

Energy Audit Investigation
For:
Cardiff University: Julian Hodge Building

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Module: Building Services and Energy Performance in Buildings

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1.0 Executive Summary

The purpose of the report is to investigate and produce an in depth description and evaluation of the building engineering services and their delivery in Cardiff University's Julian Hodge building. Maintenance of these systems will also be considered as well as the maintenance of the building itself. Different maintenance systems will be considered and a recommendation made on the most suitable and effective. An in depth energy audit of the building will also be carried out, considering current performance and recommendations will be made for potential improvements based on initial costs, maintenance and energy usage.

2.0 Procedure

Initial investigation done as a desktop survey. Information gathered from various online sources to determine details such as: site details, occupancy and building usage information, records of consumption, energy costs information was provided by Mark Durdin the facilities manager, variables affecting consumption, for benchmarking the CIBSE TM46 document was used, Display Energy Certificate, CIBSE Guide F – Energy Auditing was used as a guide for energy auditing procedure.

The next stage of the investigation involved a site visit aimed at gathering information about the current building engineering services, energy consumption, layout and usage of the building (if different to desktop). A guided tour by Mark Durdin allowed questions to be asked for further information on services and usage.

3.0 Julian Hodge Building

3.1 Building Structure and Use

Located between the Aberconwy building and the Postgraduate Teaching Centre, the Julian Hodge building was formerly 2 separate buildings, a larger, 4 storey building and a smaller, 2 storey cafeteria now linked together by a central atrium constructed in 2001. On the ground floor the larger building houses the lecture theatre as well as a plant room for the lift machinery, the lift provides full disabled access to all floors. Externally on the ground floor, a

plant room can be accessed, which facilitates the air conditioning of the ground floor and second floor lecture theatre. There is a large atrium with underfloor heating, where the main staircase goes up to access the upper levels, the building can be accessed from the front or rear of the atrium. On the ground floor of the cafeteria there is a seating and eating area as well as kitchens. There is a plant room housing a gas meter which is accessed externally, also externally is a large freezer unit servicing the kitchens.

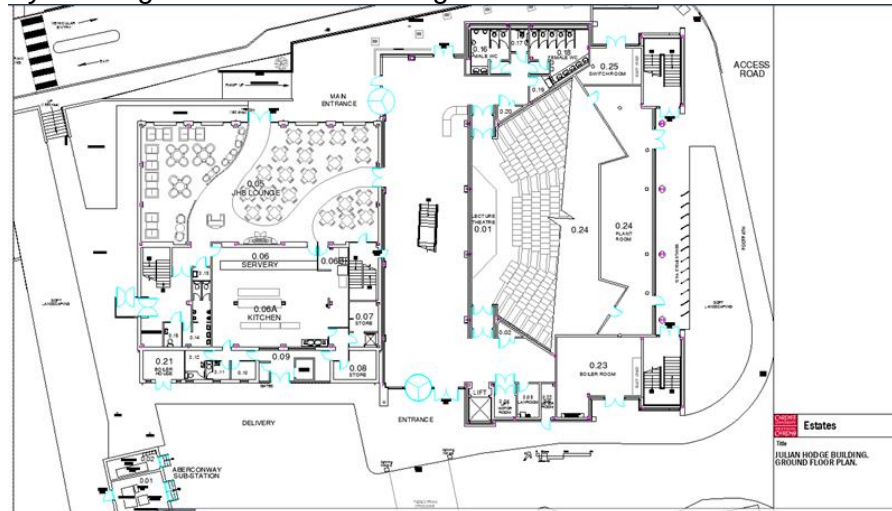


Image 1: Ground floor plan.

The first floor of the larger building houses more of the 460 seater lecture theatre, the first floor of the smaller cafeteria has a small mezzanine corridor and three small classrooms or offices



Image 2: First Floor Plan

Only the larger building goes higher, it's second floor contains a large study room for students or staff to work on fully networked computers (Cardiff University, 2023) and lift access. Also on the second floor are toilet facilities and the first plant room facilitating the air conditioning for all rooms and corridors on this floor.



Image 3: Second Floor Plan

The third floor is similar to the second, made up of offices and toilet facilities and a lift. There is also a plant roof for air conditioning on the 3rd floor.



Image 4: Third Floor Plan

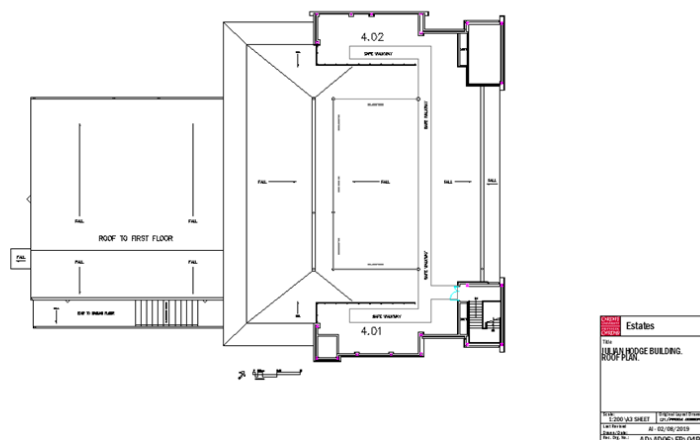
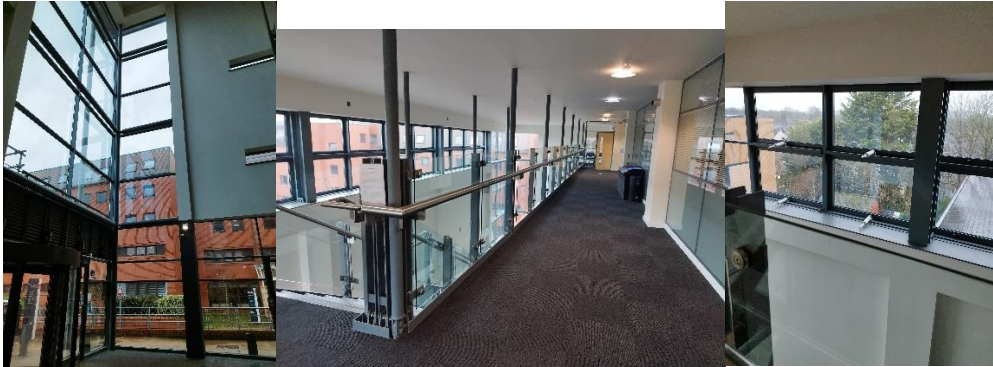


Image 5: Roof Plan

3.2 Existing Building Engineering Services

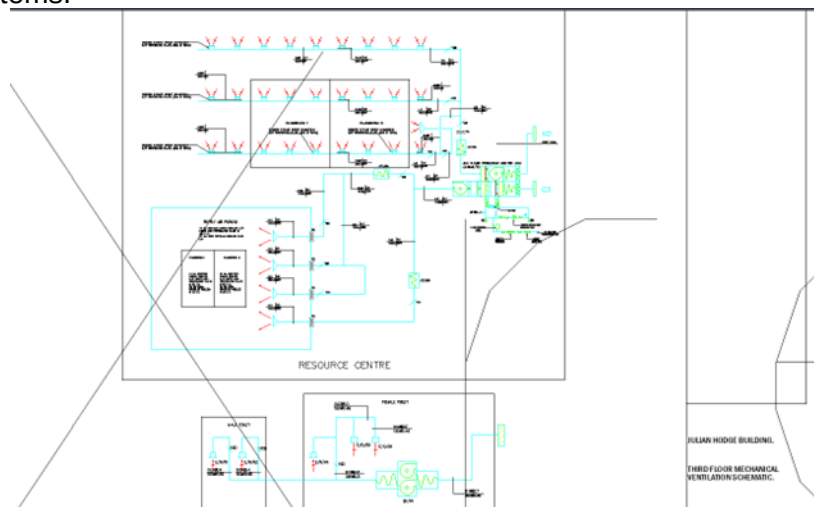
The atrium is heated via underfloor heating (wet system), ventilation is provided by high level controllable window ventilators to create stack effect ventilation with air being heated by the underfloor heating and solar gains from the glazed atrium and rising naturally (CIBSE, 2005).



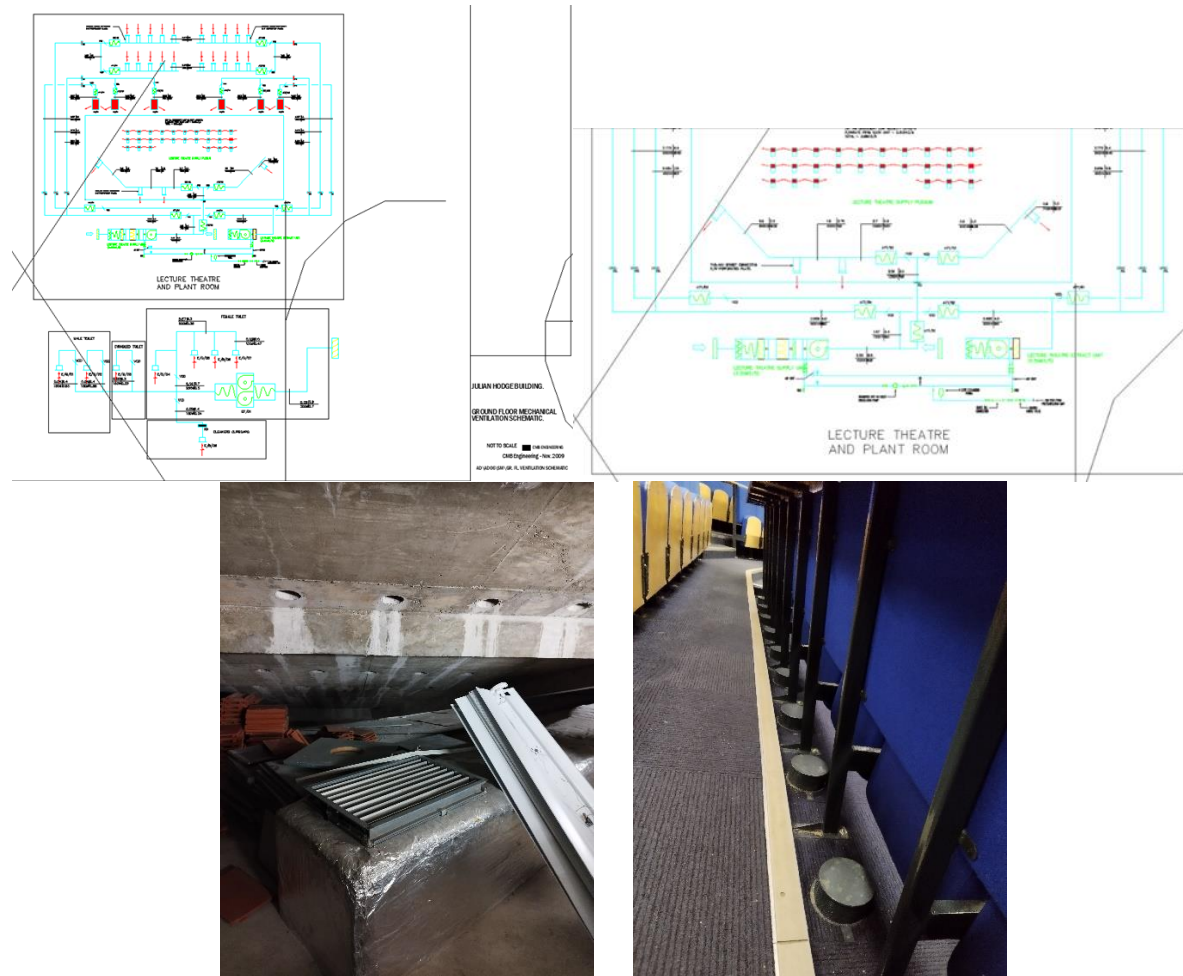
From initial conversation with Mark Durdin, it was established that the larger building is heated via air conditioning, while the smaller building housing the cafeteria used a wet system. This was confirmed through investigation. The hallway and office floors of the first, second and third floors show floor, and high level vents which facilitate displacement ventilation. There are also 'wet' radiators around the corridors and atrium, which supplement the heating.



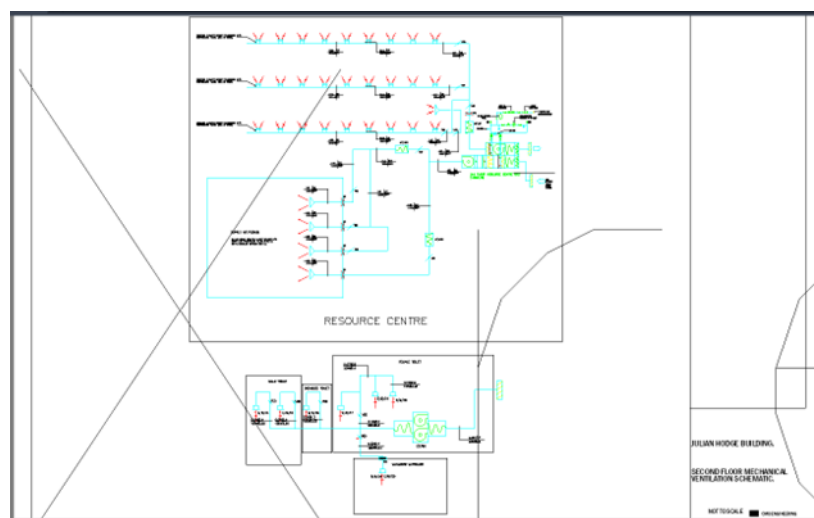
The plant rooms on the corresponding floors confirm this along with the schematics for the ventilation systems.



The plans for the lecture theatre show the use of displacement ventilation. Heated air is blown into the room below the lecture theatre, creating positive pressure, this moves up into low level diffusers under the seats in the lecture theatre.



The schematic for the second floor also clearly show the use of air conditioning and heaters to heat the rooms and corridors.



There are various air handling units (AHU) located in the building, shown on various floor plans. These are responsible for heating and moving the air around as a means of heating the larger of the two buildings. There is a unit on the ground floor, responsible for supplying the lecture theatre, and on the second and third floors.



These units also filter the air and are fan driven using belts. They appear to have chillers installed to cool air, but this doesn't seem to be in use. All of which require regular maintenance to operate to optimum performance.

Mains gas is supplied via 2 points (as the building was previously 2 separate buildings). In the larger building, the Gas main and meter is located on the ground floor in a small room, accessible externally, next to the boiler room (image 6). In the smaller, cafeteria building, the gas main and meter is in the boiler room at the rear of the building (image 7).



Image 6

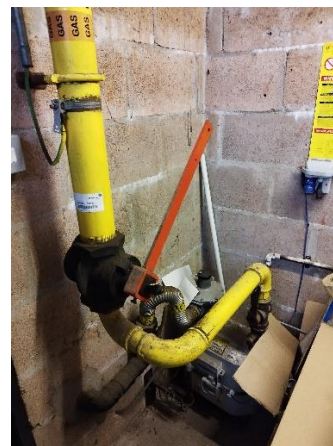
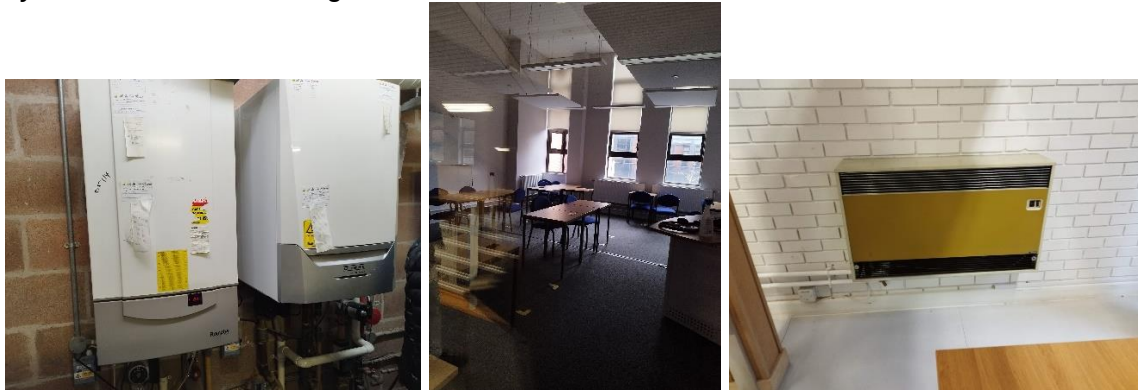


Image 7

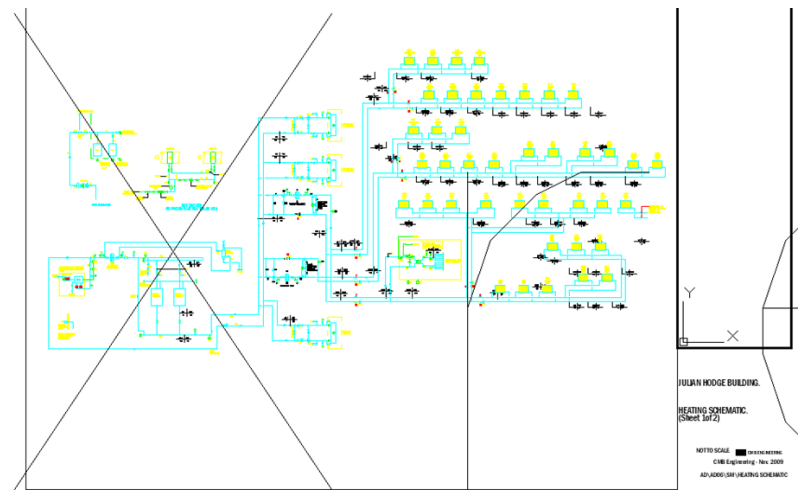
In the larger building the gas is supplied from the meter into an adjacent room where, according to the schematic, it feeds two boilers. In reality, we can see there are 4 boilers, meaning the schematic hasn't been updated since additional boilers were installed.



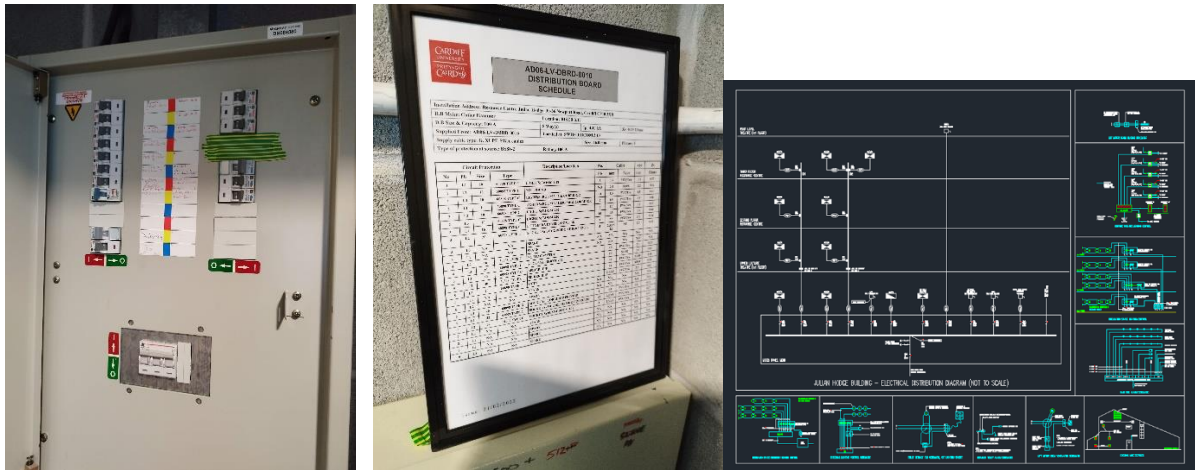
In the cafeteria, the gas supplies two boilers, which provide heating via the 'wet' radiator system shown in the images below.



The heating schematic gives further insight into the layout of the wet system in the cafeteria building, it shows the two boilers in the boiler room and the mains incoming gas and the distribution of hot water from the boilers to the various radiators.



The electrical system facilitates multiple uses in both buildings and the atrium. There is one incoming main power line, which branches off into the two buildings. Lighting has been partially upgraded to L.E.D. Automatic lights using P.I.R sensors are used in the lecture theatre, everywhere else in the building lights are controlled by switches. There are multiple fuse boards for each plant room on each floor and a separate one for the lecture theatre. There are currently no renewable or 'green' energy sources such as photovoltaic or wind turbines producing electricity for the building.



The control system used for the Julian Hodge building is the Trend IQVision, this is a software programme which integrates various control systems around the building and can produce real time consumption and usage data, accessible online allowing “centralized data logging, archiving, alarming, trending, master scheduling, system-wide database management” (Trend, 2022). This is a relatively new system to the building and is still halfway through being implemented, meaning it’s benefits haven’t been seen yet.

4.0 Maintenance

4.1 Existing Operations

Through discussion with Mark Durdin it has been concluded that the existing maintenance operations is a mixture of contracted external firms and in-house workers, employed directly by the University. Specialist, technical operations are carried out by the contractors, while more day to day maintenance or minor repairs i.e. changing a lightbulb is carried out by the direct employees. The University has a compliance and maintenance team of 12 employees, with a further 25-30 working ‘on the tools’ to carry out small scale repairs and reactive remedial work. The University portfolio includes over 300 buildings. This means that the maintenance team regularly utilises specialist contractors and sub-contractors to carry out maintenance and meet statutory compliance requirements. Broadly maintenance can be broken down into two categories, planned and unplanned (CIBSE, 2014). An example of planned maintenance given in part 3.2.2 of the CIBSE guide M is changing filters in an air handling unit once airflow falls below a set level as a preventative measure. To utilise this parameters need to be closely monitored, this is often why weekly or monthly changes are more commonly carried out, as it doesn’t require rigorous monitoring, but can incur unnecessary costs.

(Rivers, 2019) discusses the advantages and disadvantages of outsourced facilities maintenance.

Advantages of Outsourcing Maintenance

- Cost – can be seen as an advantage or a disadvantage depending on application. Any sick days, staff holidays or additional labour requirements are the responsibility of the sub-contractor and not the facilities management team. Mistakes and errors causing costly damage to systems should also be the responsibility of the sub-contractor.
- Specialist skills – more complex systems will require specialist training and skills. The initial cost of the training and subsequent wages of highly trained employees can be very high, especially if their skills are only occasionally required.
- Flexibility - using outsourced workers can enable the University to directly employ less staff and only pay for the services of specialist staff as and when they need them.
- Specialist equipment – can be costly to own testing and maintenance equipment, using an outsourced firm means that they have those costs.

Disadvantages of Outsourced Maintenance

(Kroeschell, 2021) explains the pro's and con's of and in-house maintenance team.

- Communication and co-operation – direct communication between the University and workers may be hindered as there are extra layers of management. The University and sub-contractor may also have differing management styles, which could lead to conflict.
- Response Times – are typically faster with an in-house team allowing problems to be fixed faster. Often, outsourced companies may do the minimum to meet their contractual responsibilities. Having one person on-call who is able to isolate a system by turning it off. While stopping the problem from progressing further, this doesn't help the Facilities Management Team in operating the building.
- Increased management requirements – could be needed to check work has actually been carried out, especially on large campuses or organisation with multiple buildings, like the University.
- Cost – generally, highly skilled, specialist sub-contractors charge higher rates than having in house employees with the same skills. But this can be offset by having a rigorous Facilities Management team. It is important to ensure sub-contractors aren't taking advantage of the University through practices like charging for work they haven't carried out, or carrying out work which isn't required.

Advantages of In-house Maintenance

- Timely Response – an in house team is far more likely to respond on time as there is a clear and direct management and reprimand structure in place and more ownership of responsibilities.
- Improved Communication – clearer communication and identification of problems and resolution as there are less people involved.
- Security and Data Protection – using an in-house team means no sensitive data would be passed to an external organisation.

- Bespoke Team – Directly employing individuals through an interview process gives the Facilities Management Team much more control over the skills and experience that they employ.

Disadvantages of In-house Maintenance

- Costs – employing workers 365 days a year with holiday and sick pay etc can be more costly, however this entirely depends on their skillset and how in demand they are.
- Lack of Innovation – some employees can become ‘stuck in a rut’ and lack innovative ‘outside the box’ thinking, if they are used to carrying out the same maintenance tasks repetitively.
- Flexibility – Careful programming is required to make sure not too many employees are on leave at the same time or if there are any periods when leave cannot be taken.

4.2 Recommendations

Outsourcing the maintenance contracts is a good way of achieving statutory compliance or transferring the risk of non-compliance to an external party. However it is usually a costly choice. It would always be cheaper to use in-house maintenance workers to carry out the work. But with more complex systems, the specialist skills required to carry out the work might require a vast team of multi skilled individuals, being employed full time by the University and also incurring large costs (CIBSE, 2014). Using a contractor on an on-call basis could provide more cost effective for unplanned, reactive, work. For the varied portfolio that the University’s Facilities Management Team are responsible for, it is recommended to increase the number of in-house workers. With the large amount of building there would be ample work to keep mid-skill level employees busy to justify employing them year round, this would require effective management and timetabling of employee responsibilities. This would also mean that the University could upskill and retrain some of these in-house workers to be available in emergencies to carry out essential repairs if needed and for planned maintenance. Due to the nature of the mechanical and electrical systems in the Julian Hodge Building, minimal specialist outsourcing is still required, but not to an extensive degree. The air handling units and gas boilers aren’t as specialist as other systems such as heat pumps or solar PV, which would require more specialist skills to maintain. The recommended ration would be 75% in house and 25% outsources, based on the systems used in this building.

5.0 Energy Audit

Cardiff University Julian Hodge Building

By : R Thomas



Survey Visit Date: 15/3/23

Report Completion Date: 10/5/23

5.1 Introduction

This report will assess the energy consumption of the Julian Hodge building based on current technology being used and control systems. The audit will use the benchmarks as set out in CIBSE Guidance TM46 – Energy Guidance. Based on the analysis of data, the report will recommend changes to operation or adaptation of new systems to reduce energy use and carbon footprint. The financial costs and savings as well as payback will be considered when making these recommendations. The format of the audit will be in accordance with guidance from CIBSE Guide F (CIBSE, 2012) and BRE guidance on energy audits (Hussain, 2016). Data will be collected from meter readings in the building and Display Energy Certificates (DEC).

The information in this report should be used as part of an Energy Management Plan for the Facilities Management Team on behalf of the University.

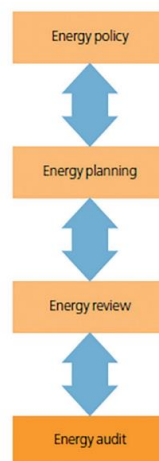


Figure 1: How energy audits fit into management framework (Hussain, 2016)

5.2 Restrictions

A key factor is time constraint, taking into account the size of the building a lot more time could be spent there. Total time spent during the visit was 3.5 hours. Some rooms (such as offices) weren't accessed but don't deduct from the outcome as key rooms such as plant and machinery were accessible. It is important to note discrepancies in the energy usage data as a result of the Covid19 pandemic and resulting lockdowns. It was also noted during the visit that Mark Durdin mentioned there was issues with meter data 3 years ago, this could also potentially be linked to the lockdowns. The systems are also midway between switching from the old system to a new Trend IQVision.

5.3 Audit process

For a recognised and standardised format, the process will follow guidance given in Guide F, Energy Performance in Buildings.

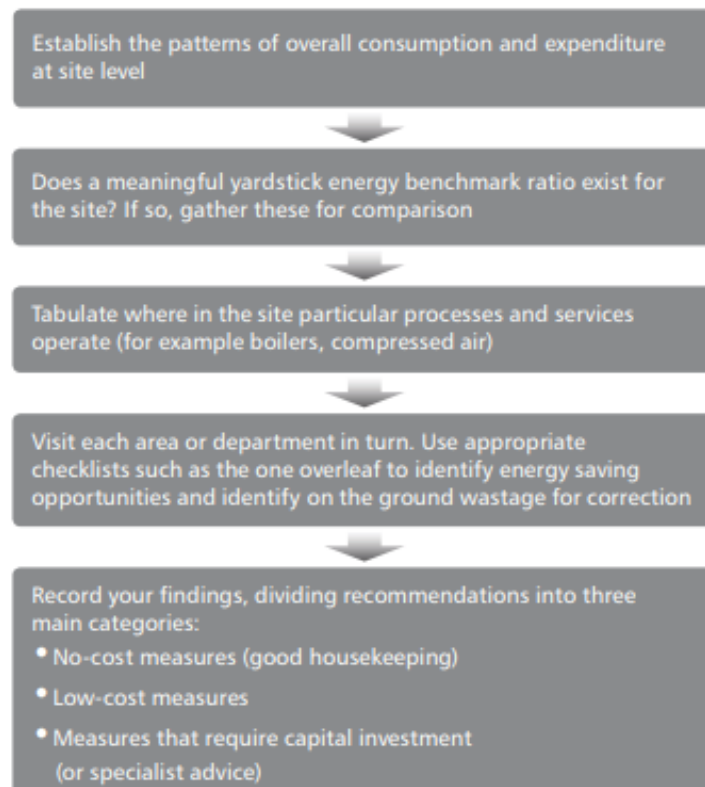


Figure 18.2 Outline structure for an energy survey (reproduced from CTV023: *Practical energy management*⁽⁴⁾ by permission of the Carbon Trust)

Figure 2 (CIBSE, 2012)

5.4 Site Information

Formerly 2 separate buildings, a larger, 4 storey building and a smaller, 2 storey cafeteria now linked together by a central atrium constructed in 2001. On the ground floor the larger building houses the 460 seat lecture theatre as well as a plant room for the lift machinery, the lift provides full disabled access to all floors. Externally on the ground floor, a plant room can be accessed, which facilitates the air conditioning of the ground floor and second floor lecture theatre. There is a large atrium with underfloor heating, where the main staircase goes up to access the upper levels, the building can be accessed from the front or rear of the atrium. On the ground floor of the cafeteria there is a seating and eating area as well as kitchens. The building contains 136 networked computers.

5.5 Current Energy Consumption

Energy consumption data was provided by the current Facilities Management Team, dating from January 2021 to December 2022. This means there would be less impact on the data from the lockdowns, but it will still need to be considered when looking at older data in the DEC's.

Energy Rates are given as the following:

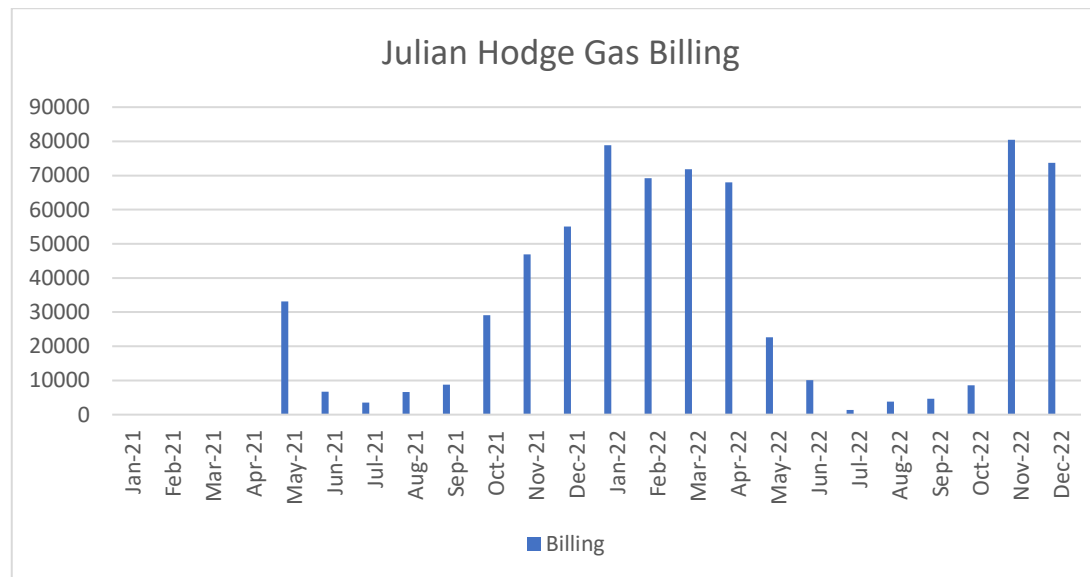
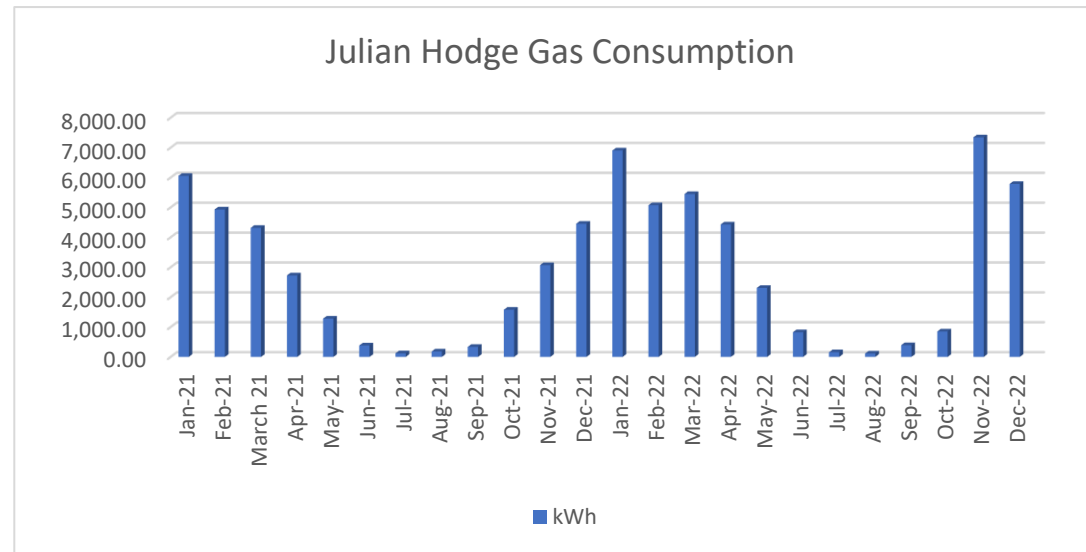
- Gas 9.5p/kWh
- Electricity 24.5p/kWh

Julian Hodge Electricity Meter Data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	
1	AD - Academic - Colson Road and Humanities Site Buildings Electricity Meter Tree with Consumption																															
2	Date: Jan 21 to Dec 22																															
3	Meter Id	Meter Name	Meter Type	Unique Meter Id	Building Name	Main Incomer?	Area m2	Jan 21 kWh	Feb 21 kWh	Mar 21 kWh	Apr 21 kWh	May 21 kWh	Jun 21 kWh	Jul 21 kWh	Aug 21 kWh	Sep 21 kWh	Oct 21 kWh	Nov 21 kWh	Dec 21 kWh	Jan 22 kWh	Feb 22 kWh	Mar 22 kWh	Apr 22 kWh	May 22 kWh	Jun 22 kWh	Jul 22 kWh	Aug 22 kWh	Sep 22 kWh	Oct 22 kWh	Nov 22 kWh	Dec 22 kWh	
4	72102	AD06 Julian Hodge Bldg M1 Main Incomer L1 Current	Electricity	AD06E02477AD06	AD06 Julian Hodge Building	6	6.00																									
5	72103	AD06 Julian Hodge Bldg M1 Main Incomer L2 Current	Electricity	AD06E02478AD06	AD06 Julian Hodge Building	6	6.00																									
6	72104	AD06 Julian Hodge Bldg M1 Main Incomer L3 Current	Electricity	AD06E02479AD06	AD06 Julian Hodge Building	6	6.00																									
7	44018	AD06 Julian Hodge Bldg M1 Main Incomer	Electricity	AD06E00172AD06	AD06 Julian Hodge Building	1	5819.39	42,992.29	52,008.40	39,246.83	32,897.62	42,131.22	84,479.79	41,008.04	65,244.99	29,179.40	72,464.23	46,409.72	51,074.22	50,700.16	47,140.29	52,894.72	32,289.08	40,246.49	40,218.75	51,161.99	76,940.79	59,642.14	59,142.21	28,454.80	44,192.32	
8	51019	AD06 Julian Hodge M1 Lecture Theatre	Electricity	AD06E00173AD06	AD06 Julian Hodge Building	6	6.00	11,161.16	14,381.16	16,199.11	17,433.06	15,391.78	17,194.25	15,237.47	19,261.55	17,784.42	18,619.24	20,142.76	33,145.18	48,181.82	32,479.97	41,018.28	14,811.69	18,402.21	16,776.77	24,081.91	49,142.32	31,764.21	24,531.47	17,721.46	16,735.41	
9	44017	AD06 Julian Hodge MR Abacus Refectory (CARBET)	Electricity	AD06E00177AD06	AD06 Julian Hodge Building	1	5819.39	2,237.62	1,489.88	1,261.89	1,111.07	1,197.82	1,291.40	1,114.26	1,294.42	2,428.27	3,094.21	4,195.49	3,721.99	3,920.16	5,294.00	6,624.05	3,041.69	5,195.14	3,974.40	3,742.81	3,297.00	4,281.83	4,471.89	7,732.49	5,824.19	
10	44019	AD06 Julian Hodge Sub - Local D.B. Elec kWh, Shark	Electricity		AD06 Julian Hodge Building	6	6.00																									
11	47176	Julian Hodge LIT Elec	Electricity	HPFRN1NOT KNOWN	No Building (M)	6	6.00																									
12	59450	AD06 Julian Hodge M4DB Sushik Room (Zara)	Electricity	AD06E00178AD06	AD06 Julian Hodge Building	6	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	59459	AD06 Julian Hodge M3 Spare	Electricity	AD06E00179AD06	AD06 Julian Hodge Building	6	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
14	72011	AD06 Julian Hodge Refectory Outside LIT	Electricity	AD06E00176AD06	AD06 Julian Hodge Building	6	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
15	72015	AD06 Julian Hodge M6 (Refectory)	Electricity	AD06E0217AD06	AD06 Julian Hodge Building	6	6.00	36,693.14	47,115.14	22,045.19	16,432.41	7,425.19	7,429.19	27,237.49	11,094.21	90,474.79	47,744.71	41,401.27	44,616.69	97,917.00	39,742.51	46,167.24	18,237.49	21,409.42	70,525.24	39,210.24	99,814.97	31,612.71	24,179.62	92,294.44	10,110.41	

Julian Hodge Gas Meter Data:

AD - Academic - Colson Road and Humanities Site Buildings Gas Meter Tree with Consumption																															
Date: Jan 21 to Dec 22																															
Meter Id	Meter Name	Meter Type	Unique Meter Id	Building Name	Main Incomer?	Area m2	Jan 21 kWh	Feb 21 kWh	Mar 21 kWh	Apr 21 kWh	May 21 kWh	Jun 21 kWh	Jul 21 kWh	Aug 21 kWh	Sep 21 kWh	Oct 21 kWh	Nov 21 kWh	Dec 21 kWh	Jan 22 kWh	Feb 22 kWh	Mar 22 kWh	Apr 22 kWh	May 22 kWh	Jun 22 kWh	Jul 22 kWh	Aug 22 kWh	Sep 22 kWh	Oct 22 kWh	Nov 22 kWh	Dec 22 kWh	
41177	AD06 Julian Hodge Gas	Gas	AD06G00145AD06	AD06 Julian Hodge Building	1	0.00	6,053.21	4,328.60	4,314.43	2,722.34	1,273.03	391.67	118.62	179.46	324.58	1,576.16	3,097.04	4,452.54	6,301.28	5,071.70	5,446.12	4,428.35	2,304.66	923.03	155.27	111.75	353.63	848.77	7,342.01	5,714.23	
45793	Julian Hodge Gas Billing MPIN: 8307701600	Gas	6307701600	Julian Hodge (M)	1	0.00					35,180.47	6,738.50	3,522.60	6,652.87	8,785.00	29,083.74	46,892.86	55,021.25	78,660.37	69,241.61	71,811.25	68,022.35	22,615.52	10,062.60	1,400.72	3,838.92	4,684.38	8,620.12	80,415.72	75,693.89	
35131	AD06 Julian Hodge LIT Gas	Gas	5171	AD06 Julian Hodge Building	1	3585.35																									
35132	AD06 Julian Hodge Refec Gas x100 cuft	Gas	5170	AD06 Julian Hodge Building	1	3585.35	16,174.01	8,518.13	7,524.02	8,077.59																					
41780	AD06 Julian Hodge Refectory Range Gas	Gas	AD06G00148AD06	No Building (M)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.10	7.20	4.59	6.71	4.43	6.87	0.00	0.00	0.00	0.00	0.00	0.00	44.31	23.45	
41781	AD06 Julian Hodge Refectory Boilers Gas	Gas	AD06G00149AD06	No Building (M)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
52460	Julian Hodge LIT Gas	Gas	8010	No Building (M)	0	0.00																									
52461	Julian Hodge LIT Gas boilers - on Banc	Gas	5172	No Building (M)	0	0.00	63,201.16	52,905.15	53,844.16	45,205.23																					
52462	Julian Hodge Refec Gas x100 cuft	Gas	8009	No Building (M)	0	0.00																									



Figures 3 & 4 Julian Hodge Gas Meter and Billing Data

Figures 3&4 show a typical pattern for energy consumption in an educational building. Its seasonal use, combined with higher energy consumption through heating and lighting in the winter give a 'peak and trough' pattern.

By combining this data with degree days data collected for Cardiff based on those dates, it is possible to create a scatter diagram showing energy consumption. It's also possible to plot an average line through the data. There are some outliers, which could warrant further investigation, however they do not detract from the overall data or results of this investigation. They could have been a unit left on over a weekend accidentally, or any number of 'unknown' variables.

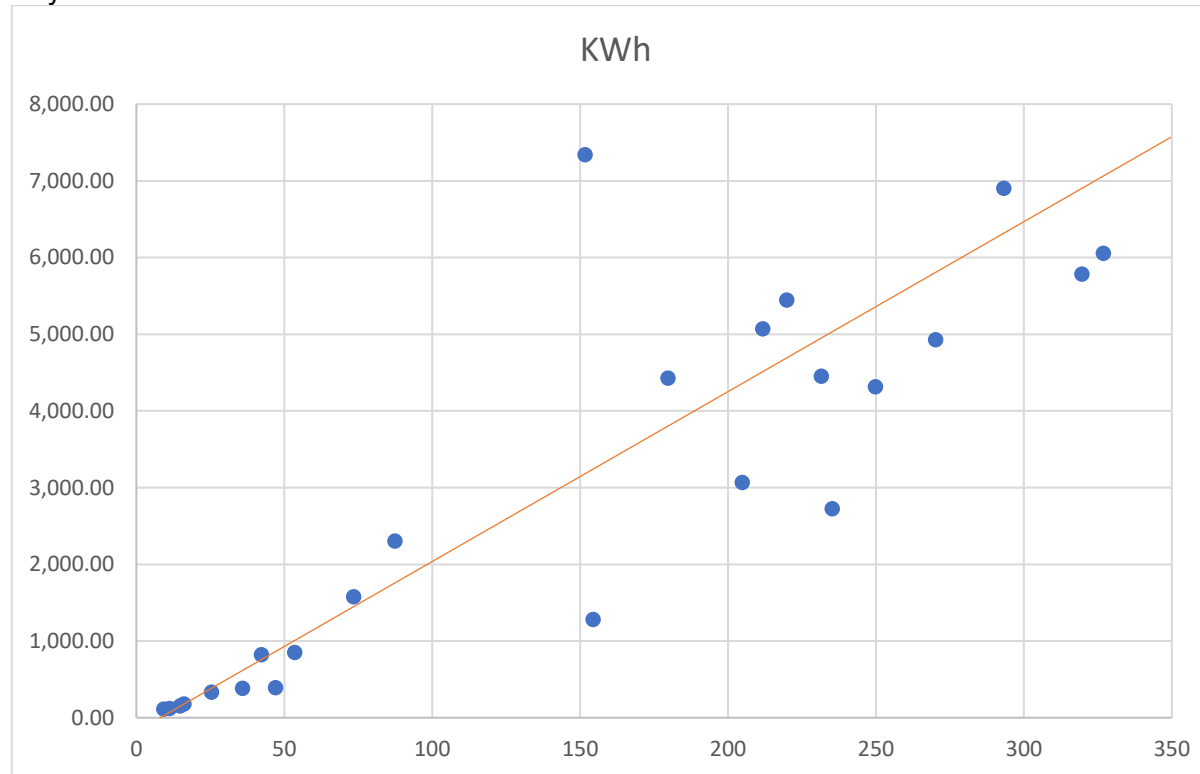


Figure 5: Scatter Diagram showing degree days against energy consumption (BizEE, 2023)

Figures 6&7 show electrical consumption from 4 different meters in different parts of the building. Again we see the same pattern as for gas usage, though not as defined. This is due to additional lighting being used in winter months and less in summer months as a result of more daylight hours.

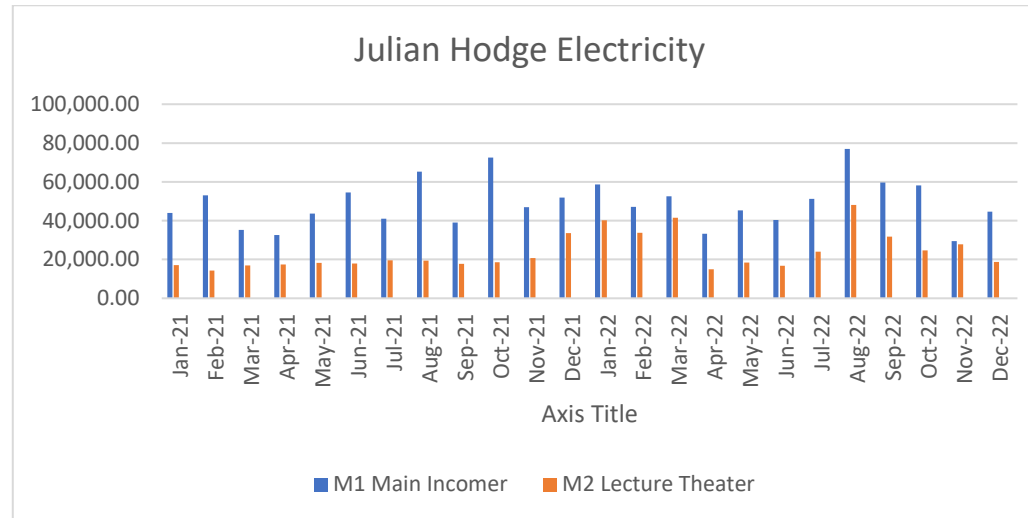


Figure 6: Chart showing Electricity Consumption

In Figure 7 the M6 refectory is considerably higher than the M5 refectory. This would suggest that M6 is the main refectory and M5 may be another system or has been mislabelled.

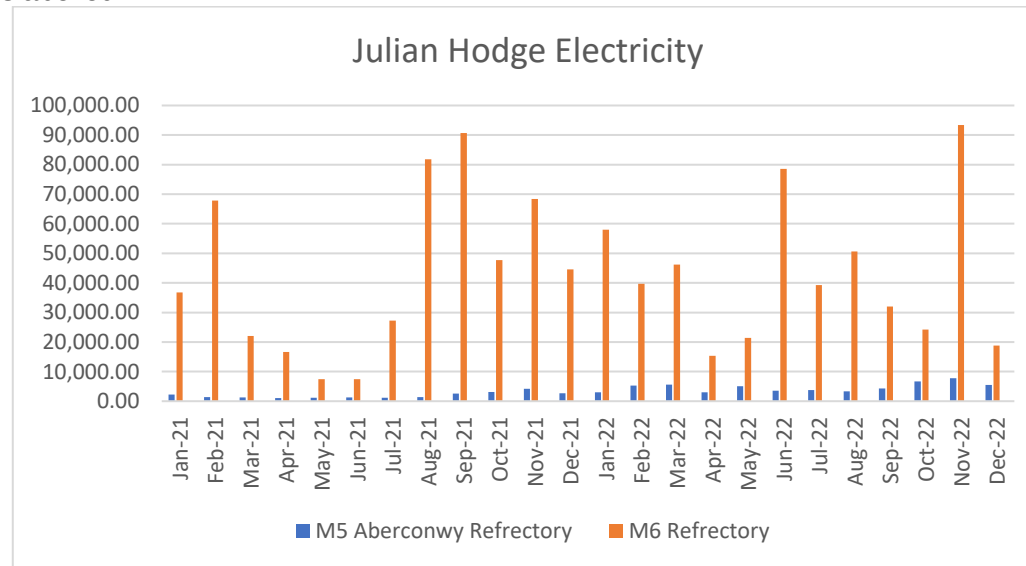


Figure 7: Chart showing Electricity Consumption

5.6 Benchmarked Energy Performance

[A]	[B]	[C]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]
Name and description			Energy benchmarks		Illustrative CO ₂ benchmarks calculated from the energy benchmarks (see Table 3)			Building size metric for use by assessors		
Category	Name	Brief description	Electricity typical benchmark (kW-h/m ²)	Fossil-thermal typical benchmark (kW-h/m ²)	Illustrative electricity typical benchmark (kgCO ₂ /m ²)	Illustrative fossil-thermal typical benchmark (kgCO ₂ /m ²)	Illustrative total typical benchmark (kgCO ₂ /m ²)	Primary metric (as in energy benchmarks)	Approved alternate metric	Default multiplier (applied to alternate metric to obtain primary metric)
18	University campus	University campus	80	240	44.0	45.6	89.6	Gross floor area measured as RICS gross internal area (GIA)	(none)	
19	Clinic	Health centres, clinics and surgeries	70	200	38.5	38.0	76.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
20	Hospital (clinical and research)	Clinical and research hospital	90	420	49.5	79.8	129.3	Gross floor area measured as RICS gross internal area (GIA)	(none)	

Figure 8 (CIBSE, 2008)

Figure 8 shows the benchmark used for data analysis. Column N gives an illustrative fossil-thermal typical benchmark (kgCO₂/m²) of 45.6. This will be the benchmark used for heating the Julian Hodge building using fossil-fuels (gas).

Display energy certificate (DEC)

Certificate contents

- Energy performance operational rating
- This building's energy use
- Previous operational ratings
- Total carbon dioxide (CO₂) emissions
- Administrative information
- Other certificates for this property

Share this certificate

✉ Email



This certificate has expired. You can [get a new certificate](#).

Cardiff University
Julian Hodge Building
Colum Drive
CARDIFF
CF10 3EU

Operational rating
F

This certificate expired on
24 May 2021

Certificate number
0529-0163-2710-7100-1003

Figure 9 (DEC, 2021)

Score	Operational rating	This building	Typical
0-25	A		
26-50	B		
51-75	C		
76-100	D		
101-125	E		
126-150	F	139 F	
150+	G		

Figure 10 (DEC, 2021)

This building's energy use

Main heating fuel	Natural Gas	
Building environment	Air Conditioning	
Total useful floor area	3700.48 square metres	
Asset rating	Not applicable	

Energy use	Electricity	Other fuels
Annual energy use (kWh/m ² /year)	171	162
Typical energy use (kWh/m ² /year)	81	237
Energy from renewables	0%	0%

Previous operational ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods.

May 2020	139 F
June 2019	140 F
June 2018	81 D

Figure 11 (DEC, 2021)

The Display Energy Certificate (DEC) dated 24th May 2021 shown in Figures 9&10 give information about the energy performance of the building and give a rating on a scale, based on carbon emissions for the year. The score of 100 (for public buildings) is used to compare to the Julian Hodge building. This equates to a D. The DEC also contains information on ratings from previous years. We can see from Figure 11 that the only time the building achieved a D rating was in 2018.

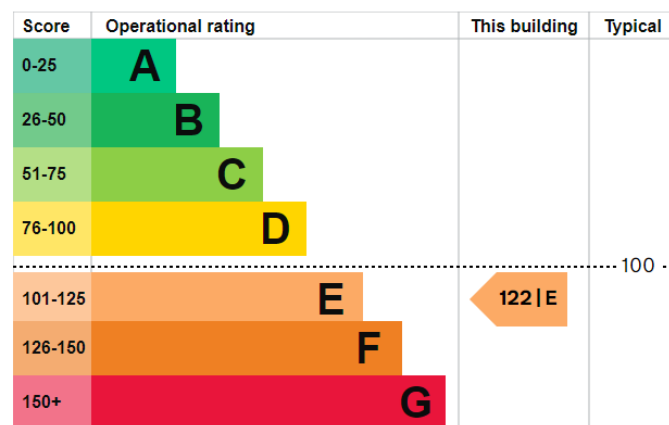


Figure 12 (DEC, 2015)

The data used in Figure 12 & 13 is from the DEC issued in 2015, this also gives previous years information and we can see that the building achieved a D band in 2013.

Previous operational ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods.

April 2014

122 | E

April 2013

88 | D

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
April 2014	325	76	0
April 2013	219	82	0

Figure 13 (DEC, 2015)

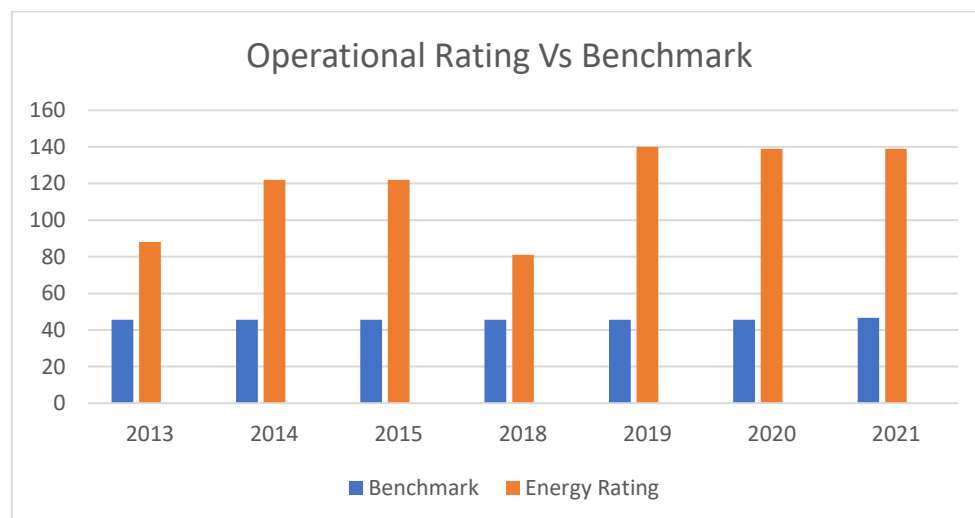


Figure 14, benchmark data vs DEC energy rating

The DEC gives a benchmark of 100 for public buildings, which explains the low banding, an F shown in Figure 10. However if we use the figure of 45.6 for University Buildings as given in CIBSE TM46, figure 9 (CIBSE, 2008) the energy rating is lower still. It is important to note that the data for 2016/17 is missing, older data from 2013 to 2015 was used for a more complete picture, as the 2020 and 2021 data could have discrepancies due to the lockdowns. It is important to note that the DEC benchmark for Public Buildings was still 100 in the earlier DEC's. The TM46 is also dated to 2008, so the same benchmark of 45.6 has been used for all years for consistency. It is also worth mentioning that this is based on the

operational rating from the DEC, table 15 compares energy use to the benchmarks given in TM46.

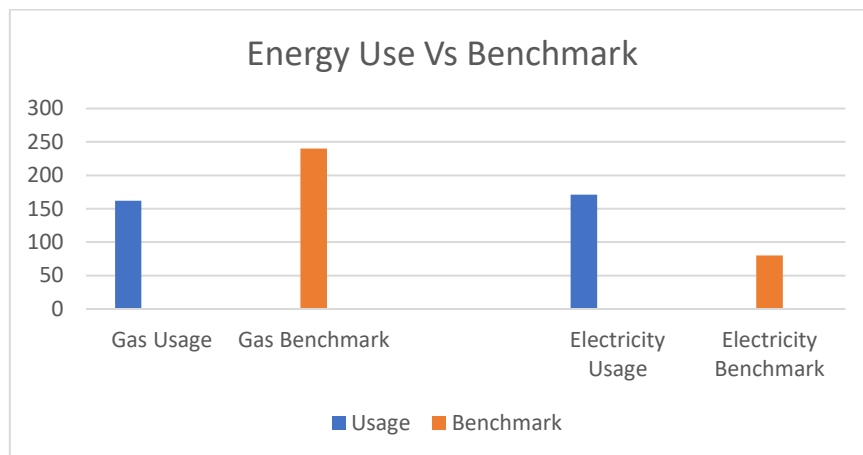


Figure 15

The table in Figure 15 shows that while gas usage is lower, electricity use is higher for a building in this category.

15-2 Energy efficiency in buildings: Part B: Operating and upgrading the building

	Policy	Organising	Training	Performance measurement	Communicating	Investment
4	Energy policy action plan and regular review have active commitment of top management ☐	Fully integrated into management structure with clear accountability for energy consumption ☐	Appropriate and comprehensive staff training tailored to identified needs, with evaluation ☐	Comprehensive performance measurement against targets with effective management reporting ☐	Extensive communication of energy issues within and outside organisation ☐	Resources routinely committed to energy efficiency in support of business objectives ☐
3	Formal policy but not active commitment from top ☐	Clear line management accountability for consumption and responsibility for improvement ☐	Energy training targeted at major users following training needs analysis ☐	Weekly performance measurement for each process, unit or building ☐	Regular staff briefings, performance reporting and energy promotion ☐	Same appraisal criteria used as for other cost reduction projects ☐
2	Unadopted policy ☐	Some delegation of responsibility but line management and authority unclear ☐	Ad-hoc internal training for selected people as required ☐	Monthly monitoring by fuel type ☐	Some use of company communication mechanisms to promote energy efficiency ☐	Low or medium cost measures considered if short payback period ☐
1	Unwritten set of guidelines ☐	Informal mainly focused on energy supply ☐	Technical staff occasionally attend specialist courses ☐	Invoice checking only ☐	Ad-hoc informal contacts used to promote energy efficiency ☐	Only low or no-cost measures taken ☐
0	No explicit energy policy ☐	No delegation of responsibility for managing energy ☐	No energy related staff training provided ☐	No measurement of energy costs or consumption ☐	No communication or promotion of energy issues ☐	No investment in improving energy efficiency ☐

Figure 16 : Energy Management Matrix (CIBSE, 2012)

The energy management matrix is a useful tool for analysing how energy is managed in a building. A key recommendation of this report is that the matrix is used as part of the University Facility Management Teams' Energy Management Plan.

5.7 Behavioural Change

Looking at the data, an obvious choice might be to change the academic calendar. We can see heavy energy use in the winter for heating. This is a time when the buildings are being used most. Schools, colleges and Universities have minimal use during the summer. Academic timetables usually start in September and have break for a few weeks over Christmas, then run until late Spring / early Summer. In essence we are using the buildings most, at times of the year when they consume the most energy. While changing the calendar would have a massive impact on energy use, it is unlikely to happen any time soon as it would require huge political backing and have subsequent far reaching socio-economic implications.

5.8 Consideration of Renewables

An obvious go-to for renewables would be solar PV. However, due to the timing of the use of the buildings these would be unfeasible. Most use is in the winter, when there is less daylight. In the summer when there is maximum daylight hours, there is minimal energy use in the building. The solution to this is batteries to store the energy. However on a building of this size with its energy consumption, the scale and cost of batteries would be substantial.

5.9 Proposals

Why reduce carbon output by improving energy performance? There are many good reasons, financially using less energy will mean lower energy costs and savings. However it is critically important to understand the process of calculating payback. This process involved taking into account:

- Initial cost of new technologies and equipment
- Maintenance cost
- Savings
- Time it will take before the savings outweigh the associated costs

It can be very tempting (and common) to just look at savings and ignore the other factors. There can also be legislative requirements, which must be met. This may mean that alternative technologies must be used to lower carbon emissions and comply with legislation, even if they cost more in maintenance etc. The Paris Climate agreement of 2015, which came into force in 2020 saw 195 countries agree to limit climate change by minimising carbon emissions. The UK pledged to cut carbon emissions 68% by 2030 (Chadwick, 2021). Energy reduction can also be considered part of risk management (Hussain, 2016). Being reliant on fossil fuels can have increased risk if there are restrictions placed on lending to fossil fuel companies or restrictions placed on certain types of fossil fuels (ECB, 2023). Considering recent conflicts in Ukraine and restrictions placed on Russia, fossil fuel prices have sharply risen (Lawson, 2023).

An initial basic investment would be a review and update of equipment and sub-metering in the building. There are a number of meters installed, but some contain question marks and some seem to contain data for other buildings (Aberconway). In some instances schematics show 2 boilers, where upon inspection there are 4. Reviewing and updating information is

key to understanding energy consumption data for the building and being able to understand whether new measures are working (Hussain, 2016).

As per the key recommendations in the AC TM44, using EC fan motors, which can be more than 90% efficient, instead of AC (where rated smaller than 12 kW) in the Air Handling Units. If these EC motors are paired with high efficiency fans, saving of 70% energy consumption can be made against the original AC (Sheldon, 2023).

The AC TM44 also identified loose belt tensions on the fan drive belts, this can lead to a reduced air flow and increased wear on parts. The life expectancy of a belt driven fan can be 20 years, however switching to an EC motor means higher efficiency but also not belts or pulleys being used therefore less maintainable components (Taylor, 2021).

EC vs AC Fans

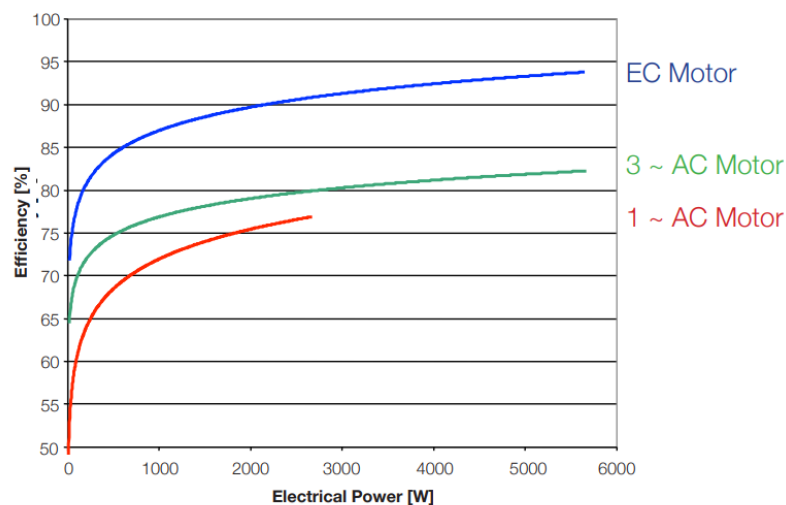


Figure 17 (ELTA, 2018)

Figures generated for AC and EC fan motors are based on a single EC motor, costing £60, consuming 21w vs an AC motor at 60w for 8hrs a day (TerraBloom, 2021). Converted into kWh (RapidTables, 2023). Costs were given as 24.5p/kWh. A saving of 0.32kWh per day was converted into kg CO₂e using (RenSmart, 2023) to determine a reduction of 7.46 kg CO₂e.

Figures for lighting based on one x 50w halogen 750-lumen bulb running for 521 hours per year (EST, 2020). Replacement costs for bulbs are given as a 2 year lifespan for halogen, based on 3 hrs use / day = 2,000 hours. The same use of an LED bulb would be 15,000 - 20,000 hours (CIBSE, 2012).

From the visit it was established that the main lecture theatre has automatic light controls fitted whereas all other areas in the building are on manual switches. Given that lighting can consume up to 40% of a buildings electrical consumption (CIBSE, 2012) it is an area with potential for significant savings. Some studies have shown that in normally daylight building, the correct use of controls could affect use by 30–40%. Occupancy control (presence detection) switching would be suitable to corridors where there is some natural light and the sudden boost of light wouldn't be so noticeable or irritating. Study areas and IT rooms would benefit from reset control timed off, manual on. This means the lights would switch off at

certain times meaning they couldn't accidentally be left on. If required for longer hours, there would be a switch. This would be less irritable in a study area, compared to presence detection such as infrared (CIBSE, 2012). Based on the 2021 DEC of 171 kWh/m²/year, creating a 39.867 kg CO₂e and an average saving of 26% using lighting controls (DiLouie, 2023).

AI – Artificial intelligence is such a rapidly developing technology, exact figures on savings are difficult to determine in facilities management. However, looking at Nest smart thermostats, which use AI to learn patterns in building use and develop the most efficient programmes based on use and behaviour, claims saving of 10-12% in heating bills (ServiceChannel, 2022). The benefits of using AI include:

- Predict Faults & Schedule Preventative Maintenance
- Reduce Energy Expenditure
- Identify Security Risks
- Smarter Reporting & Analytics

The savings calculated in the table are based purely on heating savings, but there would be countless further savings from more efficient management of resources and programming of maintenance.

The installation of sensors in the seat of the main lecture hall, linked to the BMS would allow the collection of data as to how many people are in the room. There is currently a 'clocking in' system, but it's used for registers and not linked to the BMS. Sensors would be more accurate as the clocking in system could be ignored. But anyone spending time in the room is likely to sit down. This data could be used to streamline the heating and ventilation energy usage and even predict patterns to prepare rooms for use ahead of time or turn off systems if classes were cancelled but FM hadn't been notified. Cost is calculated based on a basic £12 pressure sensor for seats x 460 seats.

No.	Recommendation	Savings			Cost	Payback
		£	Co2	Energy		
1	Change lighting to LED.	£6 p/a	5 kg CO2e Reduction	6W (vs 50W)	£7.50	1.5 years
2	Automatic lighting controls throughout building.	£1500	10.36 kg CO2e Reduction	26%	£300	5 months
3	Changing AC fan motors to EC. (Figures based on single unit operating for 8 hrs a day)	£0.78p	7.46 kg CO2e Reduction	21W (vs 60W)	£60	77 days
4	AI system to control and monitor services and energy use.	£6,262	4.154 kg CO2e Reduction	11%	£4.5k - £240k	On an average of the cost 19 years, based purely on heating savings.
5	Installation of sensors on seats in lecture hall	£6,262	4.154 kg CO2e Reduction	11%	£5,520	Immediate

6.0 Glossary of Terms

AHU – Air Handling Unit

BMS – Building Management System

CIBSE - Chartered Institution of Building Services Engineers

DEC – Display Energy Certificate

EMP – Energy Management Plan

ESOS - Energy Savings Opportunity Scheme

FMT – Facilities Management team

PIR – Passive Infrared

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