Harnessing diverse climate and weather conditions

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To make a building sustainable, taking into account its climatic conditions is key. No better examples than the three showcase buildings under the EU funded DIRECTION project. They are based in Munich, Germany and Valladolid, Spain, and a third is in planning in Bolzano, Italy. Each has to deal with very different climate conditions and yet meet the challenge of being sustainable through different means. José Luis Alfranca, who is the head of installation services at the Spanish construction company DRAGADOS, in Madrid, and one of the project partners, talks about the relevance of tailoring the buildings for variable climate and weather conditions.

How important are variable climate and weather conditions in designing energy efficient building?

We look at this issue with close attention since solutions may be very different according to the climate of the place in which the buildings are located. Energy efficiency systems need to be flexible enough to adapt to the range of different conditions. In particular, they need to combine energy storage with a rapid response to eventual changes.

What are the typical solutions being tested in the Munich showcase?

Munich, for example, has a cold, humid continental climate, with relatively mild and short summers. The projects' Munich showcase

building is very well insulated to best reduce the energy consumption for heating. It also allows making the most out of groundwater, mainly for cooling.

Air conditioning in the building is mainly provided by the energy storage system, which consists of so-called 'inertial slabs'. They are made of a water piping equipment, which acts as cooling system that is located above the concrete horizontal plates separating one floor from the other. By accumulating power in the slabs, the eventual peaks in demand become smoother.

However, the slabs have a high thermal inertia, which means that temperatures variations occur at a low rate and comfort could suffer if optimal temperature takes a while to be reached. Therefore, ventilation has also been included to provide better responsiveness. What can be done with ventilation is nevertheless very limited. Indeed, it controls indoor humidity rather than give the system the flexibility it would require.

Could you explain the different solutions implemented in Bolzano?

By comparison to Munich, Bolzano has an almost alpine climate, with many days of sunshine per year. This means there is a demand for cooling due to exposure of the building to sunlight and heat generated by the internal equipment. In parallel, cold air is also available at different times of day.

The building has areas with so-called 'all air systems' which generates cooling and heating thanks to propelled air, with free cooling—a method based on letting outside cooler air into the building. It can be used to provide quick response to temperature changes.

Besides, the building's energy storage system consists of areas of radiant floor made of pipes embedded in the floor for heating or heating-cooling.

The building also features office areas with mixed water and air systems to provide both heating and cooling. These systems consist of a radiant cooling ceiling complemented by a ventilation system. As part of the radiant cooling system, water pipes run above the ceiling so that, for example, when water temperature rises the ceiling becomes hotter than the environmental temperature. It therefore releases heat to the environment.

Compared to the radiant floor and to the framework systems used in Munich it has much lower inertia. This is because the ceiling has less mass and can therefore store less energy. So compared the other two, this system can better follow the variations in the demand and natural ventilation for cooling in summer.

How does the Valladolid building stand out?

Despite being at a more southern latitude, Valladolid has a very cold winter with little sun. It relies on a cooling radiant floor system. This type of floor allows reducing the peaks in demand in changing conditions. This building can thus take advantage of the outer air both in winter and in summer.

Again, the problem is that at certain times the system will not be able to respond quickly enough. However, in this case, problems at control level are less than in the Munich showcase. Air conditioning does not depend on the radiant floor as much as it does on the frameworks in Munich. Moreover the ventilation system, used in complement to the radiant floor to have higher reactivity, has a higher thermal capacity than in the German showcase.

Both heating and cooling of the office area come from a so-called 'closed geothermal system' consisting of heat pumps, which work using the ground as thermal focal point and does not require water. When you need to cool the building, the system extracts heat from the building and injects it to the ground through a geothermal system. Conversely, it can also extract heat from the ground and pumps it to the building.

Can we expect a more widespread uptake of such solutions in the future?

Some solutions will be easier to spread, such as the increasing thermal insulation, used in Germany. This is particularly true, in a country where there is a large energy needs in winter and high energy costs.

Some solutions are tailor-made to the location of the building. For example, so-called 'open geothermal' energy cannot be exploited where there is no water in the ground. This is the case in Munich, where water is taken from an underground current at one place and is brought back to the underground after exchaning heat. This type of solution can only be implemented with great difficulty and costs where the soil is not made of compact rocks but, say, of clay.

Overall these solutions are based to a certain extend on energy accumulation, to increase the energy efficiency of the building. And they also tend to free the building from the most severe outdoor conditions. Their objective is to try and reduce energy demand while facilitating the exploitation of renewable energies. This could be particularly attractive in countries that import most of their conventional energy and that could instead use renewable ones sources locally.

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