THE UNIVERSITY OF MANCHESTER – ALAN GILBERT LEARNING COMMONS (AGLC)

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the AGLC building is relatively moderate, though it indicates a high out-of-hours electrical baseload.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

AGLC CAFÉ POWER

The AGLC café consumes quite a large amount of power (when compared to other cafes on campus). This could be due to the facility being used by students across various hours of the day, however, particularly during pre-exam periods. Interestingly, the power consumption is much higher than the lighting consumption – typically, lighting is more significant than power consumption for non-lab buildings.

Power consumption starts around 06:00 on most weekdays but depending on the month, we do not see a decrease back to the average baseload level until 21:00. This profile has been demonstrated in the Figure. This may be another potential area to reduce electrical consumption. Additionally, power consumption remains high on weekdays and weekends; hence this space appears to be used seven days a week.

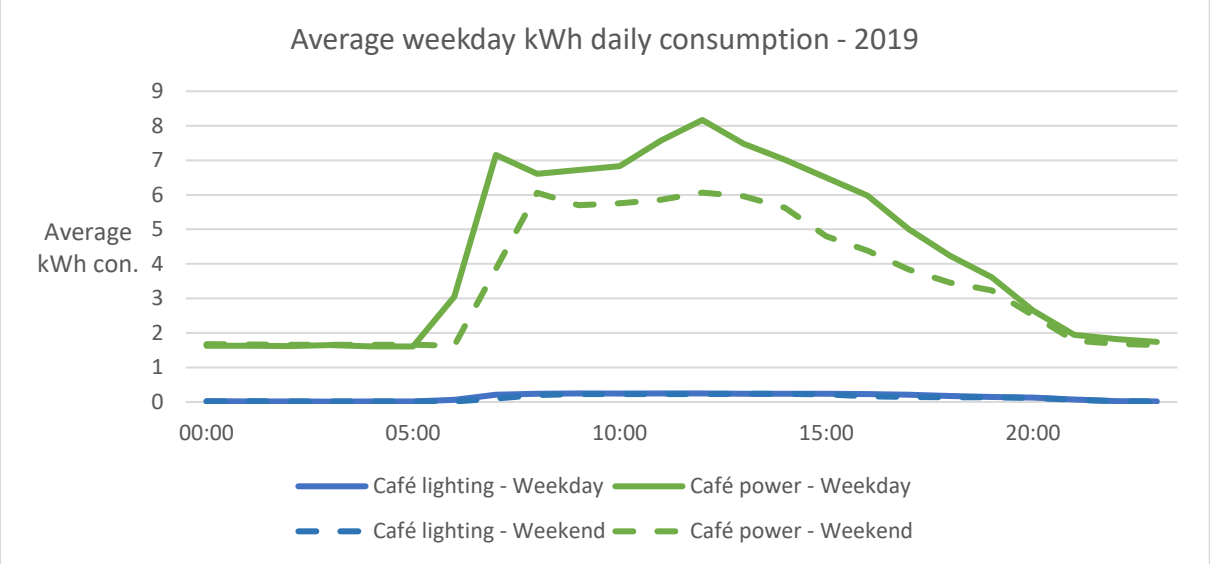

Figure 1: Average weekday and weekend performances for the AGLC building.

AGLC CAFÉ LIGHTING

As expected for lighting, it is a little sporadic during the year but is generally lower during the summer months. The distribution is relatively small and varies from 0-7 kWh per day. Lighting also appears to be left on late during the day. For the average Monday, lighting consumption does not decrease until 18:00 – 22:00, depending on the month. This may be one potential area of reducing electrical consumption.

KEY OBSERVATIONS

- The AGLC is one of the few modern library buildings assessed within the research, making it difficult to compare the data to other like-for-like buildings. However, the data provided from the AGLC demonstrates a highly used space. Weekdays and weekends demonstrate similar daily consumption profiles, indicating the space used throughout the week, as indicated in Figure 2.
- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020.
- As the out of hours baseload remains relatively high for the building, it is suggested here that computing equipment is likely being left on out of hours.
- The sub-metering within the building breaks down floor-by-floor power consumption and lighting consumption, allowing for a semi-detailed comparison of electrical consumption across the different floors of the building.

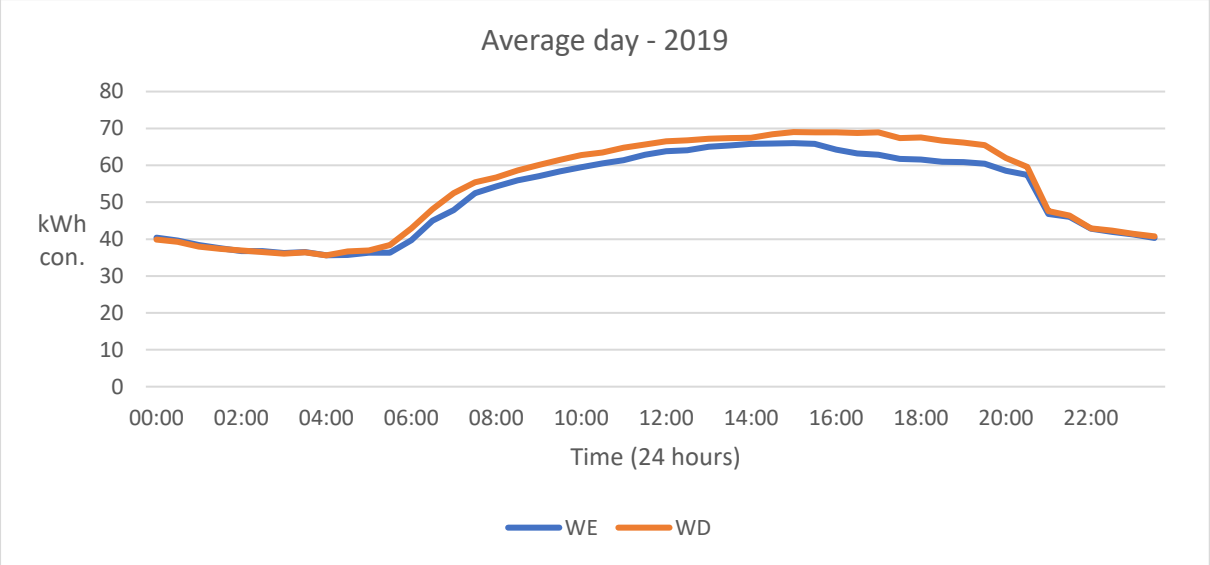

Figure 2: Average 2019 weekday daily consumption (WD) and average 2019 weekend daily consumption (WE) within the AGLC.

THE UNIVERSITY OF MANCHESTER – FERRANTI

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Ferranti building is relatively moderate. However, it indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

FERRANTI ROOM B23 DB HV CHAMBER

Out of all the rooms within Ferranti, the HV chamber is one of the most interesting. This is a variable, high consuming space, with readings ranging from 7-271 kWh per day, indicating a noticeable difference between weekdays and weekends. Whilst most months perform similarly, on average, May consumes the most. Finally, daytime consumption does not necessarily decrease substantially over out-of-hours periods (such as between daytime vs night-time consumption).

It would be beneficial to understand what caused the massive, sustained electrical consumption reduction on 11/11/2017 – 16/11/2017, as shown below. Annually, consumption goes from 95,192 (2017) to 34,683 (2019), as shown below.

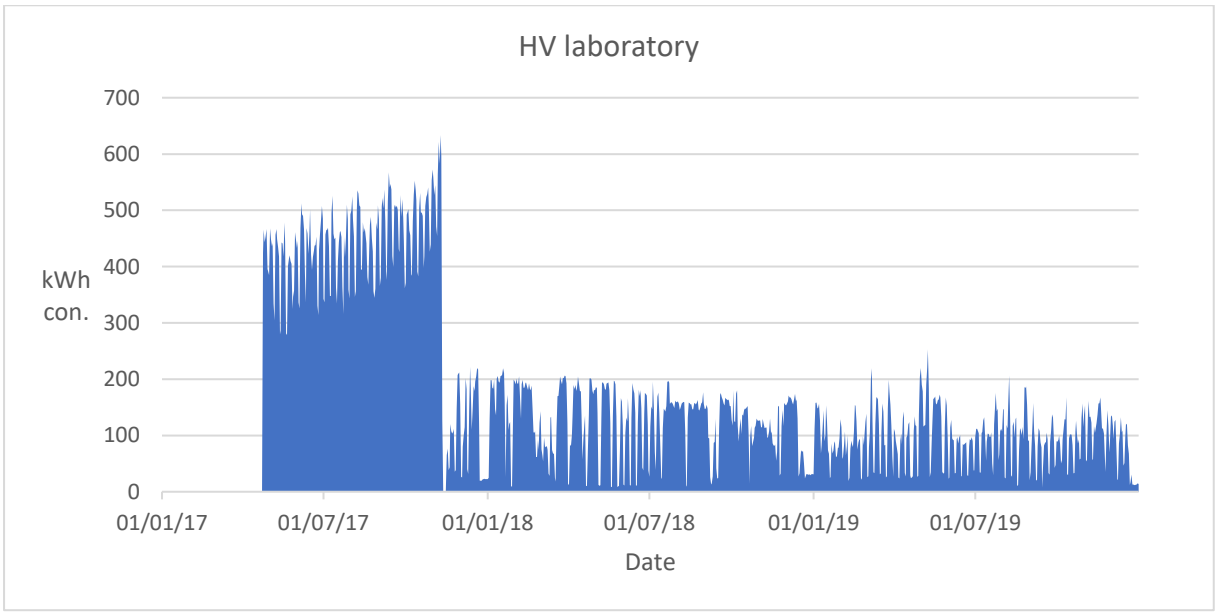

Figure 3: HV laboratory annual electrical consumption from 2017 – 2019.

KEY OBSERVATIONS

- In 2021, the building consumed 5.53% less electricity than in 2020. In 2020, the building consumed 28.40% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- The sub-metering within the building is quite limited, so breaking down electrical consumption within certain rooms in the building was a complex process. Using the sub-metering available, the breakdown of the sub-metering included:
    - Generic Distribution Boards – 36.81%
    - Busbar risers – 38.42%
    - Laboratory rooms – 24.43%
    - Lifts – 0.35%
- If they can be determined what these sub-meters refer to, more detailed analysis can be conducted: Ferranti Room B21 DB EMS$, Ferranti Room 21 DB EMt3, Ferranti Room A17 DB EMt1, Ferranti Room A17 DB EMS1.
- Considering Ferranti is predominantly a laboratory building, the electrical consumption is very low compared to other Manchester and other universities.
- Whilst overall annual consumption has slowly decreased over the years, average daily electrical consumption in the building is slowly increasing, as indicated below.

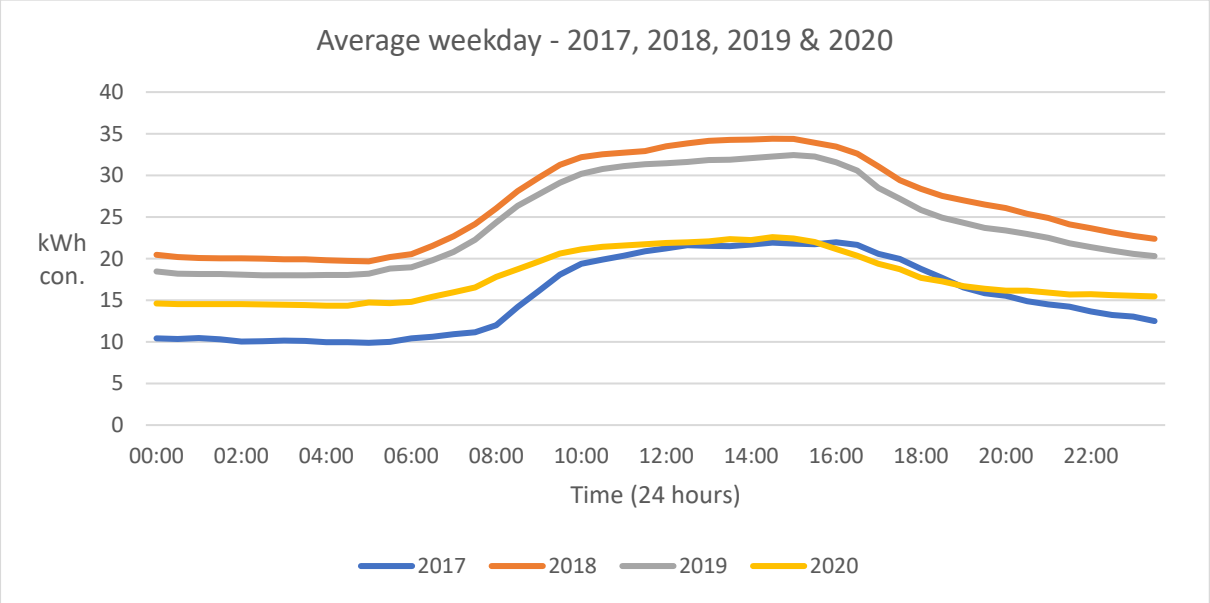

Figure 4: Average 2017 – 2020 weekday daily consumption within the Ferranti building.

THE UNVIERSITY OF MANCHESTER – GEORGE BEGG

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the George Begg building is significant, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

GB COMPUTER CLUSTER LIGHTING AND POWER

The daily consumption for the George Begg computer cluster lighting sub-meter (consuming, on average, 229kWh per day) is relatively high. There is some reduction in consumption for weekends compared to weekdays, yet the baseload for the room remains high. There was a significant reduction during the Christmas shutdown, suggesting the lighting was off during this time. Overall, for both the cluster's lighting and power, there was a considerable reduction in electrical consumption during the COVID-19 crisis, as indicated in Figure 5.

Regarding computer cluster power, the average daily consumption is high for a consumption cluster (consuming approximately 142 kWh per day). There is a high out-of-hours baseload for the cluster, steadily decreasing from 2017 to 2020. There is only a minor difference between weekdays and weekends for the computer cluster power. From the data, it is suggested that the computers are left on consistently across the day.

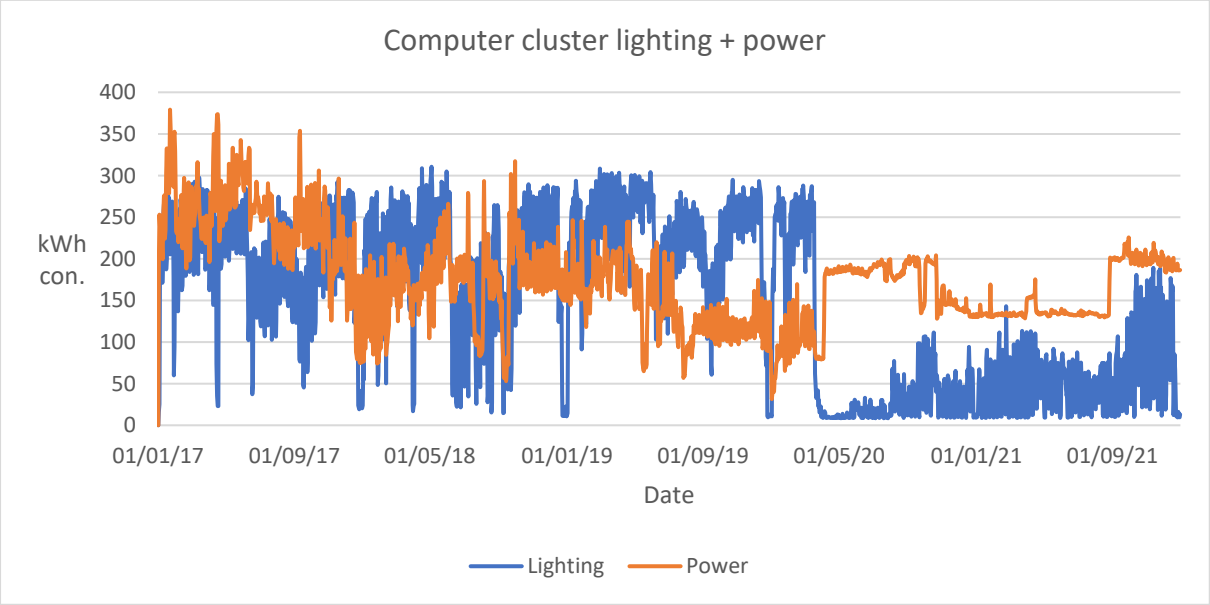

Figure 5: George Begg's computer cluster daily lighting and power consumption.

SUB-METERING WITHIN THE BUILDING

Generally, sub-metering within the George Begg building primarily relates to generic distribution boards, making detailed analysis on a room-by-room level difficult. For example, the following sub-meters could link to specific rooms; however, a further breakdown of electrical consumption from the sub-meter definitions alone is impossible. To alleviate this issue, it would be beneficial if the building's electrical distribution schematic were available for further analysis.

GB B1 DB SWB5
GB B2 DB B10/0205B

KEY OBSERVATIONS

- In 2021, the building consumed 20.74% less electricity than in 2020. In 2020, the building consumed 24.25% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- The cluster could act as an excellent sustainability study, as it remains one of the few computer clusters that measure both power and lighting consumption. There is also a substantial reduction in consumption between 2017-2019. If it is due to IT hardware changes, it will prove the difference energy-efficient equipment can have. If it is due to occupancy changes, it will demonstrate the benefits of reducing computer usage (only turning the computers to sleep mode when not in use).
- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020. This reduction in consumption is indicated in Figure 6.
- Weekdays and weekends demonstrate similar daily consumption profiles, indicating the space used throughout the week.
- As the out of hours baseload remains relatively high for the building, it is suggested here that computing equipment is likely being left on out of hours.

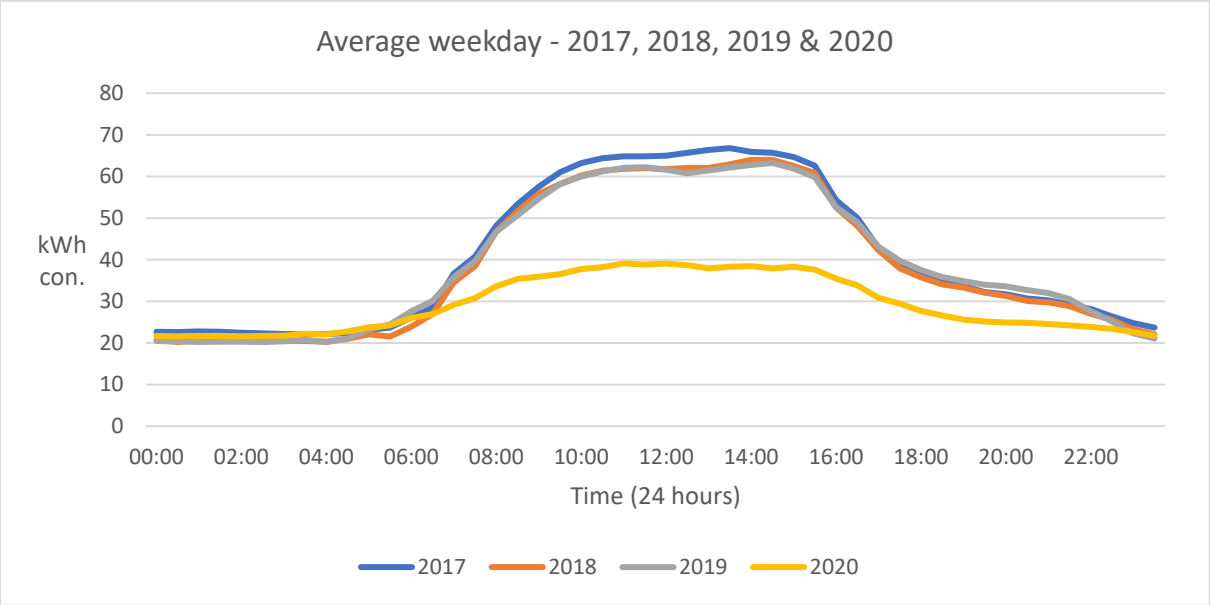

Figure 6: Average 2017 – 2020 weekday daily consumption.

THE UNIVERSITY OF MANCHESTER – KILBURN

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Kilburn building is significant, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

KILBURN CENTRAL RISER (W9 COMMS ROOM) (2.27 AND 2.77)

Initially, this was a comms room but has since been remodelled into a server room. This space also contains a large number of servers. In January-February 2019, some equipment was moved into the room, indicating a potential for an increase in electrical consumption from these dates onwards. There are also over 100 servers and two large AC units.

The Kilburn server room appears to be performing similarly to other server rooms at both Manchester and other universities. However, there was a clear increase in electrical consumption in February 2018 and a clear reduction in consumption in September 2021. The reasoning for these changes is currently undetermined.

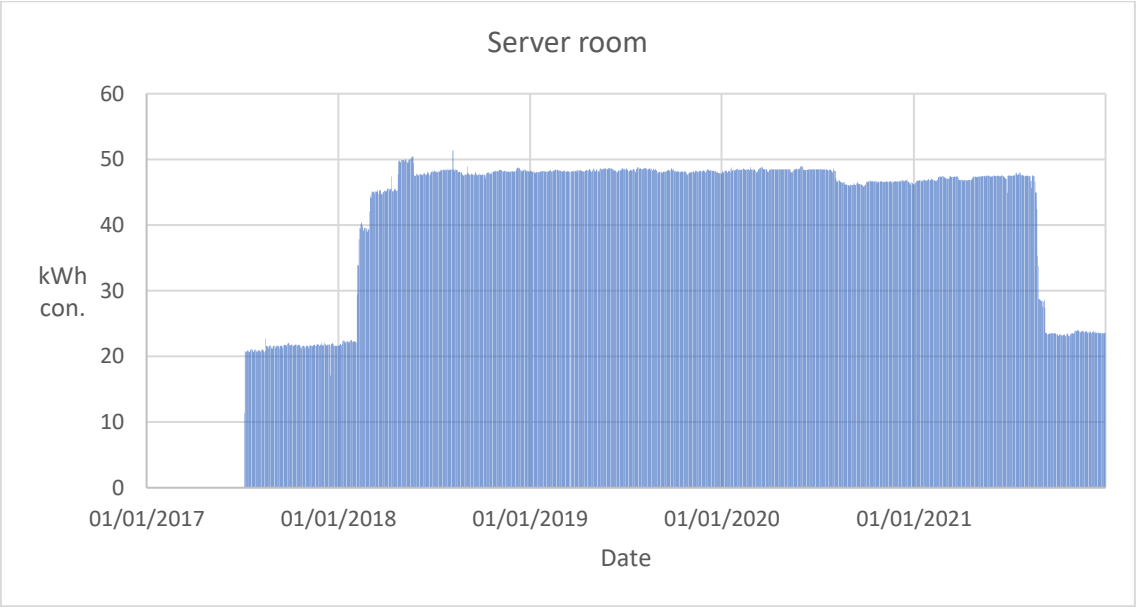

Figure 7: Electrical consumption within the server room.

KILBURN CENTRAL RISER (W10 COMMS ROOM)

This performs very differently from the previous sub-meter, where the baseload is small, and there are clear weekend and holiday decreases in the consumption. Based on the sub-meter name, it was assumed the room would be a comms room, however, the sub-meter is actually linked to a computer cluster.

Daytime consumption is high, but it appears that the equipment is being turned off during out-of-hours periods. This sub-meter feeds into rooms 2.52a and 2.52b, which is an office used by students. There are approximately 100 computers in the room, and this sub-meter may link into the fluorescent lights above.

Similar to other university computer clusters, there is a clear difference between daytime vs out-of-hours periods, as shown in Figure 8. Compared to other computer clusters within Manchester and other universities, the Kilburn computer cluster indicates a low electrical consumption baseload, and equipment is clearly turned off out-of-hours.

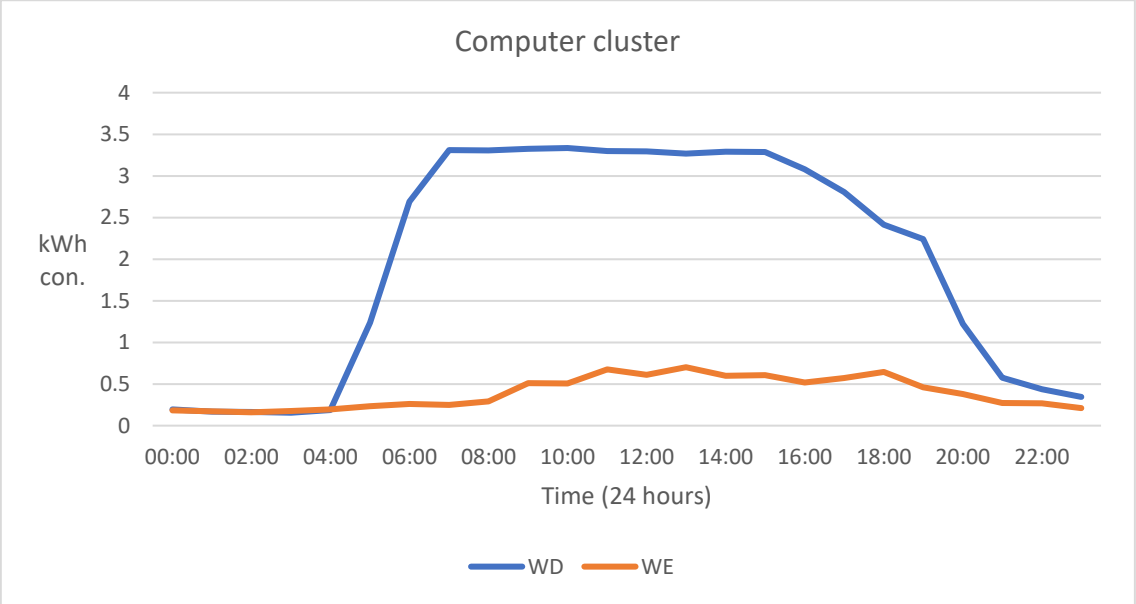

Figure 8: Average 2019 weekday daily consumption (WD) and average 2019 weekend daily consumption (WE) within the computer cluster.

KEY OBSERVATIONS

- Both the computer cluster and sever room appear to perform well compared to other buildings, considering the number of servers and desktop computers overall.
- The server room indicates an increase in consumption during summer 2020, compared to spring 2020. Considering the number of staff/students working from home, this is not too unexpected. However, there is only a slight reduction in the average daily consumption for the computer cluster during the same time.
- There is an issue with the building's virtual meter reading, as it indicates that the building consumes a negative amount of electricity in 2019 (indicated in the Figure 9). This error should be further investigated in order to rectify the reading.

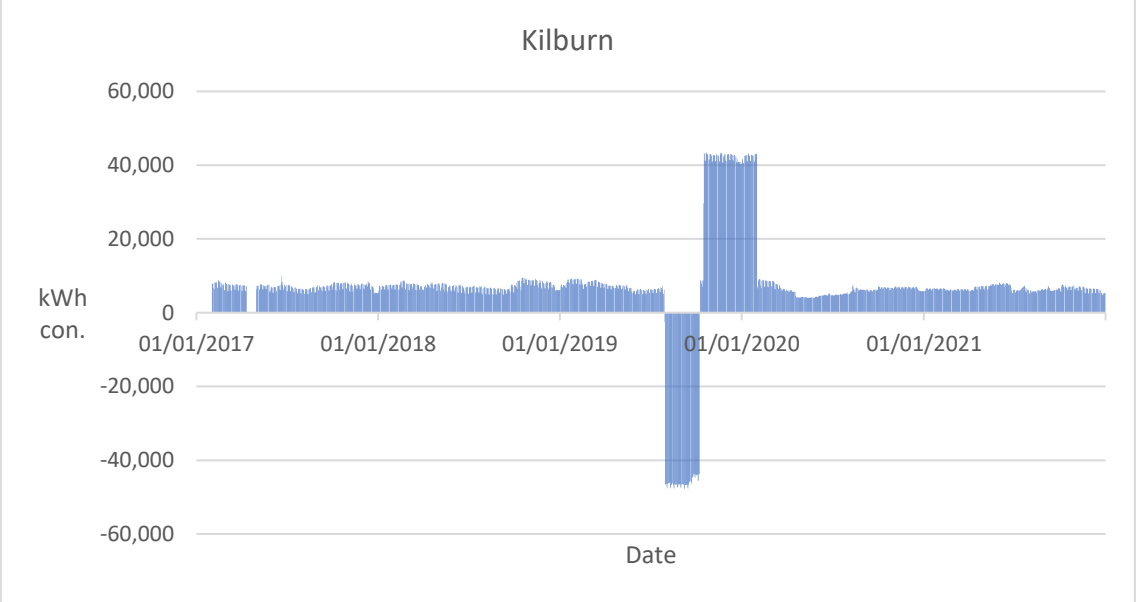

Figure 9: Kilburn's annual electrical consumption, from 2017 – 2020.

THE UNIVERSITY OF MANCHESTER – NATIONAL GRAPHENE INSITUTE

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the NGI building indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

OPEN PLAN 1

This room houses two sub-meters, both of which measure several types of equipment. Sub-meter 1 (S1) has a cryostat connected to it, hence why the electrical consumption measured by this sub-meter is so much higher than S2 readings. Comparatively, S2 measures other kit pieces and is mainly linked to small power loads. The consumption here is much lower than in S1.

There is a clear correlation between occupancy levels and electrical consumption within the room, as is indicated in Figure 10. There was a sizeable electrical consumption reduction across many laboratory rooms in the case study universities during the COVID-19 crisis.

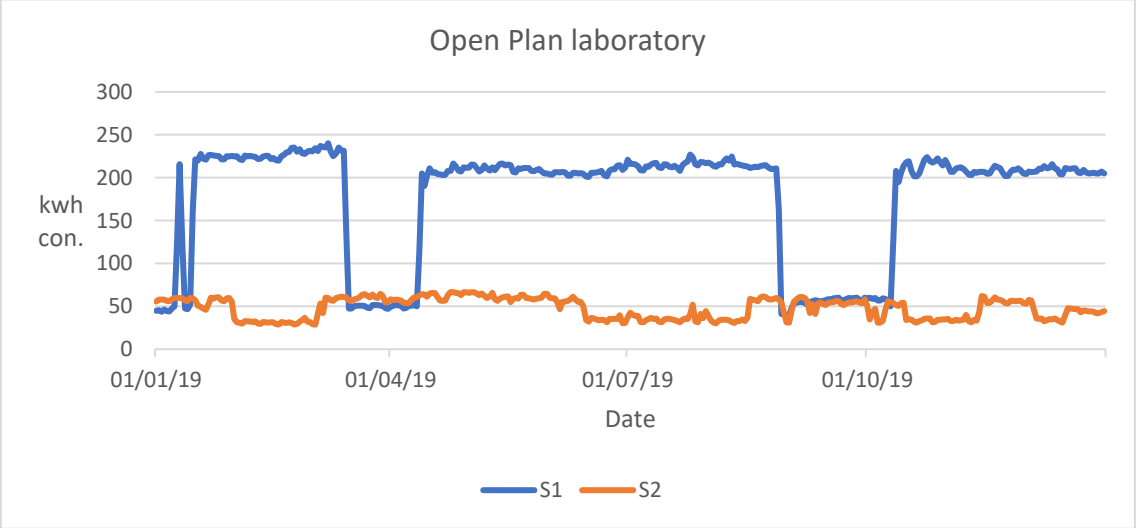

Figure 10: Electrical consumption in the Open Plan laboratory, comparing the two sub-meters within the room.

EM ROOM 2

This room is an electromagnetic control room (EMC). Inside the room, there is only one piece of kit, a cage, which is the only thing measured by the sub-meter. The room has the capacity for two three-phase sockets and two single-phase sockets. The kit in the room only uses the three-phase socket. Interestingly, there is little variability across a 24-hour period. This is the same for both weekdays and weekends, thereby suggesting whatever is used in this room is constantly on 24/7.

It is evident when the magnet inside the cage is turned on and off, as is demonstrated in Figure 11, which compares how different EMC rooms can perform. Currently, little information is known about EM room 1. For both rooms, however, there is not a clear correlation between daytime vs our-of-hours electrical consumption compared to other laboratory rooms across campus.

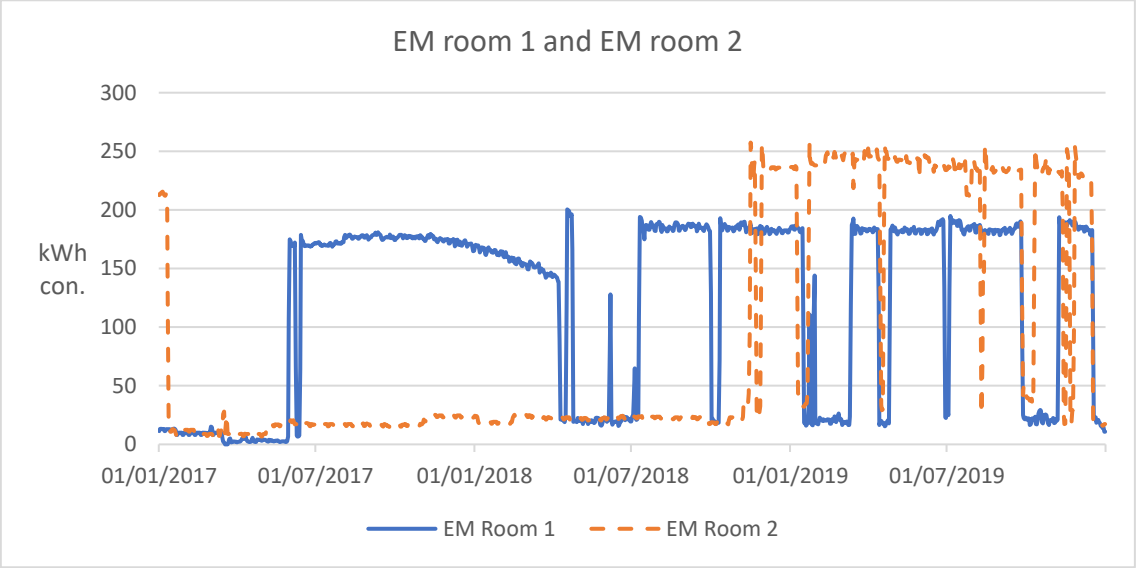

Figure 11: Electrical consumption comparison between two NGI laboratories (EM room 1 and EM room 2).

RESEARCH LABORATORY 4

This laboratory is defined as an Energy lab. As part of the equipment in the room, there are three fume hoods running on single-phase sockets. From August 2017, there was a significant increase in consumption (that remained consistent until 2020). The building manager stated this was due to the room changing from a composite lab to an energy lab, and the room's occupants changed (the group using the room changed). Across the dataset, there is little variety, even across weekends and holiday periods. Either this space is used consistently across the year, or equipment is not being turned off across this space. This measures equipment consumption and lighting consumption; potentially, there may be a possibility to reduce unregulated consumption in this space.

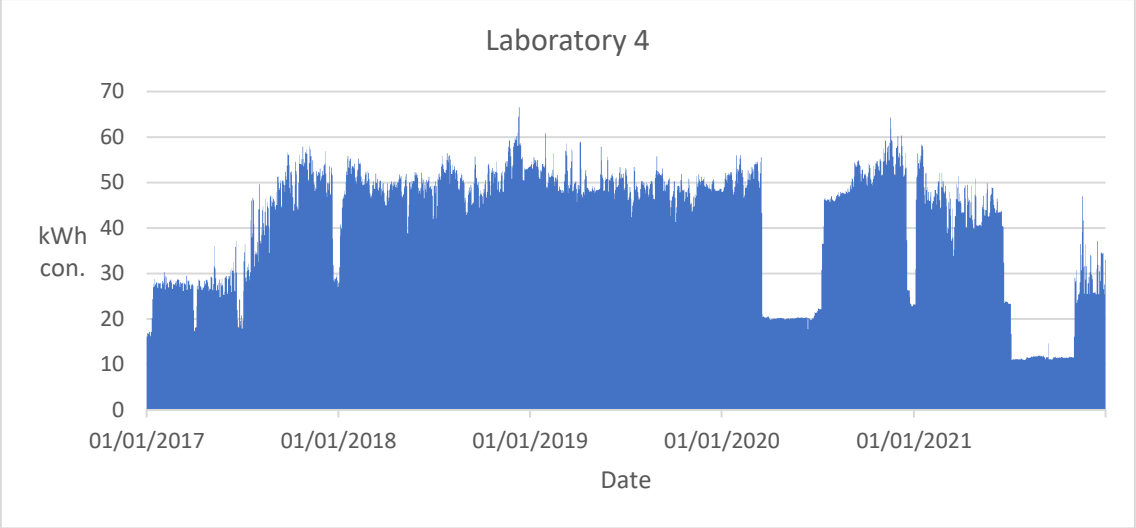

Figure 12: Electrical consumption in Laboratory 4.

RESEARCH LABORATORY 6

This room acts as an industrial partner lab and has low occupancy usage. There are numerous low-level desktop instruments and one single-phase fume hood. Similar to Laboratory 4, there is a correlation between occupancy levels and electrical consumption, as electrical consumption is lowest during Christmas breaks and the COVID-19 crisis.

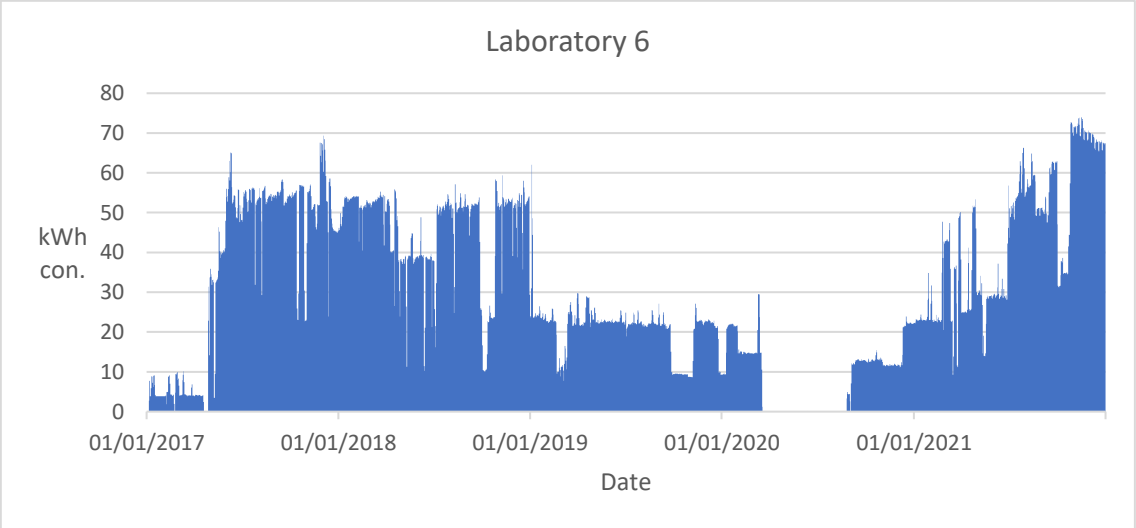

Figure 13: Electrical consumption in Laboratory 6.

RESEARCH LABORATORY 1

Inside the room, there is numerous low powered equipment, such as benchtop 13A atom force microscopes. Most equipment in the room is single-phase equipment, and there is a single piece of three-phase equipment.

Over the last couple of years, a 16A three-phase cryostat was also installed. There is a singular, massive reading on the (22/11/2019-25/11/2019); average daily consumption during this time was approximately 162 kWh per day. Usually, it is only approximately 10 kWh per day. The reasoning for this reading was determined to be a sub-metering error. Another error is noticed at 16/03/2021-24/03/2021, where the days offer readings of 55,297,500,189 kWh and 80,802,500,197 kWh, respectively. After these dates, the room's sub-meter appears to be turned off or malfunctioning.

It is suggested here that the sub-meter be checked, as this singular reading vastly changes how much electricity the room is assumed to consume, as indicated in Figure 14. Once these incorrect readings are removed, the room consumes

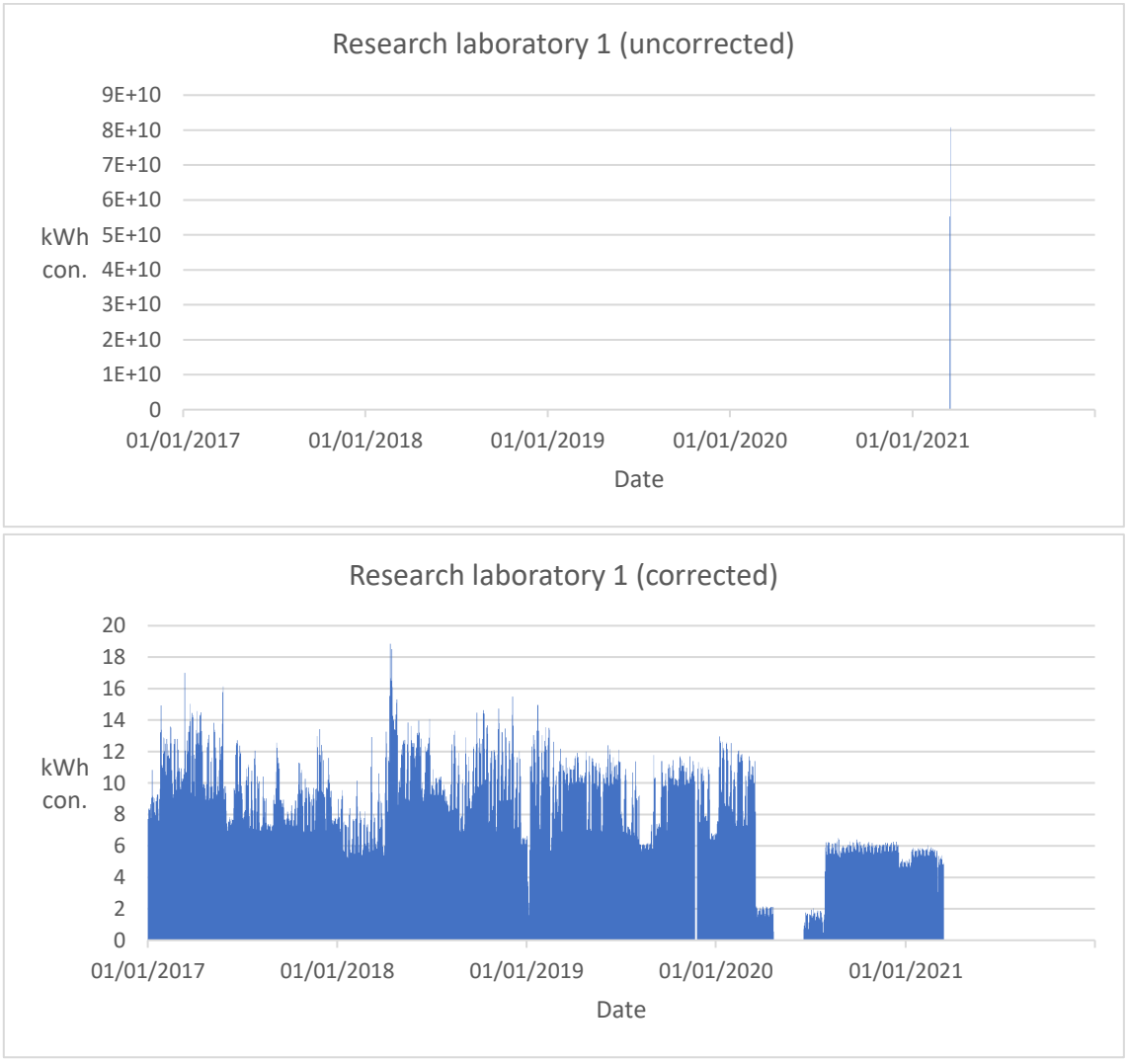

Figure 14: Uncorrected and corrected electrical consumption in Research laboratory 1.

KEY OBSERVATIONS

- In 2021, the building consumed 9.56% more electricity than in 2020. In 2020, the building consumed 8.28% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- Certain labs continue to have a high constant out-of-hours baseload (e.g., Lab 4, for example).
- The level of detail provided by the building manager was exquisite, and Graphene hence represents the building with the best contextual data.
- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020.
- Weekdays and weekends demonstrate similar daily consumption profiles, indicating the space used throughout the week.
- As the out of hours baseload remains relatively high for the building, it is suggested here that equipment is frequently left on out-of-hours. This is partially demonstrated in Figure 16, indicating a high electrical baseload in the building across the last four years.

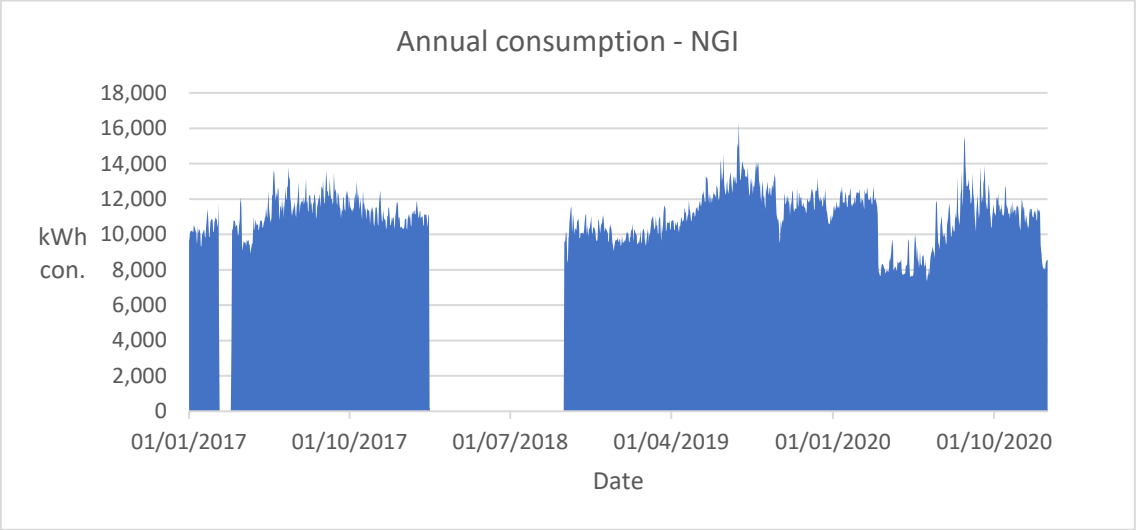

Figure 15: Annual electrical consumption, from 2017 – 2021, within the NGI.

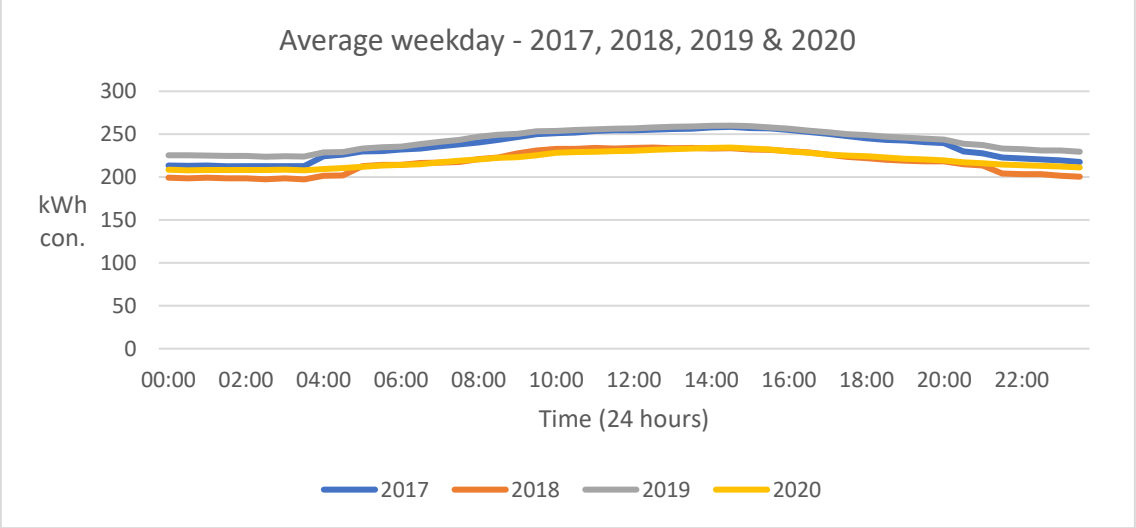

Figure 16: Average weekday electrical consumption, from 2017 – 2020, within the NGI.

THE UNIVERSITY OF MANCHESTER - MCRC

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the MCRC building is significant, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy. As there are many sub-meters within the building, this report only focuses on rooms representing the building or particularly interesting data. For the MCRC, the last two digits of the sub-meter codes have been included (in order to identify which sub-meters are being discussed in each section).

CATERING FACILITIES

S60 - GF café power & 61 - GF café LTG:

The baseload power consumption for this room is moderate, and general consumption is consistent across the year. Across both sub-meters, annual, weekday and weekend consumption patterns are practically the same. There is also a high constant baseload; however, the profile suggests consumption similar to the power reading sub-meter.

S62 - (GK1) Kitchen:

The 2019 consumption patterns are more sporadic, with a noticeable difference between weekdays and weekends. There is also an apparent reduction during the Christmas break, suggesting there may be a specific switch-off routine for this space. The daytime consumption is much more pronounced than the out of hours consumption, so this space is used for only a small amount of time.

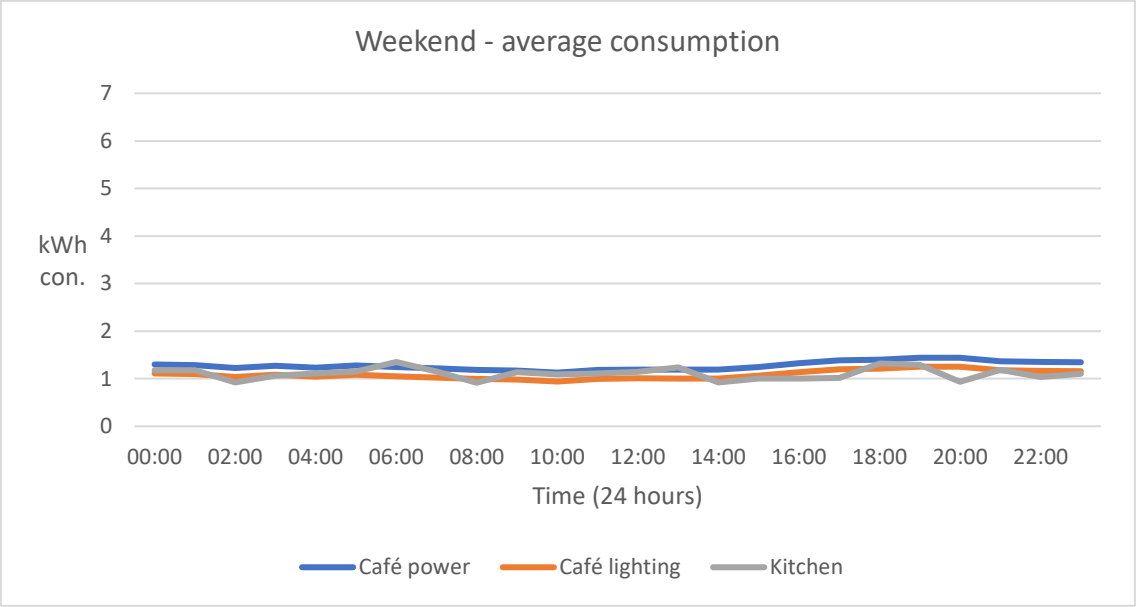

Figure 17: Average weekday and weekend consumption for the MCRC catering facilities (calculated using 2019 data).

GENERAL LABS

104 - GL4 FF GENERAL LAB POWER:

This is a fairly standard room, with apparent weekend decreases and consistent weekday consumption patterns. Typical daily distribution values vary, but most range from 31 - 36 kWh, indicating a relatively low-consuming laboratory.

36 - GL3 POWER:

This sub-meter is variable, where the weekday consumption varies a lot and weekend consumption is generally low. Evening average consumption is also high.

40 - (gl1) GENERAL LAB 1 PWR (125/5):

The patterns here are similar to the previous sub-meter, with similar peaks and troughs. The daily distribution ranges are smaller, and consumption is also lower. It was suspected, for a lab, that the consumption would be higher, so this might only measure single-phase equipment. The daily distribution is somewhat odd, where consumption increases at 08:00 and only decreases at 20:00 - 21:00.

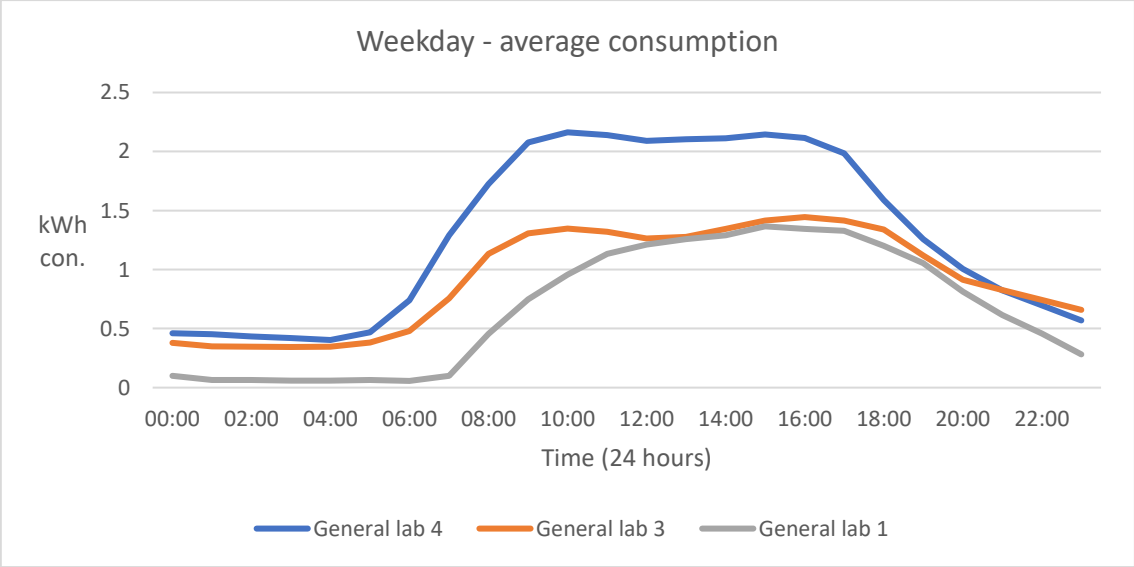

Figure 18: Average daily consumption (using 2019 data) for the three general laboratories.

-80C FREEZERS

107 - ESF -80 FREEZERES:

This is a high-consuming space, similar to the other -80 freezers spaces. There is little to no annual variation for this space, and across weekdays and weekends, there is a constant baseload of approx. 4kWh. The constant baseload is typical for a -80C freezer space.

38 - (E3F) -80 FREEZERS:

The 2019 annual consumption is slightly smaller than that of the previous sub-meter – most likely, this space is smaller than the first sub-meter, or there is less equipment measured under this sub-meter. There is no difference between weekdays and weekends average consumption – again, this is not particularly surprising (as expected that -80C freezers consume consistently).

39 - (E3F) -80 FREEZERS:

This is a reasonably high-consuming room with an average daily reading of 93 kWh per day. It is remarkably similar to the first EF -80 freezer in that sense. There is a slight annual variation, except 23rd - 24th July 2019, where there's a noticeable peak (the daily readings here are 131 kWh and 120 kWh, respectively).

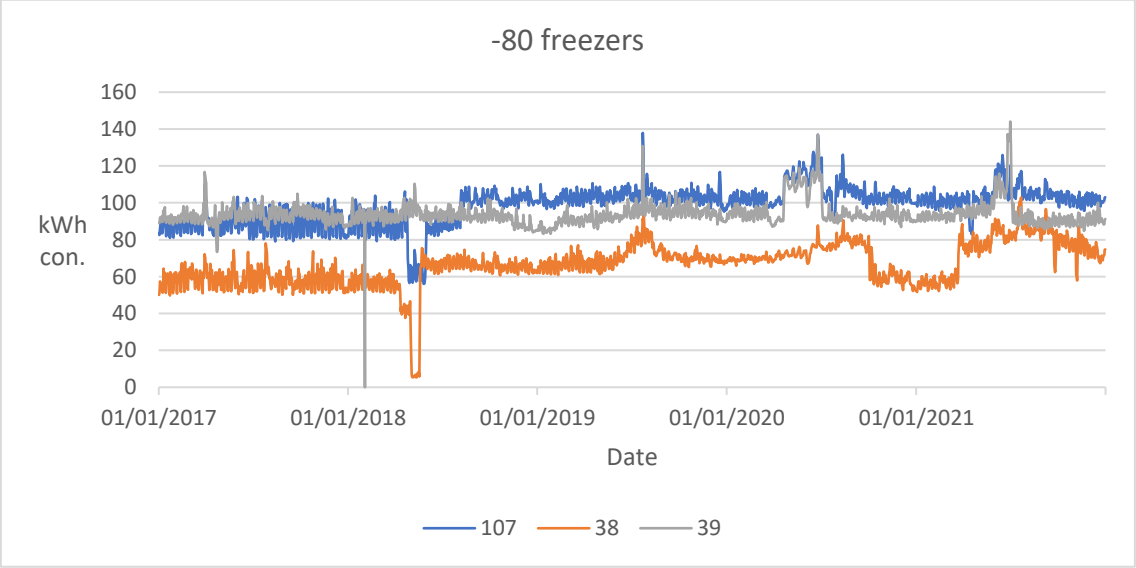

Figure 19: Daily consumption for the -80 freezers.

AUTOCLAVES

69 - AUTOCLAVE 2 150/5:

The 2019 annual dataset is relatively variable, where there's a clear distinction between weekdays and weekends. However, there are no noticeable reductions across holiday periods (e.g., there is no noticeable decrease during the Christmas break). During holiday periods, it is suspected that equipment might be left on in this space. The average weekday consumption also is contained within typical work-hour periods. For example, consumption increases from around 09:00 and decreases back to the baseload at 16:00.

70 - AUTOCLAVE 1 150/5:

Interestingly, this performs quite differently than the previous autoclave room. While the baseload is about the same (approximately 1.2 kWh), there is more annual variability. Across the year, there is an apparent increase in consumption on Thursdays compared to the rest of the week. Additionally, from the end of January to mid-April, there is a noticeable increase in consumption in the room.

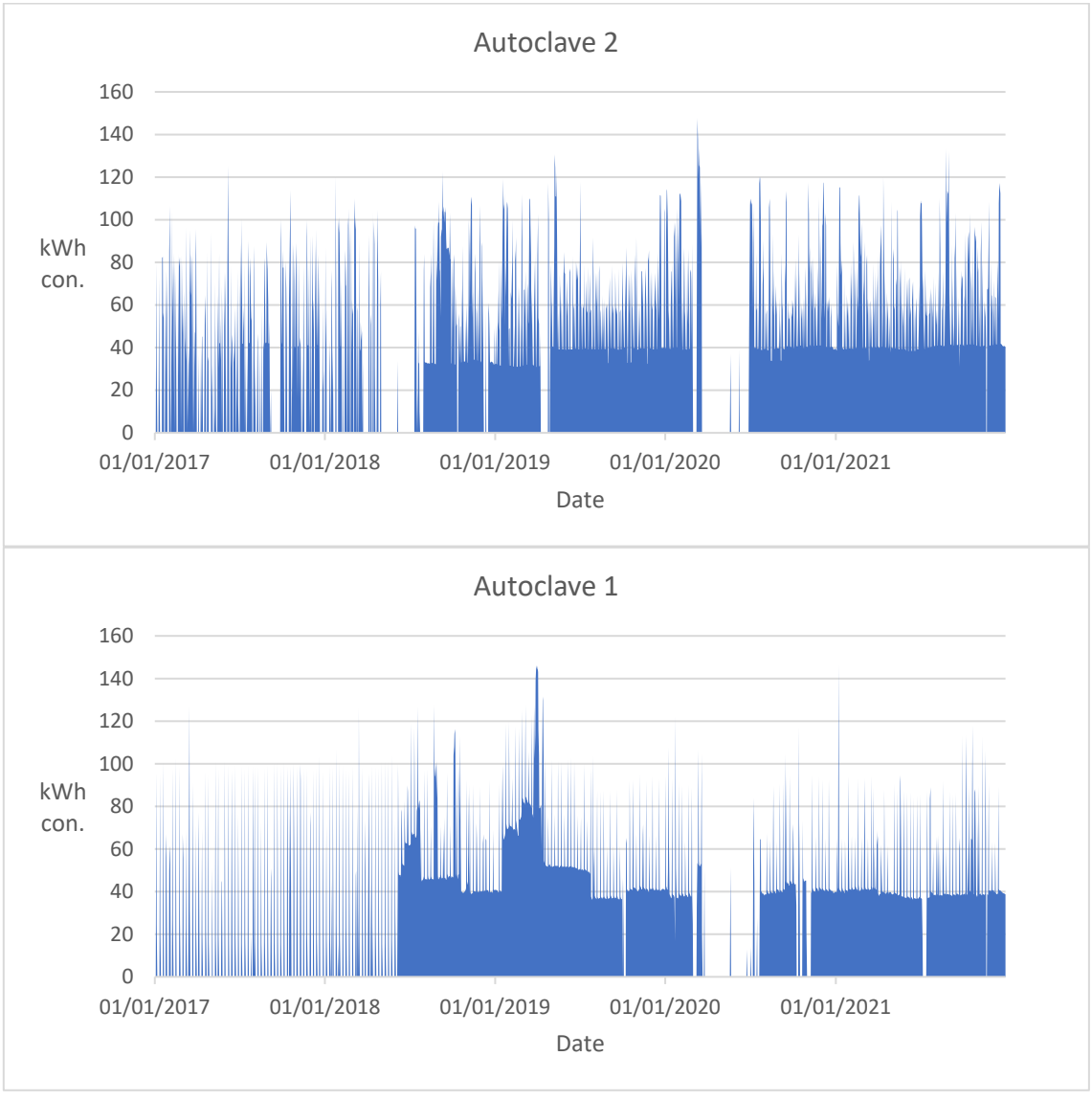

Figure 20: Daily consumption in the two autoclave rooms.

KEY OBSERVATIONS

- In 2021, the building consumed 15.10% more electricity than in 2020. In 2020, the building consumed 13.88% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- For the MCRC, it is difficult finding out what rooms link to what when comparing Coherent and the floorplan data. The Estates should aim to align the two databases more clearly.
- Generally, for a lot of the sub-meters, there is not a clear difference between weekdays and weekend consumption. I recommend that the Estates assess how to reduce weekend consumption on a building-wide level, e.g., a building-wide sustainability competition.
- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020.
- Weekdays and weekends demonstrate similar daily consumption profiles, indicating the space used throughout the week.
- As the out of hours baseload remains relatively high for the building, it is suggested here that equipment is likely being left on out of hours.

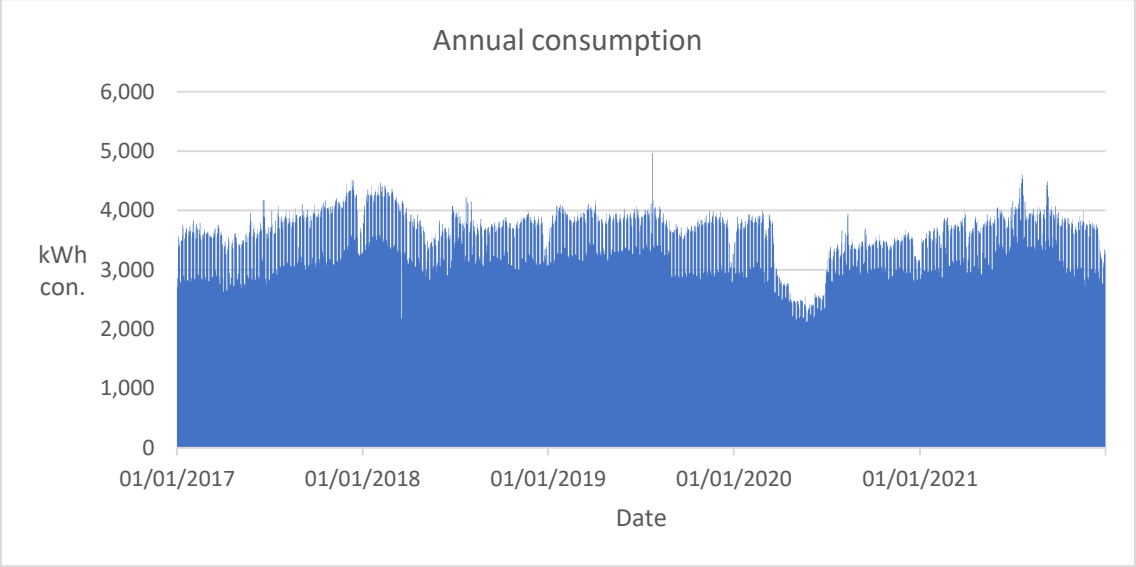

Figure 21: Annual electrical consumption, from 2017 – 2021, within the MCRC.

THE UNVIERSITY OF MANCHESTER – PARISER

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Pariser building is significant, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

PARISER WORKSHOPS LV SWITCH A6 CONCRETE LAB

This sub-meter has a small electrical baseload and indicates clear peaks and troughs within the data, indicating a correlation between out-of-hours periods and a reduction of electrical consumption. The sub-meter is primarily used within the daytime (e.g., most equipment is turned off during out-of-hours).

Comparing weekdays and weekends, the building indicates a significant reduction in electrical consumption across weekends, as indicated in Figure 22. This pattern was noticed to also occur during other years, not just across the 2019 dataset.

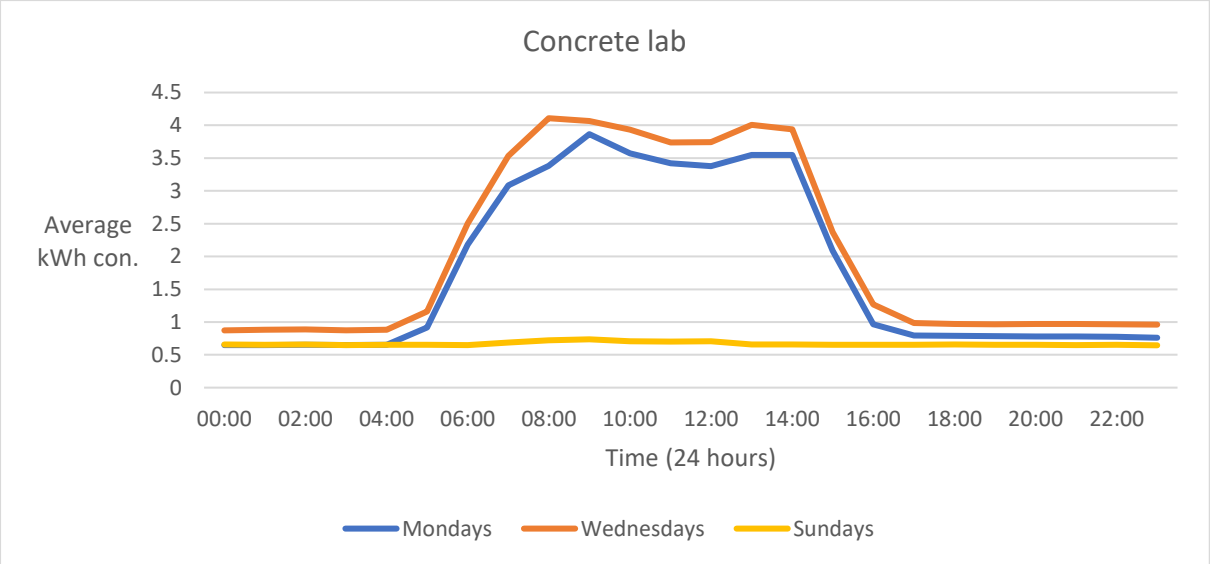

Figure 22: Average weekday consumption within the Concrete lab, using 2019 data.

PARISER WORKSHOPS LV SWITCH A7 STRENGTH SHOP

There are noticeable differences between weekdays and weekends, and there is also a significant drop in consumption during the Christmas break. Certain months have a high out-of-hours baseload, such as November, March, December, and October. It is suggested here it may be due to a change in occupation or a change in types of equipment used. As with the building's other sub-meters, there is a substantial reduction in electrical consumption during the COVID-19 crisis, as shown in Figure 23.

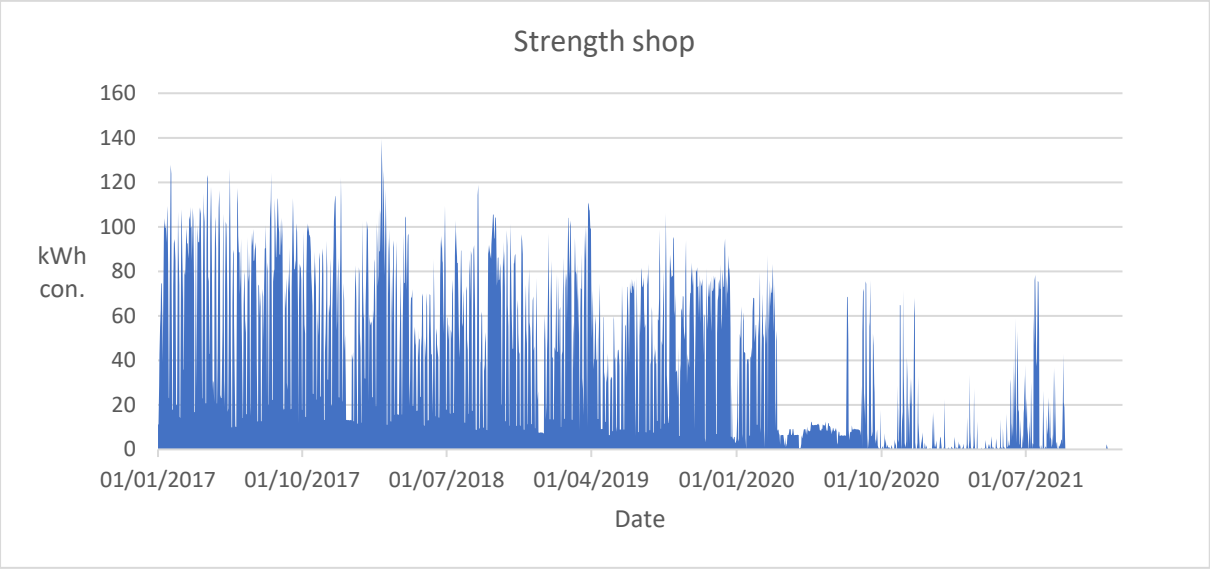

Figure 23: Daily consumption within the Strength shop.

PARISER WORKSHOPS LV SWITCH A8 WELDING SHOP

There is a relatively moderate constant baseload across the year, with only a small difference between weekdays and weekends. On 12/11/2019 - 13/11/2019, the consumption was much higher for no apparent reason (50 - 41 kWh per day, respectively). Similar to the Strength shop, there is a clear correlation between electrical consumption and occupancy of the room, as electrical consumption substantially decreased during the COVID-19 crisis.

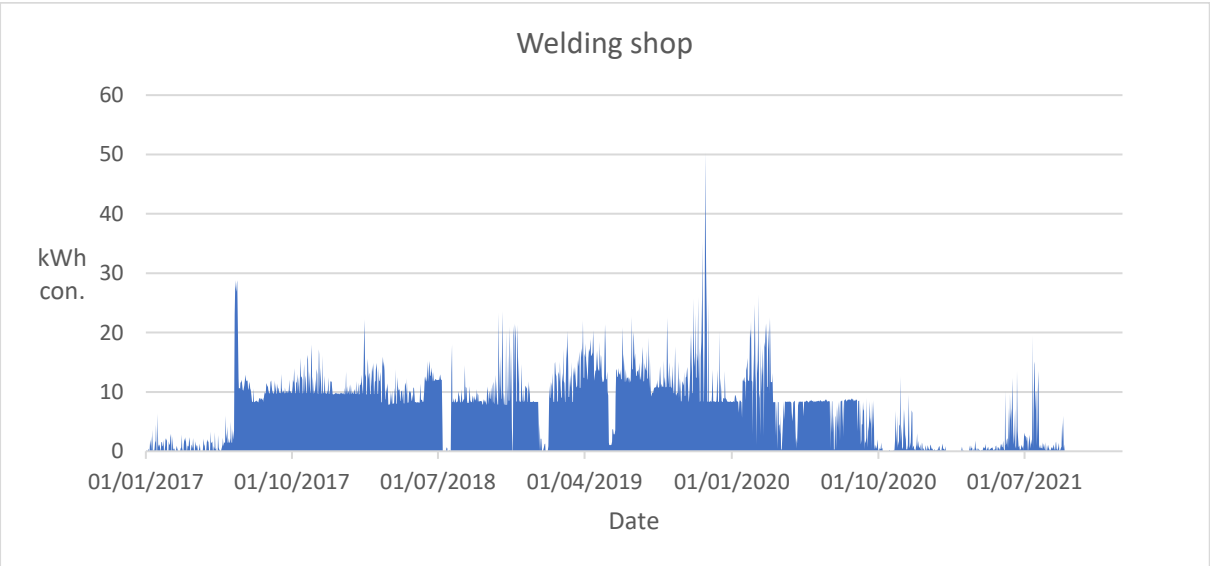

Figure 24: Daily consumption within the Welding shop.

KEY OBSERVATIONS

- In 2021, the building consumed 4.79% more electricity than in 2020. In 2020, the building consumed 21.50% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- The welding shop sub-meter offers much lower readings compared to other workshops; also, for the welding shop, it would be beneficial to understand why consumption substantially increases between 12/11/2019 – 13/11/2019. This may be a sub-metering error or may indicate the space was highly used for these two days.
- For the workshops, there is a noticeable reduction across weekend consumption and holiday-time consumption. As a result, the sub-meters indicate the rooms are performing well.
- There are a lot of sub-meters within Pariser that are not linked to specific rooms/floors, thereby making a detailed analysis of the building difficult.
- Overall, the building indicates a substantial consistent electrical baseload out-of-hours, suggesting large volumes of equipment are left on out-of-hours.

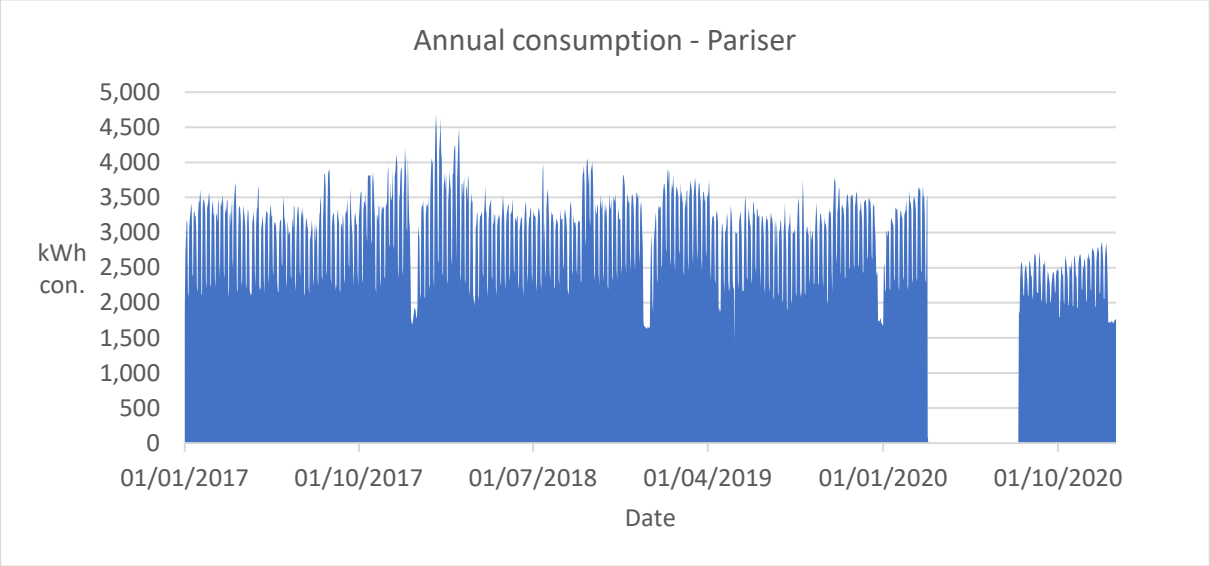

Figure 25: Annual electrical consumption within Pariser from 2017 – 2020.

THE UNIVERSITY OF MANCHESTER – SCHUSTER

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Schuster building is significant, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

SERVER ROOMS

Across the two server rooms in Schuster, the data suggests high-consuming but highly stable electrical consumption patterns. Compared to other server rooms on campus, the readings for these two server rooms suggest higher kWh figures than initially anticipated.

Unlike other types of rooms, there is not a particular correlation between occupancy levels and server room electrical consumption data. This was particularly evident during the COVID-19 crisis, where both servers consume similarly to pre-COVID levels, as indicated in Figure 26. Additionally, there is no major weekday vs weekend vs holiday period variability; no variability is expected for server rooms, so this performs as expected.

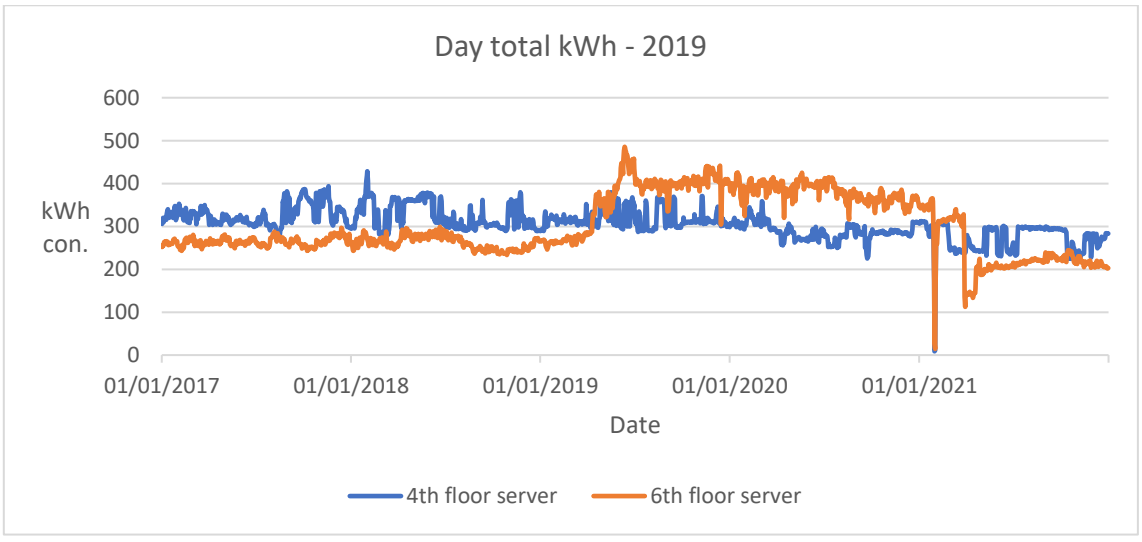

Figure 26: Electrical consumption for the two server rooms.

H1 KITCHEN

This is a low-consuming room, where the baseload is low, there are apparent weekend reductions, and during 2019 there is a massive reduction around September 2019. During 2020, the kitchen consumption goes from an average of 0.93 kWh per day to 0.04 kWh. This reduction has been consistently sustained, even though the building has been re-occupied for a considerable amount of time. It is suggested here that the H1 kitchen may not have been frequently used since the beginning of the pandemic or that pieces of equipment may have been removed from the kitchen.

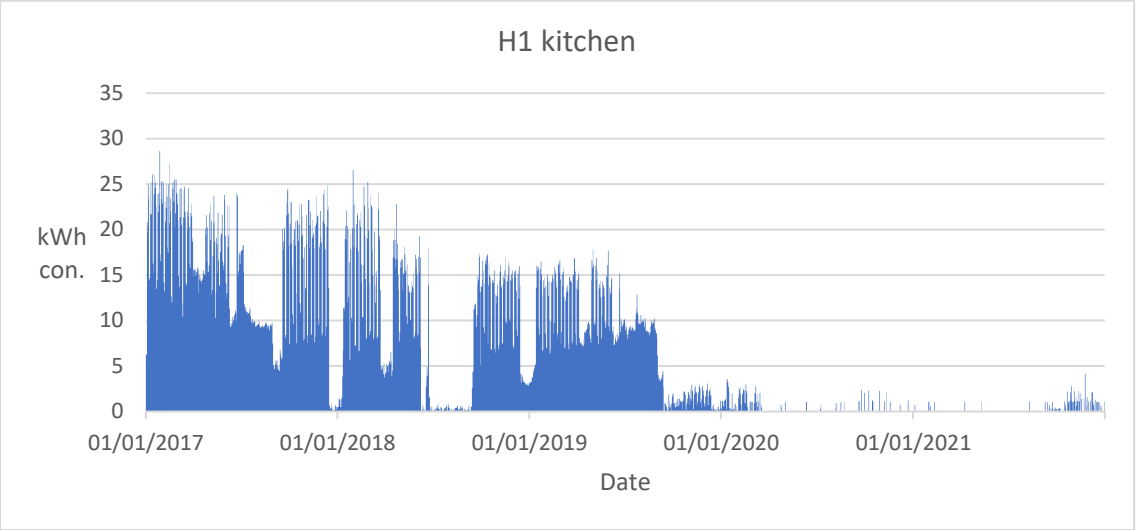

Figure 27: Daily consumption in the H1 kitchen.

LECTURE THEATRE J

The annual consumption is surprisingly high for a lecture theatre, and the baseload is high (the average daily consumption is 176 kWh per day). This consumption is much larger than for other lecture theatres; hence there is a possibility this sub-meter also measures HVAC, as the electrical consumption within the space is much more substantial than in other, similarly-sized lecture theatres.

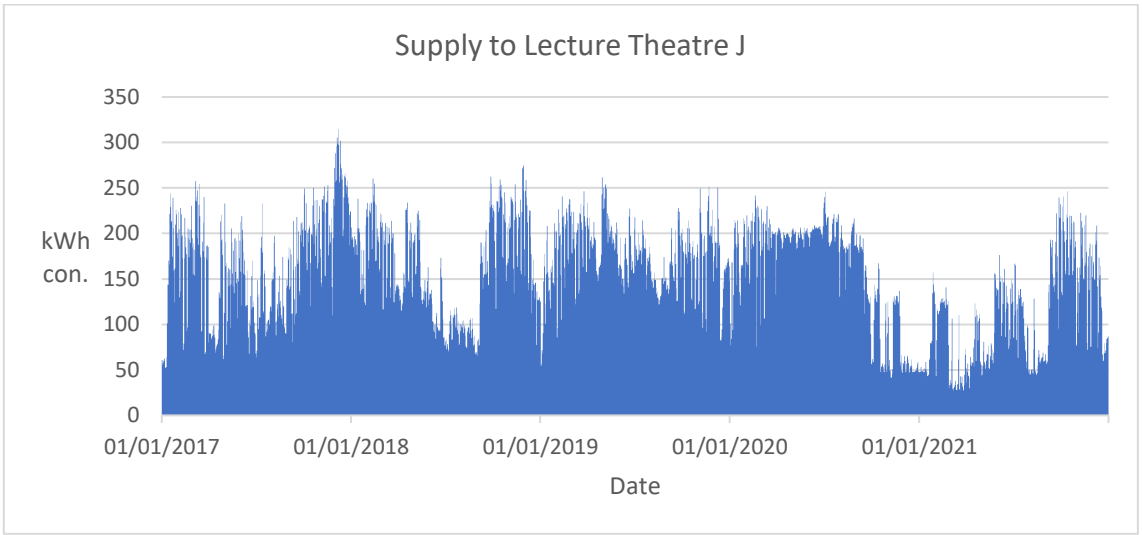

Figure 28: Daily consumption for the supply to Lecture Theatre J.

KEY OBSERVATIONS

- In 2021, the building consumed 14.57% more electricity than in 2020. In 2020, the building consumed 15.66% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis.
- In terms of baseload electrical consumption, the building consumes a substantial amount of electricity. This is comparable to other laboratory buildings, however.
- The supply to lecture theatre J is a much higher consumption than it should be, assuming it should just measure power or lighting. It is hypothesised here that this sub-meter likely measures multiple spaces rather than just the theatre. Alternatively, it may also measure power, lighting, and HVAC rather than just power.
- Both the server room consumption profiles are larger than other server rooms on campus. However, they perform more or less how typical server rooms should perform.
- As the building breaks down floor-by-floor power consumption, an electricity reduction campaign could ask people to switch off unnecessary equipment. This could work on a percentage reduction or a kWh reduction basis.
- For many rooms and floor-by-floor consumption sub-meters, weekdays and weekends consume a similar amount. Hence, equipment appears to be being left on; a sustainability campaign targeting weekends may be beneficial.

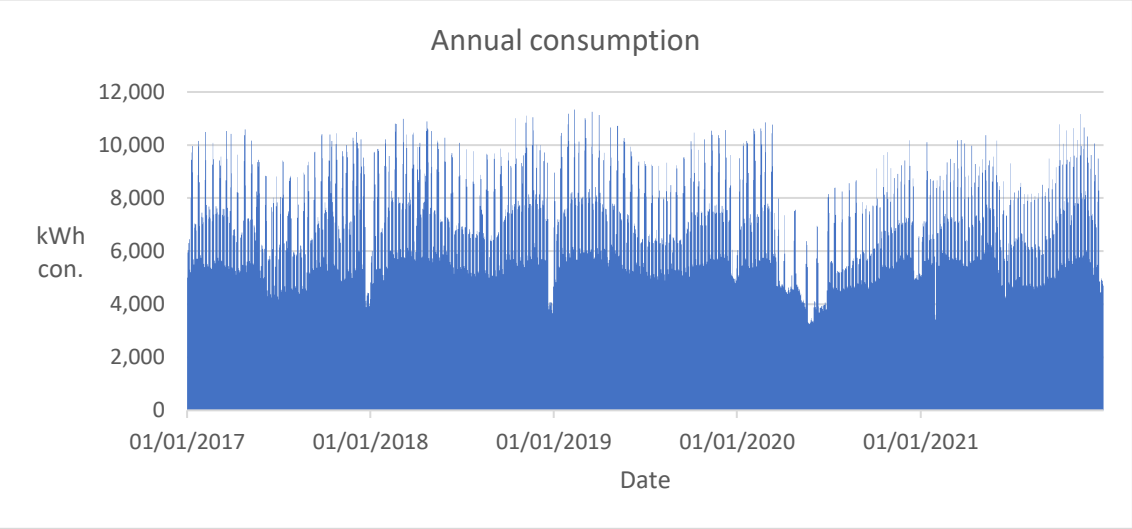

Figure 29: Annual electrical consumption, from 2017 – 2021, within Schuster.

THE UNIVERSITY OF MANCHESTER – SIMON

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Simon building is relatively moderate and indicates a high out-of-hours electrical baseload.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

BENUGO (POTTER'S CAFÉ)

This is a high consuming space but performs similarly to other cafes across the other universities. Generally, consumption is very high from January until the middle of April, before a massive drop-off point until May. This reduction is likely due to lower occupancy numbers (as fewer students are in the building). The rest of the year performs normally, and weekend consumption is much lower. The baseload consumption varies high out of hours, from 0-7kWh, suggesting that some equipment may be left on overnight. To demonstrate this, Figure 30 indicates the vast differences between weekday and weekend consumption.

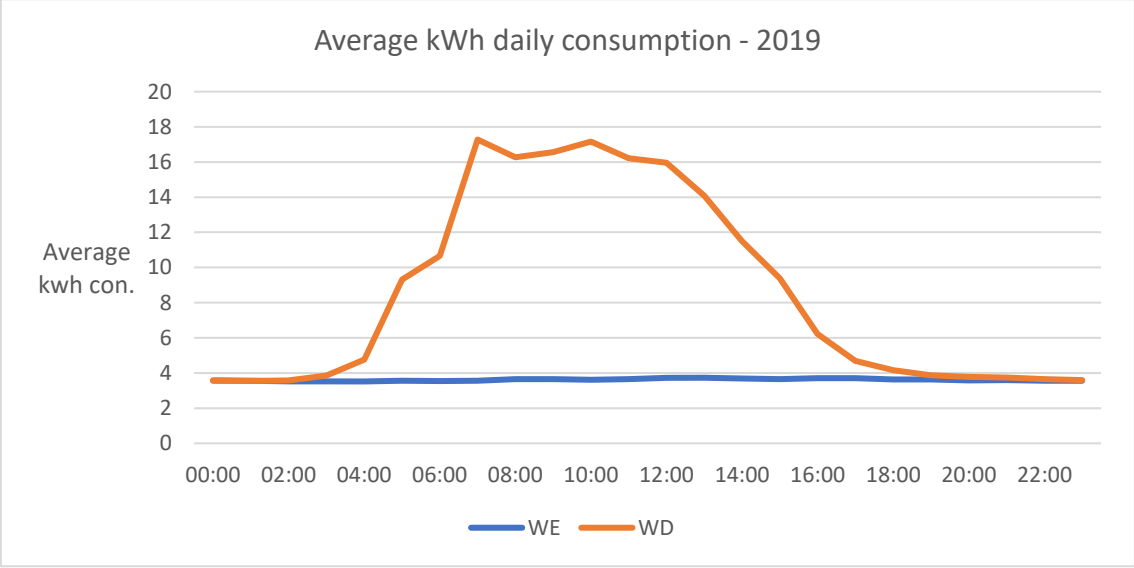

Figure 30: Average daily consumption (using 2019 data) for the BENUGO café.

THEATRE A LIGHTING + POWER 66/0570:

The consumption in this space is surprisingly constant during 2019, and the space is mainly used from mid-January-April, then August-mid-December. There has been an assumption made that the space contains AV equipment and that lighting and small power loads are being measured under this sub-meter.

The average weekday performs pretty similarly to the average weekend due to a moderate constant baseload (on a typical weekend, there are no peaks/troughs in the data, just a constant baseload). Compared to other lecture theatres on campus, this theatre has one of the highest average daily elegiacal consumption values.

There is also a clear correlation between occupancy levels and electrical consumption, as indicated in Figure 31. During weekends and the COVID-19 crisis, there is an apparent reduction in electrical consumption – this pattern has been replicated in other lecture theatres across other universities as well.

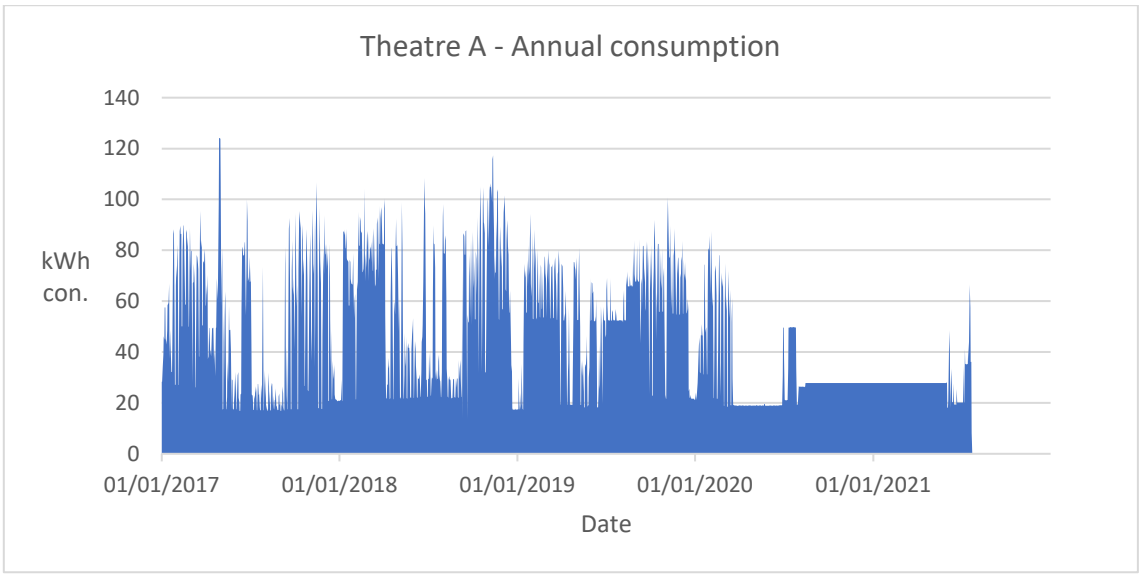

Figure 31: Electrical consumption within Theatre A.

KEY OBSERVATIONS

- In 2021, the building consumed 6.98% more electricity than in 2020. In 2020, the building consumed 21.67% less electricity than in 2019. This reduction is primarily correlated to the COVID-19 crisis. This sizeable electrical consumption reduction is demonstrated in Figure 32.
- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020.
- As the out of hours baseload remains relatively high for the building, it is suggested here that equipment is likely being left on out of hours. During weekends, for example, there is still a clear substantial baseload, as shown in Figure 33.

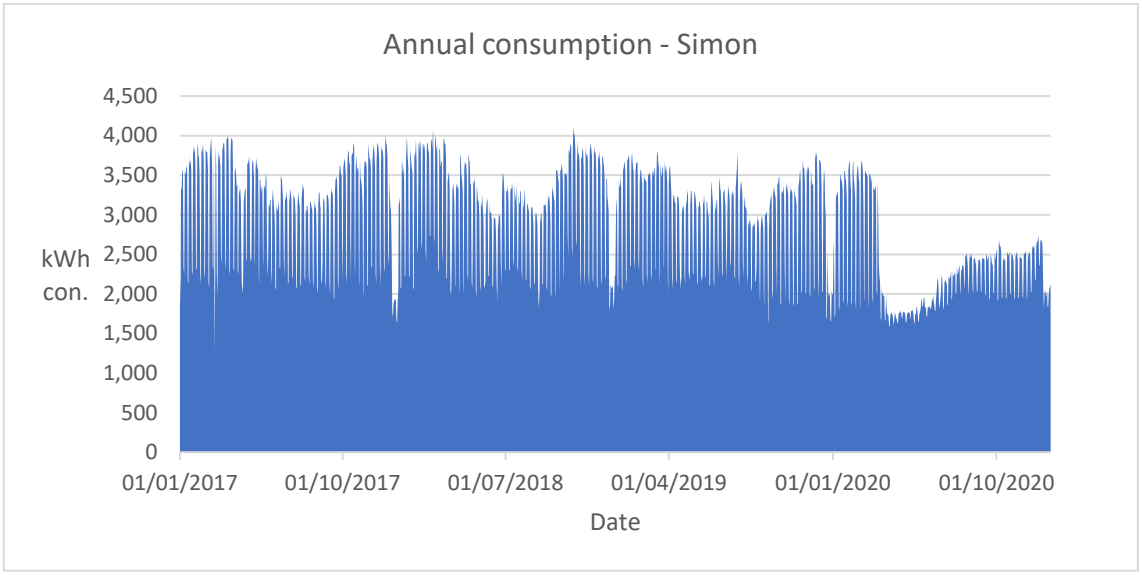

Figure 32: Annual electrical consumption within the Simon building from 2017 – 2020.

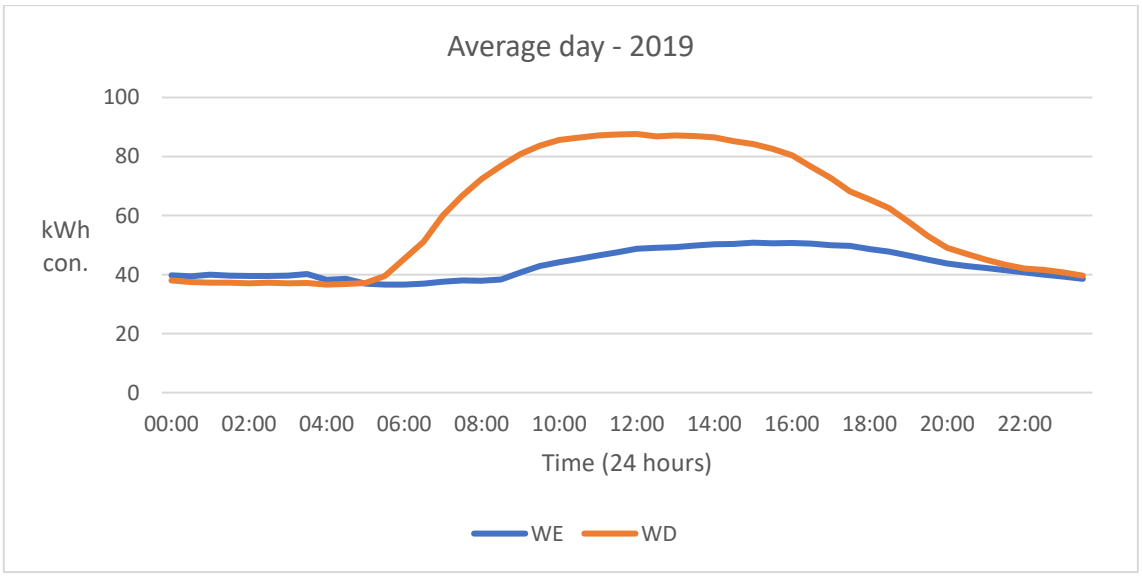

Figure 33: Average 2019 weekday (WD) and weekend (WE) daily consumption within the Simon Building.

THE UNVIERSITY OF MANCHESTER – STOPFORD

The process of monitoring electrical consumption within buildings assists in the understanding of how regulated and unregulated consumption varies across different buildings. Using data provided by Manchester's different energy management teams and building managers, this report presents the findings of the unregulated energy analysis. Data was also provided from five other universities, which allowed for comparisons to be made between the universities.

The analysis highlights that unregulated energy consumption in the Stopford building is relatively moderate, indicates a high out-of-hours electrical baseload and demonstrates that laboratories, in particular, have the highest unregulated energy consumption.

Particularly interesting rooms, or pieces of equipment, are discussed in further detail here, focusing primarily on the sub-meters that appear to be predominantly linked to unregulated energy.

FREEZER FARMS (DB NO1 AND DB NO2)

The freezer farms indicate unexpected electrical consumption variability between the two sub-metres. Due to the difference between the two sub-meters, it is hypothesised here that DB No1 measures single-phase power whilst DB No2 measures three-phase power. DB No1 is entirely dwarfed by DB No2 in terms of electrical consumption, as shown in Figure 34.

Across the latter sub-meter sub-meters, the baseload for both weekdays and weekends are consistent and indicate little variability across the months.

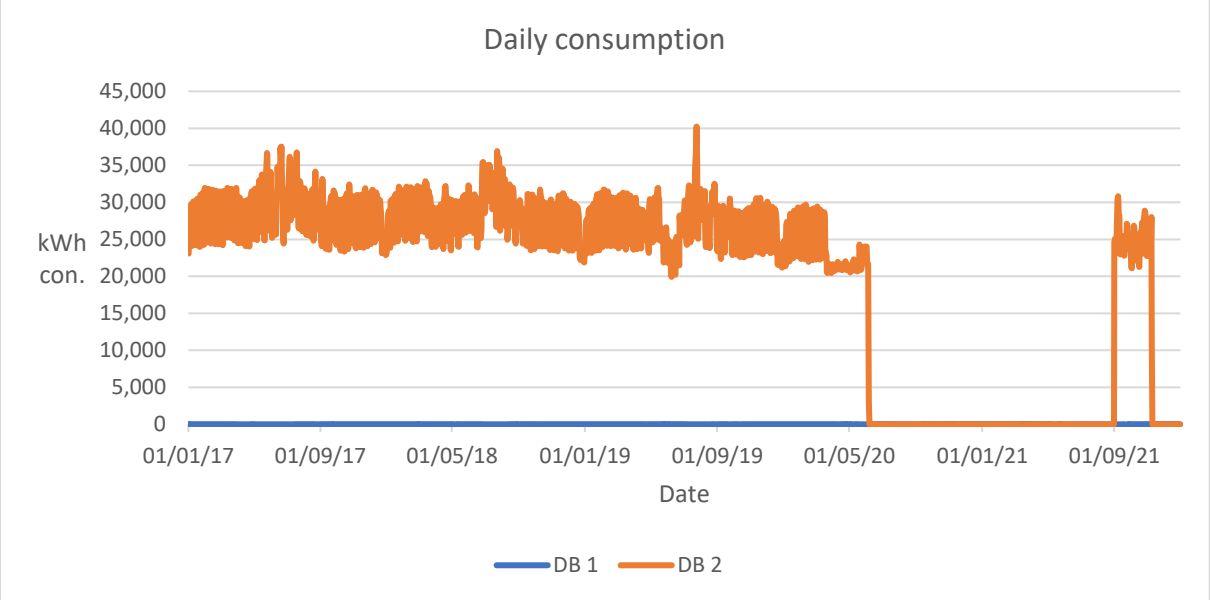

Figure 34: Daily kWh consumption for the two-freezer farm sub-meters.

LECTURE THEATRES (2ND FLOOR NO2, 2ND FLOOR NO3, 2ND FLOOR NO 4&5 & 3RD FLOOR NO 6)

Generally, the lecture room sub-meters perform similarly to what would be expected for a lecture room, based on data obtained from other buildings and universities. There is a clear difference between weekends and weekdays (for example, there are no peaks or troughs on the average Sunday, suggesting the rooms are unoccupied). Interestingly, consumption sometimes remains high until late into the evening for the lecture rooms – potentially, this room may be occupied for longer than is usually expected.

The "Lecture theatre 3rd F No 6" room indicates a particular period in the year where the consumption for this space remains relatively high and constant. This period is 6/03/2019 – 22/03/2019. There is no obvious weekday vs weekend decreases during this period compared to the rest of the year.

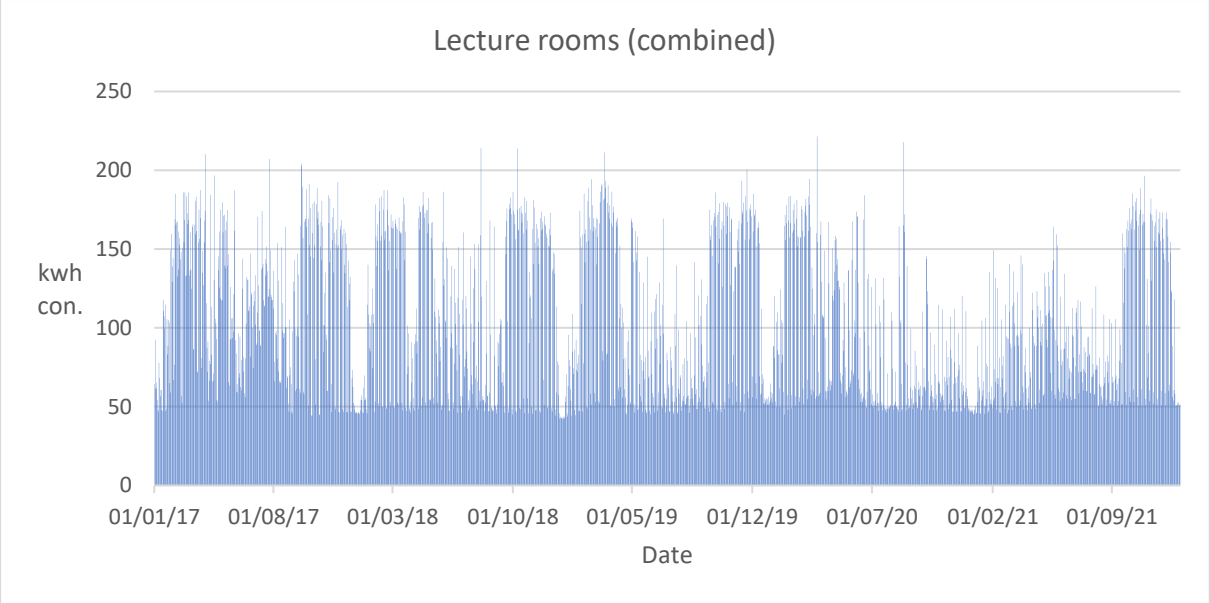

Figure 35: Daily kWh consumption for the four lecture rooms.

KEY OBSERVATIONS

- There is only a clear correlation between electrical consumption and occupancy numbers during the COVID-19 crisis, where the building was predominantly empty during 2020.
- Weekdays and weekends demonstrate similar daily consumption profiles, indicating the space used throughout the week.
- Out of the four lecture rooms, only “Lecture theatre 3rd F No 6” indicated a substantial reduction in 2020 electrical consumption. If the equipment types are similar across the four lecture rooms, then a similar reduction in electrical consumption should be possible within the other lecture theatre rooms.
- All of the lecture theatres perform as might be expected for a lecture theatre. Relatively low-consuming, noticeable weekend electrical consumption reductions and a low baseload consumption.
- The building’s overall sub-meter reading appears not to be working, hence the sizeable missing data gap demonstrated in Figure 36 below.

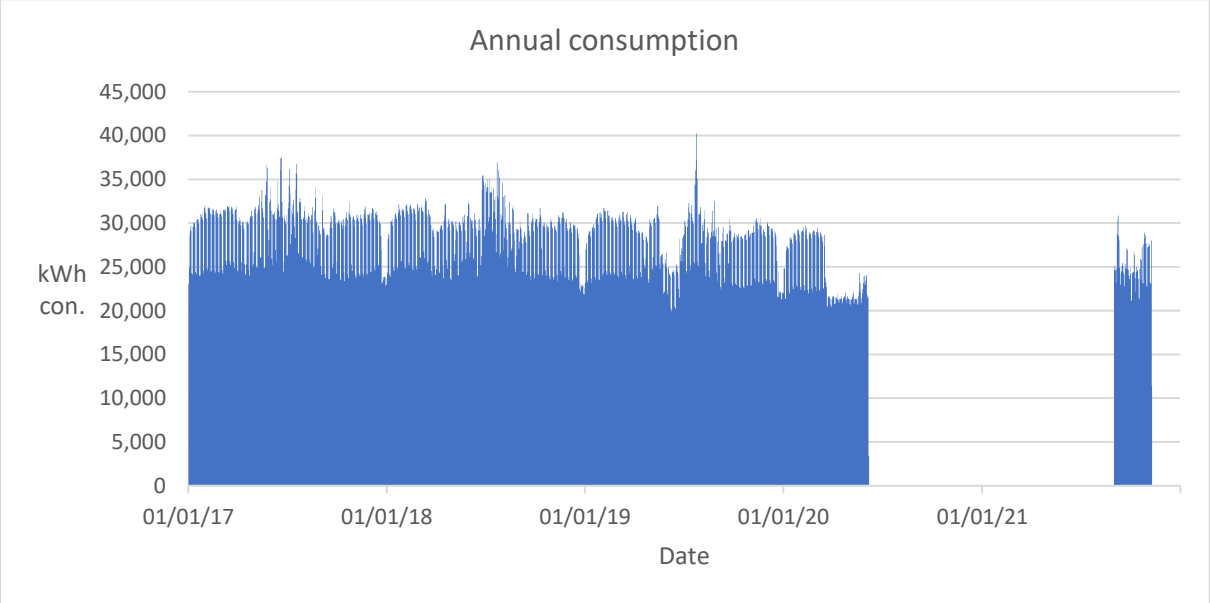

Figure 36: Annual electrical consumption, from 2017 – 2021, within Stopford.