

iSERV Measured Data Analysis by HVAC Component and Activity - PORTUGAL

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1. Introduction

This report presents the measured HVAC component and end use activity data obtained for Portugal during the iSERV project. This particular report presents the recorded energy use information by floor area and HVAC components for each activity type within the iSERV system.

A separate report presents the energy use information by the floor area served only. The reports have been separated for reasons of size and clarity, as well as due to the more controversial nature of the initial benchmarks used for apportionment by activity, as reported in this document.

2. Overall 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 Portugal as well as summarising the measured data from the more detailed parts of this report.

2.1 Overall HVAC Components and Activities Summary

Table 1 summarises the data collected for the HVAC Components and the iSERV Activity types available in Portugal. It can be seen that the HVAC components in this country service 61 total activity types with areas ranging in size from 23 to 141,000 m². There were an average of 1 meters available for each system analysed.

Table 1 – Overall Systems Summary for Portugal showing numbers of components and meters associated with each activity type. For the components columns, the first number shows total components associated with each activity.

Activity type	Floor Area / m ²	# of spaces	Heat meter	Electricity	Heat Generators	Cold Generators	Air Handling Units	Pumps
Multi-storey car parks (public use)	76656.1	2	0	14	0	0	127	0
Circulation area (corridors and stairways)	61231.76	335	29	208	12	39	287	277
Reception	1834.1	11	14	79	3	13	39	102
Waiting Rooms	746.03	12	0	6	0	1	4	16
Cellular Office Area	16144.23	8	0	19	0	5	51	43
Cellular Office Area - multiple occupation	7295.94	136	22	95	8	17	47	141
Consulting/treatment room	10491.92	56	2	18	0	4	80	38
Open Plan Office Area	46673.96	467	33	195	9	29	146	143
Lounges	785.6	6	0	9	0	3	6	15
Meeting Room	533.9	10	2	20	0	2	6	18
Library - reading room	393.44	3	0	7	4	1	2	29
Library - open stacks	244.12	3	0	17	0	3	6	33
IT: High Density IT Suite	39.4	7	0	9	0	1	4	13
IT: LAN Rooms	229	16	0	14	0	0	6	0
IT: Server Room	2077.84	99	5	81	3	6	84	52
Catering: Bars	34.5	1	0	1	0	0	1	0
Catering: Eating/drinking area	5440.72	35	2	86	3	12	29	88
Catering: Full Kitchen Preparing Hot Meals	8197.44	66	16	107	13	17	99	152
Catering: Limited Hot Food Preparation Area	1691.5	57	14	119	5	18	99	113
Catering: Kitchenette (small appliances, fridge and sink)	97.53	6	5	12	0	4	5	24
Catering: Snack Bar with Chilled Cabinets	1288.02	17	2	40	0	9	29	31
Catering: Vending Machines	1518	1	0	8	0	2	4	4
Lecture theatre	851.55	15	14	31	4	10	7	75

Activity type	Floor Area / m ²	# of spaces	Heat meter	Electricity	Heat Generators	Cold Generators	Air Handling Units	Pumps
Assembly areas / halls	1020.7	6	8	24	0	7	9	51
Teaching Areas	3896.56	42	4	39	7	6	19	67
Spectator area (theatres and event buildings)	3891.6	11	0	8	1	6	18	25
Bathroom	1351.19	35	0	4	0	0	8	0
Toilet	6628.13	208	4	158	7	9	150	53
Bedroom	7249.62	23	2	14	0	4	25	35
Laboratory	1588.5	9	4	23	5	4	16	46
Laboratory with fume cupboards	1192	1	2	6	0	3	5	17
Laboratory - Sterile	22.85	1	0	3	0	1	1	16
Workshop	600.6	5	0	2	1	0	5	3
Retail Warehouse Sales area - chilled	1294.1	8	0	6	0	0	20	2
Retail Warehouse Sales area - electrical	45.1	3	0	3	0	0	9	0
Retail Warehouse Sales area - general	19296.42	32	0	36	2	6	79	6
Small Shop Unit Sales area - general	5120.02	13	0	38	4	9	23	70
Dept Store Sales area - chilled	342.3	7	0	4	0	0	7	0
Dept Store Sales area - electrical	432	1	0	3	0	0	0	0
Dept Store Sales area - general	140892.4	453	26	197	9	24	147	147
Warehouse storage	7869.52	77	0	38	5	7	47	83
Storage Area/Cupboard	6263.77	178	10	139	5	18	119	119
Library - stacks and storeroom	23	1	0	4	4	0	1	13
Recreational : Fitness Studio	183.06	1	0	3	0	1	1	16
Recreational : Fitness Suite/Gym	239	1	0	1	0	0	0	0
Recreational : Sports ground changing rooms	267.9	3	0	3	1	0	3	3
Recreational : Changing facilities with showers	2671.18	30	18	78	5	15	48	117
Generic Checkin areas	12866.5	3	0	20	0	4	36	17
Nursery	973.22	17	0	41	2	5	23	57
Operating theatre	1516.09	15	2	14	0	4	31	36
Diagnostic Imaging	1995	3	2	6	0	3	17	18
Physiotherapy Studio	825.32	2	2	9	0	4	4	33
Generic Ward	1139.59	41	0	11	0	1	18	16
Post Mortem Facility	184	1	2	7	0	3	7	17
Laundry	304.4	4	2	11	0	4	10	33
Industrial process area	67	4	0	1	0	0	1	2
Heavy Plant Room	41.5	1	0	1	0	0	2	0
Light Plant Room	1553	30	0	47	3	8	34	42
External Space	287	1	0	2	0	0	2	0
Unoccupied space	787.7	13	0	11	0	0	15	0

2.2 Summary by Activity type of measured Electrical Power Demands

This summary section contains 47 tables, one 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 iSERV.

The main observations from all these tables are:

- Only 47 activities had measured data
- Of these activities only 36 had a sufficient number of metered samples to obtain reasonably accurate benchmarks from.

A summary of the average **maximum** power demand benchmarks is shown in Table 2. Values in brackets indicate the standard deviation found from this average maximum. This data can be used to estimate the likely power demand to be incurred by the HVAC component while servicing this type of activity in this country. The more detailed tables also show the annual average and minimum power demands found for this equipment. Zero figures are excluded from the minima i.e. the minima show how little power might be drawn by energised equipment.

The first column shows the section number in which these benchmarks can be found. Benchmarks in red are considered to have too few samples or too short a measurement period to be reliable.

Table 2 – Benchmarks for measured Average and Standard Deviation Power Demands in W/m² Summary by HVAC Component and Activity Type for Portugal.

Activity type	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Recovery	Heat Rejection
Circulation area (corridors and stairways)	0.05 (0.04)	8.23 (24.04)	0.49 (0)	3.8 (2.14)	0.65 (0.88)	0.56 (0.98)	0.23 (0.39)		0.49 (0)
Reception	0 (0)	3.89 (2.42)	0.52 (0)	2.7 (2.37)	0.37 (0.42)	0.14 (0.08)	0.61 (0.34)		0.22 (0.24)
Cellular Office Area	0 (0)	0 (0)	0 (0)	1.17 (0.91)	0.07 (0.08)	0.06 (0.03)	0 (0)		0 (0)
Cellular Office Area - multiple occupation	0 (0)	6.51 (0.34)	9.1 (1.19)	1.17 (0.91)	2.71 (0.82)	0.36 (0.59)	0.61 (0.03)		0.66 (0.13)
Consulting/treatment room	0 (0)	4.15 (0.05)	0 (0)	0 (0)	0.84 (0)	0 (0)	0.6 (0)		0.63 (0)
Open Plan Office Area	0.02 (0)	16.64 (47.36)	8.31 (1.75)	4.01 (2.11)	3.91 (11.78)	0.72 (0.89)	2.74 (13.02)		194.73 (663.57)
Lounges	0 (0)	6.11 (3.53)	0 (0)	3.22 (0)	3.25 (2)	0.85 (0.69)	0 (0)		0 (0)
Meeting Room	0 (0)	91.6 (127.96)	0 (0)	3.99 (2.58)	3.28 (1.19)	0.22 (0.14)	1.51 (1.16)		1053.45 (1824.21)
Library - open stacks	0 (0)	0.71 (0)	0 (0)	3.29 (0)	1.55 (0)	0.17 (0.07)	0 (0)		0 (0)
IT: LAN Rooms	0 (0)	0 (0)	0 (0)	0 (0)	172.7 (342.85)	0 (0)	181.78 (346.43)		28.04 (77.74)
IT: Server Room	0.03 (0)	350.01 (13.47)	0.31 (0)	0.45 (0.25)	2.06 (2.62)	9.3 (3.44)	17.91 (76.51)		7.87 (27.88)
Catering: Bars	0 (0)	0 (0)	0 (0)	0 (0)	0.66 (0)	0 (0)	0 (0)		0 (0)
Catering: Eating/drinking area	0.02 (0)	24.83 (59.04)	23.17 (0)	3.8 (2.14)	3.09 (2.49)	0.64 (0.59)	0.77 (0.4)		1.29 (0)
Catering: Full Kitchen Preparing Hot Meals	0.24 (0.3)	112.89 (276.91)	9.1 (1.19)	0 (0)	62.39 (200.75)	6.88 (18.05)	0 (0)		0 (0)
Catering: Limited Hot Food Preparation Area	0 (0)	25.61 (56.31)	9.95 (2.21)	3.22 (0)	77.46 (287.55)	0.74 (0.56)	0.5 (0.82)		0.14 (0)
Catering: Snack Bar with Chilled Cabinets	0 (0)	1.89 (0.53)	9.96 (2.21)	3.99 (2.58)	127.93 (287.95)	0.86 (0.6)	0.3 (0.87)		0 (0)

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Catering: Vending Machines	0 (0)	1.48 (1.69)	0 (0)	0 (0)	0.3 (0.16)	0.23 (0)	0.18 (0)	0 (0)
Lecture theatre	0 (0)	3.56 (1.36)	0 (0)	0 (0)	0 (0)	7.16 (3.07)	4.52 (0)	0 (0)
Assembly areas / halls	0 (0)	0.86 (0.36)	0 (0)	3.22 (0)	4.46 (6.83)	0.68 (0.29)	0 (0)	0 (0)
Teaching Areas	0.01 (0)	0.94 (0.05)	0 (0)	0 (0)	3.09 (0)	0.33 (0.1)	0 (0)	0 (0)
Spectator area (theatres and event buildings)	0.16 (0)	2.92 (0.89)	0 (0)	0 (0)	2.31 (1.3)	1.71 (1.91)	6.32 (2.18)	0.14 (0)
Toilet	0.31 (0.38)	0.66 (0.27)	7.61 (1.93)	3.22 (0)	3.36 (5.01)	2.37 (5.61)	9.57 (0)	0 (0)
Bedroom	0 (0)	2.55 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Laboratory	0 (0)	7.57 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Laboratory with fume cupboards	0 (0)	7.57 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Retail Warehouse Sales area - chilled	0 (0)	0 (0)	0 (0)	0 (0)	0.3 (0.35)	2.87 (3.61)	0 (0)	0 (0)
Retail Warehouse Sales area - electrical	0 (0)	0 (0)	0 (0)	0 (0)	357.79 (235.51)	0 (0)	0 (0)	0 (0)
Retail Warehouse Sales area - general	3.45 (4.67)	2.1 (2.29)	12.02 (15.4)	0.45 (0)	10.82 (75.92)	171.72 (256.9)	38.48 (108.99)	0.22 (0.12)
Small Shop Unit Sales area - general	0 (0)	44.18 (81.99)	9.95 (2.21)	1.17 (0.91)	103.51 (201.65)	0.17 (0.1)	8.39 (0)	0.59 (0)
Dept Store Sales area - chilled	0 (0)	0 (0)	0 (0)	0 (0)	1.65 (2.36)	0 (0)	0 (0)	0 (0)
Dept Store Sales area - general	0.05 (0.04)	14.25 (42.35)	8.05 (3.18)	2.21 (2.3)	9.42 (50.98)	1.77 (1.72)	1.98 (1.98)	2.01 (3.73)
Warehouse storage	0.94 (0)	6.24 (0)	0 (0)	0 (0)	15.57 (17.59)	56.16 (0)	2.8 (10.36)	0.21 (0.21)
Storage Area/Cupboard	0.02 (0.02)	2.36 (5.28)	0 (0)	3.99 (2.58)	6.21 (34.7)	0.73 (0.93)	0.82 (1.54)	0.07 (0)
Recreational : Sports ground changing rooms	0 (0)	0 (0)	0 (0)	0 (0)	6.72 (0)	0 (0)	1.2 (0)	0 (0)
Recreational : Changing facilities with showers	0 (0)	0 (0)	0 (0)	0 (0)	11.65 (14.29)	0.84 (0)	1.2 (0)	0 (0)
Generic Checkin areas	0 (0)	5.49 (5.76)	0 (0)	1.17 (0.91)	0.27 (0.61)	0.07 (0.1)	0 (0)	0 (0)
Nursery	0.02 (0)	57.88 (105.97)	0 (0)	0 (0)	0.84 (0.46)	0.46 (0.18)	0.79 (0.83)	0 (0)
Operating theatre	0 (0)	7.57 (0.1)	0 (0)	0 (0)	24.37 (0)	0 (0)	0 (0)	0 (0)
Diagnostic Imaging	0 (0)	7.57 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Physiotherapy Studio	0 (0)	13.73 (0.17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Post Mortem Facility	0 (0)	7.57 (0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Laundry	0 (0)	0 (0)	0 (0)	0 (0)	3.71 (0)	0 (0)	0 (0)	0 (0)
Industrial process area	0 (0)	0 (0)	0 (0)	0 (0)	0.45 (0)	0 (0)	0 (0)	0 (0)
Heavy Plant Room	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (0)	0 (0)	0 (0)	0 (0)
Light Plant Room	0 (0)	1.36 (3.23)	0 (0)	0 (0)	1.13 (1.48)	0 (0)	0 (0)	0 (0)
Unoccupied space	0 (0)	0 (0)	0 (0)	0 (0)	0.45 (0.5)	0 (0)	0 (0)	0 (0)

2.2.1 Assembly areas / halls – power demand summary by component

The table shows the average, maximum and minimum power demands found from the data for this activity type for the overall component type shown in each column.

Table 3 – Measured Overall Power Demands in W/m² Summary by HVAC Component Type for Circulation area (corridors and stairways) for Portugal

Parameter	Cold Generators	Heat Pumps	Air Handling Units	Pumps
Sample size (number)	3	1	4	4
Average (Standard Deviation)	0.86 (0.36)	3.22 ()	4.46 (6.83)	0.68 (0.29)
Maximum (Standard Deviation)	2.87 (1.1)	11.71 ()	10.53 (14.33)	2.23 (0.95)
Minimum (Standard Deviation)	0.17 (0.15)	0 ()	0.05 (0.06)	0 (0)

2.2.2 Bedroom – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	2.55 (0.03)
Maximum (Standard Deviation)	5.38 (0.23)
Minimum (Standard Deviation)	0.63 (0)

2.2.3 Catering: Bars – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	1
Average (Standard Deviation)	0.66 ()
Maximum (Standard Deviation)	1.36 ()
Minimum (Standard Deviation)	0.01 ()

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

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	9	1	4	19	52	29	1
Average (Standard Deviation)	0.02 (0)	24.83 (59.04)	23.17 ()	3.8 (2.14)	3.09 (2.49)	0.64 (0.59)	0.77 (0.4)	1.29 ()
Maximum (Standard Deviation)	0.07 (0)	399.21 (1020.3)	260.37 ()	12.59 (2.27)	78.92 (145.76)	11.57 (21.7)	1.86 (0.94)	4.52 ()
Minimum (Standard Deviation)	0 (0)	0.14 (0.14)	0.08 ()	0.12 (0.25)	0.44 (0.75)	0.05 (0.13)	0.17 (0.09)	0.1 ()

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

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Air Handling Units	Pumps
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Sample size (number)	6	8	6	56	53
Average (Standard Deviation)	0.24 (0.3)	112.89 (276.91)	9.1 (1.19)	62.39 (200.75)	6.88 (18.05)
Maximum (Standard Deviation)	14.64 (22.21)	1758.02 (4804.44)	18.01 (1.06)	3076.13 (13992.82)	370.09 (1274.72)
Minimum (Standard Deviation)	0.01 (0.02)	1.33 (2.15)	0.02 (0.01)	7.92 (24.98)	0.36 (1.16)

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

Parameter	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	8	7	1	57	22	130	1
Average (Standard Deviation)	25.61 (56.31)	9.95 (2.21)	3.22 ()	77.46 (287.55)	0.74 (0.56)	0.5 (0.82)	0.14 ()
Maximum (Standard Deviation)	371.96 (988.72)	28.24 (2.85)	11.7 ()	150.19 (461.33)	2.42 (2.43)	1.11 (2.62)	1.59 ()
Minimum (Standard Deviation)	1.41 (1.71)	0.48 (0.06)	0 ()	1.08 (2.04)	0.14 (0.33)	0.3 (0.55)	0 ()

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

Parameter	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units
Sample size (number)	7	7	3	19	15	14
Average (Standard Deviation)	1.89 (0.53)	9.96 (2.21)	3.99 (2.58)	127.93 (287.95)	0.86 (0.6)	0.3 (0.87)
Maximum (Standard Deviation)	8.62 (6.9)	28.24 (2.85)	12.89 (2.68)	208.53 (465.35)	2.05 (1.15)	1.72 (5.06)
Minimum (Standard Deviation)	0.48 (0.51)	0.48 (0.06)	0.16 (0.28)	2.47 (3.84)	0.24 (0.47)	0.06 (0.13)

2.2.8 Catering: Vending Machines – power demand summary by component

Parameter	Cold Generators	Air Handling Units	Pumps	Terminal Units
Sample size (number)	2	4	2	4

Average (Standard Deviation)	1.48 (1.69)	0.3 (0.16)	0.23 (0)	0.18 (0)
Maximum (Standard Deviation)	3.65 (3.81)	0.7 (0.44)	0.76 (0)	0.5 (0)
Minimum (Standard Deviation)	0.16 (0.22)	0.01 (0.01)	0 (0)	0 (0)

2.2.9 Cellular Office Area – power demand summary by component

Parameter	Heat Pumps	Air Handling Units	Pumps
Sample size (number)	3	47	27
Average (Standard Deviation)	1.17 (0.91)	0.07 (0.08)	0.06 (0.03)
Maximum (Standard Deviation)	9.18 (5.05)	0.86 (2.14)	1.14 (1.13)
Minimum (Standard Deviation)	0.01 (0.01)	0 (0)	0 (0)

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

Parameter	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	6	3	6	38	29	3
Average (Standard Deviation)	6.51 (0.34)	9.1 (1.19)	1.17 (0.91)	2.71 (0.82)	0.36 (0.59)	0.61 (0.03)	0.66 (0.13)
Maximum (Standard Deviation)	158.3 (6.91)	18 (1.06)	9.18 (5.05)	159.71 (80.53)	13.95 (23.2)	1.6 (0.07)	2.28 (0.77)
Minimum (Standard Deviation)	0.14 (0)	0.02 (0.01)	0.01 (0.01)	0.08 (0.08)	0.01 (0.01)	0.12 (0.01)	0.04 (0.02)

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

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	4	23	4	4	122	116	230	1
Average (Standard Deviation)	0.05 (0.04)	8.23 (24.04)	0.49 (0)	3.8 (2.14)	0.65 (0.88)	0.56 (0.98)	0.23 (0.39)	0.49 ()
Maximum (Standard Deviation)	0.31 (0.29)	104.98 (414.37)	1.2 (0)	12.59 (2.27)	3.85 (11.88)	5.48 (12.64)	0.63 (1.47)	1.72 ()
Minimum (Standard Deviation)	0 (0)	0.82 (1.86)	0.03 (0)	0.12 (0.25)	0.21 (0.5)	0.08 (0.48)	0.05 (0.07)	0.04 ()

2.2.12 Consulting/treatment room – power demand summary by component

Parameter	Cold Generators	Air Handling Units	Terminal Units	Heat Rejection
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Sample size (number)	2	1	10	1
Average (Standard Deviation)	4.15 (0.05)	0.84 ()	0.6 (0)	0.63 ()
Maximum (Standard Deviation)	8.75 (0.37)	2.17 ()	1.55 (0)	2.64 ()
Minimum (Standard Deviation)	1.02 (0)	0.17 ()	0.12 (0)	0.02 ()

2.2.13 Dept Store Sales area - chilled – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	6
Average (Standard Deviation)	1.65 (2.36)
Maximum (Standard Deviation)	10.08 (17.25)
Minimum (Standard Deviation)	0.02 (0.03)

2.2.14 Dept Store Sales area - general – power demand summary by component

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	4	15	21	11	96	44	40	9
Average (Standard Deviation)	0.05 (0.04)	14.25 (42.35)	8.05 (3.18)	2.21 (2.3)	9.42 (50.98)	1.77 (1.72)	1.98 (1.98)	2.01 (3.73)
Maximum (Standard Deviation)	0.31 (0.3)	205.26 (734.21)	24.38 (10.38)	75.24 (215.48)	19.29 (82.45)	7.11 (11.44)	9.68 (13.28)	12.55 (19.42)
Minimum (Standard Deviation)	0 (0)	0.54 (0.9)	0.19 (0.22)	0.06 (0.06)	0.16 (0.56)	0.19 (0.63)	0.07 (0.08)	0.12 (0.13)

2.2.15 Diagnostic Imaging – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	7.57 (0.1)
Maximum (Standard Deviation)	15.96 (0.67)
Minimum (Standard Deviation)	1.86 (0)

2.2.16 Exhibition rooms, museum – power demand summary by component

Parameter	Cold Generators	Air Handling Units	Pumps
Sample size (number)	3	12	9
Average (Standard Deviation)	2.23 (0)	7.13 (0)	0.46 (0.17)
Maximum (Standard Deviation)	3.99 (0)	12.01 (0)	1 (0.21)
Minimum (Standard Deviation)	1.03 (0)	4.8 (0)	0.14 (0.22)

2.2.17 Generic Check-in areas – power demand summary by component

Parameter	Cold Generators	Heat Pumps	Air Handling Units	Pumps
Sample size (number)	2	3	34	15
Average (Standard Deviation)	5.49 (5.76)	1.17 (0.91)	0.27 (0.61)	0.07 (0.1)
Maximum (Standard Deviation)	13.65 (12.74)	9.18 (5.05)	1 (1.88)	0.26 (0.32)
Minimum (Standard Deviation)	0.58 (0.78)	0.01 (0.01)	0.01 (0.05)	0 (0)

2.2.18 Heavy Plant Room – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	2
Average (Standard Deviation)	0.08 (0)
Maximum (Standard Deviation)	0.5 (0)
Minimum (Standard Deviation)	0 (0)

2.2.19 Industrial process area – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	1
Average (Standard Deviation)	0.45 (0)
Maximum (Standard Deviation)	1.06 (0)
Minimum (Standard Deviation)	0.05 (0)

2.2.20 IT: LAN Rooms – power demand summary by component

Parameter	Air Handling Units	Terminal Units	Heat Rejection
Sample size (number)	4	9	9
Average (Standard Deviation)	172.7 (342.85)	181.78 (346.43)	28.04 (77.74)
Maximum (Standard Deviation)	282.66 (552.76)	300.75 (557.2)	58.69 (125.34)
Minimum (Standard Deviation)	0.87 (1.54)	2.76 (4.51)	0.75 (1.34)

2.2.21 IT: Server Room – power demand summary by component

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	2	2	3	45	20	52	34
Average (Standard Deviation)	0.03 (0)	350.01 (13.47)	0.31 (0)	0.45 (0.25)	2.06 (2.62)	9.3 (3.44)	17.91 (76.51)	7.87 (27.88)
Maximum (Standard Deviation)	0.12 (0)	1761.6 (137.58)	1.88 (0)	2.75 (1.51)	7.02 (10.34)	32.21 (18.27)	33.21 (123.39)	14.72 (45.01)
Minimum (Standard Deviation)	0 (0)	4.95 (2.21)	0.01 (0)	0.01 (0.01)	0.26 (0.8)	0.15 (0.04)	0.73 (1.62)	0.11 (0.18)

2.2.22 Laboratory – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	7.57 (0.1)
Maximum (Standard Deviation)	15.96 (0.67)
Minimum (Standard Deviation)	1.86 (0)

2.2.23 Laboratory with fume cupboards – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	7.57 (0.1)
Maximum (Standard Deviation)	15.96 (0.67)
Minimum (Standard Deviation)	1.86 (0)

2.2.24 Laundry – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	1
Average (Standard Deviation)	3.71 ()
Maximum (Standard Deviation)	9.22 ()
Minimum (Standard Deviation)	1.12 ()

2.2.25 Lecture theatre – power demand summary by component

Parameter	Cold Generators	Pumps	Terminal Units
Sample size (number)	4	4	2
Average (Standard Deviation)	3.56 (1.36)	7.16 (3.07)	4.52 (0)
Maximum (Standard Deviation)	14.48 (10.02)	21.49 (9.46)	15.38 (0)
Minimum (Standard Deviation)	0.45 (0.26)	1.76 (0.82)	1.29 (0)

2.2.26 Library– power demand summary by component

Parameter	Cold Generators	Heat Pumps	Air Handling Units	Pumps
Sample size (number)	1	1	1	4
Average (Standard Deviation)	0.71 ()	3.29 ()	1.55 ()	0.17 (0.07)
Maximum (Standard Deviation)	6.01 ()	11.7 ()	2.51 ()	0.56 (0.24)
Minimum (Standard Deviation)	0 ()	0 ()	0.1 ()	0 (0)

2.2.27 Light Plant Room – power demand summary by component

Parameter	Cold Generators	Air Handling Units
Sample size (number)	7	21
Average (Standard Deviation)	1.36 (3.23)	1.13 (1.48)
Maximum (Standard Deviation)	21.79 (55.75)	4.67 (5.91)

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Minimum (Standard Deviation)	0 (0)	0.08 (0.17)
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2.2.28 Lounges – power demand summary by component

Parameter	Cold Generators	Heat Pumps	Air Handling Units	Pumps
Sample size (number)	3	1	6	15
Average (Standard Deviation)	6.11 (3.53)	3.22 ()	3.25 (2)	0.85 (0.69)
Maximum (Standard Deviation)	139.02 (102.67)	11.71 ()	124.27 (86.07)	31.96 (24.69)
Minimum (Standard Deviation)	0.12 (0.1)	0 ()	0.37 (0.81)	0.02 (0.02)

2.2.29 Meeting Room – power demand summary by component

Parameter	Cold Generators	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	3	4	7	17	3
Average (Standard Deviation)	91.6 (127.96)	3.99 (2.58)	3.28 (1.19)	0.22 (0.14)	1.51 (1.16)	1053.45 (1824.21)
Maximum (Standard Deviation)	1557.89 (2201.42)	12.89 (2.68)	7.8 (4.02)	0.5 (0.18)	3.11 (1.95)	12246.48 (21210.73)
Minimum (Standard Deviation)	0.04 (0.05)	0.16 (0.28)	0.64 (0.27)	0.05 (0.05)	0.23 (0.11)	387.98 (671.98)

2.2.30 Nursery – power demand summary by component

Parameter	Heat Generators	Cold Generators	Air Handling Units	Pumps	Terminal Units
Sample size (number)	2	4	5	23	5
Average (Standard Deviation)	0.02 (0)	57.88 (105.97)	0.84 (0.46)	0.46 (0.18)	0.79 (0.83)
Maximum (Standard Deviation)	0.08 (0)	945.13 (1842.06)	6.29 (7.21)	1.5 (0.95)	5.91 (11.54)
Minimum (Standard Deviation)	0 (0)	0.06 (0.05)	0.09 (0.13)	0.01 (0.01)	0.1 (0.05)

2.2.31 Open Plan Office Area – power demand summary by component

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	20	5	4	123	52	412	37
Average (Standard Deviation)	0.02 (0)	16.64 (47.36)	8.31 (1.75)	4.01 (2.11)	3.91 (11.78)	0.72 (0.89)	2.74 (13.02)	194.73 (663.57)
Maximum (Standard Deviation)	0.07 (0)	216.55 (822.4)	28.05 (3.65)	13.36 (2.38)	14.11 (31.82)	2.15 (2.68)	5.16 (21.15)	2266.02 (7714.45)
Minimum (Standard Deviation)	0 (0)	0.77 (1.45)	0.37 (0.17)	0.12 (0.25)	0.26 (0.64)	0.12 (0.29)	0.16 (0.37)	71.67 (244.44)

2.2.32 Operating Theatre – power demand summary by component

Parameter	Cold Generators	Air Handling Units
Sample size (number)	2	14
Average (Standard Deviation)	7.57 (0.1)	24.37 (0)
Maximum (Standard Deviation)	15.96 (0.67)	32.2 (0)
Minimum (Standard Deviation)	1.86 (0)	18.07 (0)

2.2.33 Physiotherapy Studio – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	13.73 (0.17)
Maximum (Standard Deviation)	28.93 (1.22)
Minimum (Standard Deviation)	3.37 (0.01)

2.2.34 Post Mortem Facility – power demand summary by component

Parameter	Cold Generators
Sample size (number)	2
Average (Standard Deviation)	7.57 (0.1)
Maximum (Standard Deviation)	15.96 (0.67)
Minimum (Standard Deviation)	1.86 (0)

2.2.35 Reception – power demand summary by component

Parameter	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	5	2	6	11	8	28	2
Average (Standard Deviation)	3.89 (2.42)	0.52 (0)	2.7 (2.37)	0.37 (0.42)	0.14 (0.08)	0.61 (0.34)	0.22 (0.24)
Maximum (Standard Deviation)	26.78 (38.07)	3.16 (0)	9.45 (5.18)	6.96 (13.17)	0.48 (0.22)	1.45 (0.87)	0.87 (1.06)
Minimum (Standard Deviation)	0.31 (0.36)	0.01 (0)	0.09 (0.2)	0.02 (0.04)	0 (0)	0.13 (0.07)	0.01 (0)

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

Parameter	Air Handling Units	Pumps	Terminal Units
Sample size (number)	13	6	2
Average (Standard Deviation)	11.65 (14.29)	0.84 (0)	1.2 (0)
Maximum (Standard Deviation)	27.27 (23.32)	2.18 (0)	3.71 (0)
Minimum (Standard Deviation)	5.05 (10.24)	0 (0)	0.13 (0)

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

Parameter	Air Handling Units	Terminal Units
Sample size (number)	1	10
Average (Standard Deviation)	6.72 ()	1.2 (0)
Maximum (Standard Deviation)	17.49 ()	3.12 (0)
Minimum (Standard Deviation)	1.34 ()	0.24 (0)

2.2.38 Retail Warehouse Sales area – chilled – power demand summary by component

Parameter	Air Handling Units	Pumps
Sample size (number)	7	2
Average (Standard Deviation)	0.3 (0.35)	2.87 (3.61)
Maximum (Standard Deviation)	1.16 (1.94)	16.82 (21.2)
Minimum (Standard Deviation)	0.05 (0.01)	0.31 (0.39)

2.2.39 Retail Warehouse Sales area – electrical – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	4
Average (Standard Deviation)	357.79 (235.51)
Maximum (Standard Deviation)	579.59 (380.04)
Minimum (Standard Deviation)	1.72 (0.96)

2.2.40 Retail Warehouse Sales area – general – power demand summary by component

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	2	6	11	2	64	6	18	2
Average (Standard Deviation)	3.45 (4.67)	2.1 (2.29)	12.02 (15.4)	0.45 (0)	10.82 (75.92)	171.72 (256.9)	38.48 (108.99)	0.22 (0.12)
Maximum (Standard Deviation)	5.7 (7.39)	18.76 (22.89)	22.49 (21.44)	2.73 (0)	20.42 (122.65)	284.01 (411.26)	63.84 (175.85)	0.62 (0.24)
Minimum (Standard Deviation)	0.02 (0.01)	0.12 (0.16)	0.11 (0.16)	0.01 (0)	0.18 (0.44)	1.17 (1)	0.32 (0.5)	0.04 (0.01)

2.2.41 Small Shop Unit Sales area - general – power demand summary by component

Parameter	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	4	7	3	14	30	2	2
Average (Standard Deviation)	44.18 (81.99)	9.95 (2.21)	1.17 (0.91)	103.51 (201.65)	0.17 (0.1)	8.39 (0)	0.59 (0)

Maximum (Standard Deviation)	723 (1423.75)	28.24 (2.85)	9.18 (5.05)	170.13 (324.96)	2.54 (2.6)	20.31 (0)	1.44 (0)
Minimum (Standard Deviation)	0.18 (0.23)	0.48 (0.06)	0.01 (0.01)	0.72 (0.88)	0.01 (0.03)	3.55 (0)	0.25 (0)

2.2.42 Spectator area (theatres and event buildings) – power demand summary by component

Parameter	Heat Generators	Cold Generators	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	1	6	18	25	2	1
Average (Standard Deviation)	0.16 ()	2.92 (0.89)	2.31 (1.3)	1.71 (1.91)	6.32 (2.18)	0.14 ()
Maximum (Standard Deviation)	9.05 ()	68 (103.57)	130.02 (74.67)	69.58 (120.18)	230.5 (314.61)	7.93 ()
Minimum (Standard Deviation)	0 ()	0.61 (0.62)	0.18 (0.65)	0.13 (0.34)	1.63 (2.25)	0 ()

2.2.43 Storage Area/Cupboard – power demand summary by component

Parameter	Heat Generators	Cold Generators	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	3	10	3	69	44	35	2
Average (Standard Deviation)	0.02 (0.02)	2.36 (5.28)	3.99 (2.58)	6.21 (34.7)	0.73 (0.93)	0.82 (1.54)	0.07 (0)
Maximum (Standard Deviation)	0.2 (0.29)	31.18 (93.12)	12.89 (2.68)	15.17 (56.79)	2.32 (3.2)	2.1 (4.69)	0.22 (0.15)
Minimum (Standard Deviation)	0 (0)	0.21 (0.29)	0.16 (0.28)	0.21 (0.5)	0.15 (0.56)	0.06 (0.08)	0 (0)

2.2.44 Teaching Areas – power demand summary by component

Parameter	Heat Generators	Cold Generators	Air Handling Units	Pumps
Sample size (number)	2	2	1	20
Average (Standard Deviation)	0.01 (0)	0.94 (0.05)	3.09 ()	0.33 (0.1)
Maximum (Standard Deviation)	0.03 (0)	5.24 (0.67)	5.61 ()	0.98 (0.47)
Minimum (Standard Deviation)	0 (0)	0.01 (0.01)	0.92 ()	0.01 (0)

2.2.45 Toilet – power demand summary by component

Parameter	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units
Sample size (number)	5	9	2	1	99	43	1
Average (Standard Deviation)	0.31 (0.38)	0.66 (0.27)	7.61 (1.93)	3.22 ()	3.36 (5.01)	2.37 (5.61)	9.57 ()

Maximum (Standard Deviation)	9.51 (19.76)	2.65 (1.03)	27.65 (0.34)	11.7 ()	36.09 (195.57)	60.15 (254.13)	23.85 ()
Minimum (Standard Deviation)	0.03 (0.06)	0.15 (0.22)	0.48 (0)	0 ()	0.29 (0.81)	0.3 (0.81)	0.03 ()

2.2.46 Unoccupied space – power demand summary by component

Parameter	Air Handling Units
Sample size (number)	12
Average (Standard Deviation)	0.45 (0.5)
Maximum (Standard Deviation)	3.02 (4.58)
Minimum (Standard Deviation)	0.01 (0.02)

2.2.47 Warehouse storage – power demand summary by component

Parameter	Heat Generators	Cold Generators	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Sample size (number)	3	1	7	1	20	5
Average (Standard Deviation)	0.94 (0)	6.24 ()	15.57 (17.59)	56.16 ()	2.8 (10.36)	0.21 (0.21)
Maximum (Standard Deviation)	2.37 (0)	15.8 ()	39.43 (44.52)	142.18 ()	7.11 (26.21)	0.6 (0.55)
Minimum (Standard Deviation)	0.25 (0)	1.69 ()	4.11 (4.85)	15.2 ()	0.72 (2.81)	0.04 (0.07)

2.3 Summary of measured annual energy use by HVAC Component type servicing a given activity

This summary section contains 7 tables, one for each activity type for which we have data, summarising the range of electrical annual energy consumption per m² found across all the HVAC sub-component types monitored in iSERV.

The main observations from all these tables are:

- Only 22 activities had measured data
- Some of the components have very high ranges, such as AHU's. On the other hand, components such as all in one systems have low ranges of energy consumption.

A summary of the measured average annual energy use benchmarks by activity type and HVAC component type is shown in Table XX. 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 the HVAC component while servicing this type of activity in this country. The more detailed tables also show the annual maximum and minimum annual energy use ranges found for this equipment.

The first column shows the section number in which these benchmarks can be found. Benchmarks in red are considered to have too few samples or too short a measurement period to be reliable.

Table 4 – Benchmarks for measured Average and Standard Deviation Annual Energy Use in kWh/m² Summary by HVAC Component and Activity Type for Portugal.

Activity type	Heat Generators	Cold Generators	All-in-One Systems	Heat Pumps	Air Handling Units	Pumps	Terminal Units	Heat Rejection
Circulation area (corridors and stairways)				19.36	3.15 (1.72)	2.03 (1.17)	3.64 (0)	
Reception		10.34		19.36	8.8	1.58 (0.67)		
Open Plan Office Area		24.16	52.84 (13.25)	24.42	11.34 (11.48)	2.36 (1.1)	4.24 (3.64)	3.3 (4.54)
Lounges		19.15		19.36	5.98	1.58 (0.67)		
Library - open stacks				19.36		1.58 (0.67)		
IT: LAN Rooms							24.77 (6.93)	9.29 (5.11)
IT: Server Room							41.28 (25.01)	12.25 (7.42)
Catering: Eating/drinking area		16.09	31.64	19.36	8.65	1.58 (0.67)		
Catering: Full Kitchen Preparing Hot Meals					115.57 (0)			
Catering: Limited Hot Food Preparation Area			54.71 (11.54)	19.36	87.57 (58.06)	1.58 (0.67)		
Catering: Snack Bar with Chilled Cabinets			54.71 (11.54)		36.59	3.84		
Assembly areas / halls				19.36	18.06 (4.02)	6.33 (2.68)		
Toilet			45.04 (16.59)	19.36	12.66 (11.95)	2.03 (1.16)		
Retail Warehouse Sales area - general	2.32		60.61 (3.18)		9.71 (31.78)	172.87 (0)	4.97 (5.94)	1.13
Small Shop Unit Sales area - general			54.71 (11.54)		23.66 (21.53)			
Dept Store Sales area - general			54.72 (11.54)		4.66 (2.31)			18.14 (0)
Storage Area/Cupboard					12.81 (11.67)			
Light Plant Room					5.89 (0)			

2.3.1 Activity types – annual energy use/m² summary by All-in-One Systems sub-components

The table shows the average and standard deviation annual energy use found from the data for all activity types for the Heat Generator sub-component type shown in each column.

These figures include directly measured energy use and energy use apportioned by initial benchmarks from metered data serving more than one component.

Table 5 – Overall Data Summary by Heat Generator Sub-component types vs Activity. Average (Standard Deviation in brackets) Annual kWh/m² in Portugal

Activity type	Air Source Heat Pump (ASHP)	Water Source Heat Pump (WSHP)
Open Plan Office Area	52.84 (13.25)	
Catering: Eating/drinking area		31.64
Catering: Limited Hot Food Preparation Area	54.71 (11.54)	
Catering: Snack Bar with Chilled Cabinets	54.71 (11.54)	
Toilet	45.04 (16.59)	
Retail Warehouse Sales area - general	60.61 (3.18)	
Small Shop Unit Sales area - general	54.71 (11.53)	
Dept Store Sales area - general	54.72 (11.54)	

Table 5Error! Reference source not found. provides the range of annual energy consumptions found in different Heat Generator Component sub-types servicing the activities shown in buildings across Portugal. Having reference to the activities serviced enables estimation of the likely range of annual energy consumptions to be found in buildings composed of multiple activities.

2.3.2 Activity types – annual energy use/m² summary by Cold Generator sub-components

Activity type	Centrifugal Liquid Chillers
Reception	10.3426
Open Plan Office Area	24.1585
Lounges	19.1532
Catering: Eating/drinking area	16.0884

2.3.3 Activity types – annual energy use/m² summary by Heat Pump sub-components

Activity type	Air source reverse cycle
Circulation area (corridors and stairways)	19.3621
Reception	19.3631
Open Plan Office Area	24.4231
Lounges	19.363
Library - open stacks	19.3604
Catering: Eating/drinking area	19.3627
Catering: Limited Hot Food Preparation Area	19.3606
Assembly areas / halls	19.363
Toilet	19.3611

2.3.4 Activity types – annual energy use/m² summary by Heat Rejection sub-components

Activity type	Air source reverse cycle
Open Plan Office Area	3.3 (4.54)
IT: LAN Rooms	9.29 (5.11)
IT: Server Room	12.25 (7.42)
Retail Warehouse Sales area - general	1.13
Dept Store Sales area - general	18.14 (0)

2.3.5 Activity types – annual energy use/m² summary by Pumps sub-components

Activity type	Chilled water primary pumps	Hot water primary pumps	Hot water secondary pumps
Circulation area (corridors and stairways)	0.57	2.88 (1.36)	1.92
Reception	0.58	1.92	1.92
Open Plan Office Area	0.73	3.13 (1.01)	2.42
Lounges	0.58	1.92	1.92
Library - open stacks	0.57	1.92	1.92
Catering: Eating/drinking area	0.58	1.92	1.92
Catering: Limited Hot Food Preparation Area	0.57	1.92	1.92
Catering: Snack Bar with Chilled Cabinets		3.84	
Assembly areas / halls	2.3	7.67	7.67
Toilet	0.57	2.88 (1.36)	1.92
Retail Warehouse Sales area - general		172.87	172.87

2.3.6 Activity types – annual energy use/m² summary by Terminal Units sub-components

Activity type	DX indoor unit	Fan Coils – 2 or 4 tubes
Circulation area (corridors and stairways)	3.64 (0)	
Open Plan Office Area	3.97 (3.75)	6.62 (0)
IT: LAN Rooms	24.77 (6.93)	
IT: Server Room	41.28 (25.01)	
Retail Warehouse Sales area - general	5.79 (6.51)	1.94 (0)

2.3.7 Activity types – annual energy use/m² summary by Air Handling Units sub-components

Activity type	Extract only	Supply and extract	Supply and extract with heating and cooling variants, etc	Supply only
Circulation area (corridors and stairways)	2.22 (0.62)	5.37 (2.21)		3.33
Reception		8.8		
Open Plan Office Area	5.92 (2.41)	16.75 (8.89)	19.69	12.68 (17.01)
Lounges		5.98		
Catering: Eating/drinking area		8.65		
Catering: Full Kitchen Preparing Hot Meals		115.57 (0)		
Catering: Limited Hot Food Preparation Area	110.57 (43.4)	18.58		
Catering: Snack Bar with Chilled Cabinets	36.59			
Assembly areas / halls		18.06 (4.02)		
Toilet	25.56 (3.15)	4.07 (1.84)		
Retail Warehouse Sales area - general	4.82 (4.41)		208.99	5.1 (2.29)
Small Shop Unit Sales area - general	23.66 (21.53)			
Dept Store Sales area - general	6.36 (4.21)		3.93 (0)	
Storage Area/Cupboard	12.81 (11.67)			
Light Plant Room	5.89			5.89

2.4 Summary of measured monthly energy use by HVAC Sub-component type servicing a given activity

The tables in this section provide the ranges of average and standard deviation monthly energy consumptions found in different HVAC sub-component types servicing the noted end use activity across Portugal i.e. it further subdivides the information in section 2.3.

Whilst this data has the same caveats as for the annual data in Table 5, what it does illustrate is how the consumption of each sub-component varies with the month of the year. From this information it can be seen that there are seasonable consumptions in some components, such as chillers, and also some cases where we detect very high values for months in particular, which makes possible to detect a problem in the installation. For example in the component Hot Water Primary Pumps, and for activity of Open plan offices, we can see that the highest consumption is in July and August, which is an alert to try to understand the reason why it has happened.

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2.4.1.1 Activity types – monthly energy use/m² summary by Air Handling Units

This table shows the measured ranges of monthly energy use recorded for this sub-component type.

Table 6 – Measured average monthly energy consumption (standard deviation in brackets) in kWh/m² by Air Handling Unit component servicing the given activity for Portugal

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	11.05(3.01)	2(2.07)	2(2.36)	1.64(2.12)	2.77(2.09)	1.03(1.16)	1.48(2.14)	1.55(1.5)	1.57(1.19)	2.05(1.26)	1.86(1.87)	1.95(2.09)	1.92(2.33)
Reception	4.92(3.13)	1.17(0.44)	1.07(0.32)	1.08(0.35)	0.99(0.36)	1.27(0.45)	0.38(0.47)	0.4(0.54)	1.53(0.44)	0.46(0.47)	0.3(0.28)	0.35(0.33)	0.14(0)
Cellular Office Area	()	0.06(0.05)	0.06(0.05)	0.11(0.14)	()	()	()	()	()	()	()	()	0.07(0.06)
Cellular Office Area - multiple occupation	()	()	()	()	()	()	()	6.79(0)	6.71(0)	6.15(0)	()	()	()
Consulting/treatment room	()	()	()	()	()	()	()	()	2.95()	()	()	()	()
Open Plan Office Area	140.38(95.03)	41.56(166.3)	9.23(12.43)	10.9(12.95)	9.8(11.42)	10.97(12.02)	8.88(10.58)	16.22(11.76)	13.52(11.77)	8.29(10.61)	7.68(12.03)	7.96(10.47)	12.03(12.3)
Lounges	55.29(2.17)	3.7(0.22)	3.47(0.26)	3.93(0.27)	4.13(0.29)	4.55(0.33)	4.97(0.34)	9.94(0.71)	7.76(0.65)	8.61(0.51)	4.43(0.27)	3.56(0.58)	3.85(0)
Meeting Room	()	7.63(8.22)	7.06(7.79)	14.12(8.54)	7.72(8.3)	7.97(8.42)	9.49(8.14)	8.29(7.89)	12.99(7.67)	()	()	()	()
Library - open stacks	()	0.23(0.19)	0.35(0.23)	0.36(0.24)	0.38(0.25)	0.44(0.29)	0.44(0.3)	0.67(0.45)	0.66(0.45)	0.63(0.42)	0.32(0.22)	0.54(0.36)	()
IT: LAN Rooms	()	411.27(578.92)	1.67()	1.81()	1.88()	2.12()	1.69()	()	0.35()	()	()	1.74()	2.65(1.29)
IT: Server Room	54.35(0.19)	9.79(11.27)	8.97(10.69)	9.85(11.83)	9.38(10.9)	8.57(10.28)	7.32(9.72)	14.4(9.7)	9.09(9.04)	2.94(3.46)	2.19(3.01)	2.11(2.53)	2.11(2.71)
Catering: Bars	()	0.46()	0.42()	0.48()	0.44()	0.5()	0.47()	()	()	0.33()	0.51()	0.5()	0.51()
Catering: Eating/drinking area	80.9(2.3)	6.61(0.32)	6.12(0.38)	6.87(0.39)	3.77(3.39)	4.07(3.86)	4.29(3.84)	13.24(2.08)	12.8(3.61)	11.47(1.87)	3.52(3.83)	6.29(0.84)	6.71()
Catering: Full Kitchen Preparing Hot Meals	122.21(5.25)	25.03(4.33)	21.96(3.76)	24.37(4.69)	23.08(3.9)	62.26(29.26)	74.53(109.02)	146.54(30.35)	94.23(58.44)	59.27(45.06)	15.98(5.96)	24.07(4.1)	22.91(3.84)
Catering: Limited Hot Food Preparation Area	104.02(65.2)	532.7(993.58)	15.81(13.19)	17.66(14.64)	27.42(14.58)	14.49(11.07)	18.65(13.73)	17.45(11.21)	16.61(11.14)	8.84(8.28)	11.33(10.49)	15.4(11.79)	16.36(11.81)

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Catering: Snack Bar with Chilled Cabinets	18.3(0)	406.32(859.49)	11.1(13.54)	12.9(14.58)	14.32(11.41)	13.32(13.09)	16.78(16.06)	15.27(15.16)	15.05(14.9)	4.33(2.42)	3.71(1.98)	6.64(3.29)	7.2(3.29)
Catering: Vending Machines	()	0.41(0)	0.33(0)	0.39(0)	0.3(0.22)	0.16(0.01)	0.33(0.19)	()	()	0.88(0)	0.72(0)	0.67(0)	0.56(0)
Assembly areas / halls	9.85(5.67)	1.3(0.64)	1.24(0.5)	1.46(0.59)	1.76(0.81)	1.59(0.68)	1.13(0.88)	1.39(1.17)	0.8(0.9)	0.87(0.89)	0.53(0.5)	0.73(0.59)	0(0)
Teaching Areas	()	()	()	()	()	()	0.4(0.29)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	2.1(0.52)	()	()	7.39(2.48)	4.4(1.43)	6.83(2.65)	()	()	()
Toilet	29.64(3.72)	4.5(3.6)	4.49(3.56)	5.23(2.41)	6.05(3.38)	4.03(3.03)	4.88(4.38)	4.29(3.25)	4.62(2.99)	2.29(1.47)	3.02(2.23)	3.86(3.24)	4.51(4.45)
Retail Warehouse Sales area - chilled	()	()	()	()	()	()	0.76()	()	0.13(0)	()	()	()	()
Retail Warehouse Sales area - electrical	()	852.22(600.44)	1.57()	2.74()	3.59()	4.17()	4.05()	3.96()	3.79()	()	()	3.1()	4.32(0.17)
Retail Warehouse Sales area - general	73.59(42.48)	177.63(380.95)	6.19(4.78)	8.11(5.33)	8.84(4.62)	8.86(4.03)	12.63(5.84)	12.98(5.33)	12.68(5.77)	8.17(5.56)	6.67(4.87)	8.41(4.64)	9.08(4.35)
Small Shop Unit Sales area - general	23.66(21.53)	598.55(380.63)	2.62(1.82)	3.01(1.47)	2.62(1.88)	1.46(1.47)	4.75(3.41)	3.85(2.96)	3.78(2.81)	3.62(2.71)	3.2(2.58)	2.42(1.83)	4.7(1.93)
Dept Store Sales area - chilled	()	5.08()	5.46()	3.74()	1.45()	1.91()	1.33(1.78)	()	()	()	8.53()	1.82()	3.87()
Dept Store Sales area - general	12.16(1.38)	70.68(161.39)	9.72(10.07)	10.51(10.98)	8.36(8.95)	5.01(6.43)	7.07(7.7)	4.86(6.09)	5.23(5.66)	2.96(1.55)	4.26(3.18)	6.2(5.29)	7.45(5.08)
Warehouse storage	()	()	()	()	()	()	()	()	8.99(7.23)	()	()	()	()
Storage Area/Cupboard	12.81(11.67)	13.36(59.07)	3.81(3.92)	3.77(3.28)	3.3(2.55)	2.92(3.21)	3.45(4.19)	3.43(3.87)	2.86(3.59)	1.14(1.19)	1.75(1.76)	2.8(2.24)	3.09(2.97)
Recreational : Sports ground changing rooms	()	()	()	()	()	()	()	()	11.81()	()	()	()	()
Recreational : Changing facilities with showers	()	59.83(62.85)	55.33(59.5)	60.47(65.23)	55.18(50.12)	62.57(64.46)	43.2(57.51)	71.65(64.01)	67.69(56.81)	()	()	3.28()	3.27()
Generic Checkin areas	()	0.68(0.32)	0.64(0.31)	1.03(0.21)	0.93(0.42)	0.59(0.59)	0.78(0.36)	()	()	1.03(1.08)	1.25(0.88)	0.88(0.72)	0.8(0.53)
Nursery	()	()	()	()	()	()	1.24(0.86)	()	()	()	()	()	()
Laundry	()	()	()	()	()	()	()	()	2.76()	()	()	()	()
Industrial process area	()	()	()	()	()	()	()	()	0.12()	()	()	()	()
Heavy Plant Room	()	0.07(0)	0.05(0)	0.04(0)	0.05(0)	0.05(0)	()	()	0.08(0)	0.09(0)	0.05(0)	0.05(0)	0.07(0)
Light Plant Room	11.79()	2.28(1.12)	2.79(1.33)	2.8(1.62)	1.7(1.04)	1.53(1.08)	1.22(1.23)	1.96()	1.58(0.51)	2.12()	1.82(0.95)	2.08(1.21)	1.81(0.88)
External Space	()	()	()	()	()	()	()	()	()	()	()	()	()
Unoccupied space	()	1.05(0.45)	0.96(0.44)	1.23(0.77)	0.58(0.29)	0.59(0.27)	0.55(0.31)	()	()	()	0.15(0.23)	0.88(0.32)	0.98(0.43)

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2.4.1.2 Activity types – monthly energy use/m² summary by All in One Systems

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCOTBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	()	()	()	()	()	0.27(0)	0.34(0)	0.35(0)	0.37(0)	()	()	()	()
Reception	()	0.44(0)	0.29(0)	0.25(0)	0.34(0)	0.32(0)	()	()	0.54(0)	0.56(0)	0.34(0)	0.34(0)	0.43(0)
Cellular Office Area - multiple occupation	()	()	()	()	()	()	()	()	1.21(0.21)	()	()	()	()
Open Plan Office Area	52.84(13.25)	3.57(2.4)	2.9(1.41)	3.05(1.39)	3.56(1.32)	4.46(1.67)	5.36(2.06)	7.93(0.82)	8.11(1.01)	5.92(1.96)	3.94(2.47)	3.08(0.91)	3.16(1.51)
IT: Server Room	()	0.33(0)	0.21(0)	0.19(0)	0.25(0)	0.24(0)	()	()	0.4(0)	0.41(0)	0.25(0)	0.25(0)	0.32(0)
Catering: Bars	()	()	()	()	()	()	()	()	()	()	()	()	()
Catering: Eating/drinking area	36.45(3.43)	0.18()	0()	0.01()	0.02()	3.57()	4.72(0.83)	8.02(0.05)	5.23(0.58)	9.05(3.24)	4.27(1.74)	0.47(0.53)	0.13()
Catering: Full Kitchen Preparing Hot Meals	()	()	()	()	()	()	()	()	1.21(0.21)	()	()	()	()
Catering: Limited Hot Food Preparation Area	54.71(11.54)	2.54(1.12)	2.35(1.04)	2.53(1.11)	3.47(1.28)	3.99(1.73)	5.22(1.85)	7.85(0.6)	8.53(1.06)	6.93(1.95)	5.25(2.17)	3.33(1.32)	2.72(1.42)
Catering: Snack Bar with Chilled Cabinets	54.71(11.54)	2.54(1.12)	2.35(1.04)	2.53(1.11)	3.47(1.28)	3.99(1.73)	5.22(1.85)	7.85(0.6)	8.53(1.06)	6.93(1.95)	5.25(2.17)	3.33(1.32)	2.72(1.42)
Toilet	45.04(16.59)	2.15(1.01)	1.94(0.91)	1.94(0.3)	2.89(1.7)	3.78(2.98)	4.91(3.5)	7.34(0.37)	7.38(0.21)	5.01(0.13)	2.95(3.36)	2.61(1.37)	2.15(1.01)
Retail Warehouse Sales area - general	38.84(2.04)	2.34(0.46)	2.05(0)	2.2(0)	2.86(1.03)	3.54(0.51)	4.02(0.9)	5.45(0.47)	4.18(7.06)	4.96(1.83)	4.04(0.82)	2.74(0.03)	2.38(0.55)
Small Shop Unit Sales area - general	54.71(11.54)	2.54(1.12)	2.35(1.05)	2.53(1.11)	3.47(1.28)	3.99(1.73)	5.22(1.85)	7.85(0.6)	8.53(1.06)	6.93(1.95)	5.25(2.17)	3.33(1.32)	2.72(1.42)
Dept Store Sales area - general	54.72(11.54)	4.69(2.97)	4.28(3.22)	4.23(2.89)	4.18(1.24)	4.61(1.55)	4.78(1.48)	7.85(0.6)	4.46(3.68)	7.51(1.95)	4.83(2.17)	4.06(1.48)	4.24(2.12)

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2.4.1.3 Activity types – monthly energy use/m² summary by Cold Generators

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	()	0.41(0.56)	0.3(0.42)	0.13(0.13)	0.92(0.63)	0.25(0.28)	1.12(1.3)	0.65(0.74)	0.78(0.64)	2.81(0.95)	0.44(0.86)	0.24(0.27)	0.28(0.32)
Reception	11.33(2.87)	0.1()	0.06()	0.1(0)	0.61(0)	1.94(0)	2.56(0)	3.91(0)	3.19(2.51)	3.86(2.02)	0.44(0.62)	0.21(0.3)	0()
Cellular Office Area - multiple occupation	()	()	()	()	()	()	()	1.48(0.86)	1.15(0.67)	1.27(0.86)	()	()	()
Consulting/treatment room	()	()	()	()	()	()	()	()	()	0.13(0.13)	()	()	()
Open Plan Office Area	18(24.68)	1.58(2.99)	1.5(2.65)	1.28(2.59)	3.35(4.24)	2.83(2.54)	3.33(3.03)	10.72(2.61)	10.99(2.39)	2.33(2.68)	1.13(1.76)	1.43(2.43)	1.51(2.56)
Lounges	38.08(31.37)	2.64(3.63)	2.85(3.25)	3(4.16)	2.88(3.5)	3.75(1.83)	3(2.17)	2.9(3.25)	2.55(3.09)	2(2.2)	2.08(2.15)	2.58(2.98)	2.54(3.47)
Meeting Room	()	()	()	()	()	()	3.7(3.83)	()	()	()	()	()	()
Library - open stacks	()	0.05()	0.03()	0.05()	0.33()	0.55()	0.89()	1.75()	0.96(1.35)	0.57(0.81)	0.24(0.33)	0.23()	()
IT: Server Room	()	()	()	()	()	()	149.04(19.84)	()	()	()	()	()	()
Catering: Eating/drinking area	31.99(26.35)	2.22(3.05)	2.39(2.73)	2.52(3.5)	2.42(2.94)	3.15(1.53)	5.14(5.95)	3.77(2.77)	3.21(2.71)	2.53(1.96)	1.75(1.8)	2.17(2.5)	2.14(2.91)
Catering: Full Kitchen Preparing Hot Meals	()	()	()	()	()	()	14.35(14.81)	()	1.65(1.95)	7.04(2.83)	5.5()	()	()
Catering: Limited Hot Food Preparation Area	()	0.41(0)	0.28(0)	0.44(0)	4.24(1.56)	2.71(0.07)	6.86(5.49)	10.83(0)	8.6(3.54)	1.5(2.12)	0.62(0.87)	1.68(0)	0.78(0)
Catering: Snack Bar with Chilled Cabinets	()	0.36(0.44)	0.27(0.32)	0.12(0.07)	0.61(0.29)	0.31(0.2)	0.88(0)	2.31(0)	2.25(0)	0.26(0.21)	0.18(0.15)	0.23(0.16)	0.33(0.2)
Catering: Vending Machines	()	()	()	()	0.83()	()	()	()	()	()	0.95(1.06)	()	()
Lecture theatre	21.66(17.37)	1.69(2.02)	1.83(1.72)	1.92(2.32)	1.73(2.01)	2.19(0.9)	1.55(1.3)	2.35(2.01)	2.19(1.86)	3.68(1.39)	1.25(1.18)	1.63(1.61)	1.65(1.9)
Assembly areas / halls	()	0.02(0.01)	0.01(0)	0.02(0.01)	0.11(0.03)	0.19(0.05)	0.3(0.08)	0.6(0.16)	0.33(0.39)	0.96(0.25)	0.08(0.1)	0.04(0.05)	()
Teaching Areas	()	()	()	()	()	()	0.59(0.02)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	2.22(0.46)	()	()	2.47(1.75)	1.63(1.01)	2.31(1.9)	()	()	()
Toilet	()	0.11(0.12)	0.08(0.09)	0.04(0.02)	0.29(0.15)	0.26(0.06)	0.52(0.09)	0.72()	0.4(0.56)	0.28(0.39)	0.23(0.04)	0.12(0.04)	0.06(0.07)
Bedroom	()	()	()	()	()	()	()	()	()	1.84(0.02)	()	()	()
Laboratory	()	()	()	()	()	()	()	()	()	5.44(0.07)	()	()	()

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Laboratory with fume cupboards	()	()	()	()	()	()	()	()	()	5.44(0.07)	()	()	()
Retail Warehouse Sales area - general	()	0.3(0.02)	0.22(0.02)	0.33(0.02)	0.85(0.24)	1.35(0.1)	2.43(0)	7.77(0.95)	7.67(0.99)	1.67(1.11)	0.56(0.37)	1.14(0.02)	0.83(0.02)
Small Shop Unit Sales area - general	()	0.71(0.1)	0.61(0.08)	1.06(0.15)	0.63(0)	1.25(0)	3.39(5.17)	()	()	()	()	()	0.68(0.09)
Dept Store Sales area - general	()	3.11(4.89)	2.87(4.59)	3.25(5.07)	3.66(2.28)	1.63(0.75)	2.59(3.35)	7.29(0)	4.4(3.22)	1.11(0)	2.77(2.58)	2.45(2.3)	2.52(2.95)
Warehouse storage	()	()	()	()	()	()	()	()	1.16(0.63)	()	()	()	()
Storage Area/Cupboard	()	()	()	()	0.29(0.23)	()	0.16(0.16)	()	()	0.31(0)	0.06()	()	()
Recreational : Swimming Pools	()	()	()	()	()	()	()	()	()	()	()	()	()
Generic Checkin areas	()	()	()	()	1.47(0.41)	()	()	()	()	()	2.34(1.34)	()	()
Nursery	()	()	()	()	()	()	5.19(5.73)	()	()	()	()	()	()
Operating theatre	()	()	()	()	()	()	()	()	()	0.49(0.7)	()	()	()
Diagnostic Imaging	()	()	()	()	()	()	()	()	()	1.81(0.28)	()	()	()
Physiotherapy Studio	()	()	()	()	()	()	()	()	()	9.87(0.13)	()	()	()
Hydrotherapy pool hall	()	()	()	()	()	()	()	()	()	()	()	()	()
Generic Ward	()	()	()	()	()	()	()	()	()	()	()	()	()
Post Mortem Facility	()	()	()	()	()	()	()	()	()	5.44(0.07)	()	()	()
Light Plant Room	()	0(0)	0(0)	0(0)	0(0)	0(0)	0.2(0.23)	0.05(0)	0.05(0)	0.06(0)	0.02(0)	0(0)	0(0)

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2.4.1.4 Activity types – monthly energy use/m² summary by Heat Pump

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	7.15(2.52)	1.6(0.9)	1.47(0.85)	1.2(0.75)	0.81(0.57)	0.78(0.49)	0.37(0.13)	0.9(0.33)	0.47(0.56)	0.37(0.44)	0.28(0.33)	0.54(0.64)	0(0)
Reception	21.44(3.78)	4.79(0.64)	4.36(0.67)	3.54(0.66)	2.38(0.52)	2.31(0.38)	1.1()	2.71()	1.94(1.98)	1.68(1.58)	1.18(1.19)	1.95(2.27)	0.43(0)
Waiting Rooms	()	()	()	()	()	()	()	()	()	()	()	()	()
Cellular Office Area	()	0.17(0.07)	0.18(0.05)	0.19(0.05)	()	()	()	()	()	()	()	()	0.26(0.1)
Cellular Office Area - multiple occupation	()	0.34(0.15)	0.36(0.11)	0.38(0.1)	()	()	()	()	()	()	()	()	0.53(0.22)
Open Plan Office Area	9.01(1.86)	1.86(0.63)	1.69(0.61)	1.34(0.57)	0.86(0.45)	0.86(0.38)	0.46(0.07)	1.14(0.17)	0.59(0.66)	0.47(0.52)	0.35(0.39)	0.68(0.75)	0(0)
Lounges	21.44(3.78)	3.81()	3.38()	2.53()	1.42()	1.56()	1.1()	2.71()	1.4(1.98)	1.12(1.58)	0.84(1.19)	1.61(2.27)	0()
Meeting Room	()	1.16(0.65)	1.21(0.61)	1.26(0.56)	1.17(0.42)	0.89(0.32)	()	()	()	()	()	()	()
Library - open stacks	22.66(3.01)	3.81()	3.38()	2.53()	1.42()	1.56()	1.1()	2.71()	2.81()	1.12(1.58)	0.84(1.19)	1.61(2.27)	0()
IT: Server Room	()	0.42(0.17)	0.28(0.11)	0.24(0.1)	0.33(0.13)	0.31(0.12)	()	()	0.52(0.2)	0.53(0.21)	0.32(0.13)	0.32(0.13)	0.41(0.16)
Catering: Eating/drinking area	21.44(3.78)	4.97(0.65)	4.59(0.61)	3.79(0.56)	2.59(0.42)	2.45(0.32)	1.1()	2.71()	1.4(1.98)	1.12(1.58)	0.84(1.19)	1.61(2.27)	0()
Catering: Limited Hot Food Preparation Area	21.43(3.78)	3.81()	3.38()	2.53()	1.42()	1.56()	1.1()	2.71()	1.4(1.98)	1.12(1.58)	0.84(1.19)	1.61(2.27)	0()
Catering: Snack Bar with Chilled Cabinets	()	1.16(0.65)	1.21(0.61)	1.26(0.56)	1.17(0.42)	0.89(0.32)	()	()	()	()	()	()	()
Assembly areas / halls	10.72(2.82)	1.91(0.52)	1.69(0.46)	1.27(0.34)	0.71(0.19)	0.78(0.21)	0.55(0.15)	1.36(0.37)	0.7(0.84)	0.56(0.67)	0.42(0.5)	0.8(0.96)	0(0)
Toilet	21.43(3.78)	3.81()	3.38()	2.53()	1.42()	1.56()	1.1()	2.71()	1.4(1.98)	1.12(1.58)	0.84(1.19)	1.61(2.27)	0()
Retail Warehouse Sales area - general	()	0.46(0)	0.3(0)	0.26(0)	0.35(0)	0.33(0)	()	()	0.56(0)	0.57(0)	0.35(0)	0.35(0)	0.45(0)
Small Shop Unit Sales area - chilled	()	()	()	()	()	()	()	()	()	()	()	()	()
Small Shop Unit Sales area - electrical	()	()	()	()	()	()	()	()	()	()	()	()	()
Small Shop Unit Sales area - general	()	0.34(0.15)	0.36(0.11)	0.38(0.1)	()	()	()	()	()	()	()	()	0.53(0.22)

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Dept Store Sales area - general	()	2.62(3.74)	2.44(3.71)	10.38(18.53)	1.76(2.44)	1.43(1.9)	1.2(1.52)	()	0.56(0)	0.57(0)	1.35(1.74)	2.1(3.04)	2.45(3.47)
Storage Area/Cupboard	()	1.16(0.65)	1.21(0.61)	1.26(0.56)	1.17(0.42)	0.89(0.32)	()	()	()	()	()	()	()
Generic Checkin areas	()	0.34(0.15)	0.36(0.11)	0.38(0.1)	()	()	()	()	()	()	()	()	0.53(0.22)

2.4.1.5 Activity types – monthly energy use/m² summary by Heat Rejection

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	()	()	()	()	()	()	()	()	0.37()	()	()	()	()
Reception	()	()	()	()	()	()	()	()	0.17(0.16)	()	()	()	()
Cellular Office Area - multiple occupation	()	()	()	()	()	()	()	()	0.49(0.1)	()	()	()	()
Consulting/treatment room	()	()	()	()	()	()	()	()	0.47()	()	()	()	()
Open Plan Office Area	3.33(4.49)	312.75 (845.02)	230.18 (621.83)	162.96 (440.06)	99.12 (267.32)	112.91 (304.48)	123.62 (408.76)	326.95 (881.94)	278.73 (768.71)	0.38(0.62)	75.78 (275.81)	110.53 (402.76)	225.31 (608.74)
Meeting Room	()	3295.79()	2425.34()	1716.47()	1042.86()	1187.84()	948.48 (1340.73)	3440.46()	1526.76 (2158.94)	()	1394.41 ()	2036.06 ()	2374.24()
IT: LAN Rooms	11.31(5.72)	35.6(99)	0.53(0.3)	0.57(0.56)	0.62(0.27)	0.67(0.26)	0.92(0.47)	1.23(1.03)	8.46(0.62)	0.95(0.36)	0.75(0.3)	0.68(0.43)	0.63(0.19)
IT: Server Room	12.25(7.42)	47.32(72.02)	0.64(0.33)	0.55(0.22)	0.8(0.44)	0.98(0.6)	0.76(0.84)	1.28(0.8)	2.01(2.33)	1.24(0.76)	1.1(0.69)	0.8 (0.49)	0.71(0.41)
Catering: Eating/drinking area	()	()	()	()	()	()	()	()	0.96()	()	()	()	()
Catering: Limited Hot Food Preparation Area	()	()	()	()	()	()	0.05(0.07)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	()	()	()	0.06(0.05)	0.04(0.03)	0.06(0.05)	()	()	()
Retail Warehouse Sales area - general	1.91()	0.13()	0.12()	0.07()	0.12()	0.14()	0.17()	0.24()	0.26(0.06)	0.22()	0.2()	0.13()	0.13()
Small Shop Unit Sales area - general	()	()	()	()	()	()	()	()	0.44(0)	()	()	()	()

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Dept Store Sales area - general	17.45(0.63)	0.26(0)	0.23(0)	0.24(0)	1.18(0)	1.57(0)	0.68(0.99)	3.64(0)	12.29(0)	2.41(0)	1.23(0.45)	0.78(0.34)	0.15(0)
Warehouse storage	()	()	()	()	()	()	()	()	0.18(0.11)	()	()	()	()
Storage Area/Cupboard	()	()	()	()	()	()	0.06(0.02)	()	()	()	()	()	()

2.4.1.6 Activity types – monthly energy use/m² summary by Pumps

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	1.72(0.83)	0.12(0.13)	0.14(0.14)	0.14(0.12)	0.27(0.27)	0.17(0.35)	0.27(0.45)	0.66(0.85)	0.64(0.94)	0.46(0.61)	0.17(0.17)	0.17(0.16)	0.13(0.15)
Reception	5.6(1.13)	0.22(0.08)	0.39(0.31)	0.37(0.27)	0.37(0.29)	0.34(0.41)	0.54(0)	0.77(0)	0.47(0.63)	0.43(0.58)	0.22(0.3)	0.36(0.48)	0(0)
Cellular Office Area	()	0.03(0)	0.03(0)	0.06(0.04)	()	()	()	()	()	()	()	()	0.04(0)
Cellular Office Area - multiple occupation	()	0.06(0)	0.06(0)	0.18(0.01)	()	()	()	0.91(0.52)	0.55(0.31)	0.82(0.48)	()	()	0.08(0)
Open Plan Office Area	7.29(11.03)	0.26(0.64)	0.27(0.62)	0.29(0.68)	0.44(0.88)	0.34(0.73)	0.34(0.72)	0.72(0.96)	0.64(0.98)	0.57(0.92)	0.51(0.89)	0.36(0.68)	0.31(0.72)
Lounges	16.13(15.25)	1.16(1.34)	1.35(1.17)	1.42(1.33)	1.39(1.29)	1.88(1.24)	1.37(1.3)	1.05(1.2)	0.88(1.21)	0.91(1.17)	1.19(1.42)	1.17(1.18)	1.14(1.42)
Meeting Room	()	0.18(0)	0.18(0)	0.19(0)	0.18(0)	0.08(0)	0.05(0)	()	()	()	()	()	()
Library - open stacks	5.59(1.13)	0.18(0)	0.62(0)	0.55(0)	0.59(0)	0.76(0)	0.54(0)	0.77(0)	0.47(0.63)	0.43(0.58)	0.22(0.3)	0.36(0.48)	0(0)
IT: Server Room	()	()	()	()	()	()	1(0.43)	()	()	()	()	()	()
Catering: Eating/drinking area	16.13(15.25)	1.01(1.34)	1.07(1.21)	1.13(1.34)	1.1(1.32)	1.32(1.48)	1.25(1.32)	2.09(1.43)	1.62(1.38)	1.7(1.52)	1.21(1.45)	1.41(1.17)	1.36(1.5)
Catering: Full Kitchen Preparing Hot Meals	()	4()	3.44()	1.51(1.37)	3.7()	4.6(3.14)	5.25(9.65)	4.38(3.69)	5.87(4.11)	()	0.33(0)	4.31()	3.91()
Catering: Limited Hot Food Preparation Area	5.59(1.13)	0.76(0.34)	0.83(0.11)	1.4(0.72)	1.19(0.75)	0.75(0.2)	0.74(0.15)	0.77(0)	0.47(0.63)	0.43(0.58)	0.22(0.3)	0.8(0.4)	0.67(0.43)
Catering: Snack Bar with Chilled Cabinets	1.88(0.03)	0.29(0.12)	0.28(0.11)	0.27(0.09)	0.56(0.41)	0.2(0.1)	0.15(0)	0.16(0)	0.16(0)	0.33(0)	0.34(0.02)	0.21(0.04)	0.25(0)
Catering: Vending Machines	()	()	()	()	()	()	()	()	()	()	0.08(0)	()	()
Lecture theatre	68.53(62.8)	5.42(5.62)	5.43(5.05)	5.96(5.73)	5.71(5.57)	7.95(4.88)	5.69(5.63)	6.05(5.39)	6.02(5.41)	5.64(5.3)	5.49(5.65)	5.13(4.37)	5.7(5.87)
Assembly areas / halls	11.19(3.13)	0.36(0.09)	1.24(0.32)	1.1(0.28)	1.17(0.3)	1.51(0.39)	1.09(0.28)	1.53(0.39)	0.94(1.1)	0.87(1.01)	0.44(0.52)	0.71(0.84)	0(0)

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Teaching Areas	()	()	()	()	()	()	0.09(0.04)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	1.36(0.73)	0.3(0)	()	6.16(6.62)	3.99(3.96)	5.82(6.85)	()	()	()
Toilet	3.83(1.69)	0.16(0.08)	0.33(0.16)	0.29(0.14)	0.38(0.39)	0.29(0.49)	0.79(1.49)	0.81(0.76)	0.76(1.03)	0.3(0.39)	0.2(0.21)	0.21(0.26)	0.08(0.09)
Retail Warehouse Sales area - chilled	()	()	()	1.91(0.55)	()	()	()	()	()	()	()	()	()
Retail Warehouse Sales area - electrical	()	()	()	()	()	()	()	()	()	()	()	()	()
Retail Warehouse Sales area - general	93.19(48.83)	286.91(626.83)	4.49(4.71)	5.24(5.03)	5.68(4.91)	6.43(4.93)	7.01(4.48)	8.49(4.24)	7.43(4.83)	7.75(4.7)	7.04(4.79)	5.72(4.96)	6.54(4.08)
Small Shop Unit Sales area - general	()	0.17(0)	0.16(0)	0.43(0.1)	()	()	0.13(0.11)	()	()	()	()	()	0.22(0)
Dept Store Sales area - general	()	2.79()	2.4()	2.52()	3.43(2.27)	2.77(1.92)	2.16(1.69)	3.05(2.58)	4.1(2.86)	()	0.23(0)	3.01()	2.73()
Warehouse storage	()	()	()	()	()	()	()	()	10.45(5.69)	()	()	()	()
Storage Area/Cupboard	()	0.46(0.47)	0.41(0.39)	0.43(0.41)	0.73(0.79)	0.32(0.34)	0.76(0.56)	()	()	()	0.04(0.01)	1.08()	0.98()
Recreational : Changing facilities with showers	()	()	()	()	0.33(0.34)	0.18(0)	0(0)	()	()	()	()	()	()
Generic Checkin areas	()	0.06(0)	0.06(0)	0.07(0)	()	()	()	()	()	()	0.11(0)	()	0.08(0)
Nursery	()	()	()	()	()	()	0.18(0.03)	()	()	()	()	()	()

2.4.1.7 Activity types – monthly energy use/m² summary by Terminal Units

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	4.91(0)	0.33(0.25)	0.33(0.26)	0.26(0.18)	0.2(0.12)	0.26(0.25)	0.67(0.01)	0.83(0)	1.03(0)	0.9(0.01)	0.46(0.02)	0.25(0.01)	0.23(0.02)
Reception	()	0.65(0)	0.57(0)	0.44(0)	0.39(0)	0.61(0)	()	()	0.64(0.33)	0.3()	0.18()	0.18()	0.23()
Cellular Office Area - multiple occupation	()	()	()	()	()	()	()	()	0.22(0.01)	()	()	()	()

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Consulting/treatment room	()	()	()	()	()	()	()	()	0.21(0)	()	()	()	()
Open Plan Office Area	26.2(21.09)	1.77(8.16)	0.61(1.57)	0.62(1.52)	0.6(1.56)	0.66(1.64)	1.72(2.68)	0.7(1.39)	1.23(2.11)	0.53(1.07)	0.63(1.37)	0.57(1.51)	0.59(1.63)
Lounges	15.68(0.05)	1.1(0)	0.98(0)	1.12(0)	1.18(0)	1.29(0)	1.43(0)	1.71(0.05)	1.68(0.03)	1.54(0)	1.35(0.01)	1(0.03)	1.23(0)
Meeting Room	()	1.08(1.53)	1.04(1.42)	2.36(1.61)	0.83(1.63)	1.14(1.58)	5.21(2.56)	3.66(3.48)	4.68(3.38)	()	()	()	()
IT: LAN Rooms	24.77(6.93)	1082.49 (356.76)	1.45(0.47)	1.24(0.57)	1.8(0.5)	1.98(0.58)	2.67(1.17)	2.87(0.77)	5.96(8.4)	2.8(0.66)	2.47(0.7)	1.81(0.52)	5.16(0.68)
IT: Server Room	23.82(10.77)	88.37(190.15)	2.49(2.68)	2.47(2.9)	3.04(3.28)	3.6(4.22)	2.52(2.66)	3.09(1.87)	2.61(1.79)	2.77(1.94)	2.43(1.75)	1.81(1.25)	2.02(1.24)
Catering: Eating/drinking area	15.68(0.05)	0.39(0.36)	0.38(0.34)	0.32(0.32)	0.27(0.32)	0.42(0.42)	0.27(0.49)	1.71(0.05)	1.9(0.03)	0.47(0.67)	0.41(0.59)	0.32(0.43)	0.24(0.44)
Catering: Limited Hot Food Preparation Area	()	0.01(0)	0.01(0)	0.01(0)	0.04(0.04)	0.01(0)	0.06(0.16)	0.01(0)	0.01(0)	0.01(0)	0.01(0)	0.01(0)	()
Catering: Snack Bar with Chilled Cabinets	()	0.09(0.46)	0.17(0.62)	0.07(0.31)	0.05(0.21)	0.09(0.39)	0.01(0)	0.01(0)	0.01(0)	0.02(0.01)	0.03(0.02)	0.02(0.01)	0.03(0)
Catering: Vending Machines	()	0.04(0.01)	0.03(0.01)	0.03(0.01)	0.04(0.02)	0.01(0.01)	0.04(0.02)	()	()	0.07(0.06)	0.06(0.04)	0.05(0.04)	0.05(0.02)
Lecture theatre	31.36(0.11)	2.19(0)	1.96(0)	2.25(0)	2.36(0)	2.58(0)	2.85(0)	3.43(0.1)	3.37(0.06)	3.07(0.01)	2.71(0.01)	2.01(0.06)	2.46(0)
Teaching Areas	()	()	()	()	()	()	0.15(0)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	2.43(0.6)	()	()	3.68(2.86)	2.39(1.65)	3.48(3.06)	()	()	()
Toilet	()	7.57(0)	6.83()	7.66(0.01)	7.18(0.01)	7.09(0.01)	6.11()	()	()	0.04(0.01)	5.57(0.01)	7.25(0.01)	7.6(0.01)
Retail Warehouse Sales area - general	8.4(2.71)	94.96(129.65)	0.39(0.2)	0.3(0.11)	0.33(0.22)	0.35(0.27)	1.01(0.2)	1.29(0.3)	3.41(0.28)	1.36(0.27)	0.79(0.3)	0.45(0.21)	0.68(0.57)
Small Shop Unit Sales area - general	()	()	()	()	()	()	()	()	6.24(0)	()	()	()	()
Dept Store Sales area - general	()	2.54(3.2)	2.63(3.15)	1.97(1.87)	1.79(1.96)	1.64(1.98)	2.3(1.64)	0.52(0.36)	0.52(0.35)	0.01(0)	2.01(1.71)	2.31(2.74)	2.89(3.82)
Warehouse storage	()	()	()	()	()	()	()	()	8.93(4.75)	()	()	()	()
Storage Area/Cupboard	()	0.25(0.36)	0.24(0.35)	0.19(0.26)	0.12(0.16)	0.26(0.38)	3.42(0.63)	0.02(0.03)	0.02(0.03)	0.01(0.02)	0.01(0.02)	0.01(0.02)	0(0)
Recreational : Sports ground changing rooms	()	()	()	()	()	()	()	()	0.21(0)	()	()	()	()
Recreational : Changing facilities with showers	()	1.68(1.48)	1.56(1.4)	1.7(1.54)	1.7(1.49)	1.76(1.52)	1.77(1.41)	1.83(1.42)	1.81(1.38)	()	()	()	()
Nursery	()	()	()	()	()	()	1.83(0.05)	()	()	()	()	()	()

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2.4.1.8 Activity types – monthly energy use/m² summary by Heat Generators

Activity type	ANNUAL TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Circulation area (corridors and stairways)	()	()	()	()	()	0.02(0.02)	0.02(0.01)	0.02(0.02)	0.03(0.02)	()	()	()	()
Open Plan Office Area	()	()	()	()	()	()	0.01(0.01)	()	()	()	()	()	()
IT: Server Room	()	()	()	()	()	()	0.04(0)	()	()	()	()	()	()
Catering: Bars	()	()	()	()	()	()	()	()	()	()	()	()	()
Catering: Eating/drinking area	()	()	()	()	()	()	0.02(0.02)	()	()	()	()	()	()
Catering: Full Kitchen Preparing Hot Meals	()	()	()	()	()	0.02(0.02)	0.03(0.05)	0.02(0.02)	0.03(0.02)	()	()	()	()
Teaching Areas	()	()	()	()	()	()	0.04(0)	()	()	()	()	()	()
Spectator area (theatres and event buildings)	()	()	()	()	()	()	()	0.07(0.06)	0.05(0.03)	0.07(0.06)	()	()	()
Toilet	()	()	()	()	()	0.02(0.02)	0.02(0.03)	0.02(0.02)	0.03(0.02)	()	()	()	()
Retail Warehouse Sales area - general	0.63(0.33)	1.93(4.21)	0.03(0.03)	0.04(0.03)	0.04(0.03)	0.04(0.03)	0.05(0.03)	0.06(0.03)	0.06(0.03)	0.05(0.03)	0.05(0.03)	0.04(0.03)	0.04(0.03)
Dept Store Sales area - general	()	()	()	()	()	0.02(0.02)	0.02(0.02)	0.02(0.02)	0.03(0.02)	()	()	()	()
Display window area	()	()	()	()	()	()	()	()	()	()	()	()	()
Warehouse storage	()	()	()	()	()	()	()	()	0.17(0.09)	()	()	()	()
Storage Area/Cupboard	()	()	()	()	()	()	0.03(0)	()	()	()	()	()	()
Nursery	()	()	()	()	()	()	0.04(0)	()	()	()	()	()	()

3. Detailed Data Summary and Analysis

This section examines each System in detail, along with summaries of the measured data in the first column of each table. The summaries are used in the overview section in this report.

The data is considered at the level of consumption by HVAC component using the following metrics: W/m² and Annual kWh/m² and kWh/m² by month.

The data in this section is derived directly from the HERO database and is normalised to the floor areas allocated to each HVAC component within the iSERV spreadsheet for each building.

3.1 Measured data accuracy

The actual floor areas are expected to be between -1 to +4% of the value recorded in the iSERV spreadsheet, and 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 findings presented here should be read with these potential inaccuracies in mind.

3.2 Energy Consumption Section – Annual Data

This section covers the annual energy consumption figures measured for each HVAC System Component and Sub-Component type.

The following tables show the average, maximum and minimum (plus their standard deviations) measured Annual Energy Consumption in kWh/m² serviced by each sub-component. This data does not take into account the activities being serviced but serves to provide an indication of the in-use ranges of Annual Energy Consumption being found in Portugal for this HVAC component. These figures include directly measured energy use and energy use apportioned by initial benchmarks from metered data serving more than one component.

3.2.1 Air Handling Units Annual Energy Consumption by Sub-Component types

Table 7 – Overall measured annual energy use by Air Handling Units Sub-component types. Average kWh/m² in Portugal

	Extract only	Supply and extract	Supply and extract with heating and cooling variants, etc	Supply only
Average	14.26	70.36	31.69	13.15
SD Average	28.20	65.39	73.79	12.36
Average Max	14.30	74.03	31.69	13.42
SD Max	28.23	65.40	73.79	13.17
Average Min	14.21	66.92	31.69	12.91
SD Min	28.16	66.15	73.79	11.63

3.2.1.1 Conclusions for Cold Generators

- The average Annual Energy Consumption measured across all Air Handling Units sub-components ranges from 13.15 in supply only sub-component to 74.03 kWh/m² in Supply and extract.

3.2.2 All-in-One System Annual Energy Consumption by Sub-Component types

Table 8 – Overall measured annual energy use by All-in-One System Sub-component types. Average kWh/m² in Portugal

	ASHP Reverse Cycle - Cooling Optimised	WSHP Reverse Cycle - Heating Optimised
Average	54.15	36.45
SD Average	11.23	
Average Max	54.15	39.70
SD Max	11.23	
Average Min	54.15	31.64
SD Min	11.23	

3.2.2.1 Conclusions for All-in-One Systems

From the data it can be seen that:

- The average Annual Energy Consumption measured across all All-in-One sub-components ranges from 36.45 in WSHP sub-component to 54.15 kWh/m² in ASHP

3.2.3 Heat Pump Annual Energy Consumption by Sub-Component types

Table 9 – Overall measured annual energy use by Heat Pump Sub-component types. Average kWh/m² in Portugal

Air source reverse cycle - heating optimised	
Average	25.57
SD Average	
Average Max	31.58
SD Max	
Average Min	19.74
SD Min	

3.2.4 Cold Generator Annual Energy Consumption by Sub-Component types

Table 10 – Overall measured annual energy use by Cold Generator Unit Sub-component types. Average kWh/m² in Portugal

Centrifugal Liquid Chillers	
Average	97.87
SD Average	73.43
Average Max	107.38
SD Max	77.31
Average Min	86.87
SD Min	71.91

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3.2.5 Pump Annual Energy Consumption by Sub-Component types

Table 11 – Overall measured annual energy use by Pump Sub-component types. Average kWh/m² in Portugal

	Chilled water primary pumps	Hot water primary pumps	Hot water secondary pumps
Average	15.37	53.69	63.64
SD Average	23.24	76.31	106.29
Average Max	15.67	54.26	64.01
SD Max	23.18	76.04	105.97
Average Min	15.13	53.17	63.21
SD Min	23.34	76.59	106.67

3.2.5.1 Conclusions for Pumps

From the data it can be seen that:

- The average Annual Energy Consumption measured across all Pump sub-components ranges from 15.37 in Chilled Water primary pumps sub-component to 63.64 kWh/m² in Hot Water secondary pumps

3.2.6 Terminal Unit Annual Energy Consumption by Sub-Component types

Table 12 – Overall measured annual energy use by Terminal Unit Sub-component types. Average kWh/m² in Portugal

	DX indoor unit	Fan Coils – 2 or 4 tubes
Average kWh/m2/year	9.39	13.57
SD Average kWh/m2/year	13.08	11.56
Average Max kWh/m2/year	9.39	13.61
SD Max kWh/m2/year	13.09	11.60
Average Min kWh/m2/year	9.38	13.50
SD Min kWh/m2/year	13.07	11.48

3.2.6.1 Conclusions for Terminal Units

From the data it can be seen that:

- The average Annual Energy Consumption measured across all Terminal Unit sub-components ranges from 11.56 in Fan coils sub-component to 13.08 kWh/m² in DX units
- The energy use observed for fan coils do not have into account the energy use to produce the supplied chilled or hot water to these units, so higher value for DX units was expected

3.2.7 Heat Rejection Annual Energy Consumption by Sub-Component types

Table 13 – Overall measured annual energy use by Heat Rejection Sub-component types. Average kWh/m² in Portugal

Air condensers	
Average kWh/m ² /year	5.40
SD Average kWh/m ² /year	6.09
Average Max kWh/m ² /year	5.54
SD Max kWh/m ² /year	6.26
Average Min kWh/m ² /year	5.26
SD Min kWh/m ² /year	5.92

4. References

Knight I P – “Measured Energy Use and Power Demands in European HVAC Components”, CIBSE ASHRAE Technical Symposium, Dublin, Ireland, 3-4 April 2014.

Jomni Y, v. Deventer J and Delsing J – “Comparing heat measurement accuracy of a new adaptive algorithm with existing heat meters in accordance to the Swedish test standard”, 10th International Symposium on District Heating and Cooling, September 3 – 5, 2006.