GRENFELL TOWER REGENERATION PROJECT

PLANNING APPLICATION

OCTOBER 2012

SUSTAINABILITY AND ENERGY STATEMENT

THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA

Kensington & Chelsea TMO

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MAX FORDHAM

Sustainability & Energy Statement

Grenfell Tower Refurbishment

17 August 2012

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ISSUE HISTORY

Issue	Date	Description
*	17/08/12	Planning
A	15/10/12	Planning resubmission Page 9/10 – updated overheating window options and page 14 – BREEAM health and wellbeing credit commentary updated.

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CONTENTS

1.0 INTRODUCTION

1.1 Overview

The aim of this report is to identify how, as part of the Grenfell Tower refurbishment scheme, the current energy and environmental comfort problems can be addressed, and how the chosen solutions sit within the London Plan's aim to bring existing housing stock up to the Mayor's standards on sustainable design and construction.

The poor insulation levels and air tightness of both the walls and the windows at Grenfell Tower result in excessive heat loss during the winter months. Addressing this issue is the primary driver behind the refurbishment.

Due to valid safely concerns the windows at Grenfell Towers are restricted to open no more than 100 mm. This restriction causes chronic overheating in the summer months. It is essential that the renovation works do not make the overheating problems any worse and where possible we will strive to reduce overheating in line with current guidelines.

The heating system exacerbates the overheating problem due to its high uncontrolled heat losses throughout the year (including summer) and is also reaching the end of its design life. The client wishes to update the heating system at this point. Updating the heating system allows the disruptive works to 'piggy back' on the recladding works.

'The London Plan July 2011' aims to conserve energy. A defined energy hierarchy should be followed. This hierarchy is as follows:

1. Be lean: use less energy, in particular by adopting sustainable design and construction measures
2. Be clean: supply energy efficiently
3. Be green: use renewable energy

This approach has been adopted to illustrate the environmental benefits achieved through the refurbishment of the tower.

1.2 Site & Flat Details

Grenfell Tower is a twenty three storey residential block built in the early 1970's and is located in the Lancaster West Estate in North Kensington.

The tower contains office space, a nursery and a boxing club which will be relocated within the tower as part of the refurbishment process. There is also a desire to convert two of the lower levels to new housing. The new housing design will following the same principals as the existing refurbished flats but will comply with the current building regulations.

Figure 1-1 Site Plan

1.3 Insulation and Energy

The wall construction of Grenfell tower is a solid concrete construction. Insulation is provided by a 12 mm layer of insulation bonded to the rear of the integral plaster board lining. The resulting U-value of the existing wall is 1.5 $W/m^2.K$. This is five times higher than current Building Regulations would allow on a new flat.

The existing windows are now coming to the end of their design life and require replacing. The existing window U-value is in the order of 5.5 $W/m^2.K$ or about three times that above the level required by current Building Regulations. In addition to the poor thermal performance these windows also leak heavily which contributes to excessive heat loss, drafts and noise penetration.

Grenfell Tower has a communal bathroom extract system. This system extracts air at a rate of 1.8 m^3/s, 24 hours a day, 365 days a year. This warm air extracted from the bathrooms represents a significant wasted energy stream out of the building.

1.4 Overheating

Grenfell Tower currently suffers from chronic overheating in the summer. Presently the south facing flats experience the highest temperatures. The current climate change predictions for London over the next 30 to 50 years predict that peak summertime temperatures will rise. Doing nothing to improve the overheating now will result in further problems to all flat orientations in the future.

Ventilation to the flats is via single glazed horizontal sliding windows. These units are poorly sealed compared to modern standards and offer no solar control. There is also a desire to restrict the opening of the windows for safety reasons; both to mitigate the risk of falls and to combat the problem of residents throwing objects from the windows.

By providing constant ventilation the existing poorly sealed windows are helping to reduce overheating. Increasing the air tightness and insulation levels alone without thinking about the flat cooling would result in a worse overheating problem than that currently being experienced.

1.5 Heating System

The residential units are heated by a single loop ladder arrangement which also provides domestic hot water (DHW) via a hot water cylinder in each flat. The pipework serves the flats via six risers (1 per flat on each floor) and from there runs within the flats to radiators through pipework cast into the screed floors. The pre-existing problem with summertime overheating of the flats is in part caused by the floor and ceiling slabs radiating heat due to the hot pipework within. There is also currently no individual control of the heating system within each flat beyond the ability to turn off a radiator manually.

The summertime overheating is a symptom of the greater problem of heat loss and therefore energy waste due to the inefficient method of heat distribution throughout the building. The heating system is now 30 years old and is coming to the end of its design life. Occurrences of leaks in this heating system are beginning to increase.

2.0 REFURBISHMENT RESPONSE TO EXISTING ENERGY & ENVIRONMENTAL ISSUES

2.1 Insulation

Improving the insulation levels of the walls, roof and windows is the top priority of this refurbishment.

Improving the insulation levels on a solid wall construction is always best done from the outside of the wall. This solves several issues with thermal bridging and interstitial condensation. Thermal bridging will be kept to a minimum by insulation window reveals and using thermal breaks on all fixings that link the new rain screen cladding to the existing concrete structure.

The chosen strategy is to wrap the building in a thick layer of insulation and then over-clad with a rain screen to protect the insulation from the weather and from physical damage.

Table 2-1 below shows the target levels of insulation for Grenfell Tower. The proposed insulation levels far exceed those required by Building Regulations. Insulation improvements may only happen once or twice in a buildings lifetime due to the complexity and disruption caused. For this reason we are going over and above current building regulations to make sure the building continues to perform well into the future.

Column two of the Appendix A Heating Options Study shows the energy improvements that are made to Grenfell Tower by applying the improved insulation and new windows.

Element	Building Regulations[1] (W/m^2.K)	Grenfell Refurbishment (W/m^2.K)	Improvement over Building Regulations
External Walls	0.3	0.15	50 %
Roof	0.25	0.15	40 %
Windows	2.0	1.6	20 %

Table 2-1 Proposed U-values at Grenfell Tower

[1] Part L1 2010 Building Regulations 2010, maximum permissible values for each element in the notional building.

External Walls

An external wall target U-value of 0.15 W/m^2.K was calculated using the areas shown in Figure 2-1 and the thickness build-ups illustrated in Figure 2-2 and detailed in Table 2-2, Table 2-3, Table 2-4 and Table 2-5.

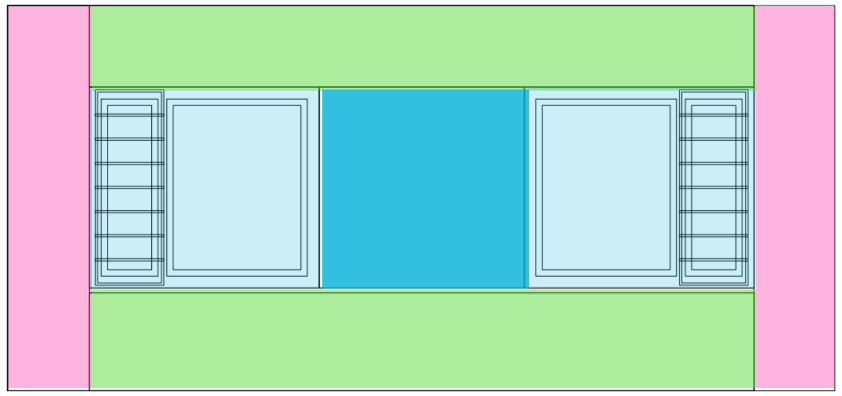

Figure 2-1 Area Weighted U-Value Calculation Areas

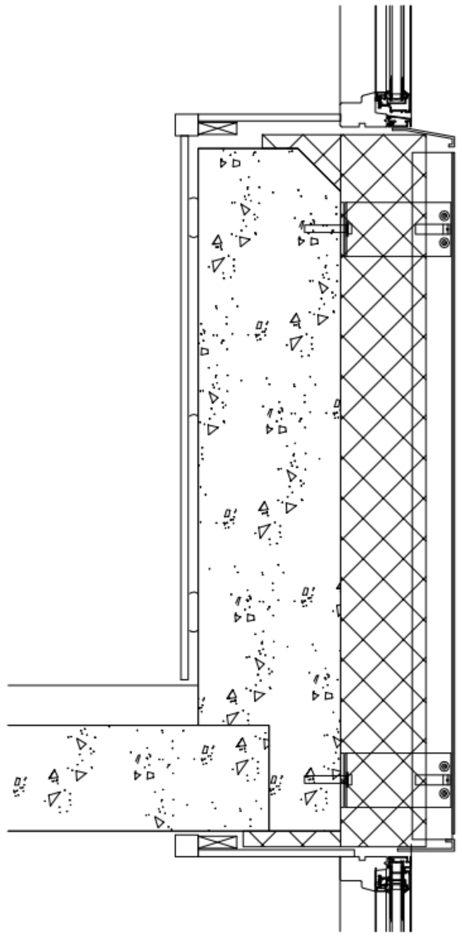

Figure 2-2 Section of Spandrel Wall Panel with New Insulation and Rain Screen Cladding

Spandrel Wall Panel (Green)

Element (Outside to Inside)	Conductivity W/(m.K)	Thickness mm
Zink Cladding (New Rain Screen)	160.0	3
Ventilated Cavity	n/a	50
Insulation (New, Celotex FR5000)	0.021	150
Cast Concrete (Existing)	1.400	250
Insulation (Existing)	0.035	10
Plasterboard (Existing)	0.160	12
Total		**475**
U-value (W/m2.K)		**0.1248**

Table 2-2 Spandrel Wall Panel Build-up

Column (Pink)

Element (Outside to Inside)	Conductivity W/(m.K)	Thickness mm
Zink Cladding (New Rain Screen)	160.0	3
Ventilated Cavity	n/a	50
Insulation (New, Celotex FR5000)	0.021	100
Cast Concrete (Existing)	1.400	100
Insulation (Existing)	0.035	10
Plasterboard (Existing)	0.160	12
Total		**275**
U-value (W/m2.K)		**0.1810**

Table 2-3 Column Build-up

Glazing Infill Panel (Blue)

Element (Outside to Inside)	Conductivity W/(m.K)	Thickness mm
Glass	1.1	6
Insulation (New, Celotex FR5000)	0.021	100
Insulation (New, Celotex FR5000)	0.021	25
Plasterboard	0.160	12
Total		**143**
U-value (W/m2.K)		**0.16**

Table 2-4 Glazing Infill Panel Build-up

Total Area Weighted Average

Building Element	U-Value W/m2.k	Area
Spandrel Wall Panel	0.1248	5.45
Column	0.1810	2.88
Glazing Infill Panel	0.1617	1.88
Total Area Weighted Average		**0.15**

Table 2-5 Area Weighted Average Calculation Results

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2.2 Overheating

Grenfell Tower suffers from summertime overheating due to the design and operation of the current heating system and the safety restrictors that restrict the window openings to 100 mm. To add additional insulation without improving the ventilation will make the existing overheating problem worse.

Ventilation to the flats is currently via single glazed horizontal sliding windows. These units are poorly sealed compared to modern standards and offer no solar control. There is also a desire to restrict the opening of the windows for safety reasons; both to mitigate the risk of falls and to combat the problem of residents throwing objects from the windows. For this reason the re-cladding of the building will be carefully designed in conjunction with the ventilation systems in order to ensure adequate summertime cooling.

The design of ventilation and window options for Grenfell Tower was driven primarily by four key requirements;

1. Prevention of summertime overheating as a result of increased insulation incorporated within the cladding system.
2. Comply with Building Regulations
3. Ability for the windows to be cleaned from inside the dwellings by residents.
4. 100 mm restriction on window opening aperture desired by client for safety reasons and to address anti-social behaviour of residents throwing items from the windows.

Building Regulations
For refurbishment works to existing buildings Building Regulations Approved Document Part F, section 7.1 states that;

"When building work is carried out on an existing building, the work should comply with the applicable requirements of schedule 1 of the Building Regulations, and the rest of the building should not be made less satisfactory in relation to the requirements than before the work was carried out…"

Therefore there must not be an overheating issue created due to the restrictions placed on the window apertures and/or the design of the proposed ventilation solution.

Building Regulations (Part L1A 2010) describes how overheating to new apartments must be limited. Although the majority of the Grenfell Tower is a refurbishment project rather than a new development, Part L1A does provide a good framework for ensuring that no overheating issues are created as a result of the works undertaken. The method of demonstrating compliance is by SAP (Standard Assessment Procedure) calculation, which includes a component to calculate the risk of overheating.

Planning Policy - Regional (The London Plan)
The London Plan (July 2011) states *'Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible.'*

Building Regulations - New Build
The Building Regulations (Part L1A 2010) describe how overheating to apartments must be limited. The method of demonstrating compliance is by SAP (Standard Assessment Procedure) calculation, which includes a component to calculate the risk of overheating. SAP does this by assigning each flat a "likelihood of high internal temperatures" score of slight, medium or high. This assessment method was carried out in the early design phase and identified that the one bedroom flats had a high likelihood of overheating. SAP is a static calculation that does not take into account real world weather data, for this reason a dynamic computer simulation was also carried out as part of the design process.

The following criteria are taken from the CIBSE A Guide and are also referenced in the Draft Climate Change Adaptation Strategy for London.

Living Room:	28˚C shall not be exceeded for more than 1% of occupied hours (09:00 to 22:00, 41 h per year)
Bedroom:	26˚C shall not be exceeded for more than 1% of occupied hours (22:00 to 09:00m, 47 h per year)

Recommended Regulatory Approach for Grenfell Tower
To comply with the Part F requirement we need only to ensure that the existing overheating problem does not become any worse than it currently is. However we are aware that the summertime temperatures in Grenfell Tower cause many residents discomfort. These conditions do not provide a sensible target for overheating. As such the overheating of the flats at Grenfell Tower will be assessed against both the refurbishment criteria and the new build criteria using a dynamic thermal model to predict the number of hours that rooms will be hotter than their target temperature, focusing on the temperatures in the living rooms and the bedrooms as this is what the legislation is concerned with.

A short list of three different types of window configuration for dealing with overheating and the criteria above have been investigated. The three window types that were looked at are central pivot, tilt and turn and horizontal sliding.

A series of computer simulations were run to assess the effects of the different window types and to help assess the requirements for solar control glass and areas of window that allows safe rapid purge ventilation in the summer. These simulations were each given a model name shown in Table 2-6.

Model Reference	Description	Insulation	Heating
A	Current Grenfell Tower	Existing	Existing
B	Improved Heating System	Existing	New
C1	Pivot windows with acoustic trickle ventilation	New	New
C2	Tilt and Turn windows with acoustic trickle vent	New	New
C3	Horizontal Sliding windows with acoustic trickle vent	New	New
D1	Pivot with Solar Control	New	New
D2	Tilt and Turn with Solar Control	New	New
D3	Horizontal Sliding with Solar Control	New	New
E1	Pivot with Purge ventilation	New	New
E2	Tilt and Turn with Purge ventilation	New	New
E3	Horizontal Sliding with Purge ventilation	New	New
E4	Pivot with Purge ventilation, No solar control glass	New	New
E5	Tilt and Turn with Purge ventilation, No solar control glass	New	New
E6	Horizontal Sliding with Purge ventilation, No solar control glass	New	New

Table 2-6 Summary of Computer Simulations

Overheating Study Results

Reducing/eliminating the uncontrolled heat loss through the installation of the proposed new heating system is shown in model B. This has the effect of reducing but not solving the overheating issues at Grenfell Tower (Figure 2-4 and Figure 2-5).

Series C shows the effect on overheating of improving the insulation and airtightness of the dwelling while limiting the openings of the new windows to 100 mm (Figure 2-4 and Figure 2-5). The improved insulation means that the flats cannot lose heat during the night and the improved air tightness means the building cannot lose heat through being 'leaky'.

Introducing solar control to the D series models reduces the occurrences of overheating dramatically in D2 & D3 (Figure 2-4 and Figure 2-5). However, on its own solar control is not capable of reducing the overheating below the new build target for any window option.

The E series introduces an area of fully openable windows that provides high ventilation rates (Figure 2-4 and Figure 2-5) without compromising safety. An illustration of the "safe purge" ventilation models E1 to E4 is shown in Figure 2-3.

The new build target is not achieved for the living room area in options E1, E2, E3 and E4 (Figure 2-4 and Figure 2-5). This is because the living room is assessed between 09:00 and 22:00 when the external air temperature is at its highest. Opening the windows when the external air temperature is above the target temperature of 28 °C can only heat the living room, not cool it. Therefore adding openable area will not improve the overheating any further. To further improve the situation we would need to include measures such as exposing thermal mass or active cooling which are beyond the scope of this refurbishment.

Grenfell Refurbishment Solution

The initial thermal simulations (A to E3) were performed out before the daylight assessment was carried out for the new and existing flats. The now completed daylight study showed that solar control glass was not a viable option on Grenfell Tower. Solar control glazing cuts out as much thermal energy as possible while allowing as much visible light to pass as possible. However using solar control glass will reduce the total visible light through the glass by a further 20% compared to normal double glazing. This 20% reduction of visible light transmittance made it impossible for the new or refurbished flats to pass the minimum daylight requirements.

As solar control glass is not an option due to daylight levels simulations E4, E5 and E6 were used to model the overheating of the flats with centre pivot windows, tilt and turn windows and horizontal sliding windows with purge ventilation panels and normal double glazing (no solar control). Removing the solar control glass increased the occurrences of overheating in the bedrooms and living rooms by an average of 32% and 22% respectively compared to the "E" series models. However using centre pivot windows the resulting overheating for the bedrooms is still below the new build threshold as can be seen in Figure 2-4.

Option E4 and E5 are both being considered for use as these option achieve the lowest number of hours above 26/28 °C and are compatible with the minimum daylight standards in section 5.0 of this report. The final decision between option E4 and E5 on window choice will be dictated by the budget.

Figure 2-3 Safe purge ventilation

Bedroom Overheating Results – East Facing Single Bed Flat (worst case)

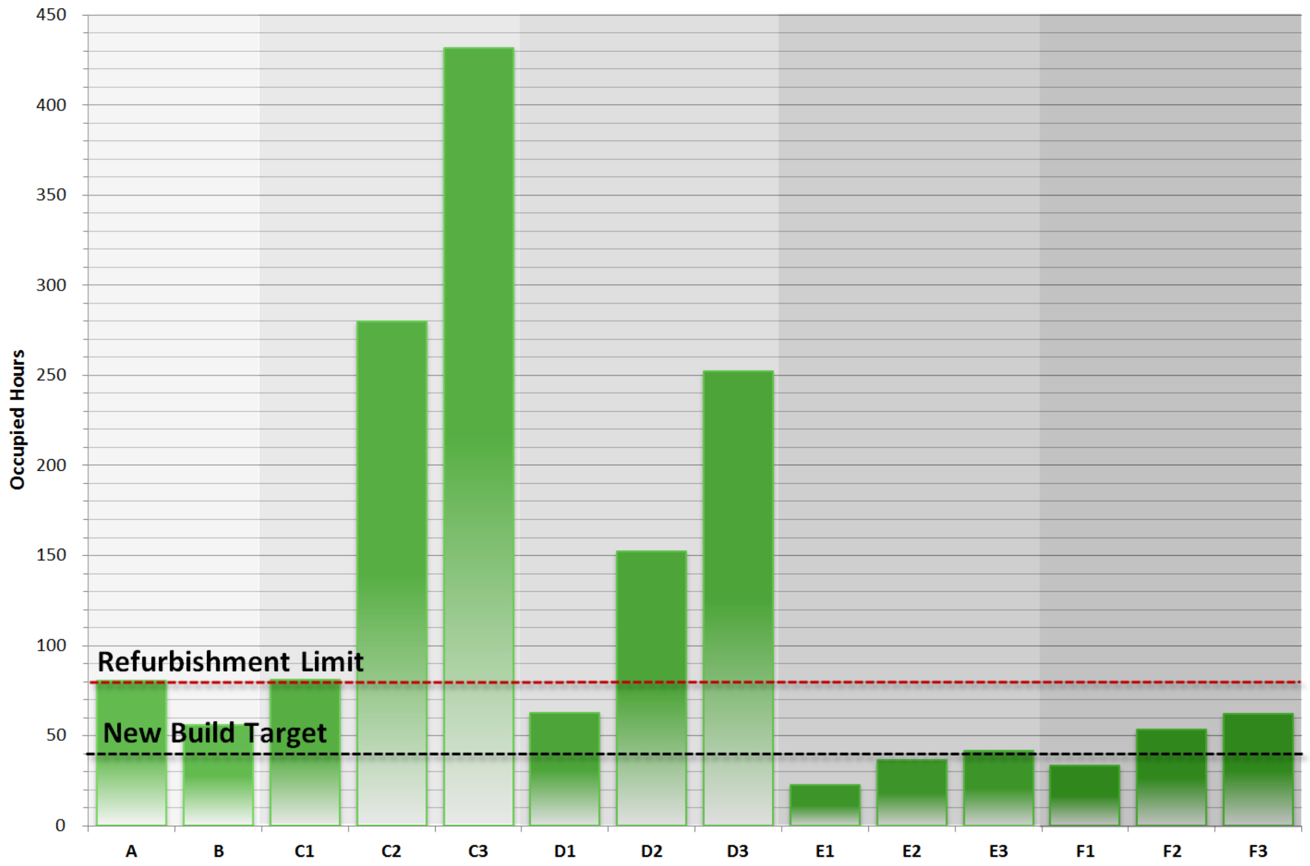

Figure 2-4 Overheating analysis in worst case bedroom

Living Room Overheating Results – East Facing Single Bed Flat (Worst Case)

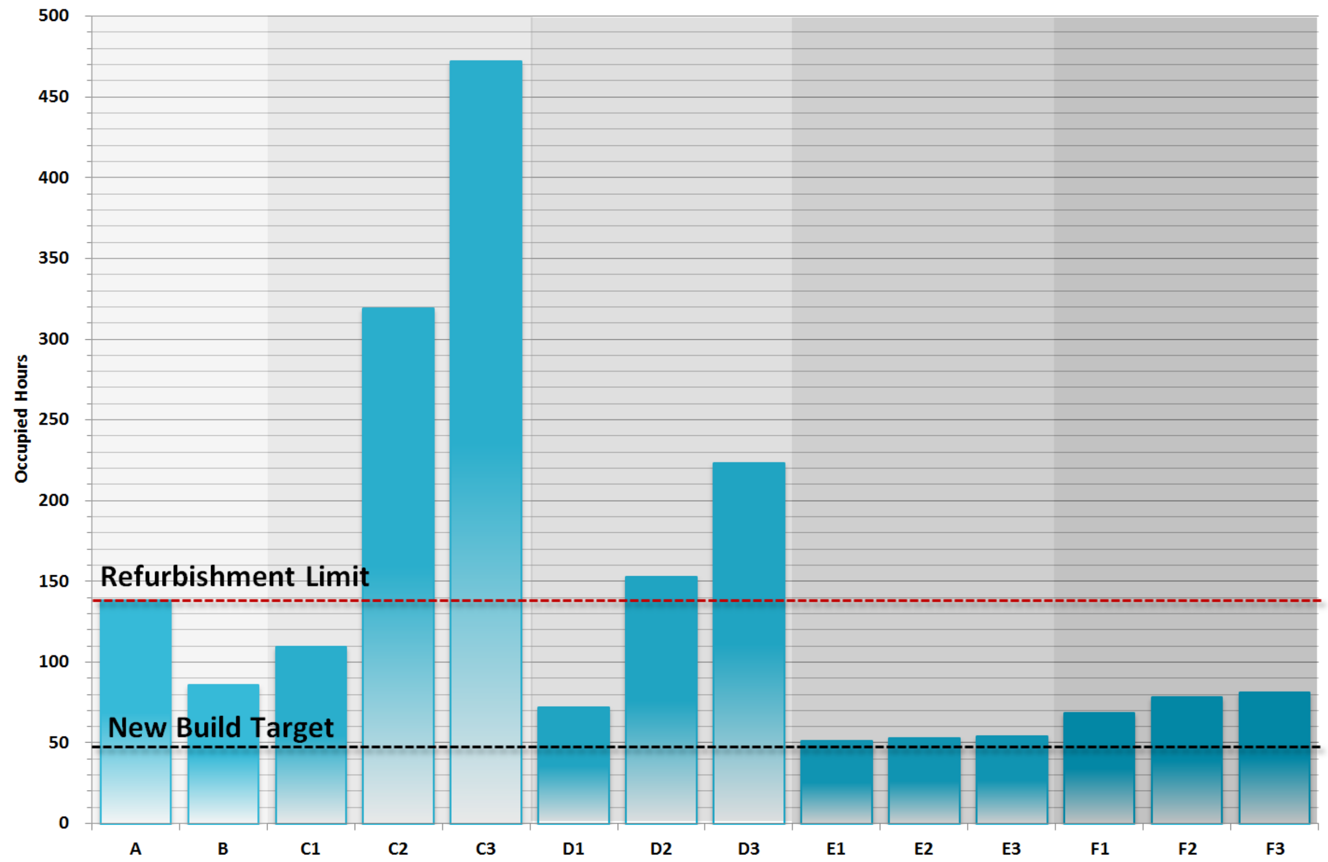

Figure 2-5 Overheating analysis in worst case living room

2.3 Heating System

Existing System
The residential units are heated by a single loop ladder arrangement which also provides domestic hot water (DHW) via a hot water cylinder in each flat. The pipework serves the flats via six risers (1 per flat on each floor) and from there runs within the flats to radiators through pipework cast into the screed floors. There is a pre-existing problem with summertime overheating of the flats caused by the floor and ceiling slabs radiating heat due to the hot pipework within. There is also no individual control of the heating system within each flat beyond the ability to turn off a radiator manually.

The summertime overheating is a symptom of the greater problem of heat loss and therefore energy waste due to the inefficient method of heat distribution throughout the building. When the age/construction of the building façade and likely efficiency of the heating plant is taken into consideration, it is clear that there are significant carbon reductions to be made by refurbishing the façade and heating in a cohesive manner.

The basement heating plant consists of 3x gas-fired boilers located in the basement. These boilers are old, inefficient and unreliable with an estimated efficiency of 60%. Hot water for both heating and DHW is pumped from the basement up the six risers to the flats on each floor. As these risers supply both the DHW and heating flow and return there is a requirement for them to be active both during and outside the heating season.

The heating system was comprehensively surveyed in 2008 and found to have a useful service life of approximately 10 years remaining. When this is taken into consideration along with the inefficiencies and issues mentioned previously it was decided that a complete new system would be required.

Design Brief for Refurbished Heating System
The initial client brief included the following primary issues to be solved with the new heating system as summarised below;

1. Prevent overheating due to DHW and LTHW distribution pipework.
2. Give tenants control over individual heating systems.
3. Reduce energy use and therefore operating cost.
4. Minimise disruption to tenants during and after installation.
5. Improve reliability

In addition to the above considerations the design team has also gathered further considerations from the weekly tenant consultations at Grenfell Tower. The tenants/long lease holders would also like the following to be incorporated into the refurbishment.

6. Provide mains pressure hot water to allow tenants to install showers in their properties.
7. Reduce amount of heating equipment (water storage etc) within the flat to increase storage space.

Heating System Proposal
Several different heating options were considered. A full appraisal can be found in Appendix A. Option B2 (centralised gas absorption heat pump with central DHW storage and trace heating) was chosen as it could best address the client's and the tenant's requirements. What follows is a short summary of how the new heating system addresses the briefing points above.

1. **Reduce Overheating**
   a. Each flat will have individual heating control via a wall mounted thermostat. When the heating is off there will be no hot water flow in the flat pipework; eliminating the heating system's contribution to the summer time overheating.
   b. All pipework running through flats to be insulated to a high standard to reduce heat loss as much as possible.
   c. Replacing the radiators and insulating the external walls will allow the heating to run at a reduced temperature. This will facilitate the use of renewable heat sources and will reduce overheating.

2. **User Control**
   a. Each flat will have a thermostat that allows the user to set an air temperature for their flat and to turn the heating on/off.
   b. Thermostatic radiator valves on every radiator allow individual rooms to be controlled.

3. **Reduce Energy Consumption**
   a. The energy consumption of several heating options were analysed (see Appendix A for full appraisal). The Gas Absorption Heat pump (GAHP) (option B1 to B3) was selected due to its low carbon and running costs compared to the other options.
   b. The central extract system at Grenfell Tower currently rejects over 1.8 m^3/s of warm air from the tower. Placing the heat pumps in the path of this extract air stream allows energy to be recycled from the central extract system; turning a waste energy stream into a useful contributor to the heating and hot water demand of Grenfell Tower.

4. **Minimise Disruption to Tenants**
   a. Keeping the system renewal confined to spaces that are currently only used for heating and hot water means that the installation of the new system will minimise the disruption to the flats.

5. **Improved Reliability**
   a. The selected heat pump will be a cascaded system that combines the output of five individual units. If one of the individual units was to fail the remaining four can continue to operate independently of the failed unit.
   b. A top up/backup high efficiency gas boiler will also be provided to supplement the output of the heat pumps. This will only be necessary during periods of very cold weather and high domestic hot water use.

6. **Mains Pressure**
   a. The selected system will be a mains pressure system to allow the tenant to install showers if they wish to. The current system is open vented to the flats and does not provide enough pressure to shower.

7. **Space**
   a. Option B2 was selected in part due to its space saving within the flats. This option will remove the need for a local hot water storage unit in the flats. The space that was taken up by the water storage vessel can now become storage.

3.0 PLANNING POLICY

The following sections describe The London Plan planning policy, spatial development strategy for greater London July 2011. The policy is described in a national, regional and local context. We summarise the planning policies at these levels that have informed our approach to the Grenfell Tower energy strategy.

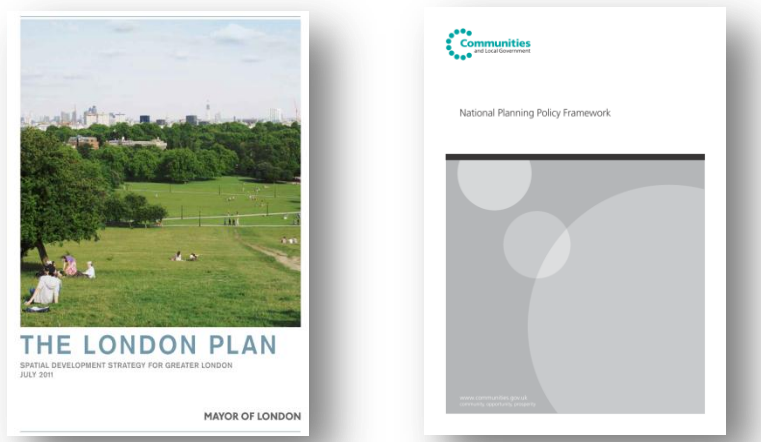

Table 3-1 The London Plan 2011 & National Planning Policy Framework

3.1 Policy Context – National

National Planning Policy Framework (NPPS) set out the Government's national policies for different aspects of land use planning in England. This policy outlines that the local planning authorities are empowered to include policies in their plans requiring a percentage of on-site renewable energy within both new and some existing developments.

3.2 Policy Context – Regional

The London Plan. Spatial Development Strategy for Greater London, July 2011

Policy 5.4: Retrofitting
A: The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

B: Within LDFs boroughs should develop policies and proposals regarding the sustainable retrofitting of existing buildings. In particular they should identify opportunities for reducing carbon dioxide emissions from the existing building stock by identifying potential synergies between new developments and existing buildings through the retrofitting of energy efficiency measures, decentralised energy and renewable energy opportunities (see Policies 5.5 and 5.7).

3.3 Policy Context – Local

The Royal Borough of Kensington and Chelsea's (RBKC's) Core Strategy outlines their environmental requirements for new and refurbished developments in the following policy:

Policy CE1: Climate Change
The Council recognises the Government's targets to reduce national carbon dioxide emissions by 26% against 1990 levels by 2020 in order to meet a 60% reduction by 2050 and will require development to make a significant contribution towards this target.

To deliver this the Council will:

a. Require an assessment to demonstrate that all new buildings and extensions of 800m^2 or more residential development or 1,000m^2 or more non-residential achieve the following Code for Sustainable Homes / BREEAM standards;
   i. **Residential Development:** Code for Sustainable Homes:
      Up to 2012: Level Four; and seek to achieve:
      2013 to 2015: Level Five;
      2016 onwards: Level Six.
   ii. **Non Residential Development:** Relevant BREEAM Assessment:
      Up to 2015: Excellent; and seek to achieve:
      2016 onwards: Outstanding;

b. Require an assessment to demonstrate that conversions and refurbishments of 800m^2 or more residential development or 1,000m^2 or more non-residential achieve the following relevant BREEAM standards;
   i. **Residential Development:** EcoHomes Very Good (at design and post construction) with 40% of credits achieved under the Energy, Water and Materials sections, or comparable when BREEAM for refurbishment is published;
   ii. **Non Residential Development:**
      Up to 2015: Very Good (with 40% of credits achieved under the Energy, Water and Materials sections);

c. Require an assessment to demonstrate that the entire dwelling where subterranean extensions are proposed meets EcoHomes Very Goof (at design and post construction) with 40% of the credits achieved under the Energy, Water and Materials sections, or comparable when BREEAM for refurbishment is published;

d. Require that carbon dioxide and other greenhouse gases are reduced to meet the Code for Sustainable Homes, EcoHomes and BREEAM standards in accordance with the following hierarchy:
   i. Energy efficient building design, construction and materials, including the use of passive design, natural heating and natural ventilation;
   ii. Decentralised heating, cooling and energy supply, through Combined Cooling Heat and Power (CCHP) or similar, whilst ensuring that heat and energy production does not result in unacceptable levels of air pollution;
   iii. On-site renewable and low-carbon energy sources;

e. Require the provision of a Combined Cooling, Heat and Power plant, or similar, which is of a suitable size to service the planned development and contribute as part of a district heat and energy network for:
   i. Strategic site allocations at Kensal, Wornington Green, Kensington Leisure Centre and Earl's Court; and

ii. significant redevelopment and regeneration proposals at Notting Hill Gate and Latimer as set out in the places section of this document;

f. Require all CCHP plant or similar to connect to, or be able to connect to, other existing or planned CCHP plant or similar to form a district heat and energy network;

g. Require development to connect into any existing district heat and energy network, where the necessary service or utility infrastructure is accessible to that development;

h. Require development to incorporate measures that will contribute to on-site sustainable food production commensurate with the scale of development;

i. Require, in due course, development to further reduce carbon dioxide emissions and mitigate or adapt to climate change, especially from the existing building stock, through financial contributions, planning conditions and extending or raising the Code for Sustainable Homes and BREEAM standards for other types of development.

From the relevant national, regional and local policies outlined previously it can be seen that in order to comply with planning policies it is necessary to achieve a BREEAM Domestic Refurbishment assessment score of Very Good. The implications and methodology of this is described in more detail in the following section.

4.0 BREEAM DOMESTIC REFURBISHMENT 2012

4.1 BREEAM Domestic Refurbishment 2012

Figure 4-1 BREEAM Domestic Refurbishment Technical Manual

This section provides additional information regarding measures taken to comply with BREEAM Domestic Refurbishment requirements. For a full report and details of the scores achieved for each credit please refer to the "BREEAM Domestic Refurbishment 2012 Pre-Assessment Estimator".

RBKC's Policy CE1 states that a qualifying refurbishment should achieve a score of Very Good (at design and post construction) with 40% of credits achieved under the Energy, Water and Materials sections. After discussion with the RBKC planning department it has been decided that the strategy should be to demonstrate the score achieved *within the scope of the project*, with reasons/evidence given for any credits not gained.

The BREEAM Refurbishment section is laid out in the following manner; section title, excerpt from BREEAM Domestic Refurbishment Technical Manual describing the section, and Max Fordham LLP (MF) comments on the credits which fall within the scope of this project.

Management
The management section covers issues that aim to ensure the home owner is able to operate their home efficiently and effectively as well as being able to live in a home that is safe and secure. The category also covers issues relating to effective project management and sustainable site practices, to providing a framework that encourages refurbishment projects to be managed in an environmentally, socially considerate and accountable manner.

MF: We believe that the following credits are within the scope of the project;

- Provide a Home Users Guide to all new dwellings.
- Specify windows and doors to minimum security standards.
- Obtain ecology report from the Kensington Academy and Leisure Centre (KALC) project.
- Ensure the project manager has assigned individual and shared responsibilities across the team.
- Involve a BREEAM assessor prior to the refurbishment specification being produced.
- In addition to the above measures it was also assumed that the construction contractors (Leadbitters) will achieve the same high standards of responsible construction practises on Grenfell Tower as they are on the concurrent KALC project.

Health & Wellbeing
The Health and Wellbeing category aims to improve the quality of life in homes by recognising refurbishments that encourage a healthy and safe internal environment for occupants including the following aspects during refurbishment:

- Minimising impacts on daylighting and encouraging enhanced daylighting. (see section 5 for further details).
- Improving sound insulation values for separating walls and floors to Part E standards and beyond.
- The specification of finishes which avoid the use of Volatile Organic Compounds
- Improving accessibility to the home and allowing for future adaptability
- Providing sufficient ventilation
- Providing fire and carbon monoxide detection

MF: The majority of the Health & Wellbeing credits are beyond the scope of the Grenfell Tower project. However, there are some credits that fall within the scope of the project, or that can be reasonably delivered during the refurbishment. These are;

- Architect to specify all paints etc. to have low VOC emissions.
- Install a kitchen extract spigot above the kitchen purge ventilation panel. This spigot will allow existing kitchen extract systems to be connected to outside or for a new wall mounted kitchen extract fan to be installed.
- Install a compliant battery operated fire and carbon monoxide detector to each dwelling.

Energy
The energy category assesses measures to improve the energy efficiency of the home through refurbishment. 65% of the available score relates the energy targets, based upon SAP or the EPC. These targets bring a balanced assessment of the impact that the refurbishment has on improving the dwellings energy performance including:

- How much the Energy Efficiency Rating has been improved as a result of refurbishment.
- The dwellings energy demand post refurbishment.
- The % of the dwellings demand that is met by renewable technologies.
- 35% of remaining credits relate to additional measure that save energy that are not covered under SAP or measures that provide occupants with opportunities to reduce their energy use or their impact on transport energy use, thus reducing CO2 emissions including:
- Providing energy efficient white goods.
- Providing a reduced energy means of drying clothes.
- Encouraging the provision of energy efficient lighting.
- Providing a device for occupants to monitor energy use.
- Encouraging occupants to cycle by providing adequate and secure cycle storage facilities.
- Reducing the need to commute to work by ensuring residents have the necessary space and services to be able to work from home.

MF: The proposed works to Grenfell Tower include the replacement of the outdated heating and hot water system and improvements to insulation through the replacement of windows and re-cladding of the building. The method of heating is to be gas absorption heat pumps (GAHPs). These are classed as a renewable source of energy within the BREEAM assessment criteria and as such is likely to achieve all available credits under the renewable technologies Ene 04 section.

There are a number of available credits that fall outside the scope of the project and as such have not been included due to the difficulty and additional cost required to achieve. These include; white goods, energy efficient lighting, drying space, home offices and compliant cycle storage.

Water

The water category is focused on identifying means of reducing water consumption in the home including internal water use and external water use. The assessment covers all sanitary fittings in the home and the targets provide recognition for both small changes in the home (e.g. installing a low flow shower) all the way up to a complete replacement of sanitary fittings. Where sanitary fittings are replaced (e.g. a new bathroom), credits can be gained through use of fittings that meet the appropriate fittings standards, or through use of the water calculator. The water calculator looks at the impact that a fitting has on reducing water use, indicating whether a target has been met and the number of credits that can be awarded (subject to the provision of appropriate evidence).

An additional credit is also available for reducing outdoor water use, through the specification of a water butt or a similar device to collect rainwater rather than use mains potable water. Whilst all these measures are designed to reduce water use, it is up to the occupants to use water appropriately therefore an additional credit is gained for providing a water meter, to let occupants monitor their water use. Overall, the following aspects are covered in the water category:

- Fitting low use water fittings for sanitary applications.
- Providing a water collection system for external water use.
- Providing water metering systems including smart water meters or AMRs.

MF: The water services are outside the scope of the Grenfell Tower project and as such the score predicted for this section of the assessment is low. The score achieved is due to the residents not having access to individual or communal garden space, therefore negating the need for rainwater collection for irrigation purposes. Providing a main pressurised hot water system will allow the tenants to install showers. Washing using showers uses on average 60% less water than using a bath.

Materials

The materials category focuses on the procurement of materials that are sourced in a responsible way and have a low embodied impact over their life including how they have been extracted and manufactured. Overall it aims to encourage the retention of existing materials and where new materials are procured that they have they the lowest environmental impact and the greatest potential impact on reducing the dwellings operational energy demand including the following aspects during refurbishment:

- Using thermal insulation which has a low embodied environmental impact relative to its thermal properties.
- Sourcing responsible sourced materials with appropriate certification e.g. FSC, ISO14001 etc.
- Sourcing materials with a high Green Guide rating.

MF: A high score can be achieved in the materials section of the BREEAM assessment. It should be possible to achieve a high score by selecting materials based on the following;

- All materials will have a Green Guide rating of at least A+ (3).
- Cladding materials chosen to achieve a U-value of 1.5 $W/m^2/K$.
- Windows specified to have a U-value of 1.6 $W/m^2/K$.

Waste

The waste category covers issues that aim to reduce the waste arising from refurbishment work and from the operation of the home, encouraging waste to be diverted from landfill including the following:

- Providing recycling storage facilities.
- Providing composting facilities.
- Implementing a site wide waste management plan (SWMP) to reduce refurbishment waste.

MF: The Household Waste part of this section was deemed outside the scope of the project. Credits gained have been from within the Refurbishment Site Waste Management allocation with the assumption being that the contractor will adhere to best practice methods during the construction phase as on the neighbouring KALC project.

Pollution

The pollution category covers issues that aim to reduce the homes impact on pollution as well as reducing risk from flooding. This includes the following aspects being considered during refurbishment:

- The use of low NOx space heating and hot water systems.
- Having a neutral impact on runoff or reducing or eliminating runoff from the dwelling as a result of refurbishment.
- Providing flood resistance and resilience strategies, where dwellings are in a medium or high flood risk zone.
- Rewarding dwellings which are located in a low flood risk zone.

MF: Credits can be achieved through the use of the GAHPs and gas-fired back up boilers. It is expected that the proposed works will have a neutral impact on surface water run-off. A Flood Risk Assessment (FRA) would need to be carried out by a qualified person but preliminary checks on the Environment Agency website indicate that two credits should be expected to be gained through classification of the site as having a low annual probability of flooding.

5.0 DAYLIGHT ASSESSMENT

5.1 Introduction

As part of the refurbishment works at Grenfell Tower the fenestration dimensions and glazing type will be altered.

This report aims to compare the pre-refurbishment levels of daylight within the flats with those expected post-refurbishment.

Two new levels of residential flats are proposed for the Mezzanine level and Walkway+1 level. These flats will be assessed to confirm compliance with the minimum daylight levels as set out by the relevant standard.

5.2 Daylight Assessment Criteria

BS 8206 part 2 code of practice for daylighting sets out the minimum requirements for average daylight factors in new dwellings. These minimum standards are shown in Table 5-1 below.

Room	Minimum Average Daylight Factor (ADF)
Living Room	1.5 %
Bedroom	1.0 %
Kitchen	2.0 %

Table 5-1 Minimum ADF (BS 8206-2)

The assessment criteria of BS 8206 part 2 will be applied to both the existing refurbished and new flats at Grenfell Tower.

The existing flats will also be assessed against the pre-refurbishment average daylight factors to get a sense of the change in the available daylight due to the refurbishment.

5.3 Assessment Procedure

The daylight simulations are carried out using a modelling platform called IES (Integrated Environmental Solutions). The modelling engine within IES is 'Radiance' and the calculation algorithm used the CIE overcast sky for London.

A model of Grenfell Tower was created using the planning submission layouts and elevations. Proposed wall thicknesses were included to take into account the reduction in daylight caused by increased window reveal depths.

Figure 5-1 shows local shading objects such as the canopy (yellow), the finger blocks (orange), walkway and future academy (green) that were included in the model of Grenfell Tower.

The canopy was modelled as a solid element. Should the canopy be transparent to light the daylight factor to the floors below would be improved.

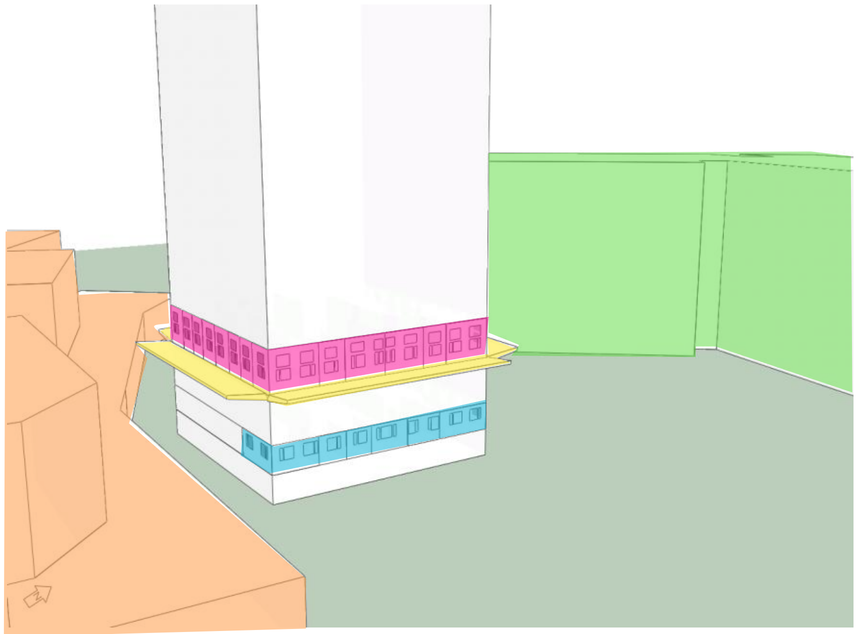

Figure 5-1 Daylight Model of New Residential Units

Every living room, kitchen and bedroom situated off of the mezzanine and walkway+1 level was modelled to show compliance.

A west facing single bedroom flat and a north west facing two bedroom flat situated on the 1st residential floor were modelled. Because the 4th is the lowest refurbished residential floor the daylight levels on this floor will represent the 'worst case' within the refurbished flats.

5.4 Daylight Results

The IES daylight simulation results for Grenfell Tower are shown below. Figure 5-2 and Table 5-2 Mezzanine Level New Residential Average Daylight Factor Results show the layout and average daylight factor results for new residential flats on the mezzanine level. Figure 5-3 and Table 5-3 show the layout and average daylight factor results for new residential flats on the walkway+1 level. Table 5-4 shows the daylight factor results for existing flats situated on the first refurbished residential floor before and after the proposed refurbishment.

New Flats Mezzanine Level

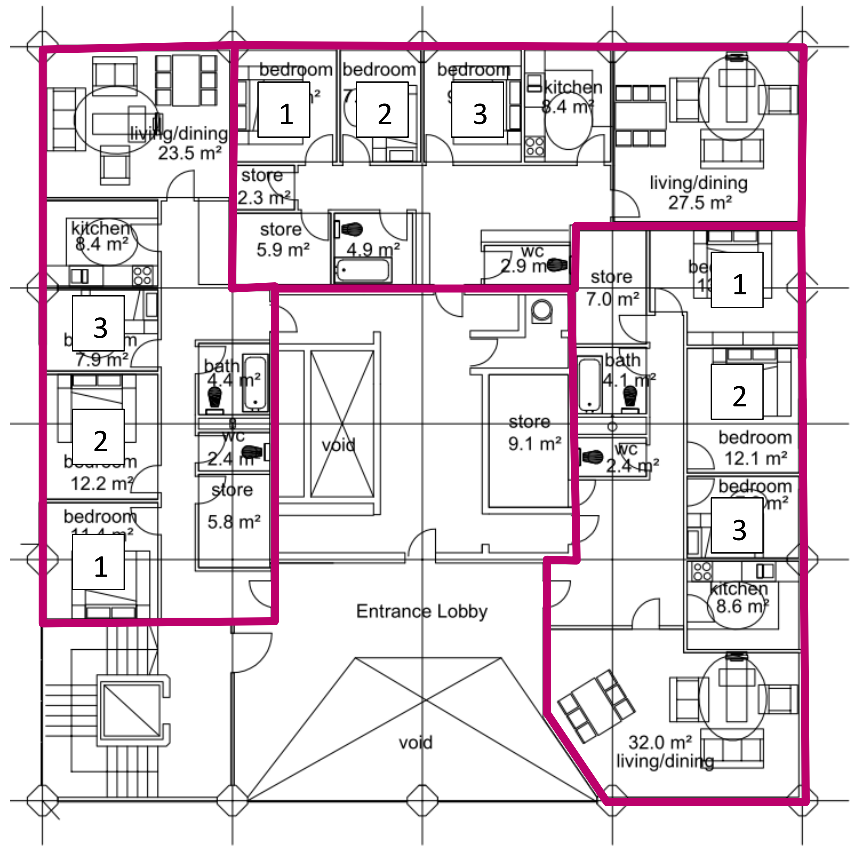

Figure 5-2 Mezzanine Level showing bedroom numbering

Flat	Room Type	ADF	Pass/Fail
Mezz_West	Living Room	2.37	Pass
	Kitchen	2.22	Pass
	Bedroom_1	1.82	Pass
	Bedroom_2	1.68	Pass
	Bedroom_3	1.33	Pass
Mezz_North	Living Room	2.16	Pass
	Kitchen	2.13	Pass
	Bedroom_1	1.52	Pass
	Bedroom_2	1.80	Pass
	Bedroom_3	1.92	Pass
Mezz_East	Living Room	1.59	Pass
	Kitchen	2.11	Pass
	Bedroom_1	2.00	Pass
	Bedroom_2	1.95	Pass
	Bedroom_3	1.79	Pass

Table 5-2 Mezzanine Level New Residential Average Daylight Factor Results

New Walkway+1 Level

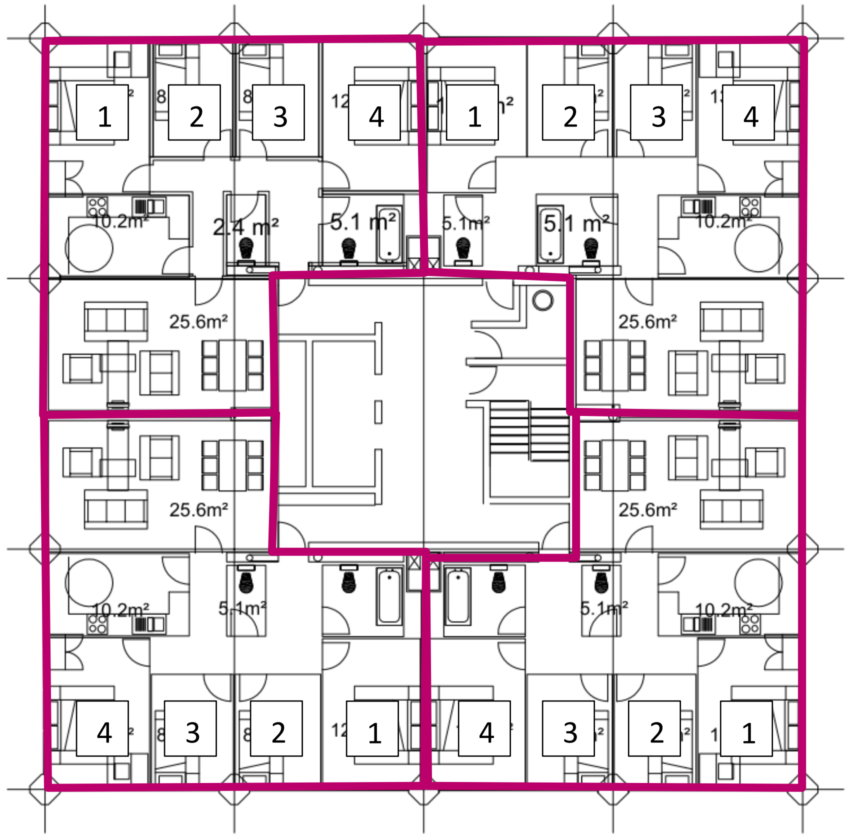

Figure 5-3 Walkway+1 Level showing bedroom numbering

Flat	Room Type	ADF	Pass/Fail
W+1_ North_West	Living Room	2.54	Pass
	Kitchen	2.86	Pass
	Bedroom_1	5.13	Pass
	Bedroom_2	2.31	Pass
	Bedroom_3	2.29	Pass
	Bedroom_4	1.69	Pass
W+1_ North_East	Living Room	2.05	Pass
	Kitchen	2.37	Pass
	Bedroom_1	1.62	Pass
	Bedroom_2	2.42	Pass
	Bedroom_3	2.45	Pass
	Bedroom_4	5.47	Pass
W+1_ South_West	Living Room	2.17	Pass
	Kitchen	2.31	Pass
	Bedroom_1	1.74	Pass
	Bedroom_2	2.48	Pass
	Bedroom_3	2.48	Pass
	Bedroom_4	5.32	Pass
W+1_ South_East	Living Room	2.12	Pass
	Kitchen	2.08	Pass
	Bedroom_1	1.74	Pass
	Bedroom_2	2.42	Pass
	Bedroom_3	2.50	Pass
	Bedroom_4	5.63	Pass

Table 5-3 Walkway+1 New Residential Average Daylight Factor Results

Existing Flats

Flat Type	Room Type	Existing	Refurbished With Solar Control		Refurbished Normal Double Glazing	
		ADF	ADF	% Reduction	ADF	% Reduction
Double	Living Room	4.41	2.12	52%	4.24	4%
Double	Bedroom	2.74	1.22	55%	2.35	14%
Double	Kitchen	2.81	1.50	47%	2.41	14%
Single	Living Room	2.00	1.22	39%	1.98	1%
Single	Bedroom	2.68	1.23	54%	2.37	12%
Single	Kitchen	3.93	1.63	59%	2.60	34%

Table 5-4 Existing Flats Example, Average Daylight Factor Pre and Post Refurbishment

5.5 Summary

New flats on the mezzanine and walkway+1 levels comply with the minimum daylight levels as set out in BS8206 part 2.

Refurbished flats will all have reduced average daylight factors. In part this is necessary to reduce the current overheating problem. All rooms comply with the minimum standards set out by BS 8206 part 2.

The single bedroom flat kitchen has a noticeable reduction in daylight due to the high provision for glazing in the existing window arrangement. The average daylight factor has dropped by 34%, however the refurbished daylight factor is well above the minimum level of 2.0 for a kitchen and as such this is not deemed to be a problem.

6.0 APPENDIX A – HEATING OPTIONS STUDY

	Existing	Option A	Option B_1	Option B_2	Option B_3	Option C
System Description	As existing, central district heating boiler plant, 24h LTHW circulation, limited control over heating system and overheating problems in summer. Ventilated domestic hot water storage in each flat served by the district heating central boilers in the basement plant room. The existing hot water storage is poorly insulated and is not recommended to be retained in any of the options.	Replace the existing central heat plant with a new boiler located in the basement plant room area. Replace existing ventilated hot water storage tanks in every flat with a new unventilated hot water storage tank in each flat.	Replace the existing central heat plant with a gas absorption heat pump located in the rooftop plant room area. Replace existing ventilated hot water storage tanks in every flat with a new unventilated hot water storage tank in each flat.	Replace the existing central heat plant with a gas absorption heat pump located in the rooftop plant room area. Install a new central domestic hot water (DHW) system at roof-level with DHW return pipework.	Replace the existing central heat plant with a gas absorption heat pump located in the rooftop plant room area. Install a new central domestic hot water (DHW) system at roof-level with trace heating to the supply pipework.	Remove existing heat distribution pipework and hot water cylinders. Install individual gas combination (combi) boilers to each flat to supply instantaneous domestic hot water and individual heating systems.
Energy Carbon	400 kWh/m2.year 77.8 $kgCO_2/m^2$.year	99 kWh/m^2.year 19 $kgCO_2/m^2$.year	68 kWh/m^2.year 13 $kgCO_2/m^2$.year	69 kWh/m^2.year 14.7 $kgCO_2/m^2$.year	70 kWh/m^2.year 14 $kgCO_2/m^2$.year	81 kWh/m^2.year 16 $kgCO_2/m^2$.year

	Existing	Option A	Option B_1	Option B_2	Option B_3	Option C
User comfort and control	Users currently have on/off control of their radiators. Turning radiators off does not stop the hot water flow within the heating distribution pipes that are cast into the floor. These pipes are hot all year round. This is an uncontrolled heat source and is a major contributor to the high energy consumption and summertime overheating. Due to the type of existing radiators and the way in which the system is piped it is not possible to remove the uncontrolled heat loss from the pipes and provide heating control to each individual room.	Install a simple heating controller that allows users to set a central flat temperature and time clock. The controller would operate a control valve to control the temperature of the flat. The thermostat is usually placed within the principal habitable room, in this case the living room of the flats. Individual room control via thermostatic radiator valves (TR) would only be possible if a replacement radiator pipe system was installed, the current system cannot facilitate this. If individual TRVs were not installed overheating could occur in other rooms.	The user controls proposed would be the same as those in option ‘A’. Centralised weather compensation will vary the temperature of the water being circulated around the building. The temperature would depend on the external air temperature. Only when it is very cold does water need to be circulated at the maximum flow temperature. When external temperatures are warmer the flow temperature can be reduced which improves the heat pump efficiency and reduces uncontrolled heat gains. The unventilated domestic hot water storage cylinder would be sized to provide 24 hours of hot water storage. This allows the storage cylinders to be re-charged once a day. We propose to recharge the DHW overnight between 01:00 and 04:00. During this time the main pipework flow temperature cannot be decreased as it can when supplying the heating. By only supplying hot water for DHW at night this strategy allows the distribution pipework to be run at lower temperatures during the day which reduces overheating problems. If a tenant runs out of hot water before the next recharge has started they could use an electric immersion heater to provide extra hot water.	As option ‘B_1’ As described previously, larger radiators can be run at cooler temperatures while supplying the same amount of heat to a room as a small radiator running at a higher temperature. Cooler radiators reduce the risk of elderly or very young tenants burning themselves. Each room would have temperature control via a thermostatic radiator valve (TRV) which gives the tenants individual temperature control of each room. A central time clock will also be provided to switch heating off at night and when on holiday etc. When radiators are controlled with TRVs low temperature radiators are less likely to overshoot the room temperature set point, this leads to a more comfortable environment. DHW to be provided via a central distribution system from roof level.		This option allows for the maximum amount of user control. As there is no central hot water flowing through each flat there are none of the associated unwanted heat gains. Hot water is always available and cannot run out as can happen with a DHW storage vessel. The user would be able to change the flow temperature of the heating to suit their individual needs.

	Existing	**Option A**	**Option B_1**	**Option B_2**	**Option B_3**	**Option C**
Ease of installation		Due to the flat construction any new pipework feeding new radiators would need to be surface run within the flats and concealed to avoid damage. Pipework routes would need to be planned to minimise disruption and clashes with door thresholds etc. This applies to all options where the existing radiators and pipework is replaced. Full access into each riser would be required to replace the existing hot water storage tank. All new equipment would be sized to fit within the existing riser space. No further space will be taken up within the flats due to the new heating system. No impact on plant rooms as the new boiler would be installed in the available ‘boiler no.4’ area within the basement plant room.	As Option A with the exception of the following; The GAHPs are to be installed on the top of the rooftop plant room to take advantage of the bathroom extract fans. Back up boilers will be situated within the rooftop plant room.	As Option B_1 with the exception of the following; 4nr central domestic hot water tanks are to be situated within the rooftop plant room. Existing hot water storage cylinders in all flats are to be removed and cupboard space created.		A space roughly the size of a wall hung kitchen cabinet would need to be found in every flat to mount the combi boiler. Each combi boiler would require its own balanced flue which would be approximately 100 mm in diameter and would need to terminate on an external wall. If the combi position was away from an external wall the flue would need to be run at high level, boxed in and access hatches would need to be provided to allow for periodic inspections. The flats at Grenfell Tower are not large and do not have an abundance of storage space. A combi boiler is at minimum the same size as a wall hung kitchen cabinet. The kitchen was chosen as the ideal location as the gas service runs here and has access to an external wall. If a clear area of wall cannot be found an area of wall will need to be created, perhaps by removing an existing cupboard.

	Existing	**Option A**	**Option B_1**	**Option B_2**	**Option B_3**	**Option C**
Metering	A central gas meter measures gas used by the district heating system. Tenants are billed based on an estimated rate multiplied by their flat floor area. This billing strategy effectively charges each tenant a flat rate for their heat. It is difficult to encourage energy saving by the tenants using a strategy such as this.	Metering could be incorporated into this option by adding a heat meter (more accurate) or a water meter(less accurate) into the heating and hot water flow pipework into the flat. If tenant billing was required the more accurate heat meter would be required than if the metering was installed to monitor heat use. Metering with feedback, be that in the form of a bill or statement showing energy consumption against the neighbours consumption, could encourage individuals to think more about the heat they use. The cost analysis to follow will set out estimated costs for installing heat metering to each flat.	Metering could be incorporated in the same way as option 'A'. The electric top-up element of the DHW system is intended to encourage responsible use of the hot water. If heat continues to be unmetered then there is a perception that the heat is free. This option proposes to give each flat a generous daily allowance of hot water (200 litres); if they run out of hot water then they must use the electric emersion heater to top it up. As the tenants pay their own electricity bills they will pay for any extra hot water used over and above what is being provided to their flats under the flat rate.	Metering for the heating system could be incorporated in the same was as Options A & B_1. DHW could be metered using a water flow meter at the point of entry to the flat as the temperature will be a known constant value.		Each flat is served by a 22 mm natural gas supply originating from the kitchen riser. The single void flat has a pay-as-you-go gas meter under the kitchen sink. It is unclear as yet if this is the standard arrangement in all flats. If this is the standard arrangement then it would be relatively simple to install new gas combi boilers off the existing natural gas supplies. A meeting between MF and the TMO maintenance team for Grenfell towers has been scheduled for the week beginning the 11^{th} of June. MF will be in a better position to comment on the existing gas supplies and metering arrangement after this meeting. If each flat is metered separately the tenants will pay normal domestic gas rates, this could result in higher bills that they currently pay but is likely to be offset by the increased efficiency of the building fabric and heating system.

	Existing	Option A	Option B_1	Option B_2	Option B_3	Option C
Ease of maintenance	Very few components within the existing system required routine maintenance. It is good practice to carry out an annual inspection on any heating system, although there is no legal requirement to do so.	Replacing the existing open vented domestic hot water storage vessel with a modern equivalent will have the same low maintenance requirements as the existing system. However this system results in water pressure within the flats that is not capable of running showers. If the option to increase the pressure of the DHW to allow showers was a priority then an unvented DHW storage system similar to Option 'B' would be required. This system would have a slightly more onerous maintenance regime than the existing; see option 'B' for details.	There is no legal requirement for an annual inspection of an unvented hot water system. It is however strongly recommended that an annual inspection is carried out to check that the expansion vessel membrane and that all the safety devices are working correctly. This will require access to be maintained to the riser. This option is no more onerous than the current installation. If the gas inspection lapses to more than a year between inspections the landlord is in breach of the law and is liable to be prosecuted. This can result in the TMO having no choice but to force entry into a flat to carry out a gas inspection. This is not the case for the yearly heating system inspection as there is no legal requirement. If a property cannot be entered a different date can be scheduled. The advantage of an unventilated hot water system is that the tenants will be able to install showers in their flats. Showers use less hot water than baths so should help to reduce the energy consumption. All other maintenance can be carried out centrally with no disruption to the tenants.	All maintenance can be carried out centrally with no disruption to the tenants. The GAHPs require a check on a yearly basis with scheduled maintenance occurring every two years.		Gas appliances require yearly safety inspections. This is a legal requirement and must be carried out otherwise the landlord is in breach of the law. Installing gas boilers in each flat will impose an inspection burden on the TMO. It can be difficult to gain entry into tenanted flats to carry out these inspections on a yearly basis. Forced entry may be necessary if no other means of entry can be arranged. This option has the most onerous maintenance regime of any of the other options. Accessing the boilers form outside via a cleaning rig was tabled as an option for boiler maintenance access. This option would require the gas engineer to be specially trained in the use of a cleaning rig. This option is not currently being actively pursued but could be investigated further if required.

	Existing	Option A	Option B_1	Option B_2	Option B_3	Option C
Threats		Not getting permission to renew radiators in the long lease holders flats would leave them with a lower level of user control. Not being able to access the service risers. If furniture obstructs access into the service riser it would have to be removed and reinstated. This will vary on a flat by flat basis.	The existing heating pipework may not be in an acceptable condition to be retained. New central pipework would need to be installed within all six service risers. This would involve partially removing the fire stopping between floors and replacing it after the new pipework was installed. A scope of works for an appropriate survey will be produced by Max Fordham LLP to gauge the condition of the existing pipework. Not being able to access the service risers. If furniture obstructs access into the service riser it would have to be removed and reinstated. This will vary on a flat by flat basis. The ability to replace radiators in all flats, if one flat did not agree to replace their radiators the hot water circulation temperature would not be able to be decreased. Therefore the efficiency improvements from the heat pump could not be realised.	As Option B_1.		Unknowns regarding the existing gas services. If all flats have gas metered installed then new combi boilers could be added without notifying the gas utility. If not all flats have utility meters then the utility company will need to be involved to add new meters. If new gas pipework is required to the flats it will have to be run externally and remain accessible for inspection.
Tenant Feedback from Consultation		Energy consumption was seen as being too high for this option when viewed relative to the GAHP options.	Method was seen as being acceptable – see Options B_2 and B_3 for more information.	Preferred option due to increased space available. No clear preference between Options B_2 and B_3 due to differences being seen as purely technical issues.		Safety concerns from all tenants spoken to regarding combi-boilers in each flat. Also space concerns were raised due to the likely loss of cupboard area within the kitchens.

7.0 APPENDIX B – RENEWABLE OPTIONS

The following section evaluates a number of possible renewable energy sources considered for the refurbishment of Grenfell Tower.

Solar Energy

The majority of the façades could be utilised for solar collector installation, in addition to the roof space. The different options are discussed below.

Solar Thermal Panels

Solar thermal panels are designed to collect solar energy and transfer it as heat to increase the temperature of water flowing within the panel. The hot water is distributed directly to a storage tank where it heats up water for hot water provision. Conventional boilers back-up the system for when the solar energy is not sufficient enough to provide the required temperature level.

Solar Thermal is a good solution for a residential project in London since it targets a significant energy demand and when mounted horizontally has little visual impact. In general there are two systems of solar collectors: evacuated tube collectors and flat plate collectors, see Figure 7-1.

Figure 7-1 Solar Thermal Panels: Evacuated Tube & Flats Plate Panels

Evacuated tube solar panels exhibit a greater efficiency as heat loss through convection and radiation is reduced to a minimum through the vacuum inside of the tubes. Flat plate collectors have a lower efficiency and temperature level but are more favourably priced.

Solar thermal panels are sized to meet the summer hot water load, which is around $4m^2$ per dwelling. This is the limit that solar thermal panels can contribute- if the panels were sized any larger they would overheat in the summer, which is damaging to the system.

We have discounted solar thermal panels as a renewable option for this project due to the density of dwellings within the tower. As the domestic hot water storage will become centralized at rooftop level a solar thermal system could be incorporated into the towers energy strategy in the future.

Photovoltaic Panels

Photovoltaic (PV) panels produce electricity which is simply delivered to the tower. This can be either into the landlord's supply to provide power for communal lighting, lifts and pumping power, or directly into the residents' supplies. Furthermore any excess of electricity during the summer can be exported to the national grid. There is no technical limitation on PV array size.

A PV panel converts the sun's energy directly into electrical energy. As noted above PV panels can deliver electricity to the site as well as easily exporting the excess electricity to the national grid. The size of the PV installation is therefore only limited by the size of the roof/façade area available. The orientation and height of the building would allow PV panels on the roof and potentially all four façades, though the most efficient use of the available area would be to use the roof and South-facing façade only.

Figure 7-2 PV array on flat and pitched roofs

After completing an assessment of the potential cost benefits of installing PV (Figure 7-4 and Figure 7-5) panels as part of the refurbishment works it was decided that it was not a suitable solution. This was due to a number of factors; the refurbishment budget would not stretch to the installation costs; there is not an adequate demand within the landlord's system to make full use of the power generated; feeding the electricity into the residents' supplies would be costly and complex; the payback period was deemed too long.

For these reasons it was decided not to propose photovoltaic array as part of the works. Instead focusing the project budget on the 'be lean' strategy of improving the buildings insulation.

Gas Absorption Heat Pumps

A gas absorption air source heat pump is similar in construction to a gas absorption chiller but, by operating in reverse cycle mode, it is able to produce hot water (heating). In heating mode it can efficiently provide water at up to 65°C.

A gas absorption heat pump (GAHP) can be more efficient than traditional heating (gas fired boilers) systems; so offering reduced overall carbon emissions. Thus it is considered a low carbon technology. The heat pump can use the heat from the surrounding air, or a combination of this and heat recovery from another source.

Figure 7-3 GAHP Image

Heat pumps are easily integrated in centralised systems and the availability of waste heat in the form of a central bathroom extract system makes them ideally suited to this application. They will be supplemented with back up gas-fired boilers to meet demand during peak loading conditions.

***The following calculations are based on a peak PV output of 56.8 kW.**

Location	**Area (m^2)**	**Electricity Generated per year per m2 (kWh/year)**	**Total Electricity Generated Per Year (kWh/year)**
South Façade	450	71.7	32,265
Upper Roof Area	260	100.3	26,078
Total	**710**	**-**	**58,343**

Estimated Landlord Loads	**Yearly Load (kWh/year)**	
Stair Core Lighting	14,507	
Lift	3,000	
Trace Heating to DHW Supply Pipes	13,140	
Heating System Pumps	1,000	**Low due to trace heating*
Total	31,647	
Generated by PVs and not directly used	26,696	

Electricity Exported	**26,696**	**kWh/Y**
Electricity Saved	**31,647**	**kWh/Y**

Capital Cost		
PV Cost	400	£/m2
Total	£284,000	

Figure 7-4 PV Generation

Data	
Discount Rate	3.5%
Retail Price index	4.8%

PV

Year	Capital Cost	Export to Grid Revenue	FIT Revenue	Electricity Saving	Total Effective Cost	Revenue - Cost	Discount Factor	(Revenue - Costs) * Discount Factor	NPV
0	£ 284,000				£ -	-£ 284,000	1	-£ 284,000	-£284,000
1	£ -	£ 854	£ 6,009	£ 3,798	£ 10,661	£ 10,661	0.97	£ 10,288	-£273,712
2	£ -	£ 895	£ 6,298	£ 3,980	£ 11,173	£ 11,173	0.93	£ 10,405	-£263,307
3	£ -	£ 938	£ 6,600	£ 4,171	£ 11,709	£ 11,709	0.90	£ 10,522	-£252,785
4	£ -	£ 983	£ 6,917	£ 4,371	£ 12,271	£ 12,271	0.87	£ 10,641	-£242,144
5	£ 500	£ 1,031	£ 7,249	£ 4,581	£ 12,860	£ 12,360	0.84	£ 10,343	-£231,800
6	£ -	£ 1,080	£ 7,597	£ 4,801	£ 13,478	£ 13,478	0.81	£ 10,884	-£220,917
7	£ -	£ 1,132	£ 7,961	£ 5,031	£ 14,125	£ 14,125	0.78	£ 11,007	-£209,910
8	£ -	£ 1,186	£ 8,344	£ 5,273	£ 14,803	£ 14,803	0.75	£ 11,131	-£198,778
9	£ -	£ 1,243	£ 8,744	£ 5,526	£ 15,513	£ 15,513	0.73	£ 11,258	-£187,521
10	£ 550	£ 1,303	£ 9,164	£ 5,791	£ 16,258	£ 15,708	0.70	£ 11,000	-£176,521
11	£ -	£ 1,365	£ 9,604	£ 6,069	£ 17,038	£ 17,038	0.68	£ 11,514	-£165,007
12	£ -	£ 1,431	£ 10,065	£ 6,360	£ 17,856	£ 17,856	0.65	£ 11,644	-£153,363
13	£ -	£ 1,499	£ 10,548	£ 6,666	£ 18,713	£ 18,713	0.63	£ 11,776	-£141,587
14	£ -	£ 1,571	£ 11,054	£ 6,986	£ 19,611	£ 19,611	0.61	£ 11,909	-£129,678
15	£ 605	£ 1,647	£ 11,585	£ 7,321	£ 20,552	£ 19,947	0.59	£ 11,690	-£117,988
16	£ -	£ 1,726	£ 12,141	£ 7,672	£ 21,539	£ 21,539	0.57	£ 12,180	-£105,808
17	£ -	£ 1,809	£ 12,723	£ 8,041	£ 22,573	£ 22,573	0.55	£ 12,318	-£93,489
18	£ -	£ 1,896	£ 13,334	£ 8,427	£ 23,656	£ 23,656	0.53	£ 12,458	-£81,032
19	£ -	£ 1,987	£ 13,974	£ 8,831	£ 24,792	£ 24,792	0.51	£ 12,599	-£68,433
20	£ 666	£ 2,082	£ 14,645	£ 9,255	£ 25,982	£ 25,316	0.49	£ 12,415	-£56,018
21	£ -	£ 2,182	£ 15,348	£ 9,699	£ 27,229	£ 27,229	0.47	£ 12,886	-£43,132
22	£ -	£ 2,287	£ 16,085	£ 10,165	£ 28,536	£ 28,536	0.46	£ 13,031	-£30,101
23	£ -	£ 2,396	£ 16,857	£ 10,653	£ 29,906	£ 29,906	0.44	£ 13,179	-£16,922
24	£ -	£ 2,511	£ 17,666	£ 11,164	£ 31,341	£ 31,341	0.43	£ 13,328	-£3,594
25	£ 732	£ 2,632	£ 18,514	£ 11,700	£ 32,846	£ 32,114	0.41	£ 13,179	£9,585
26	£ -	£ 2,758	£ -	£ 12,261	£ 15,020	£ 15,020	0.40	£ 5,948	£15,533
27	£ -	£ 2,891	£ -	£ 12,850	£ 15,741	£ 15,741	0.38	£ 6,015	£21,548
28	£ -	£ 3,029	£ -	£ 13,467	£ 16,496	£ 16,496	0.37	£ 6,083	£27,632
29	£ -	£ 3,175	£ -	£ 14,113	£ 17,288	£ 17,288	0.36	£ 6,152	£33,784
[illegible]	[illegible]	[illegible]	-	£ 14,791	£ 18,118	£ 17,313	0.34	£ 5,945	£39,729

25 year payback period

Figure 7-5 PV Net Present Value Calculation