First Steps: What Can be a Passive House in Your Region with Your Climate?

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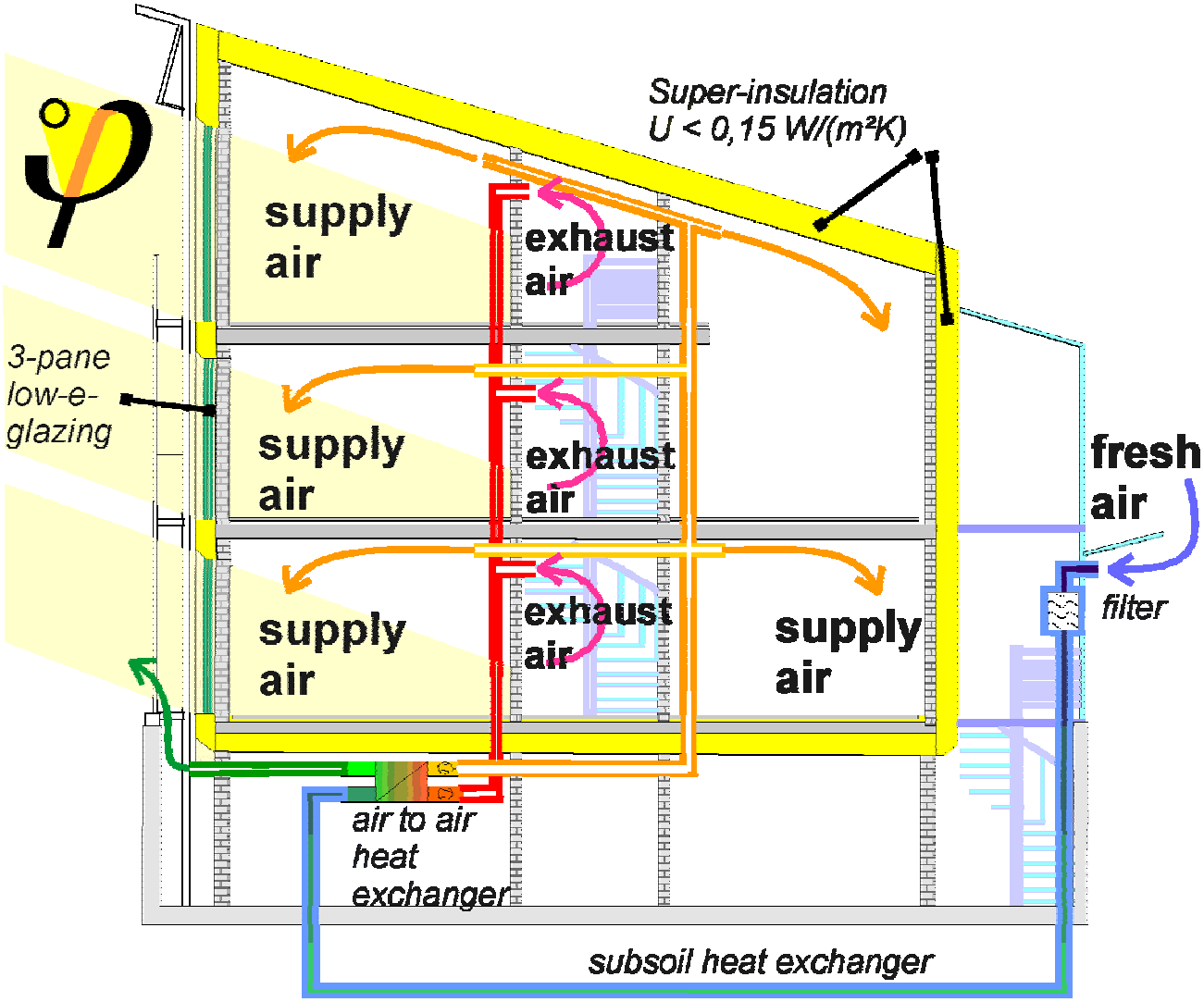
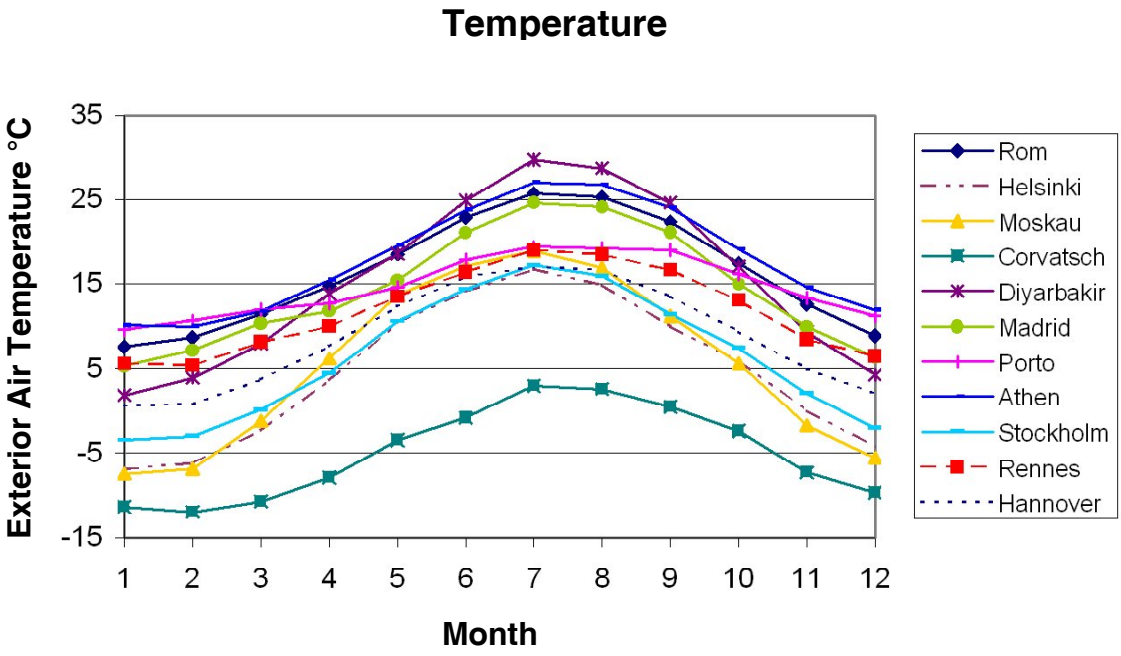


1. The Passive House: A Method Rather than a Building Style

The Passive House Institute has developed several Passive House building techniques to suit the Central European climate. However, it would be folly to directly copy details, especially those for insulation, windows and ventilation from the Central European example to other parts of the world. Instead, the details should be found to suit the climate and geographic conditions to develop a Passive House solution of each

location. The following boundary conditions of each region must especially be considered:

- The local building traditions
- The specific climatic conditions



Therefore, specific Passive House solutions must be adapted for each territory and climate under consideration.

Californian passive solar building techniques were copied and directly applied to construction projects in the European climate in the past. This way designed European houses had poor results because of the difference in solar gain between sunny California and cloudy mid-Europe. This mistake should not be repeated by simply copying Central European housing solutions to potential projects in other places with dissimilar climates and differing construction techniques like Korea, Australia or Florida. However, the Passive House concept and the laws of physics remain the same around the world and in every climate and region.

The challenge to build nearly energy self-sufficient homes, i.e. Passive Housing, is well defined. The physical equations remain the same – only the construction conditions vary. The methodology of the Passive House solution can be soundly applied independent of the geographic and climatic circumstances. The first steps towards starting a Passive House development in your region is to use the Passive House method.

The proven Passive House process can be used to determine the appropriate Passive House design solutions for each region and climate.

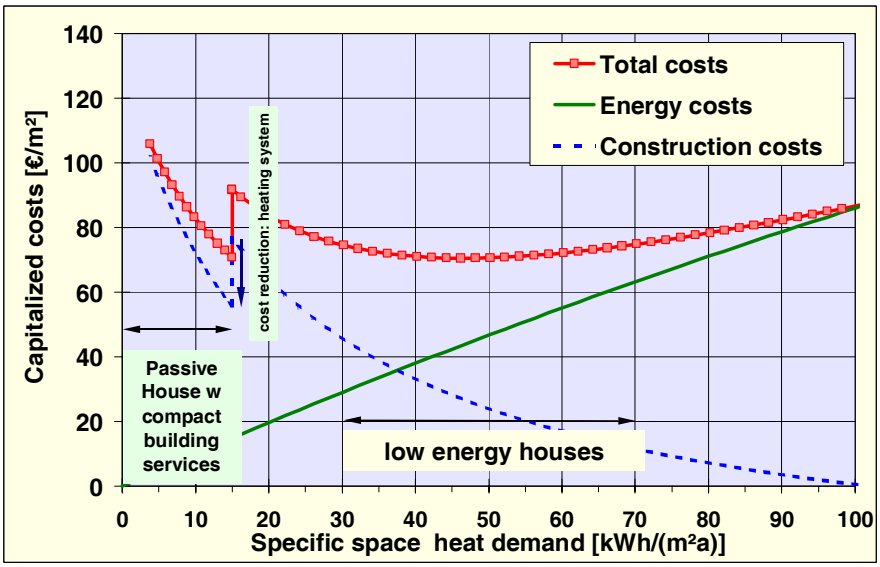
2. The Passive House: The Functional Definition

Although the designs of Passive Houses may appear quite different, the principle remains the same. The principle behind a Passive House is based on the concept by Amory Lovins of reducing investment through energy efficient design. By dramatically increasing the energy efficiency of a building, the HVAC systems can be radically simplified upon reaching a certain level of efficiency.

Consider the example of building a house for a cold climate. The heat demand for heating the house in the cold season is the major energy consuming service. If the heat demand is reduced by means of insulation, heat recovery, superwindows, passive solar gains and other measures, the heating system can be simplified step-by-step. But the most significant threshold appears when the peak heating load reaches

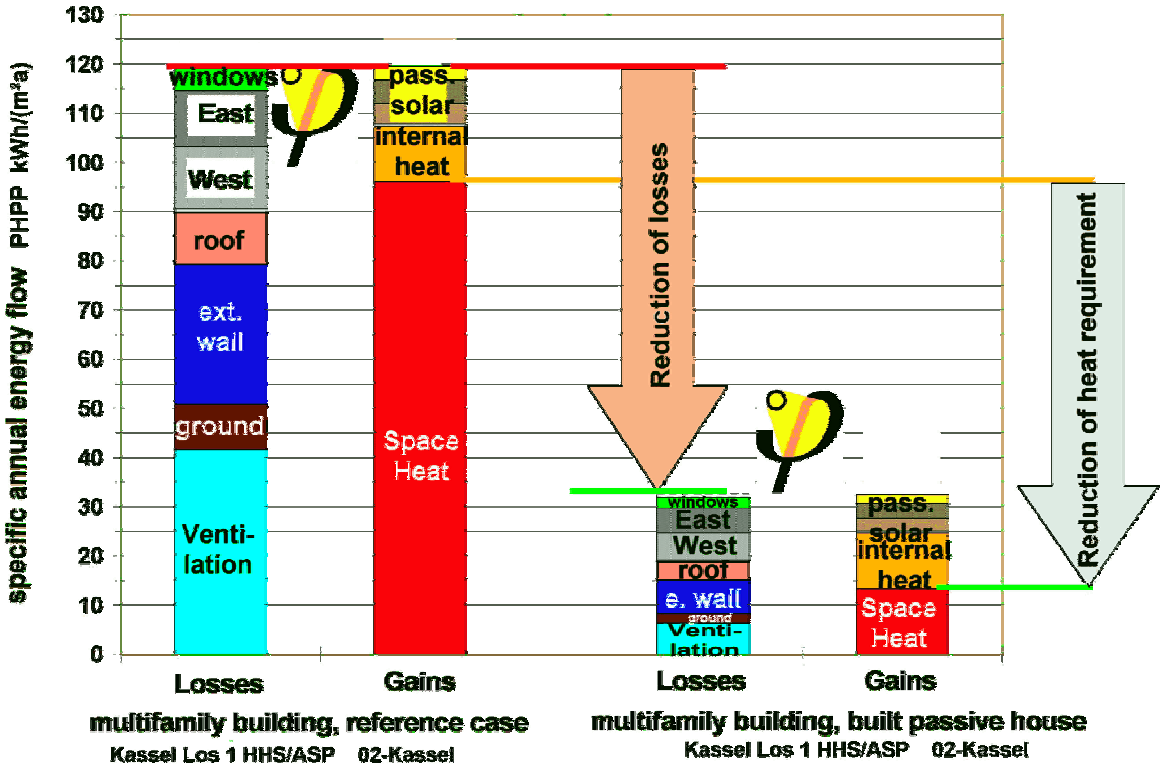
10 W/m².

When the peak heating load is less than 10 W/m², independent of climate, the ventilation system can easily be used for space heating, and a separate heating system is no longer required.



The primary function of the ventilation system is to maintain excellent indoor air quality. If the maximum load is lower than 10 W/m², the ventilation system can distribute all heat needed throughout the building as well. The definition of a Passive House is therefore that the peak heating load should be projected to a lower level than 10 W/m². In warmer climates, this value may be easy to achieve, however in colder climates, careful planning is required.

There is almost no extra benefit gained by increasing efficiencies beyond this point the 10 W/m² threshold. The construction costs could rise dramatically if the goal is to construct a "Zero Energy House" instead of simply a Passive House. As well, there is almost no additional environmental benefit. A Passive House has a very low energy demand for maintaining interior comfort in the heating season. The heating demand is so low that the environmental impact is negligible even if fossil fuels such as oil, gas, or coal are the heating sources. There are also no problems with primary energy resources. If higher energy efficiencies are sought, the project costs escalate beyond affordability, and the likelihood is that the project will not be replicated.



Examining the heating load is just one example. In other regions, other energy services, like cooling or dehumidification, could be of greater importance than heating. Again, the method for investigating a Passive House solution will be the following:

1. Attempt to use passive technologies to reduce the peak load demand of the service in question. Possible approaches include insulation, shading, use of subsoil heat exchangers and reduction of internal heat loads by using high efficiency appliances.
2. If comfortable indoor climate conditions differ greatly from outdoor conditions, it is always recommendable to use a ventilation system with heat recovery (or vice versa with cold recocery) to maintain a high indoor air quality without the need of huge heating or cooling demands. See Ole Fanger's work, "Thermal Comfort" or ISO 7730 for a definition of "comfortable indoor climate".
3. There will be a certain point in the cooling/dehumidification demand so that with lower demands, there will be an appreciable simplification of the active technology needed. This defines the Passive House Solution in your climate!

Some rules of thumb:

- Comfort should be kept at a high level. Passive Houses should be well known as the most comfortable homes in any region and within all climates. Keep in mind that everyone wishes to live in a comfortable indoor climate and that everybody is entitled to that. Therefore, in the long run, no solution will last which does not contribute to a better indoor climate.
- The solution should be simpler than what is presently used in conventional buildings and contemporary technical systems. Only affordable solutions will be attractive in comparison to customary technologies like air conditioning systems using forced air.
- It is not necessary that the solution shift from conventional energy demands to solutions that might be very expensive, like the Zero Energy House. It is sufficient to minimize energy use with simple systems from conventional sources. As a general rule, if the energy consumption is between a tenth and a quarter of current consumption levels, the savings from conserved energy is enough to pay for the extra construction costs.
- Insulation is highly recommended in all climates.
- Shading is absolutely necessary in all climates with high levels of solar radiation.
- Heat recovery is necessary in all cold and hot climates. If the houses have a ventilation system, the supply air ducts may be used to transport heat during the heating season, cool air during hot periods, and dry air to dehumidify if required.

It is recommended to install heat recovery if the external temperatures are often below 8°C or above 32°C.

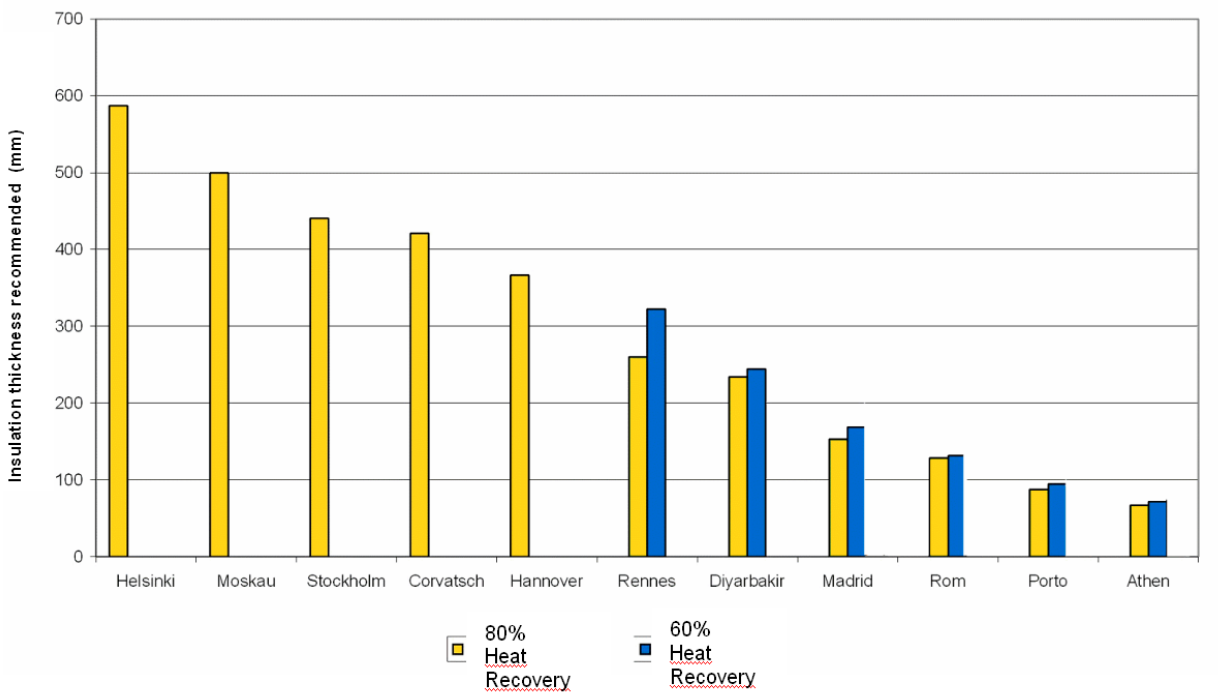
- Using very low auxiliary energy is an important precondition for passive solutions. It is especially important that the ventilators in ventilation systems use high efficiency electronically commutated motors (ECM). In recovering cooling energy, it is obvious that the ECM's are necessary, however, they are also essential in heat recovery systems.
- In many cases, the ground may be used as a heat or cold buffer. Historically used ground coupled systems in your region should be studied to determine if an opportunity exists to use the ground to reduce heating and cooling loads. The traditional solution may be very expensive, however, like huge air channels or earth-buried houses, that will not be a reproducible option for the future. There are more economical alternatives using modern technology like ground heat exchangers or so called "geothermal energy".

3. Passive Houses: The Parametric Study Method

After defining the goals for Passive Houses in various countries with different climates, the next step is to perform a computer based parametric study of the building design solutions and to check the results for energy demands, financial investment, and healthy indoor climate. A traditional building design can be used as a starting point, and then each element can be modified step-by-step: external walls, roofs, windows, floor slabs, ventilation, etc. It is recommended to consider parameters such as the exterior wall and roof colour (solar absorption coefficient), the longwave emissivity of external surfaces, the effect of varying internal mass and internal loads. The parametric study is performed using a computerised thermal building model. Possibilities are,

- A simulation first principle model using programs like "Derob", "DYNBIL", "Energy Ten"
- A validated simplified model based on EN 832, e.g. PHPP.

Results for Insulation Level in Passive Houses (European Climates)



The Passive House Institute has broad experience in performing parametric evaluations and successfully developing appropriate passive solutions for different climates. Do not hesitate to contact the Institute when evolving a Passive House design for your region.

References:

[Feist/Adamson] Feist, Wolfgang; Adamson, Bo: **Design of Low Energy Houses in the Federal Republic of Germany**; Lund University, Report BKL 1989:3(E)

[PHPP 2004] Feist, Wolfgang et al.: **Passive House Planning Package 2004,** Darmstadt, Passive House Institute, April 2004.