AIRZONE

Smart climate control

Reduction of **installed capacity of aerothermal systems** wtih Airzone

REDUCTION OF INSTALLED CAPACITY OF AEROTHERMAL SYSTEMS WITH AIRZONE

The Arrival of Aerothermal Systems in Buildings

Directive 2009/28/EC of the European Parliament and of the Council [1] on the promotion of the use of energy from renewable sources recognises as renewable energy the energy captured by heat pumps, which are thermal units capable of transferring heat from a cold source to a hot source. In the case of aerothermal energy, heat is extracted from a natural environment (air) through the evaporator and transferred to the interior of the building through the condenser. The cycle, being reversible, allows the fluid in the evaporator to be cooled in cooling mode.

Currently, in newly constructed residential buildings, it is becoming the main option for covering DHW and heating and air conditioning needs, meeting the minimum renewable energy contribution established by the RITE standards, thus replacing solar thermal collectors. In many European countries, there are regulations that promote the use of aerothermal energy as a production system for heating and air conditioning and DHW in the residential sector.

In France, the purchase costs associated with heat pumps, as opposed to air/air pumps, whose main purpose is the production of heat or domestic hot water, are eligible for the energy transition tax credit (CITE) at a rate of 30%. However, for heat pumps dedicated to the production of domestic hot water, the expenses paid from 2018 onwards remain within the limit of an expenditure ceiling, per type of unit, set at €3,000 all taxes included [2].

In Italy, the Agenzia Nazionale per l'Efficienza Energetica (ENEA) promotes a series of tax deductions for energy redevelopment interventions and for building renovations. For heat pumps, the new ENEA Superbonus proposes an incentive of up to 110% for the installation of an aerothermal system (in place of the previous 65%), with the replacement of the winter heating and air conditioning system in the following cases: shared areas, detached homes or houses in residential blocks with centralised installations using heat pumps [3].

In Portugal, the installation of aerothermal heat pumps in new buildings must comply with a set of criteria imposed by Decree Law No. 118/2013 that aims to ensure the energy efficiency of the units. In particular, Ordinance no. 349-B / 2013 (Requirements for technical performance and efficiency of technical systems in new buildings subject to major intervention), defines in point 4.2 d) that: "Heat pumps for the exclusive production of DHW must show a performance, determined according to EN 16147, characterised by a minimum COP of 2.3...", which demonstrates the firm commitment to this production technology [4].

The Airzone Zoned Control System in Aerothermal Systems

Just as in a home there is a switch to turn on the light in each room, the concept of **thermal zoning** allows the temperature in each zone to be controlled by means of a thermostat in each room.

In countries such as Spain or France, the country's regulations are beginning to consider thermal zoning as mandatory under certain precepts, with the aim of obtaining a high level of comfort and energy savings. The standards EN 15232-1:2017 [5] and EN 15500-1:2017 [6] consider the effect of heating and air conditioning systems on the energy efficiency of the building and in France they are implemented in the calculation methods of simulation programs. Eu.bac certification plays an important role in this.

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In Spain, Royal Decree 1027/2007 approving the RITE states in its IT 1.2.4.5.4. that "*the zoning of a heating and air conditioning system shall be adopted for the purpose of obtaining high comfort and energy savings. Each system shall be divided into sub-systems, taking into account the compartmentalisation of interior spaces, their orientation, as well as their use, occupancy and hours of operation".* According to Article 15 of the same, when the rated capacity to be installed for the generation of heating or cooling is between 5 and 70 kW, a technical report is required to justify the project and, therefore, the thermal zoning [7].

In Italy, the installation of automatic management and control technology for the thermal and electrical installations of buildings is eligible for incentives under the Ecobonus incentives [3]. In cases where there are no other key actions, the incentives linked to Building Automation are 65% and in cases where there are other key actions, incentives of 110% can be reached if a two-letter improvement in the energy rating is achieved or the highest achievable letter for the installation is reached. For incentives linked to Building Automation, devices must comply with the following parameters:

- Display energy consumption via multimedia channels through regular data delivery.
- Display the current operating conditions and control temperature of the installation.
- Enable remote switching on and off and weekly programming of the installations.

In Portugal, the order or Portaria no. 349-B/2013 [4] defines the methodology for the determination of the energy efficiency class of SCE pre-certificates and certificates, as well as the requirements for technical performance and efficiency of residential building technical systems (REH). This order establishes that:

- Heating and air conditioning systems must have control and regulation mechanisms that ensure at least the limitation of maximum and minimum indoor air temperature values, as appropriate, in any heated/cooled space or group of heated/cooled spaces.

- Technical heating and air conditioning systems with a rated thermal capacity of 50 kW or more shall have control and regulation mechanisms that ensure at least the following functions:
    - regulation of the heating and cooling capacity of the equipment according to the thermal requirements of the building or heated/cooled spaces;
    - possibility of controlling the heating and air conditioning system by space or group of spaces, in a period of non-occupancy;
    - possibility of configuring operating hours.

On one hand, the **non-zoned 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**, on the other hand, is based on independently controlling the temperature of each of the zones. To do this a thermostat is installed 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 motorised damper which interrupts the airflow supply to that room.

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Below is an image of a home thermally zoned with **Acuazone**, Airzone's control system for hydronic installations, which in this case combines the control of a multi-zone fancoil with underfloor radiant heating and cooling, in which the production system is a heat pump.

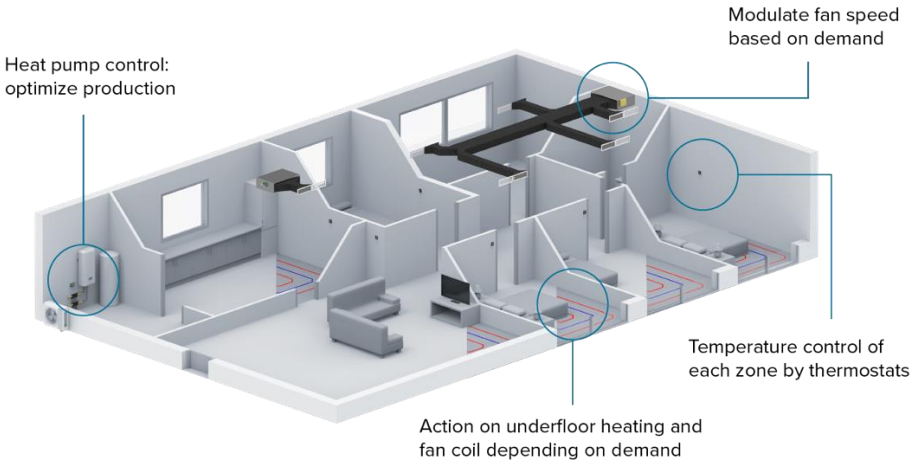

Figure 1. Residential home controlled with Acuazone

Simultaneity Study for Capacity Reduction of the Production Unit

Case Study: Residential Block

The home, simulated with the Trnsys 17 software [8] (see Figure 2), has five heated/cooled zones (living room, kitchen, office, parents' bedroom and children's bedroom) with a surface area of 121 m^2, and the remaining area considered as a single zone without heating/cooling.

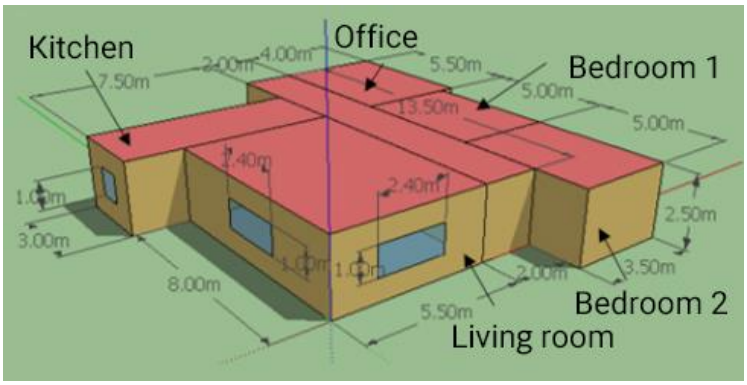

Figure 2. 3D representation of the home with measurements

The overall heat transfer coefficients limits for walls and windows according to the regulations of each country are considered in Table 1:

Country	Regulations
Spain	CTE [9]
France	RT 2012 [10]
Italy	D. Lgs. N. 192 of August 19, 2005 [11]
Portugal	Portaria no. 349-B/2013 [4]
Germany	EnEV 2009 [12]
England	Building regulations 2013 [13]

Table 1. Home occupancy profile

Since in a zoned system the thermal load of the unoccupied zones is not combated, it is important to determine the use profile of each room (Figure 3).

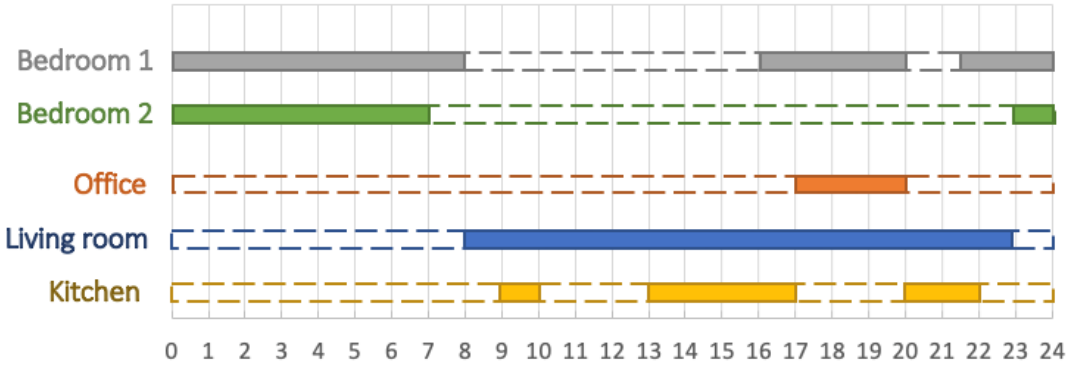

Figure 3. Home occupancy profile

Climatic Conditions

The home is simulated in a city representative of the different climatic zones established by each country. The EnergyPlus Weather database (.epw file) [14] was used for the load calculation simulation.

Load Calculation: Sizing of AC Units

The sizing of the AC units is done taking into account that the user comfort range will be set between **22°C and 24°C**.

In a non-zoned system, the distribution network has no element that allows the system to deal separately with the needs of each zone. Therefore, to guarantee the possibility of meeting peak load in all zones, the rated capacity 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.

However, in a zoned system, the distribution network has motorised 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 based on the annual maximum for cooling and heating.

Simultaneity Study for Capacity Reduction of the Production Unit

Climatic zone	Peak loads (W)		Simultaneous loads (W)		% reduction		Aerothermal production unit [15,16]		Reduces
	Heating	Cooling	Heating	Cooling	Heating	Cooling	Non-zoned	Zoned	
Paris	7989	4005	7248	2523	9.3	37	ERGA08DV	ERGA06DV	YES
Marseille	6786	5673	5976	4598	11.9	19	ERGA06DV	ERGA04DV	YES
Barcelona	6325	5560	5567	4512	12.0	18.9	EBHQ011BB6V3	EBLQ07CV3	YES
Madrid	7515	5780	6849	4471	8.9	22.6	EBHQ011BB6V3	EBLQ07CV3	YES
Milan	8775	4816	8106	3963	7.6	17.7	EBHQ011BB6V3	EBHQ011BB6V3	NO
Rome	7267	4946	5896	3843	18.9	22.3	EBHQ011BB6V3	EBLQ07CV3	YES
Lisbon	4566	4582	3949	3345	13.5	27	EBLQ07CV3	EBLQ05CV3	YES
Faro	4434	5221	3228	4173	27.2	20.1	EBHQ011BB6V3	EBLQ07CV3	YES
London	5036	3561	4908	1763	2.6	50.2	EBLQ07CV3	EBLQ07CV3	NO
Munich	4339	4671	1986	1374	-7.7	30.8	EBLQ07CV3	EBLQ07CV3	NO

Tables 2 and 3 show the data relating to the heat pump for air conditioning, heating and domestic hot water production (compact system).

[15] Daikin Altherma Monobloc Low Capacity (Table 2)

	EBLQ05CV3	EBLQ07CV3	EBHQ011BB6V3
Heating_cap (kW)	4.03	6.9	10.87
COP	3.58	3.42	3.37
Cooling_cap (kW)	4.2	5.4	10
EER	2.32	3.8	2.78

[16] Daikin Altherma Bibloc Bluevotion (Table 3)

	ERGA04DV	ERGA06DV	ERGA08DV
Heating_cap (kW)	5.75	7.4	8.86
COP	3.70	3.68	3.47
Cooling_cap (kW)	4.62	5.57	6.34
EER	3.72	3.48	3.31

Results and Conclusions

- The **percentage of load reduction** by simultaneity varies:
  - Cooling: in warm cities it is between 17-22%, and in climates with a low cooling load it reaches between 30-50%.
  - Heating: in colder cities it is reduced by less than 9%, and in more temperate climates it is between 12-27%.
- The benefits of capacity reduction in economic and environmental terms can be summarised as follows:
  - **Savings of up to €1,906** in the cost of: outdoor unit + storage tank + control box + controller + drainage pipe.
  - Reduction of up to **1.95 kg of refrigerant** and 4.1 tonnes of CO_2 equivalent.

References

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[3] https://www.efficienzaenergetica.enea.it/detrazioni-fiscali/ecobonus.html

[4] Portaria n.º 349-B/2013. Ministério do Ambiente, Ordenamento do Território e Energía. https://data.dre.pt/eli/port/349-b/2013/11/29/p/dre/pt/html

[5] EN 15232-1:2017. Energy Performance of Buildings - Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management.

[6] EN 15500-1:2017. Energy Performance of Buildings - Control for heating, ventilating and air conditioning applications - Part 1: Electronic individual zone control equipment.

[7] Reglamento de las Instalaciones Térmicas en Edificios (RITE) 2007.

[8] TRNSYS 17. www.trnsys.com

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[10] The Réglementation Thermique 2012 (RT2012) (www.rt-batiment.fr).

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[13] The Building (Amendment) Regulations 2013 (3rd June 2013).

(http://www.legislation.gov.uk/uksi/2013/1105/contents/made).

[14] EnergyPlus (2020) (https://energyplus.net/weather).

[15] Daikin Altherma Monobloc Low Capacity.

[16] Daikin Altherma Bibloc Bluevotion.

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