

The five Passivhaus principles

Insulation, windows, airtightness, thermal bridges and ventilation: the foundations for achieving energy consumption up to 90% lower.

What exactly is a Passivhaus home?

Passivhaus (or passive house) is a building standard developed in Germany that sets very strict energy-consumption criteria. The goal is for the home to need a minimal amount of energy to maintain indoor comfort throughout the year: $\leq 15 \text{ kWh/m}^2\text{a}$ for both heating and cooling. In practice, this means savings of between 75% and 90% compared with conventional construction.

The standard does not prescribe specific materials or solutions: it defines outcomes. To achieve them, you work with five fundamental principles that, applied together and coherently, completely transform a building's energy behaviour. At PAPIK Group we have spent more than 15 years applying them in every project, and we explain them here as we understand them: from the experience of those who put them into practice every day.

1. High-quality thermal insulation

Insulation is the first line of defence against energy losses. In a Passivhaus, the envelope (walls, roof and ground slab) incorporates insulation thicknesses far greater than those of conventional construction. While the Spanish Technical Building Code calls for thermal transmittances (U-values) of between 0.35 and $0.56 \text{ W/m}^2\text{K}$ for walls, we routinely work with values of $0.12\text{--}0.15 \text{ W/m}^2\text{K}$.

In our projects we mainly use wood fibre and mineral wool as insulation, integrated within the lightweight timber frame. In a typical PAPIK Group wall, the insulation takes up between 20 and 30 cm of total thickness, split between the structural cavity and a continuous outer layer that eliminates thermal bridges. On the K-Alzina project (180 m^2 in the Montseny), for example, we chose FSC-certified wood fibre across the whole envelope, achieving a wall U-value of $0.13 \text{ W/m}^2\text{K}$.

Unlike conventional construction, where insulation is often limited to meeting the regulatory minimums, in a Passivhaus every centimetre of insulation is calculated to maximise the efficiency of the whole system.

2. High-performance windows and doors

Windows can be responsible for up to 25% of the heat losses of a conventional home. In a Passivhaus, triple glazing with low emissivity and argon or krypton gas in the cavities is installed, combined with high-performance frames (timber, timber-aluminium or PVC with multiple chambers). The goal is to achieve a U_w value (transmittance of the complete window, including frame and glass) below $0.85 \text{ W/m}^2\text{K}$.

In our projects, typical values sit between 0.70 and $0.80 \text{ W/m}^2\text{K}$, with a solar factor (g-value) that we select according to orientation: higher on north façades to maximise light, lower on south and west façades to control solar gain in summer. The placement of the window within the wall is also critical: we position it within the insulation plane to avoid thermal bridges around the frame perimeter.

3. Airtightness

A Passivhaus home is sealed to prevent uncontrolled air infiltration. This does not mean it is a closed box: it means that air enters and leaves exclusively through the controlled mechanical ventilation system, which is incomparably more efficient than the gaps and leaks of conventional construction.

Airtightness is verified with the Blower Door test, which measures air changes per hour (ACH) at a pressure difference of 50 Pa . The Passivhaus standard requires a value below 0.6 ACH . On PAPIK Group projects, results usually sit between 0.3 and 0.5 ACH , well below the limit. We achieve these values thanks to the timber-frame building system, which allows continuous airtightness membranes to be integrated and each joint to be sealed with specific tapes during factory assembly.

Sealing is not a final step: it is a discipline applied from the very first moment of the project. Every service penetration, every wall-to-roof junction, every pipe run is planned and resolved with specific construction details.

4. Absence of thermal bridges

A thermal bridge is any point of the envelope where the thermal resistance is lower than the rest, causing localised heat losses, condensation and, often, damp and mould problems. In conventional construction, the most common thermal bridges are found at slab edges, window lintels, corners and wall-to-roof junctions.

In a Passivhaus, these critical points are carefully eliminated during the design phase. In the timber-frame system we use at PAPIK Group, the continuity of the exterior insulation is relatively straightforward to achieve: the insulation wraps the entire structure without interruption, and the junctions are resolved with specific low-conductivity components. Each construction detail is modelled with thermal simulation software (THERM or similar) to verify that the linear transmission coefficient (Ψ) is below 0.01 W/mK .

The practical result is a thermally homogeneous envelope, with no cold spots, where the interior surface temperature is uniform across every wall. This not only improves efficiency: it eliminates the radiant cold sensation that so many conventional homes suffer near their exterior walls.

5. Mechanical ventilation with heat recovery (MVHR)

The fifth principle is the one that closes the circle and makes the whole system possible. A controlled mechanical ventilation unit constantly renews the indoor air, extracting stale air from kitchens and bathrooms and introducing filtered fresh air into the main rooms. The heat recovery unit reclaims up to 90% of the thermal energy of the outgoing air to condition the incoming air.

In all our projects we install the Zehnder ComfoAir Q350, a unit with a heat-recovery rate above 90% and an electrical consumption below 40 W in normal operation. The system includes F7 filters that retain pollen, fine dust and pollutants, which makes the indoor air quality of a Passivhaus significantly better than that of any home with natural ventilation.

The result: an interior with air that is always clean, with no draughts, no energy losses and a stable relative humidity. Many of our clients with allergies or asthma report a noticeable improvement in their symptoms from the first day.

An extra point for the Mediterranean: solar protection

The Passivhaus standard was born in central Europe, where the main challenge is the winter cold. In the Mediterranean climate, the situation is different: hot summers are often the limiting factor. That is why, in our projects, solar protection is not an add-on: it is an element as important as any of the five principles.

We work with a combination of passive strategies: overhangs calculated to block the high summer sun while allowing the low winter sun to enter, adjustable external shutters, glazing with a controlled solar factor and, where possible, deciduous vegetation on south façades. At K-Codines (212 m²), the shadow study was as decisive for summer comfort as the insulation was for winter comfort.

Certification: what it involves and how it works

Passivhaus certification is awarded by the Passivhaus Institut (PHI) in Germany or its accredited bodies. The process involves detailed energy modelling with the PHPP software (Passive House Planning Package), verification of all construction details, supervision during the build and a final Blower Door test. The cost of certification usually sits between 3,000 and 5,000 €, and the process takes between 8 and 12 months from design to final certificate.

The total additional cost of a Passivhaus compared with conventional construction of similar quality sits between 10% and 15%. But that additional cost is amply recovered through energy savings (between 75% and 90% less consumption) over the life of the building.

Is Passivhaus for me?

If you are considering building a house, the question should not be "can I afford a Passivhaus?", but "can I afford not to build a Passivhaus?". The initial additional cost is offset by minimal energy bills, superior indoor comfort and long-term appreciation of the property. With 120 homes delivered, none of our clients has regretted the decision.

That said, Passivhaus is not a magic solution: it requires an experienced technical team, a rigorous design process and flawless execution. Not every builder can offer it, and choosing your partner well is as important as choosing the site well.

The five Passivhaus principles do not work in isolation: it is their integration into a coherent system that makes energy-consumption reductions of up to 90% possible. Each principle reinforces the others, and neglecting a single one can compromise the performance of the whole.