

iSERVcmb Measured Energy Consumption Data by HVAC Component and Activity: UK

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iSERVcmb Measured Data Analysis – UK HERO Dataset

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1 Introduction

This report presents the measured HVAC component energy consumption and end use activity data obtained for the UK during the iSERVcmb project.

The report tabulates the recorded energy use and power demand information by floor area, HVAC component and sub-component type, for each activity type within the iSERVcmb system.

The figures presented include energy use data which has been apportioned across more than one activity and/or component in some cases. The apportionments have been made using a mixture of pre-existing data and data collected during the project period. Care has been taken to ensure the data produced is not simply self-referencing.

1.1 Measured data accuracy

The actual floor areas recorded for each building and system are expected to be between -1 to +4% of the value recorded in the associated iSERVcmb spreadsheet.

While this document deals only with electricity, the maximum expected error in the read for each electricity and gas meter is $\pm 2\%$ [Knight 2014]. For heat meters the expected errors are around -10% based on studies of the actual performance of installed heat meters in Sweden [Jomni 2006] and observations of installation practice in real buildings.

The data presented here should be read with these potential inaccuracies in mind.

1.2 Data overview

The datasets show that the measured overall average annual energy use and power demands by HVAC component type are as in Table 1. It can be seen that power demands are not a good indicator of likely annual energy use, and that ALL elements of an HVAC system appear to play a significant role in the overall annual energy consumption likely to arise from that system.

Table 1 – Overall measured average power demands and annual energy consumptions across the entire UK by HVAC component type

| | Cold Generators | Air Handling Units | Heat Pump | Pumps | Terminal Units | Heat Generators | Heat Rejection | Heat Recovery | Dehumidification | All in One Systems |
|--------------------------|-----------------|--------------------|-----------|-------|----------------|-----------------|----------------|---------------|------------------|--------------------|
| W/m² | 9.9 | 6.8 | 3.6 | 1.8 | 4.3 | 1.4 | 0.7 | 0.1 | 0.01 | 14.6 |
| kWh/m² | 46.0 | 41.3 | 30.0 | 24.4 | 19.0 | 18.5 | 1.5 | 1.1 | | 134.8 |

1.3 Major conclusions

The data presented shows that there are significant variations in the power demands and energy use of almost every combination of HVAC sub-component and activity. These variations are due to a variety of reasons ranging from climate, through building and system design, to simple inefficiency in operation and maintenance of the HVAC systems.

What the wider iSERVcmb project has shown is that the inefficiencies are a significant part of the variations being found in the data presented in this document.

The data presented in these tables is a look at the detail of how building services consume energy in operational buildings across the UK. However, on its own this information does not allow the

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owners/operators of the systems which contributed this data to know how or whether they should be doing better.

The full dataset from which this document is drawn, used in conjunction with the iSERVcmb approach, can however start this process by benchmarking individual systems and buildings against this data.

It has not been possible to fully describe the iSERVcmb dataset in a document yet, as there was too much work to do during the project just to assemble the raw data. Continuing analysis will produce further information and data out of this project which will form the basis of professional guidance and standards in the future.

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2 HVAC Component and Activities Overview plus Data Summaries

This section covers the overall description of the HVAC components as given in the iSERV spreadsheets for the UK, as well as summarising the measured data from the more detailed parts of this report.

Table 1a - Number of meters serving each activity

| Activity type | Electricity | Gas | Heat |
|---|-------------|-----|------|
| Assembly areas / halls | 14 | 6 | 3 |
| Catering: Eating/drinking area | 26 | 6 | 3 |
| Catering: Full Kitchen Preparing Hot Meals | 15 | | |
| Catering: Kitchenette (small appliances, fridge and sink) | 22 | 3 | 3 |
| Catering: Limited Hot Food Preparation Area | 17 | 8 | 4 |
| Catering: Snack Bar with Chilled Cabinets | 8 | 4 | |
| Catering: Vending Machines | 8 | 4 | |
| Cellular Office Area | 73 | 9 | 4 |
| Cellular Office Area - multiple occupation | 16 | 6 | 3 |
| Circulation area (corridors and stairways) | 69 | 9 | 4 |
| Consulting/treatment room | 14 | | |
| Heavy Plant Room | 2 | 2 | 3 |
| IT: High Density IT Suite | 46 | 9 | 3 |
| IT: LAN Rooms | 35 | 8 | 3 |
| IT: Server Room | 18 | 6 | 3 |
| Laboratory | 7 | 3 | |
| Laboratory with fume cupboards | 6 | 1 | |
| Lecture theatre | 14 | 1 | |
| Library - open stacks | 9 | 4 | |
| Library - stacks and storeroom | 8 | 4 | |
| Lifts | 43 | | |
| Light Plant Room | 73 | 9 | 3 |
| Lounges | 21 | 1 | |
| Meeting Room | 65 | 8 | 4 |
| Open Plan Office Area | 51 | 5 | |
| Reception | 35 | 7 | 3 |
| Recreational : Changing facilities with showers | 15 | 1 | |
| Recreational : Fitness Studio | 15 | 1 | |
| Recreational : Fitness Suite/Gym | 11 | | |
| Recreational : Sports ground changing rooms | 21 | 6 | |
| Retail Warehouse Sales area - general | 1 | 1 | |
| Small Shop Unit Sales area - general | 3 | 2 | 3 |
| Stage (theatres and event buildings) | 4 | 1 | |
| Storage Area/Cupboard | 56 | 9 | 4 |
| Teaching Areas | 9 | 3 | |
| Toilet | 53 | 8 | 4 |
| Waiting Rooms | 13 | | |
| Workshop | 5 | 1 | |

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2.1 Overall HVAC Components and Activities Summary

Table 2b summarises the data collected for the HVAC Components and the iSERV Activity types available in the UK. It can be seen that the HVAC components in the UK service 38 different activity types with total areas ranging in size from 8 to 9,500 m². The most frequently encountered component types in the project were AHU's and pumps.

Table 2b – Overall Systems Summary for UK showing numbers of components and spaces associated with each activity type

| Activity Name | Floor Area m2 | Num Spaces | Air Handling Units | All in One Systems | Cold Generators | Heat Generators | Heat Pump | Heat Recovery | Heat Rejection | Humidifiers | Pumps | Storage Systems | Terminal Units |
|---|---------------|------------|--------------------|--------------------|-----------------|-----------------|-----------|---------------|----------------|-------------|-------|-----------------|----------------|
| Assembly areas / halls | 217.3 | 4 | 5 | | 2 | 6 | | | 2 | | 6 | | |
| Catering: Eating/drinking area | 488.8 | 8 | 8 | | 8 | 9 | | | 5 | 2 | 15 | | |
| Catering: Full Kitchen Preparing Hot Meals | 684.3 | 5 | 5 | | 6 | 3 | | | 3 | 3 | 10 | | |
| Catering: Kitchenette (small appliances, fridge and sink) | 40.24 | 6 | 7 | | 8 | 7 | | | 3 | 2 | 19 | 1 | 1 |
| Catering: Limited Hot Food Preparation Area | 49.2 | 8 | 6 | 1 | 4 | 10 | | | 4 | 1 | 20 | | 2 |
| Catering: Snack Bar with Chilled Cabinets | 76.33 | 1 | 2 | 1 | 2 | 3 | | | 2 | | 5 | | |
| Catering: Vending Machines | 27.7 | 1 | 2 | | 2 | 3 | | | 2 | | 5 | | |
| Cellular Office Area | 9097 | 466 | 43 | | 13 | 15 | | | 7 | 29 | 40 | 1 | 7 |
| Cellular Office Area - multiple occupation | 372.3 | 13 | 7 | | 2 | 6 | 1 | 1 | 2 | | 6 | | |
| Circulation area (corridors and stairways) | 9487 | 216 | 48 | | 12 | 14 | | | 7 | 35 | 35 | 1 | 3 |
| Consulting/treatment room | 40.8 | 4 | 4 | | 6 | 3 | | | 3 | 2 | 10 | | |
| Heavy Plant Room | 10.8 | 1 | | | | 3 | | | | | 1 | | |
| IT: High Density IT Suite | 855.1 | 22 | 20 | 1 | 13 | 12 | | | 7 | 9 | 34 | 1 | 6 |
| IT: LAN Rooms | 166.1 | 18 | 18 | 1 | 10 | 11 | 1 | 1 | 7 | 3 | 28 | | 2 |
| IT: Server Room | 319.3 | 8 | 4 | 7 | 3 | 7 | | | 7 | | 10 | | 2 |
| Laboratory | 1163 | 46 | 6 | | 5 | 5 | | | 2 | 1 | 22 | 1 | 2 |
| Laboratory with fume cupboards | 234.5 | 3 | 3 | | 3 | 3 | | | | | 10 | 1 | |
| Lecture theatre | 149 | 2 | 4 | | 7 | 4 | | | 4 | 2 | 15 | | 1 |
| Library - open stacks | 629.7 | 2 | 2 | | 2 | 3 | | | 2 | | 4 | | |
| Library - stacks and storeroom | 232.8 | 1 | 2 | | 2 | 3 | | | 2 | | 4 | | |
| Lifts | 861.4 | 49 | 32 | | 6 | 3 | | | 3 | 26 | 10 | | 1 |
| Light Plant Room | 3513 | 102 | 48 | | 12 | 12 | | | 7 | 35 | 37 | 1 | 3 |
| Lounges | 131.6 | 4 | 7 | | 8 | 6 | | | 3 | 2 | 20 | 1 | |
| Meeting Room | 2612 | 80 | 40 | 3 | 11 | 13 | 1 | 1 | 8 | 21 | 35 | | 4 |
| Open Plan Office Area | 7350 | 62 | 35 | 2 | 9 | 7 | 1 | 1 | 6 | 17 | 22 | | 1 |
| Reception | 360.6 | 9 | 13 | | 10 | 10 | | | 5 | 4 | 24 | 1 | |
| Recreational : Changing facilities with showers | 190.4 | 5 | 2 | | 8 | 4 | | | 3 | 1 | 18 | 1 | 1 |
| Recreational : Fitness Studio | 500.2 | 6 | 2 | 1 | 8 | 6 | | | 3 | 1 | 20 | 1 | 1 |
| Recreational : Fitness Suite/Gym | 117.9 | 1 | 1 | 1 | 6 | 3 | | | 3 | 1 | 10 | | |
| Recreational : Sports ground changing rooms | 87.37 | 4 | 5 | 1 | 10 | 8 | | | 7 | 2 | 25 | | 2 |
| Retail Warehouse Sales area - general | 8.15 | 1 | 1 | | 1 | 1 | | | 1 | 1 | 5 | | 1 |
| Small Shop Unit Sales area - general | 63.45 | 1 | | | | 3 | | | | | 2 | | |
| Stage (theatres and event buildings) | 135.9 | 1 | 1 | | 2 | 3 | | | | | 10 | 1 | |
| Storage Area/Cupboard | 1204 | 158 | 28 | 1 | 13 | 15 | | | 7 | 10 | 43 | 1 | 3 |
| Teaching Areas | 5315 | 28 | 4 | | 7 | 3 | | | 2 | 1 | 18 | 1 | 4 |
| Toilet | 1142 | 84 | 32 | | 10 | 12 | | | 7 | 22 | 28 | | 3 |
| Waiting Rooms | 15.87 | 1 | 3 | | 6 | 3 | | | 3 | 1 | 10 | | |
| Workshop | 90.26 | 2 | 2 | | 2 | 3 | | | | | 10 | 1 | |

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3 Summary of measured annual energy use by HVAC Component and sub-component type servicing a given activity

This section summarises the range of electrical annual energy consumption per m² by activity served, that have been measured across all the HVAC sub-component types monitored in iSERVcmb.

The main observations from the tables are:

- Many of the HVAC components have significant average energy consumptions across a number of the end use activities
- IT related end uses are clearly the most significant loads on many HVAC components
- Air handling units and Cold generators have the highest average annual consumptions
- Pumps and Terminal Units also consume significant quantities of energy over a year – reflecting their more continuous operation, in particular for pumps.

A summary of the measured average annual energy use by activity type and HVAC component type is shown in Table 3. Values in brackets indicate the standard deviation found from this average. This data can be used to estimate the likely annual energy use range to be incurred by an HVAC component while servicing this type of activity in the UK. The more detailed tables also show this information by HVAC sub-component as well.

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Table 3 – Benchmarks for measured Average and Standard Deviation Annual Energy Use in kWh/m2 Summary by HVAC Component and Activity Type. Average W/m2 and Standard Deviation

| Activity Name | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Pump | | Heat Rejection | | Pumps | | Terminal Units | |
|---|--------------------|--------|--------------------|--------|-----------------|--------|-----------------|------|--------------|----|----------------|-------|--------------|--------|----------------|--------|
| | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD |
| Assembly areas / halls | 125.22 | 141.62 | | | 0.31 | 0.20 | 2.36 | 3.21 | | | 0.03 | 0.02 | 157.71 | 247.82 | | |
| Catering: Eating/drinking area | 41.40 | 52.22 | | | 1.31 | 0.82 | 2.36 | 3.21 | | | 0.07 | 0.04 | 39.43 | 61.95 | | |
| Catering: Kitchenette (small appliances, fridge and sink) | 17.45 | | | | | | 5.87 | 0.00 | | | | | 0.88 | 0.81 | | |
| Catering: Limited Hot Food Preparation Area | 79.32 | 51.29 | 130.16 | | 7.67 | 7.52 | 1.75 | 2.81 | | | 0.36 | 0.36 | 17.11 | 36.68 | 11.17 | 0.61 |
| Catering: Snack Bar with Chilled Cabinets | 56.47 | 63.49 | 130.16 | | 0.44 | 0.27 | 0.03 | 0.00 | | | 0.06 | 0.04 | 29.86 | 54.09 | | |
| Catering: Vending Machines | 56.47 | 63.49 | | | 0.44 | 0.27 | 0.03 | 0.00 | | | 0.06 | 0.04 | 29.86 | 54.09 | | |
| Cellular Office Area | 7.96 | 5.68 | | | 15.60 | 18.53 | 1.75 | 2.82 | | | 0.27 | 0.27 | 12.76 | 26.86 | 61.14 | 77.94 |
| Cellular Office Area - multiple occupation | 2.11 | 2.54 | | | 1.28 | 0.80 | 2.36 | 3.21 | 58.21 | | 0.04 | 0.03 | 29.57 | 29.96 | | |
| Circulation area (corridors and stairways) | 6.89 | 3.94 | | | 5.45 | 5.34 | 1.75 | 2.82 | | | 0.17 | 0.16 | 9.33 | 26.28 | 11.17 | 0.61 |
| IT: High Density IT Suite | 43.87 | 23.23 | 152.27 | | 216.83 | 212.32 | 1.75 | 2.82 | | | 0.61 | 0.59 | 118.06 | 328.17 | 93.14 | 86.08 |
| IT: LAN Rooms | 7.70 | 11.09 | | | 456.49 | 447.00 | 1.75 | 2.82 | 41.20 | | 3.59 | 3.52 | 212.03 | 383.38 | 22.35 | 1.22 |
| IT: Server Room | 8.63 | 7.37 | 640.69 | 273.03 | 247.86 | 308.41 | 1.99 | 3.01 | | | 97.83 | 89.70 | 225.63 | 472.95 | 15.98 | |
| Laboratory | 41.19 | 13.30 | | | 26.51 | 1.45 | 0.22 | 0.01 | | | 0.65 | 0.04 | 7.73 | 6.54 | 11.18 | 0.61 |
| Laboratory with fume cupboards | | | | | | | | | | | | | 2.70 | 2.75 | | |
| Lecture theatre | 47.21 | | | | 10.06 | | 0.23 | | | | 1.31 | | 14.96 | 10.76 | 23.22 | |
| Library - open stacks | 2.78 | 0.11 | | | 0.45 | 0.28 | 0.01 | 0.00 | | | 0.08 | 0.05 | 39.43 | 61.95 | | |
| Library - stacks and storeroom | 2.77 | | | | 0.30 | 0.19 | 0.01 | 0.00 | | | 0.08 | 0.05 | 15.12 | 23.76 | | |
| Light Plant Room | 4.68 | 3.32 | | | 0.40 | 0.40 | | | | | 0.08 | 0.08 | 0.50 | 0.03 | | |
| Lounges | | | | | | | | | | | | | 0.59 | 0.51 | | |
| Meeting Room | 13.91 | 13.84 | 64.91 | 27.06 | 9.02 | 7.29 | 1.55 | 2.67 | 58.21 | | 0.47 | 0.38 | 13.59 | 27.28 | 10.11 | 1.89 |
| Open Plan Office Area | 5.48 | 8.43 | 32.07 | 0.00 | 7.49 | 10.29 | 0.07 | 0.11 | 58.21 | | 0.25 | 0.34 | 23.15 | 35.69 | 11.61 | |
| Reception | 2.11 | 1.50 | | | 0.84 | 0.53 | 2.36 | 3.21 | | | 0.03 | 0.02 | 17.40 | 41.28 | | |
| Recreational : Changing facilities with showers | 38.88 | | | | | | | | | | | | 0.59 | 0.47 | | |
| Recreational : Fitness Studio | 19.44 | | | | | | | | | | | | 0.39 | 0.30 | | |
| Recreational : Sports ground changing rooms | 64.79 | 37.18 | | | | | 0.11 | 0.10 | | | | | 9.68 | 22.42 | 11.17 | 0.61 |
| Retail Warehouse Sales area - general | 20.89 | | | | 14.91 | | 0.23 | | | | 0.82 | | 10.47 | 7.46 | 11.61 | |
| Small Shop Unit Sales area - general | | | | | | | 5.88 | 0.00 | | | | | | | | |
| Stage (theatres and event buildings) | 0.79 | | | | | | | | | | | | 0.59 | 0.51 | | |
| Storage Area/Cupboard | 8.76 | 7.48 | | | 1.58 | 1.92 | 1.75 | 2.82 | | | 0.07 | 0.08 | 18.74 | 34.40 | 11.17 | 0.61 |
| Teaching Areas | 15.84 | 4.70 | | | 6.92 | 3.60 | 0.22 | 0.01 | | | 0.48 | 0.03 | 2.90 | 2.36 | 124.37 | 196.06 |
| Toilet | 41.87 | 71.58 | | | 1.21 | 1.19 | 2.55 | 4.17 | | | 0.26 | 0.25 | 11.19 | 28.79 | 11.17 | 0.61 |
| Workshop | 25.39 | | | | | | | | | | | | 0.14 | 0.02 | | |

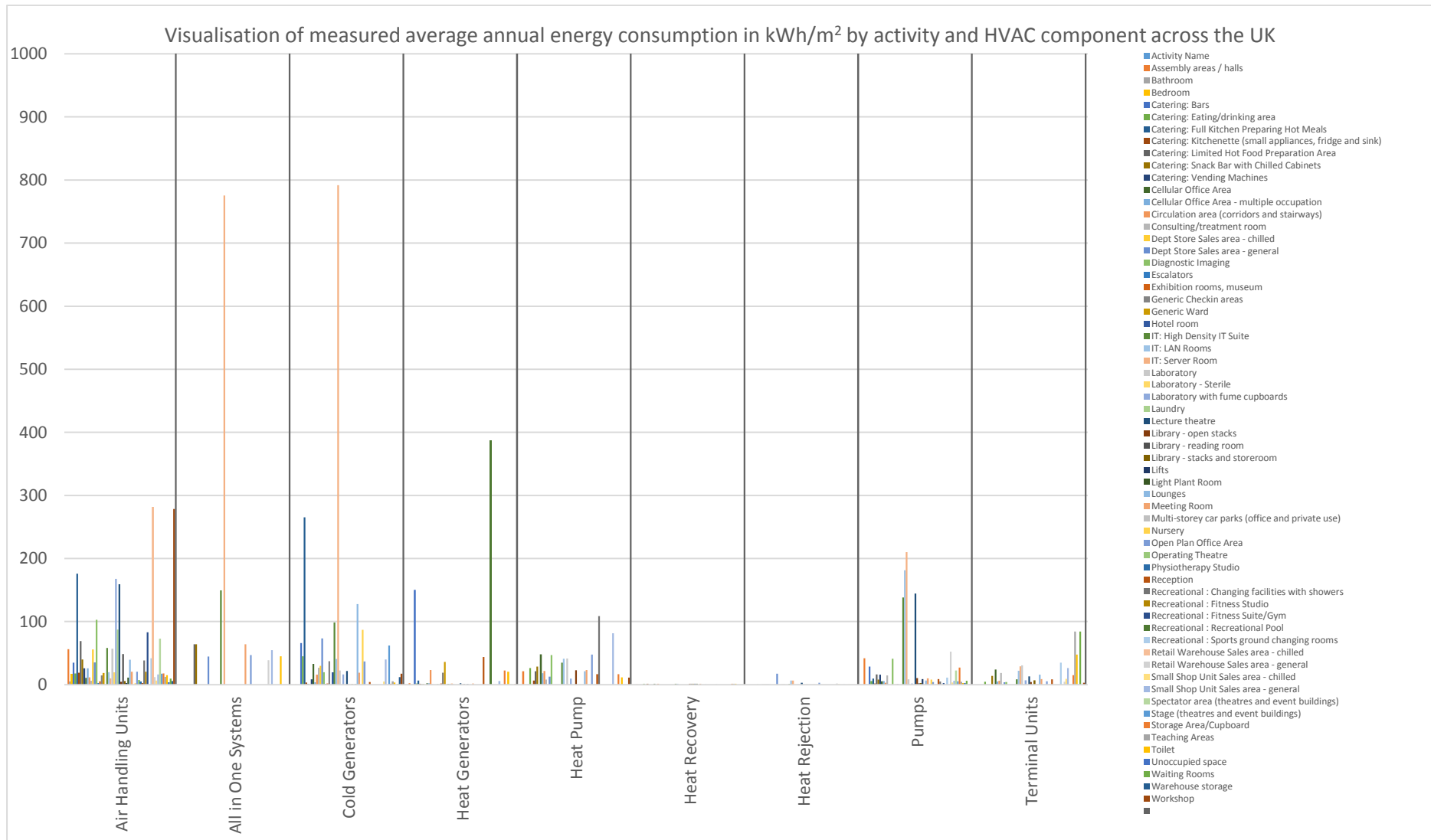


Figure 1 - Visualisation of measured average annual energy consumption in kWh/m² by activity and HVAC component across the UK

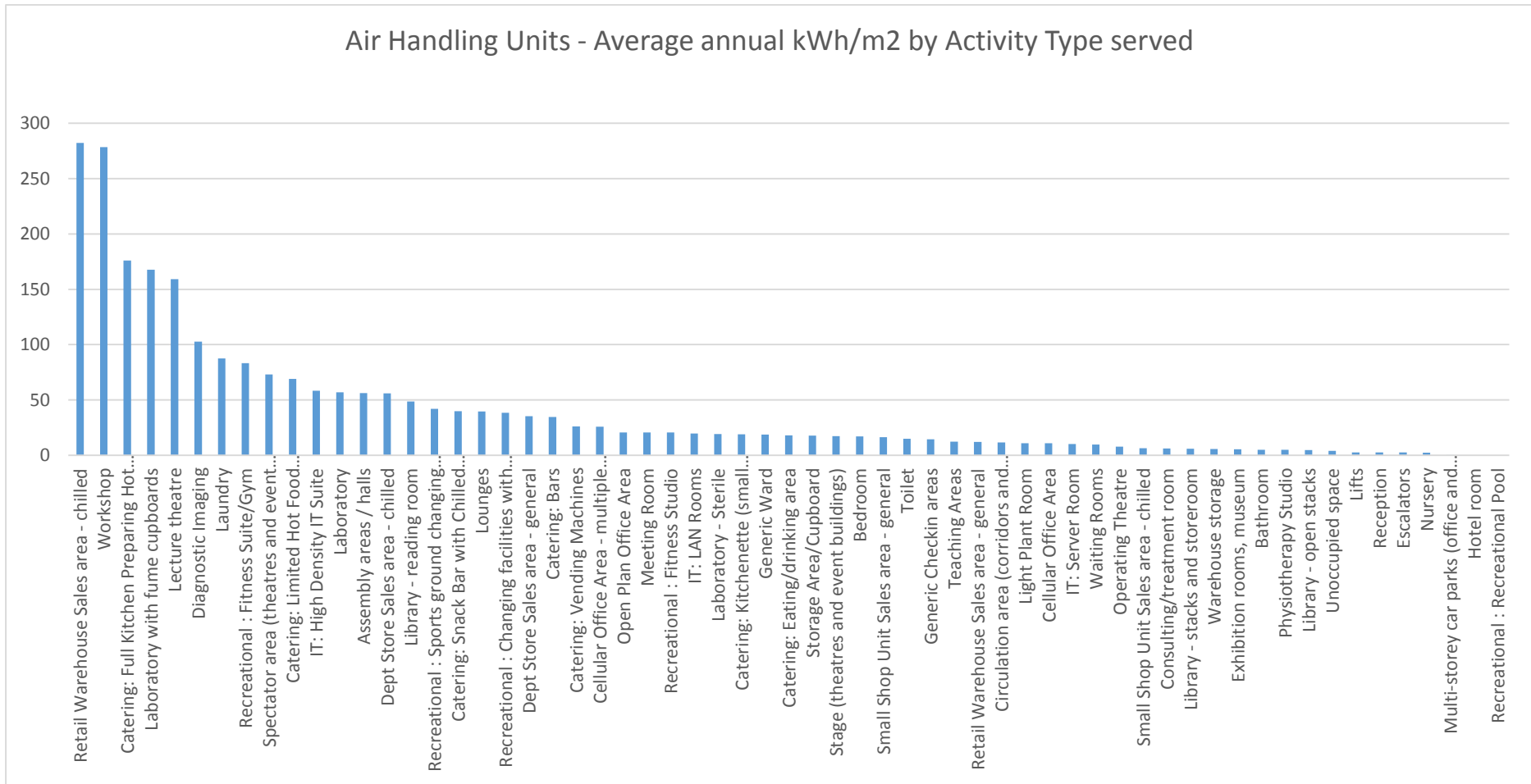


Figure 2 - Air Handling Units - Average annual kWh/m2 by Activity Type served

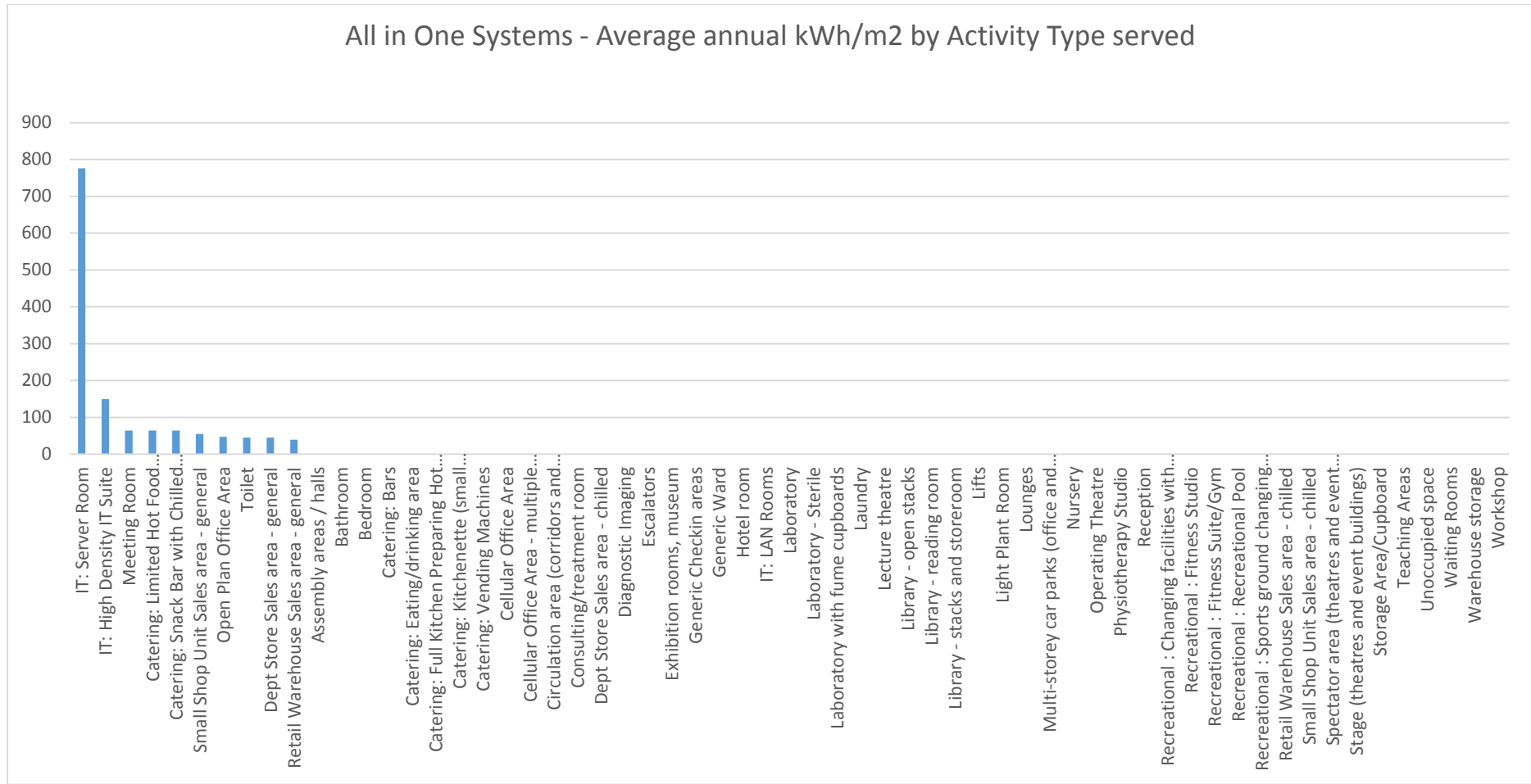


Figure 3 - All in One Systems - Average annual kWh/m2 by Activity Type served

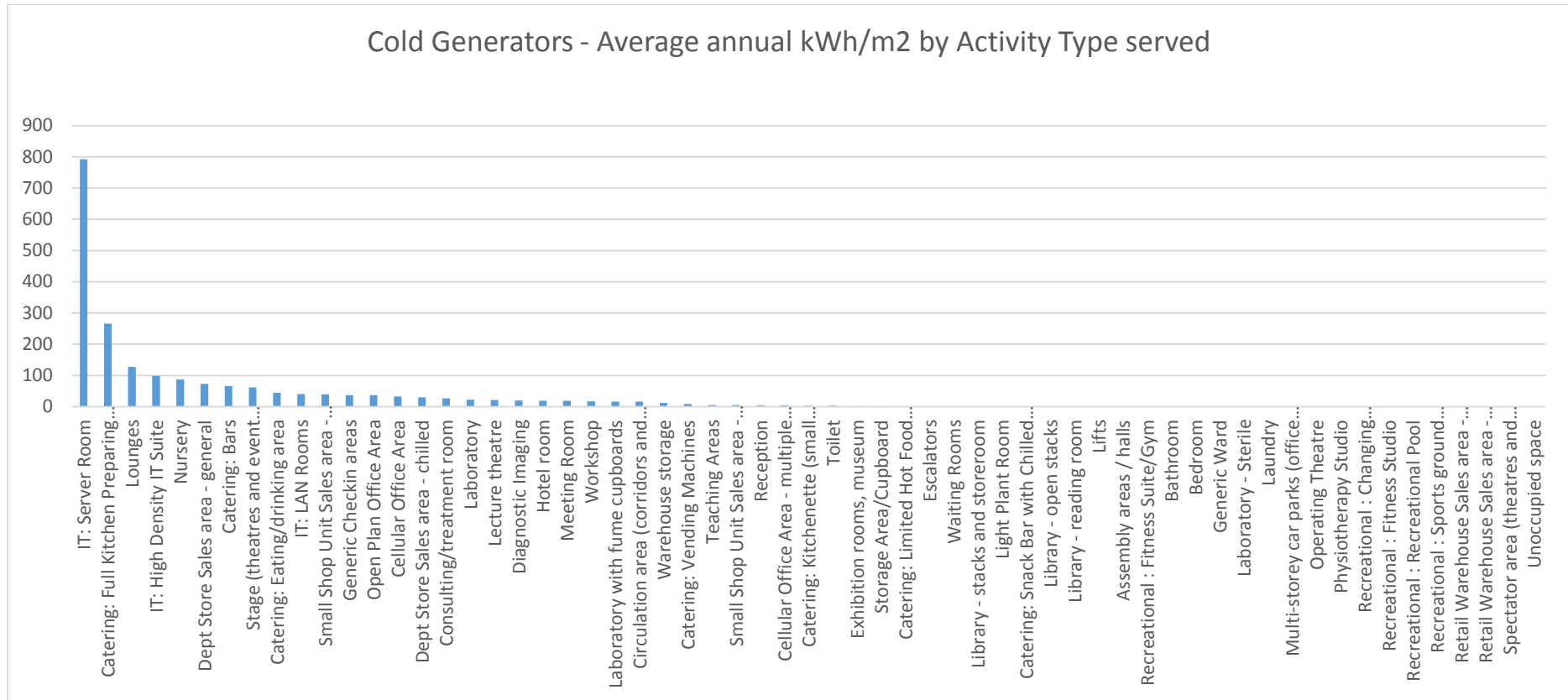


Figure 4 - Cold Generators - Average annual kWh/m2 by Activity Type served

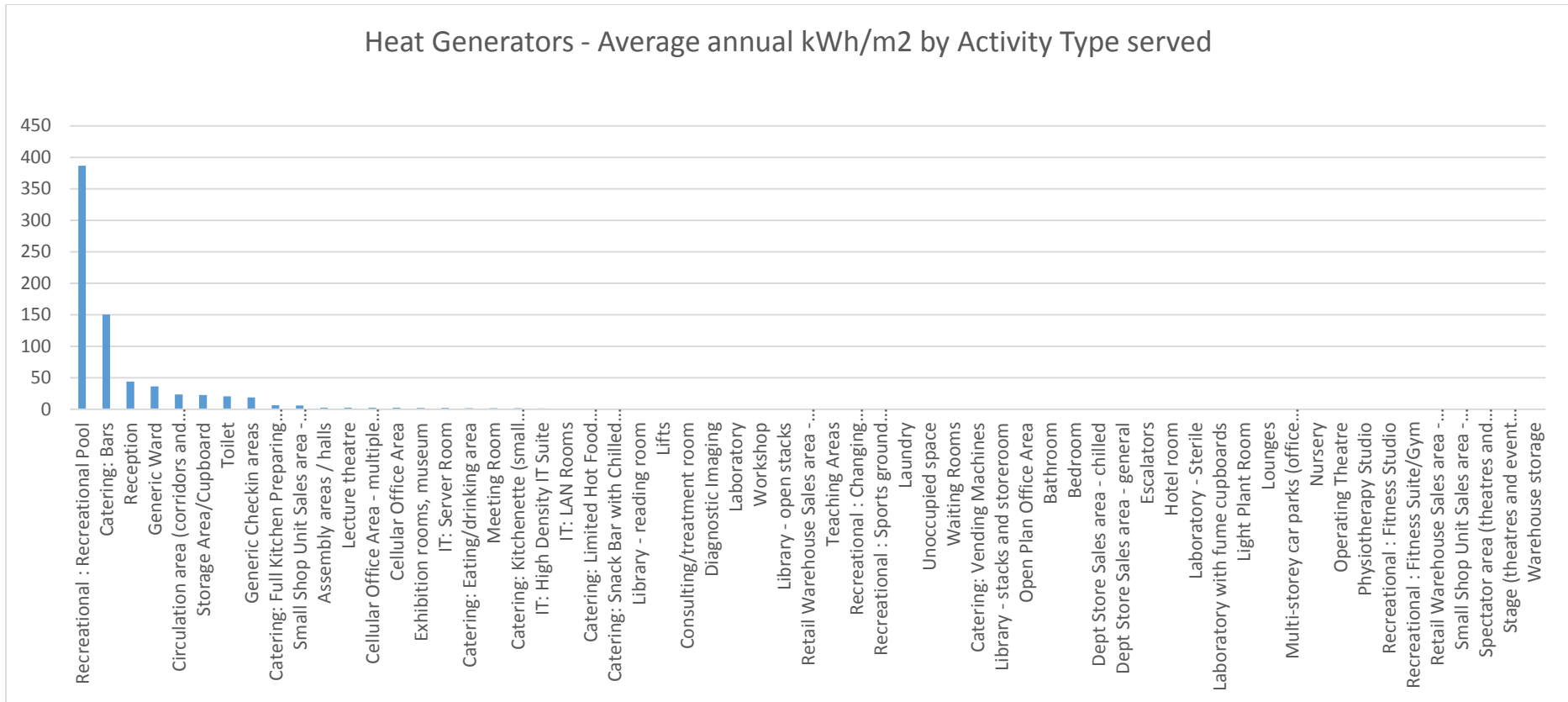


Figure 5 - Heat Generators - Average annual kWh/m2 by Activity Type served

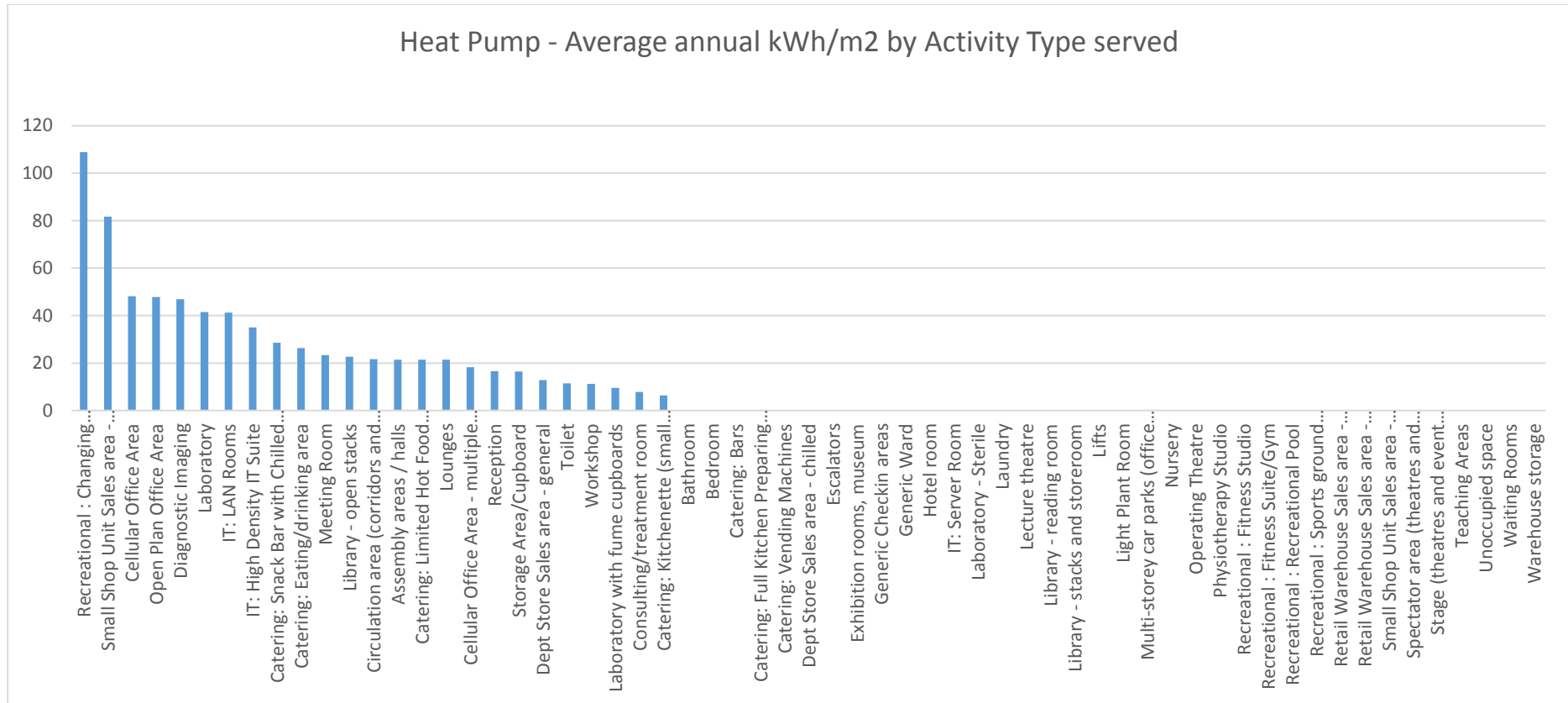


Figure 6 - Heat Pump - Average annual kWh/m2 by Activity Type served

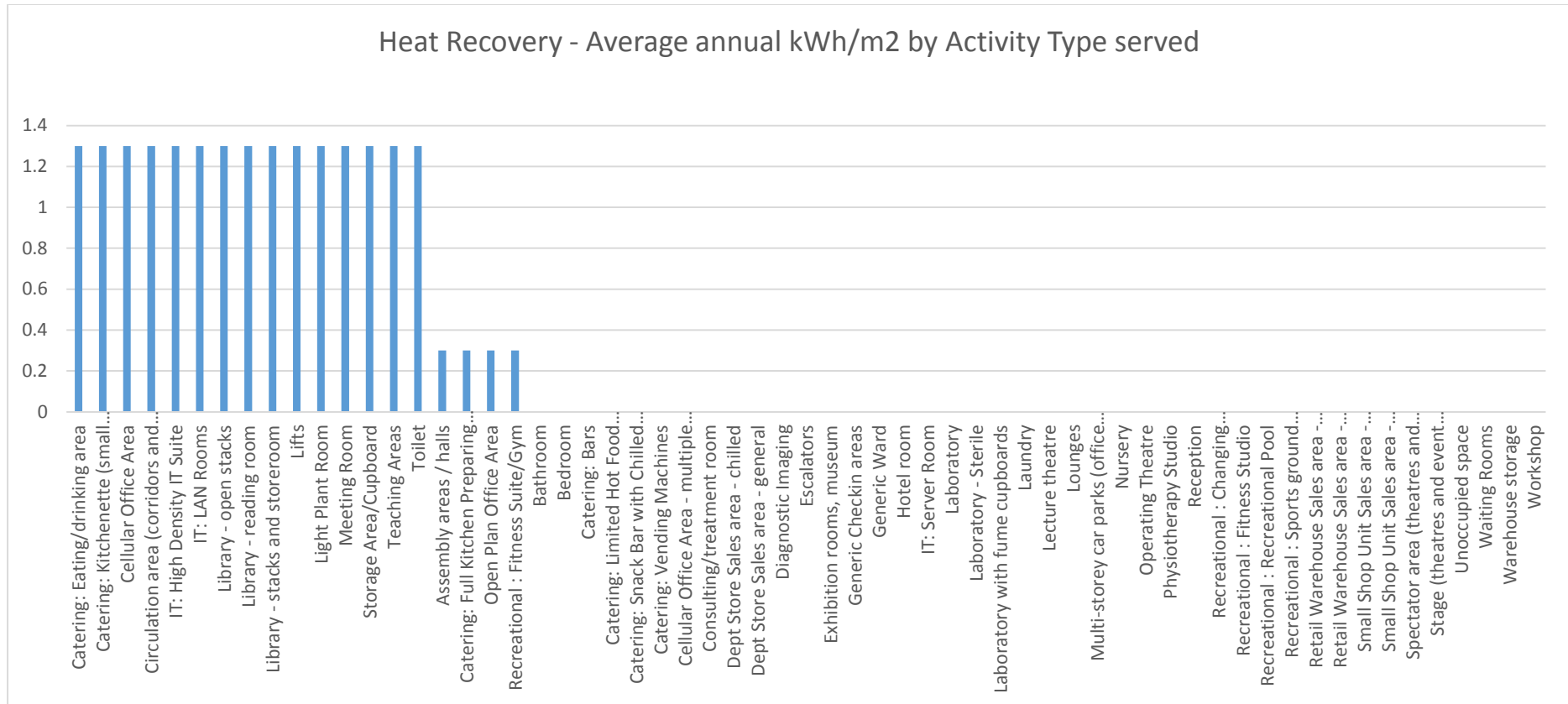


Figure 7 - Heat Recovery - Average annual kWh/m2 by Activity Type served

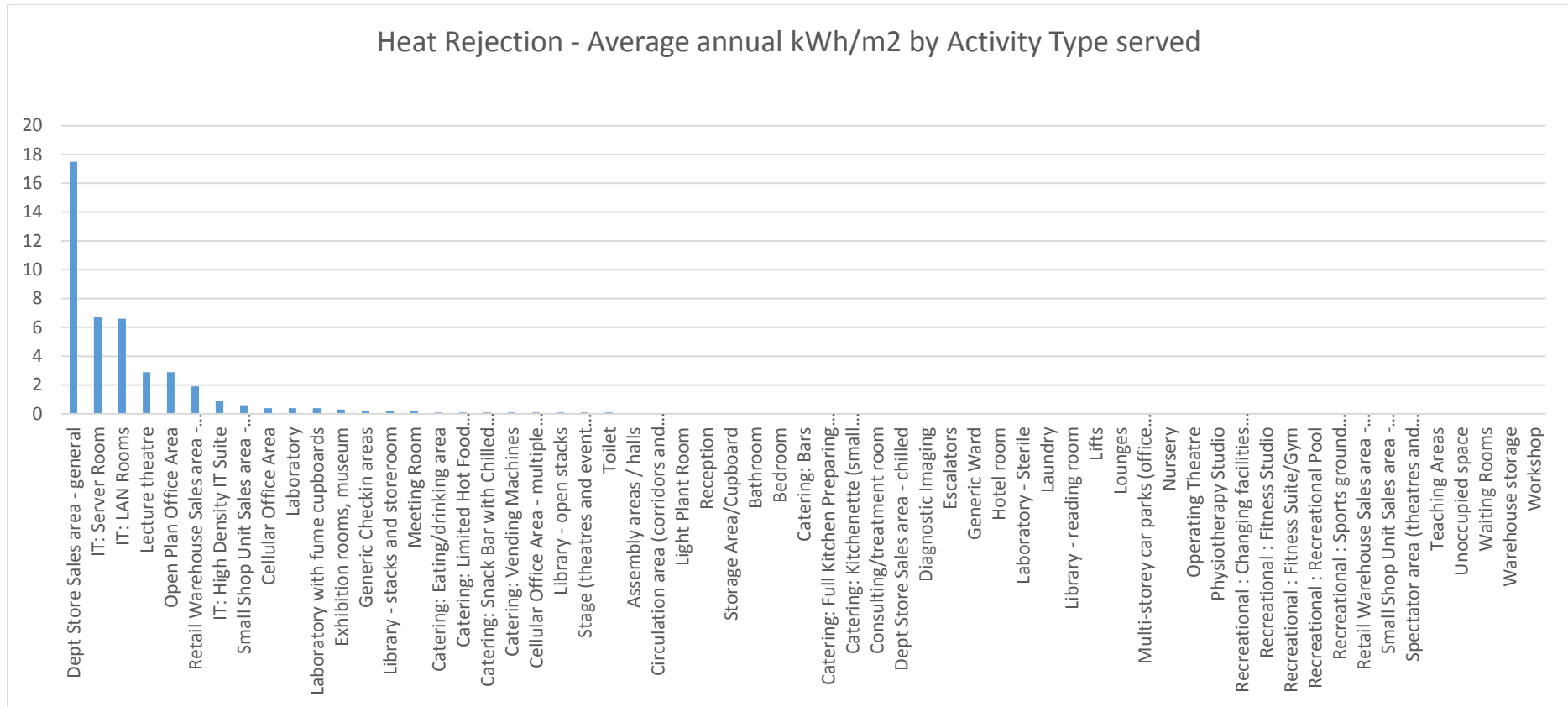


Figure 8 - Heat Rejection - Average annual kWh/m2 by Activity Type served

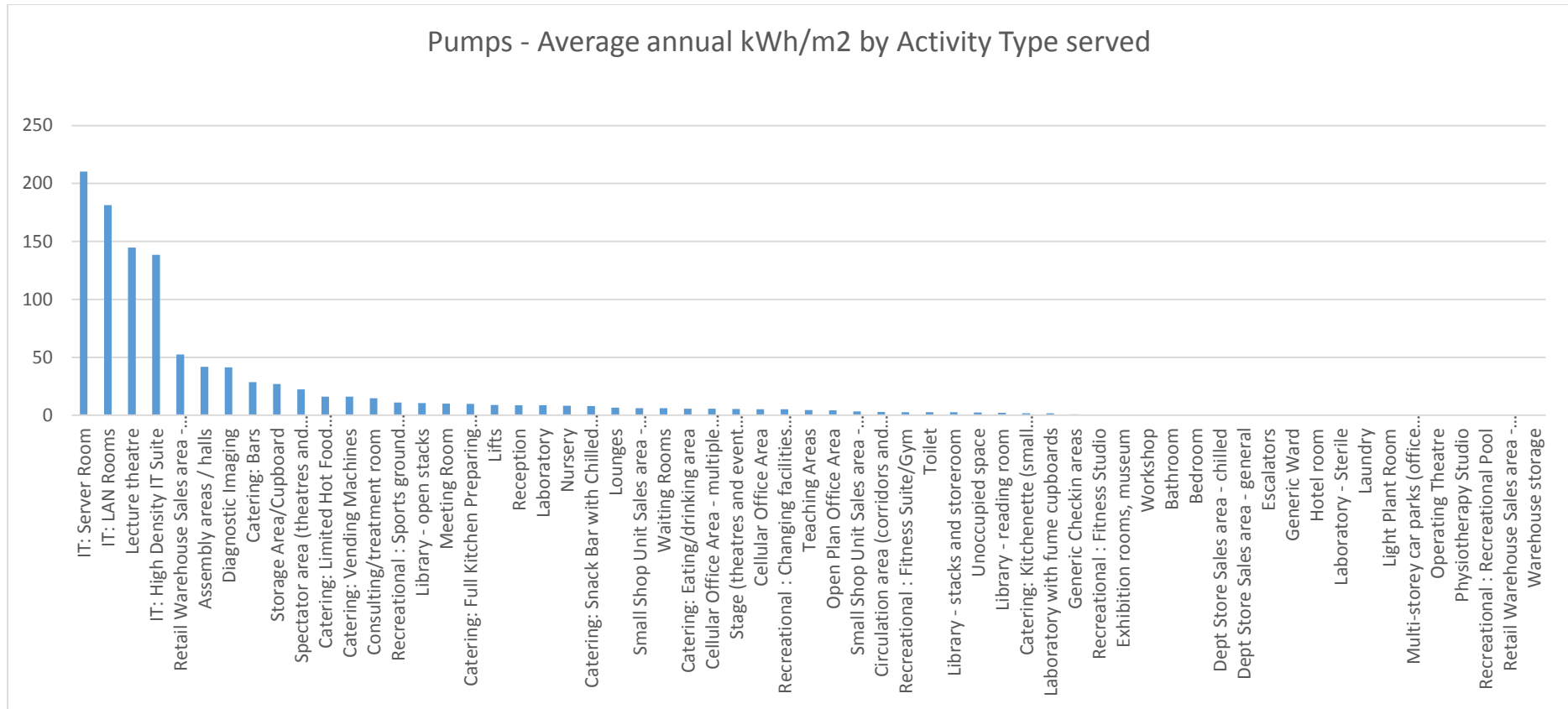


Figure 9 - Pumps - Average annual kWh/m2 by Activity Type served

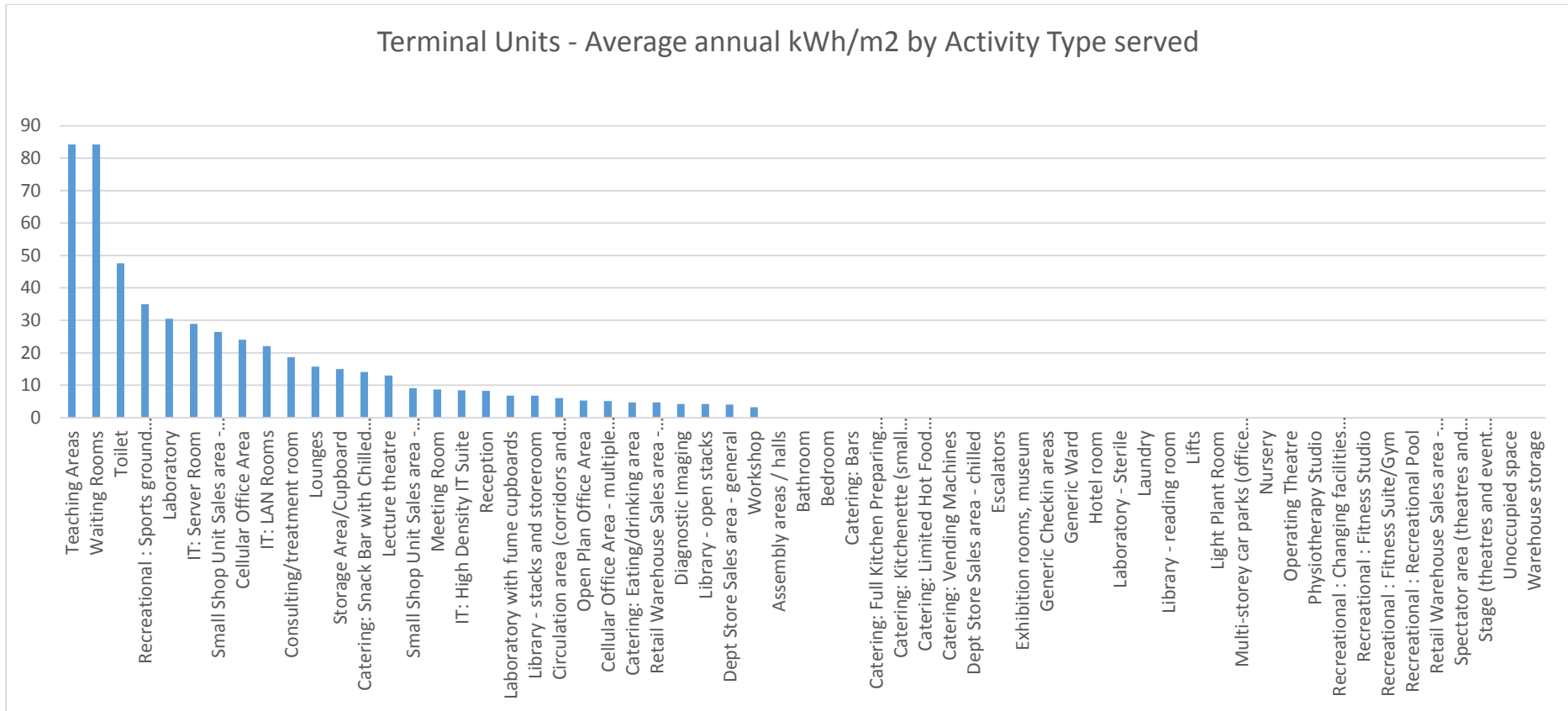


Figure 10 - Terminal Units - Average annual kWh/m2 by Activity Type served

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3.1 Air Handling Units in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the Air Handling Unit sub-components shown in each column.

Table 4 – Air Handling Units sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | Extract only | | Supply and extract | | Supply and extract with heating and cooling variants, etc | | Supply only | | Supply with heating and cooling variants | |
|---|---------------------------|----|---------------------------|------|---|-------|---------------------------|-------|--|-------|
| | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD |
| Assembly areas / halls | | | 247.86 | 0.00 | 2.64 | | 2.50 | | | |
| Catering: Eating/drinking area | | | | | 78.33 | | 4.47 | | | |
| Catering: Kitchenette (small appliances, fridge and sink) | | | | | 17.45 | | | | | |
| Catering: Limited Hot Food Preparation Area | 82.52 | | | | 92.31 | 65.73 | 58.24 | 55.72 | | 82.52 |
| Catering: Snack Bar with Chilled Cabinets | | | | | 101.37 | | 11.58 | | | |
| Catering: Vending Machines | | | | | 101.37 | | 11.58 | | | |
| Cellular Office Area | | | | | 8.83 | 5.70 | 2.76 | | | |
| Cellular Office Area - multiple occupation | | | | | 5.22 | 2.69 | 2.76 | | 0.40 | |
| Circulation area (corridors and stairways) | | | 10.70 | 0.00 | 5.03 | 1.63 | 5.86 | 6.81 | | |
| IT: High Density IT Suite | | | | | 52.34 | 15.53 | 10.00 | | | |
| IT: LAN Rooms | | | | | 12.89 | 7.75 | 18.85 | 22.51 | 0.53 | |
| IT: Server Room | | | | | 13.85 | | 3.42 | | | |
| Laboratory | | | | | 41.19 | 13.30 | | | | |
| Lecture theatre | | | | | 47.21 | | | | | |
| Library - open stacks | | | | | 2.86 | | 2.70 | | | |
| Library - stacks and storeroom | | | | | | | 2.77 | | | |
| Light Plant Room | | | | | 5.27 | 3.22 | 1.18 | | | |
| Meeting Room | 38.44 | | | | 18.66 | 11.42 | 4.47 | | 0.64 | 38.44 |
| Open Plan Office Area | | | | | 11.96 | 10.19 | 3.09 | | 0.48 | |
| Reception | | | | | 3.17 | | 1.05 | | | |
| Recreational : Changing facilities with showers | | | | | 38.88 | | | | | |
| Recreational : Fitness Studio | | | | | 19.44 | | | | | |
| Recreational : Sports ground changing rooms | | | | | 62.58 | 3.43 | 67.00 | 64.15 | | |
| Retail Warehouse Sales area - general | | | | | 20.89 | | | | | |
| Stage (theatres and event buildings) | | | | | 0.79 | | | | | |
| Storage Area/Cupboard | | | 14.68 | | 8.18 | 7.88 | 8.12 | 9.28 | | |
| Teaching Areas | | | | | 15.84 | 4.70 | | | | |
| Toilet | | | 169.58 | | 9.68 | 0.53 | 10.20 | 10.16 | | |
| Workshop | | | | | 25.39 | | | | | |

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3.2 All in One Systems in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the All-in-one sub-components shown in each column.

Table 5 – All-in-one sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | ASHP Cooling Only | | ASHP Reverse Cycle - Cooling Optimised | |
|---|-------------------|--------|--|----|
| | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD |
| Catering: Limited Hot Food Preparation Area | 130.16 | | | |
| Catering: Snack Bar with Chilled Cabinets | 130.16 | | | |
| IT: High Density IT Suite | 152.27 | | | |
| IT: Server Room | 640.69 | 273.03 | | |
| Meeting Room | 80.53 | - | 33.67 | |
| Open Plan Office Area | 32.07 | - | | |

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3.3 Cold Generators in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the Cold Generator sub-components shown in each column.

Table 6 – Cold Generators sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | Indirect evaporative cooler | | Reciprocating Liquid Chillers | | Screw Liquid Chillers | |
|---|-----------------------------|------|-------------------------------|-------|-----------------------|-------|
| | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD | AVG kWh/m2.a | SD |
| Assembly areas / halls | | | | | 0.31 | 0.20 |
| Catering: Eating/drinking area | | | | | 1.31 | 0.82 |
| Catering: Limited Hot Food Preparation Area | | | 14.15 | 0.77 | 1.18 | 0.74 |
| Catering: Snack Bar with Chilled Cabinets | | | | | 0.44 | 0.27 |
| Catering: Vending Machines | | | | | 0.44 | 0.27 |
| Cellular Office Area | 46.53 | | 14.53 | 0.80 | 1.22 | 0.76 |
| Cellular Office Area - multiple occupation | | | | | 1.28 | 0.80 |
| Circulation area (corridors and stairways) | | | 10.06 | 0.55 | 0.84 | 0.53 |
| IT: High Density IT Suite | | | 400.08 | 21.90 | 33.59 | 21.00 |
| IT: LAN Rooms | | | 842.28 | 46.10 | 70.70 | 44.21 |
| IT: Server Room | | | 602.14 | | 70.71 | 44.21 |
| Laboratory | | | 26.51 | 1.45 | | |
| Lecture theatre | | | 10.06 | | | |
| Library - open stacks | | | | | 0.45 | 0.28 |
| Library - stacks and storeroom | | | | | 0.30 | 0.19 |
| Light Plant Room | | | 0.74 | 0.04 | 0.06 | 0.04 |
| Meeting Room | | | 14.16 | 2.65 | 1.31 | 0.82 |
| Open Plan Office Area | | | 19.35 | | 1.56 | 0.98 |
| Reception | | | | | 0.84 | 0.53 |
| Retail Warehouse Sales area - general | | | 14.91 | | | |
| Storage Area/Cupboard | 4.77 | | 1.49 | 0.08 | 0.07 | 0.07 |
| Teaching Areas | 9.55 | 0.00 | 2.98 | 0.16 | | |
| Toilet | | | 2.23 | 0.12 | 0.18 | 0.12 |

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3.4 Heat Generators in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the Heat Generator sub-components shown in each column.

Table 7 – Heat Generators sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | AVG kWh/m2.a | SD |
|---|--------------|------|
| Assembly areas / halls | 2.36 | 3.21 |
| Catering: Eating/drinking area | 2.36 | 3.21 |
| Catering: Kitchenette (small appliances, fridge and sink) | 5.87 | - |
| Catering: Limited Hot Food Preparation Area | 1.75 | 2.81 |
| Catering: Snack Bar with Chilled Cabinets | 0.03 | - |
| Catering: Vending Machines | 0.03 | - |
| Cellular Office Area | 1.75 | 2.82 |
| Cellular Office Area - multiple occupation | 2.36 | 3.21 |
| Circulation area (corridors and stairways) | 1.75 | 2.82 |
| IT: High Density IT Suite | 1.75 | 2.82 |
| IT: LAN Rooms | 1.75 | 2.82 |
| IT: Server Room | 1.99 | 3.01 |
| Laboratory | 0.22 | 0.01 |
| Lecture theatre | 0.23 | |
| Library - open stacks | 0.01 | - |
| Library - stacks and storeroom | 0.01 | - |
| Meeting Room | 1.55 | 2.67 |
| Open Plan Office Area | 0.07 | 0.11 |
| Reception | 2.36 | 3.21 |
| Recreational : Sports ground changing rooms | 0.11 | 0.10 |
| Retail Warehouse Sales area - general | 0.23 | |
| Small Shop Unit Sales area - general | 5.88 | - |
| Storage Area/Cupboard | 1.75 | 2.82 |
| Teaching Areas | 0.22 | 0.01 |
| Toilet | 2.55 | 4.17 |

Fuel Fired Boilers

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3.5 Heat Pumps in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the Heat Pump sub-components shown in each column.

Table 8 – Heat Pump sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | ASHP Reverse Cycle - Cooling Optimised | |
|--|--|----|
| | AVG kWh/m ² .a | SD |
| Cellular Office Area - multiple occupation | 58.21 | |
| IT: LAN Rooms | 41.20 | |
| Meeting Room | 58.21 | |
| Open Plan Office Area | 58.21 | |

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3.6 Heat Rejection in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for the Heat Rejection sub-components shown in each column.

Table 9 – Heat Rejection sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | AVG kWh/m2.a | SD |
|---|--------------|-------|
| Assembly areas / halls | 0.03 | 0.02 |
| Catering: Eating/drinking area | 0.07 | 0.04 |
| Catering: Limited Hot Food Preparation Area | 0.36 | 0.36 |
| Catering: Snack Bar with Chilled Cabinets | 0.06 | 0.04 |
| Catering: Vending Machines | 0.06 | 0.04 |
| Cellular Office Area | 0.27 | 0.27 |
| Cellular Office Area - multiple occupation | 0.04 | 0.03 |
| Circulation area (corridors and stairways) | 0.17 | 0.16 |
| IT: High Density IT Suite | 0.61 | 0.59 |
| IT: LAN Rooms | 3.59 | 3.52 |
| IT: Server Room | 97.83 | 89.70 |
| Laboratory | 0.65 | 0.04 |
| Lecture theatre | 1.31 | |
| Library - open stacks | 0.08 | 0.05 |
| Library - stacks and storeroom | 0.08 | 0.05 |
| Light Plant Room | 0.08 | 0.08 |
| Meeting Room | 0.47 | 0.38 |
| Open Plan Office Area | 0.25 | 0.34 |
| Reception | 0.03 | 0.02 |
| Retail Warehouse Sales area - general | 0.82 | |
| Storage Area/Cupboard | 0.07 | 0.08 |
| Teaching Areas | 0.48 | 0.03 |
| Toilet | 0.26 | 0.25 |

Forced air
condensers

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3.7 Pumps in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for Pump sub-components shown in each column.

Table 10 – Pump sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | Chilled water primary pumps | | Chilled water secondary pumps | | Condenser water pumps | | DHW secondary (circulation) pumps | | Hot water primary pumps | | Hot water secondary pumps | |
|---|-----------------------------|------|-------------------------------|-------|---------------------------|------|-----------------------------------|------|---------------------------|-------|---------------------------|--------|
| | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD | AVG kWh/m ² .a | SD |
| Assembly areas / halls | | | 25.32 | | | | | | 4.21 | | 443.61 | |
| Catering: Eating/drinking area | | | 6.33 | | | | | | 1.05 | | 110.90 | |
| Catering: Kitchenette (small appliances, fridge and sink) | | | | | | | 0.18 | - | 1.59 | - | | |
| Catering: Limited Hot Food Preparation Area | 1.79 | 0.10 | 5.25 | 1.25 | 0.50 | 0.03 | 0.14 | | 4.79 | 2.04 | 58.43 | 60.58 |
| Catering: Snack Bar with Chilled Cabinets | | | 6.33 | | | | 0.12 | | 2.11 | | 110.90 | |
| Catering: Vending Machines | | | 6.33 | | | | 0.12 | | 2.10 | | 110.90 | |
| Cellular Office Area | 1.79 | 0.10 | 5.25 | 1.25 | 0.50 | 0.03 | 0.29 | 0.04 | 3.44 | 2.06 | 46.74 | 43.57 |
| Cellular Office Area - multiple occupation | | | 6.33 | | | | | | 1.05 | | 55.45 | - |
| Circulation area (corridors and stairways) | 1.79 | 0.10 | 4.89 | 1.25 | 0.50 | 0.03 | 0.18 | - | 3.23 | 2.51 | 40.94 | 60.59 |
| IT: High Density IT Suite | 22.35 | 1.22 | 61.15 | 15.71 | 0.50 | 0.03 | 0.36 | - | 48.39 | 26.30 | 511.76 | 757.36 |
| IT: LAN Rooms | 22.35 | 1.22 | 65.63 | 15.65 | 0.50 | 0.03 | | | 54.21 | 35.26 | 584.31 | 544.67 |
| IT: Server Room | 15.98 | | 141.36 | 71.87 | 0.36 | | | | 33.21 | 28.36 | 719.77 | 942.59 |
| Laboratory | 4.99 | 0.27 | 11.65 | 0.64 | 0.50 | 0.03 | 0.29 | 0.06 | 11.04 | 5.24 | 16.64 | 0.91 |
| Laboratory with fume cupboards | | | | | | | 0.21 | 0.03 | 5.19 | 0.63 | | |
| Lecture theatre | 7.43 | | 17.33 | | 0.52 | | | | 24.76 | | 24.76 | |
| Library - open stacks | | | 6.33 | | | | | | 1.05 | | 110.90 | |
| Library - stacks and storeroom | | | 2.43 | | | | | | 0.40 | | 42.53 | |
| Light Plant Room | | | | | 0.50 | 0.03 | | | | | | |
| Lounges | | | | | | | 0.12 | 0.00 | 1.06 | 0.00 | | |
| Meeting Room | 1.62 | 0.30 | 4.80 | 1.48 | 0.46 | 0.09 | | | 4.31 | 2.32 | 39.66 | 42.66 |
| Open Plan Office Area | 1.86 | | 5.66 | 1.15 | 0.52 | | | | 3.62 | 3.63 | 57.00 | 42.79 |
| Reception | | | 6.33 | | | | 0.18 | - | 1.41 | 0.31 | 110.90 | |
| Recreational : Changing facilities with showers | | | | | | | 0.18 | - | 0.99 | - | | |
| Recreational : Fitness Studio | | | | | | | 0.12 | - | 0.66 | - | | |
| Recreational : Sports ground changing rooms | | | | | 0.50 | 0.03 | 0.15 | | 3.06 | 1.17 | 25.59 | 37.87 |
| Retail Warehouse Sales area - general | 5.18 | | 12.10 | | 0.52 | | | | 17.28 | | 17.28 | |
| Stage (theatres and event buildings) | | | | | | | 0.12 | - | 1.06 | 0.00 | | |
| Storage Area/Cupboard | 1.79 | 0.10 | 5.45 | 1.17 | 0.50 | 0.03 | | | 2.85 | 2.42 | 57.43 | 46.95 |
| Teaching Areas | 1.79 | 0.10 | 4.17 | 0.23 | 0.50 | 0.03 | 0.19 | - | 3.84 | 2.45 | 5.96 | 0.33 |
| Toilet | 1.79 | 0.10 | 4.89 | 1.25 | 0.50 | 0.03 | 0.14 | | 4.80 | 2.03 | 40.94 | 60.59 |
| Workshop | | | | | | | 0.14 | 0.02 | | | | |

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3.8 Terminal Units in UK – Electricity Average Annual Energy Consumption - kWh/m²

The table shows the measured average and standard deviation annual energy use for all activity types for Terminal Unit sub-components shown in each column.

Table 11 – Terminal Unit sub-components in UK – Electricity Average and Standard Deviation Annual Energy Consumption - kWh/m².

| Activity Name | AVG kWh/m2.a | SD |
|---|--------------|--------|
| Catering: Limited Hot Food Preparation Area | 11.17 | 0.61 |
| Cellular Office Area | 61.14 | 77.94 |
| Circulation area (corridors and stairways) | 11.17 | 0.61 |
| IT: High Density IT Suite | 93.14 | 86.08 |
| IT: LAN Rooms | 22.35 | 1.22 |
| IT: Server Room | 15.98 | |
| Laboratory | 11.18 | 0.61 |
| Lecture theatre | 23.22 | |
| Meeting Room | 10.11 | 1.89 |
| Open Plan Office Area | 11.61 | |
| Recreational : Sports ground changing rooms | 11.17 | 0.61 |
| Retail Warehouse Sales area - general | 11.61 | |
| Storage Area/Cupboard | 11.17 | 0.61 |
| Teaching Areas | 124.37 | 196.06 |
| Toilet | 11.17 | 0.61 |

Fan Coils – 2 or 4 tubes

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4 Summary of measured electrical power demands by HVAC Component and sub-component type servicing a given activity

This section contains a table for each activity type for which we have data, summarising the range of electrical power demands found across all the HVAC component types monitored in iSERVcmb.

A summary of the measured average and standard deviation power demands by component and activity type is shown in Table 12. Values in brackets indicate the standard deviation found from this average. This data can be used to estimate the likely power demand to be incurred by the HVAC component while servicing this type of activity across UK. The more detailed tables that follow Table 12 also show the annual average, maximum and minimum power demands found for this equipment servicing the specific activity noted.

Zero figures are excluded from the minima i.e. the minima shows how little power might be drawn by energised equipment, and the average is also drawn only from those readings when the equipment is operational.

Table 12 – Benchmarks for measured Average and Standard Deviation Power Demands in W/m² Summary by HVAC Component and Activity Type for UK

| Activity Name | Sample Size | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|---|-------------|----------------------|-------|----------------------|-------|----------------------|--------|----------------------|-------|----------------------|------|----------------------|-------|----------------------|-------|
| | | AVG W/m ² | SD | AVG W/m ² | SD | AVG W/m ² | SD | AVG W/m ² | SD | AVG W/m ² | SD | AVG W/m ² | SD | AVG W/m ² | SD |
| Assembly areas / halls | 5 | 0.41 | 0.09 | | | 0.08 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 3.48 | 6.90 | | |
| Catering: Eating/drinking area | 8 | 2.85 | 3.61 | | | 0.65 | 0.43 | 0.00 | 0.00 | 0.01 | 0.01 | 0.12 | 0.06 | | |
| Catering: Full Kitchen Preparing Hot Meals | 5 | 12.49 | 7.46 | | | 5.16 | 3.13 | 0.01 | 0.00 | 0.05 | 0.00 | 0.37 | 0.13 | | |
| Catering: Kitchenette (small appliances, fridge and sink) | 7 | 3.25 | 3.02 | | | 0.29 | 0.15 | 0.00 | 0.00 | 0.01 | 0.00 | 0.14 | 0.11 | | |
| Catering: Limited Hot Food Preparation Area | 6 | 14.15 | 9.58 | 15.29 | | 1.53 | 1.46 | 6.82 | 16.66 | 0.07 | 0.07 | 0.69 | 0.96 | 2.17 | 0.48 |
| Catering: Snack Bar with Chilled Cabinets | 2 | 6.75 | 7.29 | 15.29 | | 0.11 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 0.14 | 0.14 | | |
| Catering: Vending Machines | 2 | 6.75 | 7.29 | | | 0.11 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 0.14 | 0.14 | | |
| Cellular Office Area | 43 | 2.59 | 2.24 | | | 1.20 | 1.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.48 | 0.72 | 47.45 | 62.31 |
| Cellular Office Area - multiple occupation | 7 | 0.98 | 0.63 | | | 0.33 | 0.06 | 0.00 | 0.00 | 0.01 | 0.00 | 0.58 | 0.65 | | |
| Circulation area (corridors and stairways) | 48 | 1.01 | 0.71 | | | 1.34 | 0.98 | 0.01 | 0.02 | 0.02 | 0.03 | 0.50 | 0.72 | 2.18 | 0.48 |
| Consulting/treatment room | 4 | 1.18 | 1.37 | | | 0.70 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.07 | | |
| IT: High Density IT Suite | 20 | 6.62 | 4.22 | 17.55 | | 33.96 | 27.14 | 0.01 | 0.02 | 0.07 | 0.10 | 6.06 | 9.49 | 11.76 | 9.53 |
| IT: LAN Rooms | 18 | 2.57 | 2.63 | 4.65 | | 60.65 | 59.37 | 0.01 | 0.02 | 0.43 | 0.60 | 6.89 | 10.67 | 4.35 | 0.97 |
| IT: Server Room | 4 | 14.11 | 11.88 | 56.87 | 37.37 | 334.75 | 548.01 | 0.07 | 0.13 | 12.17 | 9.26 | 44.03 | 51.81 | 25.67 | |
| Laboratory | 6 | 20.64 | 14.78 | | | 4.24 | 1.50 | 0.04 | 0.01 | 0.13 | 0.03 | 1.44 | 1.20 | 2.18 | 0.48 |
| Laboratory with fume cupboards | 3 | 19.99 | 0.00 | | | 2.39 | 0.73 | | | | | 0.57 | 0.48 | | |
| Lecture theatre | 4 | 4.98 | 4.08 | | | 0.62 | 0.50 | 0.01 | 0.02 | 0.06 | 0.10 | 0.96 | 1.37 | 3.67 | |
| Library - open stacks | 2 | 0.44 | 0.10 | | | 0.12 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 1.41 | 2.21 | | |

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| | | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|---|----|--------------------|-------|--------------------|-------|-----------------|------|-----------------|------|----------------|------|-------|------|----------------|-------|
| Library - stacks and storeroom | 2 | 0.38 | | | | 0.08 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.54 | 0.85 | | |
| Lifts | 32 | 0.82 | 0.51 | | | 0.49 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.07 | | |
| Light Plant Room | 48 | 0.98 | 0.59 | | | 0.06 | 0.05 | | | 0.01 | 0.01 | 0.15 | 0.07 | | |
| Lounges | 7 | 3.02 | 4.19 | | | 1.00 | 0.52 | 0.00 | 0.00 | 0.01 | 0.00 | 0.13 | 0.10 | | |
| Meeting Room | 40 | 4.32 | 4.89 | 18.98 | 12.92 | 2.66 | 5.18 | 0.04 | 0.08 | 0.16 | 0.32 | 1.10 | 1.83 | 5.73 | 6.16 |
| Open Plan Office Area | 35 | 2.58 | 1.69 | 7.20 | 0.00 | 1.02 | 0.90 | 0.01 | 0.01 | 0.02 | 0.04 | 0.55 | 0.91 | 1.83 | |
| Reception | 13 | 0.64 | 0.60 | | | 0.48 | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.80 | | |
| Recreational : Changing facilities with showers | 2 | 2.76 | 2.50 | | | | | 0.00 | 0.00 | | | 0.11 | 0.08 | | |
| Recreational : Fitness Studio | 2 | 1.65 | 0.87 | 28.06 | | 2.58 | 1.35 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.08 | | |
| Recreational : Fitness Suite/Gym | 1 | 1.04 | | 28.06 | | 2.30 | 1.39 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.08 | | |
| Recreational : Sports ground changing rooms | 5 | 12.09 | 11.91 | 39.32 | | | | 0.01 | 0.01 | | | 0.42 | 0.61 | 2.16 | 0.47 |
| Retail Warehouse Sales area - general | 1 | 3.30 | | | | 2.35 | | 0.03 | | 0.13 | | 1.65 | 1.18 | 1.83 | |
| Small Shop Unit Sales area - general | 2 | | | | | | | | | | | 0.13 | 0.02 | | |
| Stage (theatres and event buildings) | 1 | 0.09 | | | | 2.49 | 0.77 | | | | | 0.15 | 0.13 | | |
| Storage Area/Cupboard | 28 | 1.51 | 1.47 | | | 0.11 | 0.10 | 0.01 | 0.02 | 0.01 | 0.01 | 0.48 | 0.74 | 2.17 | 0.48 |
| Teaching Areas | 4 | 2.47 | 1.18 | | | 0.41 | 0.22 | 0.04 | 0.01 | 0.09 | 0.02 | 0.49 | 0.44 | 17.08 | 25.82 |
| Toilet | 32 | 1.32 | 1.01 | | | 0.17 | 0.16 | 0.01 | 0.02 | 0.03 | 0.04 | 0.48 | 0.81 | 2.17 | 0.48 |
| Waiting Rooms | 3 | 1.60 | 1.76 | | | 0.90 | 0.53 | 0.00 | 0.00 | 0.01 | 0.00 | 0.12 | 0.07 | | |
| Workshop | 2 | 18.06 | 21.36 | | | 0.53 | 0.16 | | | | | 0.02 | 0.00 | | |

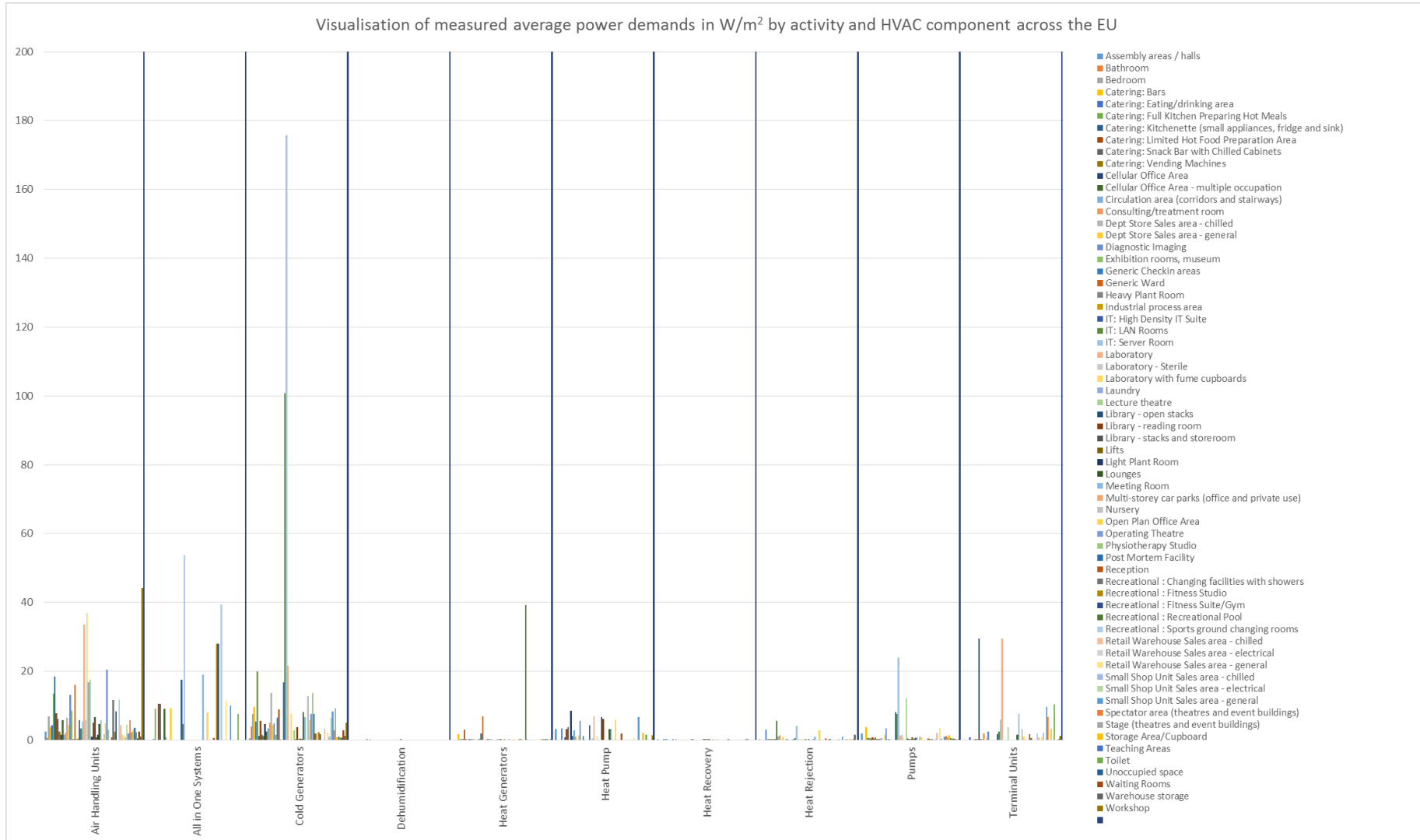


Figure 11 - Measured Overall Power Demand in W/m^2 by HVAC Component type. Summary for UK

Figure 11 shows how the average power demand varies by HVAC component and activity served across the UK. It can be seen that the large majority of the power demand HVAC component: activity type combinations are less than 20 W/m^2 on average across the UK. Figure 11 is further broken down into individual HVAC components in Figure 12 to Figure 21, where the activities are rank ordered by their measured average power demands.

The following figures present this data by individual component type .The activities for each component are rank ordered to clarify which activities were measured as demanding the largest average power demand when the component was operational.

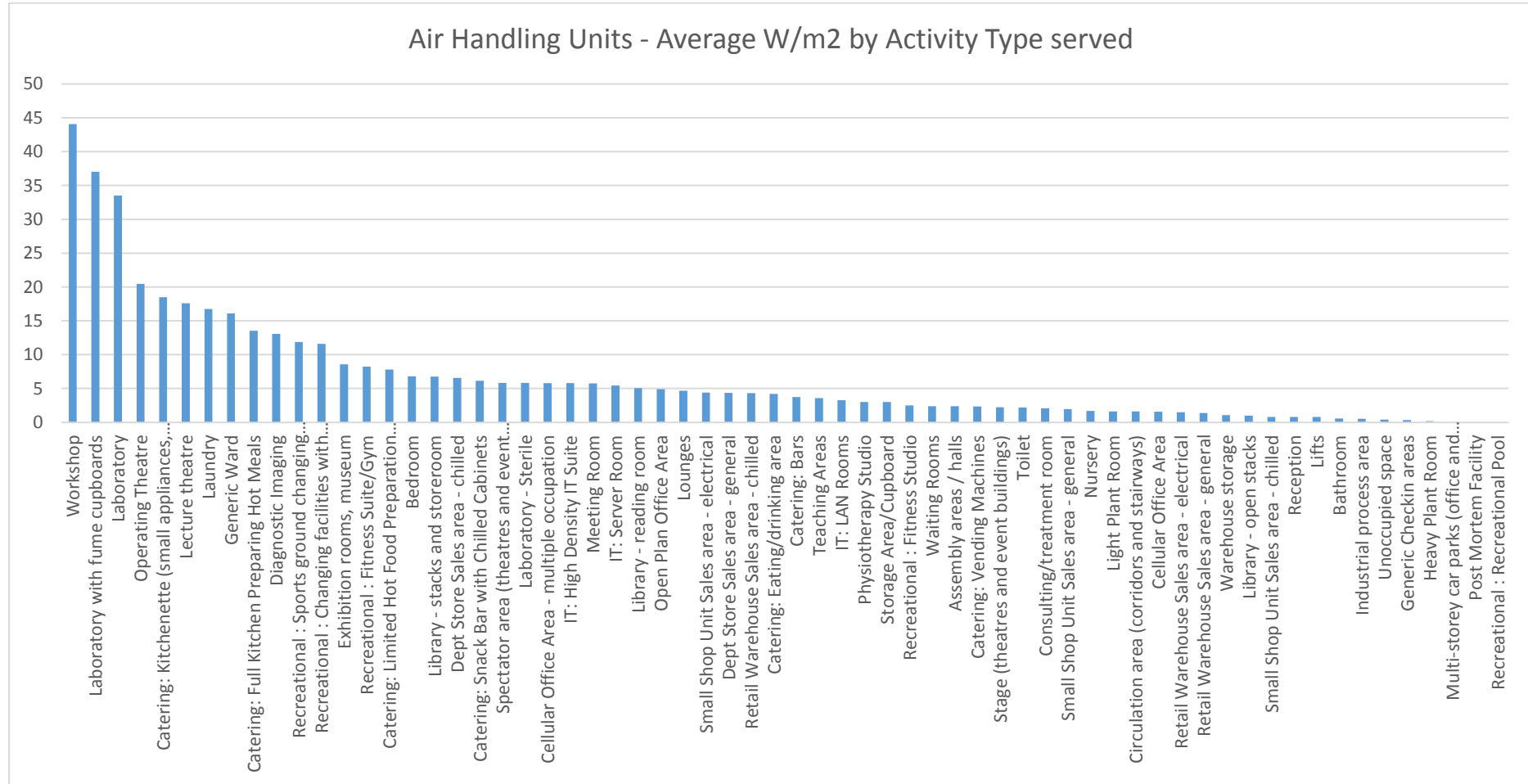


Figure 12 - Air Handling Units - Average W/m2 by Activity Type served

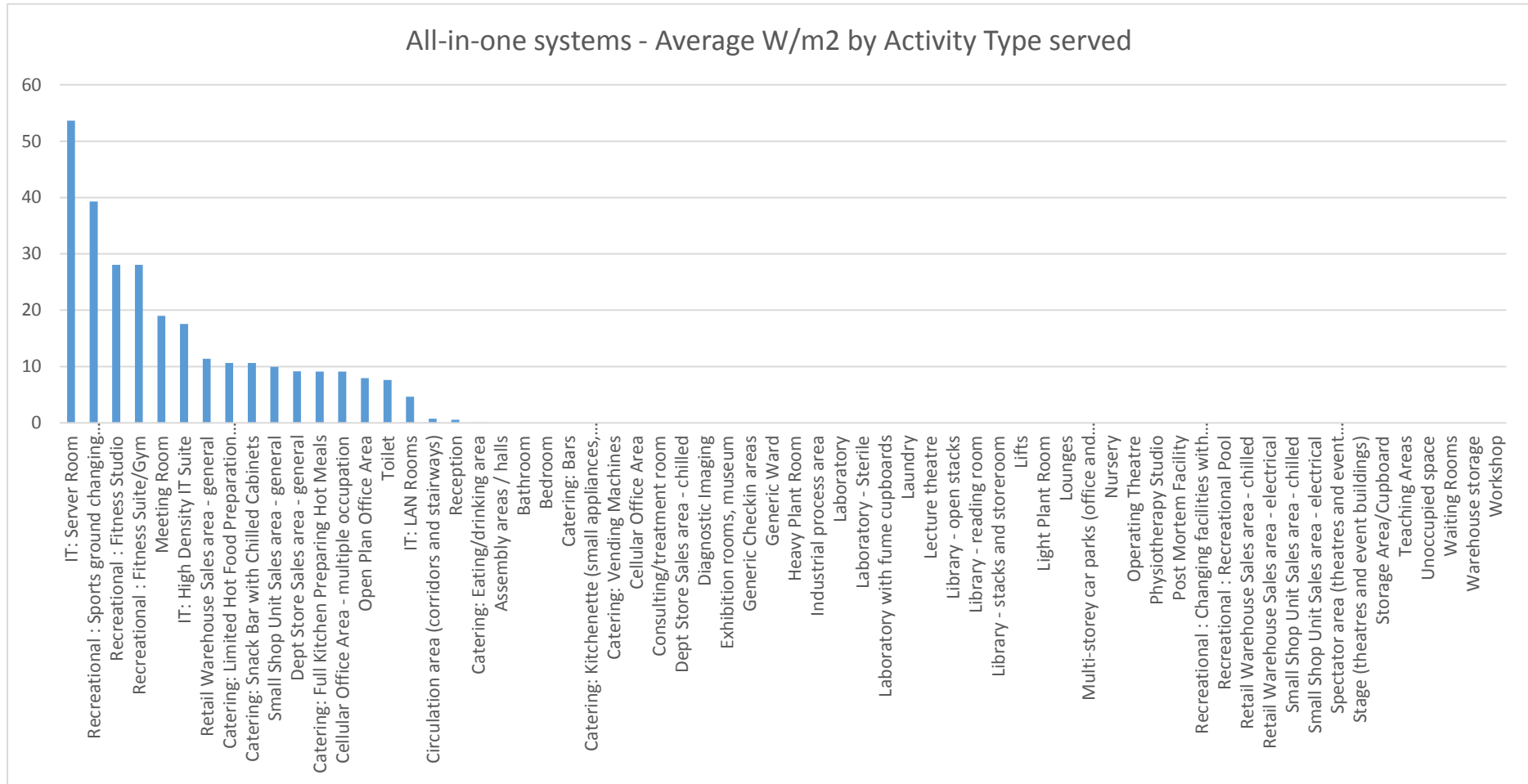


Figure 13 - All-in-one systems - Average W/m2 by Activity Type served

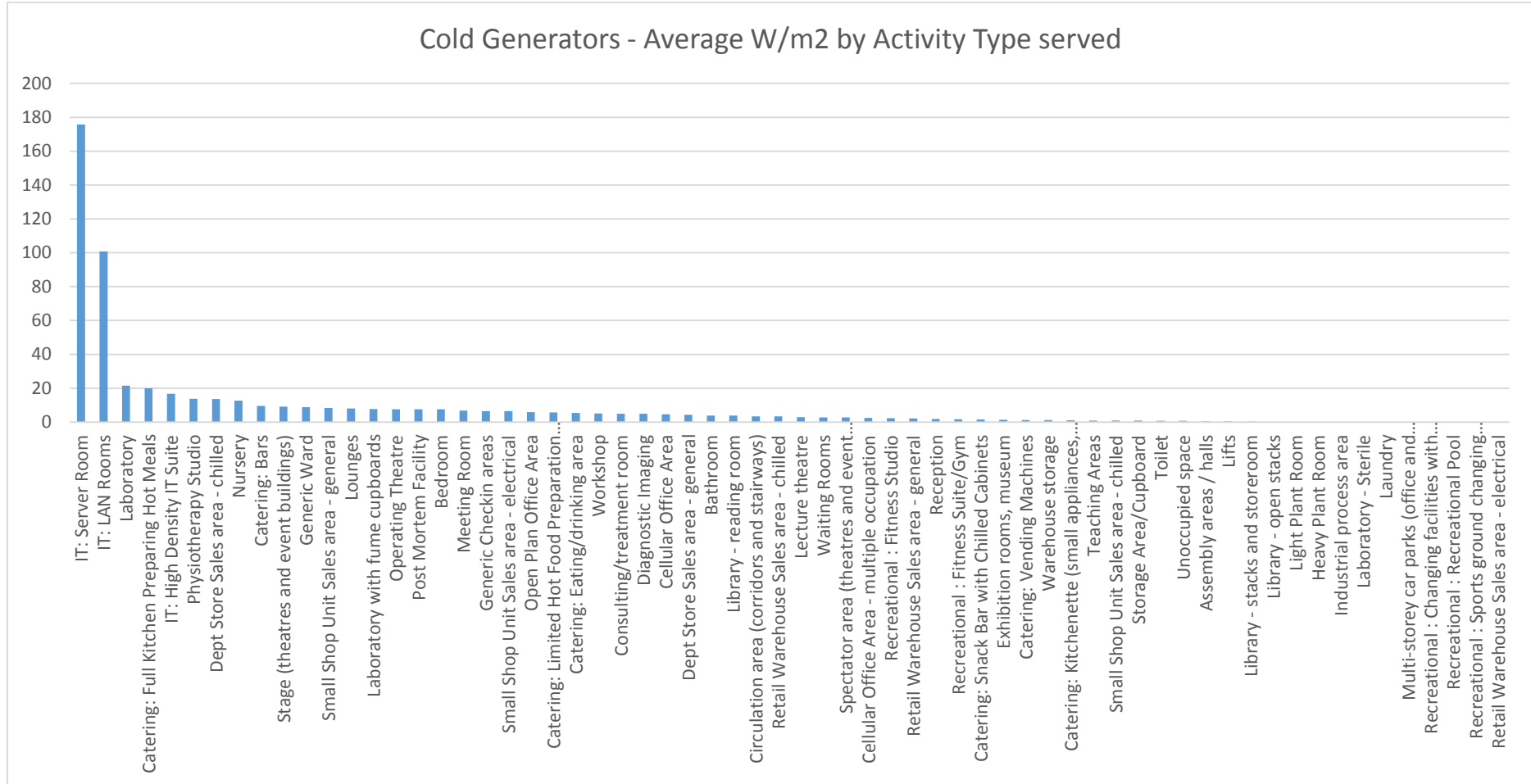


Figure 14 - Cold Generators - Average W/m2 by Activity Type served

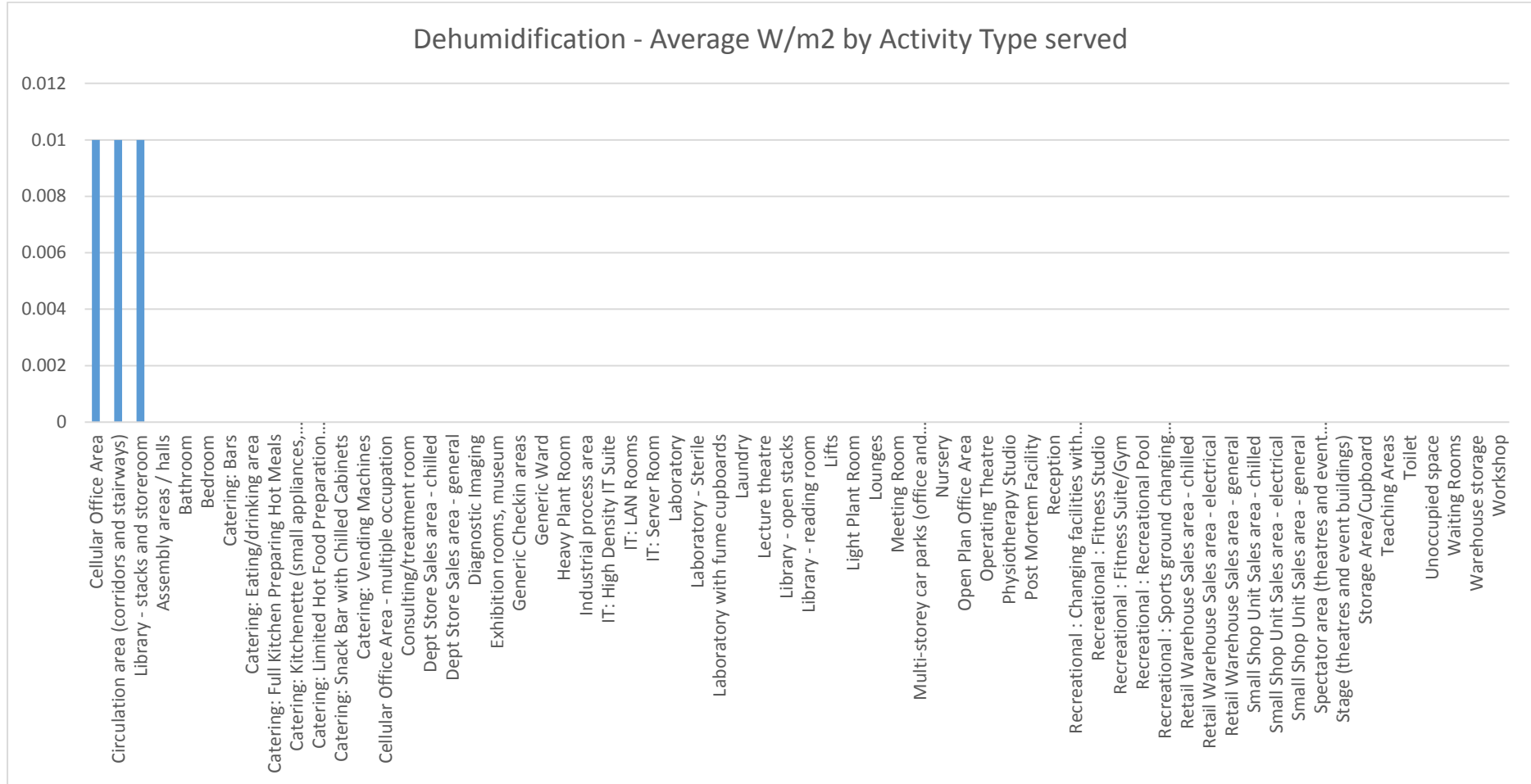


Figure 15 - Dehumidification - Average W/m2 by Activity Type served

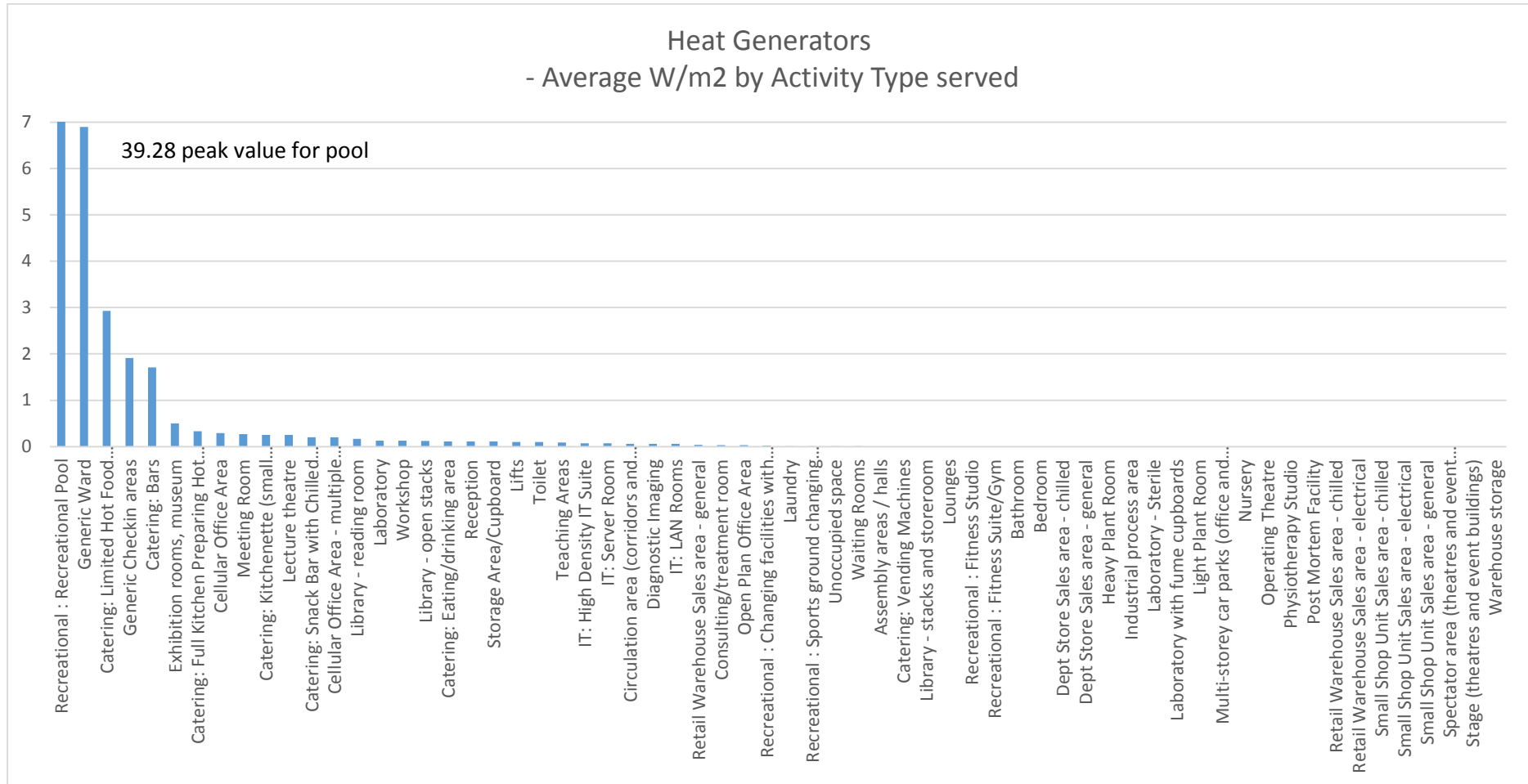


Figure 16 - Heat Generators – Average W/m² by Activity Type served

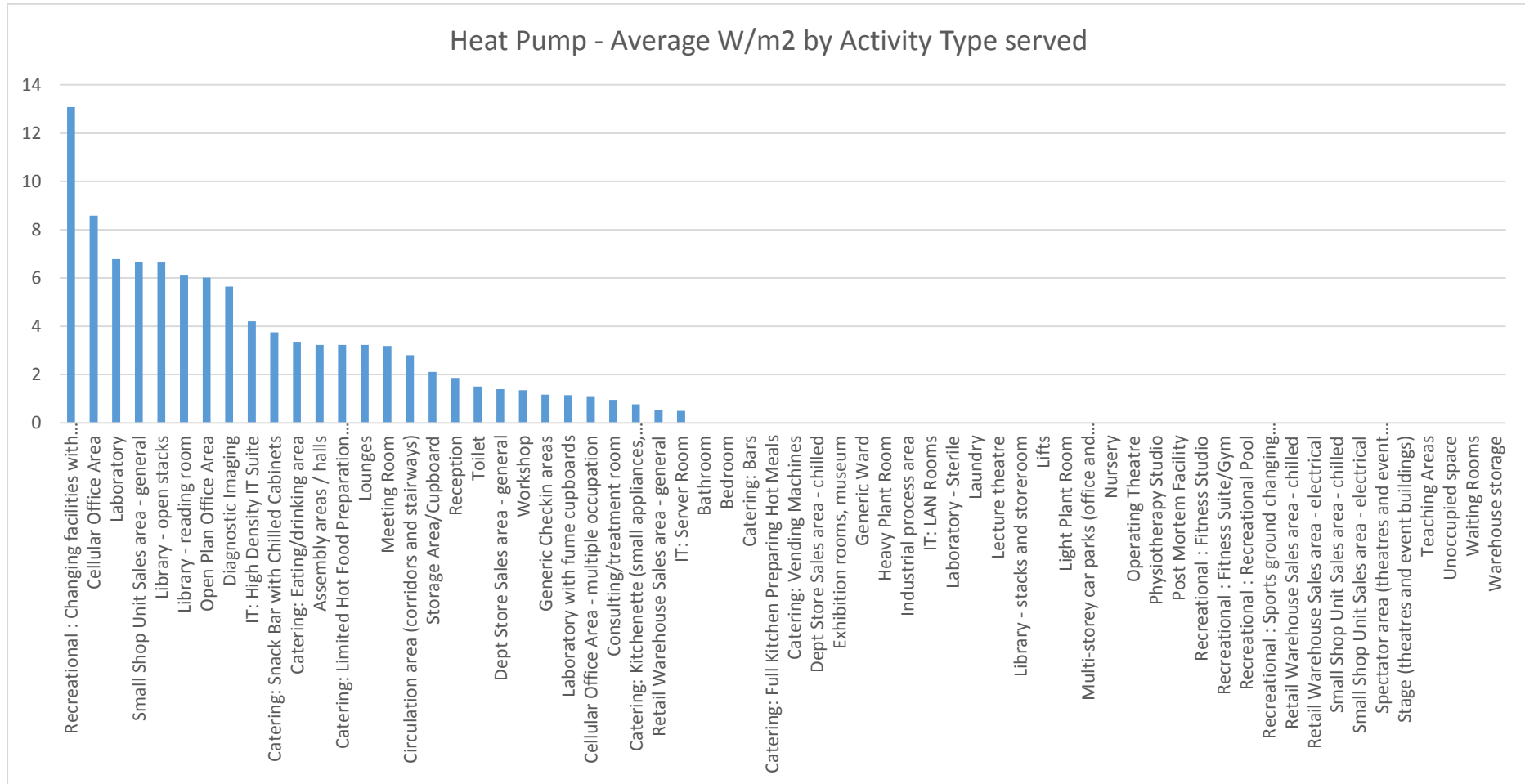


Figure 17 - Heat Pump - Average W/m2 by Activity Type served

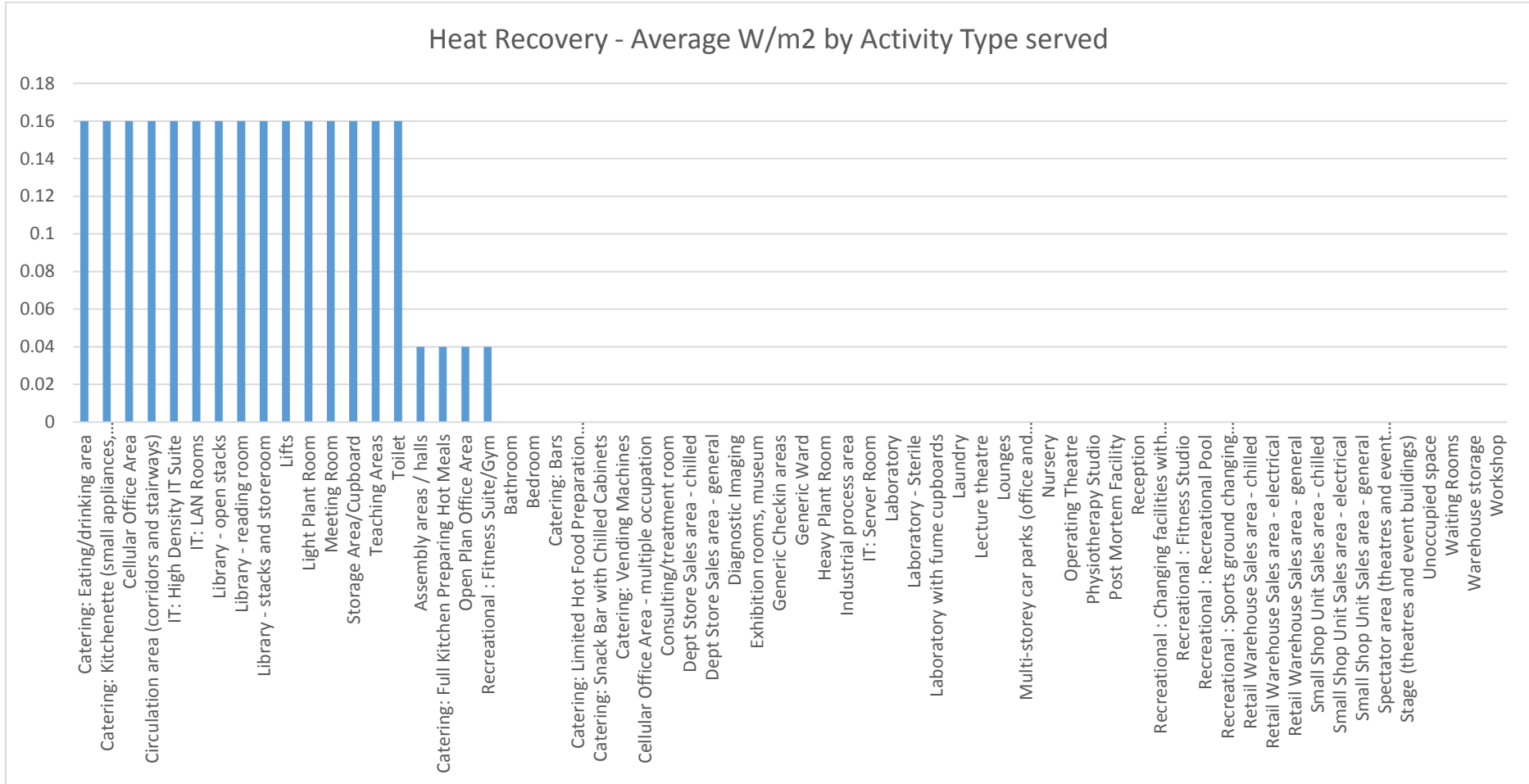


Figure 18 - Heat Recovery - Average W/m2 by Activity Type served

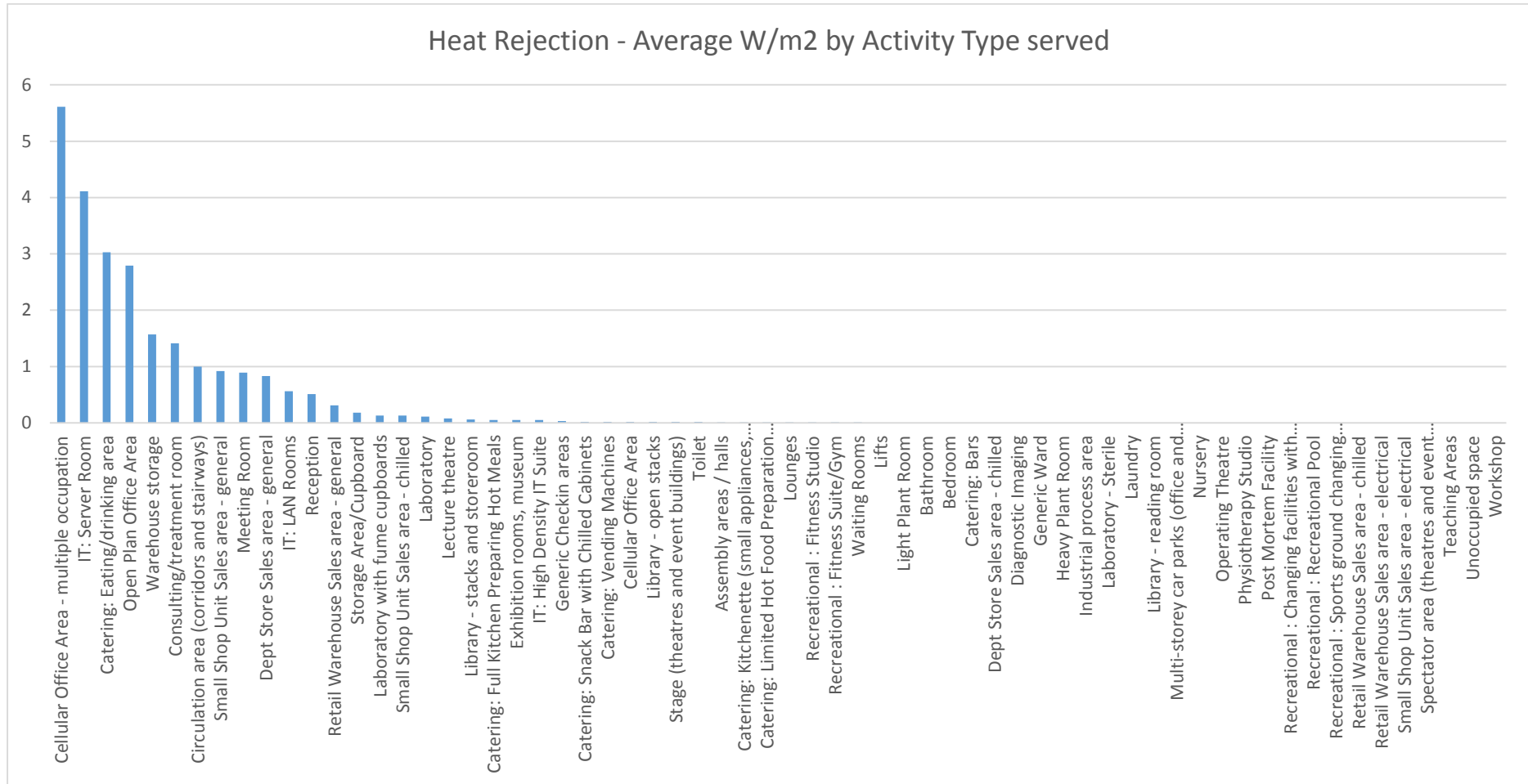


Figure 19 - Heat Rejection - Average W/m2 by Activity Type served

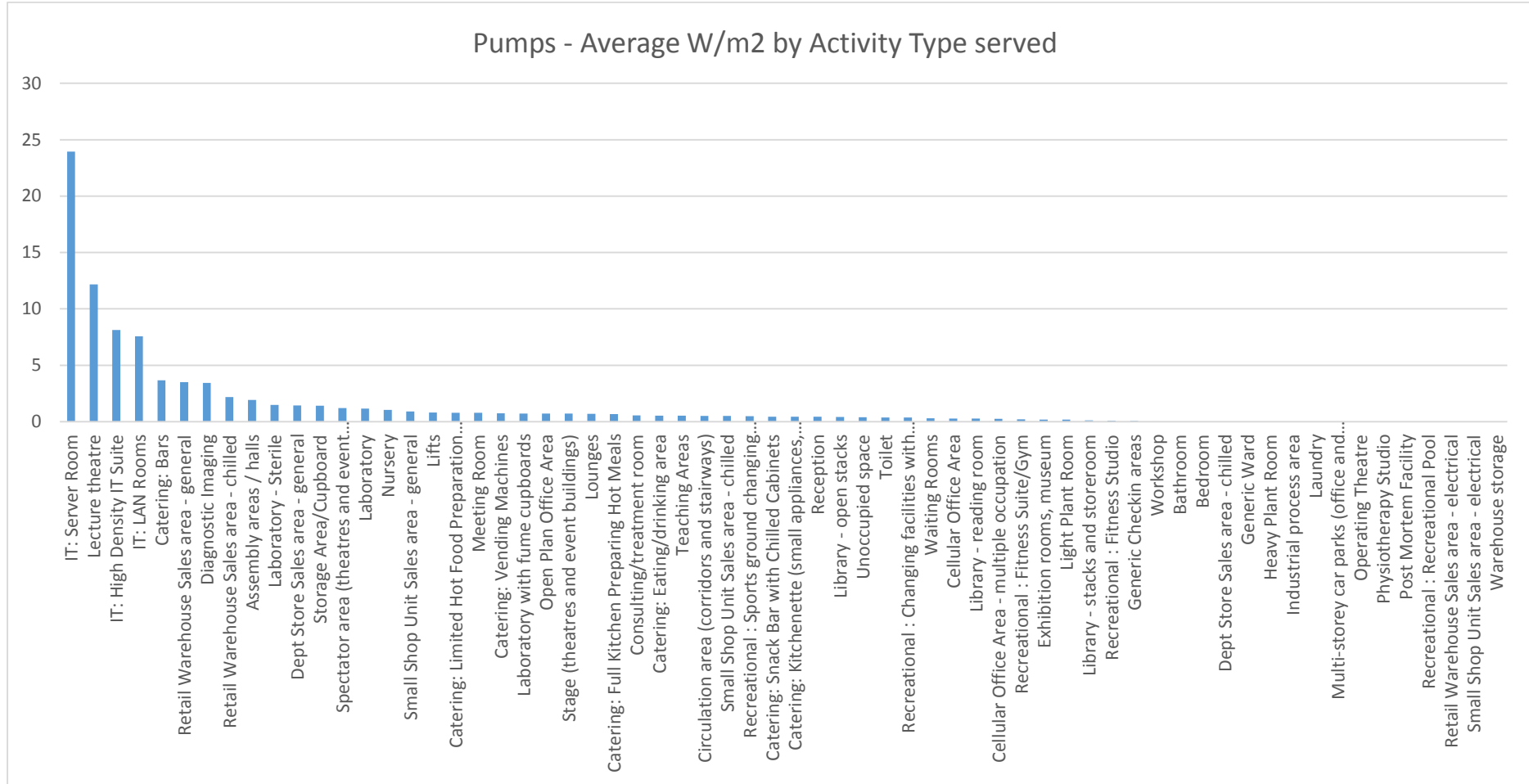


Figure 20 - Pumps - Average W/m2 by Activity Type served

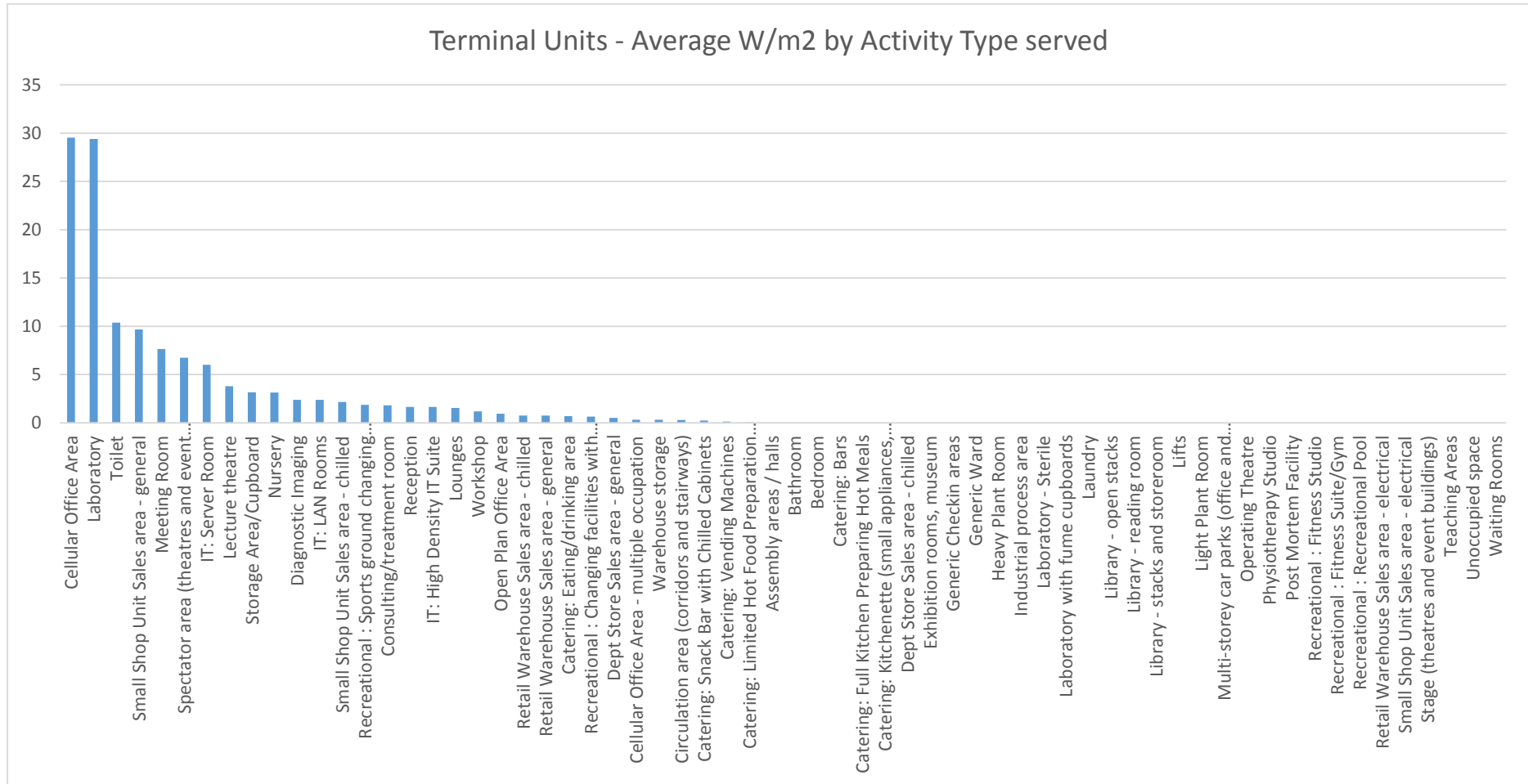


Figure 21 - Terminal Units - Average W/m2 by Activity Type served

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The following tables shows the average, maximum and minimum power demands found from the data for specific activity types for the overall component type shown in each column.

4.1 Assembly areas / halls - Electricity power demand summary by component

Table 13– Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Assembly areas / halls. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|-------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.41 | 0.09 | 0.08 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 3.48 | 6.90 |
| Maximum | 1.55 | 0.39 | 2.64 | 1.05 | 0.01 | - | 0.28 | 0.11 | 9.52 | 17.70 |
| Minimum | 0.02 | 0.03 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.09 | 0.10 |
| Sample Size | 2.00 | | 2.00 | | 3.00 | | 2.00 | | 5.00 | |

4.2 Catering: Eating/drinking area – Electricity power demand summary by component

Table 14 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Eating/drinking area. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|-------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.85 | 3.61 | 0.65 | 0.43 | 0.00 | 0.00 | 0.01 | 0.01 | 0.12 | 0.06 |
| Maximum | 10.95 | 17.31 | 5.10 | 4.16 | 0.01 | 0.00 | 0.24 | 0.33 | 0.23 | 0.20 |
| Minimum | 0.16 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 |
| Sample Size | 8.00 | | 8.00 | | 6.00 | | 5.00 | | 13.00 | |

4.3 Catering: Full Kitchen Preparing Hot Meals – Electricity power demand summary by component

Table 15 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Full Kitchen Preparing Hot Meals. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|-------|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 12.49 | 7.46 | 5.16 | 3.13 | 0.01 | - | 0.05 | 0.00 | 0.37 | 0.13 |
| Maximum | 20.99 | 14.95 | 21.39 | 7.13 | 0.01 | - | 0.10 | - | 0.57 | 0.38 |
| Minimum | 0.91 | 1.14 | 0.02 | 0.01 | 0.00 | - | 0.00 | - | 0.01 | 0.01 |
| Sample Size | 5.00 | | 6.00 | | 3.00 | | 3.00 | | 10.00 | |

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4.4 Catering: Kitchenette (small appliances, fridge and sink) – Electricity power demand summary by component

Table 16 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Kitchenette (small appliances, fridge and sink). Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 3.25 | 3.02 | 0.29 | 0.15 | 0.00 | - | 0.01 | - | 0.14 | 0.11 |
| Maximum | 6.22 | 5.11 | 1.25 | 0.55 | 0.00 | - | 0.01 | 0.00 | 0.23 | 0.18 |
| Minimum | 0.73 | 1.73 | 0.00 | 0.00 | 0.00 | - | 0.00 | - | 0.03 | 0.06 |
| Sample Size | 7.00 | | 8.00 | | 3.00 | | 3.00 | | 19.00 | |

4.5 Catering: Limited Hot Food Preparation Area – Electricity power demand summary by component

Table 17 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Limited Hot Food Preparation Area. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|----|--------------------------|------|--------------------------|--------|--------------------------|------|--------------------------|------|--------------------------|-------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 14.15 | 9.58 | 15.29 | | 1.53 | 1.46 | 6.82 | 16.66 | 0.07 | 0.07 | 0.69 | 0.96 | 2.17 | 14.15 |
| Maximum | 68.59 | 58.25 | 79.26 | | 9.83 | 3.75 | 47.67 | 116.62 | 0.45 | 0.17 | 2.23 | 2.75 | 7.60 | 68.59 |
| Minimum | 0.74 | 1.00 | 0.95 | | 0.15 | 0.30 | 2.51 | 6.14 | 0.01 | 0.01 | 0.05 | 0.09 | 0.23 | 0.74 |
| Sample Size | 5.00 | | 1.00 | | 4.00 | | 6.00 | | 4.00 | | 17.00 | | 2.00 | 5.00 |

4.6 Catering: Snack Bar with Chilled Cabinets – Electricity power demand summary by component

Table 18 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Snack Bar with Chilled Cabinets. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|-------|--------------------------|----|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 6.75 | 7.29 | 15.29 | | 0.11 | 0.02 | 0.00 | - | 0.02 | 0.00 | 0.14 | 0.14 |
| Maximum | 35.11 | 37.65 | 79.27 | | 3.70 | 1.48 | 0.02 | - | 0.52 | 0.21 | 0.71 | 0.75 |
| Minimum | 0.38 | 0.51 | 0.95 | | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.00 | 0.00 |
| Sample Size | 2.00 | | 1.00 | | 2.00 | | 3.00 | | 2.00 | | 3.00 | |

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4.7 Catering: Vending Machines – Electricity power demand summary by component

Table 19 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Catering: Vending Machines. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|-------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 6.75 | 7.29 | 0.11 | 0.02 | 0.00 | - | 0.02 | 0.00 | 0.14 | 0.14 |
| Maximum | 35.10 | 37.65 | 3.69 | 1.48 | 0.02 | 0.00 | 0.51 | 0.20 | 0.71 | 0.75 |
| Minimum | 0.38 | 0.51 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.00 | 0.00 |
| Sample Size | 2.00 | | 2.00 | | 3.00 | | 2.00 | | 3.00 | |

4.8 Cellular Office Area – Electricity power demand summary by component

Table 20 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Cellular Office Area. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|----------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.59 | 2.24 | 1.20 | 1.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.48 | 0.72 | 47.45 | 62.31 |
| Maximum | 6.06 | 4.03 | 6.52 | 4.43 | 0.04 | 0.07 | 0.20 | 0.21 | 1.46 | 2.27 | 736.77 | 1,104.19 |
| Minimum | 0.28 | 0.42 | 0.05 | 0.18 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.10 | 33.98 | 51.49 |
| Sample Size | 43.00 | | 12.00 | | 8.00 | | 7.00 | | 38.00 | | 6.00 | |

4.9 Cellular Office Area - multiple occupation – Electricity power demand summary by component

Table 21 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Cellular Office Area - multiple occupation. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.98 | 0.63 | 0.33 | 0.06 | 0.00 | 0.00 | 0.01 | 0.00 | 0.58 | 0.65 |
| Maximum | 7.28 | 5.81 | 10.83 | 4.33 | 0.01 | 0.00 | 0.36 | 0.14 | 2.51 | 2.81 |
| Minimum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.02 | 0.01 |
| Sample Size | 3.00 | | 2.00 | | 3.00 | | 2.00 | | 5.00 | |

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4.10 Circulation area (corridors and stairways) – Electricity power demand summary by component

Table 22 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Circulation area (corridors and stairways). Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.01 | 0.71 | 1.34 | 0.98 | 0.01 | 0.02 | 0.02 | 0.03 | 0.50 | 0.72 | 2.18 | 0.48 |
| Maximum | 3.04 | 3.83 | 6.50 | 2.49 | 0.05 | 0.07 | 0.13 | 0.12 | 1.32 | 2.13 | 7.62 | 4.04 |
| Minimum | 0.10 | 0.15 | 0.04 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.07 | 0.24 | 0.33 |
| Sample Size | 47.00 | | 12.00 | | 9.00 | | 7.00 | | 34.00 | | 2.00 | |

4.11 Consulting/treatment room – Electricity power demand summary by component

Table 23 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Consulting/treatment room. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.18 | 1.37 | 0.70 | 0.41 | 0.00 | - | 0.00 | 0.00 | 0.12 | 0.07 |
| Maximum | 2.25 | 2.58 | 2.88 | 0.96 | 0.01 | - | 0.01 | - | 0.16 | 0.08 |
| Minimum | 0.57 | 1.10 | 0.00 | 0.00 | 0.00 | - | 0.00 | - | 0.01 | 0.00 |
| Sample Size | 4.00 | | 6.00 | | 3.00 | | 3.00 | | 10.00 | |

4.12 IT: High Density IT Suite – Electricity power demand summary by component

Table 24 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for IT: High Density IT Suite. Average W/m² and SD for component and activity (Standard Deviation).

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|----|--------------------------|--------|--------------------------|------|--------------------------|------|--------------------------|-------|--------------------------|----------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 6.62 | 4.22 | 17.55 | | 33.96 | 27.14 | 0.01 | 0.02 | 0.07 | 0.10 | 6.06 | 9.49 | 11.76 | 9.53 |
| Maximum | 18.49 | 13.90 | 62.36 | | 187.67 | 121.24 | 0.04 | 0.07 | 0.45 | 0.46 | 16.54 | 27.36 | 1,027.22 | 2,218.04 |
| Minimum | 0.48 | 0.59 | 2.29 | | 1.43 | 4.63 | 0.00 | 0.00 | 0.01 | 0.02 | 0.74 | 1.37 | 2.24 | 1.65 |
| Sample Size | 19.00 | | 1.00 | | 13.00 | | 8.00 | | 7.00 | | 33.00 | | 5.00 | |

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4.13 IT: LAN Rooms – Electricity power demand summary by component

Table 25 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for IT: LAN Rooms. Average W/m² and SD for component and activity (Standard Deviation).

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|----|--------------------------|--------|--------------------------|------|--------------------------|------|--------------------------|-------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.57 | 2.63 | 4.65 | | 60.65 | 59.37 | 0.01 | 0.02 | 0.43 | 0.60 | 6.89 | 10.67 | 4.35 | 0.97 |
| Maximum | 10.86 | 14.85 | 5.07 | | 334.69 | 255.50 | 0.04 | 0.07 | 2.68 | 2.71 | 23.16 | 33.26 | 15.24 | 8.10 |
| Minimum | 0.32 | 0.80 | 0.60 | | 3.65 | 11.17 | 0.00 | 0.00 | 0.04 | 0.10 | 0.43 | 0.92 | 0.47 | 0.66 |
| Sample Size | 12.00 | | 1.00 | | 10.00 | | 8.00 | | 7.00 | | 26.00 | | 2.00 | |

4.14 IT: Server Room – Electricity power demand summary by component

Table 26 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for IT: Server Room. Average W/m² and SD for component and activity (Standard Deviation).

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|--------|--------------------------|----------|--------------------------|------|--------------------------|-------|--------------------------|--------|--------------------------|----|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 14.11 | 11.88 | 56.87 | 37.37 | 334.75 | 548.01 | 0.07 | 0.13 | 12.17 | 9.26 | 44.03 | 51.81 | 25.67 | |
| Maximum | 45.88 | 60.91 | 166.72 | 121.99 | 2,072.75 | 2,560.45 | 0.34 | 0.66 | 40.56 | 25.49 | 213.99 | 271.00 | 133.28 | |
| Minimum | 6.54 | 11.32 | 3.98 | 7.22 | 0.03 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.12 | 0.25 | 0.00 | |
| Sample Size | 3.00 | | 7.00 | | 3.00 | | 4.00 | | 7.00 | | 9.00 | | 1.00 | |

4.15 Laboratory – Electricity power demand summary by component

Table 27 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Laboratory. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 20.64 | 14.78 | 4.24 | 1.50 | 0.04 | 0.01 | 0.13 | 0.03 | 1.44 | 1.20 | 2.18 | 0.48 |
| Maximum | 39.07 | 19.63 | 17.10 | 9.87 | 0.15 | 0.08 | 0.45 | 0.24 | 4.09 | 4.62 | 7.62 | 4.04 |
| Minimum | 1.62 | 1.25 | 0.45 | 0.59 | 0.00 | 0.01 | 0.01 | 0.02 | 0.31 | 0.41 | 0.24 | 0.33 |
| Sample Size | 6.00 | | 5.00 | | 2.00 | | 2.00 | | 22.00 | | 2.00 | |

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4.16 Laboratory with fume cupboards – Electricity power demand summary by component

Table 28 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Laboratory with fume cupboards. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Pumps | |
|--------------------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 19.99 | - | 2.39 | 0.73 | 0.57 | 0.48 |
| Maximum | 40.40 | - | 12.64 | 3.20 | 1.08 | 0.81 |
| Minimum | 1.75 | - | 0.01 | 0.01 | 0.19 | 0.27 |
| Sample Size | 2.00 | | 2.00 | | 10.00 | |

4.17 Lecture theatre – Electricity power demand summary by component

Table 29 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Lecture theatre. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|----|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 4.98 | 4.08 | 0.62 | 0.50 | 0.01 | 0.02 | 0.06 | 0.10 | 0.96 | 1.37 | 3.67 | |
| Maximum | 10.91 | 8.87 | 2.24 | 1.02 | 0.03 | 0.04 | 0.15 | 0.26 | 2.32 | 3.67 | 9.53 | |
| Minimum | 2.10 | 3.02 | 0.06 | 0.15 | 0.00 | 0.00 | 0.01 | 0.03 | 0.21 | 0.37 | 0.94 | |
| Sample Size | 4.00 | | 7.00 | | 4.00 | | 4.00 | | 15.00 | | 1.00 | |

4.18 Library - open stacks – Electricity power demand summary by component

Table 30 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Library - open stacks. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.44 | 0.10 | 0.12 | 0.02 | 0.00 | - | 0.02 | 0.00 | 1.41 | 2.21 |
| Maximum | 1.68 | 0.43 | 3.84 | 1.54 | 0.01 | 0.00 | 0.68 | 0.27 | 3.85 | 5.57 |
| Minimum | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.02 | 0.03 |
| Sample Size | 2.00 | | 2.00 | | 3.00 | | 2.00 | | 3.00 | |

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4.19 Library - stacks and storeroom – Electricity power demand summary by component

Table 31 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Library - stacks and storeroom. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|-------------|--------------------------|----|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.38 | | 0.08 | 0.01 | 0.00 | - | 0.02 | 0.00 | 0.54 | 0.85 |
| Maximum | 2.03 | | 2.52 | 1.01 | 0.01 | - | 0.68 | 0.27 | 1.48 | 2.14 |
| Minimum | 0.00 | | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.01 | 0.01 |
| Sample Size | 1.00 | | 2.00 | | 3.00 | | 2.00 | | 3.00 | |

4.20 Lifts – Electricity power demand summary by component

Table 32 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Lifts. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|-------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.82 | 0.51 | 0.49 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.07 |
| Maximum | 1.91 | 1.31 | 1.99 | 0.67 | 0.01 | - | 0.01 | - | 0.16 | 0.08 |
| Minimum | 0.09 | 0.11 | 0.00 | 0.00 | 0.00 | - | 0.00 | - | 0.01 | 0.00 |
| Sample Size | 32.00 | | 6.00 | | 3.00 | | 3.00 | | 10.00 | |

4.21 Light Plant Room – Electricity power demand summary by component

Table 33 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Light Plant Room. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Rejection | | Pumps | |
|-------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.98 | 0.59 | 0.06 | 0.05 | 0.01 | 0.01 | 0.15 | 0.07 |
| Maximum | 2.58 | 2.02 | 0.29 | 0.20 | 0.06 | 0.06 | 0.24 | 0.13 |
| Minimum | 0.10 | 0.17 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Sample Size | 47.00 | | 12.00 | | 7.00 | | 6.00 | |

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4.22 Lounges – Electricity power demand summary by component

Table 34 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Lounges. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|----|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 3.02 | 4.19 | 1.00 | 0.52 | 0.00 | 0.00 | 0.01 | - | 0.13 | 0.10 |
| Maximum | 6.12 | 6.74 | 4.52 | 1.97 | 0.01 | 0.00 | 0.01 | - | 0.22 | 0.16 |
| Minimum | 0.21 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.03 | 0.06 |
| Sample Size | 7.00 | | 8.00 | | 3.00 | | 3.00 | | 20.00 | |

4.23 Meeting Room – Electricity power demand summary by component

Table 35 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Meeting Rooms. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|-------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 4.32 | 4.89 | 18.98 | 12.92 | 2.66 | 5.18 | 0.04 | 0.08 | 0.16 | 0.32 | 1.10 | 1.83 | 5.73 | 6.16 |
| Maximum | 14.59 | 25.17 | 60.17 | 28.85 | 14.13 | 26.63 | 0.18 | 0.42 | 0.89 | 1.61 | 4.82 | 9.28 | 27.28 | 34.17 |
| Minimum | 0.24 | 0.22 | 0.29 | 0.11 | 0.06 | 0.20 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.07 | 0.16 | 0.27 |
| Sample Size | 35.00 | | 3.00 | | 11.00 | | 9.00 | | 8.00 | | 33.00 | | 3.00 | |

4.24 Open Plan Office Area – Electricity power demand summary by component

Table 36 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Open Plan Office areas. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|----|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.58 | 1.69 | 7.20 | - | 1.02 | 0.90 | 0.01 | 0.01 | 0.02 | 0.04 | 0.55 | 0.91 | 1.83 | |
| Maximum | 7.23 | 5.63 | 35.72 | - | 6.28 | 4.67 | 0.02 | 0.03 | 0.19 | 0.22 | 1.61 | 2.66 | 4.76 | |
| Minimum | 0.22 | 0.36 | 0.00 | - | 0.09 | 0.26 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.08 | 0.47 | |
| Sample Size | 28.00 | | 2.00 | | 9.00 | | 7.00 | | 6.00 | | 20.00 | | 1.00 | |

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4.25 Reception – Electricity power demand summary by component

Table 37 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Reception. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.64 | 0.60 | 0.48 | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.80 |
| Maximum | 1.83 | 1.83 | 3.38 | 2.38 | 0.01 | 0.00 | 0.09 | 0.12 | 0.70 | 2.10 |
| Minimum | 0.04 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.06 |
| Sample Size | 12.00 | | 10.00 | | 6.00 | | 5.00 | | 23.00 | |

4.26 Recreational: Changing facilities with showers – Electricity power demand summary by component

Table 38 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Recreational: Changing facilities with showers. Average W/m² and Standard Deviation

| | Air Handling Units | | Heat Generators | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.76 | 2.50 | 0.00 | - | 0.11 | 0.08 |
| Maximum | 6.89 | 7.71 | 0.01 | - | 0.18 | 0.09 |
| Minimum | 0.05 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sample Size | 2.00 | | 3.00 | | 11.00 | |

4.27 Recreational: Fitness Studio – Electricity power demand summary by component

Table 39 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Recreational: Fitness Studio. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.65 | 0.87 | 28.06 | | 2.58 | 1.35 | 0.00 | - | 0.01 | - | 0.10 | 0.08 |
| Maximum | 3.86 | 3.27 | 30.63 | | 11.67 | 5.09 | 0.01 | - | 0.01 | - | 0.15 | 0.10 |
| Minimum | 0.06 | 0.03 | 3.62 | | 0.01 | 0.01 | 0.00 | - | 0.00 | 0.00 | 0.02 | 0.04 |
| Sample Size | 2.00 | | 1.00 | | 8.00 | | 3.00 | | 3.00 | | 20.00 | |

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4.28 Recreational: Fitness Suite/Gym – Electricity power demand summary by component

Table 40 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Recreational: Fitness Suite/Gym. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|----|--------------------------|----|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.04 | | 28.06 | | 2.30 | 1.39 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.08 |
| Maximum | 1.55 | | 30.63 | | 9.53 | 3.18 | 0.01 | 0.00 | 0.01 | - | 0.12 | 0.09 |
| Minimum | 0.08 | | 3.62 | | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sample Size | 1.00 | | 1.00 | | 6.00 | | 3.00 | | 3.00 | | 10.00 | |

4.29 Recreational: Sports ground changing rooms – Electricity power demand summary by component

Table 41 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Recreational: Sports ground changing rooms. Average W/m² and Standard Deviation

| | Air Handling Units | | All in One Systems | | Heat Generators | | Pumps | | Terminal Units | |
|--------------------|--------------------------|-------|--------------------------|----|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 12.09 | 11.91 | 39.32 | | 0.01 | 0.01 | 0.42 | 0.61 | 2.16 | 0.47 |
| Maximum | 55.89 | 70.04 | 42.93 | | 0.04 | 0.04 | 1.22 | 1.78 | 7.56 | 3.97 |
| Minimum | 0.60 | 1.14 | 5.07 | | 0.00 | 0.00 | 0.03 | 0.05 | 0.23 | 0.33 |
| Sample Size | 5.00 | | 1.00 | | 8.00 | | 16.00 | | 2.00 | |

4.30 Retail Warehouse Sales area – general – Electricity power demand summary by component

Table 42 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Retail Warehouse Sales area – general. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|----|--------------------------|----|--------------------------|----|--------------------------|----|--------------------------|------|--------------------------|----|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 3.30 | | 2.35 | | 0.03 | | 0.13 | | 1.65 | 1.18 | 1.83 | |
| Maximum | 8.57 | | 6.12 | | 0.09 | | 0.33 | | 4.30 | 3.06 | 4.76 | |
| Minimum | 0.85 | | 0.60 | | 0.01 | | 0.03 | | 0.42 | 0.30 | 0.47 | |
| Sample Size | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 5.00 | | 1.00 | |

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4.31 Small Shop Unit Sales area – general – Electricity power demand summary by component

Table 43 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Small Shop Unit Sales area – general. Average W/m² and Standard Deviation

| Pumps | | |
|-------------|--------------------------|------|
| | Average W/m ² | SD |
| Average | 0.13 | 0.02 |
| Maximum | 0.34 | 0.08 |
| Minimum | 0.04 | 0.00 |
| Sample Size | 2.00 | |

4.32 Stage (theatres and event buildings) – Electricity power demand summary by component

Table 44 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Stage (theatres and event buildings). Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Pumps | |
|-------------|--------------------------|----|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 0.09 | | 2.49 | 0.77 | 0.15 | 0.13 |
| Maximum | 0.25 | | 13.18 | 3.34 | 0.27 | 0.20 |
| Minimum | 0.00 | | 0.01 | 0.01 | 0.05 | 0.08 |
| Sample Size | 1.00 | | 2.00 | | 10.00 | |

4.33 Storage Area/Cupboard – Electricity power demand summary by component

Table 45 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Storage Area/Cupboard. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|-------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.51 | 1.47 | 0.11 | 0.10 | 0.01 | 0.02 | 0.01 | 0.01 | 0.48 | 0.74 | 2.17 | 0.48 |
| Maximum | 5.39 | 6.45 | 0.58 | 0.41 | 0.05 | 0.07 | 0.06 | 0.06 | 1.50 | 2.35 | 7.62 | 4.04 |
| Minimum | 0.12 | 0.23 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.07 | 0.24 | 0.33 |
| Sample Size | 27.00 | | 12.00 | | 8.00 | | 7.00 | | 35.00 | | 2.00 | |

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4.34 Teaching Areas – Electricity power demand summary by component

Table 46 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Teaching Areas. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|--------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 2.47 | 1.18 | 0.41 | 0.22 | 0.04 | 0.01 | 0.09 | 0.02 | 0.49 | 0.44 | 17.08 | 25.82 |
| Maximum | 10.11 | 6.11 | 1.63 | 0.80 | 0.15 | 0.08 | 0.32 | 0.17 | 1.56 | 1.80 | 87.13 | 137.73 |
| Minimum | 0.20 | 0.35 | 0.03 | 0.06 | 0.00 | 0.01 | 0.01 | 0.01 | 0.08 | 0.10 | 1.48 | 2.17 |
| Sample Size | 4.00 | | 4.00 | | 2.00 | | 2.00 | | 18.00 | | 3.00 | |

4.35 Toilet – Electricity power demand summary by component

Table 47 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Toilet. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | | Terminal Units | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.32 | 1.01 | 0.17 | 0.16 | 0.01 | 0.02 | 0.03 | 0.04 | 0.48 | 0.81 | 2.17 | 0.48 |
| Maximum | 3.57 | 4.76 | 0.88 | 0.68 | 0.05 | 0.07 | 0.19 | 0.19 | 1.47 | 2.39 | 7.62 | 4.04 |
| Minimum | 0.15 | 0.24 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.07 | 0.24 | 0.33 |
| Sample Size | 31.00 | | 10.00 | | 8.00 | | 7.00 | | 27.00 | | 2.00 | |

4.36 Waiting Rooms – Electricity power demand summary by component

Table 48 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Waiting Rooms. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Heat Generators | | Heat Rejection | | Pumps | |
|--------------------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 1.60 | 1.76 | 0.90 | 0.53 | 0.00 | 0.00 | 0.01 | - | 0.12 | 0.07 |
| Maximum | 3.11 | 3.23 | 3.69 | 1.23 | 0.01 | - | 0.01 | 0.00 | 0.16 | 0.08 |
| Minimum | 0.84 | 1.42 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.01 | 0.00 |
| Sample Size | 3.00 | | 6.00 | | 3.00 | | 3.00 | | 10.00 | |

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4.37 Workshop – Electricity power demand summary by component

Table 49 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Workshop. Average W/m² and Standard Deviation

| | Air Handling Units | | Cold Generators | | Pumps | |
|--------------------|--------------------------|-------|--------------------------|------|--------------------------|------|
| | Average W/m ² | SD | Average W/m ² | SD | Average W/m ² | SD |
| Average | 18.06 | 21.36 | 0.53 | 0.16 | 0.02 | 0.00 |
| Maximum | 30.02 | 31.06 | 2.80 | 0.71 | 0.05 | 0.01 |
| Minimum | 1.27 | 1.72 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sample Size | 2.00 | | 2.00 | | 3.00 | |

5 References

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