floor build-ups and ceiling heights or for all spaces due to the maximum output of 55 W/m² depending on floor build up[4].

The advantages of UFH over radiators are;

Advantages

- Flexibility with furniture layouts
- Low maintenance
- Reduced likelihood of damage / tampering
- Very quiet – no pipework, fan or other noises.

Disadvantages

- Higher cost
- Difficult to repair or replace if damaged.
- Requires floors to be refitted.

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[3] *As of 22/02/21 a 1200x600mm Stelarad K2 (623W) retails for around £130 ex controls, a 500x500 Dimplex Smartrad SRX080 (634W Speed 2) retails for around £430.*

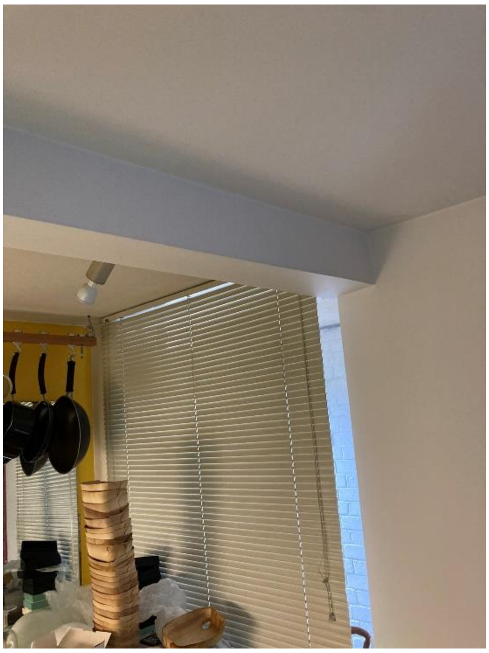
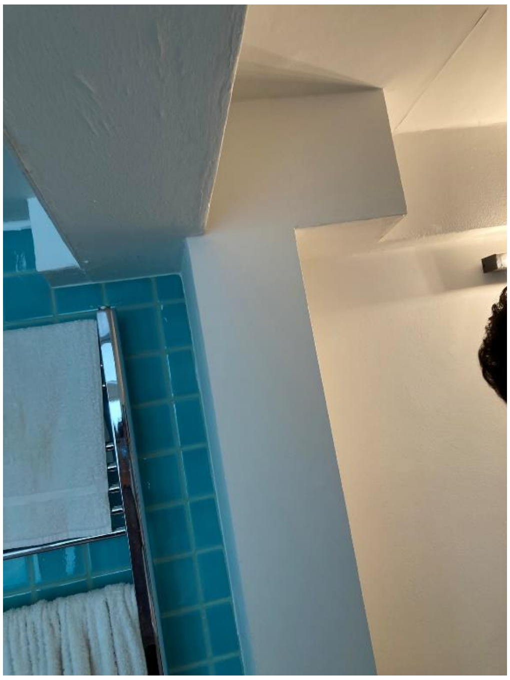
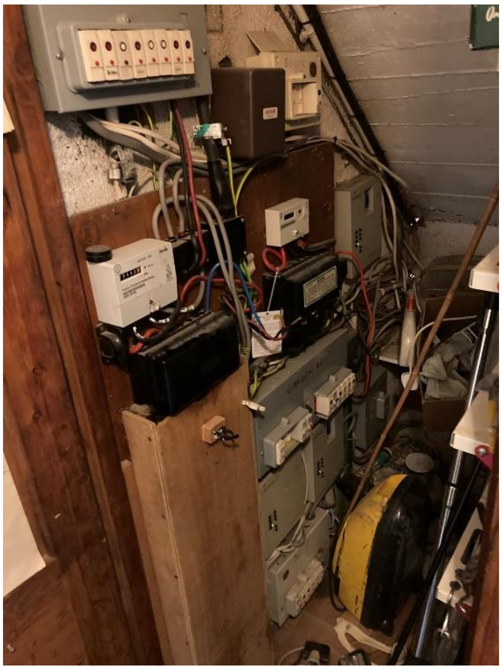
[4] BSRIA Under Floor Heating and Cooling guidance – based on a max floor temperature of 28°C, a floor U-value of 0.15 W/m²K or less and an average UFH water temp of 42.5°C.

APPENDIX A – EXISTING SERVICES INFRASTRUCTURE - SITE VISIT

General Site Observations

- The building has no existing ceiling voids and generally has exposed slabs and walls.
- Vertical services distribute either side of the stair core.
- There is some evidence of damp in areas.
- Mix of radiators and underfloor heating.
- Thermal bridging and airtightness are generally poor.

	
E.1 – Dropped ceiling to allow recessed lights.	E.2 – Single glazing to rear windows.
	
E.3 – Double glazing to front windows.	E.4 – External stair and exposed slab – significant thermal bridge.

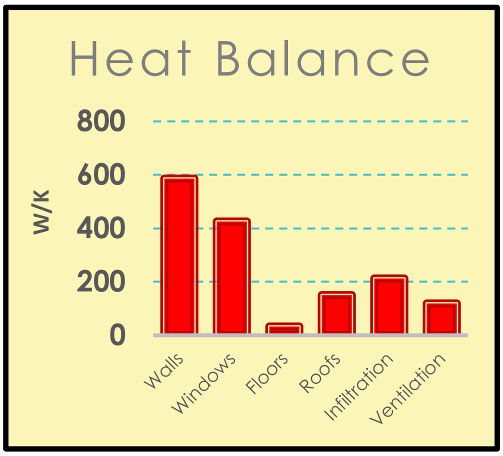
	
E.5 – Existing balcony and timber shelter / brise solei	E.6 – Kitchen – beam is below slab height and windows extend to slab making distribution of services though voids difficult without reducing ceiling hieghts.
	
E.7 – Lower ground floor – boxing out to route drainage.	E.8 – Existing electrical services

	
E.9 – Stair core and service risers either side.	

APPENDIX B – FABRIC ELEMENTAL HEAT LOSS CALCULATION

The graphs below are produced from the fabric heat loss calculation to show the relative proportion of heat loss from each fabric element.

Base Model – 36.2 kW



New Flat – 29.7 kW