Operational Carbon Summary Report, RIBA Stage 2 Analysis.

HADSCAL,
Hay-on-Wye.

02/11/2026

Quality Management

Issue/ Revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft Issue for Comment	Updated to include lifts		
Date	30/10/2026	02/11/2026		
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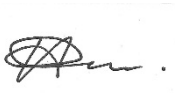
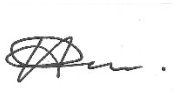
Position	Senior Sustainability Consultant	Senior Sustainability Consultant		
Signed				
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Position	Associate Director	Associate Director		
Signed				
Project Number	P-01436	P-01436		

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1.0 EXECUTIVE SUMMARY

RedSix have been appointed to undertake an Operational Carbon assessment for the proposed development at HADSCAL, Hay-on-Wye, Wales.

The proposed development comprises of a new leisure centre and community centre, 10no, business units, community gardens and external sports and leisure spaces.

The energy model for the HADSCAL development was created within IES Virtual Environment 2026. This is a suitable dynamic simulation model that has advanced capabilities for modelling accurate HVAC systems and controls.

Both regulated and unregulated energy usage has been determined for the two sites and have been calculated in accordance with CIBSE TM54:2022 'Evaluating Operational Energy Performance of Buildings at the Design Stage.'

The pie charts below show the modelled operational energy consumption per annum, highlight that unregulated energy consumption is a large proportion of energy consumption for both the leisure and community centre and the business units. In both cases, the energy consumption modelled is less than the corresponding CIBSE TM46:2008 Energy Benchmarks.

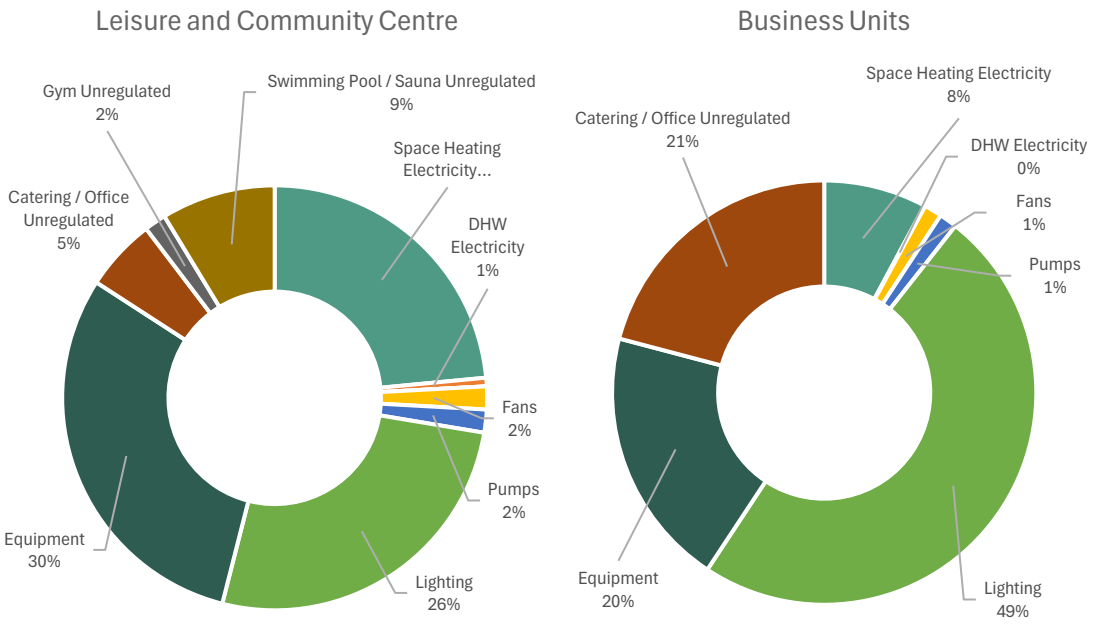


Figure 1: Summary Results Charts

2.0 BACKGROUND

The prediction of a building's energy performance and its actual performance can sometimes differ. This can be due to several reasons, such as the following:

- Changes of occupancy schedules
- Changes of installed equipment loads
- Differences of building component performances, such as degradation over time
- Imperfect installation of building systems and controls
- Imperfect commissioning and handover
- Human behaviour and lack of operational knowledge

This analysis aims to encourage all those involved in the building design, construction, commissioning, facilities management, and operation to take steps to close the energy performance gap.

The expected outcomes and benefits of completing this analysis are:

- Improved energy performance of the building
- More realistic modelling through better modelers and better models
- Improved design decisions
- Better commissioning
- Better facilities management
- Lower running costs
- More productive occupants

The following report has been completed at RIBA stage 2.

3.0 THE ENERGY MODEL

3.1 Climate Data

CIBSE weather data has been used based on geographical location of the site. BRE recommends using the nearest available Test Reference Year (TRY) weather data. For this development, the CardiffTRY weather file has been used.

3.2 Building Typology and Geometry

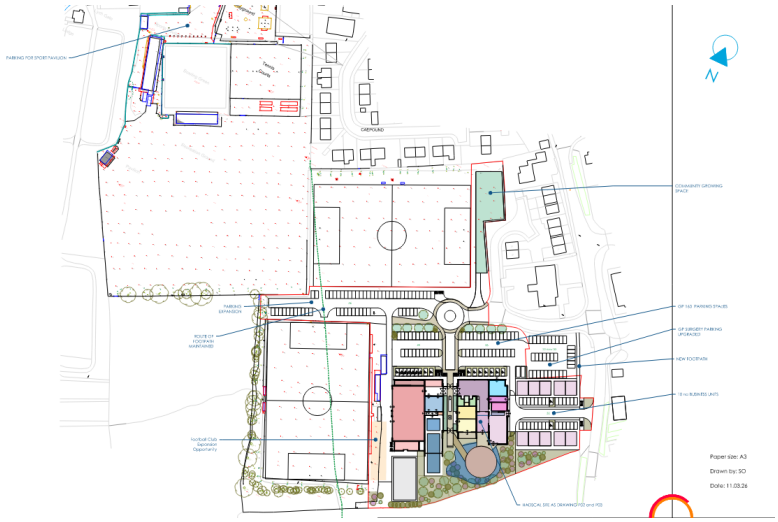


Figure 2: Site Layout Plan

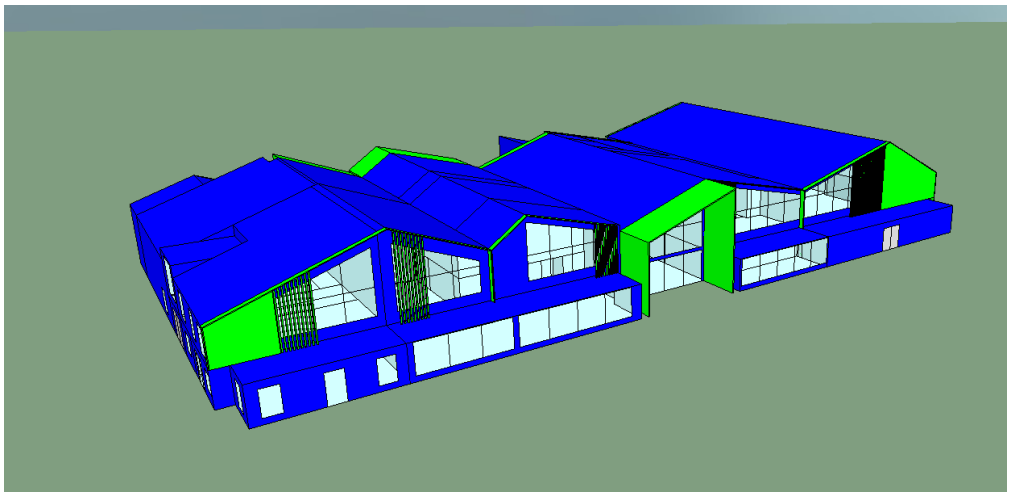


Figure 3: Leisure and Community Centre Model Image 1

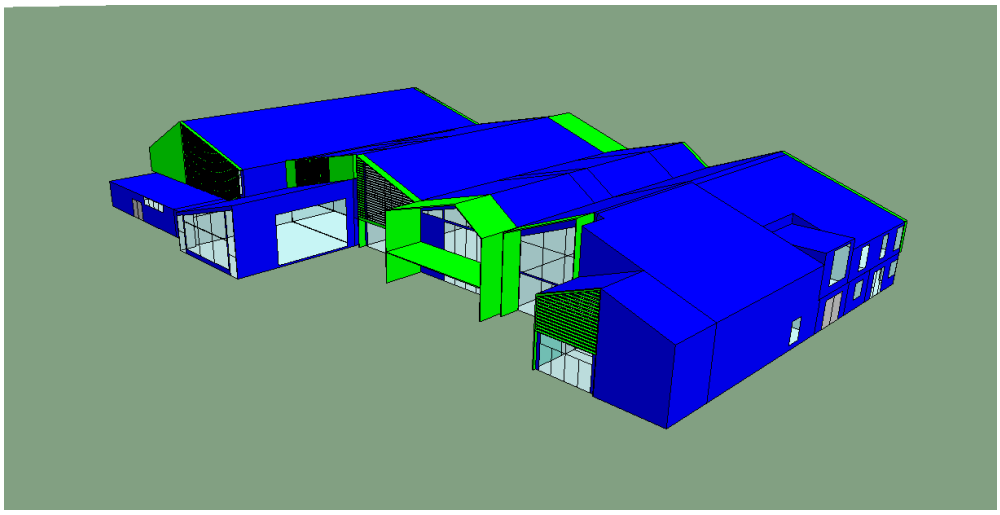


Figure 4: Leisure and Community Centre Model Image 2

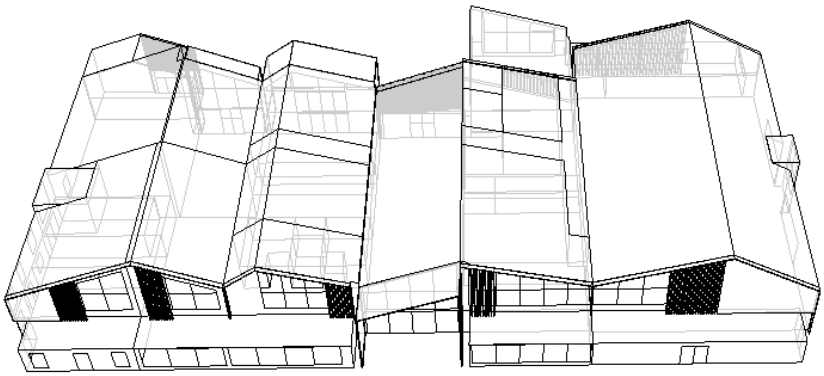


Figure 5: Leisure and Community Centre Model Image 3

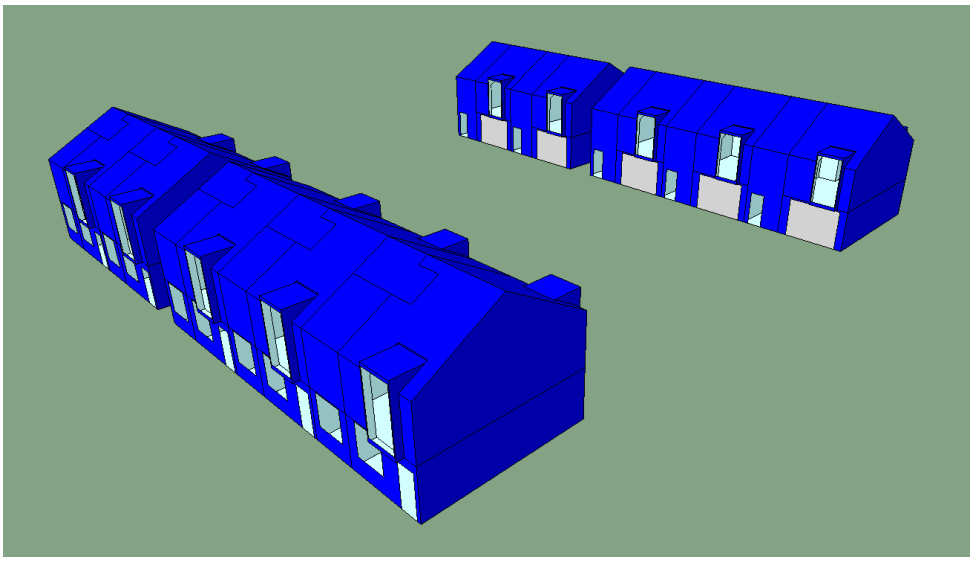
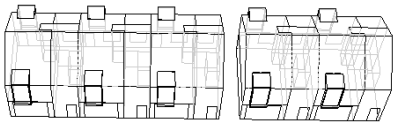


Figure 6: Business Units Model Image 1



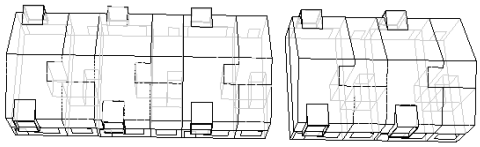


Figure 7: Business Units Model Image 2

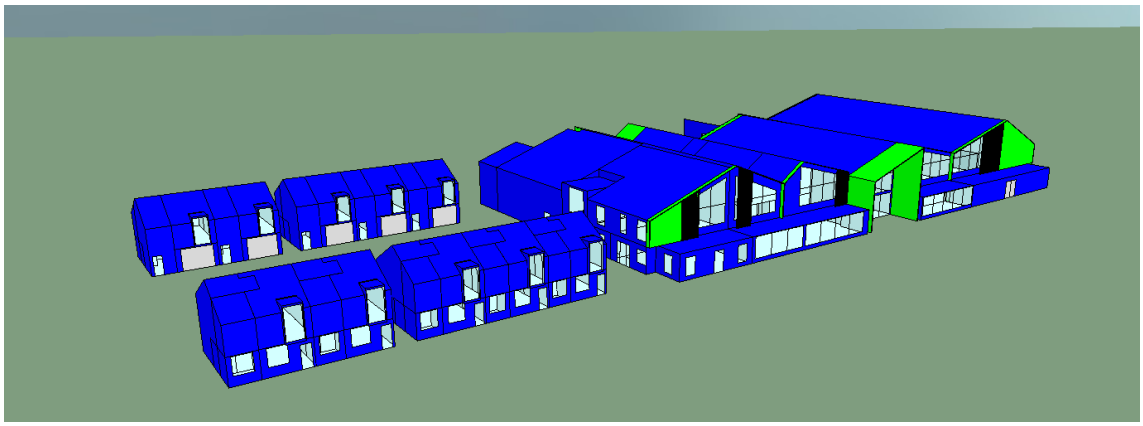


Figure 8: Whole Site Model Image

The following table shows the U-values for the construction of the unit which have been modelled.

Table 1: Construction U-Values

Construction	U-Value	
	Leisure and Community Centre	Business Units
External Wall	0.15 W/m^{2}K	0.12 W/m^{2}K
Wall between Sports Hall/Pool and leisure centre	0.15 W/m^{2}K	-
Ground floor	0.15 W/m^{2}K	0.12 W/m^{2}K
Roof	0.15 W/m^{2}K	0.12 W/m^{2}K
Ceiling above pool	0.15 W/m^{2}K	-
Windows/Curtain walling	1.4 W/m^{2}K g-value: 0.4	1.4 W/m^{2}K g-value: 0.4
Personnel Doors (Glazed)	1.4 W/m^{2}K g-value: 0.4	1.4 W/m^{2}K g-value: 0.4
Personnel Doors (Opaque)	1.6 W/m^{2}K	1.6 W/m^{2}K
Air permeability	3m^3/h.m^2 @ 50 Pa	3m^3/h.m^2 @ 50 Pa

3.3 Floor Area

The table below provides an overview of the floor area. The thermal templates were made up specifically for the leisure and community centre and taken from the most appropriate NCM template for the business units and modified to best represent the developments occupancy, building services and lighting and equipment usage.

Table 2: Modelled Floor Area

Leisure and community centre floor area (m^2)	3,625
Business units floor area (m^2)	1,015
Total Floor area (m^2)	**4,640**

3.4 HVAC System Types

Heating and Cooling

The development is served primarily by a borehole ground source heat pump to underfloor heating, with the exception of the leisure and community centre atrium, pool and sports hall, which are all unheated. At this stage, a conservative, default COP has been used for the heating system.

Table 3: Heating and Cooling Systems

Heating System	Heat/ Cooling Source	Efficiency
Under floor heating	Heat pump (electric): Ground Source	2.55

Hot Water

The domestic hot water across the site will be served by the same system, as detailed below in Table 4. This will be a heat pump, raising the water to 35°, with an electric immersion top up. Any boost requirements will be met by the Solar PV system

Table 4: Hot Water Systems

Heating System	Heat/ Cooling Source	Efficiency
Hot water cylinder	Heat pump (electric): Ground Source with electric immersion top up	2.5

Ventilation

The leisure and community centre and the business units also benefit from an MVHR system, as detailed in Table 5. The areas which have been modelled as served by the MVHR are shown in Table 6 below.

Table 5: Ventilation Systems

Ventilation Type	Air Supply	Heat Recovery	Efficiency
MVHR System	Centralised balanced A/C or local MVHR system	Plate heat exchanger (Recuperator)	0.80

Table 6: Ventilation Areas and Rates

Building	Area	Ventilation Rate
Leisure and community centre	Changing rooms	10 ach/hr
	Kitchen	6 ach/hr
	Dail-a-ride	10 l/s/person
	First aid	10 l/s/person
	Function rooms	10 l/s/m^2
	Sports hall	10 l/s/person
	Tuck shop	10 l/s/person
	Youth rooms	10 l/s/person
	Fitness studio	10 l/s/person
	Gym	10 l/s/person
	Library	10 l/s/person
	Meeting room	10 l/s/person
	Music studio	10 l/s/person
	Spaces to let	10 l/s/person
Business units	Workspaces	10 l/s/person
	Flexispaces	10 l/s/person
	Offices	10 l/s/person

3.5 Solar PV Panels

The project currently has a proposal of 288no. 450 W panels, equating to circa 130 kWp of PV.

4.0 METHODOLOGY

The full dynamic simulation is in accordance with CIBSE TM54:2013 that combines the effects of:

- CIBSE Design Summer Year (DSY) weather data and CIBSE Test Reference Year (TRY) weather data
- Equipment, lighting and people heat gains
- Fresh air supply
- Occupancy and variation
- Building fabric
- Solar heat gains and shading.

4.1 Occupancy

The opening hours for the leisure and community centre, and the business units are shown below:

Leisure centre: **9am until 10pm**, every day
Number of hours occupied: **4,745** hours a year

Community Centre: **9am until 7pm**, every day
Number of hours occupied: **3,650** hours a year

Business Units: **8am until 6pm**, every day
Number of hours occupied: **3,650** hours a year

The NCM templates were used for the business units, and the operational profiles for the leisure and community centre can be updated as the project progresses and operational profiles become more apparent.

4.2 Set Points

Table 7 shows the various heating setpoints used where present.

Table 7: Heating Setpoints

Building	Space	Heating Setpoint (°C)	Set-back Setpoint (°C)
Leisure and community centre	Café	20	12
	Changing rooms	22	12
	Office-like	20	12
	Toilets	20	12
	Youth clubs	20	12
	Function rooms	20	12
Business units	Office	22	12
	Sales area	20	12
	Kitchenette	22	12
	Toilets	20	12

4.3 Lighting Energy Use

The lighting profiles modelled have been shown in the table below.

Table 8: Lighting Lux Levels

Building	Space	Lighting Illuminance (lux)
Leisure and community centre	Atrium	100
	Café	150
	Changing rooms	100
	Circulation	100
	Dial-a-ride	400
	First-aid	400
	Fitness studio	150
	Function/ youth club rooms	300
	Gym	150
	Kitchen	500
	Library	400
	Meeting room	400
	Music studio	400
	Reception	200
	Spaces to let	400
	Sports hall	300
	Storage	50
	Swimming pool	300
	Toilets	200
Business units	Circulation	100
	Sales area	600
	Kitchenette	400
	Office	400
	Toilet	200

4.4 Unregulated Energy Use

There are numerous unregulated energy sources present within the development. The use of general office equipment has been determined through the simulation model. It has considered the number of workstations in each area along with estimates of the average power consumptions of the equipment.

The simulation model however does not calculate the energy use for other unregulated equipment. As there is a significant amount of unregulated equipment within the leisure and community centre, an estimation has been undertaken in order to determine the likely unregulated energy use. This includes any catering equipment, refrigeration and vending machines, gym equipment, pool plant, the sauna and additional office equipment such as large-photocopiers, kettles and microwaves.

The energy consumption from these items have been calculated in accordance with CIBSE TM54:2013 and CIBSE Guide F: Energy Efficiency in Buildings where possible. Quantities have been taken or assumed based on space type. The estimates of local small power equipment have been shown below:

Table 9: Unregulated Equipment – Leisure and Community Centre

Category	Type	Quantity	Average Power Demand (W)	Sleep Mode Power Demand (W)	Load Factor	Annual Consumption (kWh/annu,)
Catering / office	Commercial refrigerator	1	700	-	1	6,132
	Commercial freezer	1	500	-	1	4,380
	Commercial electric oven	1	6,000	100	0.4	12,074
	Commercial dishwasher	1	6,500	50	0.2	6,559
	Large photocopier/MFD	1	400	5	0.15	325
	Kettle	1	700	300	0.15	2,913
	Microwaves	1	700	20	0.15	659
	Refrigerated vending machine	3	170	30	1	4,468
Gym	Treadmill	6	750	10	0.3	6,846
	Cross trainer	4	250	5	0.25	1,338
	Exercise bike	4	100	2	0.25	535
	Rowing machine	2	50	1	0.2	111
	Television screens	4	100	2	1	1,930
	Music/AV system	1	100	10	1	515
Swimming Pool	Main circulation pump	1	3,000	-	-	26,280
	Secondary/feature pump	1	1,500	-	-	13,140
	Chemical dosing system	1	100	-	-	876
	Pool water treatment controls	1	100	-	-	876
Sauna	Sauna heater	1	6,000	100	0.6	17,673
	Sauna lighting	1	50	5	1	257
	Controls	1	10	2	1	55

Table 10: Unregulated Equipment – Business Units

Category	Type	Quantity	Average Power Demand (W)	Sleep Mode Power Demand (W)	Load Factor	Annual Consumption (kWh/annu,)
Business Units	Refrigerator	10	150	-	1	8,395
	Dishwasher	10	1,500	5	0.15	9,473
	Large photocopier/MFD	10	2,500	1	0.1	10,128
	Kettle	10	1,000	5	0.05	2,470
	Microwaves	10	400	5	0.15	2,848

Equation 1: Small power load consumption

Energy Use = (power demand during operation x hours of operation x load factor) + (out of hours power demand x (8760 – hours of operation) x (1 – load factor))/1000

The results for the unregulated energy uses determined from this calculation are shown below:

Table 11: Unregulated Energy Consumption - Leisure and Community Centre

Type	Energy consumption (kWh/annum)
Catering / office	37,510
Equipment	205,487
Gym	11,274
Swimming pool	41,172
Sauna	17,986
Total unregulated power consumption	**313,429**

Table 12: Unregulated Energy Consumption – Business Units

Type	Energy consumption (kWh/annum)
Catering / office	33,313
Equipment	31,593
Total unregulated power consumption	**64,906**

4.5 Lift Energy

Lift energy consumption is also excluded from the model simulation. There is one lift present within the development. A propriety energy calculator by TKElevator has been used to estimate the annual lift consumption, shown in the table below.

Table 13: Unregulated Energy Consumption - Lifts

Type	Energy consumption (kWh/annum)
Lift 1	4,323
Total lift energy consumption	**4,323**

4.6 Domestic Hot Water Energy Use

The simulation model has determined the domestic hot water energy use in accordance with CIBSE TM54:2013.

Equation 2: Hot water consumption

Annual energy consumption = mass of water (kg) x Temperature difference (K) x specific heat capacity of water (kj/kg.K) / 3600

4.7 Internal Heat Gains

The internal heat gains from all equipment and processes in the building are calculated within the simulation. These include lighting gains; equipment gains and occupant gains. The tables below provide a summary of the internal gains for the development.

Table 14: Internal Gains Summary – Leisure and Community Centre

Name	People Max Latent Gains (W)	People Max Sensible Gains (W)	Lighting Max Sensible Gains (W)	Equipment Max Sensible Gains (W)
0_Atrium	1,793.40	1,793.40	1,332.24	512.40
0_Cafe	2,737.76	4,282.14	2,239.98	5,060.07
0_Changing	1,174.10	1,174.10	610.53	679.80
0_Circulation1	499.73	499.73	371.23	142.78
0_Circulation2	64.68	64.68	48.05	18.48
0_Circulation3	135.45	135.45	100.62	38.70
0_Dail-a-ride	624.58	911.89	1,686.38	1,513.24
0_Equipment_Store	582.40	582.40	140.40	0.00
0_First_Aid	69.17	100.98	186.75	167.58
0_Football_Changing	962.50	962.50	500.50	557.29
0_Function1	485.44	750.23	826.14	105.92
0_Function1	1,717.63	2,654.51	2,923.09	374.76
0_Function2	943.20	1,457.68	1,605.16	205.79
0_Kitchen	697.98	375.83	1,240.85	1,452.27
0_Leisure_Reception	312.88	483.54	473.30	245.75
0_Pool	2,179.23	1,141.50	1,942.63	249.06
0_Pool	2,654.27	1,390.33	2,366.09	303.35
0_Sauna	126.00	66.00	112.32	14.40
0_Sports_Hall	6,580.51	3,389.96	11,146.98	1,507.70
0_Storage	409.87	409.87	98.81	0.00
0_Toilets1	176.41	176.41	259.48	124.75
0_Toilets2	188.17	188.17	276.77	133.06
0_Tuck_Shop	68.75	106.25	117.00	15.00
0_Void	0.00	0.00	0.00	0.00
0_Youth_Clean	901.98	1,393.96	1,535.00	196.80
0_Youth_Messy	892.76	1,379.73	1,519.32	194.79
1_Bridge	504.47	504.47	374.75	144.14
1_Bridge_Gallery	230.04	230.04	170.88	65.72
1_Fitness_Studio	1,596.54	822.46	471.70	120.95
1_Gym	5,580.55	2,874.83	1,319.04	2,709.10
1_Library	660.57	964.43	1,783.54	1,600.43
1_Meeting_Room	686.07	1,001.66	1,852.39	1,662.21
1_Music_Studio	151.67	221.43	409.50	367.46
1_Spaces_to_Let	873.75	1,275.68	2,359.13	2,116.92
1_Store	135.33	135.33	32.63	0.00
1_WC	166.87	166.87	245.44	118.00

Table 15: Internal Gains Summary – Business Units

Name	People Max Latent Gains (W)	People Max Sensible Gains (W)	Lighting Max Sensible Gains (W)	Equipment Max Sensible Gains (W)
Unit01_Workspace	168.83	246.49	532.35	429.03
Unit01_WC	19.17	19.17	27.46	11.01
Unit01_Kitchenette	28.55	41.69	90.04	72.56
Unit01_Office	28.55	41.69	90.04	72.56
Unit01_FlexiSpace	287.28	287.28	351.15	182.60
Unit01_Stairs	117.58	117.58	84.21	33.69
Unit02_Workspace	168.83	246.49	532.35	429.03
Unit02_WC	19.17	19.17	27.46	11.01
Unit02_Kitchenette	28.55	41.69	90.04	72.56
Unit02_Office	28.55	41.69	90.04	72.56
Unit02_FlexiSpace	287.28	287.28	351.15	182.60
Unit02_Stairs	117.58	117.58	84.21	33.69
Unit03_Workspace	168.83	246.49	532.35	429.03
Unit03_WC	19.17	19.17	27.46	11.01
Unit03_Kitchenette	28.55	41.69	90.04	72.56
Unit03_Office	28.55	41.69	90.04	72.56
Unit03_FlexiSpace	287.28	287.28	351.15	182.60
Unit03_Stairs	117.58	117.58	84.21	33.69
Unit04_Workspace	168.83	246.49	532.35	429.03
Unit04_WC	19.17	19.17	27.46	11.01
Unit04_Kitchenette	28.55	41.69	90.04	72.56
Unit04_Office	28.55	41.69	90.04	72.56
Unit04_FlexiSpace	287.28	287.28	351.15	182.60
Unit04_Stairs	117.58	117.58	84.21	33.69
Unit05_Workspace	168.83	246.49	532.35	429.03
Unit05_WC	19.17	19.17	27.46	11.01
Unit05_Kitchenette	28.55	41.69	90.04	72.56
Unit05_Office	28.55	41.69	90.04	72.56
Unit05_FlexiSpace	287.28	287.28	351.15	182.60
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Unit06_Workspace	168.83	246.49	532.35	429.03
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Unit06_Office	28.55	41.69	90.04	72.56
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Unit06_Stairs	117.58	117.58	84.21	33.69
Unit07_Workspace	168.83	246.49	532.35	429.03
Unit07_WC	19.17	19.17	27.46	11.01
Unit07_Kitchenette	28.55	41.69	90.04	72.56

Unit07_Office	28.55	41.69	90.04	72.56
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Unit10_Kitchenette	28.55	41.69	90.04	72.56
Unit10_Office	28.55	41.69	90.04	72.56
Unit10_FlexiSpace	287.28	287.28	351.15	182.60
Unit10_Stairs	117.58	117.58	84.21	33.69

5.0 RESULTS

5.1 Leisure and Community Centre

Figure 9 to Figure 11 and Table 11 show the results of the unregulated and regulated energy consumption at the leisure and community centre using the design specification and assumptions detailed in this report using the TM54:2013 methodology.

The graphs below show that equipment and lighting accounts for the majority of the annual energy consumption. This is due to the use of generic data at this stage of the assessment. It is likely that, as the design progresses and more accurate data becomes available, these values will decrease. Figure 11 also shows that a significant amount of energy use is predicted to be unregulated energy use, primarily from the pool and sauna followed by the catering and office unregulated energy, accounting for 46% of the overall energy use.

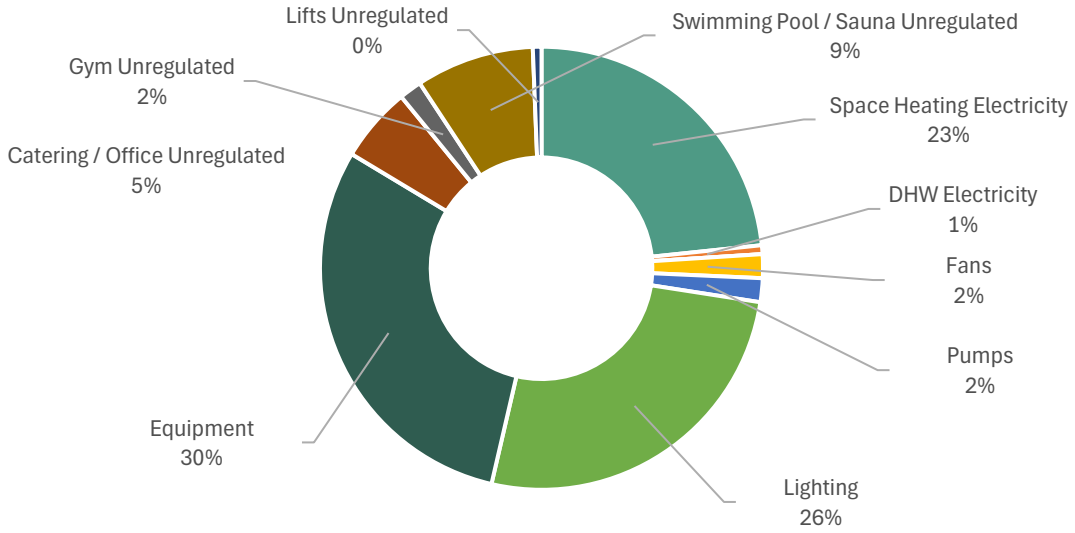

Figure 9: Annual Energy Consumption Pie Chart – Leisure and Community Centre

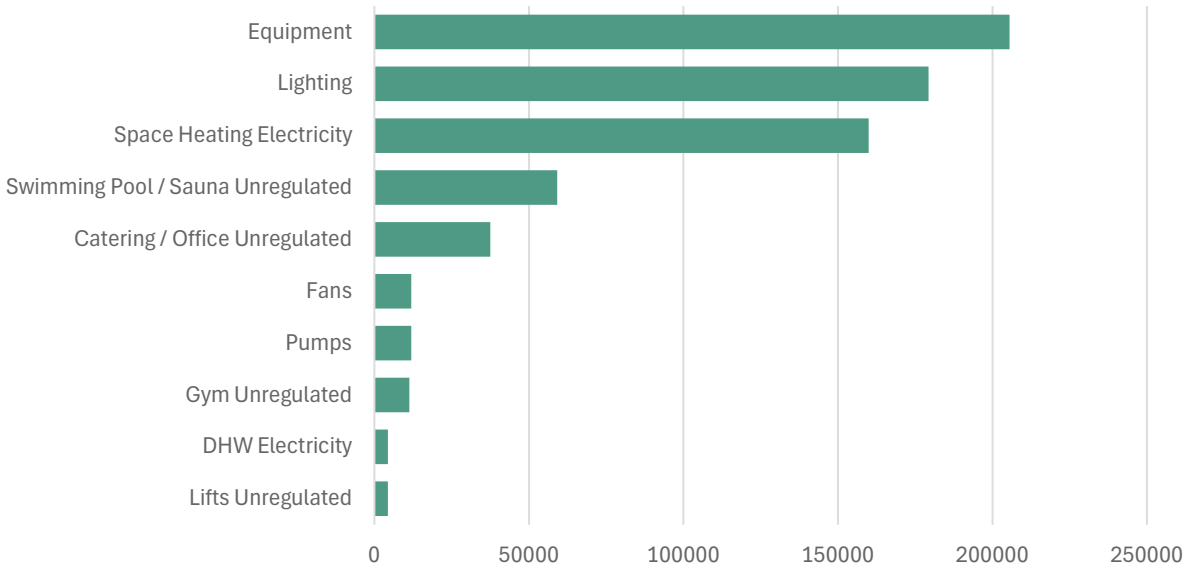

Figure 10: Annual Energy Consumption Horizontal Bar Chart – Leisure and Community Centre

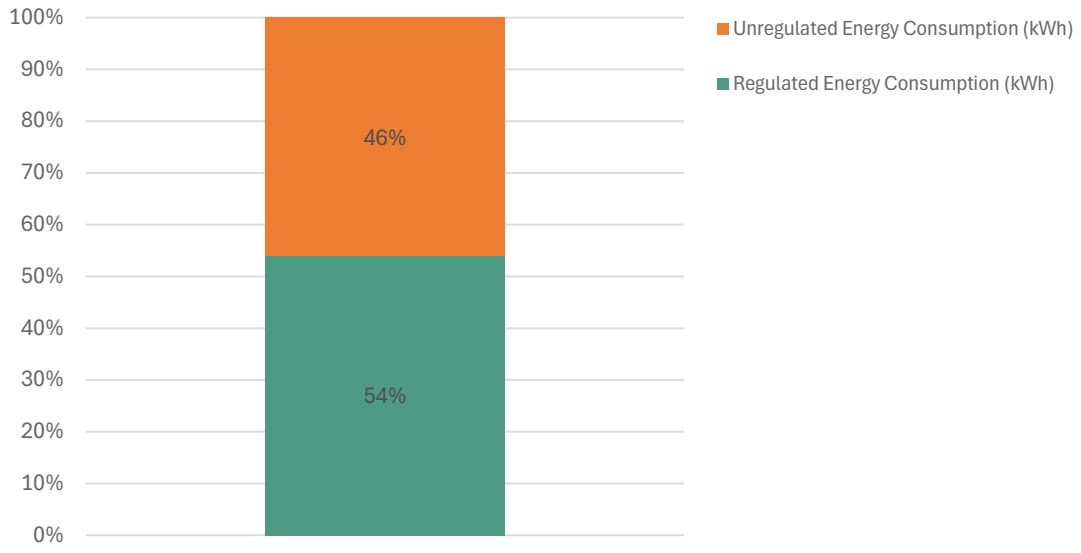

Figure 11: Annual Unregulated vs Regulated Energy Consumption – Leisure and Community Centre

Table 16: Energy Consumption Breakdown – Leisure and Community Centre

Category	Type	Energy consumption (kWh/annum)
Regulated	Space Heating Electricity	159,932
	DHW Electricity	4,415
	Fans	11,895
	Pumps	11,895
	Lighting	179,363
Unregulated	Equipment	205,487
	Catering / Office Unregulated	37,510
	Gym Unregulated	11,274
	Swimming Pool / Sauna Unregulated	59,158
	Lift Unregulated	4,323
Total		**685,251**

5.2 Business Units

Figure 12 to Figure 14 and Table 16 show the results of the unregulated and regulated energy consumption at the leisure and community centre using the design specification and assumptions detailed in this report using the TM54:2013 methodology.

The graphs below show that lighting accounts for the majority of the annual energy consumption. This is due to the use of generic data at this stage of the assessment. It is likely that, as the design progresses and more accurate data becomes available, these values will decrease. Figure 14 also shows that a significant amount of energy use is predicted to be unregulated energy use, from the office equipment and catering equipment, accounting for 41% of the overall energy use.

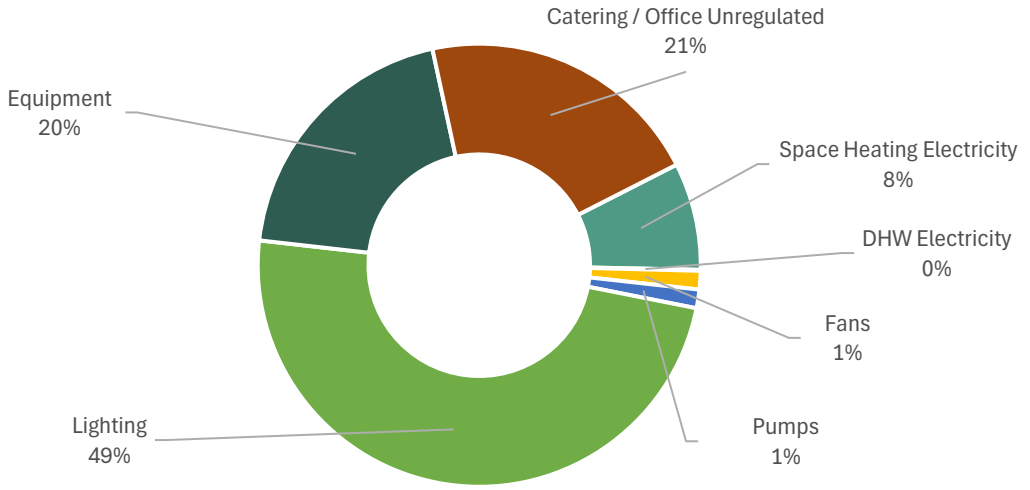

Figure 12: Annual Energy Consumption Pie Chart – Business Units

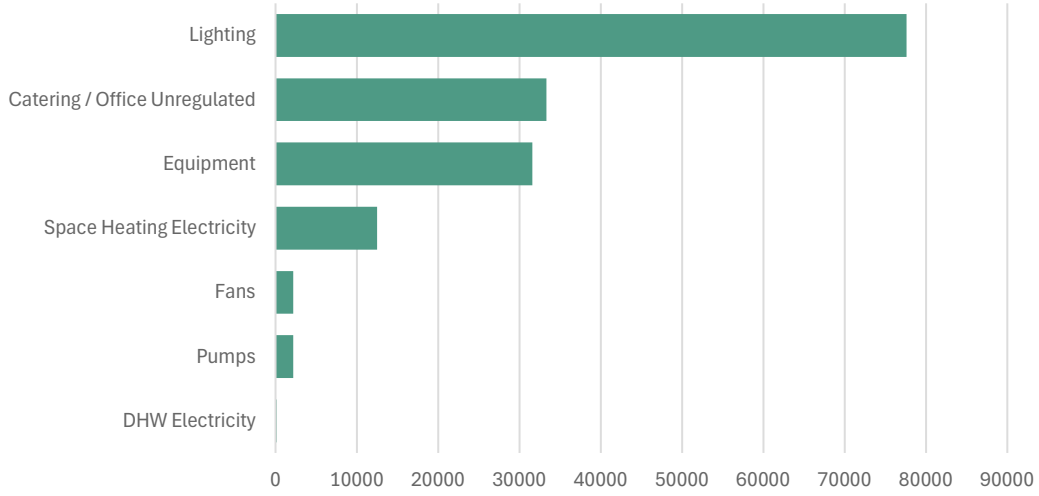

Figure 13: Annual Energy Consumption Horizontal Bar Chart – Business Units

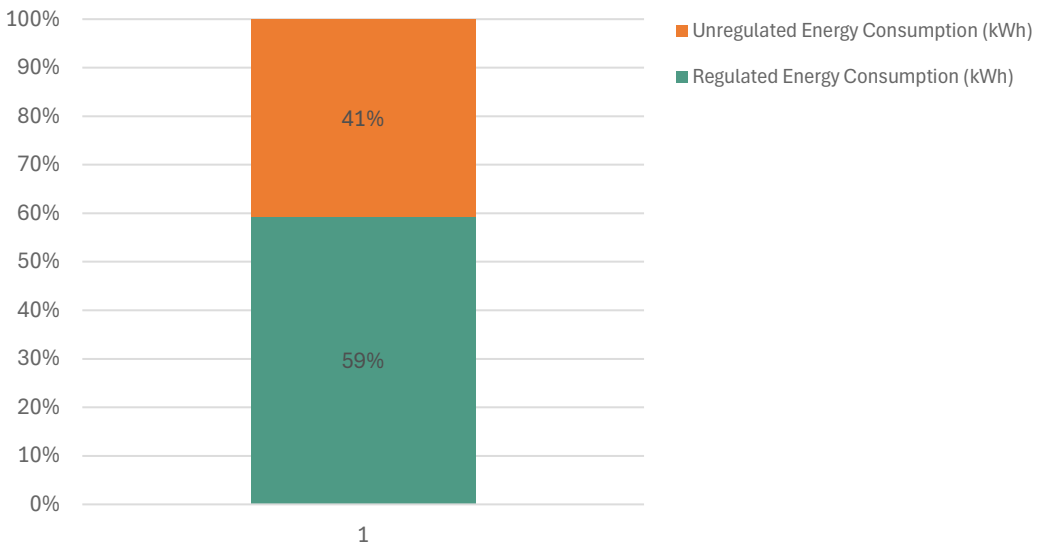

Figure 14: Annual Unregulated vs Regulated Energy Consumption – Business Units

Table 17: Energy Consumption Breakdown – Business Units

Category	Type	Energy consumption (kWh/annum)
Regulated	Space Heating Electricity	12,489
	DHW Electricity	114
	Fans	2,161
	Pumps	2,161
	Lighting	77,600
Unregulated	Equipment	31,593
	Catering / Office Unregulated	33,313
Total		**159,431**

5.3 Solar PV

Table 18: Solar PV Generation

Number of Panels	Panel Performance	Total Installed Capacity	Energy Generation (kWh/annum)
288	450 W	130 kWp	99,500

6.0 RISK ASSESSMENT

When predicting energy use, using a dynamic simulation model contains simplifications and assumptions compared to how the real building would operate. The assumptions that have been made of the construction of the building also have a risk of being inaccurate. Simplifications when applying the constructions to the model may differ to the installed U-values and construction.

Another risk with this project relates to the occupation profiles, general profiles have been used, which are likely to differ in the real-life scenario. The profiles have allowed time for cleaning as well as pre-heating and pre-cooling the building. This has been modelled as a worst-case scenario where during these hours the building will be fully occupied.

Due to there being a number of ways in which the building will be managed, a wide range of outcomes are possible. We have determined what is a likely scenario (the central case) to the best of our knowledge. When predicting the operational energy for a building, there is a performance gap between variables that are out of control of the designers. These variables can affect the internal environment of the building and therefore increase the energy use.

7.0 COMPARISON WITH BENCHMARKS

The results have been compared with existing industry benchmarks taken from CIBSE TM46:2008 Energy Benchmarks for a combined sports and recreation centre, and clothing shop for the business units. These have been divided by fuel and shows the 'typical', 'good practice' and the modelled results.

The results show that both the leisure and community centre and the business units consumption is much better than the benchmark values. This is likely due to the assumptions and simplifications that have had to be made and that the building is using high efficiency electric systems throughout without the use of fossil fuels.

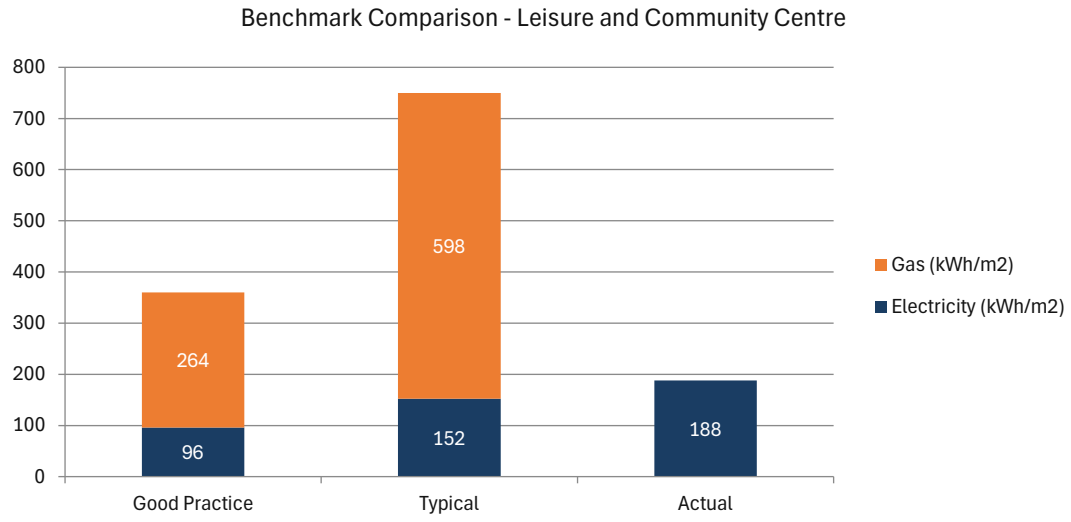

Figure 15: CIBSE Benchmark Comparison - Leisure Community Centre

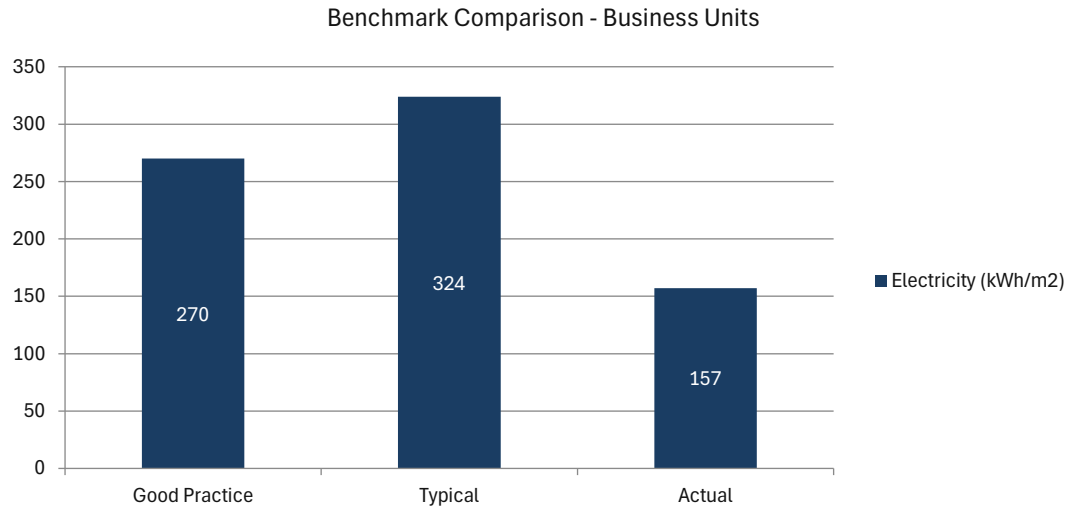

Figure 16: CIBSE Benchmark Comparison - Business Units

8.0 CONCLUSION

The simulation model results along with the appropriate calculations in accordance with TM54:2013 show that the predicted operational energy use is below the CIBSE benchmark figures for both sites. Assumptions and simplifications have been made in generating the model. This will affect the accuracy of this prediction, and the actual operational energy use is likely to differ.

This analysis helps to indicate where to focus energy reduction, however, with the use of a ground source heat pump, well performing building fabric and a large PV array, the development performs well in terms of operational energy.

The below table shows the calculated energy consumption for the development, including the annual PV generation.

Table 19: Development Annual Operational Energy Consumption

Category	Type	Leisure and Community Centre	Business Units
		Energy consumption (kWh/annum)	
Regulated	Space Heating Electricity	159,932	12,489
	DHW Electricity	4,415	114
	Fans	11,895	2,161
	Pumps	11,895	2,161
	Lighting	179,363	77,600
Unregulated		317,752	64,906
Total		**685,251**	**159,431**
Solar PV Generation		**99,500**	

REFERENCES

Thermal simulation software: IES Virtual Environment – Version 2025.0.1.0.

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