

Developing Summer Comfort Design Guidance

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Introduction

Overheating in buildings is a growing concern in the UK. Recent academic papers have blamed this on increased insulation and airtightness. Some of the buildings studied have been certified to the Passivhaus Standard.

The Passivhaus Standard includes targets for overheating and the Passivhaus design software (PHPP) provides increasingly powerful tools to model this in a wide range of climates around the world. However, as we will show, the impact of design assumptions on summer comfort are very significant and have the potential to undermine the value of otherwise rigorous calculations.

To address this problem, the UK Passivhaus Trust is developing guidance and protocols for designers [PHT 2016]. This paper will outline some of the findings and recommendations that have been developed in consultation with designers and Certifiers. All the recommendations can be implemented without changes to the PHPP but the use of more pessimistic cooling season defaults in future updates would be beneficial.

Design for Summer Comfort or Acceptable Discomfort?

The Passivhaus approach places considerable emphasis on achieving exemplary winter comfort with no drafts and limited radiant asymmetry. However, for the summer case we are more likely to design for acceptable levels of discomfort rather than for comfort.

The Passive House Planning Package (PHPP) uses a steady state monthly model to estimate the hours that the average building temperature exceeds 25°C. For Passivhaus Certification, the summer comfort condition must be assessed as 'acceptable' or better when using the PHPP (table 1). Less than 5% over 25°C is a recommended target and some designers aim for 0%.

Hours>25°C	Hours/year	Assessment
>15%	>1314	Catastrophic
10 – 15%	8760 – 1314	Poor
5 – 10%	438 – 8760	Acceptable
2 – 5%	175 – 438	Good
0 – 2%	0 – 175	Excellent

Maximum daily swing 3K, according to PHPP to ensure reliable result.

Table 1: PHPP summer comfort criteria.

Steady state tools, such as PHPP, can be accurate enough simply because they are tolerant of vagaries such as the daily weather, and to some extent human behaviour. However,

experience shows that the choice of assumptions turns out to be far more critical than the choice of dynamic or static model, limit temperature or overheating hours.

Erroneous assumptions

Indoor temperatures result from the balance between heat gains and losses. Unlike a winter heating system, summer gains are largely uncontrolled and come from the sun and internal heat gains such as people and appliances. Cooling is controlled by opening windows, especially at night when it is cooler outside, and sometimes also by deploying moveable shading. In other words, a passive cooling strategy requires active interventions by occupants. When windows can be opened fully, high levels of ventilation can usually be achieved. However, this may not be possible or desirable due to concerns about noise, insects and security.

Furthermore, some interventions may not be intuitive or obvious to occupants – particularly those people that are used to occupying buildings with very different thermal characteristics i.e. the majority.

Internal heat gains vary over time and between buildings. They depend on occupancy and the choice of appliances; such as dryers rather than clothes lines. In the PHPP summer overheating calculations now include internal heat gains arising from a given design. However, if appliances, occupancy and hot water system design are not realistically included in the planning stage model, then summer overheating will be underestimated. This will have implications for fenestration, shading and other design elements that may be difficult to change as the design progresses post planning permission.

The authors know of examples where moveable shading was specified but not installed in order to reduce costs. In the UK, summers are not consistently hot so the case for such measures can be hard to make. We tend to get caught out when a heatwave does strike. Similarly, it is not in our culture to close blinds in the day or to open windows at night in summer. Such cultural realities cannot be dismissed and need to be considered by designers.

Sensitivity to Design Assumptions

To illustrate the sensitivity of the summer comfort certification criteria we used a PHPP model for the Passivhaus Certified and monitored building, Steel Farm. In practice this building has performed very well. In 2014, the warmest year on record, monitored temperatures only rose above 25°C for 2% of the year in the warmest occupied room, compared to a PHPP model result of 0% averaged over the whole house [Siddall and Johnston, 2017].

Figure 2 and table 2 show the impact of a range of reasonable scenarios as modelled in PHPP, some of which would lead to very poor summer comfort should they occur.



Figure 1. Steel Farm Passivhaus.

The design had several constraints relevant to summer comfort. Being in a designated area of Outstanding Natural Beauty (AONB) meant limited options for external shading. Whilst night time noise and security were not a concern for this rural farmhouse, summer flies can limit window opening. Consequently, the building was modelled without window opening, but with summer bypass in operation. Scenarios 1 and 3 assume that the mechanical vent rate is increased by 50% however a lower figure is entered in PHPP to reflect the less than perfect effectiveness of summer bypass [PHT 2015]. Internal heat gains (IHG) were 2.6W/m² for the summer and winter case but a higher but plausible 5W/m² was also modelled for all scenarios. Night ventilation was assumed as a default strategy, but with the comfort of knowing the building should still perform if this proved impractical or undesirable.

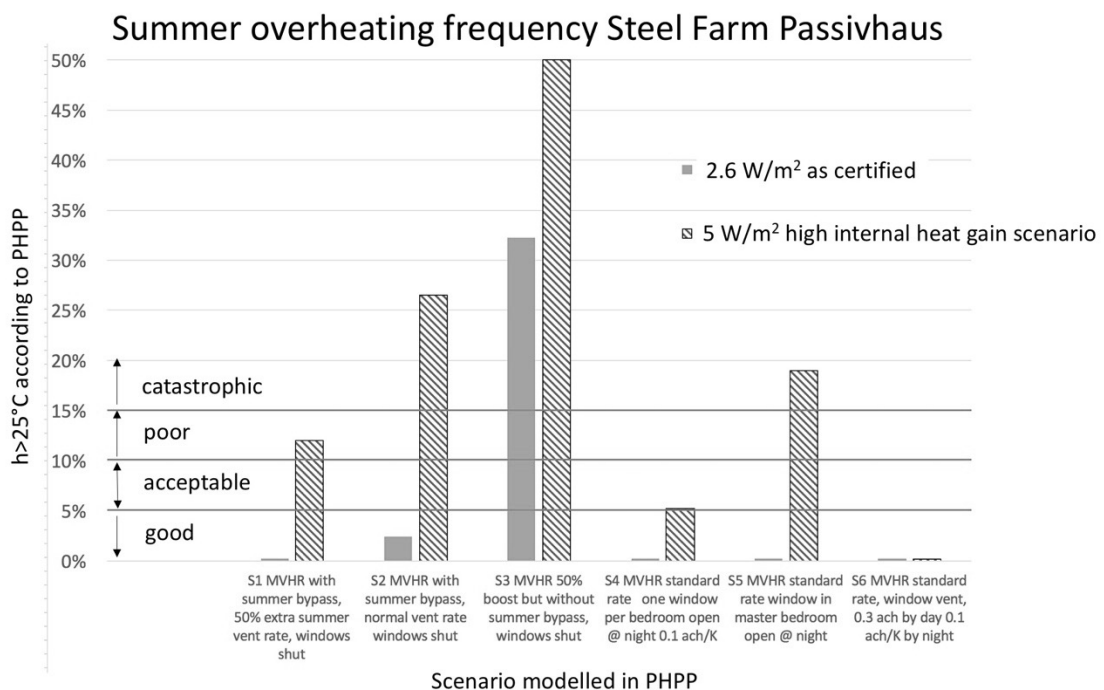


Figure 2: %hours >25°C based on different assumptions for occupant behaviour [PHT 2016].

	MVHR with summer bypass unless stated.	Window vent air-changes per hour per K (for night vent)	% hours per year over 25°C for standard and high IHG scenario	
			2.6 W/m ²	5 W/m ²
S1	50% extra vent rate	Closed	0%	12%
S2	Normal base vent rate	Closed	2%	27%
S3	50% extra vent, no summer bypass	Closed	32%	50%
S4	Standard vent rate	1 window per bedroom 0.1 air-changes/h/K night vent	0%	5%
S5	Standard vent rate	Only master bedroom window open 0.03 air-changes/h/K night vent	0%	19%
S6	Standard vent rate	0.3 air-changes/h by day and 0.1/air-changes/h/K at night	0%	0%

Table 2: Twelve scenarios from figure 2 and the calculated overheating frequency.

The example used to demonstrate the sensitivity to assumptions is a generously sized detached masonry dwelling with a design occupancy of about 3 people in a rural location in Northern England. The glazing was carefully oriented and, whilst generous, not excessive for an architect designed house. In figure 2 we can see how sensitive the result is to internal heat gains.

Flats and Social Housing

Smaller dwellings with higher occupancy (such as social housing) located close to noisy roads demand a very different set of design assumptions to assess summer comfort. These should be determined at an early stage before glazing, shading, and possible cooling strategies are fixed by planning.

Figure 3 shows the use of PHPP to model the impact of IHG on summer overheating for a block of flats. This highlighted the crucial importance of reducing hot water distribution losses and lighting energy for corridors and communal areas. The scenario modelled assumes windows are kept closed, though the intention is that in practice windows are left open at night in warm weather.

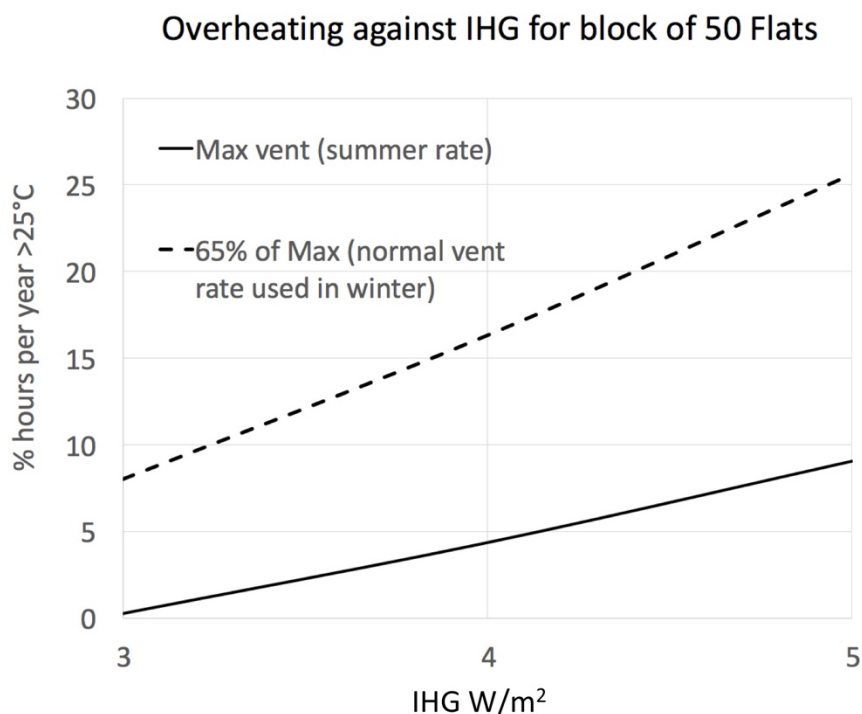


Figure 3: PHPP used to show the impact of Internal heat gains (IHG) and mechanical vent rate on overheating for Extra Care flats in Devon UK.

Design Responsibility

Because of the influence of behaviour, it is common to blame occupants for overheating. But what behaviour can be reasonably expected? How much active input is required on behalf of the occupants will depend on several factors including; who is occupying the building, where that building is located, it's compactness and the glazing ratios.

Freedom and Control in Good Design

A precautionary approach would be to insist, through regulations or Certification, that all buildings are designed to deliver good summer comfort for the most sensitive occupants independent of external factors such as noise. However, such an approach would be unacceptably prescriptive, very costly and may require active cooling to guarantee compliance – yet in many instances this may not be necessary.

In practice the design process typically involves many, often conflicting, requirements. For example, the owners who commissioned the Denby Dale Passivhaus (figure 4) were keen to have full height glazing on the south west corner of their home. [Butcher, 2011] This had several implications including the need for external blinds to ensure good summer comfort. The occupants were made aware of, and accepted, the additional cost, ongoing maintenance and need for awareness of weather conditions including impending storms. Whilst not a cost optimal solution, the design decisions and trade-offs were consciously made.



Figure 4: South and West full height corner glazing. Courtesy Green Building Company.

Figure 5 shows a simplified illustration of what we believe to be an unavoidable reality relating to design choice and summer comfort.

The Steel Farm example accepted some design restraint on glazing size and orientation resulting in an economic design with little user input required to achieve good comfort. The Denby Dale example knowingly traded reduced constraints on glazing, for additional capital cost and ongoing user input for controlling blinds. A problem appears to occur when attempting to meet, or believing a design can achieve, all 3 criteria.

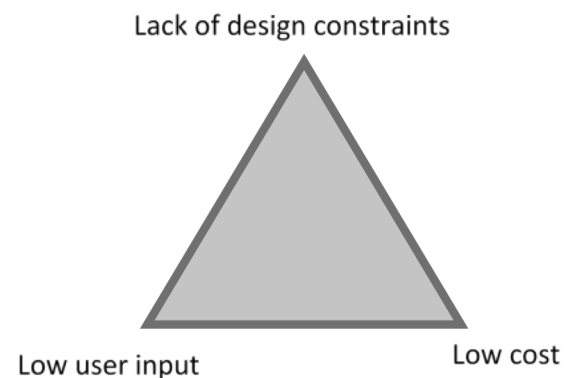


Figure 5: Choose any two, otherwise summer comfort will suffer [PHT 2016].

Controlling Overheating: A Model for a Management Process

Not all factors affecting overheating risk can be managed using energy modelling tools such as PHPP. For this reason, in addition to modelling, the assessment of overheating risks benefits from a carefully considered management process. This is particularly the case when designing large and complex buildings. It is suggested that clients and design teams work together and create an overheating risk register similar to that show in figure 6.

Parameter	Behaviour/ Opportunity Affected	Likelihood	Severity	Risk	Risk Management Activity	Design Action/s Arising
<i>NOISE</i>						
Noise from outside	Window vent.	5	4	20	Consult acoustician to minimise noise intrusion	Client to appoint acoustician
Ground floor ventilation only?	Window vent.	5	4	20	Design in secure night time ventilation	
Vehicles	Window vent.	5	4	20	Consult acoustician to	Client to appoint

Figure 6: An example of an overheating risk register. [PHT 2016].

Conclusions

To maximise summer comfort and minimise the risk of overheating, design teams and clients need to act responsibly and complete the PHPP using realistic parameters. If this is not done, PHPP's ability to alert designers to overheating risks will be impaired.

One of the benefits of the certification process is the third-party review of design decisions. It is on this basis, when a Certifier is engaged, that Clients can be reassured overheating risks are being given appropriate scrutiny. Overheating risk need to be taken seriously and gaming PHPP calculations to conceal risks should not be tolerated by Certifiers.

Whilst the Passivhaus certification process challenges designers by encouraging them to achieve summer comfort and address overheating risks in a realistic manner, the final responsibility lies with the design team.

To help inform this process, and on behalf of the Passivhaus Trust, the authors developed the guidance "Designing for Summer Comfort in the UK" [PHT 2016, 2015]. You can download a copy of the guide by going to <http://snip.ly/ajz3r>

References

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