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Passive Houses in South West Europe

This document shows the table of contents and a few sample pages of the printed publication only.

A quantitative investigation of some passive and active space conditioning techniques for highly energy efficient dwellings in the South West European region

2nd, corrected edition
Jürgen Schnieders
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Δ [K]	air-conditioned	free-running
90 % acceptability	1.2	2.5
80 % acceptability	2	3.5

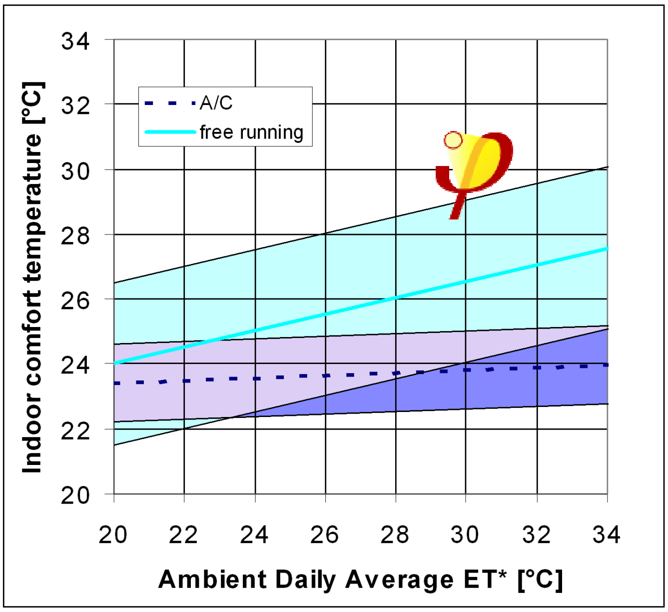


Fig. 3: Adaptive comfort ranges according to RP-884 for air-conditioned and free-running buildings (90 % acceptability range)

Other adaptive comfort models have been proposed for free-running buildings by other authors, e.g.:

T_{comf} = 11.9 ℃ + 0.534 T_m with the ambient monthly mean air temperature T_m [Auliciems 1969]

T_{comf} = 18.5 ℃ + 0.36 T_{olt} with the ambient long-term monthly mean air temperature T_{olt} [Nicol 1999]

T_{comf} = 21.42 ℃ + 0.206 T_{rm} with a running-mean ambient air temperature T_{rm} [McCartney 2002]

T_{comf} = 18.8 ℃ + 0.33 T_{rm} with a running-mean ambient air temperature T_{rm} [Nicol 2005]

In practice, adaptive models are only used for the assessment of summer comfort in buildings in which no active cooling system is operating. For this application, they have also been implemented in [ASHRAE 55] and [EN 15251].

Assuming that thermal comfort is indeed judged differently by users of air-conditioned and free-running buildings, it still appears obvious that a linear relationship of ambient temperature and comfort temperature, as assumed in various correlations of adaptive models, can only be valid within certain boundaries, and extrapolation may lead to erroneous results. An indication for the limits of validity can be found in [de Dear 1997]: the preferred temperature (i.e. the temperature at which the same fraction of subjects preferred a warmer temperature and a cooler temperature) is documented for 116 buildings with and without air-conditioning. 2 of these 116 preferred temperatures are below 21 ℃, 3 are above 27 ℃. It may be concluded that temperatures above 27 ℃ are hardly considered ideal in any climate. Interestingly, this notion is even supported by the results of the Pakistan study ([Nicol 1999]): most of the subjects started to use fans, probably in order to reduce thermal discomfort, at indoor temperatures above approximately 26 ℃. A similar limit can be derived from a field study conducted by [Aggelakoudis 2005] in five office buildings in Patras, Greece. The indoor

5.2.1.12.2 Performance overview

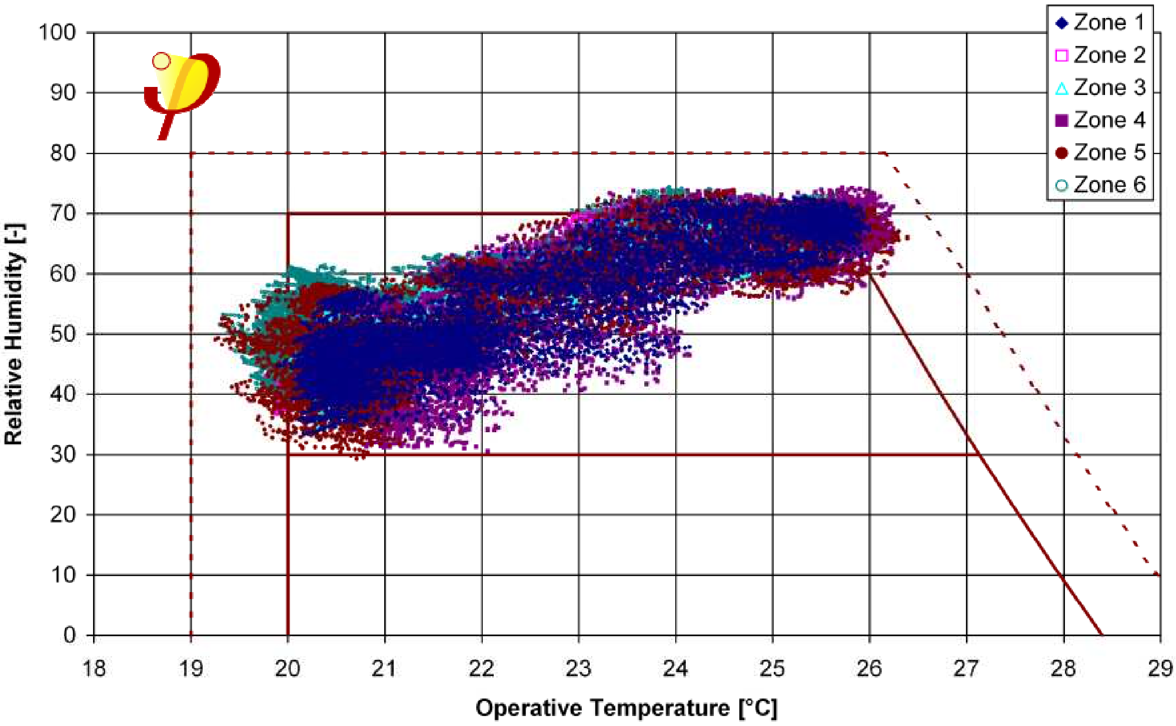
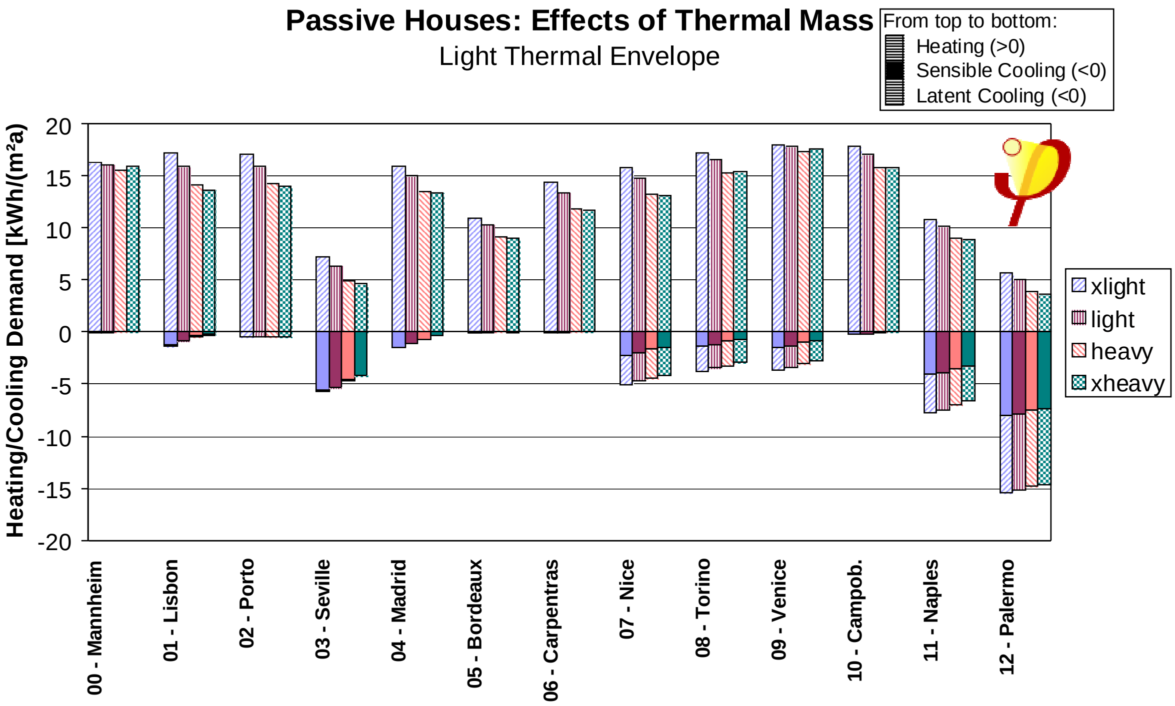


Fig. 48: Operative temperatures and relative humidities in 11 - Naples for the reference case with supply air heating and cooling.

The following useful energy demands and maximum loads result:

	Ideal System	Real System
Useful heating demand (20 °C) [kWh/(m²a)]	8.44	10.02
Sensible cooling demand (26 °C) [kWh/(m²a)]	3.32	4.08
Latent cooling demand (70 %) [kWh/(m²a)]	3.37	4.02
24-h average heating load [W/m²]	10.28	9.71
24-h average sensible cooling load [W/m²]	5.01	5.49
24-h average latent cooling load [W/m²]	7.25	7.51

- Higher solar gains increase the ratio of solar gains and heat losses, thus reducing the utilisation factor.
- The time constant of the Passive Houses becomes smaller because less thermal protection is required in the warmer climates. This effect also reduces the utilisation factor.



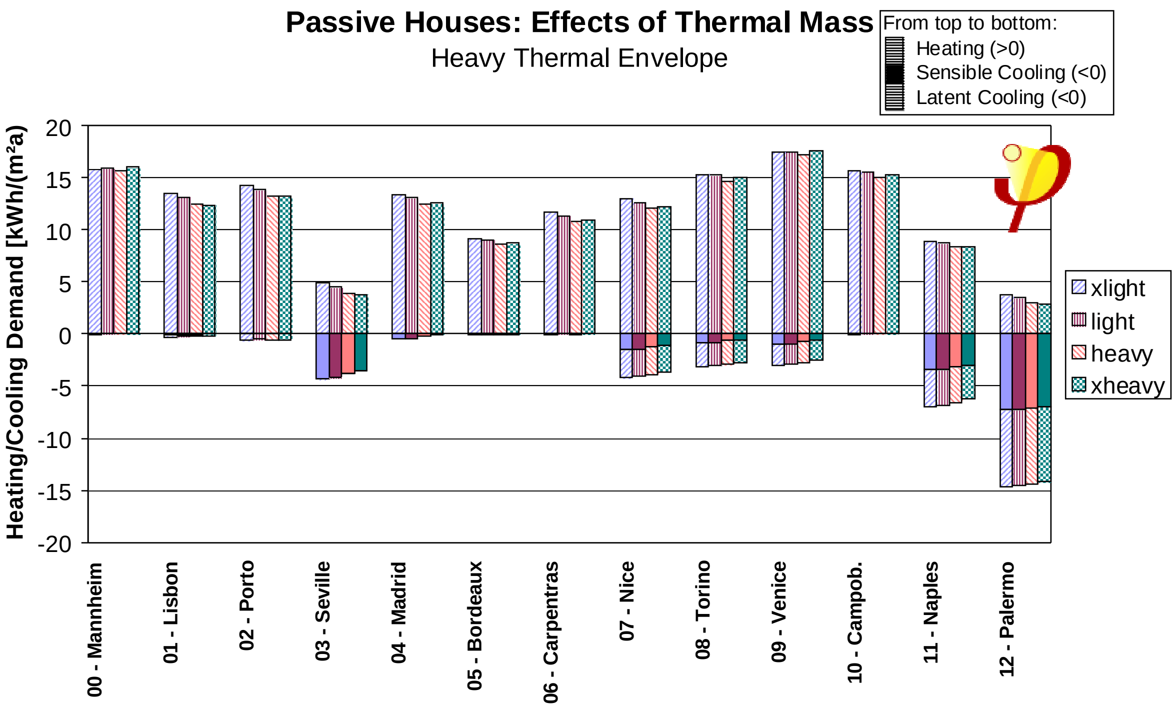


Fig. 96: Heating and cooling demand as a function of thermal mass.

7 Sensitivity to User Behaviour

Dynamic building simulation inevitably has to make assumptions concerning the user behaviour. This comprises, for example, the desired temperatures and humidities, the production of internal heat gains or the patterns of window opening and blinds operation. The preceding simulations, studying the effects of changes in the building properties, were always performed for the same users.

It is well-known that the behaviour and the requirements of different users vary to a large extent. The current section considers the question how the proposed Reference Passive Houses perform for different user behaviours: If the buildings are designed and built such that they maintain indoor conditions within the extended comfort range for standard user behaviour, are they still able to do so for other types of users and other comfort requirements? What will be the consequences of such different user behaviour for the energy demand?

These questions relate particularly to supply air heating and cooling and to the passive cooling strategies. Therefore, instead of ideal space conditioning systems as in section 6, where the focus was on the possibilities to optimise energy demand and space conditioning loads, the real systems for heating and cooling proposed for the Reference Passive Houses in section 5.2 are considered in most cases. Generally, these systems will consist of a supply air heating and cooling with some support by night ventilation and blinds operation; depending on the location, purely passive cooling strategies may also be applied (cf. also Appendix B for an overview).

7.1 Indoor Temperature Requirements

In section 3.2.5 it was already discussed that there are large differences in the preferred temperature between individuals. The present section investigates the effects of changes in the temperature setpoints: how is the energy demand affected, and to what extent are heating or cooling systems with limited power able to respond to increased comfort requirements?

7.1.1 Effects of Different Setpoints for Ideal Heating and Cooling Systems

For central European conditions, it is well known from both theory and experimental results that the heating demand of Passive Houses may vary by a factor of 4 or more, depending on the average indoor temperature during the heating period (cf. e.g. [Schnieders 1998], [Schnieders 2001]). Possible crossflows of heat between dwelling units may contribute to these differences. The *relative* differences are higher than in conventional buildings, whereas the *absolute* additional heating demand increases slowlier than in conventional buildings, due to the lower specific heat loss.

Fig. 136 shows the effects of changes in the heating setpoint for the Reference Passive Houses in all locations, i.e. for setpoints from 18 to 24 °C, assuming an ideal heating system. The setpoints for secondary temperature control mechanisms, namely control of the heat recovery bypass, beginning of night ventilation and closing of shading devices, were shifted by the same amount as the heating setpoint.

It can be seen that the heating demand increases strongly with the indoor temperature, showing a small nonlinearity that is believed to be mainly due to a longer heating period at higher setpoints.