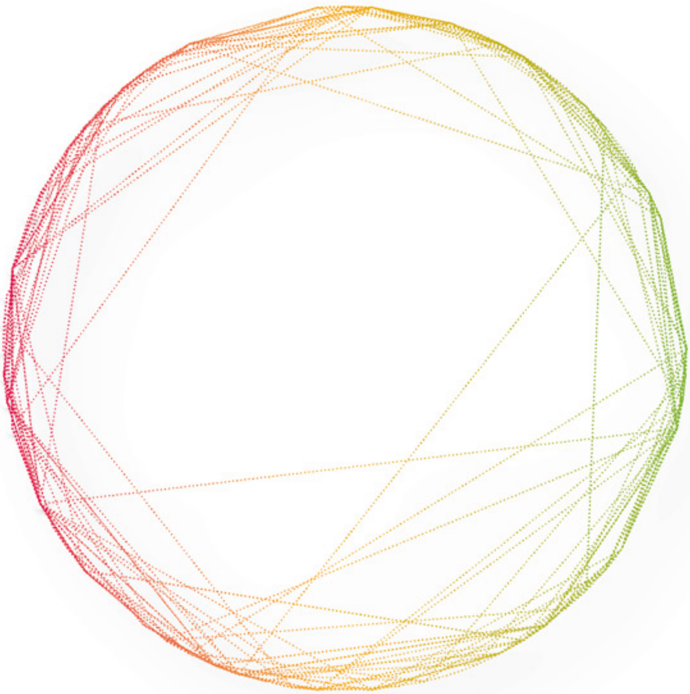
Global Dwelling

Intertwining Research, Community Participation and Pedagogy



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Passive Design

EDGARS BONDARS

Regardless of the part of the globe in which a dwelling might be located, one of its key functions is to protect dwellers from climate conditions. Due to innovations brought about by the Industrial Revolution in the 19th century and thanks to the rapid development of HVAC systems, buildings in the first half of the 20th century became more technically sophisticated than ever before. Indoor climate in buildings was typically regulated by advanced building systems, which actively used energy for heating or cooling purposes. However, in the second half of the last century our societies began to face a number of global economic and ecological problems, including the 1970s oil crisis and the environmental pollution created by the burning of fossil fuels. The building industry began to look for other solutions in line with the greater sensibility to sustainability. The aim was to provide a comfortable indoor climate primarily by taking advantage of the physical properties of building materials and secondly through improvements in building design (Olgyay & Olgyay, 1963; Burberry, 1978; Szokolay, 1986). Such solutions became known as *passive design*. Then, active energy-consuming engineering systems became a secondary component in ensuring the building indoor climate.

The goals of a passive design can be summarised as follows. The first goal is to minimise heat losses. This can be achieved by creating a well-insulated building shell and applying airtight measures to prevent the uncontrollable air exchange between indoor and outdoor spaces, as well as by making the building form as compact as possible (i.e., building surface-to-volume ratio must be as low as possible). Heated areas of a building must be separated from unheated ones (e.g., staircases, garages, etc.) in order to diminish thermal bridges. The second goal of a passive design is to maximise solar heat gains during the winter by increasing south-facing glazing areas and reducing north-facing ones. This is carried out by sizing and arranging windows according to solar angles, thus avoiding shadows created by nearby buildings or vegetation. The third goal is to ensure a consistent indoor climate by using building materials with a high thermal capacity in order to minimise temperature fluctuations, thus providing the necessary window shading (e.g., by means of overhangs and blinds) to avoid overheating in the summertime, and to buffer humidity by applying absorbent indoor materials.

The concepts of *passive design* and *passive house* are not quite the same. Passive design is meant to be a set of design principles and methods that can be used to design any energy-efficient building, without necessarily having to reach the passive house standard. The application of passive design measures enables designers to obtain significant energy savings during the lifespan of the building. The effectiveness of these measures can be significantly improved with building energy performance calculations (using, for instance, the software PHPP—Passive House Planning Package at the building design stage), which help designers comply with the energy-efficiency requirements of a passive house, that is, of a building without a conventional heating system (Feist, 2013).The challenge for architects, however, is to balance the aesthetical, technological and ecological criteria and translate them into a contemporary architectural language.

RELATED CASES

Lielkalni. Energy-Efficient Building in Ģipka, Latvia

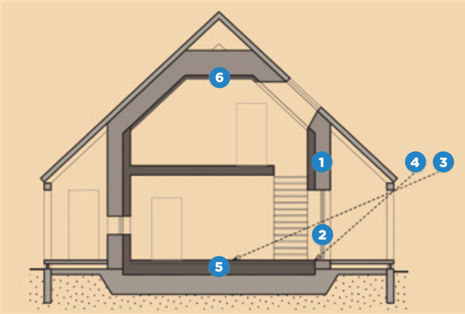
Architect: Ervins Krauklis

The design of this residential building located in a temperate continental climate reflects some features of the local architectural traditions in the form, proportions and sloped roofs. It is a an energy-efficient, highly-insulated building with an airtight shell. Its main features can be seen in the cross-section: **(1)** prevents heat losses, **(2, 3)** large south-facing windows ensure solar heat gains in winter when the sun is at a low angle, **(4)** it has large overhangs to prevent overheating in summer when the sun is at a high angle, **(5)** materials with high thermal mass are used in floors and walls to absorb and later release the heat energy, and **(6)** moisture absorbing materials are used in the ceiling to help to keep the indoor relative humidity constant.

Load-bearing exterior walls consisted of lightweight ceramsite concrete blocks, while the roof structure was built of nail plate timber trusses. Glass wool was the main insulation material for the walls and for the roof. The building's annual energy demand is 26 kWh/m² (not reaching the passive house standard which is 15 kWh/m²), while construction costs were 1,520 €/m².

LIELKALNI BUILDING: WEST FACADE

CROSS SECTION



Lielkalni, energy-efficient building in Ģipka, Latvia (2010). Source: Edgars Bondars

Ezernieki. Passive House in Jaunmārupe, Latvia

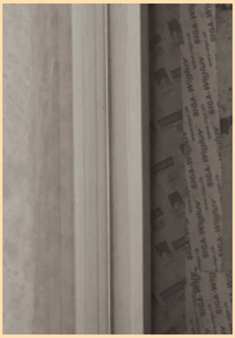
Architect: Ervins Krauklis

This single-family residential building has small windows on the northern facade to diminish heat loss. The heated residential part **(1)** is compact to ensure the best area-to-volume ratio in order to minimise heat loss through the building shell. The unheated parts, like the garage and auxiliary rooms **(2)**, and the covered terrace **(3)** are integrated in the mass of the building, but at the same time, they are thermally separated from its heated core. The large southern glazed area provides enough light and energy and the movable shades prevent the room overheating during the summertime. Sealing tapes on all structural joints ensure the airtightness of the building. The structural system is made of a laminated timber frame, filled with insulation. The specific annual energy demand for heating is 14 kWh/m² (reaching the passive house standard), while construction costs are 1,000 €/m²).

"EZERNIEKI" BUILDING: NORTH FACADE

SOUTHERN GLAZING

SEALED JOINTS



Ezernieki, passive house in Jaunmārupe, Latvia (2016). Source: Edgars Bondars

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