Optimising comfort and reducing bills for a new property in Spain

The brief

The clients were planning on building a 2-story home in the hills of the Costa Blanca in Spain. Initially the property would be used as a holiday home, but in future it would act as the couple's permanent residence.

Silvercrest was asked to recommend ways to optimise energy usage and comfort levels on the basis of the architect's drawings.

The challenges

The prevailing weather pattern of the area was used to determine year-round property behaviour. This was combined with the thermal properties of the house (expected heat loss, heat gain, and energy requirements throughout the year), based on planned building materials.

We identified the following challenges as a result:

Summer

Due to solar gain as a result of a lack of cloud cover, there would be a danger of overheating between the months of June and September. The strength of the sun on the flat roof (nearly 1 kW/m^2) between April and September was especially worth noting.

The large expanse of glazing that was planned for the property would also significantly add to the solar gain.

A fully glazed roof enclosure was planned on top of the roof. Temperatures in the enclosure could easily rise to 60°C or higher in summer.

Due to water shortages in summer the mains water supply had become expensive.

Winter

Between November and March the property would need to be heated to remain comfortable.

Solar gain as a result of the large expanse of glazing could help to provide heat, even in the cold season, but this could easily be lost at night.

An open fire was planned for the living area, to act both as a focal point and a heating source in winter. However, open fires have a very low efficiency (typically 15%). They are notorious for cooling, rather than heating a property, as drafts generated by the fire reduce the efficiency even further.

The master bedroom was planned above the terrace. As a result, the floor of this bedroom was expected to become very cold in winter.

Obligatory investment

Solar panels are obligatory for every new build in Spain. It would be a waste not to use the abundance of sunshine in this way. Solar collectors could help to provide hot water for the property or, depending on size, even help with winter heating requirements. A solution was needed that would provide the best value for money.

The recommendations

To keep the energy demand (and therefore cost) of the property as low as possible and to maximise comfort levels, several options were identified. These ranged from small layout changes in the design to extensive improvements in the operation of the property. Several options could be combined to achieve a cost optimised, comfortable home the whole year round.

Keeping summer heat and winter cold out

1. Insulation

Insulation can maintain the temperature difference between inner controlled environment and the outside. The recommendation was to have additional insulation on the roof, walls and under the master bedroom. This would reduce the heating season from 5 to 3 months in winter and decrease the risk of overheating in summer.

The easiest and most cost-effective way to prevent heat loss during the evening and night through windows would be with tight fitting lined curtains. Automatic opening/closing of the curtains as a result of inside temperature and solar glare would also be a possibility.

2. Shading

Shading of the south side of the property was already planned for. It was recommended to extend the shading on the west side of the property to reduce heat gain in the evenings.

The width of the balcony would need to be 0.6 times the height it has to provide shade for. These measurements match the balconies of traditional Spanish properties.

To prevent heat transfer from the balcony into the structure of the property, a fully wooden balcony, would provide the necessary shade without the heat transfer problems of a fully concrete/stone one.

Optimising the inside temperature

3. Under-floor heating

With the reduced heat demand in winter due to better insulation, low temperature heating in the form of under floor heating would be sufficient to keep the house warm. We recommended 50-100mm insulation under the soil slab to prevent the heat escaping into the soil.

4. Ventilation in winter and summer mode

To keep moisture levels in the property low without heat loss, ventilation with heat recovery was recommended. This would make it possible to lower the heating need even further and improve cooling without the need of an air conditioning unit.

In winter warm air from the staircase to the roof would be entered into the heat recovery unit on one side. Cold external air would be sucked into the other side of the unit. The external air would be warmed by the heat exchanger using the warmth of the outgoing air before being blown into the living spaces of the house.

Normally moist warm air would be extracted from bathroom and kitchen, but considering the relatively low usage of these compared with year round occupation, it was recommended to use standard extraction fans in these rooms.

In summer, cold air could be provided from under the basement at the north side of the house. The air would be cooled down even further by passing it through an air duct laid under the soil plate at about 50cm deep. This cool air would then be used to cool the incoming air via the heat recovery unit.

5. Use of an Air to Water heat pump

A heat pump could provide heating as well as cooling in the property.

A heat pump transfers energy in the form of heat from a cooler location to a warmer location. It uses the refrigeration process and transfers low temperature energy to a refrigeration loop, compresses the refrigerant to a high temperature, and transfers this heat to the hot water and heating distribution system, or, in the summer, removes it from the home. For this project a unidirectional air source heat pump was recommended.

Heat pumps are most effective with large low temperature radiators, for example under-floor heating. For this project it was recommended to use external air in winter to preheat the hot water for the under-floor heating. The resulting cool air would be diverted back outside. In summer the heat from external air would be dumped into the water in the borehole and the resulting cool air would be used to cool the property.

6. Wood stove as storage heater

Instead of the proposed open fire a built-in woodstove was recommended.

Stoves, and especially built-in cassettes, have very high efficiency (up to 80%).

Most wood burning stoves have at least 4 kW heating capacity, whereas, when insulated properly, this property would need less than 2 kW under normal circumstances. A chimney breast would work like a storage heater, reducing the risk of overheating.

Another possibility was considered to link the woodstove with the under floor heating system. This solution would require extensive plumbing work, and would work best with water storage, maybe even in combination with the solar collectors.

7. Solar collection for hot water and space heating

Due to the amount of sun hours in winter and the relatively small heating load, solar heating of the property could be a cost effective solution for winter heating. To use solar for the heating of the property, solar panels would be necessary.

The optimum collector area and angle for this property were estimated.

The low temperature of the under-floor heating and the relatively high temperature of the external air would make it possible to use relatively cheap, medium range performance glazed collectors. If the solar collectors would also be used to provide hot water, then higher performance collectors would be recommended.

If during sunny days in winter more heat is generated than necessary, this energy could be stored. One way of storing it would be in the concrete floor slab. Another way of storing it would be in a super-insulated water tank. This buffer tank is also necessary if the solar system would be used for hot water.

Another form of solar panels are photo voltaic panels. These generate electricity instead of hot water. The disadvantage at the moment is the high cost price. However, if local and/or governmental grants are available for these systems and if the possibility exists to sell the electricity to the local grid, it might be worth to look at this option.

<u>Water preservation</u>

To preserve drinking water, rainwater and water from an on-site bore hole could be used for the toilets and the washing machine. Rainwater could be collected from the roof and poured into the same tank as the collection tank of the bore hole. Adequate filtering would be needed to stop insects such as mosquitoes entering the tank. A simple schematic of the water system was proposed.

Dual low flush toilets and showers instead of baths were recommended to reduce water usage. The use of a pressurised system is standard on the continent; this provides enough pressure for a decent shower without the need for pumps.

The possibility of purification of water from the borehole was also discussed. A reverse osmosis or UV sterilisation system would generate potable water. However, these systems need regular maintenance.