Space Strategies and Legislation: Coursework 1

Case study: Improving the EPC rating of a building

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1: Abstract

An EPC Rating is a method for measuring the energy efficiency of a property, graded from A (Most efficient) to G (Least efficient). We have been tasked with surveying 32-38 Wells Street, a building forming part of the University of Westminster's campus, with a view to identify sections of the building which could contribute to a poor EPC rating, and recommend upgrades to the external façade and HVAC systems. To summarise, the construction of the building does not lend itself to being well insulated, and steps should be taken to install insulating cladding to prevent heat loss. The HVAC system should be upgraded to a more energy efficient system. The glazing ought to be upgraded to prevent heat loss through thermal bridging in the window panes, and through the window frames. The recommendation's are assumed to be classed as a major renovation as per Approved Document L2B, which states if over 25% of the overall building envelope is being renovated, it will be classed as a major renovation.

2: Introduction

32-38 Wells Street is a building owned and operated by the University of Westminster, housing the School of Social Sciences. The building houses lecture theaters, teaching rooms, staff break areas and staff offices to facilitate the provision of education services by the University. Wells Street's hours of operation are 09:00-17:30 Monday-Friday.

FIGURE 1: NORTH-WEST ELEVATION

The South elevation shares a wall with the adjacent building. The main entrance to the building is on the corner of the west and north elevations, opening onto Wells Street, which runs the length of the building on the West elevation. The construction on the West and part of the North elevation is concrete beams with concrete panel cladding from the first to sixth floors, with black marble cladding on the ground floor (Figure 1).

From the North and East elevations (Figure 2), the building has a plant room on the ground floor with louvres forming part of the HVAC intake, and ductwork on the flat roof above forming the HVAC exhaust. The first through sixth floors are set back from the plant room. The construction at the rear of the building comprises concrete spans with bare Flemish bonded brickwork for the exterior walls. Flemish Bonding is a solid form of brickwork meaning there will be no cavity insulation in this section of the building.

FIGURE 2: NORTH ELEVATION

The exterior glazing constitutes single pane, steel framed glass. In the circulation areas of the building the windows have been locked allowing no opportunity for ventilation. Although there is exterior HVAC plant visible on the ground floor (Daikin installed 2003 with R407C refrigerant), there were no visible HVAC vents in the internal circulation areas. Access was not permitted to offices and lecture rooms to check if they had HVAC systems present.

Wells Street is of a similar height to the other surrounding buildings, and has its primary façade facing west. Given the south elevation shares a wall with an adjacent building, the width of the street, and the height of the buildings across the street, there is little sunlight available to naturally warm the building. Figures 3 and 4 show the amount of sunlight available to Wells St on the longest and shortest days of the year.

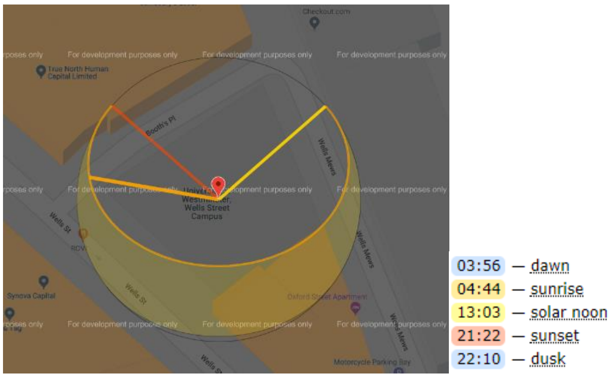

FIGURE 3: SUNLIGHT, 21ST JUNE

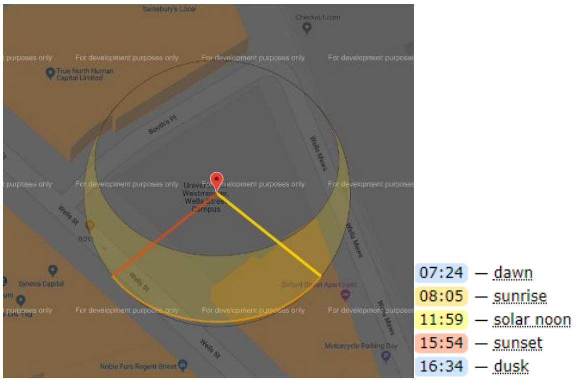

FIGURE 4: SUNLIGHT, 21ST DECEMBER

To summarise the key elements of the building which are currently contributing to poor energy efficiency:

- Glazing: Single-pane glazing with metal window frames allows for thermal bridging between the interior and exterior of the building.
- Exterior Walls: Solid brickwork and concrete cladding forming the exterior walls offer little to no insulation.
- HVAC: No evidence of internal HVAC vents in circulation areas, meaning little to no air circulation, and allowing heating via radiators and cooling by natural heat loss through poorly insulated walls and windows.
- Location: Similar height to adjacent and buildings across the road, and no exposed south elevation allows little opportunity for natural heat gain.
- Roof: Flat roof contributes to heat loss assuming the insulation is from the buildings original construction and not updated to modern building standards.

With this in mind we will look at the elements above in turn, and suggest strategies for overcoming these shortfalls in the building's design in line with approved document L2B.

<u>3: Recommendations</u>

<u>3.1: Glazing</u>

The in-situ single glazed windows are incredibly poor insulators, and ought to be replaced with double glazed units. As per approved document L2B[1], windows which have a U-Value higher than 3.3 W/m2 K ought to be replaced with windows which comply with the guidance laid out in paragraph 4.23 to 4.28 of the document. Without conducting accurate measurements of the current U value of the single glazing in-situ, and using guidance published by Pilkington Glass, the indicative U-Value of single paned glass would be 4.8[2]. Therefore I would suggest installation of double glazing using uPVC frames with non-metallic pane spacers to prevent

[1]See Appendix 1

[2] https://www.pilkington.com/~/media/Pilkington/Site%20Content/UK/Reference/TableofDefaultUValues.pdf

unwanted heat dissipation through the window and frame, in order to reduce the U-value of the building's glazing below 3.3; the assumed U-Value of double glazing is anywhere between 1.9 and 2.7 depending on the type of glass and whether certain types of gas are used in the gap between the two panes. This will allow the building's windows to meet the requirements laid out in approved document L2B.

3.2: Building Envelope

The current exterior walls are poorly insulated owing to the use of solid Flemish bonded brickwork and concrete cladding, both of which have poor thermal insulating properties. The assumed U-Value of a solid wall is 2.23 W/m2 K. Approved document L2B states the threshold for a refurbished wall is 0.70, and that anything above this threshold must be insulated to a U-Value of 0.30[3]. One way to overcome this would be to install insulating cladding to reduce heat dissipation through the walls. Installing 50-100mm of polyethelyne core cladding panels on the brickwork and concrete exterior surfaces will significantly improve the insulation of the building[4]. However care must be taken to select either a fire retardant or non-combustible type of cladding such as Reynobond FR or A2[5]. In conjunction with upgrades to double glazing and roof insulation this will ensure the entire exterior of the building is well insulated and will prevent heat dissipation. One could consider installation of photovoltaic cladding however due to the lack of sunlight for most of the year the increased payback period due to under use would render photovoltaic cladding uneconomical.

3.3: HVAC

Installation of HVAC systems throughout the building will allow for the proper regulation of temperature. The only information on the current system is from an exterior condenser/fan coil unit dated 2003. Approved Document L2B recommends replacing HVAC systems which are 15 or more years old[6]. Using an HVAC system with an efficient heat exchanger will allow some of the energy to be reclaimed and re-used in the system reducing the overall energy usage[7]. As HVAC systems are energy intensive pieces of plant, use of photovoltaic panels on the roof and cladding of the upper floors could help reduce the overall power consumption of the HVAC system. Using an inverter air conditioning system will help reduce the overall power consumption as opposed to a traditional AC system. An inverter system is advantageous compared to its non-inverter counterpart as the AC motor has a variable speed, as opposed to being either on or off. This allows the system to vary the airflow and to maintain a constant temperature in building zones, reducing the overall power consumption by eliminating the power hungry stop-start requirements[8]. Use of centralised controls set up to ensure the HVAC system is only operational during office hours will ensure no energy is wasted. Setting the temperature of the building by centralised control to 23-24 degrees, perhaps allowing a degree or two of manual control, will ensure staff and students are not able to set the HVAC to unreasonable temperatures; setting air conditioning too hot or cold can potentially damage the unit and having significant temperature disparity between HVAC units, in particular open plan areas, puts strain on the system in addition to consuming additional power for no benefit[9].

[3] See appendix 1

[4] http://www.react-ite.eu/uploads/tx_mddownloadbox/PP02_Thermal_insulation_materials_-_PP02_20130715.pdf

[5] https://www.theguardian.com/uk-news/2017/jun/16/manufacturer-of-cladding-on-grenfell-tower-identified-as-omnis-exteriors

[6] See Appendix 2

[7] Ahmadzadehtaltapeh, M., An Air Conditioning Performance Enhancement by using heat pipe based heat recovery technology, Scientia Iranica, Volume 20, Issue 2. Pp 329-336.

[8] Cheng, C et al, Smart Sensors enable smart air conditioning control, Sensors (Basel), 2014.

[9] Sannikommu, N, Centralised Control and Monitoring of Air Conditioning Units, Journal of Scientific and Industrial Research, Vol. 68, 2009 pp 934-939

3.4: Roof

If a flat roof is not properly insulated, it will contribute a significant amount to heat loss due to their being, unlike pitched roofs which have a significant air gap between the internal and exterior of the building. To overcome this a layer of non-combustible PUR insulation could be applied to the interior of the flat roof. The recommended U-Value of a flat roof is 0.25.

Installing photovoltaic panels on the roof to take advantage of what little sunlight is available to the building will reduce the overall reliance on mains electricity. With modern technology, solar panels can be mounted on motors to track the sun as it moves across the sky, maximising their potential for energy generation, and reducing the building's reliance on mains power[10].

4: Conclusion

Wells Street being a multi storey structure in a dense urban environment is subject to constraints in what can and cannot be done to improve the buildings EPC rating. The main problems with Wells Street are heat loss through the glazing, walls and roof of the building due to the use of solid brick and concrete in the construction of the exterior walls, and the lack of sufficient, efficient HVAC services within the building. The simplest and most cost effective way to improve the building's insulation would be to install fire retardant or non-combustible polyethylene cladding on the roof and walls. The single glazed windows should be replaced with PVC framed double glazing to prevent thermal bridging between the interior and exterior of the building. The HVAC system ought to be upgraded in line with recommendations outlined in approved document L2B, with centralised controls managed via a building management system. If these steps are followed Wells Street would satisfy the requirements of a refurbished building as per approved document L2B.

[10] Miloudi, L et al. Solar Tracking with Photovoltaic Panel, Energy Procedia Volume 42, 2013, pp 103-112

Appendices

5: Appendix 1: Approved Document L2B, Table 5

Table 5 Upgrading retained thermal elements

Element[1]	U-value W/(m².K)	
	(a) Threshold	(b) Improved
Wall – cavity insulation	0.70	0.55[2]
Wall – external or internal insulation	0.70	0.30[3]
Floors[4,5]	0.70	0.25
Pitched roof – insulation at ceiling level	0.35	0.16
Pitched roof – insulation at rafter level[6]	0.35	0.18
Flat roof or roof with integral insulation[7]	0.35	0.18

Notes:

1 'Roof' includes the roof parts of dormer windows, and 'wall' includes the wall parts (cheeks) of dormer windows.

2 This applies only in the case of a cavity wall capable of accepting insulation. Where this is not the case it should be treated as for 'wall – external or internal insulation'.

3 A lesser provision may be appropriate where meeting such a standard would result in a reduction of more than 5% in the internal floor area of the room bounded by the wall.

4 The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged building.

5 A lesser provision may be appropriate where meeting such a standard would create significant problems in relation to adjoining floor levels.

6 A lesser provision may be appropriate where meeting such a standard would create limitations on head room. In such cases, the depth of the insulation plus any required air gap should be at least to the depth of the rafters, and the thermal performance of the chosen insulant should be such as to achieve the best practicable U-value.

7 A lesser provision may be appropriate if there are particular problems associated with the load-bearing capacity of the frame or the upstand height.

6: Appendix 2: Approved Document L2B, Table 6

Table 6 Improvements that in ordinary circumstances are practical and economically feasible

Items 1 to 7 will usually meet the economic feasibility criterion set out in paragraph 6.5. A shorter payback period is given in item 8 because such measures are likely to be more capital intensive or more risky than the others.

No.	Improvement measure
1	Upgrading heating systems more than 15 years old by the provision of new plant or improved controls
2	Upgrading cooling systems more than 15 years old by the provision of new plant or improved controls
3	Upgrading air-handling systems more than 15 years old by the provision of new plant or improved controls
4	Upgrading general lighting systems that have an average lamp efficacy of less than 40 lamp-lumens per circuit-watt and that serve areas greater than 100 m² by the provision of new luminaires or improved controls
5	Installing energy metering following the guidance given in CIBSE TM 39
6	Upgrading ***thermal elements*** which have U-values worse than those set out in column (a) of Table 5 following the guidance in paragraphs 5.12 and 5.13
7	Replacing existing windows, roof windows or rooflights (but excluding display windows) or doors (but excluding high-usage entrance doors) which have a U-value worse than 3.3 W/m².K following the guidance in paragraphs 4.23 to 4.28
8	Increasing the on-site low and zero carbon (LZC) energy-generating systems if the existing on-site systems provide less than 10% of on-site energy demand, provided the increase would achieve a simple payback of 7 years or less
9	Measures specified in the Recommendations Report produced in parallel with a valid Energy Performance Certificate

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https://www.pilkington.com/~/media/Pilkington/Site%20Content/UK/Reference/TableofDefaultUValues.pdf

React ITE, Thermal Insulation Materials:

http://www.react-ite.eu/uploads/tx_mddownloadbox/PP02_Thermal_insulation_materials_-_PP02_20130715.pdf

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