Climate Action at The Bartlett: Journey to Net Zero by 2030
Reducing emissions from the energy we use in buildings: Central House
Progress Report: July 2022

1. Introduction

Central House is an institutional building in Central London which accommodates a library on the ground floor, meeting rooms and study spaces in the basement and office and working spaces for academic and administrative staff from first to fifth floor. It was leased by UCL from other owners and later bought. UCL then retrofitted the building in 2010 to improve its performance (Sang, 2015).

Table 1 Introduction to the case study

Element	Response	Source
Location	14 Upper Woburn place, London, WC1H 0NN	
Area (m^2)	5,025	FABRIQ Tool
	5,365	(*Display Energy Certificate (DEC) – Find an Energy Certificate – GOV.UK*, n.d.)
Ventilation	Natural	
Heating	No data available	
Heating fuel	Natural gas	(*Display Energy Certificate (DEC) – Find an Energy Certificate – GOV.UK*, n.d.)
Cooling	Air conditioning	(*Display Energy Certificate (DEC) Recommendation Report*, n.d.; Sang, 2015)
Domestic hot water (DHW)	No data available	
Occupancy	184	FABRIQ Tool
PV	Yes	

A study done on Central house in 2015 speculated the U-values[1] of different building elements according to Building regulation 2010. But in 2013, these regulations were updated. Table 2 compares the case study values with the present recommended limiting U-values. The areas of improvement have been marked in red.

Table 2 Case study building thermal properties

Building element	U-value (W/m^2K)	
	Case study building (Sang, 2015)	2013 Building regulations (*Part L2 (2021)*, n.d.)
Ground floor	0.22	0.70
Roof	0.18	0.18
External wall	0.22	0.70
External windows	1.51	1.60
Internal ceiling/floor	1.09	0.70
Internal partition (glass)	3.36	
Internal partition (plasterboard)	1.79	
Door (glass)	3.43	3.00
Door (wood)	2.20	1.40
Rooflights	N.A.	2.20

[1] Thermal transmittance or U-value is rate of transfer of heat through a structure divided by the difference in temperature across that structure.

The DEC report mentioned that the building uses no energy from renewables. However, solar PVs have been installed on the roof.

2. Results and Analysis

The building's energy performance operational rating is based on its carbon dioxide (CO_2) emissions for the last year. The typical score for a public building is 100 which gives an operational rating of D.

The building's performance improved from 2019 (82 D DEC rating) to 2020 (75 C DEC rating) to 2021 (69 C DEC Rating) (*Display Energy Certificate (DEC) – Find an Energy Certificate – GOV.UK*, n.d.). This could be accounted to low occupancy due to the pandemic which reduced the consumption thereby improving the performance.

The CO_2 emissions from electricity consumption is almost eight times the heating. This is because the electricity consumption is almost thrice as compared to other fuels. The CO_2 emissions from electricity can be reduced by switching to a greener electricity option. Table 3 summarises the total and typical energy use by the case study building and compares the building's consumption with a benchmark. As marked in red in table 3, the building's consumption is slightly more than the benchmark.

Table 3 Case study building - energy use

Energy use	Electricity	Benchmark (CIBSE TM46)
Annual energy use (kWh/m^2/year)	99	95
Typical energy use (kWh/m^2/year)	80	N.A.

Annual Electricity consumption over the past years:

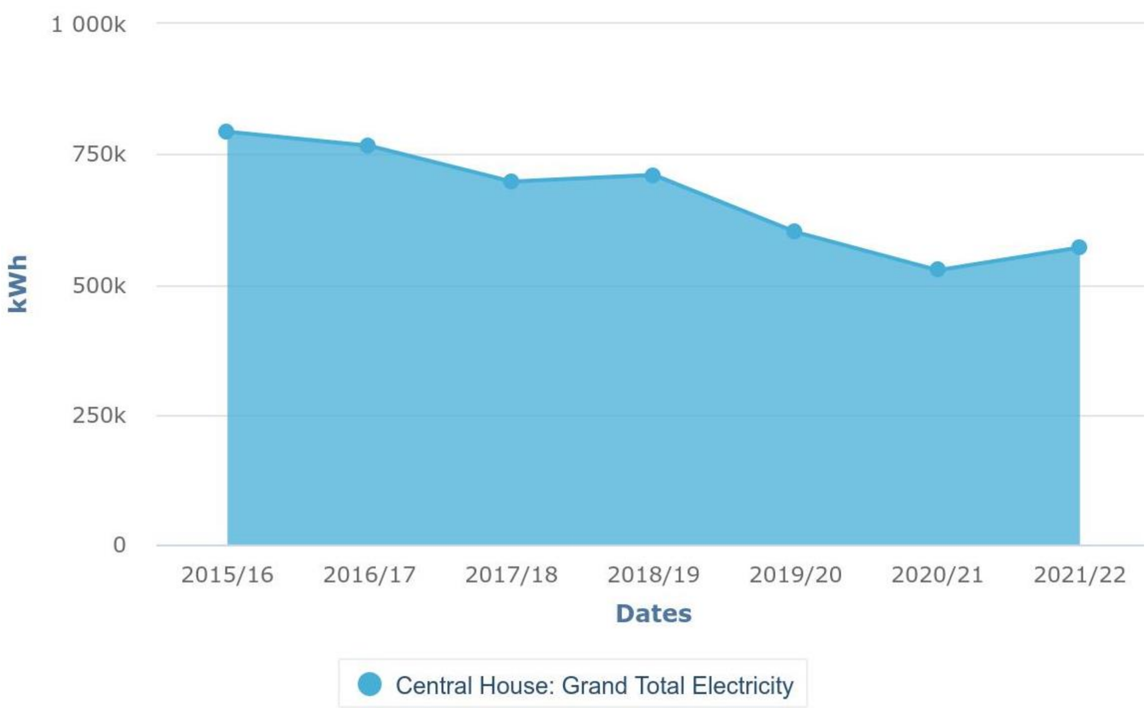

Figure 1 Electricity consumption trend: yearly

Figure I shows that the electricity consumption has declining in the past few years. The dip in 2020 was caused due to the pandemic. But it is to be noted that even without minimum/no occupants in the building, there was considerable demand. This could be due to servers, equipments, lighting and cooling systems in place. Lighting and cooling must be turned off in case of no occupants. Since the occupants in 2020 were almost negligible, the 2020 value could be treated as the minimum electricity consumption. As compared to 2020, in 2021 the building electricity consumption is quite decent with more occupants.

<u>Monthly Electricity consumption:</u>

Since the past years have defined a 'new normal', its important to analyse the monthly consumption considering 2021 and 2022. Figure 2 shows that the highest electricity consumption by the building is generally during September to December, followed by Janurary till May. With more occupants using the building, the increase in electricity consumption is evident. The higher electricity consumption during winter season can be attributed to the early sunsets and the increased need for artificial lighting. The increase can be noted in October 2021. Moreover, in 2022 the increased number of occupants could be a possible reason.

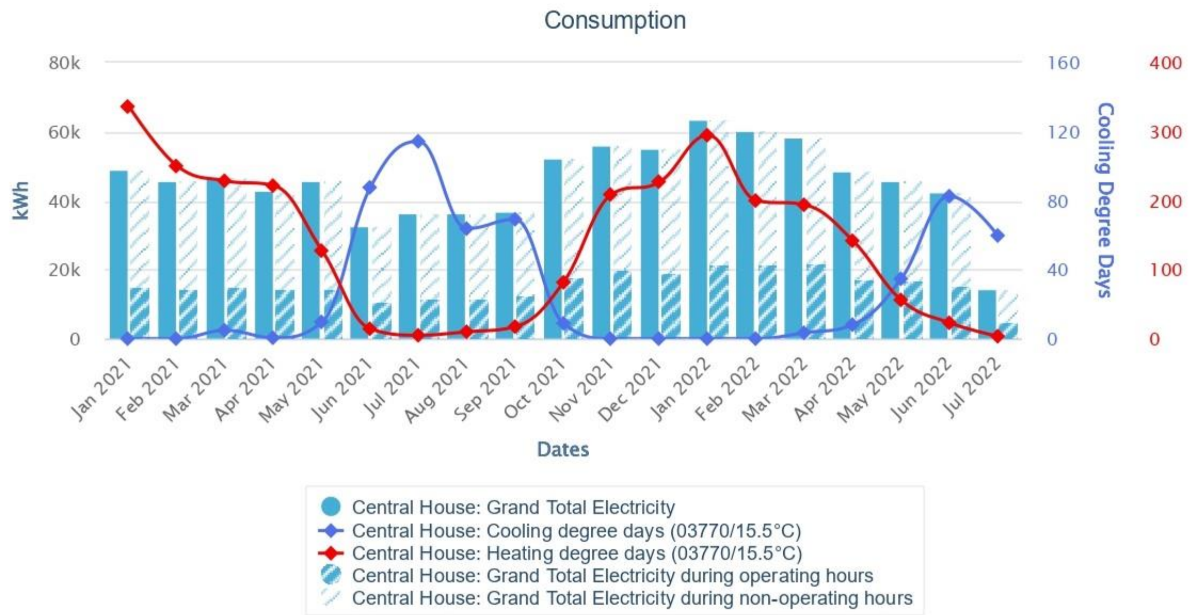

Figure 2 Electricity consumption monthly

Figure 2 shows that the electricity consumed during operating hours is far less than that consumed during non-operating hours. This was noted in 2020 as well with almost no occupants but a considerable demand. This could be justified by considering the several servers working. However, the demand by servers cannot be so high. Hence, another factor could be lighting. But the lighting system in most of the occupied spaces like offices and libraries are automated motion sensor which won't be active during the night. Hence, the only possible explanation could be that the air conditioning system might be on during the night as well. During the day, the occupants and the lights add up to the internal gains and reduce the cooling demand which is not true during the night.

This establishes that the largest consumer of electricity is cooling system, followed by lights and other equipment.

In addition to this, during a site visit, the lux levels were measured in the ground floor library space as 1760 lux which is far greater than the required 500 lux (Raynham et al., n.d.). As shown in the figure, the artificial lights were on even on a sunny day. This increases the consumption and the carbon footprint of the building.

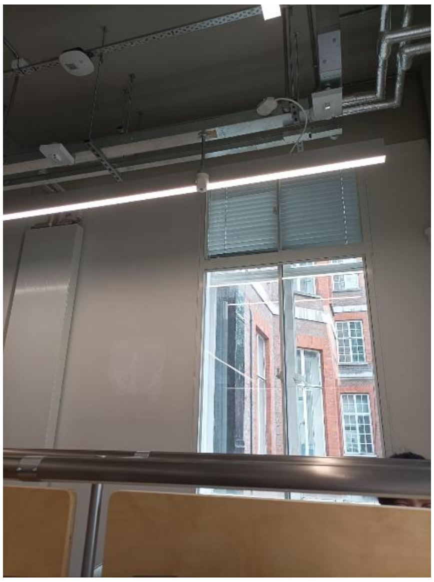

Figure 3 Central house library - during the site visit

<u>Weekly Electricity consumption:</u>

Figure 3 shows the week with highest electricity consumption. It is to be again noted that half of the energy is consumed during unoccupied hours.

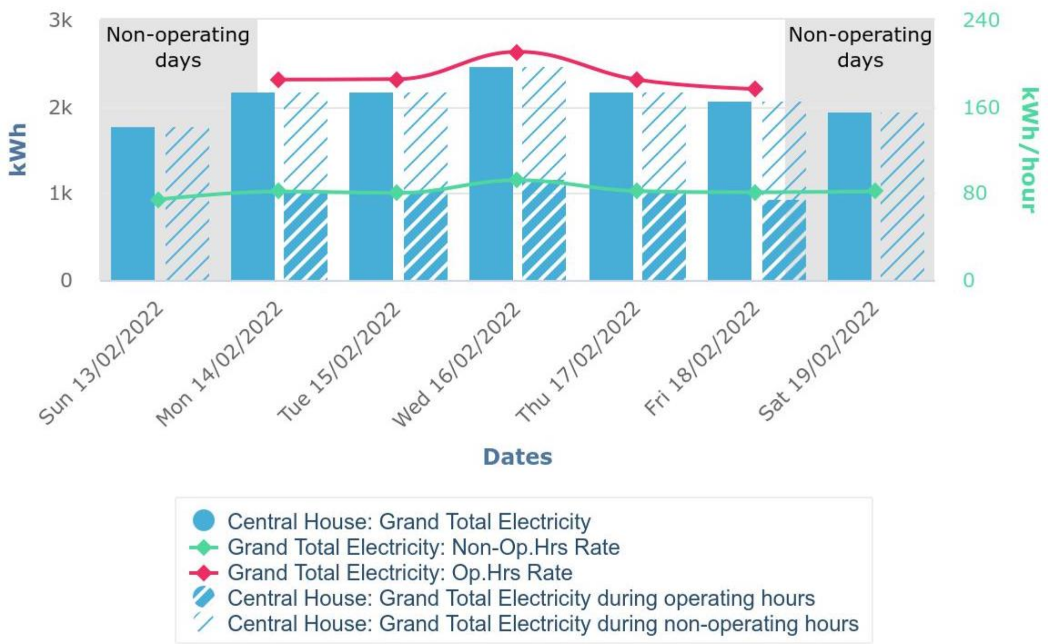

Figure 4 Electricity consumption weekly

Annual fuel and heat consumption over the past years:

As noted in figure 4, heating demand has dropped as compared to 2016. The lowest drop was noted in 2020 due to the pandemic. But with occupants coming back to the space, the demand increased. In 2022, it is considerably high considering that the data is only for half of the year.

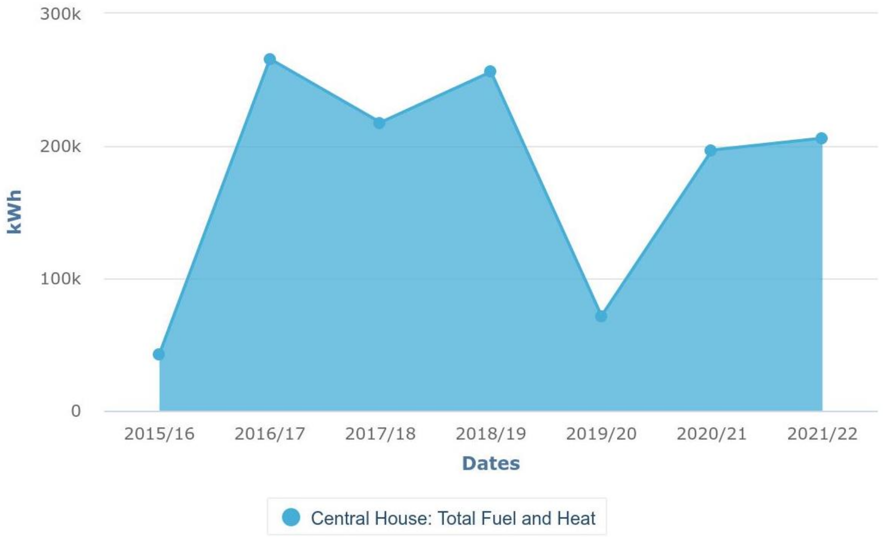

Figure 5 Total fuel and heat consumption annually

Monthly fuel and heat consumption:

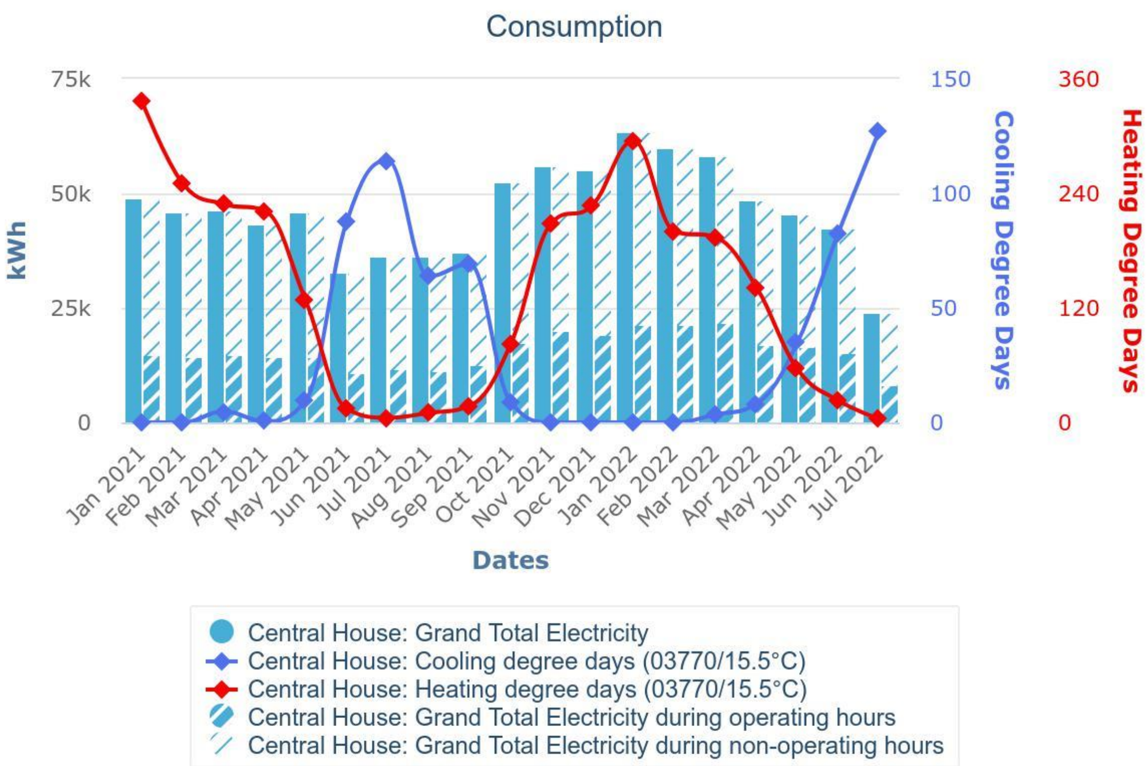

Figure 6 Total fuel and heat consumption monthly

As shown in the figure 6, the heating degree days in February 2021 and 2022 are almost equal. Yet, the consumption in 2022 is much higher. The consumption during unoccupied hours in

Feb 2022 increased by about 22% as compared to Feb 2021. Moreover, the consumption during occupied hours increased by about 50%. It can be due to increased occupants, reduced set temperature on the heating system, unregulated and excessive use of the heating system, etc.

<u>Weekly fuel and heat consumption:</u>

Figure 7 shows the coldest week of the year. The energy consumed during occupied and unoccupied hours is almost equal. This proves that the heating system is working during the unoccupied hours as well.

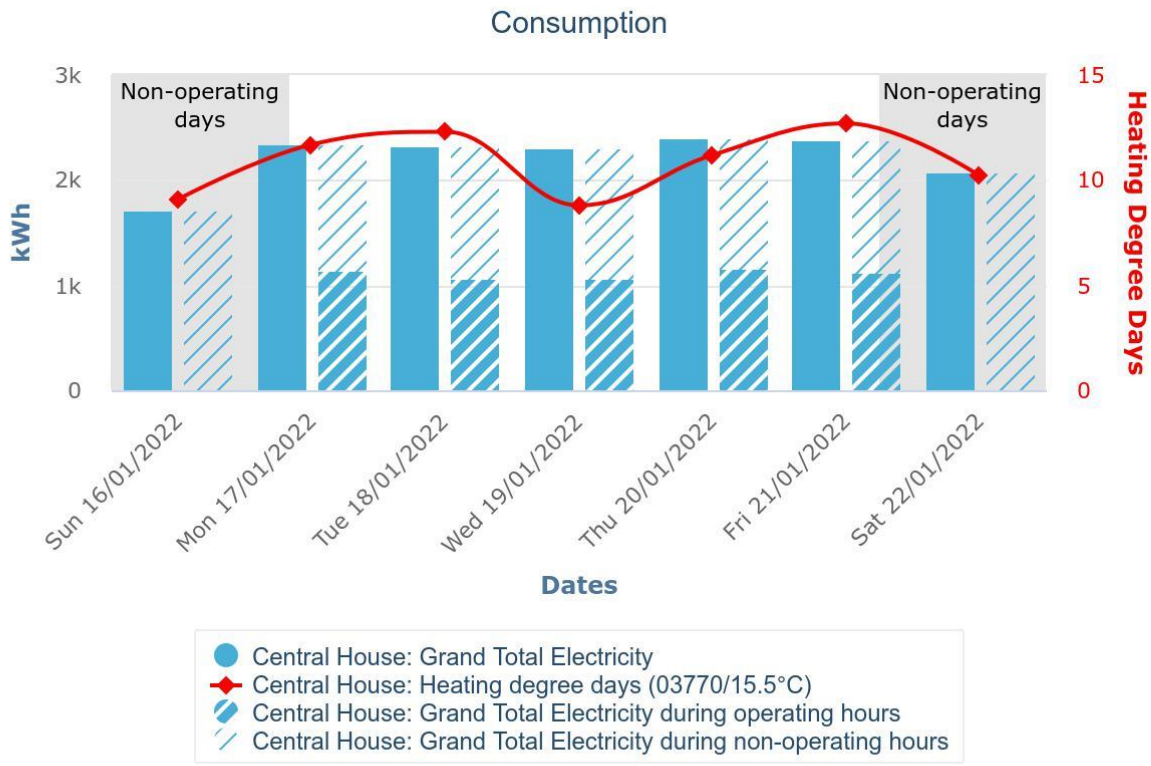

Figure 7 Total fuel and heat consumption weekly

3. Takeaways

Based on an informal interview done with about ten students working in the library and basement, it was noted that the library is sometimes too cold. This could be fixed using an automated building management system which sets the temperature according to external temperature. In addition to this, in case of library, the occupants were unable to modulate the temperature if and when required. Moreover, through the interviews it was noted that the occupants should be made aware of their impact of the building performance. This is most relevant in the basement, where the temperature is controlled by the occupants.

As noted in table 2, the flooring and doors can be improved. For other building elements, constant and frequent inspections should be done to check its insulation and performance. No data was currently available for the U-value of the skylights, but in case of further study, if required, the skylights should be modified by replacement with better performing units. In addition to this, an airtightness test must be conducted in the building and should be improved if required.

The building's energy performance can be improved by implementing the following measures:

- Procurement of energy efficient equipment,
- Installation of LED lighting systems (in places where not done already),
- Maintenance of HVAC systems by regular checks
- Regular cleaning of solar panels to increase the energy production
- Regular window and roof lights cleaning to maximise daylight entering the building
- Use of blinds and curtains can also reduce the solar gain entering the building
- Installation of self-regulating devices to increase the control over temperature separately in every room.
- Educating the building managers.
- Post occupancy evaluation, energy analysis studies of different UCL Buildings as research projects/dissertations should be encouraged.

4. Conclusion

The report analysed the energy performance of Central house, primarily based on data collected by the Fabriq tool. Site visits and informal discussions with occupants provided valuable feedback. Based on the analysis, it was found that there is a scope for improvement. The report suggested some measures for the same. One of the limitations of the analysis is the lack of data about DHW on the Fabriq tool and the data regarding the solar PV's energy generation. For further study, a detailed analysis can be done considering the future weather data to check the building's performance in the coming years. This can govern the U-value of the building elements.

5. Reference

Display energy certificate (DEC) – Find an energy certificate – GOV.UK. (n.d.).

Display energy certificate (DEC) recommendation report. (n.d.).

Part L2 (2021). (n.d.). www.legislation.gov.uk.

Raynham, Peter., Boyce, P. R., Fitzpatrick, John., & Society of Light and Lighting. (n.d.). *The SLL code for lighting*.

Sang, Y. (2015). *Comparison of design-stage simulation with POE data, and the importance of visualization in evaluating the performance gap*.

6. Appendix

Lux levels noted in the Central house library during the site visit.