

The key technologies in building a Passivhaus home

A passive house is not a house full of machines, but a house designed with common sense where each technology solves a specific problem. We review the solutions that make it possible and the trends shaping 2026.

When people talk about a Passivhaus home, many imagine a dwelling full of machines, screens, sensors and complex systems. It is an understandable idea, because for years we have been led to believe that energy efficiency depends on adding technology. The reality, however, is almost the opposite. A well-designed passive house is not a complicated house, but a house conceived with common sense, where technology works in the background and is barely noticed.

In a Passivhaus, also known as Passive House, the key technologies are not chosen to impress, but to solve very specific problems: keeping a stable indoor temperature, ensuring good air quality and minimising energy consumption. All of this without the person living in the house having to keep an eye on complex systems or constant adjustments. This is, precisely, one of the great values of the standard.

This article gathers the latest technical, scientific and industry developments in passive house construction during 2025, with an eye on the trends that will shape sustainable Passivhaus construction in 2026. Trade fairs such as Construmat 2025 have made sustainability and energy efficiency the main axes of their programme, showing the professional world not only materials, but comprehensive solutions around insulation: process digitalisation, integration of intelligent sensors and a more holistic view of industrialised construction.

What a Passivhaus home is and why it needs a different technology

A Passivhaus home is a dwelling designed to reduce energy demand to a minimum. Before thinking about how to heat or cool the house, the project focuses on preventing heat from escaping in winter or entering excessively in summer. It is a radical shift in approach compared with conventional construction.

In a traditional home, comfort is achieved through active systems: powerful boilers, air conditioning, radiators, split units. In a passive house, by contrast, comfort is achieved mainly thanks to the design and the building envelope. Technology comes into play to support that design, not to correct its mistakes.

That is why, when we talk about key technologies in building a Passivhaus home, we are not talking only about machines, but also about constructive solutions, materials and systems that work together. Everything is connected, and if one piece fails, the whole loses its meaning.

Insulation: much more than adding centimetres

Thermal insulation is one of the foundations of any passive house, but today it is no longer understood as a simple matter of thickness. In current Passivhaus construction, insulation is designed taking into account how the house behaves throughout the year, its inertia, how it interacts with the structure and how it responds to real conditions of use.

In passive houses with a timber frame, materials such as wood fibre or blown cellulose are commonly used. They not only insulate well, but also provide thermal inertia, regulate humidity and offer a sustainable constructive solution. The result is more stable interiors, both in winter and in summer. Moreover, insulation must be continuous: a very good material is useless if thermal bridges then appear at poorly resolved junctions, columns, floor slabs or window openings. Here the technology is not in the product, but in the constructive detail and in the way the work is carried out.

Aerogels and high-end materials

At the base of this evolution are materials that not long ago we only saw in laboratories or specialised fairs. Aerogels are increasingly emerging as the great protagonist of high-end insulation. Extremely light and with a surprisingly low thermal conductivity, they offer a performance that in many cases can surpass traditional materials at a fraction of the thickness. This property is especially valuable when the space for insulation is limited, as happens in energy retrofits or on the facades of existing buildings where no habitable surface should be lost.

What has captured attention in the European context, in research presented at events such as BAU 2025, are aerogels made from residual wood. Researchers at Fraunhofer WKI have developed procedures to manufacture aerogels using wood waste as raw material, generating a product that keeps the exceptional technical properties of an aerogel and that, at the same time, is recyclable and much more sustainable from a carbon footprint point of view. The project also works so that the material can be recycled with high quality once it reaches the end of its useful life, a key piece for a true circular economy in construction.

The race for bio-based materials does not stop here. Sector and market studies point to natural fibres such as cellulose, wood fibres, hemp or wool, as well as composite solutions incorporating fungal mycelium, as promising alternatives to petrochemical-based products. These materials have a much lower environmental impact and, in many cases, incorporate additional benefits: greater humidity absorption capacity, better indoor air quality and a reduction of pollutants.

Airtightness: the invisible technology that changes everything

If there is one concept that marks the difference between a house that is efficient on paper and a house that is efficient in reality, it is airtightness. A Passivhaus home is a dwelling that is practically airtight, and this is not a technical whim, but an indispensable condition for everything else to work.

In a conventional home, air leaks through gaps, shutter boxes, poorly sealed junctions or installations. These infiltrations cause constant energy losses and make it impossible to control the thermal behaviour of the house. In a passive house, by contrast, the passage of air is fully controlled.

This is achieved through airtight membranes, specific sealing tapes and extremely careful execution. It is a technology that cannot be seen once the house is finished, but which determines real consumption, indoor comfort and the durability of the structure, especially when it comes to timber construction. The well-known Blower Door test is not a final formality, but a control tool during the work: it serves to detect errors while they can still be corrected, not to disguise results at the end.

Mechanical ventilation: clean air without losing energy

An airtight house needs to be ventilated, but doing so by constantly opening windows goes against the very concept of energy efficiency. That is why one of the key technologies in a Passivhaus home is mechanical ventilation with heat recovery.

This system renews the indoor air continuously and in a controlled way, extracting stale air from kitchens and bathrooms and introducing clean air into the main rooms. Before expelling the air outside, the system recovers most of its thermal energy to pre-heat or pre-cool the incoming air. The result is excellent indoor air quality, without draughts, without noise and without energy losses. In many passive houses, enthalpy recovery units are also used to help regulate humidity, an aspect especially important in dry or very humid climates. Well designed, mechanical ventilation becomes an almost invisible system for those living in the house, with an enormous impact on comfort and health.

High-performance windows: where everything is won or lost

Windows are one of the most critical points in building a Passivhaus home. Triple glazing alone is not enough; they must be part of a complete system that takes into account the frame, the glass, the orientation and, above all, the way they are installed. A good window badly fitted can turn into an energy hole. That is why, in Passivhaus, windows are installed in the plane of the insulation, carefully sealed and designed taking into account solar gain in winter and protection against overheating in summer. When all this is done well, they stop being a weak point and become an active element of indoor comfort.

At the REBUILD 2025 fair, the startup INDRESMAT received Passivhaus certification for a window solution using biopolyurethane materials, showing that improvement is not limited to insulation alone, but extends to key envelope components that contribute directly to energy savings and indoor wellbeing. Last year consolidated a clear move towards recycled or low-carbon frame materials, a trend that seems set to continue in 2026. Manufacturers are incorporating extrusion with recycled aluminium and formulas with transparent LCA (Life Cycle Assessment) so that the buyer can know not only the thermal efficiency, but also the ecological footprint of the window being installed.

This approach represents a qualitative leap: windows are no longer defined only by U-values or by the insulation of the glazing, but by the complete environmental balance of the product. It fits perfectly with the Eskimohaus philosophy, sustainable, very high energy-efficiency homes built with a timber frame.

Dynamic glass and new research

In parallel, scientific research has advanced in smart glass, dynamic glazing capable of adjusting optical and technical properties according to external conditions. This type of technology allows the window to be not just a passive element, but a device that responds to light, heat and indoor needs. A particularly relevant development is the research on transparent, highly insulating bionic hydrogels that can block UV and infrared radiation while maintaining high visible-light transmission, which, in theory, could provide up to 11 °C of sustained thermal difference compared with conventional windows. Combined with electronically adjustable glass, capable of decreasing or increasing heat transmission, it offers a new horizon where the window becomes an adaptable climatic interface for the building.

Renewable energy: simple, coherent and well sized

One of the most notable trends of 2025 has been the commitment to storing energy in an economical and flexible way. Traditionally, lithium batteries had been the predominant tool for managing the intermittency of photovoltaics or wind, but now long-duration storage projects (LDES) and alternatives such as thermal or hydrogen systems are establishing themselves as solutions for periods of days or weeks without sun or wind. This change represents a new view of the interaction between high-efficiency buildings and energy grids: not only consumers, but flexible actors that provide stability to the overall system.

We have not yet reached the tipping point where energy storage is economical enough to represent an attractive investment. Little by little, new technologies and cost reductions bring closer the moment when investing in batteries will be profitable. Many scientific advances still have to be transformed into solutions available on the market, and perhaps 2026 will be the year that tipping point is reached and the cost of batteries begins to be profitable. In a passive house, renewable energy works because the building is already efficient by design. It is not used to compensate for mistakes, but to close the circle of a truly sustainable dwelling, which is why it is the perfect complement to reduce the energy bill to zero.

Home automation: only what is useful, and made to measure

2025 has made evident profound changes in home automation for building high-efficiency dwellings: technology has moved from a set of connected devices to an interconnected, intelligent and predictive ecosystem. The arrival of the Matter standard has made it easier for diverse sensors, controllers and actuators to speak a common language, overcoming the traditional compatibility problems between brands and protocols.

At the same time, the integration of local artificial intelligence and energy prediction has allowed automations to be not only reactive, but to learn from the behaviour of occupants and optimise efforts to reduce consumption, improving comfort and efficiency. Devices such as local AI hubs and thermostats with machine learning exemplify this leap. Finally, the convergence between open platforms such as Home Assistant and integrated physical interfaces offers centralised and contextualised control of all the systems in the home, with privacy and data sovereignty as a priority.

Home automation is beginning to offer solutions for all kinds of people, both those who do not want to have to touch buttons and settings and those who want to manage and control everything. In any case, the comfort of the house can be increased by automating installations of all kinds, from climate control to solar shading. All of this not only makes the adoption of home automation easier, but turns the dwelling into an active agent of energy optimisation.

Building Passivhaus homes means building in a different way

Building a Passivhaus home is not about adding up technologies, but about integrating them coherently. It is a way of building that demands more planning, more precision and more knowledge, but that offers far superior results in the long term. At PAPIK Group we have been applying these technologies for years in timber-frame houses, demonstrating that it is possible to build comfortable, healthy homes with no energy mortgage. Houses designed to last, to adapt to the climate and to make life easier for those who live in them.

If you are thinking about building a passive house, technology is important, but knowing how and why to use it is even more so. You can request an [indicative estimate](#) to start shaping the project.

A well-built passive house does not fill up with technology: it integrates it until it is barely noticed. Real comfort is born from the design and the envelope, and technology only closes the circle.