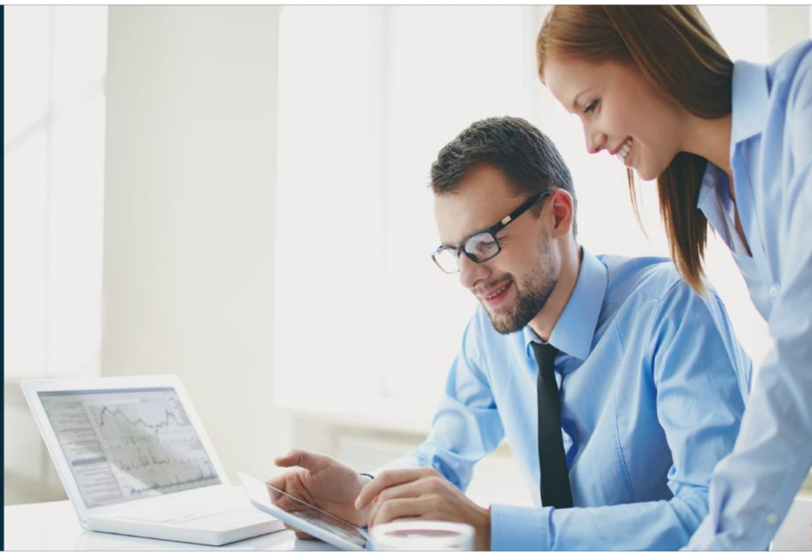
AIRZONE
Smart climate control

BREEAM certification with Airzone

Case study



BREEAM® ES

AIRZONE SYSTEMS' BREEAM CERTIFICATION

CASE STUDY

1. INTRODUCTION

In industrialized countries the trend in living habits sees people spending most of their time in enclosed spaces, leading to significant changes in both the energy use that takes place within the building, and in the requirements of thermal and visual comfort and indoor air quality, as well as how these services are managed. Directive 2012/27/EU [1] estimates that 40% of end energy consumption occurs in buildings, and that approximately 50% is attributable to cooling and heating systems.

The method of evaluation and certification of the sustainability of the building that most favors more sustainable construction is **BREEAM®** (Building Research Establishment Environmental Assessment Methodology). This translates into greater profitability for whoever builds, operates and/or maintains the building, achieving a reduction of its impact on the environment, and greater health and comfort for those who live in, work in, or use the building. It evaluates impacts in 10 categories (Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use, Pollution and Innovation), and gives a final score after applying an environmental weighting factor that takes into account the relative importance of each area of impact.

The **Airzone** control system optimizes the operation of the HVAC systems and guarantees the comfort of the building, which will contribute to the award of different points in some of the BREEAM categories.

2. AIRZONE ZONED CONTROL SYSTEMS

In the residential and services sector, that have installations with small and medium capacity units, all-air systems equipped with direct expansion inverter units and constant-flow ductwork are commonly used. This kind of system is based on controlling the temperature of a single zone to ensure comfort levels are maintained in that area. With regard to the rest of the zones, even when the ductwork is well designed and the AC unit has the required maximum capacity, if the load profile is not similar to that of the control zone (use, orientation, thermal loads, etc.), their temperatures can fall outside the comfort range.

A **zoned system**, however, is based on independently controlling the temperature of each of the zones. To do this a thermostat is included in each room, allowing the thermal demand for each of the zones to be determined, and the selection of an independent set-point temperature depending on the preferences of the user. In this way, when the set-point temperature established for the zone is reached, a control signal is sent to the zone's motorized damper which interrupts the airflow supply to that room. Figure 1 shows a diagram of a zoned system.

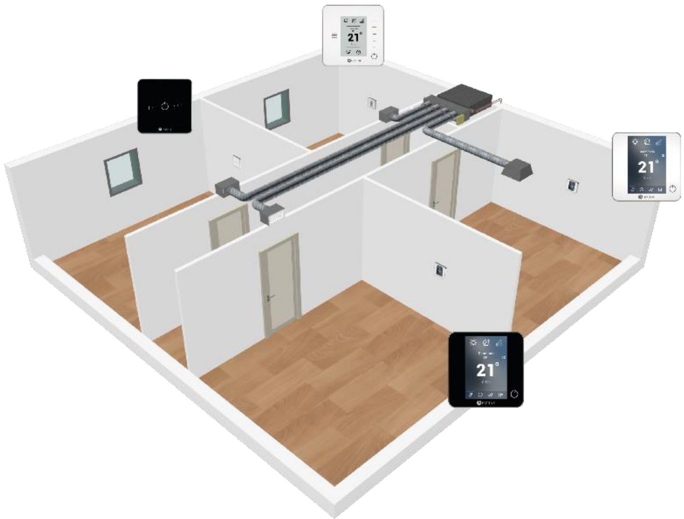


__Figure 1__. Diagram of a zoned system

In addition to thermal zoning, the Airzone control system bases its operations on a **communication gateway.** Achieving a high level of comfort at the same time as reducing power consumption requires good communication between the zoning system and the AC unit. The communication gateway is the device that enables this two-way communication between the main control board and the AC unit. Airzone has agreements in place with the main manufacturers to share the communication protocols used by their AC units. This makes it possible to have information about their operational parameters, so actions can be performed, such as:

- Switching the AC unit on or off.
- Changing the operating mode.

The AC unit's operating mode (cooling, heating or ventilation) is set by the installation's master thermostat. Those areas that are in thermal inversion, that is to say, with a demand opposite to the AC unit's operating mode, are kept closed.

- Controlling the indoor unit's fan speed.

This is regulated by the *Q-Adapt* algorithm, which adapts the flow rate of the indoor unit's fan by changing its speed dynamically.

- Limiting the zone's set-point temperature.

This is regulated by the *Eco-Adapt* algorithm, which monitors the set-point temperature in the different zones and limits the maximum or minimum selectable temperature according to whether it is in heating or cooling mode, respectively. Mode A sets the maximum temperature range in winter at 22°C and in summer at 24°C, Mode A+ at 21.5°C and 25°C and Mode A++ at 21°C and 26°C.

- Controlling the AC unit's set-point temperature.

This is regulated by the *Efi-Adapt* algorithm (*Eco-Adapt* functionality for air-to-air units), which dynamically controls the AC unit's set-point temperature based on the temperature in each zone and the return temperature to the AC unit, taking into account the effect of thermal inertia in each zone.

Figure 2 shows a diagram of a zoned ducted system in a building, with the main control board and communication gateway.

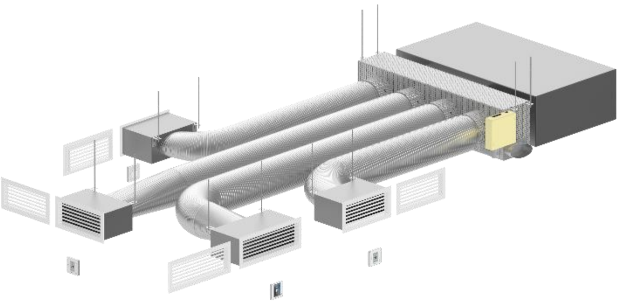


Figure 2. *Diagram showing the control of a zoned system*

3. BENEFITS OF AIRZONE IN BREEAM CERTIFICATION

Including Airzone technology in a building project can improve the BREEAM certification score in the following categories: Management, Health and Wellbeing, Energy, Pollution and Innovation.

1) In the <u>*Management*</u> category, the “Sustainable management” requirement offers up to **6 points** thanks to Airzone Cloud and BMS integration.

2) In the <u>*Energy*</u> category, the “Reduction of energy use and carbon emissions” requirement offers up to **15 points** in recognition of those buildings which are designed to minimize operational energy consumption. Moreover, with the “Energy monitoring” requirement up to **2 points** are available.

3) In the <u>*Health and Wellbeing*</u> category, up to **3 points** are available in the “Thermal zoning” and "Thermal comfort” requirements. This is based on the calculation of the PPD and PMV comfort parameters, and on compliance with category B of comfort, according to the EN ISO 7730 [2].

4) In the <u>*Pollution*</u> category, up to **1 point** is available in the “GWP of refrigerants – building installations” requirement.

5) In the *Innovation* category, up to **6 additional points** can be obtained for achieving exemplary levels in "Sustainable management" (**1**) and "Reduction of energy use" (**5**) requirements.

3.1 Case Study

The present study has been modeled using TRNSYS, one of the most advanced simulation programs on the market [3]. Mathematical models of all HVAC systems defined in the previous section have been run using this calculation platform. The results for a home simulated for the regions of Madrid, Valencia and Barcelona are shown in Figure 3.

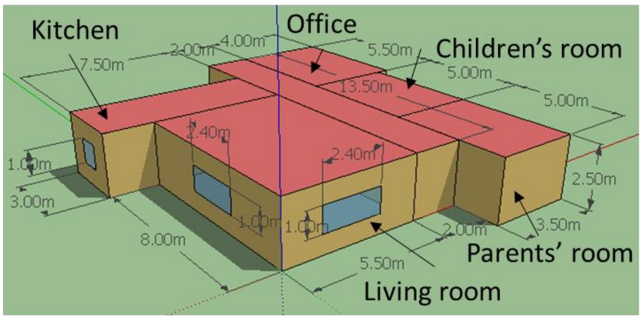


***Figure 3**. Floor plan of the home. 3D representation with measurements*

3.2. Results: Energy

Thanks to the system's strategies designed to control and manage the HVAC installation, energy savings are achieved and therefore also a reduction in carbon emissions. By way of example, in the case study, the potential for energy savings of the Eco-Adapt algorithm was assessed for the three cities modeled.

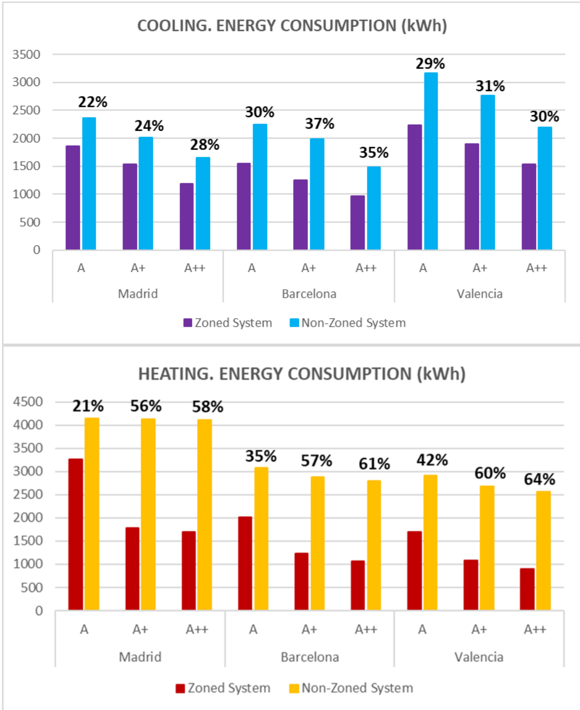


***Figure 4**. Comparative energy consumption*

With the application of the **Eco-Adapt algorithm** a reduction in the energy consumption was achieved, depending on whether the set-point temperature was increased in cooling mode or decreased in heating mode.

The savings are 56-64% in heating mode, and 24-37% in cooling mode, improving the BREEAM certification in the Energy category.

3.3. Results: Health and Wellbeing – Thermal comfort

In standard conditions of comfort associated with levels of clothing, metabolic rate and relative air speed, a comparison was made of the PPD and PMV parameters in a zoned and non-zoned system. In the first place, Figure 5 shows the comparison of the PPD parameter, highlighting the category of comfort obtained.

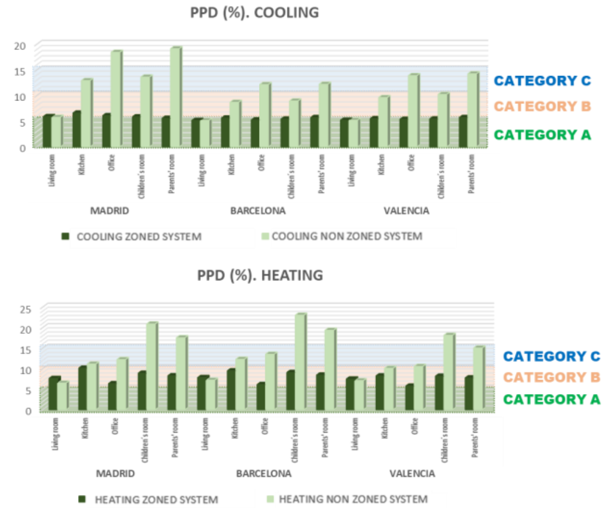
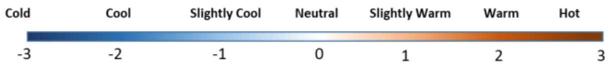


***Figure 5**. PPD comparison*

The PMV results are shown in Table 1, where color codes have been used to facilitate a more immediate comparison of the results.



CITY	ZONE	PMV			
		COOLING		HEATING	
		ZONED SYSTEM	NON-ZONED SYSTEM	ZONED SYSTEM	NON-ZONED SYSTEM
MADRID	Living room	-0.2	-0.2	0.3	0.2
	Kitchen	-0.1	-0.6	0.5	0.5
	Office	-0.2	-0.8	0.1	0.6
	Children's room	-0.1	-0.6	0.4	0.9
	Parents' room	0.0	-0.8	0.3	0.8
BARCELONA	Living room	0.0	-0.1	0.4	0.3
	Kitchen	0.1	-0.4	0.4	0.6
	Office	0.0	-0.6	0.1	0.6
	Children's room	0.1	-0.3	0.4	0.9
	Parents' room	0.1	-0.6	0.4	0.8
VALENCIA	Living room	0.0	-0.1	0.3	0.3
	Kitchen	0.1	-0.5	0.4	0.5
	Office	-0.1	-0.6	0.1	0.5
	Children's room	0.1	-0.4	0.4	0.8
	Parents' room	0.2	-0.6	0.3	0.7

***Table 1.** PMV comparison*

In a zoned system, the minimum comfort requirements demanded of category B with a PPD at around 5% and a PMV below 0.5 are met in each of the areas of the home for the three cities modeled, while the non-zoned system obtains good results in the living room zone, but the rest of the zones experience significant undercooling in zones in cooling mode and overheating in heating mode.

Airzone guarantees a minimum category B of comfort by zoning the installation.

3.4. Results: Pollution – Impact of refrigerants

In a **non-zoned system**, the distribution network has no element that allows the system to deal separately with the needs of each area. Therefore, to guarantee the possibility of meeting peak load in all zones, the performance rating of the AC unit must be equal to or greater than the sum of peak sensible loads of the zones, even if they are not simultaneous.

On the other hand, in a **zoned system,** the distribution network has motorized dampers that allow you to adjust the thermal contribution of the system to the demand of each zone separately. This means that the AC unit is sized by taking into account the maximum simultaneous sensible load of the zones. In other words, for every time step, the loads of all zones are added together, and the AC unit is sized on the basis of the annual maximum for cooling and heating.

On this basis, for this case study, the selection of AC units in the zoned system is adjusted to the simultaneous thermal load and required capacity, allowing the use of lower thermal capacity units. This means that instead of a Mitsubishi PUHZ-RP125 unit, rated with a sensible cooling load of 8,610 W and a sensible heating load of 13,900 W, a Mitsubishi PUHZ-RP100GA can be installed, rated with a sensible cooling load of 6,720 W and a sensible heating load of 10,300 W. This leads to a reduction of 0.5 kg in the amount of refrigerant used, since it drops from a load of 3.8 to 3.3 kg, with a maximum tube length of 50 m and height difference of 30 m [4].

Airzone reduces the required capacity of the AC units in an installation when compared to centralized AC units with no zoning.

4. CONCLUSIONS

The present study demonstrates the advantages of Airzone's zoned climate control system in terms of energy consumption, thermal comfort and savings in refrigerant when compared to a non-zoned system, in a residential building and subjected to different climatic conditions. These benefits contribute positively to the possibility of obtaining BREEAM certification for the building, obtaining points in key areas such as Energy, Health and Wellbeing and Pollution when compared to a non-zoned HVAC system.

REFERENCES

[1] European Commission. Directive 2012/27/EU of the European Parliament and of the Council of October 25, 2012 on Energy Efficiency. Official Journal of the European Union (2012), L 315/1.

[2] European Standard EN ISO-7730:2006. Ergonomics of the thermal environment. Analytical determination and interpretation of thermal comfort through the calculation of the PMV and PPD indexes and local thermal comfort criteria.

[3] TRNSYS http://sel.me.wisc.edu/trnsys/. (Access on January 2, 2018).

[4] http://www.mitsubishitech.co.uk/

Parque Tecnológico de Andalucía
C/Marie Curie, 21 · 29590 Málaga
+34 900 400 445 · www.airzonecontrol.com
projects@airzonecontrol.com