Sustainability & Energy Statement
Grenfell Tower Refurbishment
17 August 2012
ISSUE HISTORY

<table>
<thead>
<tr>
<th>Issue</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>17/08/12</td>
<td>Planning</td>
</tr>
</tbody>
</table>
| A     | 15/10/12 | Planning resubmission
Page 9/10 – updated overheating window options
and page 14 – BREEAM health and wellbeing
credit commentary updated. |

MAX FORDHAM LLP TEAM CONTRIBUTORS

<table>
<thead>
<tr>
<th>Engineer</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark Palmer</td>
<td>Senior Engineer / Partner</td>
</tr>
<tr>
<td>Andrew McQuatt</td>
<td>Lead Engineer / Partner</td>
</tr>
<tr>
<td>Matt Smith</td>
<td>Engineer</td>
</tr>
</tbody>
</table>
# CONTENTS

1.0 Introduction  
  1.1 Overview  
  1.2 Site & Flat Details  
  1.3 Insulation and Energy  
  1.4 Overheating  
  1.5 Heating System  

2.0 Refurbishment Response to Existing Energy & Environmental Issues  
  2.1 Insulation  
  2.2 Overheating  
  2.3 Heating System  

3.0 Planning Policy  
  3.1 Policy Context – National  
  3.2 Policy Context – Regional  
  3.3 Policy Context – Local  

4.0 BREEAM Domestic Refurbishment 2012  
  4.1 BREEAM Domestic Refurbishment 2012  

5.0 Daylight Assessment  
  5.1 Introduction  
  5.2 Daylight Assessment Criteria  
  5.3 Assessment Procedure  
  5.4 Daylight Results  
  5.5 Summary  

6.0 Appendix A – Heating Options Study  

7.0 Appendix B – Renewable Options
1.0 INTRODUCTION

1.1 Overview

The aim of the 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 safety 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 problem any worse and where possible we 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.

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 follow the same principals as the existing refurbished flats but will comply with the current building regulations.

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/m².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/m².K or about three times that allowed 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 m³/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.

"The London Plan July 2011" aims to conserve energy. A defined energy hierarchy should be followed. The 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.
1.4 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 structures.

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 building's 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.

### External Walls

An external wall target U-value of 0.15 W/m² 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.

<table>
<thead>
<tr>
<th>Element</th>
<th>Building Regulations (W/m² K)</th>
<th>Grenfell Refurbishment (W/m² K)</th>
<th>Improvement over Building Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Walls</td>
<td>0.3</td>
<td>0.15</td>
<td>50%</td>
</tr>
<tr>
<td>Roof</td>
<td>0.25</td>
<td>0.15</td>
<td>40%</td>
</tr>
<tr>
<td>Windows</td>
<td>2.0</td>
<td>1.5</td>
<td>20%</td>
</tr>
</tbody>
</table>

Table 2-1 Improved U-Value of External Walls

**Table 2-2** Spandrel Wall Panel Build-up

<table>
<thead>
<tr>
<th>Element</th>
<th>Conductivity W/(m.K)</th>
<th>Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Cladding (New Rain Screen)</td>
<td>160.0</td>
<td>3</td>
</tr>
<tr>
<td>Ventilated Cavity</td>
<td>n/a</td>
<td>50</td>
</tr>
<tr>
<td>Insulation (New, Celotex FR5000)</td>
<td>0.021</td>
<td>130</td>
</tr>
<tr>
<td>Cast Concrete (Existing)</td>
<td>1.400</td>
<td>250</td>
</tr>
<tr>
<td>Insulation (Existing)</td>
<td>0.095</td>
<td>10</td>
</tr>
<tr>
<td>Plasterboard (Existing)</td>
<td>0.160</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>475</td>
<td></td>
</tr>
</tbody>
</table>

**U-value (W/m².K)** 0.1248

**Table 2-3** Column Build-up

<table>
<thead>
<tr>
<th>Element</th>
<th>Conductivity W/(m.K)</th>
<th>Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Cladding (New Rain Screen)</td>
<td>160.0</td>
<td>3</td>
</tr>
<tr>
<td>Ventilated Cavity</td>
<td>n/a</td>
<td>50</td>
</tr>
<tr>
<td>Insulation (New, Celotex FR5000)</td>
<td>0.021</td>
<td>130</td>
</tr>
<tr>
<td>Cast Concrete (Existing)</td>
<td>1.400</td>
<td>250</td>
</tr>
<tr>
<td>Insulation (Existing)</td>
<td>0.095</td>
<td>10</td>
</tr>
<tr>
<td>Plasterboard (Existing)</td>
<td>0.160</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>275</td>
<td></td>
</tr>
</tbody>
</table>

**U-value (W/m².K)** 0.1810

**Table 2-4** Column Build-up

---

1 Part LL 2010 Building Regulations 2010, maximum permissible values for each element in the national building.
### Glazing Infill Panel (Blue)

<table>
<thead>
<tr>
<th>Element</th>
<th>Conductivity W/(m.K)</th>
<th>Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>1.1</td>
<td>6</td>
</tr>
<tr>
<td>Insulation (New, Celotex FR5000)</td>
<td>0.021</td>
<td>100</td>
</tr>
<tr>
<td>Insulation (New, Celotex FR5000)</td>
<td>0.021</td>
<td>25</td>
</tr>
<tr>
<td>Plasterboard</td>
<td>0.150</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>143</td>
</tr>
<tr>
<td>U-value (W/m2.K)</td>
<td></td>
<td>0.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Element</th>
<th>U-Value W/m2.K</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spandrel Wall Panel</td>
<td>0.1248</td>
<td>5.45</td>
</tr>
<tr>
<td>Columns</td>
<td>0.1810</td>
<td>2.88</td>
</tr>
<tr>
<td>Glazing Infill Panel</td>
<td>0.1617</td>
<td>1.88</td>
</tr>
<tr>
<td>Total Area Weighted Average</td>
<td></td>
<td>0.15</td>
</tr>
</tbody>
</table>

Table 2-4 Glazing Infill Panel build up

Table 2-5 Area Weighted Average Calculation Results

---

MAX FORDHAM

---

MAX00000412_0007
2.2 Overheating

Grenfell Tower suffers from summertime overheating due to the design and operation of the current heating system and 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 7.3 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 LIA 2010) describes how overheating to new apartments must be limited. Although the majority of the new development, Part LIA 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 LIA 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 stage 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 3% of occupied hours (09:00 to 22:00, 41 h per year)

Bedrooms: 26°C shall not be exceeded for more than 3% of occupied hours (09:00 to 09:00, 47 h per year)

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, lift 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.
Overheating Study Results
Reducing or 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 30% 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 options 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 options E4 and E5 on window choice will be dictated by the budget.
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 these runs within the flat 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 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 three 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 heating and DHW, it is clear that there is a need for significant improvements in the heating system to increase storage space.

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 costs.
4. Minimise disruption to tenants during and after installation.
5. Improve reliability
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 B1 (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 unit will have individual heating control via a wall mounted thermostat. When the heating is off, the pipework will be de-activated, allowing 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.

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 m³/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 removal 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 were 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.

b. The central extract system at Grenfell Tower currently rejects over 1.8 m³/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.
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. The London Plan 2011 & National Planning Policy Framework

3.1 Policy Context – National

National Planning Policy Framework (NPPF) 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


Policy 5.4: Retrofitting

At 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 LBs 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 (RBKCs) Core Strategy outlines their environmental requirements for new and refurbished developments in the following policy:

Policy CEI: Climate Change

The Council recognises the Government’s targets to reduce national carbon dioxide emissions by 26% against 1990 levels by 2020 and 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 800m² or more residential development or 1,000m² or more non-residential achieve the following Code for Sustainable Homes / BREEAM standards;
   i. Residential Development: 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 800m² or more residential development or 1,000m² 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 Good (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 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, Wombling Green, Kensington Leisure Centre and Earls 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

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 CEI 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 User’s 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 (Leadbitter) will achieve the same high standards of responsible construction practices 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 exhaust 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 being 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.
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 classified 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 metersing systems including smart water meters or AMRs.

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.

Material

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 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, USGBC etc.
- Sourcing materials with a high Green Guide rating.

Material: 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+ (V).
- Cladding materials chosen to achieve a U-value of 1.5 W/m²K.
- Windows specified to have a U-value of 1.6 W/m²K.

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.

Waste: 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.

Waste: 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.

<table>
<thead>
<tr>
<th>Room</th>
<th>Minimum Average Daylight Factor (ADF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living Room</td>
<td>1.5%</td>
</tr>
<tr>
<td>Bedroom</td>
<td>1.0%</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

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 uses 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 reductions 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.

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 Walkway+1 Level New Residential Average Daylight Factor Results 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

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 Walkway+1 Level New Residential Average Daylight Factor Results 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

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 Walkway+1 Level New Residential Average Daylight Factor Results 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.
<table>
<thead>
<tr>
<th>Flat</th>
<th>Room Type</th>
<th>ADF</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mezz_West</td>
<td>Living Room</td>
<td>2.37</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.22</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>1.82</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>1.68</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>1.33</td>
<td>Pass</td>
</tr>
<tr>
<td>Mezz_North</td>
<td>Living Room</td>
<td>2.36</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.13</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>1.52</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>1.88</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>1.92</td>
<td>Pass</td>
</tr>
<tr>
<td>Mezz_East</td>
<td>Living Room</td>
<td>1.59</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.11</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>2.08</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>1.95</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>1.29</td>
<td>Pass</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Flat</th>
<th>Room Type</th>
<th>ADF</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+1_North_West</td>
<td>Living Room</td>
<td>2.54</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.06</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>5.13</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>2.31</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>2.29</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_4</td>
<td>1.69</td>
<td>Pass</td>
</tr>
<tr>
<td>W+1_North_East</td>
<td>Living Room</td>
<td>2.05</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.37</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>1.62</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>2.42</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>2.45</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_4</td>
<td>5.07</td>
<td>Pass</td>
</tr>
<tr>
<td>W+1_South_West</td>
<td>Living Room</td>
<td>2.17</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.31</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>1.74</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>2.48</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>2.48</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_4</td>
<td>5.82</td>
<td>Pass</td>
</tr>
<tr>
<td>W+1_South_East</td>
<td>Living Room</td>
<td>2.12</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Kitchen</td>
<td>2.06</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_1</td>
<td>1.74</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_2</td>
<td>2.42</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_3</td>
<td>2.50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bedroom_4</td>
<td>5.63</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Table 5-3 Walkway 1 Level New Residential Average Daylight Factor Results
<table>
<thead>
<tr>
<th>Flat Type</th>
<th>Room Type</th>
<th>Existing ADF</th>
<th>Existing Reduction</th>
<th>Existing With SolarControl ADF</th>
<th>Refurbished Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double</td>
<td>Living Room</td>
<td>4.41</td>
<td>62%</td>
<td>4.24</td>
<td>4%</td>
</tr>
<tr>
<td>Double</td>
<td>Bedroom</td>
<td>2.74</td>
<td>59%</td>
<td>2.35</td>
<td>14%</td>
</tr>
<tr>
<td>Double</td>
<td>Kitchen</td>
<td>3.81</td>
<td>47%</td>
<td>2.41</td>
<td>14%</td>
</tr>
<tr>
<td>Single</td>
<td>Living Room</td>
<td>2.00</td>
<td>39%</td>
<td>1.98</td>
<td>1%</td>
</tr>
<tr>
<td>Single</td>
<td>Bedroom</td>
<td>2.68</td>
<td>58%</td>
<td>2.37</td>
<td>12%</td>
</tr>
<tr>
<td>Single</td>
<td>Kitchen</td>
<td>3.93</td>
<td>59%</td>
<td>2.60</td>
<td>34%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>System Description</th>
<th>Existing</th>
<th>Option A</th>
<th>Option B₁</th>
<th>Option B₂</th>
<th>Option B₃</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>As existing, central district heating boiler plant, 24h LTHW circulation, limited control over heating system and overheating problems in summer.</td>
<td>Replace the existing central heat plant with a new boiler located in the basement plant room area.</td>
<td>Replace the existing central heat plant with a gas absorption heat pump located in the rooftop plant room area.</td>
<td>Replace the existing central heat plant with a gas absorption heat pump located in the rooftop plant room area.</td>
<td>Install a new central domestic hot water (DHW) system at roof level with DHW return pipework.</td>
<td>Install individual gas combination (combi) boilers to each flat to supply instantaneous domestic hot water and individual heating systems.</td>
<td>Remove existing heat distribution pipework and hot water cylinders.</td>
</tr>
<tr>
<td>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.</td>
<td>Replace existing ventilated hot water storage tanks in every flat with a new unventilated hot water storage tank in each flat.</td>
<td>Replace existing ventilated hot water storage tanks in every flat with a new unventilated hot water storage tank in each flat.</td>
<td>Install a new central domestic hot water (DHW) system at roof level with trace heating to the supply pipework.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Energy Carbon | | | | | | |
|---------------|---|---|---|---|---|
| 400 kWh/m².year | 77.8 kgCO₂/m².year | 99 kWh/m².year | 13 kgCO₂/m².year | 62 kWh/m².year | 13 kgCO₂/m².year | 68 kWh/m².year | 14 kgCO₂/m².year | 70 kWh/m².year | 14 kgCO₂/m².year | 81 kWh/m².year | 16 kgCO₂/m².year |
User comfort and control

Existing

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.

Option A

Install a simple heating controller that allows users to set a central flat temperature and time clock. The controller would regulate a control valve to control the temperature of the flat. The thermostat is usually placed in the principal habitable room, in this case the living room of the flats.

Individual room control via thermostatic radiator valves (TRVs) 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.

Option B1

Controlled 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 unvented domestic hot water storage cylinder would be sized to provide 24 hours of hot water storage. This allows the storage cylinders to be recharged 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.

Option B2

As option B1.

Option B3

As described previously, larger radiators can be run at cooler temperatures while supplying the same amount of heat to a room as a smaller 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.

Option C

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.
<table>
<thead>
<tr>
<th>Existing</th>
<th>Option A</th>
<th>Option B₁</th>
<th>Option B₂</th>
<th>Option B₃</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of installation</td>
<td>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 room 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 ‘bathroom no.4’ area within the basement plant room.</td>
<td>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.</td>
<td>As Option B₁ with the exception of the following: 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.</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
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. The 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.

<table>
<thead>
<tr>
<th>Existing</th>
<th>Option A</th>
<th>Option B₁</th>
<th>Option B₂</th>
<th>Option B₃</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metering</td>
<td>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.</td>
<td>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 immersion 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.</td>
<td>Metering for the heating system could be incorporated in the same way as Options A &amp; B₁.</td>
<td>Heat 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.</td>
<td>Each flat is served by a 22 mm natural gas supply originating from the kitchen meter. 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 11th of June. MF will be in a better position to comment on the existing gas supplies and metering arrangement after this meeting.</td>
</tr>
</tbody>
</table>
### Ease of Maintenance

<table>
<thead>
<tr>
<th>Existing</th>
<th>Option A</th>
<th>Option B₁</th>
<th>Option B₂</th>
<th>Option B₃</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very few components within the existing system required routine maintenance.</td>
<td>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.</td>
<td>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 rise. This option is no more onerous than the current installation.</td>
<td>All maintenance can be carried out centrally with no disruption to the tenants.</td>
<td>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.</td>
<td>The Gas Safety (Installation and Use) Regulations 1998 require a check on a yearly basis with scheduled maintenance occurring every two years.</td>
</tr>
</tbody>
</table>

### Detailed Analysis

- **Existing**: It is good practice to carry out an annual inspection on any heating system, although there is no legal requirement to do so.

- **Option A**: 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 pressure of the DHW is not sufficient, an increase in pressure is advisable. A solution would be to install a booster pump or a smaller high efficiency hot water storage vessel. If access to all the components is not via the rise, then a larger vessel may be required. The advantage of an open vented 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. 

- **Option B₁**: 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 rise. 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.

- **Option B₂**: All maintenance can be carried out centrally with no disruption to the tenants. The GSHPs require a check on a yearly basis with scheduled maintenance occurring every two years.

- **Option B₃**: 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.

- **Option C**: This option has the most onerous maintenance regime of any of the other options. Accessing the boilers from 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.
<table>
<thead>
<tr>
<th>Threats</th>
<th>Option A</th>
<th>Option B1</th>
<th>Option B2</th>
<th>Option B3</th>
<th>Option C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not getting permission to renew radiators in the long lease holder's flats would leave them with a lower level of user control.</td>
<td>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.</td>
<td>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.</td>
<td>As Option B2.</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Tenant feedback from consultation</td>
<td>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 B2 and B3 for more information. Preferred option due to increased space available. No clear preference between Options B2 and B3 due to differences being seen as purely technical issues.</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MAX00000412_0024
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 facades 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 & Flat Plate Panels](image)

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 4 m³ 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 centralised at rooftop level a solar thermal system could be incorporated into the tower's energy strategy in the future.

Photovoltaic Panels
Photovoltaic (PV) panels produce electricity which is simply delivered to the building. 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/facade area available. The orientation and height of the building would allow PV panels on the roof and potentially all four facades, though the most efficient use of the available area would be to use the roof and South-facing facade only.

![Figure 7-2 PV array on flat and pitched roof](image)

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 pursue photovoltaic array as part of the works. Instead focusing the project budget on the "be lean" strategy of improving the building's insulation.

Gas Absorption Heat Pumps
A gas absorption or reverse 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.

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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Area [m²]</th>
<th>Electricity Generated per year per m² [kWh/year]</th>
<th>Total Electricity Generated Per Year [kWh/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Facade</td>
<td>450</td>
<td>71.7</td>
<td>32,265</td>
</tr>
<tr>
<td>Upper Roof Area</td>
<td>260</td>
<td>100.3</td>
<td>26,078</td>
</tr>
<tr>
<td>Total</td>
<td>710</td>
<td></td>
<td>58,343</td>
</tr>
</tbody>
</table>

Estimated Landlord Loads

<table>
<thead>
<tr>
<th>Source</th>
<th>Yearly Load [kWh/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stair Core Lighting</td>
<td>14,087</td>
</tr>
<tr>
<td>Lift</td>
<td>3,000</td>
</tr>
<tr>
<td>Trace Heating to DHW</td>
<td>13,140</td>
</tr>
<tr>
<td>Heating System Pumps</td>
<td>1,000</td>
</tr>
<tr>
<td>Total</td>
<td>31,647                  *Less due to lower heating</td>
</tr>
</tbody>
</table>

*Generated by PVs and not directly used 28,699kWh

<table>
<thead>
<tr>
<th>Source</th>
<th>kWh/Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Exported</td>
<td>26,696</td>
</tr>
<tr>
<td>Electricity Saved</td>
<td>31,647</td>
</tr>
</tbody>
</table>

Capital Cost

<table>
<thead>
<tr>
<th>Source</th>
<th>£/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Cost</td>
<td>430</td>
</tr>
<tr>
<td>Total</td>
<td>£284,000</td>
</tr>
</tbody>
</table>