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80 GEORGE STREET AND 6-8 PAVED COURT, RICHMOND

Prediction of Operational Energy

80 GEORGE STREET AND 6-8 PAVED COURT, RICHMOND, TW9 1HA

Prediction of Operational Energy

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80 GEORGE STREET AND 6-8 PAVED COURT, RICHMOND
Prediction of Operational Energy

80 GEORGE STREET AND 6-8 PAVED COURT, LONDON
CIBSE TM54 Report:
Evaluating Operational Energy Performance at Design Stage

Contents

Appendices

Registration of Amendments

Revision	Amendment Details	Revision Prepared By	Revision Approved By

EXECUTIVE SUMMARY

Create Consulting Engineers Ltd has been commissioned by 80 George Street Limited to prepare CIBSE TM54 analysis as per Planning Decision letter dated 17th April 2024 in order to discharge Planning Consent Condition U0178864 of application 23/2308/VRC. This report has been prepared in accordance with CIBSE TM54:2021 'Evaluating Operational Energy Performance of Buildings at the Design Stage', Appropriate methodology has been used to evaluate the predicted operational energy use of the building. For each step of the methodology, the design parameters, together with assumptions regarding levels of occupancy and operation have been used to predict the energy consumption for: lighting, lifts, small power, domestic hot water, space heating, cooling, fans and pumps.

To understand the impact of how the building is operated or the annual energy consumption, four scenarios have been analysed:

- Likely: The likely consumption based on anticipated occupancy and operation.
- Low End: The low-end consumption if the occupancy density is lower, occupancy period is shorter, and small power and equipment load are lower.
- High End: The high-end consumption if the occupancy density is higher and small power and equipment load are used more than anticipated, tested in extreme weather conditions.
- Worst Case: The worst-case consumption if the occupancy density and occupancy profile are much higher, and small power and equipment load are used much more than anticipated, tested in extreme weather conditions.

Two of the key assumptions within the analysis are the occupancy and running hours of the building. The results have clearly demonstrated that the operational energy performance of the building is dependent on the level of occupancy and operation of the building.

	Likely	Low End	High End	Worst Case
Total Electricity Intensity (including LZC) (kWh/m^2)	197.87	169.62	214.85	222.98
Total Gas Intensity (kWh/m^2)	3.13	3.11	3.56	4.28
Total Energy Intensity (including LZC) (kWh/m^2)	201.00	172.73	218.40	227.26

Table 1: Comparison of Annual Energy Intensity (including LZC)

	Likely	Low End	High End	Worst Case
Total Electricity (inc. LZC) Carbon Intensity (kg.CO_2/m^2)	46.10	39.52	50.06	51.95
Total Gas Carbon Intensity (kg.CO_2/m^2)	0.63	0.63	0.72	0.87
Total Carbon Intensity (including LZC) (kgCO_2/m^2)	46.74	40.15	50.78	52.82

Table 2: Comparison of Annual Carbon Intensity (including LZ) - SAP 10.0 Factors

The results have clearly demonstrated that the operational energy performance of the build is dependent on the level of occupancy and operation of the building. With low occupancy and good operation (Likely or Low-End Scenarios) the building will consume significantly less than Good Practice benchmarks, however if the building has high occupancy and unmanaged operation (Worst Case Scenario) the building will perform only slightly better than Good Practice benchmarks.

1.0 INTRODUCTION

1.1 Create Consulting Engineers Ltd has been commissioned by 80 George Street Limited to prepare CIBSE TM54 analysis as per Planning Decision letter dated 17th April 2024 in order to discharge Planning Consent Condition U0178864 of application 23/2308/VRC which requires to carry out CIBSE TM54 modelling at design stage 3-4 to confirm the anticipated energy consumption for the building. It is required to submit TM54 modelling report and get that approved in writing with the local planning authority. As part of the requirement, this report has been prepared to satisfy the council's requirements as well as GLA's requirement set out in the 'BE Seen' energy monitoring guidance.

1.2 This TM54 assessment consists of creating a dynamic simulation model of the building and reviewing the design against operation energy targets. The objective of this report is to is to evaluate the operational energy use during the design stage using CIBSE TM54 methodology. This report presents the methodology, explains the operational parameters for each end use and presents the results for each end use. The report concludes by comparing the results against CIBSE Energy Typical and Good Practice Benchmarks (CIBSE Guild F:2012).

1.3 A risk assessment forms part of this assessment which highlights any significant design, technical and process risks that should be monitored and managed throughout the construction and commissioning process.

1.4 To evaluate the annual operational energy consumption use during the design stage CIBSE TM54 methodology 2022 (Figure 1.0) has been followed. To understand the sensitivity of a number of the input parameters modelling tool has been developed and used to predict a range within the operational energy, while identifying the key parameters that need to be controlled during the operation to ensure excessive energy is not consumed.

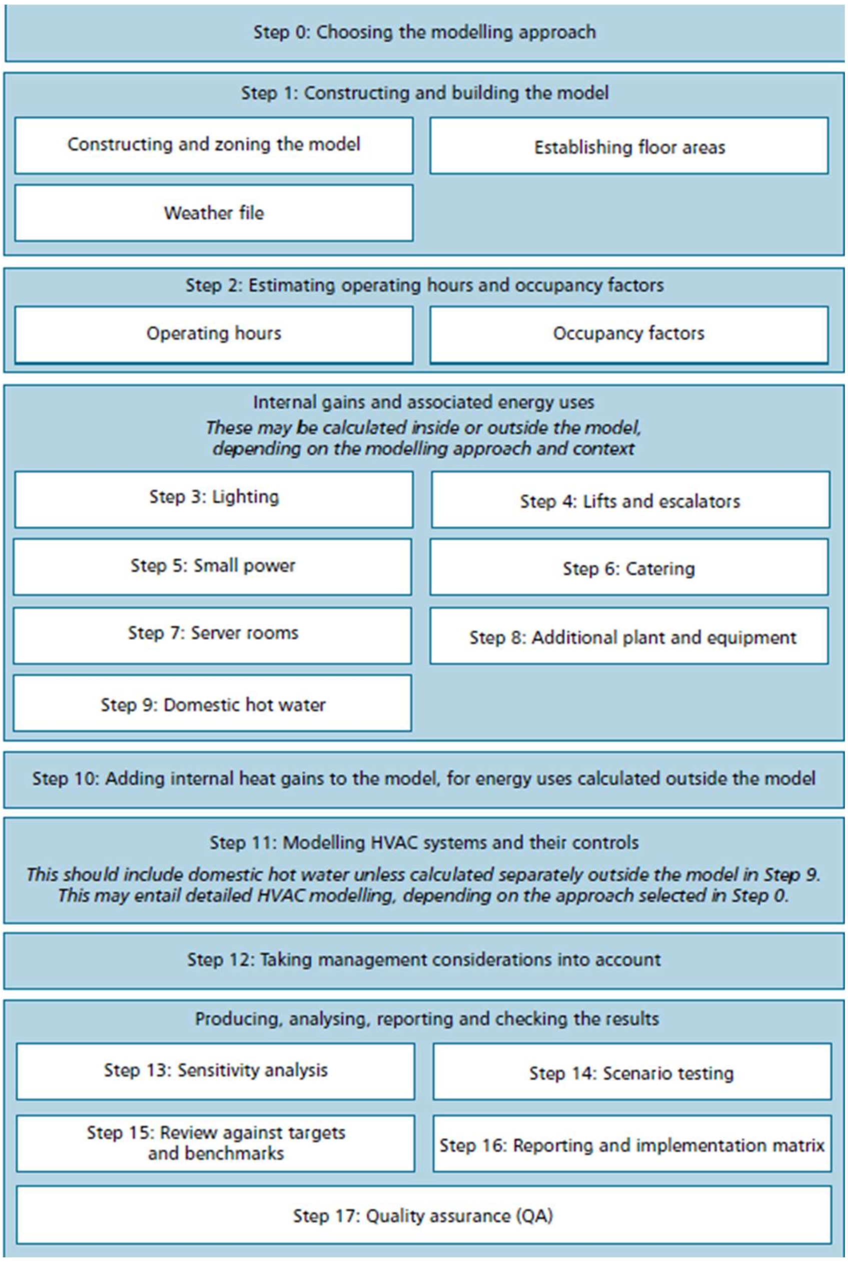

Figure 1.1: Methodology for evaluating operational energy at the design stage: Source: CIBSE TM54:2022

1.5 This report presents the methodology, outlines the operation parameters for each end use and presents the results for each end use. It also compares the results against CIBSE Energy Typical and Good Practice Benchmarks (CIBSE Guide F:2012)

Site Location and Description

1.6 The Site is located at 80 George Street (former House of Fraser) and Nos. 2-8 and 12 Paved Court in Richmond upon Thames. Please refer to figure 1.1 below for the Site Location Plan.

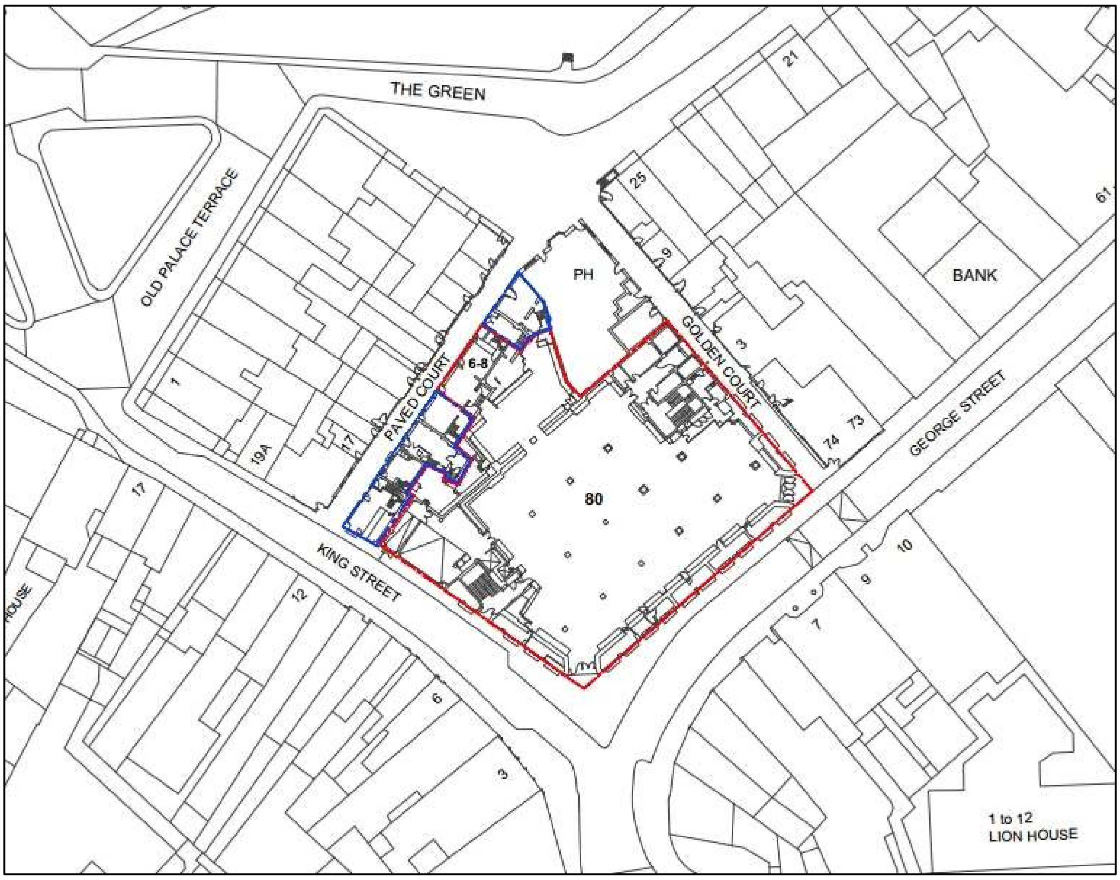

Figure 1.2: Site Location Plan (source: Architect's drawing)

1.7 The proposed amendment aims to introduce accommodation and an external terrace on the fifth floor. The changes to the fifth floor involve converting a portion of the previously approved plant room into a food and drink establishment, along with an associated terrace. This modification also includes necessary alterations to the roof level. The building is proposed to be built as Shell and Core.

Objectives

1.8 The objectives of this report are to:

- Evaluate and predict the operational energy during the design stage.
- Demonstrate the impact that different scenarios have on energy consumption including how the energy performance of the building will be affected by future weather patterns, occupancy and operating factors and management factors.
- Make the design team understand where and how energy is likely to be used in the building and have realistic expectations about the performance of the building.
- Assist the design team to understand which energy performance measures have the greatest impact on energy use.
- Inform energy end use targets which can be compared to operational data to identify opportunities to tune or optimise the building in use.

2.0 METHODOLOY

General

2.1 The annual energy consumption of the building is determined by both the design and operation of the building. The design elements are fixed and are as per the design of the building which were provided by the design team. The operational elements are dependent on how the building is used and particularly the operating hours of the building and the switching on of the building services systems. The building will be delivered as Shell and Core and multitenant space; therefore, details of tenants are operating hours are not available at this stage. Analysis has been carried out using NCM templates and on the basis of assumptions. To understand the impact of how the building is operated, the annual consumption of four scenarios have been analysed. Those are presented below.

- Likely: The likely consumption of based on anticipated occupancy and operation
- Low End: the low-end consumption if the occupancy is lower
- High End: the high-end consumption if the occupancy is higher and equipment and systems are used more than anticipated.
- Worst Case: the worst-case consumption of the occupancy is much higher and equipment and systems are used much more than anticipated.

Software

2.2 A simulation model has been built for the purposes of making a suitably accurate prediction of the building's future energy consumption. This includes consideration of the building location, massing, envelope, thermal loads, system efficiencies and other energy consuming systems. The geometry of the model has been built in IES VE 2021 and analysed with the Apache simulation module for this analysis.This program is fully accredited under CIBSE TM33.

Climate Data

2.3 For this exercise, the London TRY (Test Reference Year) 2020H weather file was used to represent "typical" weather. This simulation utilizes hourly recorded weather data from the London TRY 2020H file, which has been chosen for its suitability for energy modelling and representation of a typical year without unusually hot or cold conditions.

2.4 Given that the proposed development is within London, the London weather file has been selected for this exercise. For extreme weather scenario testing, DSY (Design Sumer Year) weather files are used.

Geometry

2.5 Architectural Drawings have been provided in Appendix A

Limitation

2.6 Computer building simulation provides an estimate of building performance. This estimate is based on necessarily simplified and idealised version of the building that does not and cannot fully represent all of the intricacies of the building once built. As a result, simulation results only represent an interpretation of the potential performance of the building. No guarantee or warrantee of building performance in practice can be based on simulation results alone.

2.7 TM54 methodology encourages the use more realistic energy modelling assumptions. It is required to report the energy consumption for the whole building, but in case of shell and core development, the targets are generally related to energy use on common areas and core services provided to tenanted areas. Where possible, technical information provided by the design team have been used in the modelling and assessment. However, in absence of information and data, NCM template has been used and some assumptions were made.

Building Envelop

2.8 The building envelope is the first opportunity for a building to reduce the demand for energy consumption and consequential greenhouse gas emissions. The proposed design for the building is outlined below and has been included in the energy model.

Air Tightness

2.9 Good air permeability of a building is required to achieve an air tightness of 8 m3/hr/m2 @ 50Pa to comply with building compliance for non-residential buildings with Part L2 of the Building Regulations 2021. To improve the building's energy performance, it is intended that the proposed development will be designed and built to achieve an air tightness of 3 m3/hr/m2 @ 50Pa.

2.10 The above has been translated into air infiltration of 0.10 ach-1 for the whole building. The above conversion has been based on table 4.19 from CIBSE Guide A 2015.

Fabric Performance

2.11 The table below 2.1 list the fabric performance which has been modelled.

Energy Efficiency Features	U-values (W/m²-k)
External solid walls - existing (W/m²K)	Ground floor and above floor: 0.18
	Basement Wall: 0.26
External new walls (W/m²K)	0.18
Ground Floor	0.12
Flat roof	0.11
New windows/glazed doors	1.2
New solid doors	1.2
Permeability Rate (m³/hm²) @ 50Pa Existing building	To be tested post-construction; improvement expected due to new wall and floor linings in most parts of the building – assumed to achieve AP rate of <8
Permeability Rate (m³/hm²) @ 50Pa New extension	3
Thermal Bridging (W/m²K)	Accredited Construction Details in new part

Table 2.1: Building Fabric Standard Specified for the New and Retained Elements

3.0 RESULTS

3.1 For each step, the operational parameters are explained, and the results are presented for each scenario. Wherever specific information was not available, BRE estimates were considered for occupancy density, occupancy profile, lighting, small power, and equipment loads, in accordance with good practice guidelines. All the detailed assumptions are included in Appendix A.

Step1: Establish Floor Areas

3.2 The following floor areas have been determined based on the Stage 4 drawings and layouts. Each room has been categorised into different space types.

- Basement: Pool, Gym Area, Communal spaces, Plant room.
- Ground Floor: Restaurant, Communal spaces.
- First Floor: Gym and Communal spaces.
- Second Floor: Office and Communal circulation.
- Third Floor: Office and Communal circulation.
- Fourth Floor: Restaurant, Office, and Communal circulation.
- Fifth Floor: Restaurant and Plant room.

Step 2: Establish Operating Hours And Occupancy Factors

3.3 The likely scenario assumes an occupancy density of 6 m^2/person in the gym and pool, 5 m^2/person in the restaurant, 9 m^2/person in offices, and 10 m^2/person for circulation spaces. For scenario testing, the occupancy density is varied as shown in the table below (Table 3.1) and the occupancy profile is presented in Table 3.2 and 3.3.

Occupancy	People/m^2			
	Likely	Low	High	Worst
Office	9	6.75	11.25	13.5
Gym	6	4.5	7.5	9
Pool	6	4.5	7.5	9
Circulation	10	7.5	12.5	15
Restaurant	5	3.75	6.25	7.5

Table 3.1: Occupancy Design data

3.4 The likely scenario assumes the following occupancy profiles, in line with the NCM template BRE estimate methodology:

Office			Gym			
Time	Weekday	Weekend	Time	Weekday	Time	Weekend
00:00	0	0	00:00	0	00:00	0
07:00	0	0	06:00	0	07:00	0
07:00	0.1	0	06:00	0.25	07:00	1
08:00	0.1	0	07:00	0.25	21:00	1
08:00	0.25	0	07:00	1	21:00	0
09:00	0.25	0	09:00	1	24:00	0
09:00	0.75	0	09:00	0.25		
10:00	0.75	0	10:00	0.25		
10:00	1	0	10:00	0		
12:00	1	0	11:00	0		
12:00	0.5	0	11:00	0.25		
14:00	0.5	0	12:00	0.25		
14:00	1	0	12:00	1		
16:00	1	0	14:00	1		
16:00	0.5	0	14:00	0.5		
18:00	0.5	0	15:00	0.5		
18:00	0	0	15:00	0		
24:00	0	0	17:00	0		
			17:00	0.5		
			18:00	0.5		
			18:00	1		
			21:00	1		
			21:00	0		
			24:00	0		

Table 3.2: Occupancy profile of the likely scenario for office and gym

Pool			Restaurant		
Time	Weekday	Weekend	Time	Weekday	Weekend
00:00	0	0	00:00	0	0
07:00	0	0	07:00	0	0
07:00	1	1	07:00	0.25	0.25
21:00	1	1	09:00	0.25	0.25
21:00	0	0	09:00	0.5	0.5
24:00	0	0	12:00	0.5	0.5
			12:00	1	1
			14:00	1	1
			14:00	0.5	0.5
			15:00	0.5	0.5
			15:00	0.25	0.25
			18:00	0.25	0.25
			18:00	0.5	0.5
			19:00	0.5	0.5
			19:00	1	1
			22:00	1	1

Pool			Restaurant		
Time	Weekday	Weekend	Time	Weekday	Weekend
			22:00	0.5	0.5
			23:00	0.5	0.5
			23:00	0	0
			00:00	0	0

Table 3.3: Occupancy profiles for the likely scenario for pool and restaurant

3.5 It can be seen that

- The Low-End Scenario reduces the operating hours by one hour for office, restaurants, gyms, and the swimming pool.
- The High-End Scenario assumes the same occupancy hours as the Likely Scenario.
- The Worst-Case Scenario further extends the occupancy for the above spaces by one hour.

Step 3: Lighting

3.6 The Lighting operating profiles are adjusted for the likely scenarios based on assumptions. Lighting profiles are presented for each occupancy type in Appendix B Step 3. The lighting energy consumption in presented in Figure 3.1.

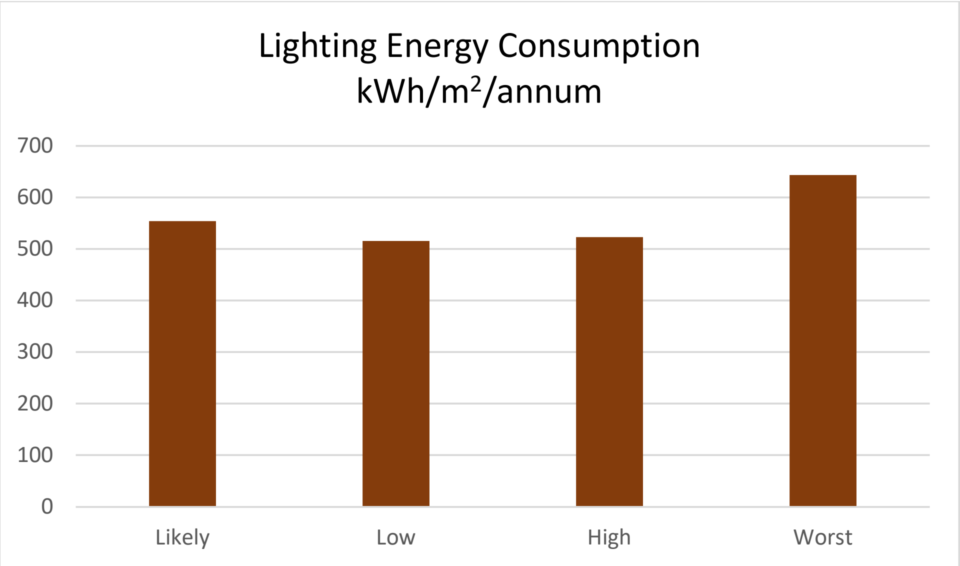

Figure 3.1: Annual Lighting Energy Consumption

Step 4: Lifts and Escalators

3.7 For the lifts, all the technical information has been provided. Please refer to Appendix B. The lifts annual energy consumption is presented in Figure 3.2. There are no escalators in the development.

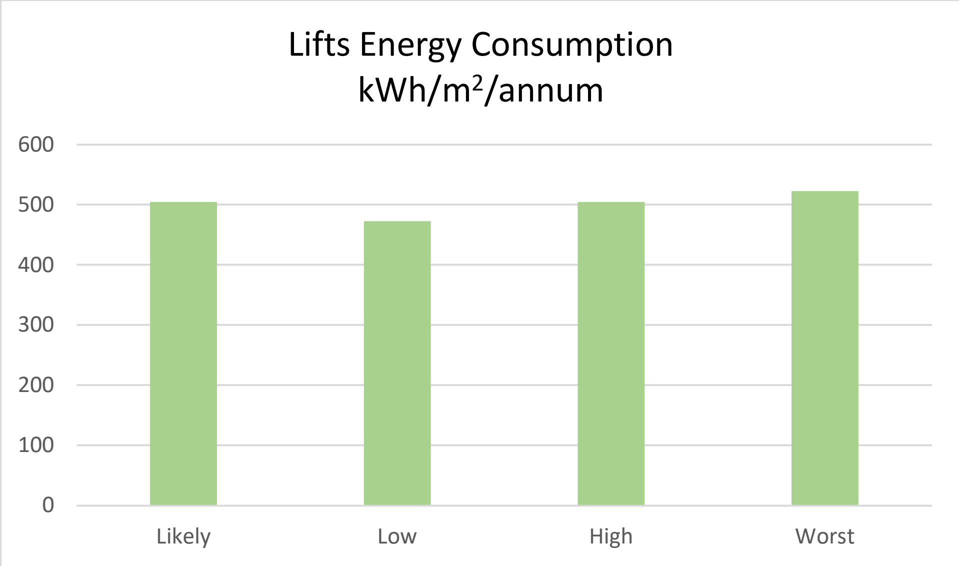

Figure 3.2: Annual Energy Consumption for Lifts

Step 5, Step 6 & Step 8: Small Power, Catering & Equipment

3.8 The information on small power and equipment load was not available, so good practice NCM template BRE estimates were considered. Small power and equipment load for the different areas have been calculated and presented in W/m², including the office, restaurant, gym, pool, and other spaces. Annual energy consumption for small power is presented in the figure below (Figure 3.3).

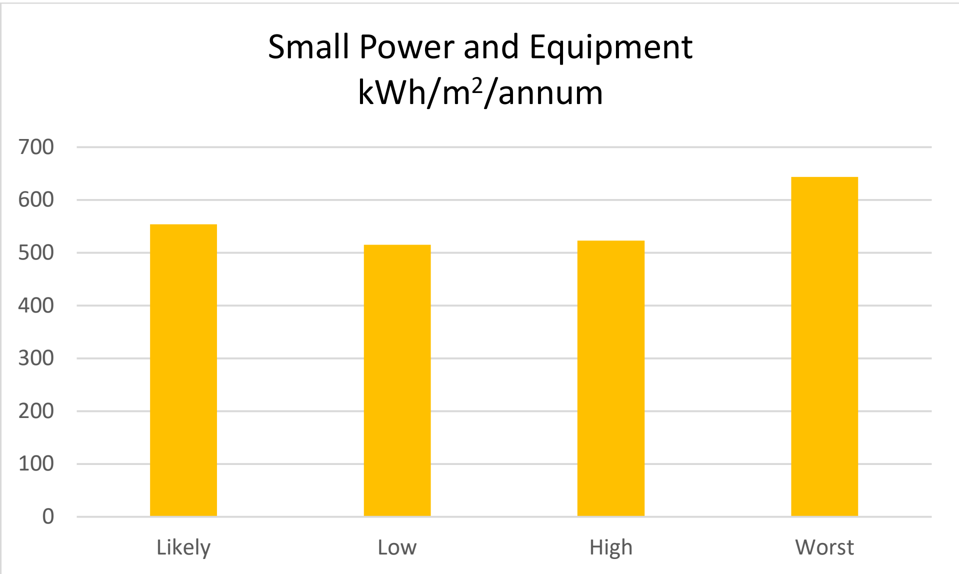

Figure 3.3: Annual Energy Consumption for Small Power and Equipment

Step 6: Catering

3.9 The restaurant will have a kitchen that will offer catering services. However, since the information on the catering services was not confirmed, so good practice NCM template BRE estimates were considered.

Step 7: Server Rooms

3.10 There are no server rooms in the building.

Step 8: Other Equipment

3.11 The information on small power and equipment load was not available, so good practice NCM template BRE estimates were considered.

Step 9: Domestic Hot Water

3.12 The number of occupants for each scenario has been determined by using occupancy densities from Step 2. Provide the assumptions for different scenarios. The domestic hot water annual energy consumption is presented in Figure 3.4.

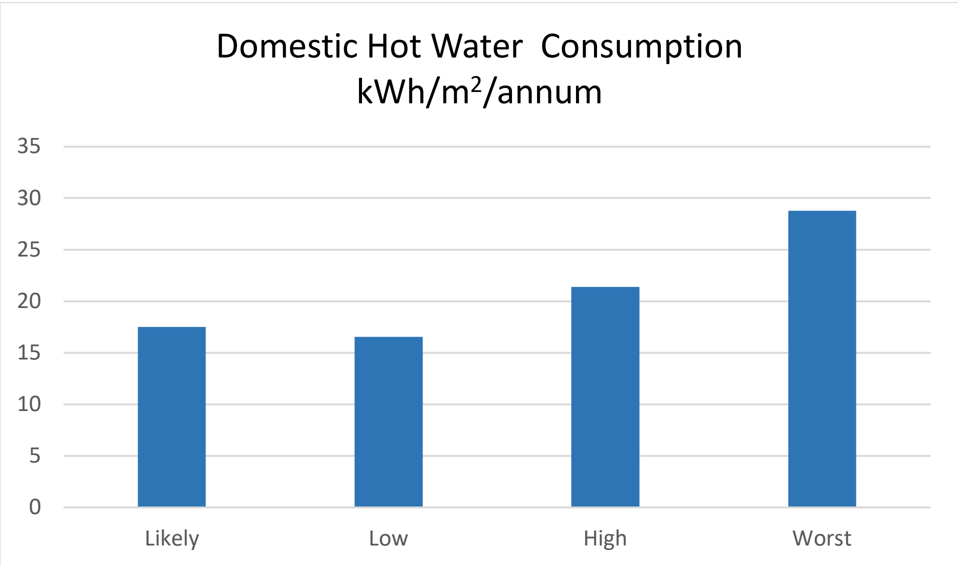

Figure 3.4: Annual Domestic Hot Water Consumption

Step 10: Internal Heat Gain

3.13 Internal gains within the energy model (only used to determine space heating and cooling) are as per the above steps.

Step 11: Modeling Hvac System and Their Controls

3.14 The space heating and space cooling loads have been undertaken using the above bespoke internal gains and profiles in a DSM (Dynamic Simulation Model).

3.15 For restaurants, gym and offices, HVAC plant follows the occupancy profile.

3.16 Pump energy has been determined using the methodology within ApacheHVAC and allocated based on the default specific fan power.

3.17 The heating annual energy consumption is presented in Figure 3.5.

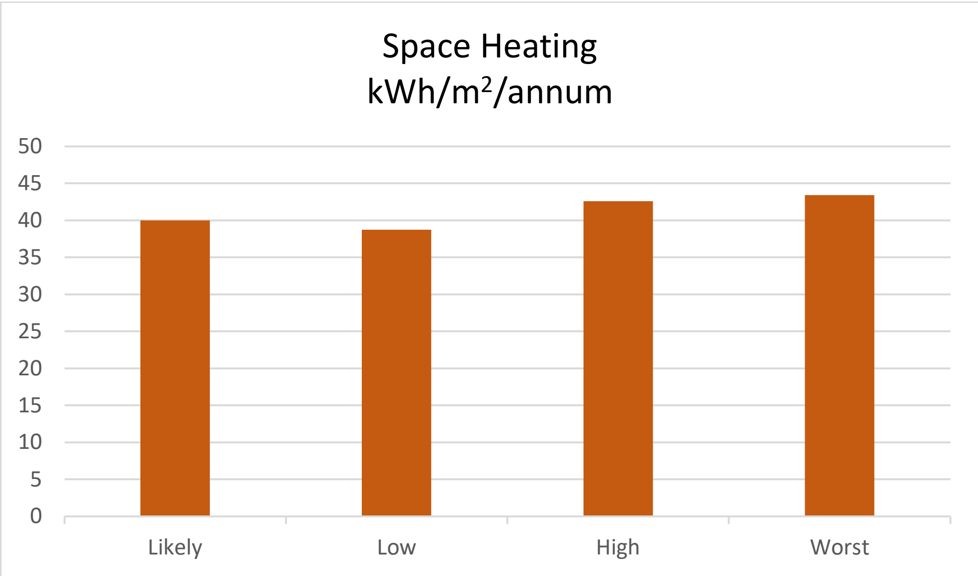

Figure 3.5: Annual Energy Consumption for Space Heating

3.18 The cooling annual energy consumption is presented in Figure 3.6.

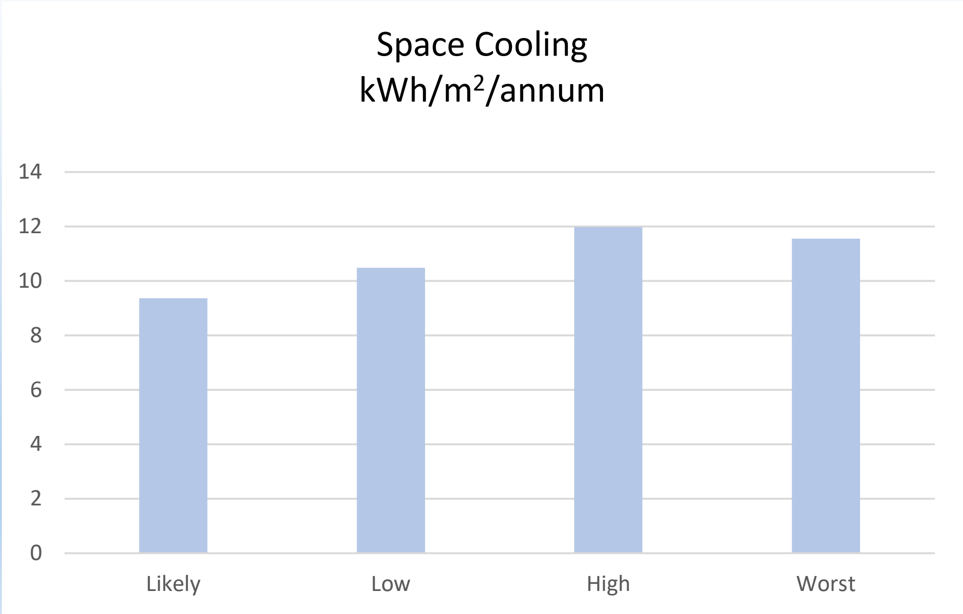

Figure 3.6: Annual Energy Consumption for Cooling

3.19 The auxiliary annual energy consumption (fans and pumps) is presented in Figure 3.7.

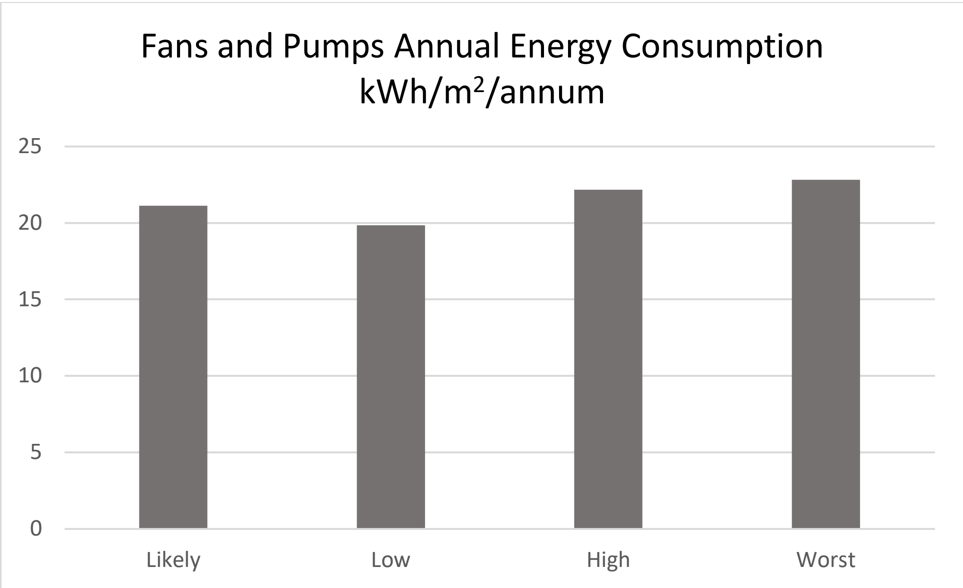

Figure 3.7: Annual Energy Consumption for Fans and Pumps

Step 12: Humidification & Dehumidification

3.20 No humidification or dehumidification has been accounted for.

4.0 COMPARISION AND BENCHMARKING

4.1 Comparing this to CIBSE Energy Benchmarks* (CIBSE Guide F: 2012) shows that if the building is operated as anticipated (Likely scenario)

Building type	Energy consumption benchmarks for existing buildings Basis of benchmark / (kWh·m^2) per year			
	Good practice		Typical practice	
	Fossil fuels	Electricity	Fossil fuels	Electricity
Office- air conditioned, standard	97	128	178	226
Sports and recreation- Swimming Pool	573	152	1336	237
Sports and recreation- Fitness centre	201	127	449	194
Restaurant-Fast food	480	820	670	890
Public House	1.5	0.8	3.5	1.8

Table 4.1: Energy Benchmark from CIBSE Guide F

4.2 Total Energy: **68%** below Typical and **52%** below Good Practice

4.3 However, if the occupancy period, occupancy density and small power and equipment loads are tested against extreme weather condition, the annual total energy consumption of the building are higher than anticipated, and the use of domestic hot water, small power, and equipment is higher (High End Scenario):

4.4 Total Energy: **66%** below Typical and **50%** below Good Practice

4.5 If the occupancy period, occupancy density, and small power and equipment loads of the building are much higher than anticipated, and the use of lighting, domestic hot water, equipment, and lifts are tested against extreme weather conditions, the annual total energy consumption of the building will be much higher (Worst Case Scenario).

4.6 Total Energy: **63%** below Typical and **46%** below Good Practice

4.7 Figure 4.1 compares the annual energy consumption against typical and good practice scenarios and table 4.2 compares annual energy consumption by the end use and presents the total energy consumption for different scenarios.

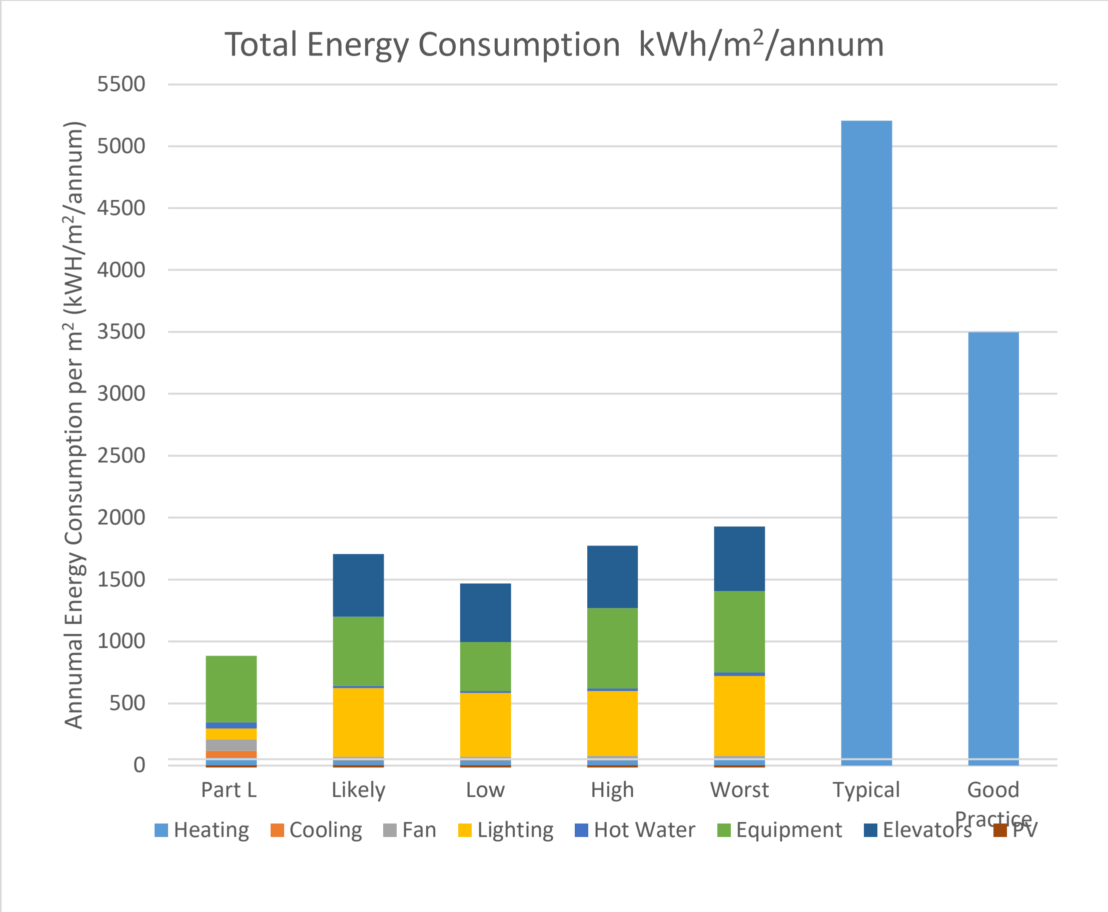

Figure 4.1: Comparison of annual energy consumption

Total Energy Consumption (kWh/m²)	Likely	Low	High	Worst
% Improvement against Good Practice	52%	59%	50%	46%
% Improvement against Typical	68%	72%	66%	63%

Table 4.2: Comparison of total energy consumption

End Use (kWh/m²)	Part L	Likely	Low	High	Worst
Heating	**7.49**	4.77	4.61	5.08	5.18
Cooling	**6.56**	1.12	1.28	1.43	1.38
Fan	**11.01**	2.52	2.37	2.65	2.72
Lighting	**10.31**	66.06	61.48	62.41	76.74
Hot Water	**5.85**	2.09	1.98	2.55	3.43
Equipment	**64.32**	66.73	47.12	77.39	78.30
Elevators	**0.00**	60.19	56.40	60.19	62.35
PV	**-3.32**	-2.48	-2.48	-2.85	-2.85
Total Energy Consumption	**102.23**	201.00	172.75	208.85	227.26

Table 4.3: Annual energy consumption by end use

5.0 DISPLAY ENERGY CERTIFICATE

5.1 Not required at this stage

6.0 CARBON DIOXIDE EMISSIONS

6.1 In the following section carbon dioxide emissions are calculated for each scenario as a result of the energy consumption (including energy generation).

6.2 The total annual energy consumption by fuel type and end use is presented in Table 6.1 and the annual energy intensity is presented in Table 6.2.

6.3 Using the SAP 10.0 carbon factors (0.233 $kgCO_2$.kWh for electricity and 0.20226 $kg.CO_2$.kWh for gas), the annual total carbon emissions by fuel type and end use are presented in table 6.3 and 6.4.

Consumption (MWh)	Part L	Likely	Low	High	Worst
Heating	62.79	39.99	38.63	42.60	43.43
Cooling	55.01	9.36	10.73	11.97	11.55
Fan	92.27	21.12	19.85	22.18	22.81
Lighting	86.37	553.64	515.20	523.05	643.17
Hot Water	49.05	17.50	16.56	21.37	28.76
Equipment	539.05	559.21	394.87	648.58	656.20
Elevators		504.44	472.68	504.44	522.54
PV	-27.80	-20.75	-20.75	-23.89	-23.90
Total Energy Consumption	856.75	1684.51	1447.78	1750.31	1904.58

Table 6.1 Comparison of Annual Energy Consumption

Consumption in kWh/m^2	Likely	Low End	High End	Worst Case
Total Electricity Intensity (including LZC) (kWh/m^2)	197.87	169.62	214.85	222.98
Total Gas Intensity (kWh/m^2)	3.13	3.11	3.56	4.28
Total Energy Intensity (including LZC) (kWh/m^2)	201.00	172.73	218.40	227.26

Table 6.2: Comparison of Annual Energy Intensity (including LZC)

Carbon Dioxide Emissions in tonnes CO_2	Likely	Low	High	Worst
Heating	9.32	9.00	9.93	10.12
Cooling	2.18	2.50	2.79	2.69
Fan	4.92	4.63	5.17	5.32
Lighting	129.00	120.04	121.87	149.86
Hot Water	3.59	3.37	4.49	6.21
Equipment	130.30	92.00	151.12	152.90
Elevators	117.53	110.13	117.53	121.75
PV	-4.83	-4.83	-5.57	-5.57
Total Carbon Emissions	392.00	336.85	407.34	443.28

Table 6.3: Comparison of Annual Carbon Emissions- SAP 10.0 factors

Carbon Intensity in $kgCO2/m^2$	Likely	Low End	High End	Worst Case
Total Electricity (inc. LZC) Carbon Intensity ($kg.CO_2/m^2$)	46.10	39.52	50.06	51.95
Total Gas Carbon Intensity ($kg.CO_2/m^2$)	0.63	0.63	0.72	0.87
Total Carbon Intensity (including LZC) ($kgCO_2/m^2$)	46.74	40.15	50.78	52.82

Table 6.4: Comparison of Annual Carbon Intensity – SAP 10.0 factors

7.0 BE SEEN REPORTING SPREADSHEET INPUTS

7.1 Aligning with the above analysis and the Energy Strategy, the following values were input in the 'Be Seen' reporting spreadsheet:

7.2 Non-Residential Elements of the development (Part L Calculation)

Annual Electricity Use	**kWh/yr**	**855,847**
Annual Gas Use	kWh/yr	903
Elec Generation, Gross (if applicable)	kWh/yr	27,796
Total Energy Use	kWh/yr	**856,750**
Predicted Annual Carbon Emissions	tCO_2/yr	78

7.3 Non-Residential Elements of the development (TM54 Calculation)

Annual Electricity Use	**kWh/yr**	**1,658,285**
Annual Gas Use	kWh/yr	26,220
Elec Generation, Gross (if applicable)	kWh/yr	20,745
Total Energy Use	kWh/yr	**1,684,505**
Predicted Annual Carbon Emissions	tCO_2/yr	392

8.0 CONCLUSION AND RECOMMENDATIONS

8.1 The results have clearly demonstrated that the operational energy performance of the building is dependent on the level of occupancy and operation of the building. With low occupancy and good operation (Likely or Low-End Scenarios) the building will consume significantly less than Good Practice benchmarks, however if the building has high occupancy and unmanaged operation (Worst Case Scenario) the building will still perform better than Good Practice benchmarks, but with an energy increase of approx. 4%-12%.

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