ENERGY AUDIT AND IMPROVEMENT OPPORTUNITIES

FOR BUILDING X

Report submitted for SPG8012 - Energy Management Summative Assignment

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1. Executive Summary

The survey was conducted circa December 2012, with the audit scope of building, energy consumption patterns, heating, cooling, hot water, internal and external lighting, and equipment. The audit aims to create a report that suggests building improvement opportunities. Some interviews were conducted to understand their understanding of the organisation's energy policy, objectives, monitoring and targeting for this site, and energy awareness.

Based on observation and interviews we create Energy Management Matrix, and the result is 1.4 which is considered low. To have a better energy management throughout company, we suggest 14 recommendations which are summarised in Chapter 2.

With estimated total capital cost of recommendation: £3,357.74, here is the comparison between existing energy situation and estimated energy situation based on calculation:

	Energy Consumption (kWh)	**Energy Cost** (£)	**CO_2 Emission** (tonne)
Before	764,893.00	71,997.00	399.73
After	619,055.74	50,758.47	327.60
Saving	**145,837.26**	**21,238.53**	**72.13**

Though there are many estimations and assumption in finding above numbers, we can show that managing energy consumption in technical and human resources aspect may contribute to the savings in energy consumption, operational cost, and CO_2 emission.

2. Summary of Energy Efficiency Recommendations

No	Energy Efficiency Recommendations	Estimated capital cost[1] (£)	Estimated annual energy saving (kWh/year)	Estimated annual energy cost saving (£/year)	Estimated annual CO_2 saving[2] (tonnes/year)	Payback period (year)
4.1.1	Installation of blockwork metal cladding insulation	69,638.00	25,735.74	1,867.77	11.839	37.28
4.1.2	Installation of insulation between suspended ceilings and roof	17,886.71	6,609.74	479.70	3.041	37.29
5.1.1	Room redistribution	165,969.44	62,254.5	5,618.49	28.64	10.02
5.1.2	Utilising timer for cooling and heating equipment		180,310	10,947.85	86.95	
5.2.1	Implement submetering in the essential rooms	5,000	39,683.8	2,879.98	18.25	1.24
6.1.1	Replacement of fluorescent tube lamp to LED tube lamp	762.01	13,104.96	1059.89	6.029	0.72
6.2.1	Installation of motion sensor	915.00	6,254.64	489.54	2.877	1.87
7.1.1	Replacement of sodium lamp to LED lamp	1,612.13	5,475.00	288.26	7.556	5.59
7.2.1	Installation of photocell sensor	68.60	399.26	21.02	0.184	3.26
8.1.1	Set the standby mode on PC	0	65,682.56	107,503.16	30.215	0
8.1.2	Set the standby mode on Monitor	0	54,920.84	19,379.82	25.265	0
9.1.1	Set up rules and raise employee awareness for energy savings	0	0	0	0	0
9.1.2	Introduce new energy policies and enforcement strategies	0	0	0	0	0
9.1.3	Conduct training and transfer knowledge about energy management	0	0	0	0	0

[1] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)

[2] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

3. Introduction and Problem Identification

3.1. Report Goals

The survey was conducted circa December 2012, [3] with the audit scope of building, energy consumption patterns, heating, cooling, hot water, internal and external lighting, and equipment. The audit aims to create a report that suggests building improvement opportunities. Some interviews were conducted to understand their understanding of the organisation's energy policy, objectives, monitoring and targeting for this site, and energy awareness.

3.2. Site Overview

The total site area is approximately 2048m^2. This site contains one flat-roofed building with two floors (ground floor and first floor) and a car park. The building is constructed of blockwork with metal cladding to the first floor. Windows are doubled-glazed fixed units on the first floor, with smaller opening high-level windows on the ground floor. Solar screen film has been applied to the inside of the first-floor windows. Besides that, there is no insulation between the suspended ceiling, the roof and the wall.[4]

This site is a relatively old building with 1970s UK building standards.

Component	1970 u-value (W/m^{2}K)	2013 u-value (W/m^{2}K)
Wall	1.6	0.18
Ceiling	1.5	0.13
Floor	1.2	0.13
Window/Door	4.8	1.4

Table 1 UK building's u-values regulations in 1970 and 2013. (Davies, 2020)

The u-values of the building do not comply with the survey date's standard. A higher u-value means the inability of the building to maintain heat, therefore requiring more energy for heating.

Figure 1 Exterior of the building

[3] Assumption: Survey is conducted in middle of the month of December 2012 because building's electricity consumption profile in December 2012 way lower than in December 2010-2011.
[4] Assumption: There is no data of wall insulation, therefore all building is considered zero insulation.

The approximated size of ground floor is (32 x 25) m or 800 m^2, with the assumed floor plan[5] as follows:

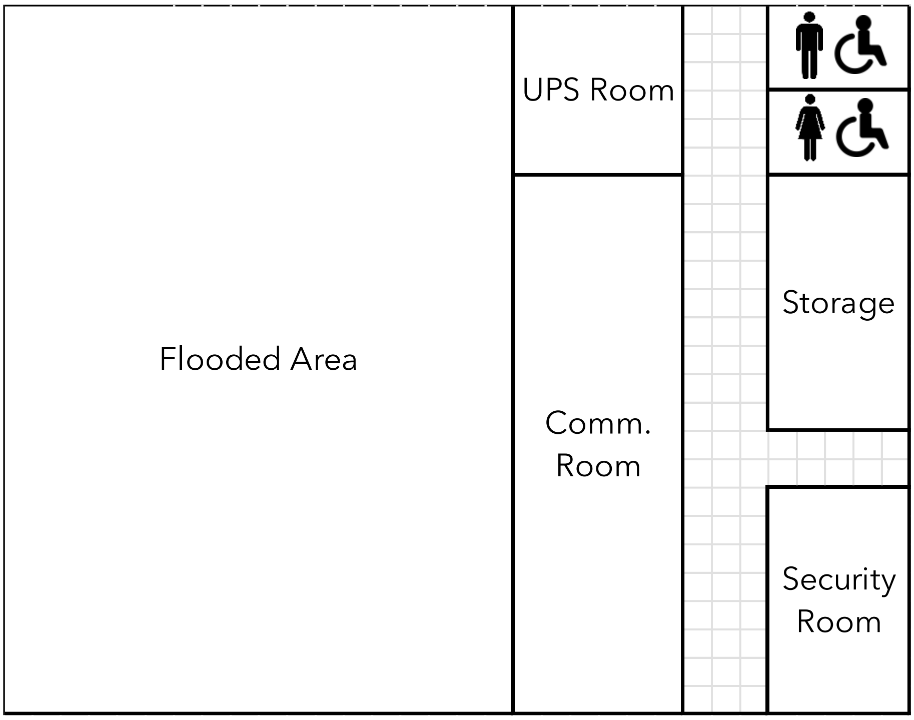

Figure 2 Assumed floor plan of the ground floor

The approximated size of the first floor is (39.5 x 31.6) m or 1248.2 m^2, with the assumed floor plan as follows:

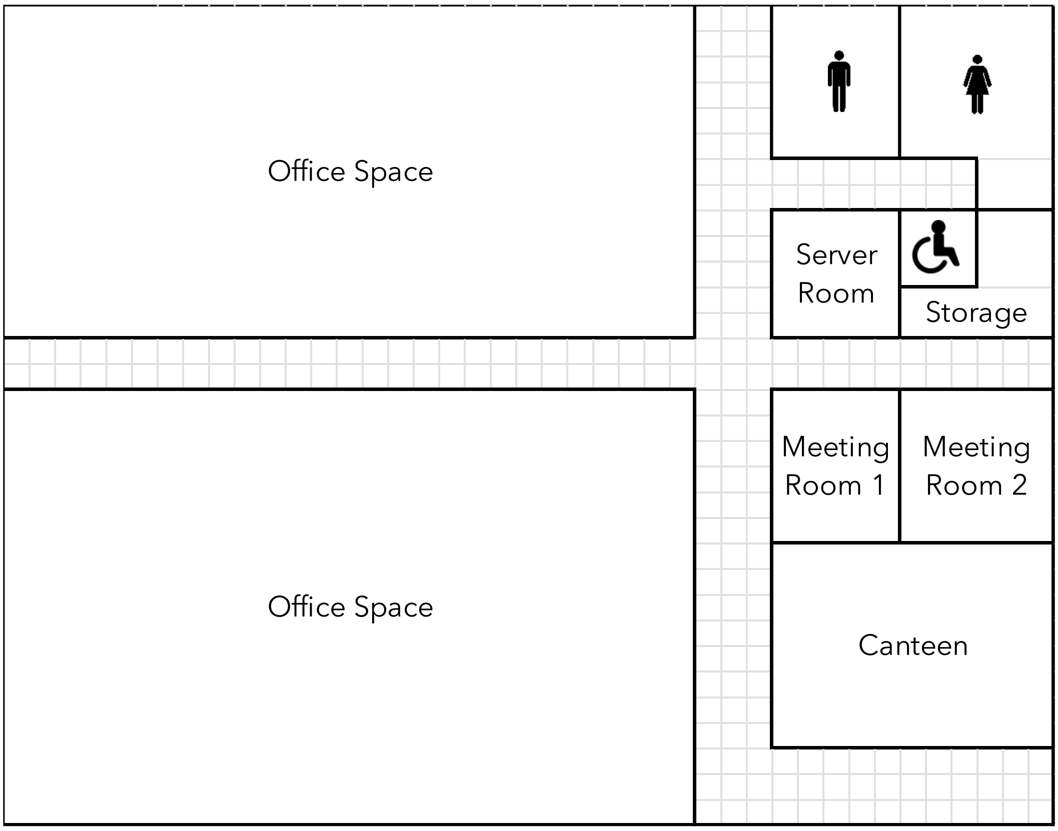

Figure 3 Assumed floor plan of the first floor

[5] Assumption: Building's floor plan is assumed based on what described on observation result.

3.3. Electricity Consumption

This site only has an electricity supply and a backup oil-powered generator. With one electricity meter and no sub-meter, the 2012 annual electricity usage was measured at 764,893 kWh and cost £71,997. This electricity usage produces 399.73 tonnes of CO_2 emission.

As shown on the monthly electricity consumption graph between 2010-2012, the difference between the highest winter month and the lowest summer month is only 16,209 kWh or approximately 20%.

As shown on the daily electricity consumption graph in October 2012, the is not much difference between the average, maximum and minimum consumption is considered relatively constant. This constancy occurs because the building was occupied 24/7, heating/cooling continuously in all areas, and three IT/communications/UPS rooms continually use power.

3.4. Energy Management Matrix

The staff interviews were conducted with two main office staff, one control room staff, and one network projects staff. The interviews are about the staff's understanding of the organisation's energy policy, objectives, monitoring and targeting for this site, and energy awareness.

All interviewees recalled attending the environmental awareness course but not the details regarding energy efficiency. One interviewee thought the organisation had an energy efficiency policy – but was unaware of the details, and three were not sure. None were aware of any specific energy targets for this site building or had received information about actual consumption.

Based on the survey and staff interviews, and to indicate the the current status on as energy policy, organization, motivation, information system, marketing and investment relating to energy management in the building (Rodriguez Toscano *et al.*, 2019), the Energy Management Matrix (EMM) overall grade for this building is 1.4.

This diagnosis was made through a matrix of competence as follows:

Level	Organisation	Staff motivation	Tracking, monitoring, and reporting systems	Staff awareness/ training and promotion	Investment
4	Energy management policy, action plan and regular review have commitment of top management as part of a corporate strategy	Formal and informal channels of communication regularly exploited by energy manager and energy staff at all levels	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking	Marketing the value of energy efficiency and the performance of energy management	Positive discrimination in favour of energy saving schemes with detailed investment appraisal
3	Formal energy management policy, but no active commitment from top management	Energy committee used as main channel together with direct contact with major users	Monitoring and targeting reports for individual premises	Program of staff training, awareness and regular publicity campaigns.	Cursory appraisal of new building, equipment and refurbishment opportunities
2	Unadopted energy management policy set by energy manager	Contact with major users through adhoc committee	Monitoring and targeting reports based on supply meter data	Energy unit has adhoc involvement in budget setting.	Investment using shortterm payback criteria only
1	An unwritten set of guidelines. Energy management the parttime responsibility	Cost reporting based on invoice data	Energy manager compiles reports for internal	Informal contacts used to promote energy efficiency	Only low-cost measures taken
0	No explicit policy. No energy manager	No information system	No accounting for energy consumption	No promotion of energy efficiency	No investment in increasing energy efficiency

Table 2 Energy Management Matrix based on survey and staff interviews

4. Energy Efficiency Problems and Recommendations: Buildings

4.1. No insulation between suspended ceiling, roof, and wall

To calculate the impact of these insulation recommendations, we use the heat loss (Q_{loss}) approach. We compare the total of energy conserved with or without insulations installed (Smith *et al.*, 2018). To overcome this problem related to insulation, the recommendations taken are:

4.1.1. Installation of blockwork metal cladding insulation

Metal cladding is the external envelope of building to protect from rain, snow, wind, or maintenance works (Brookes, 2008). But when it comes to insulation, there is no effect from metal cladding to the blockwork building structure. Therefore, the recommendation is to install stone wool insulation product which is knit together to provide continuous insulating layer (*RAINSCREEN DUO SLAB ® Non-combustible insulation for ventilated façades*, 2021).

By using 210mm RAINSCREEN DUO SLAB® stone wool insulation between metal bracket system on 200mm reinforced concrete, the u-value can be reduced until 0.18 W/m^{2}K. Cost of this product: £92.30/ m^2 (*Rockwool United Kingdom Price List 4 July 2022*, 2022).

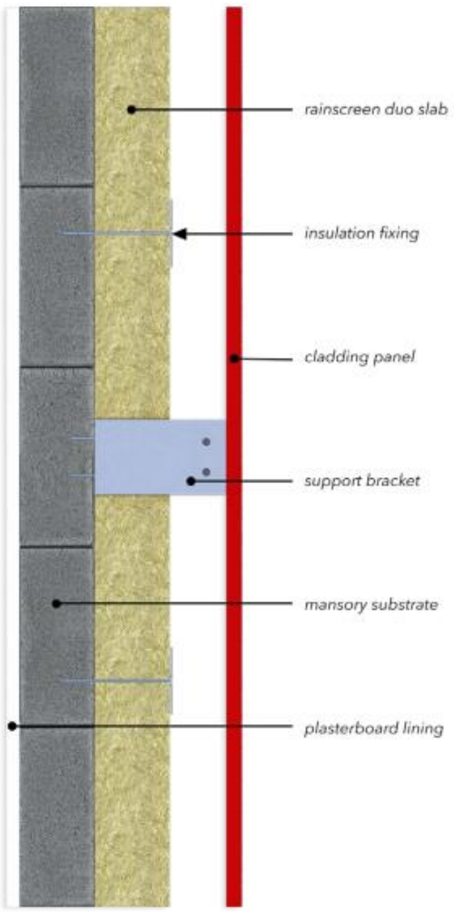

Figure 4 Diagram of stone wool insulation between cladding system and concrete/masonry

4.1.2. Installation of insulation between suspended ceilings and roof

There are two methods for installing insulation between suspended ceilings and roof: install the insulation in the ceiling or the roof. Roof insulation refers to installing insulation on the roof above and below the flat roof. In comparison, ceiling insulation refers to installing insulation within the floor nearest to the roof structure. Due to the advantages of ceiling insulation that keeps the temperature of activity space regulated, prevents the roof from moisture damage, and ease of construction (Valle, 2022), ceiling insulation is chosen.

There are several methods for ceiling insulation: blanket fill, loose fill, sheet loft, and spray foam. The first three, though have cheaper cost, but contributes low for reducing the building's u-value. Therefore, the spray foam method is chosen for ceiling insulation (J, 2022). With the estimated cost of £20/m^2, the u-value can be reduced to 0.039 W/m^{2}K (Home Logic, 2021).

Figure 5 Illustration for spray foam insulation

The estimated capital cost, annual savings, and payback period for recommendation 4.1.1. and 4.1.2. are as follows:

No	**Estimated capital cost**[6] (£)	**Estimated annual energy saving** (kWh/year)	**Estimated annual energy cost saving** (£/year)	**Estimated annual CO_2 saving**[7] (tonnes/year)	**Payback period** (year)
4.1.1	69,638.00	25,735.74	1,867.77	11.839	37.28
4.1.2	17,886.71	6,609.74	479.70	3.041	37.29

Table 3 Energy audit for recommendation 4.1.1. and 4.1.2.

The detailed assumptions and calculations are presented in Appendix A.1.

[6] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)

[7] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

5. Energy Efficiency Problems and Recommendations: Heating and Cooling

5.1. Uneven BTU capacity between rooms

The hint of uneven BTU capacity between rooms appears when report finds out two facts:

- separation between essential room that operates 24/7 (communication and UPS room on ground floor, meanwhile server room on first floor)
- plan to fit a door thus creating a separate zone for system control room

We use the approach to calculate the surplus or deficit of British Thermal Units (BTU) which is an energy required to cooling or heating in certain place and 1 kW = 3413 BTU (LearnMetrics.com, 2022). BTU surplus/deficit calculation is needed to see the unbalance distributions between rooms.

As the result of BTU calculation there is a room that has deficit BTU capacity, which is Office Room. The real condition that felt by the staffs is that room easy to get heat and difficult to release heat. The fact that clarifies the calculation is that there are additional heating and cooling equipment placed e.g., fan heaters, evaporite coolers and desk fan. To overcome this problem, the recommendations given are:

5.1.1. Room redistribution

To tackle the uneven BTU capacity between rooms, there is a need for room redistribution:

- Moving server room to ground floor, integrating the heating/cooling system with communication and UPS room.
- Substituting the function between system control room and small meeting room. System control room take place on the existing small meeting room which already has own heating/cooling system. This creates separation between normal office room which operates less than 24 hours and system control rooms that will run 24/7.

With the new room arrangement, there won't be any part of the building that has deficit BTU number. Besides that, there will be two centres of heating/cooling that operates 24/7: Communication + UPS + Server Room and System Control Room. With adequate amount of BTU in the office room, we can eliminate the need for fan heaters, evaporates coolers, and desk fans which leads to energy saving.

5.1.2. Utilising timer for cooling and heating equipment

After successfully redistribute the rooms, we can put timer in the rooms that do not require 24/7 operational hour. In result, these rooms' cooling/heating system will only operate in working hour. Besides 24 hours, the operation time can be reduced to 10 hours. This approach also leads to energy saving.

5.2. The absence of submetering in the essential rooms

According to (U.S. General Service Administration, no date), submetering is a system which generates data that can guide management strategies, operational and investment. In early implementation of submetering, the energy savings can be improved up to 15%. Therefore, there is important to implement submetering especially in essential rooms.

5.2.1. Implement submetering in the essential rooms

Submetering is implemented in communication + UPS + server room on the ground floor and in the system control room (first floor). With estimated cost spend of £5,000, submetering can save total electrical cost of £2,879.98.

The estimated capital cost, annual savings, and payback period for recommendation 5.1.1., 5.1.2, and 5.2.1. are as follows:

No	Estimated capital cost[8] (£)	Estimated annual energy saving (kWh/year)	Estimated annual energy cost saving (£/year)	Estimated annual CO_2 saving[9] (tonnes/year)	Payback period (year)
5.1.1	165,969.44	62,254.5	5,618.49	28.64	10.02
5.1.2		180,310	10,947.85	86.95	
5.2.1	5,000	39,683.8	2,879.98	18.25	1.24

Table 4 Energy audit for recommendation 5.1.1., 5.1.2 and 5.2.1

The detailed assumptions and calculations are presented in Appendix A.2.

[8] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)

[9] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

6. Energy Efficiency Problems and Recommendations: Internal Lighting

6.1. Usage of high-wattage lamp

Fluorescent tube lamp is an obsolete technology which requires high wattage. Therefore, there is a need for replacement with low-wattage lamp.

6.1.1. Replacement of fluorescent tube lamp to LED tube lamp

LED tube lamp is the substitute of fluorescent tube lamp. Without changing the fixture, the replacement can be done by only changing the starter which is the straight through electrical connector with a safety fuse (Any-lamp.co.uk, 2018). The existing fluorescent tube lamp used for building internal lighting requires power of 20W. Meanwhile, for the same number of lumens (total amounts of visible light) of 1350, LED tube lamp only requires 9W.

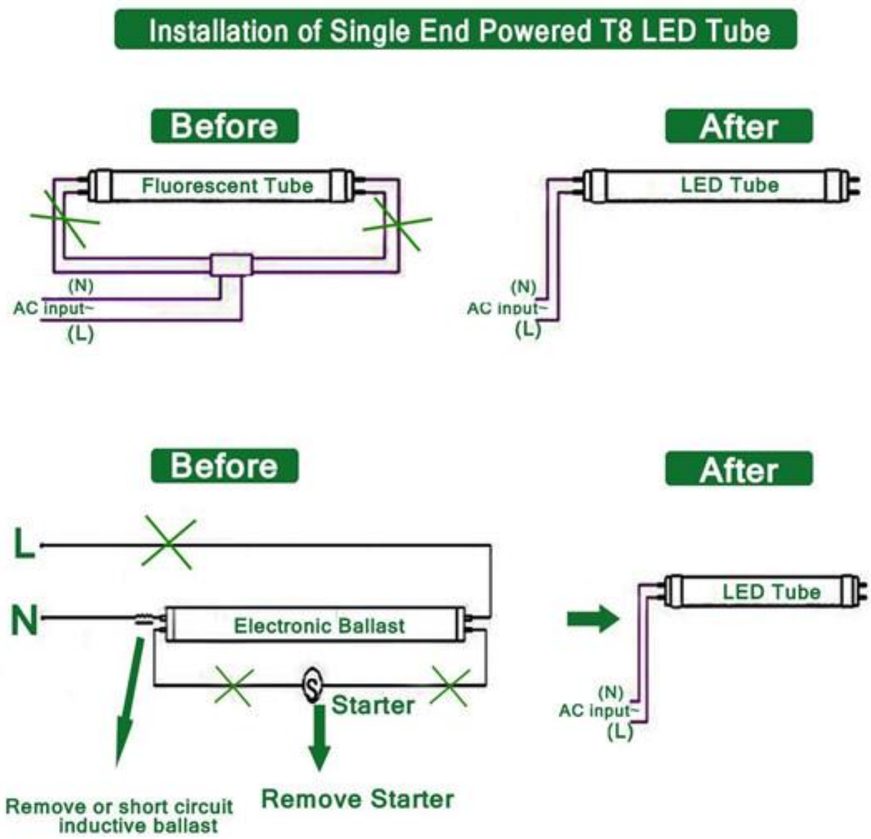

Figure 6 Installation of T8 LED tube lamp

6.2. No automatic power control to switching lamp on and off

Annually, UK has longer daylight (12.3 hours) compared to twilight (11.7 hours). There is a need to ensure that the external lighting only switched-on during twilight. Meanwhile the existing condition, the external lighting is manually switched on and off. Due to the company standard operation procedure, average of daily operation of external lighting is 12 hours.

6.2.1. Installation of motion sensor

The normal office active duration is 8 hour, 5 day per week. But instead of having the lights switched on for 40 hours per week at most, this building has the lights on 24 hours per day or 168 hours per week. The motion sensor is needed to detect movement of worker. When there is no movement detected, the lamp will switch off within 10 seconds to 7 minutes (adjustable). Moreover, LUX level can also be adjusted to prevent the lights coming on during sunny days when not required.

The estimated capital cost, annual savings, and payback period for recommendation 6.1.1. and 6.2.1. are as follows:

No	Estimated capital cost[10] (£)	Estimated annual energy saving (kWh/year)	Estimated annual energy cost saving (£/year)	Estimated annual CO_2 saving[11] (tonnes/year)	Payback period (year)
6.1.1	762.01	13,104.96	1059.89	6.029	0.72
6.2.1	915.00	6,254.64	489.54	2.877	1.87

Table 5 Energy audit for recommendation 6.1.1. and 6.2.1

The detailed assumptions and calculations are presented in Appendix A.3.

[10] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)

[11] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

7. Energy Efficiency Problems and Recommendations: External Lighting

7.1. Usage of high-wattage lamp

Sodium lamp is an obsolete technology which requires high wattage. Therefore, there is a need for replacement with low-wattage lamp.

7.1.1. Replacement of sodium lamp to LED lamp

Light emitting diode (LED) lamp is the new technology. LED lamps can provide the same work plane level of illuminance, in less size and less energy than high-pressured sodium lamp (Rodrigues *et al.*, 2011). The existing sodium lamps used for building external lighting requires power of 200W. Meanwhile, for the similar number of lumens (total amounts of visible light), LED lamps only requires 150W.

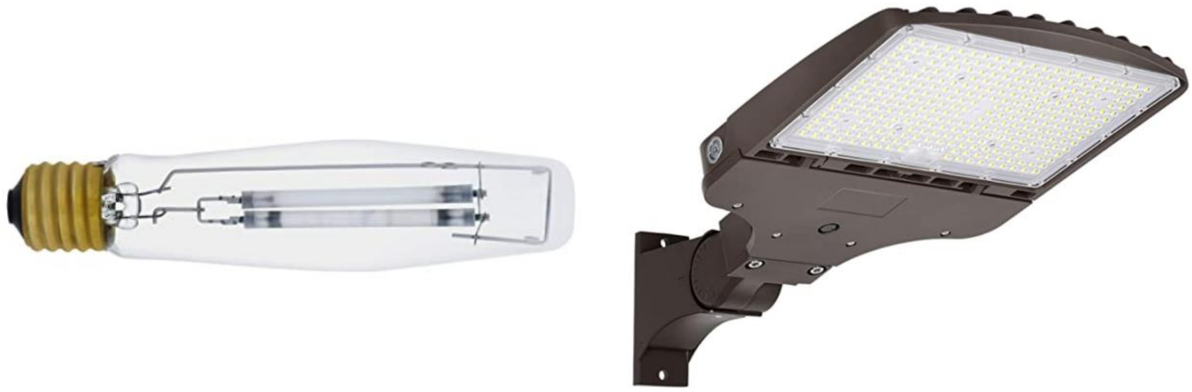

Figure 7 Comparison between sodium lamps and LED lamps for external lighting

7.2. No automatic power control to switching lamp on and off

Annually, UK has longer daylight (12.3 hours) compared to twilight (11.7 hours). There is a need to ensure that the external lighting only switched-on during twilight. Meanwhile the existing condition, the external lighting is manually switched on and off. Due to the company standard operation procedure, average of daily operation of external lighting is 12 hours.

7.2.1. Installation of photocell sensor

There is a need to install the photocell sensor which use sunlight as a driver to switch the lamp on (Sumual and Seke, 2019).

The estimated capital cost, annual savings, and payback period for recommendation 7.1.1. and 7.1.2. are as follows:

No	Estimated capital cost[12] (£)	Estimated annual energy saving (kWh/year)	Estimated annual energy cost saving (£/year)	Estimated annual CO_2 saving[13] (tonnes/year)	Payback period (year)
7.1.1	1,612.13	5,475.00	288.26	7.556	5.59
7.2.1	68.60	399.26	21.02	0.184	3.26

Table 6 Energy audit for recommendation 7.1.1. and 7.2.1.

The detailed assumptions and calculations are presented in Appendix A.4.

[12] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)
[13] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

8. Energy Efficiency Problems and Recommendations: Equipment

8.1. The workstations are switched on 24/7

The report found out that staff the workstations switched on outside of office hours. Enforcing staffs to switch off the workstations every day is difficult to implement due to possibility that there are works needed to be continued on the other day. Therefore, the recommendation is to implement the standby mode in two of workstations component: PC (desktop or laptop) and the monitors.

8.1.1. Set the standby mode on PC

There are two types of PC in the office: desktop (25 unit) and laptop (55 unit). Setting up the standby mode can cut operation hour of PC from 24 hours to 8 hours only (based on average staff working hour per day).

8.1.2. Set the standby mode on Monitor

There are 155 unit of monitor. Similar to PC, setting up the standby mode for monitor can cut its operation hour and leads to reduce of annual power consumption and annual electrical cost.

The estimated capital cost, annual savings, and payback period for recommendation 8.1.1. and 8.1.2. are as follows:

No	Estimated capital cost[14] (£)	Estimated annual energy saving (kWh/year)	Estimated annual energy cost saving (£/year)	Estimated annual CO_2 saving[15] (tonnes/year)	Payback period (year)
8.1.1	0	65,682.56	107,503.16	30.215	0
8.1.2	0	54,920.84	19,379.82	25.265	0

Table 7 Energy audit for recommendation 8.1.1. and 8.1.2.

The detailed assumptions and calculations are presented in Appendix A.5.

[14] Inflation rate UK from 2022 to 2012: -28.35% (*U.K. Inflation Calculator*, 2022)

[15] UK CO_2 emission factor: 0.46002 (UK Department of Energy & Climate Change, 2013)

9. Energy Efficiency Problems and Recommendations: Human Resources

9.1. Lack of awareness, enforcement, and knowledge on energy management

Based on energy matrix in chapter 3, the Energy Management Matrix (EMM) overall grade for this building is 1.4. Therefore, besides of the technical approach, we also recommend doing some of human resources approach:

9.1.1. Set up rules and raise employee awareness for energy savings

There is a need to campaigning the importance of energy savings. Some ways to do it:

- Circulating printed publication and e-mail regarding company energy saving rules
- Sticking poster or sticker near the lamp/electrical appliances switch
- Giving recognition to the staffs that has high awareness of energy savings

9.1.2. Introduce new energy policies and enforcement strategies

In top management level, there must be discussion to establish formal energy management roadmap document. This document will be used as the foundation for budgeting, headcount (staff recruitment), and also CSR (corporate social responsibility). At some point we recommend appointing Energy Manager as a specific person that hold accountable for energy management throughout the company.

9.1.3. Conduct training and transfer knowledge about energy management

As part of the employee development programme, training about energy management can be done. The curriculum for this training can be different based on the expertise and seniority level.

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Appendix A: Assumptions and Calculations

A.1. Buildings

Assumptions:

- Material for blockwork metal cladding insulation is 210mm RAINSCREEN DUO SLAB® stone wool insulation. Estimated cost £ 92.3/m^2
- U value of blockwork metal cladding insulation is is 0.18 W/m^2K to comply with UK standard for wall
- Thermal conductivity (W/mK) of blockwork metal cladding insulation is 0.035 (*RAINSCREEN DUO SLAB ® Non-combustible insulation for ventilated façades*, 2021)
- Material for spray foam insulation cost £ 20/m^2
- U value of spray foam insulation is 0.039 W/m^2K
- T room is room temperature: 21 degree Celsius.
- T max is temperature of warmest day in Newcastle area at 2012: 24 degree Celsius (*Past Weather in Newcastle upon Tyne, England, United Kingdom – January 2012*, no date) and T min is temperature of coldest day in Newcastle area at 2012: -7 degree Celsius.

Calculations:

- $Qloss = U \times A \times \Delta T$
- $Electrical\ loss = Qloss \times t_{operation}/year =$ annual power save
- $Electrical\ savings = Electrical\ saving_{scenario} - Electrical\ saving_{existing\ condition}$
- $Estimated\ cost\ saved = Electrical\ savings \times Electrical\ price$
- $Payback\ period = Cost\ to\ implement\ recommendation\ /\ Estimated\ cost\ saved$
- $CO_2\ savings = emission\ factor \times electrical\ savings$

A.2. Heating and Cooling

Assumptions:

- 1kW = 3413 BTU (LearnMetrics.com, 2022)
- BTU for Server Room = 337 BTU/m^2 (Mark, 2022)
- BTU for Office Room = 189.95 BTU/m^2 ad (Langer, 2022)
- Area of Commercial + UPS room is 180 m^2, Server Room is 16 m^2, main Office is 864 m^2, small meeting room is 16 m^2
- Number of laptops = number of desks = 55
- Number of fan heaters/evaporative coolers is 1 for 4 desks = 14
- Usage of each fan heaters/evaporative coolers is 1 month during peak summer or peak winter
- Unit power consumption of fan heaters is 2000W, evaporative coolers is 65W, and desk fan is 40W

Calculations:

- BTU needed or BTU capacity = Power consumption (kW) x 3413
- $Electrical\ savings = Electrical\ saving_{scenario} - Electrical\ saving_{existing\ condition}$
- $Estimated\ cost\ saved = Electrical\ savings \times Electrical\ price$

- $Payback\ period = Cost\ to\ implement\ recommendation\ /\ Estimated\ cost\ saved$
- $CO_2\ savings = emission\ factor \times electrical\ savings$

A.3. Internal Lighting

Assumptions:

- Lamp type for LED tubes is LED T8 tubes: 9W
- 2ft T8 fluorescent tubes: 20W

Calculations:

- $Electrical\ savings = Electrical\ saving_{scenario} - Electrical\ saving_{existing\ condition}$
- $Estimated\ cost\ saved = Electrical\ savings \times Electrical\ price$
- $Payback\ period = Cost\ to\ implement\ recommendation\ /\ Estimated\ cost\ saved$
- $CO_2\ savings = emission\ factor \times electrical\ savings$

A.4. External Lighting

Assumptions:

- LED lamp: 150W
- Daylight in Newcastle area 2012 is 12.3 hours and twilight is 11.7 hours (*Climate and Average Weather Year Round in Newcastle upon Tyne*, no date)

Calculations:

- $Electrical\ savings = Electrical\ saving_{scenario} - Electrical\ saving_{existing\ condition}$
- $Estimated\ cost\ saved = Electrical\ savings \times Electrical\ price$
- $Payback\ period = Cost\ to\ implement\ recommendation\ /\ Estimated\ cost\ saved$
- $CO_2\ savings = emission\ factor \times electrical\ savings$

A.5. Equipment

Assumptions:

- Number of desktops: 25
- Number of laptops: 55
- Number of monitors: 155 which is assumed based on report: 1 each in general offices, to 4 or 5 each in system and incident control (approximately 25 workstations)
- Desktop Power Consumption: 200W, standby: 3W – and laptop Power Consumption: 100W, standby: 3W (*How much power does a computer use? And how much CO2 does that represent?*, no date)
- Monitor Power Consumption: 65W, standby: 12W (EnergySavingSecrets, 2009)

Calculations:

- $Electrical\ savings = Electrical\ saving_{scenario} - Electrical\ saving_{existing\ condition}$
- $Estimated\ cost\ saved = Electrical\ savings \times Electrical\ price$
- $Payback\ period = Cost\ to\ implement\ recommendation\ /\ Estimated\ cost\ saved$
- $CO_2\ savings = emission\ factor \times electrical\ savings$

Details calculations can be seen on Excel Sheet: Energy Audit Calculation.xlsx