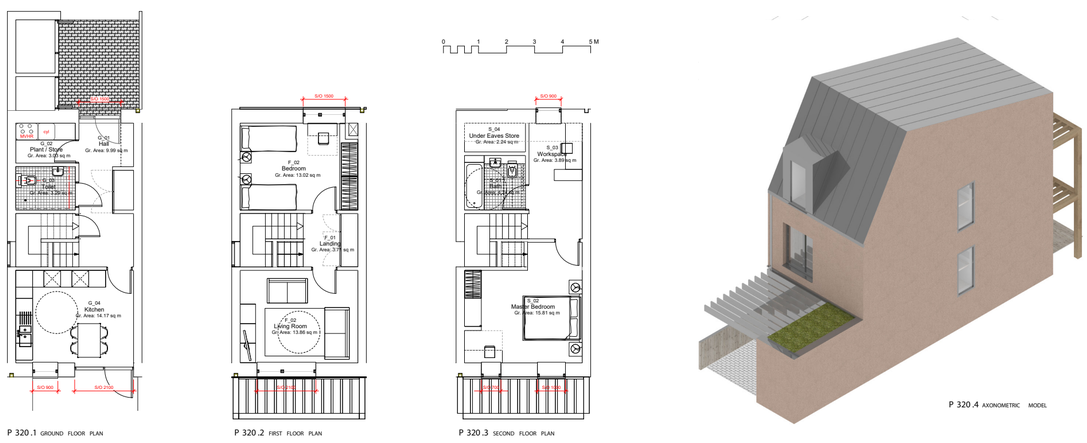
Simulation Tools for Passivhaus Design

Design tool to analyse impact of early stage design choices in affordable homes schemes

Introduction

Despite the apparent impact of early design choices on building performance, there often is a lack of communication and awareness of the importance of getting the principles right from the start. Frequently the rules of thumb can be a good starting point, however the complexity of all aspects of the design involved in the design process can quickly become overwhelming.

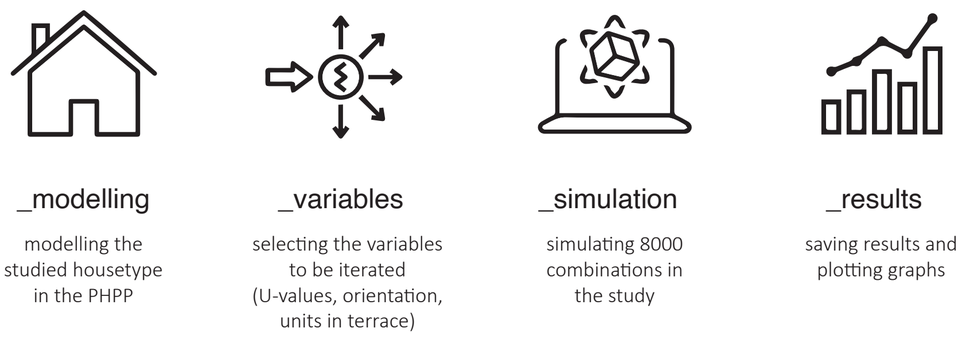
We have developed an excel based tool which is aimed to help with early design choices. The tool is targeted at people with various level of knowledge of building physics (planners, policy makers etc) and the main intention is to communicate the impact of certain options from very early stages of the design. The tool is able to run 1000's of iterations on the PHPP model and save the results for further study in a separate file.



Housetype 7- 2B4P Home

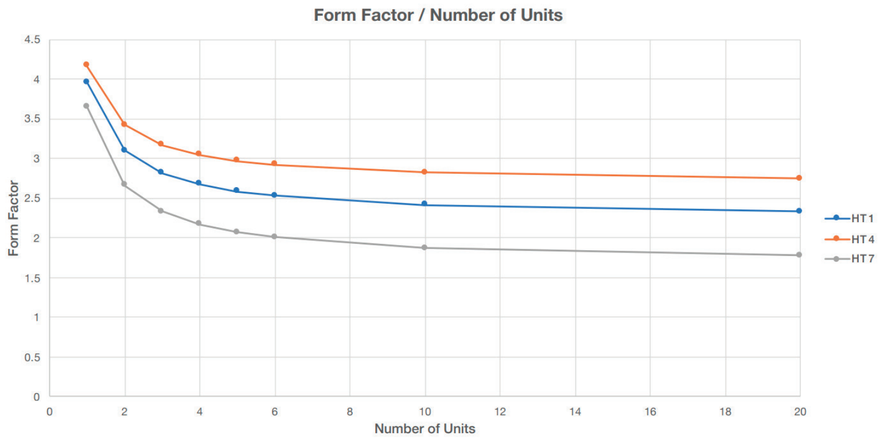
Study

We were asked to study how the amount of dwelling units in the terrace, their fabric and orientation impacts the form factor and energy use. In our pilot study we ran an initial batch of 8000 iterations for three different house-types using timber frame construction. The key focus of the pilot study was the impact of form factor, building orientation and U-values on the space heating demand and an indication of overheating risk on affordable housing schemes in Wales. In the study we were able to control: the U-value of walls, roof and ground floor, building rotation at 5° steps, number of units in the terrace from detached house to 20 units. The results of iterations were saved in a separate file to PHPP and presented in several tables and graphs.



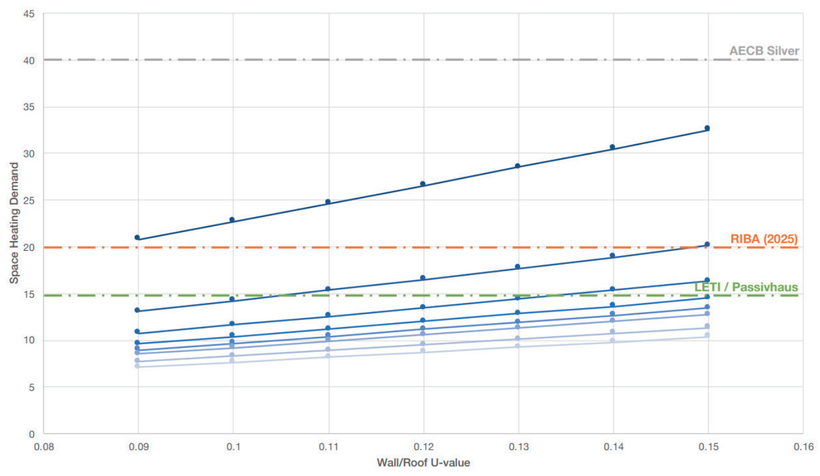
Results

Form factor / number of units in terrace



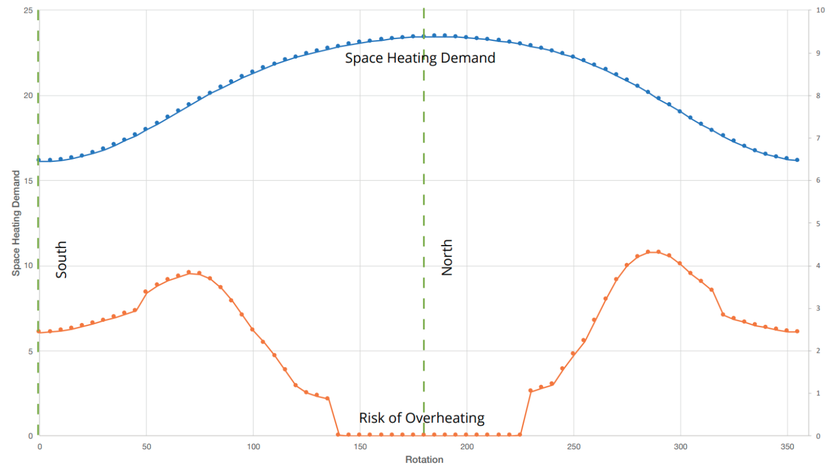
Graph shows three housetypes and the impact of adding units to the terrace on form factor. Optimal number of units in terrace seems to be 5- 6 units. Anything above that has diminishing returns. Another interesting observation is that the better starting form factor (Housetype 7- gray line) the better the improvement by adding more terrace units- the gap distance between the grey and blue line is increasing as number of units are increasing.

Space heating demand / fabric U-value and number of units in terrace



Graph shows impact of improving the U-vale of wall and roof on space heating demand. Also, number of units in terrace lines are plotted for 1, 2, 3, 4, 5, 6, 10 and 20 units. Darkest shade of blue line represents detached dwelling and lightes shade line represents 20 units in terrace.

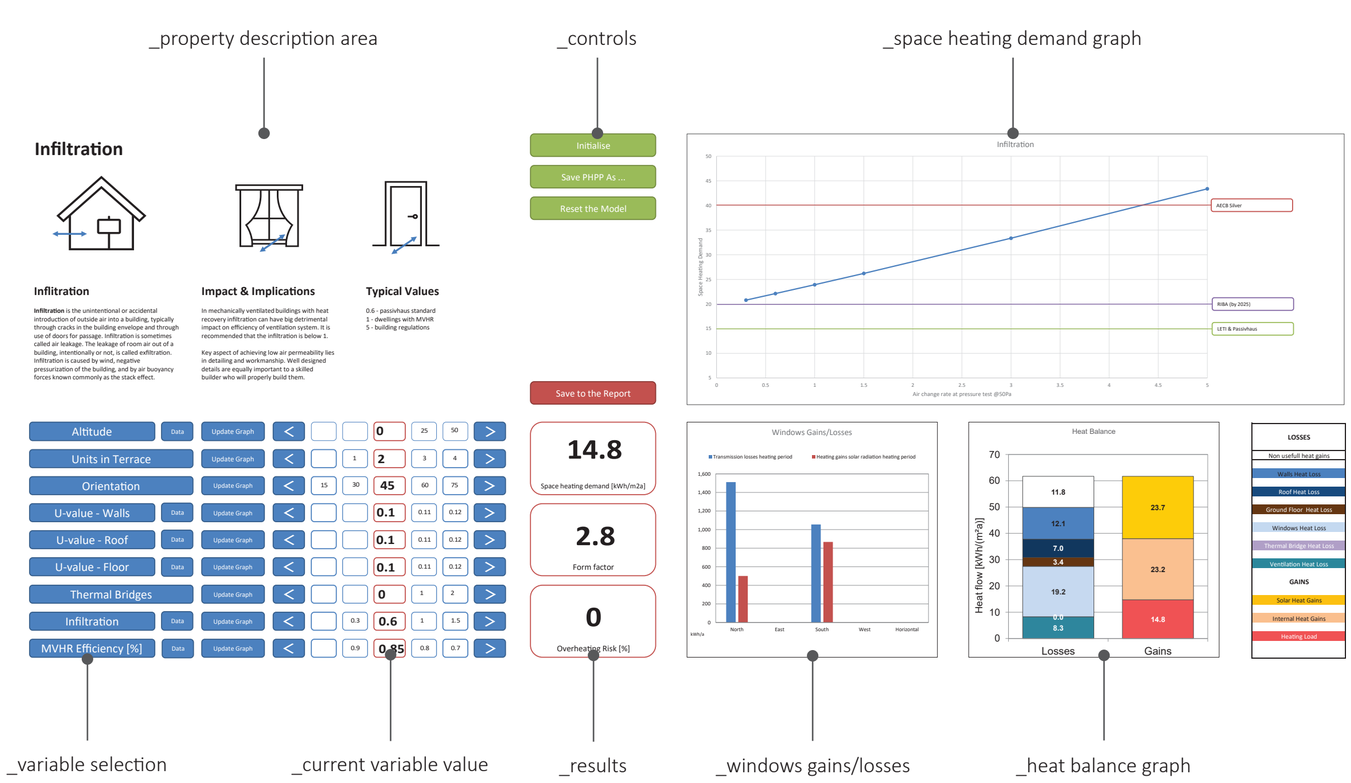
Space heating demand and overheating / deviation from North



Graph plotting building rotation at 5° increments and impact of rotation on overheating and space heating demand. This is useful to see the impact when primary facade cannot be orientated towards South (or North).

PHPP Dashboard

Currently we are working on further developing the tool based on feedback from the pilot study. Our goal is to create an interactive excel dashboard where: each variable can be changed easily and selected results from the model are updated live. Selecting each variable gives brief description of what it is and how it impacts the energy use, graph (one or more depending on layout) showing space heating demand is updated live- this should help visualise the impact of each change. Initial pool of variables will be expanded to allow control over: site location (climate and altitude), building orientation, units in the terrace, fabric U-values, thermal bridging, window properties, renewable energy generation, ventilation and more. The aim will be to create an excel based tool which can be quickly connected to a PHPP model of any type of building and which increase the base functionality of the model and also increase the speed of execution when comparing different design options. The tool is not intended to give accurate finalised PHPP models but rather demonstrate the impact of the design choices by showing the sensitivity of the building to each change.



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