CASCINA OREMO: A Renovation of a building for people with disabilities, where we all learn to achieve efficiency together

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Abstract. Cascina Oremo is a group of buildings conceived by the "Fondazione Cassa di Risparmio di Biella" to accommodate associations that focus on childhood disabilities. It is a multifunctional complex converted from an old farmhouse located in Biella. It consists of two different buildings: the multifunctional farmhouse building, created by renovating the existing farmhouse structure, and the pool building, a new building that houses the pool and sports areas. It hosts four different associations, each allocated specific spaces. This case study aims to illustrate the automation and control system choices, particularly highlighting the metering not only for cost allocation in accordance with DLgs 102/14 but also for interfacing with the Building Management System designed to assist the designer in ensuring that the building's performance adheres to the project specifications over time and improves the overall system efficiency within the Deming cycle perspective. Furthermore, it integrates with Artificial Intelligence and the smart grid. The Building Management System also serves as an enabling platform for informing occupants to achieve a high level of Sustainable and Responsible Investment.

1 Introduction

Cascina Oremo is a multipurpose building conceived by the "Fondazione Cassa di Risparmio di Biella" to accommodate associations that focus is the treatment of childhood disabilities. It is located in the small town of Biella near the University Campus and on the border with the Piedmont countryside.

The structure is made up of two different buildings. The main building was created by renovating the existing farmhouse structure (figure 1) and a new building that houses the pool and sports areas (figure 2). It hosts four different associations, each allocated in specific spaces.

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Fig. 1. An internal view of the courtyard of the ancient farmhouse

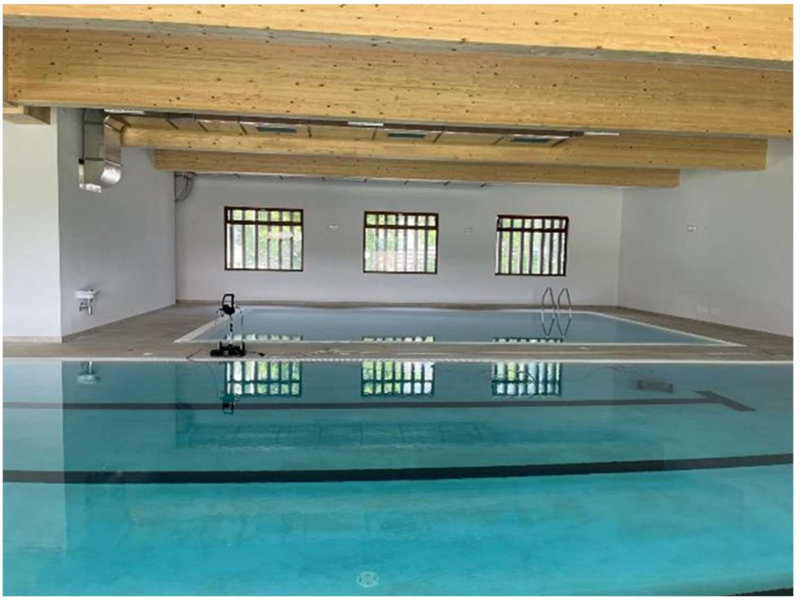

Fig. 2. Pool

2 Description of the systems

The building has a heating system, a cooling system, an air handling system and hot sanitary water system.

Thermal energy is produced through an air-condensed heat pump (Fig. 3) with power of 331 kW (heating) and 304 kW (cooling) and a high-temperature booster heat pump with power of 221 kW is used to produce domestic hot water.

Inside the structure there is also a photovoltaic system that produces the electricity necessary for the operation of the building and the heat pumps.

The energy production system, represented by the heat pump and the technological plants, has its own regulation system which manages the starting of the machines according to the temperature of the thermal accumulations represented by a 4,000 Liters water buffer for chilled water and a separated 3,000 Liters water buffer for hot water. In this way, both cooling and thermal energy will be available throughout the year, optimizing the operation of the heat pumps regardless of the building's energy demand needs.

Each subsystem (heating system, cooling system, energy production system and air handling system) has its own regulation system which optimizes its operation based on the requests of the environments to be treated or the requests for domestic hot water.

During the project phase, in agreement with the owners and the associations that manage the structure, an advanced control and monitoring system has been designed.

Through the BMS (Building Management System) interface (figure 4) it is possible to set the main parameters (temperature, humidity and air quality) and view and monitor the main operating data of the individual systems.

System errors and anomalies are reported into the same software in order to identify and resolve any problem or fault. The supervision system is also accessible remotely and can be viewed by multiple operators.

Fig. 3. Heat pump

The building is in energy class A4 (figure 4). The walls are thermally insulated with optimal transmittance values.

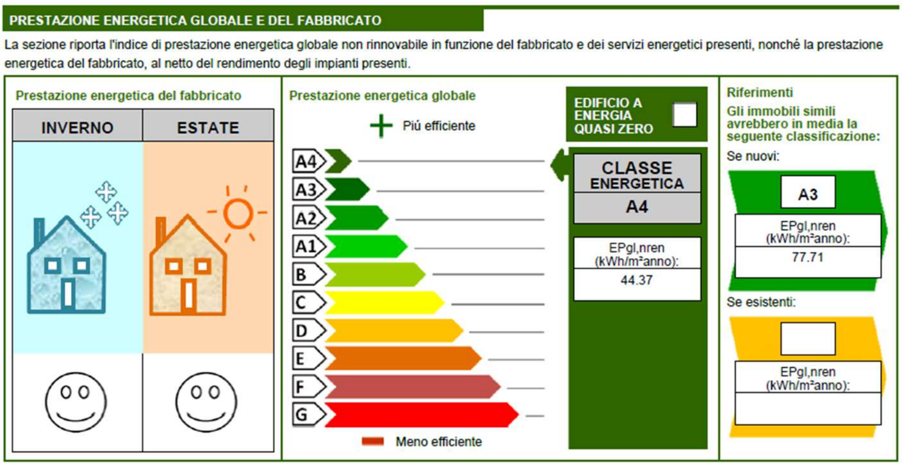

Fig. 4. Energy Performance Certificate

The Coster company, which developed the BMS with the collaboration of the suppliers of the individual components that constitute the HVAC (heating, ventilation and air conditioning) system, shares all the main parameters relating to the systems through a web server (figure 6), integrating information and functions included in third-party controllers of the various components.

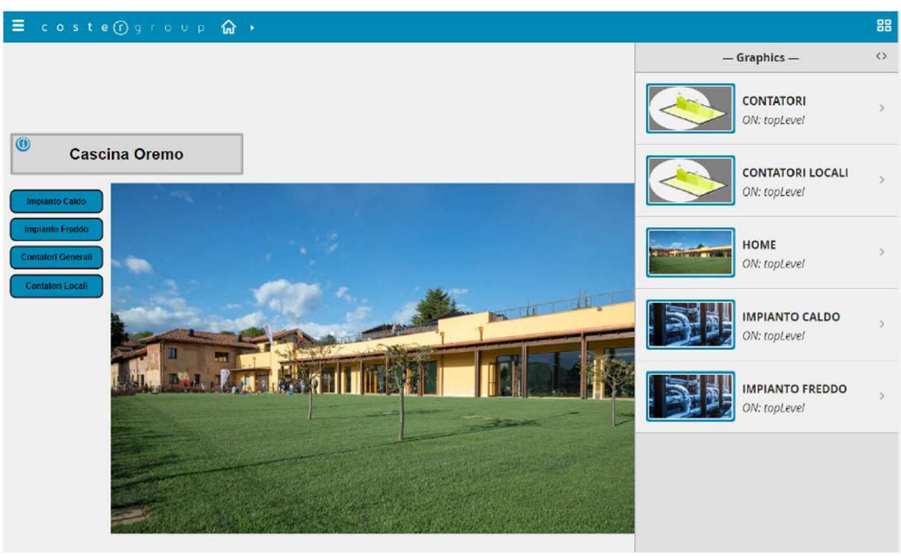

Fig.5. Entry page BMS Systems

In this way it will be possible to modify the temperatures of the individual rooms (Fig. 7) and the time slots for activation, attenuation and shutdown of the heating, cooling and ventilation services of each zone managed by each individual association. In this way it will be possible to modify the temperatures of the individual rooms and the time slots for activation, attenuation and shutdown of the heating, cooling and air exchange of each zone managed by each individual association.

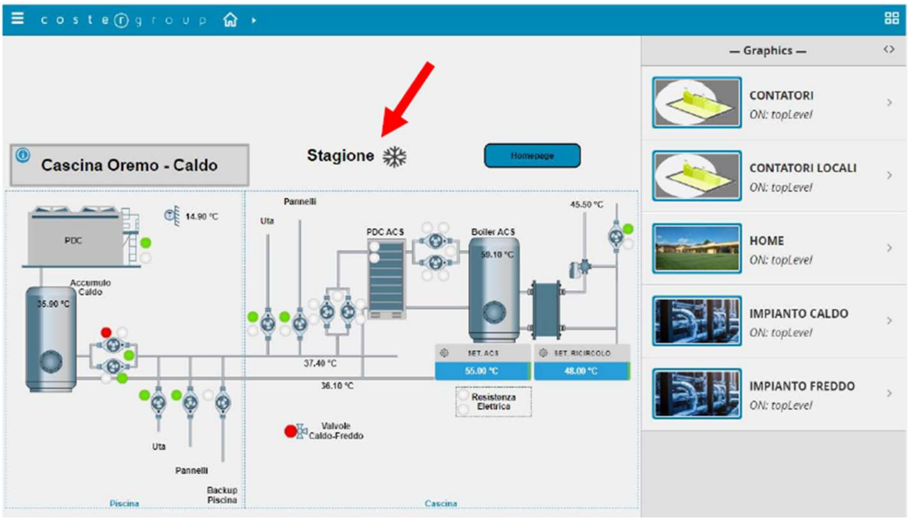

Fig.6. Graphic page Technological central control system

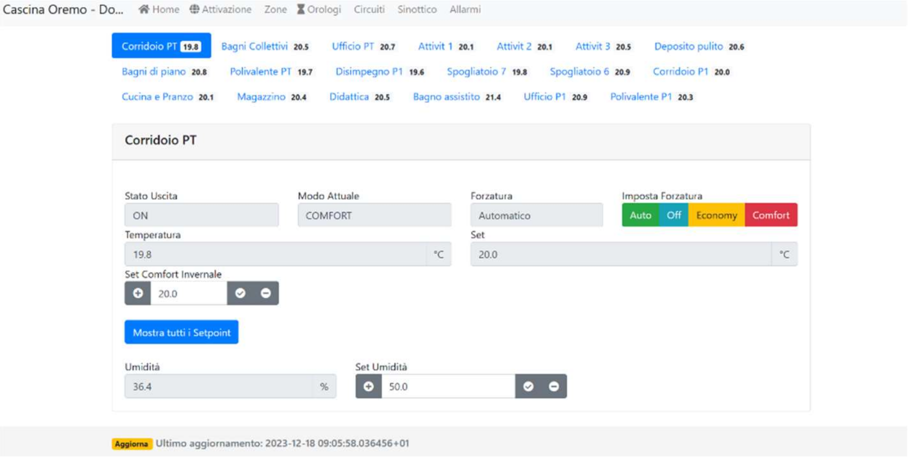

Fig.7. Graphic page Single room control system

These parameters can also be set and adjusted in the site and will be available also to the Cascina Oremo management team, the designers and the maintenance company.

The aim of the Building Management System is not only to calibrate the energy systems during the commissioning phase and to provide a remote controller for the users, but also to have a long-term monitoring with the aim of modifying their functioning during the life of the building in order to make it more energy efficient, through an optimization based on usual behaviours or a new specific fitting related to a change in the usage profile.

For this reason, the designers, in agreement with the ownership, building management and manufacturer of the systems, has decided to extend its activity also during the operation of the structure in order to monitor its energy consumption, evaluate and propose those actions that they can reduce consumption and make the activities of associations efficient and energy sustainable.

In detail, the building, which definitively entered into operation in December 2023, is equipped with thermal and electrical energy meters for each area managed by the different associations. Furthermore, energy meters have been installed for the consumption of

 https://doi.org/10.1051/e3sconf/202452306009

electricity absorbed by the heat pumps and the electrical panels of the technological power plants (heating power plant, water power plant and swimming pool power plant).

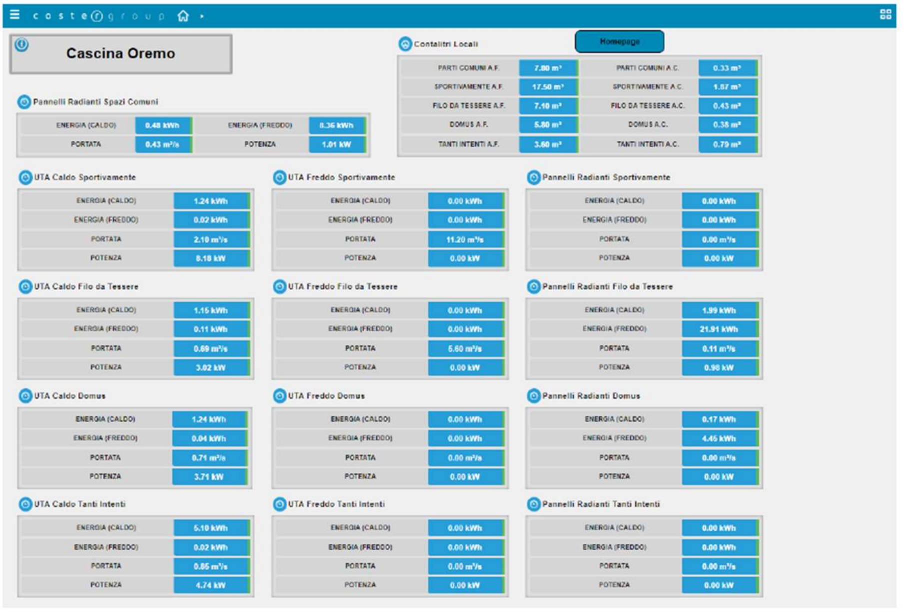

Fig. 8. Graphic page Energy metering system

The flow rates and supply and return temperatures of the air conditioning system are measured, to be able to evaluate the energy demand of each tenant for the air conditioning plants.

There is also an accounting system in the technological room that measures the primary energy produced by the heat pump, in this way by making the difference between energy produced (in heating and cooling) and energy absorbed by the tenants it will be possible to evaluate energy losses of the system. Similarly, the domestic hot water flow rates of each individual association are measured and since there is a primary energy heat meter on the booster heat pump it will also be possible to evaluate the system pressure losses for domestic hot water.

Furthermore, meters have been installed for the consumption of electricity absorbed by the heat pumps and the electrical panels of the technological power plants (heating power plant, water power plant and swimming pool power plant).

Finally, having installed meters for the electrical absorption of the two heat pumps and knowing the value of the primary energy produced, it will be possible to calculate the real time COP (Coefficient of performance) and EER (Energy Efficiency Ratio) of the individual heat pumps. The available data will be analysed and processed by the designers in the post commissioning activity to identify which users are most energy intensive and propose the actions necessary to reduce energy consumption. The energy meter systems are also effective for the purposes of allocating expenses pursuant to Legislative Decree 102/14.

3 Post-Commissioning Activities

A heterogeneous team made up of designers, property managers, association managers and the building's maintenance company, during weekly meetings, will analyse the data collected and evaluate the actions to be taken to reduce consumption. The effectiveness of these activities will then be subsequently evaluated by analysing the consumption in the following weeks.

In the meetings, it will first of all be assessed whether comfort has been satisfied within each individual environment and the necessary actions will be taken to correct any anomalies.

Consumption will be analysed by identifying which systems are most energy intensive.

If it was detected any management error it would be reported in order to correct the wrong behaviour, as incorrect temperature settings, unjustified opening of windows or turning on uninhabited system areas at full capacity.

The instant measurement of the COP and EER of the heat pumps will allow to evaluate whether they are working efficiently by comparing the real values with the factory ones.

Furthermore, by changing the temperature of the water in the puffers, it will be possible to evaluate an improvement of the efficiency of the heat pumps according to the variations of the seasons and external temperatures.

All these evaluations will be shared by the work team. It will be important to create the correct synergy between actors of different professional backgrounds who will have a common goal, that is saving energy, economic resources and minimising environmental impact of the entire site.

Through an iterative process we will try to improve the energy efficiency of the structure with the aim of guaranteeing the best comfort for users of the environments.

Considering that individual associations have different needs and times for using the spaces, through this shared procedure it will be possible to adapt the building system to the real needs of the structure, avoiding waste of energy. The analysis will be extended over an entire year in order to provide useful information for management considering the variability of external climatic conditions and the needs of the associations during their annual activity.

Particular attention will be paid to the control of the parameters to be checked during the hours or periods of inactivity of the structure through the attenuation or stopping of the thermal energy emission in the individual environments with the aim of providing the right amount of energy where it is actually required by the users.

Through the BMS regulation system it will also be possible to manage the structure even in particular and singular situations such as events or activities planned outside the normal operating hours of the structure or on days when the structure is usually closed.

4 Conclusions

Through weekly meetings, the designers and the maintenance company, collaborating with the associations, will have the opportunity to know the true needs of the structure during operation and in the same way the associations will be trained and made aware of the topic of energy consumption management. This activity will ensure that during this period the association managers will be able to develop the skills necessary to correctly operate the systems and make the necessary corrections to reduce energy consumption.

The Owner's attention to energy aspects and the desire to invest in this sharing and monitoring process will be rewarded by the possibility of having a building equipped with energy-efficient and constantly monitored systems.

Thanks to the last release of the BMS system recently installed, that is Haystack compliant, it will be possible to improve the automation and the energy optimization of the building using AI engine and the smart grid if the site will join in an energy community. During 2024 a calculation of the Smart Readiness Indicator will be finalized according to the EPBD (Energy Performance of Buildings Directive) recast 4 as this directive will be published in the EU gazette.

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