4 Use of PHPP and quality assurance

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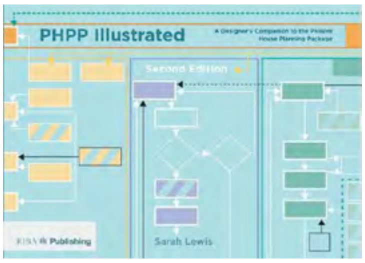
INTRODUCTION

Training in the use of PHPP is strongly recommended, in order to be fully competent with the software. This section is aimed at those who have undertaken training and are embarking on one of their first Passivhaus projects.

The PHPP manual has developed into a great resource to ensure your building is modelled correctly. The comments below are meant to be in addition to the manual, so have it close by!



PHPP Illustrated: A designer's companion to the Passivhaus Planning Package by Sarah Lewis

(RIBA Publishing, 2017)

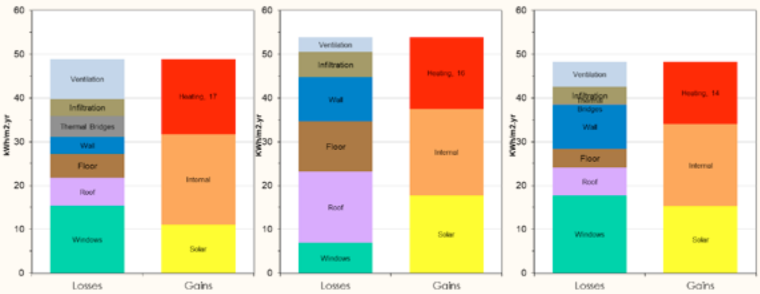
You would also likely find the book *PHPP Illustrated* a useful companion when building your first PHPP models. The book provides an excellent set of step-by-step instructions, clear examples of the sorts of supporting evidence required for certification, and tips to avoid common pitfalls.

CLIMATE AND ALTITUDE

Check carefully that you have identified the right weather data set. See the maps on page 118-119 in the PHPP 10 manual. The data sets generally follow county boundaries – if you're unsure use additional county maps to be conservative. If you have a Certifier appointed you can ask for further guidance. Entering the altitude of your site is just as important as location. Most of the data sets are from locations less than 50 m above sea level, and if your site is significantly higher than the weather station this could easily add 1 kWh/m²a or more to the heating demand. Conversely some sets are at quite high altitude – the Severn set, for instance, uses data from RAF Lyneham, which is at 150 m.

PHPP: THE PASSIVHAUS PLANNING PACKAGE

PHPP creates a bespoke energy balance for your project, quickly identifying what aspects are the most significant and what is important for you to work on. This means while the Passivhaus standard is the same for most building types, the particular solution for your building will be tailored.



PHPP energy balances for a school, a village hall and a terrace of houses (l to r)

Be conservative with values, as the thermal performance of elements very rarely gets better during design development. Optimistic inputs will be a problem later!

HEAT LOSS AREAS

Heat loss areas in Passivhaus are measured to the outside of the thermal envelope. This can be less straightforward than the SAP internal measurement methodology, as what constitutes the outside of the thermal envelope may not be immediately clear. Put simply, the thermal envelope ends at the last element used in your U-value calculation.

VARIANTS

The variants tab is a brilliant design tool, so use it!

A CRITICAL EYE

Passivhaus Certifiers will be keeping a watchful eye out for things that will affect the building performance in practice. These might include:

- Manufacturer/supplier claims for material performance – this could be, for example, the amount of timber in a timber frame or the conductivity of an insulation material
- Correct inclusion of repeating thermal bridges – refer to BS 6946 for guidance
  Explore further: pht.guide/steel
- Thermal bypass – is the insulation encapsulated for airtightness & windtightness, and can the insulation be easily constructed without air gaps between or behind the material?
  Explore further: pht.guide/thermalbypass
- Products that are likely to be damp (e.g. in contact with ground) – conductivity of porous elements such as open-cell insulation or lightweight blocks can vary significantly with moisture content
- Assumptions about occupant behaviour – is it realistic, for example will windows be opened, or equipment turned off?
  Explore further: pht.guide/summer

So, be critical about the information you're given.

The Passivhaus Planning Package (PHPP) is a very useful and powerful design tool, but it is possible to misinterpret the conventions, giving erroneous results. Avoiding these simple mistakes can reduce the need to find additional energy savings late on in a project. In a worst-case scenario, such mistakes might mean that a project cannot achieve certification.

WINDOW ENTRIES

Unlike the UK's National Calculation Methods (NCMs), such as SAP and SBEM, where each rough opening can be considered as one window, PHPP needs accurate window entries, which include each individual casement and any mullions or transoms. Then PHPP calculates a bespoke U-value and frame factor for each window. Entering two adjacent window casements as one means that the frame losses would be underestimated, and the solar gains overestimated. Opening windows nearly always have thicker frames than fixed, so it is good practice to assume that all windows are opening ones if this is likely to be the case and the designer hasn't specified yet; this should avoid underestimating frame heat losses.

Using an installation psi-value of 0.04 W/m.K is a good conservative estimate for early design, and can easily be improved upon.* This typically represents a window installed into the middle of a standard timber frame.

PRIMARY ENERGY RENEWABLE, PER

For Passivhaus Classic the PER target should be achievable without the need for renewables. There are two major exceptions: when providing heating and/or hot water by direct electric, or for multi-residential projects using a district heating system/ central plant. In these cases further efficiencies elsewhere or additional renewable generation may be required.

Meeting the PER limit will nearly always require best practice design of services such as hot water but should not necessarily come at a higher price, as demonstrated by, for example, Wilkinson Primary School – see the case study below. Choice of equipment will also need care – auxiliary systems such as trace heating for sprinkler systems and server equipment can be very energy hungry.

Make sure you've included all the equipment you can think of and ask lots of questions of the design team about their designs. Reducing auxiliary energy consumption through good design has been a major benefit of Passivhaus, particularly in non-domestic projects.

* This is not necessarily the case for steel frames – learn more at pht.guide/steel

VENTILATION RATES

The PHPP starting assumption is a ventilation rate of 0.3 air changes per hour (ACH), which is based on German property sizes and occupancy rates.

For most UK buildings higher ventilation rates are required. Some typical best practice ranges are shown below. It is important to model the actual design and controls as soon as possible to give realistic feedback. For non-domestic projects the ventilation rates can often be double these figures before optimisation of controls etc:

- Dwellings from 0.3 - 0.6 ACH
- Primary schools 0.4 - 0.6 ACH
- Secondary schools 0.6 - 0.8 ACH
- Open plan office building 0.4 – 0.6 ACH

MVHR DUCT DATA

The fresh air and exhaust ducts from the MVHR to the outside environment are essentially outdoor spaces within the thermal envelope and can add significantly to the heat loss of your design. Be realistic about the duct lengths, diameters and the amount of insulation which will be fitted. Where the MVHR is located right against an external wall, duct lengths of >1.5 m are still likely. 160 mm diameter ducts and 25 mm insulation are typical values for a domestic installation and closed cell insulation should be used to avoid condensation problems.

Where there is more than one MVHR unit in a building you must use the Additional Vent Sheet otherwise the duct losses won't be correct. Watch out though – it's easy to make mistakes, so have the manual to hand.

> *"The Passivhaus requirements to frontload and complete the design in the pre-construction phase results in many added benefits, including early procurement of sub-contractors and full coordination of the digital model. This should, in practice, enable a more efficient build process resulting in less site modification and waste, and ultimately a smoother commissioning and handover process."*
>
> **Allan Smith, Low Carbon Manager, Morrison Construction**

SHADING

The shading sheet is probably the trickiest within PHPP to get right, and it's worth reading the PHPP manual carefully so you understand the instructions, especially about averaging reveal figures. It's not sensible to be overly conservative and assume more shading than there is, because this can hide overheating problems. Be clear and reasonable in your assumptions and a Certifier is unlikely to disagree with you. If you are at all uncertain, get a Certifier appointed and agree the shading strategy early on.

For complex shading, we would strongly suggest using DesignPH, although it still needs to be inputted with care. Guidance to ensure compliance with certification is available from WARM (find a link at pht.guide/designsupport). If you have simpler shading but it includes trees or semi-opaque elements you can use the simpler 'Additional Shading Sheet'.

While it is possible to get carried away worrying about shading accuracy, a good design should not be too sensitive to exact shading values as this suggests there is probably too much glazing.

LEARN MORE

pht.guide/summer

SUMMER COMFORT

The overheating check in PHPP is basic, and as such shouldn't be used for non-residential or complex residential buildings (except as a design tool or check). However, the summer worksheet in PHPP 10 has some useful tools to carry out stress testing for different climate conditions and building uses. In addition, overheating risk key indicators and a detailed risk log can be found in the Passivhaus Trust's free PHPP plugin, available at pht.guide/summer with further guidance.

PHPP considers the building as one zone, distributing the gains evenly and as a result won't identify high solar gains concentrated in one room. Be cautious about assuming high levels of window opening to solve an overheating issue, as this may not be realistic due to security or noise issues; results from social housing indicate that night purge ventilation i.e opening windows is seldom used even with clear guidance in the user manual.

It is recommended for the building to exceed 25°C for no more than 5% of the year, and best practice is less than 2% of the year. The upper limit for certification is for the building to exceed 25°C for less than 10% of the year. Note that this is based on 'current' climate data; this broadly represents the last 20 years and so may not represent the current, let alone future scenarios. For example, a project in London had an overheating result of 6% using the standard dataset within PHPP, but this increased to 15% when replaced with the actual data for 2018. Use the stress tests!

TOO MUCH GLASS

While it is possible to build almost anything to the Passivhaus standard, be cautious about projects with large expanses of glass. Such buildings are highly reliant on the weather for both internal comfort and energy consumption – this does not make it easy to achieve the comfort and energy requirements! And moreover, overheating testing will not include for the comfort impact of lots of hot glass during the summer.

QA PROCESS

It is easy to make mistakes with any modelling software, so having a robust QA procedure within your organisation is key. Ideally there will be someone who can look over your PHPP on a regular basis. Clear mark-ups of treated floor area, heat loss areas, windows and shading make for easy checking, as does keeping previous versions of your PHPP.

If your experience is limited, employ a Certifier early on in a project to check what you're doing, agree any points of contention and provide any hand-holding you may need. While certification usually starts pre-construction, having some experienced input (especially before planning) will ensure you're on the right track.

As a simple starting point for reviewing a PHPP file, we suggest the following steps:

- Check, review and resolve any errors in the 'check' tab within the PHPP
- Review the 'plausibility statements' that are given at the bottom of the check tab. These require you to unprotect the sheet to reveal them. It's an incredibly good tool for spotting simple errors.
- Run the file through a PPP transfer to confirm it gives the same answer in a fresh PHPP. The PPP transfer tool is available with the original material provided when you purchased your copy of PHPP.

ADDITIONAL RESOURCES & PLUGINS FOR PHPP

There are many useful plugins and resources for using PHPP, including:

- **DesignPH** Sketchup based design tool that allows inputs to PHPP. Particularly good for complex shading.
- **PHribbon** allows for embodied energy calculations along with a huge range of other aspects. A fantastic addition to PHPP.
- **WARM results sheet** provides key results for reports or to keep track of a project. Other tools such as additional shading sheet are also available on the WARM website.

A number of other tools have been developed to complement and extend PHPP – find them listed at pht.guide/designsupport.

LEARN MORE

pht.guide/
designsupport

do

- **be conservative with values, as the thermal performance of elements very rarely gets better during design development – optimistic inputs will be a problem later!**
- **consider the impact on both summer and winter cases – the variants tab is helpful for this**
- **model your design in PHPP at the early design stages, making sensible assumptions**
- **leave a clear trail of what any inputs are based on**
- **keep the model up-to-date throughout the process, and give feedback to designers and client regularly**
- **get someone else to QA your work – even if you're experienced it's easy to make a mistake**

don't

- **assume that a building specification from a previous development will suit all future Passivhaus buildings**
- **forget to consider the design. Just because the PHPP is passing it doesn't mean it's a good design solution – particularly important for glazing design**

CASE STUDY: Wilkinson Primary School

Wilkinson Primary School, the third Passivhaus school delivered by Architype, firmly established the pattern for Passivhaus school design, since successfully repeated many times. Innovative services design not only met the Passivhaus primary energy target but also kept costs down. According to Architype, the school 'incurred no additional design or construction costs' over a non-Passivhaus equivalent, while running costs plummeted - just as with its Passivhaus predecessor Oak Meadow Primary where, after moving into the new Passivhaus certified building, the school's annual heating bill dropped from £45,000 to only £5,000.

For this project, the internal heat gain (IHG) factors were adjusted in agreement with the Passive House Institute to reflect the fact that UK schools have a higher density of children than German schools. Modelling assumptions for the certification of UK Passivhaus schools have since been further refined to accurately reflect typical usage, as part of the UK Certifiers Circle ongoing work to bring increased consistency and clarity to the modelling and certification processes for all types of buildings.

Wilkinson Primary School, Wolverhampton. Images: Architype