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The Passive House technology – a solution to the global problem of space heating

1. Introduction

In 1997/98, Drexel und Weiss developed the world's first compact unit for passive houses. Since 1997, house technology systems for passive and lowest-energy houses have also been planned and implemented. In this time, over 300 systems have been created, the qualitative and quantitative results of which provide a clear picture of Passive House technology.

Although the name Drexel und Weiss is mainly connected with the aerosmart compact unit, the aerosmart family actually contains six different models which can be used to run all current house technology systems based on living space ventilation. Drexel und Weiss are now globally recognised pioneers and frontrunners in the field of Passive House technology.

2. The starting situation

The world population is constantly growing – and with it, so is energy consumption. 85 million barrels of heating oil are needed every day. This is the same number of barrels as there are people in Germany. Peak Oil is predicted for 2013, which is when more oil will be needed than can be supplied.

What are the consequences of this? Energy is a contentious issue. Therefore, we must make it our aim to move away from fossil fuels. In 2009, Putin informed us that the age of cheap natural gas is over. The global climate is also changing – resulting in dramatic natural disasters with long-term consequences.

3. What can be done about this today?

In all regions of the world, we should simply follow the example of our ancestors. They all had one thing in common: compact building designs.

The Mongolians didn't make their yurts in the shape of a hemisphere for nothing! Nor the Inuits, who continue to live comfortably in their igloos at extremely low temperatures. Another example is, of course, the impressively compact farmhouses of the Bregenzwald area of Austria.

It was not until the age of fossil fuels that differently shaped houses with maximised surface area became possible. Energy consumption without measure or purpose. It soon became clear that the passive house, with its compact envelope, significantly reduces heat loss

through the building's surfaces. Think of a glove with fingers: how quickly your hand gets cold when the wind blows through your fingers. It's quite different with a mitten, which has a very small surface area compared to a glove with fingers. The positive effect of this? Your fingers stay warm. A passive house works on exactly the same principle.

4. What can be improved and optimised in this way?

In a passive house, ventilation heat losses are around 70%, so the demands made of an intelligent house technology system are clear to see.

Minimising loss is the key idea. If the building envelope and the house technology were previously two separate sections, it is clear that comfort ventilation with heat recovery must be a fixed component of the building.

5. What tasks does automatic comfort ventilation fulfil?

Originally, the focus was on energy efficiency, but today, more importance is placed on comfort. In addition to the large energy saving and loss minimisation potential, the avoidance of damage caused by damp thanks to the sealed building envelope and the lack of pollutants in internal air are also important factors.

It was George Bernard Shaw who observed: "Marriage is an alliance entered into by a man who can't sleep with the window shut, and a woman who can't sleep with the window open". CO₂ contamination in internal areas causes stuffy, unpleasant air, which provokes us to provide ventilation. In bedrooms, there can be values of up to 5000 ppm, and in school classrooms, this can be as high as 7000 ppm. CO₂ is not a poisonous gas, but it makes us tired and, in high concentrations, can be associated with sickness patterns such as headaches or nausea.

The increasingly sealed design demands comfort ventilation with heat recovery. This is because the humidity generated inside a house (for example, from showers, baths, cooking and plants) slowly, but surely damages the building envelope.

6. Features of automatic comfort ventilation

The heat provision level of the heat exchanger is just one part of the complex relationship. The electricity efficiency of the fans, the sealing of the units, the type of frost protection, the filter quality and the size of the unit are other important factors. Here it is important to focus more on the electricity efficiency ratio and less on the heat recovery level.

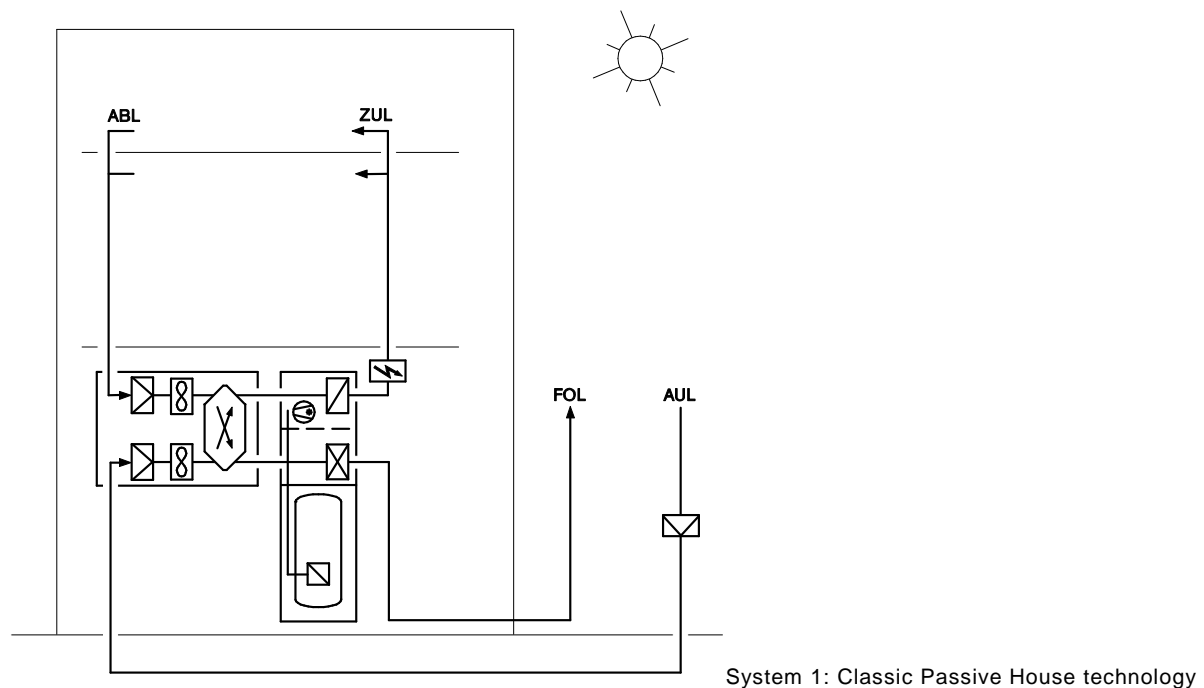
But even if all energy requirements are fulfilled, this does not necessarily mean that the ventilation device is marketable. Ultimately, acoustics are the deciding factor, because if the ventilation can be heard, then it is not suitable. Here, experience has shown that there are very few devices, only three in the whole of Europe, that fulfil the acoustic requirements.

7. Classic Passive House technology - short description of the compact unit

The passive house is not a house without heating, but rather a house which, thanks to the low heating load of max. 10 W/m^2 , can be heated using the existing comfort ventilation and supply air. There is then absolutely no need for an active heating system.

The compact aerosmart unit (s, m, l, mono) combines all the tasks of Passive House technology in a single device: ventilation, heat recovery, heating and domestic water preparation. In this process, energy efficiency and providing the highest possible standards of living comfort take priority. The device is equipped with DC fans, the electricity efficiency of which is within the level (0.4 W per m^3/h conveyed) set by the Passive House Institute. The cross counter-flow plate exchanger gives a heat provision level of approx. 80%. The heat pump (seasonal performance factor approx. 3.2) extracts the sensitive and latent residual heat from the exhaust air and feeds it to the supply air or domestic water via two condensers. Small electrical "emergency heaters" are installed in the central living area, which do not contribute more than 5% to the total energy consumption.

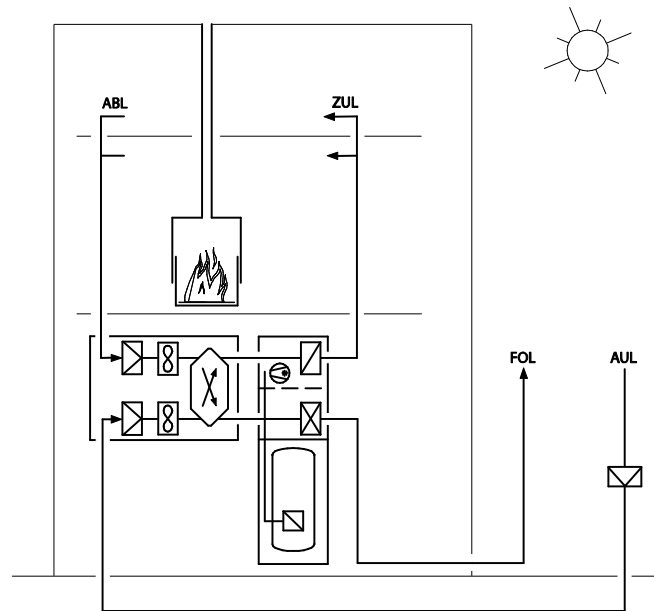
The fact that the leakage is well below the limit value of 5% (at 100 Pa differential pressure) ensures impeccable hygiene. Integrated silencers can keep the sound power level at the connections and the sound pressure level on the casing at around 40 dB(A), which minimises expenditure on external silencers and helps prevent the system from being noisy.



8. Comparison with modular house technology systems

In 2002, the Fraunhofer-Institut ISE (Freiburg, Germany) demonstrated that modular systems use considerably more energy than compact units. The reason for this is that the components do not communicate with one another and there are relatively large downtime, distribution and

readiness losses. In measurements taken in around 70 buildings, modular systems consumed on average 82% more energy.



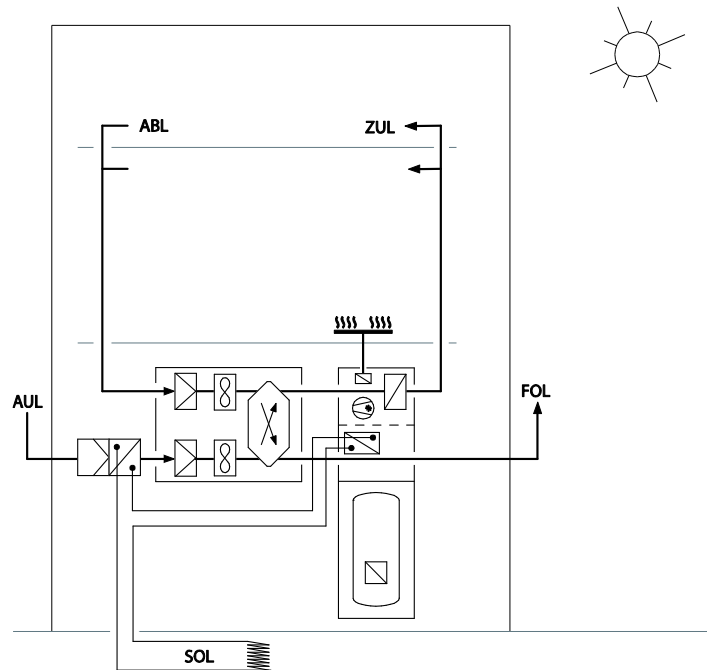
System 3: Passive House technology meets

romanticism

9. Experiences and reactions

In the rapidly growing passive house sector, it is the case that fresh air heating has not been found to be sufficient for all residents. The range of customers has broadened and the requirements of different locations demanded an additional solution. The aerosmart xls range of compact units was, therefore, developed for this purpose. This range uses a brine ground source heat exchanger to access the energy potential in the ground. This provides the heat pump with greater potential, which in turn results in an increased heating output of 2500 W.

In this way, the energy efficiency needs of virtually all customers can be met. In this solution, up to around 30% of the heat is supplied via the supply air and up to 70% via a low-temperature heating circuit. Priority is given to hot water.



System 2: Expanded Passive House

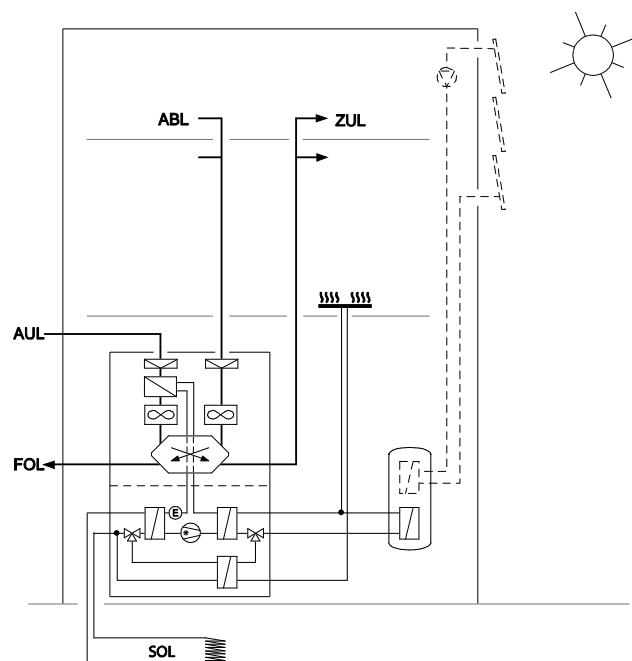
technology

10. The road to the passive house

Never before has a building standard developed so quickly and successfully as the passive house. Nevertheless, the fact remains that people need time to catch up with technological developments. Highly efficient low-energy houses are the next logical step on this road. But large passive houses such as the Austria House in Whistler should also be able to make use of the advantages offered by the compact unit technology. This has led to the development of a further addition to the compact unit segment, the aerosmart x².

This technology also employs geothermal power as an energy source. As passive houses are now spreading to all parts of Europe, requirements have also increased. Greater heating output and cooling in summer are the most important factors here. This new development, like the entire family of compact units, features a genuinely unique selling point. Heating, ventilation, heat recovery, bath heating, passive cooling, partially solar room heating if desired, solar power – all controlled by one "brain".

Thanks to this technology, builders are able to move towards the passive house building standard whilst allaying fears that houses will be too cold. In this solution, the room heating is provided exclusively via a static heating system (floor or wall heating). Hot water can be provided from either a 300, 560 or 820 litre tank. The two larger tanks can also be additionally heated via thermal solar collectors.



System 5: Passive House technology for all

11. The passive house in large-scale multistorey constructions

The largest primary energy savings can undoubtedly be found in large-scale constructions. Passive House technology has also been developed for this type of building and, like all the previously mentioned solutions, is based on the principle of minimising loss. The semi-central Passive House technology produces heat where it is needed, "just in time".

12. Investment costs

Passive house design 1 can be implemented in an average family home for approx. EUR 21,000 plus VAT. Passive house system 2 would generally cost about EUR 27,000 to implement in a family home. Passive house design 5 provides the highest levels of comfort and luxury. However, this requires investment of around EUR 32,000 plus VAT.

13. Energy consumption, operating costs

Of course, heat requirements of a passive house are not influenced by the type of house technology. The role of heat distribution losses, however, is highly variable. Passive house designs 1, 2 and 5, therefore, enable heat to be provided with virtually no loss.

In a conventional family home, energy consumption is strongly dependent on usage. Experience has shown that in a 130 m² house, energy consumption is between 1200 and 2500 kWh/a.

14. Summary and outlook

As the compact unit has impressively demonstrated its strengths in detached family houses, we are now also experiencing a strong trend towards decentralisation in terms of greater numbers of units. The reasons for this can be seen, on the one hand, in a simpler, easy to

understand design, which brings qualitative benefits to both builder and resident. On the other hand, the problem of relatively high heat distribution losses in central systems plays a significant role: 1000 kWh was previously only 10% of the thermal heat requirement of a family home; today it is around 50%.

The passive house is state of the art technology and can currently be considered a solution to the global problem of space heating. Only implementing individual components of Passive House technology would be like considering a mountain climb to be successfully completed once the peak has been reached. In fact, the mountain climber is only successful once he has safely completed his descent.

We are implementing the "state of the art" building standard – there is no time to lose!