

## Key technologies in building a Passivhaus home

Discover the essential technologies for building a Passivhaus home in 2026: advanced insulation, airtightness, mechanical ventilation, high-performance windows and home automation.

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### What is a Passivhaus home and why does it need different technology?

A Passivhaus home is not built by adding layers of insulation to a conventional project. The standard requires all the building's technologies to work as an integrated system: the envelope, the ventilation, the windows and the energy generation condition one another, and the performance of the whole depends on the precise fit between all the pieces. If one fails, the others cannot compensate for it.

This system logic radically changes the way you design and build. At PAPIK Group we have proven it across more than 120 homes delivered: what distinguishes a Passivhaus from a simply well-insulated house is the coherence between decisions. Each of the technologies we describe below makes sense because it works in combination with the rest, especially in the Mediterranean context, where the main challenge is not the winter cold but the management of summer heat.

### Insulation: much more than adding centimetres

Thermal insulation is the foundation of any Passivhaus, but the choice of materials goes far beyond thickness. In a climate like the Mediterranean, where summer can be as demanding as winter, we need insulation that not only slows the transmission of heat but also provides thermal inertia and phase shift. Wood fibre, for example, delays the entry of summer heat by up to twelve hours, keeping the interior cool during the hours of peak radiation without the need for active cooling.

Aerogels represent the high-performance extreme: with a thermal conductivity up to three times lower than that of conventional insulation, they make it possible to achieve the same performance in far more compact thicknesses. They are especially valuable in retrofits or complex junctions where every centimetre counts. Expanded cork and treated sheep's wool round out a range of biomaterials that, as well as insulating, regulate indoor humidity naturally.

However, the most sophisticated material is useless if the envelope has thermal bridges. At K-Codines, one of our projects of 212 m<sup>2</sup>, we spent more time on the design of the construction details of the junctions than on the selection of the insulation. Every joint, every corner, every connection between slab and wall must be resolved for the system to work as a continuous whole.

## Airtightness: the invisible technology that changes everything

A poorly sealed envelope can lose up to 30% of its energy through uncontrolled air infiltration. That is why the Passivhaus standard requires a result below 0.6 air changes per hour (ACH) in the Blower Door pressurisation test. In our projects, we usually achieve values of between 0.3 and 0.5 ACH, well below the required threshold.

Reaching these results demands two ingredients: quality airtightness membranes and flawless execution. Today's humidity-variable membranes adjust their vapour permeability according to ambient conditions: in winter, when the indoor air is dry, they become more impermeable to prevent condensation; in summer, they open up to help the building element dry out. Combined with tapes and sealants specific to each type of junction, they guarantee the continuity of the air barrier around the entire perimeter of the building.

Airtightness, however, makes no sense on its own: it needs mechanical ventilation to guarantee the constant renewal of the indoor air. They are two sides of the same coin.

## Mechanical ventilation: clean air without losing energy

In an airtight house, controlled mechanical ventilation with heat recovery (MVHR) is not an add-on but a structural necessity. The unit extracts stale air from the kitchen, bathrooms and wet areas and introduces filtered air from outside, transferring up to 95% of the thermal energy between the two flows. The result: constantly renewed air with practically no energy cost.

At PAPIK Group we work with the Zehnder ComfoAir Q350, a unit that combines exceptional recovery efficiency with almost imperceptible sound levels. It incorporates an automatic summer bypass, which makes it possible to cool the home during summer nights by introducing fresh air directly, without passing through the recovery unit. In a Mediterranean climate, this function is as important as winter heat recovery: during the warm months, the bypass can lower the indoor temperature by several degrees by taking advantage of the night-time coolness.

The F7 and G4 filters remove pollen, fine dust and pollutants, which turns the MVHR into a health system, not just an efficiency one. Our clients with allergies notice the difference from the first day.

## High-performance windows

Windows have historically been the weak point of the thermal envelope, but in a Passivhaus they become active elements of the energy balance. Triple-layer glazing with noble gases in the cavities and selective low-emissivity treatments achieve  $U_g$  values below  $0.6 \text{ W/m}^2\text{K}$ . This means insulation comparable to that of a conventional wall.

In the Mediterranean, the selection of the glass is especially delicate. You need a solar factor (g-value) low enough to avoid summer overheating, but high enough to take advantage of passive solar gains in winter. Each orientation of the house calls for a different glass: more transparent to the south to capture winter heat, more selective to the west to curb afternoon radiation in summer.

Timber-aluminium frames combine the natural insulation of timber on the inside with the strength and low maintenance of aluminium on the outside. At K-Valld'Or, a project of 280 m<sup>2</sup>, the careful choice of windows made it possible to reduce the cooling demand by 40% compared with a standard triple-glazing solution.

## Renewable energy

One of the clearest advantages of the Passivhaus standard is that, once the energy demand has been minimised, a modest photovoltaic installation can cover practically all the residual consumption. None of our projects uses gas: aerothermal energy, with coefficients of performance (COP) above 4, handles heating, cooling and domestic hot water with minimal electrical consumption.

For storage, we opt for high-quality lead batteries, which offer proven durability and straightforward recycling. The solar surplus is managed intelligently: first it is consumed, then it is stored and, if necessary, it is returned to the grid. This sequence maximises self-consumption and reduces dependence on the external supply.

## Home automation: just enough, useful, and nothing more

Home automation in a Passivhaus should not be a catalogue of gadgets. Its role is discreet but essential: automatically controlling the solar protections according to the position of the sun, regulating the ventilation flow based on the indoor air quality, and managing photovoltaic production and consumption so that they align as much as possible.

Temperature, humidity and CO<sub>2</sub> sensors distributed throughout the home make it possible to monitor the performance of each system in real time and detect deviations before they turn into problems. This is not technology to impress, but management tools that ensure the house works as it was designed.

## Building Passivhaus is building in a different way

None of these technologies works in isolation. Insulation needs airtightness. Airtightness needs mechanical ventilation. Mechanical ventilation benefits from the window strategy. And renewables cover a demand that is only this low because the whole chain before it works. This makes integrated planning from the design phase not an ideal, but an indispensable condition.

After more than fifteen years building Passivhaus in timber, we have learned that the difference is not made by the materials: it is made by the ability to get all the systems talking to one another from the very first sketch.

The result is a home that consumes between 75% and 90% less energy than a conventional build, that keeps a stable temperature all year and that offers a much higher indoor air quality. The additional investment, which sits between 10% and 15% above the cost of conventional construction, is recovered within a few years thanks to the energy savings and to the added value of living in a healthy and comfortable environment.

