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25 years of the first Passivhaus: how the Darmstadt building founded the high-efficiency standard

A quarter of a century after the first Passivhaus in history, built in Darmstadt, we revisit how a standard that now defines high-efficiency construction came to be.

Twenty-five years ago, physicist Wolfgang Feist built the first Passivhaus in history in Darmstadt, Germany. To mark the anniversary, the Passivhaus Institute published an interview by Katrin Krämer, the institute's head of press, with its driving force, to find out how it all began. PAPIK Group gathers the essentials here, because that prototype is the direct origin of the standard we build to today.

The origins: why we produced so much energy

The project was born in a very different context from today's. By the 1970s it was already clear that the fossil fuel era was drawing to a close and that the central problem of this form of energy was carbon dioxide emissions. Even so, the emphasis of those years fell on replacing fossil fuels with nuclear alternatives, and few scientists, such as Klaus Traube, had rigorously assessed the risks of fission.

Feist recalls a generation of pioneers working the same question from different disciplines: William Shurcliff, Arthur Rosenfeld and Amory Lovins in the United States, Harold Orr in Canada, Vagn Korsgaard and Joergen Noergard in Denmark, and Bo Adamson and Arne Elmroth in Sweden. Rather than seeking new sources, they decided to tackle the problem at its root and analyse why such enormous quantities of fuel were being used. The finding was striking: most modern energy consumption went to heating buildings, more than a third of the total. For a physicist, the implication was clear. The room for improvement was vast, and it was only a matter of working out how to implement it, focusing on heating systems, heat distribution, windows, roofs and ventilation.

From Lund to Darmstadt: the origin of the "passive house"

The underlying idea emerged from a conversation with Bo Adamson around 1987 in Lund, Sweden. Adamson had just returned from a research trip to southern China, where he had worked on improving the comfort of unheated houses, and referred to them as "passive houses": buildings that work passively in thermal terms, which also simplifies the scientific analysis. The two decided to investigate whether such buildings could work in Europe, with far colder winters.

That intuition led to a research project preceding the construction of passive houses. The team studied every conceivable variant and, on paper, the concept appeared to hold. Having a reliable theoretical procedure to describe the thermal behaviour of buildings proved decisive: without that calculation base, the prototype would not have been possible.

The Darmstadt prototype

The city of Darmstadt had plots reserved for experimental housing construction, promoted by the State of Hesse research institute and the Institute for Housing and Environment (IWU). At the request of the mayor at the time, Günther Metzger, and thanks to a series of coincidences, that became the project's site. The city offered the land under long-term lease, with a long list of applicants and preferential access for low-income families.

Bringing co-owners together was not easy. Only when the promoting team decided to press ahead on its own did three families come forward, families who did not know one another and had very different professions. The support of Rasch & Partner and of architects Bott, Ridder and Westermeyer was decisive in avoiding the usual obstacles of collective self-build. The IWU covered the complementary research and the State of Hesse Ministry of Economy provided funding. To document the building's performance, hundreds of sensors were buried, a far more laborious task than today: with no wifi, hundreds of cables had to be laid correctly.

Building with what existed, and making what did not

One strategic decision shaped the whole design: a promising concept could not stray too far from usual construction methods, dominated by small and medium-sized firms. So the team chose to simplify rather than complicate, drawing on existing components such as sandstone masonry walls, a beam roof and wooden windows. The construction had to be reproducible, not exotic.

Some elements, however, did not yet exist on the market. High-efficiency triple glazing was the clearest example. Feist recalls a 1989 conversation with Dr. Ortmanns, head of research at Vegla (today Saint-Gobain), who agreed to supply panes with a specific coating for the project. It was not always so easy: obtaining thermal spacers took years, until the industry recognised the opportunities. Other parts had to be made in the laboratory itself, such as modifying the four central ventilation units, fitted with custom-developed direct-current fans and an air-quality control. The joinery trades responded especially quickly: specialists expanded their expertise and offered substantially optimised solutions, such as the careful placement of airtight membranes, without a single fold, following passive house principles.

Costs, subsidy and community life

The standard version followed a progressive scale: clients could order and pay for extras such as a custom kitchen or a particular parquet, but the four homes shared an identical structural quality, and all still meet the criteria of the current Passivhaus standard. The extra cost of the time, still considerable, amounted to some 90,000 German marks per home, of which the State of Hesse Ministry of Economy covered a 50% subsidy. Feist compares it to the first scientific pocket calculators, which cost around 2,000 marks: once their effectiveness was proven, the price fell sharply.

Life within the development also left lessons. The co-owners formed an association centred on comfort and trialled the shared use of resources, such as a laundry and drying room inspired by the Swedish model. The idea did not quite take hold, probably because of the growing tendency towards individualisation. In the first two years, the building received some 5,000 visitors, a volume that eventually made it necessary to limit visits, always taking care to anonymise the data and preserve the residents' privacy.

Twenty-five years on

With the benefit of hindsight, Feist notes what he would do differently today. He would tilt the sloped roof slightly to the south to make use of more advanced photovoltaics, use the certified Passivhaus elements now available on the market, almost 50% better than the hand-made solutions, especially the windows, simplify the ventilation still further and add heat pumps. He would build a Passivhaus again without hesitation: the success is proven in constantly clean air, stable indoor comfort and negligible heating costs. At the time, some colleagues published theoretical papers arguing that the concept would never work; the results proved them wrong.

The Passivhaus standard today

Passivhaus belongs to a tradition that has been evolving for more than a century. Heat losses from external components have fallen progressively from around 1.5 W/m²K to about 0.15 W/m²K in passive buildings, a tenth of the original. As early as 1980, Sweden had a building code equivalent to the German benchmark regulation, with a consumption of around 7 litres of fuel per square metre per year. The Passivhaus standard is its logical development: reducing losses through walls, roofs and windows to the point where the heating system becomes irrelevant. It is the same principle that guides our work, both in new build and in energy retrofit.

The advice Feist offered to anyone wanting to build a passive house still holds:

- Plan rigorously. A complete PHPP calculation (Passive House Planning Package) and certified planning are needed, ensuring that everything works as it should once built.
- Do not be persuaded that passive elements are expensive. Today they are reasonably priced, and a well-planned passive house is not much more expensive than a conventional one.
- Choose a simple, certified ventilation system, with high-quality air filters for health reasons.
- Attend to the PHPP summer comfort calculation, with ever-hotter summers in mind.

> Feist closed the interview quoting astrophysicist Carl Sagan: "We are a way for the Cosmos to know itself." That first Darmstadt prototype was not merely a technical exercise, but a way of taking responsibility for how we inhabit the planet.