Predicting the Solar Energy and Space-heating Energy Performance for Solid-wall Detached House Retrofitted with the Composite Edge-sealed Triple Vacuum Glazing

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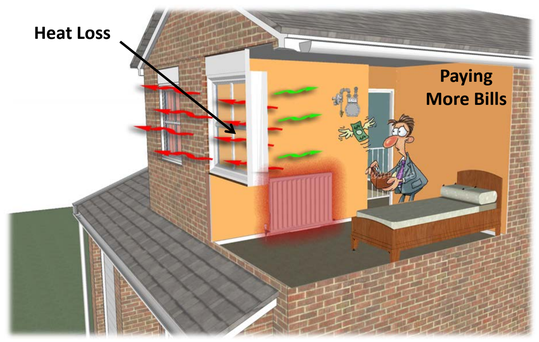
OVERVIEW OF RESEARCH

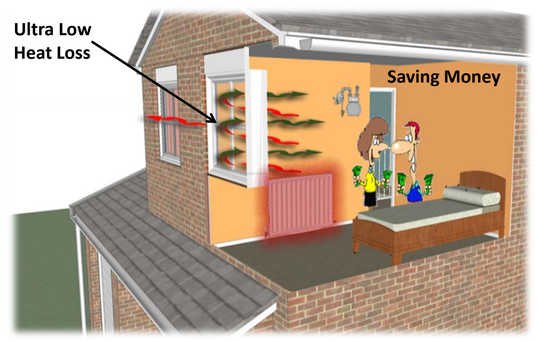
A Big Picture

Problem



Heat loss through the windows of dwellings is a major concern due to the increase in use of natural gas in domestic boilers that not only increases the gas utility bills but also emits CO_2 that is a greenhouse gas.

Solution



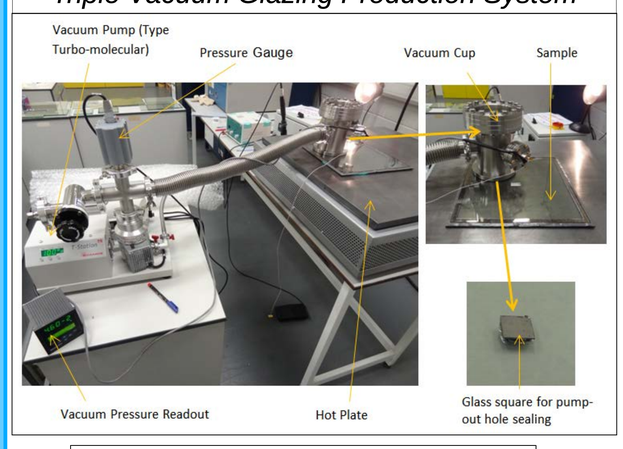
Vacuum glazing can not only reduce gas bills and CO_2 emissions but allows an increase in the window to wall area ratio that permits an increase in day light transmittance and solar gains.

ABSTRACT

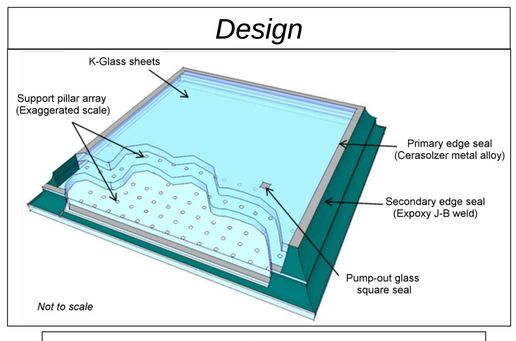
Existing UK solid-wall houses, which have both heritage values and historic fabric, are being improved but yet they tend to have preventable heat loss through windows. Triple Vacuum Glazing is regarded as evolutionary step in minimising the space-heating loss. This poster takes a comparative analysis approach to envisage space-heating supply required for achieving thermal comfort temperatures and attainable solar energy gains to households with the retrofit of the thermal transmittance (U-value) of a new composite edge-sealed triple vacuum glazing i.e. 0.33 $Wm^{-2}K^{-1}$. 3D dynamic thermal models (timely regimes of heating, occupancy, ventilation and internal heat gains) of an externally-insulated solid-wall detached house with a range of existing glazing types along with triple vacuum glazing with frame areas are modelled. The predictions of varying window-to-wall ratios on space-heating energy and solar energy gains for winter months are analysed. The notable winter and annual space-heating energy savings of 14.58% (EUR 49.2) and 15.31% (EUR 105.4), respectively, were obtained with the solid-wall detached house retrofitted with triple vacuum glazed windows compared to single glazed windows. The heat loss calculations show a prominent reduction from 12.92% to 1.37% when replacing single glazed windows to triple vacuum glazed windows.

INTRODUCTION

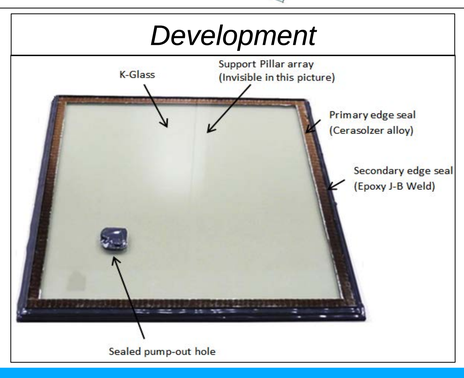
Triple Vacuum Glazing Production System



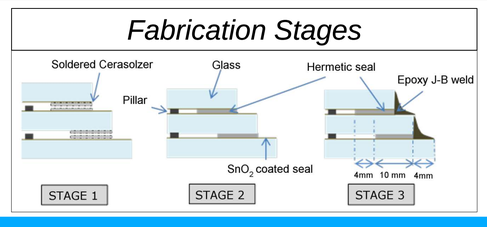
Design



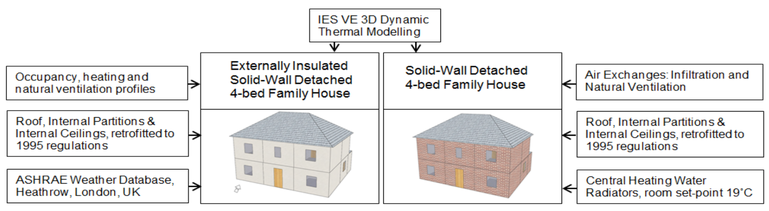
Development



Fabrication Stages

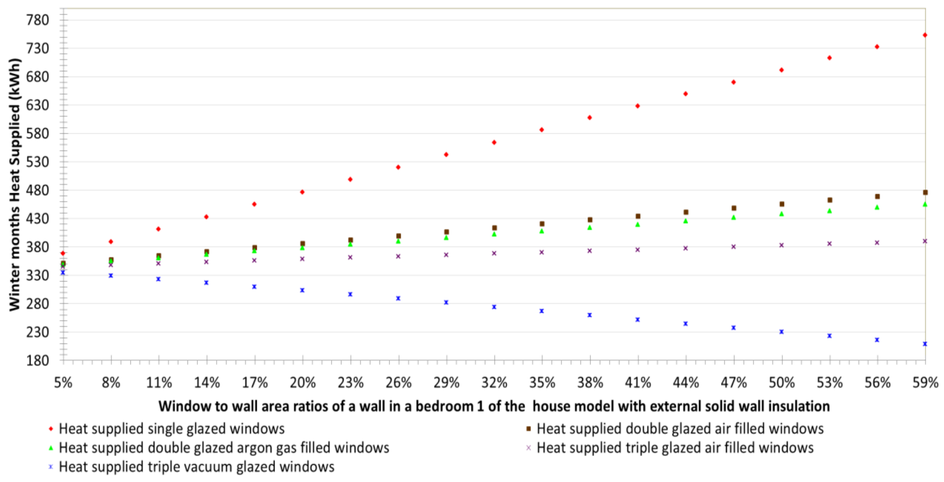


METHODOLOGY



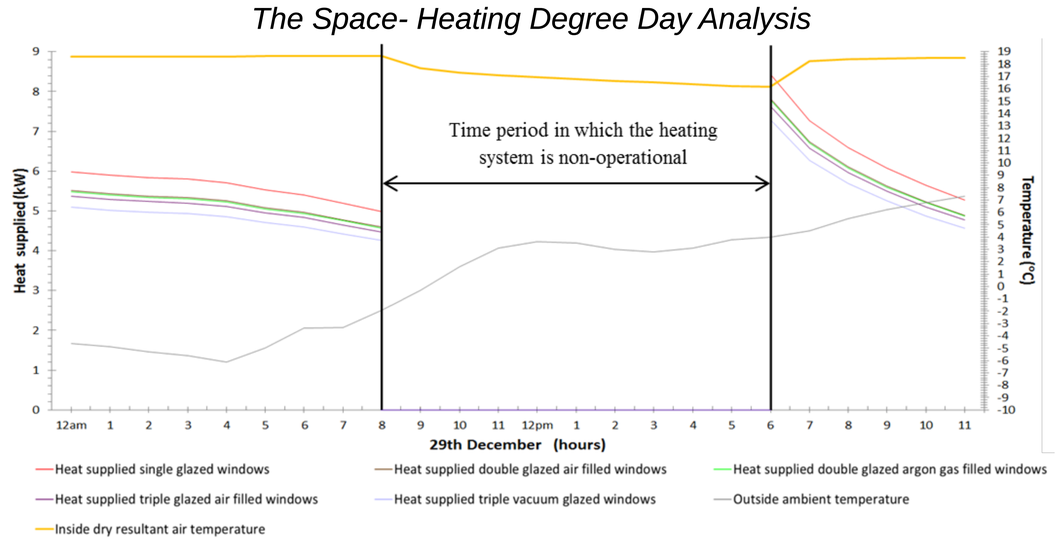
RESULTS

Influence of Varying WWR on Space Heating

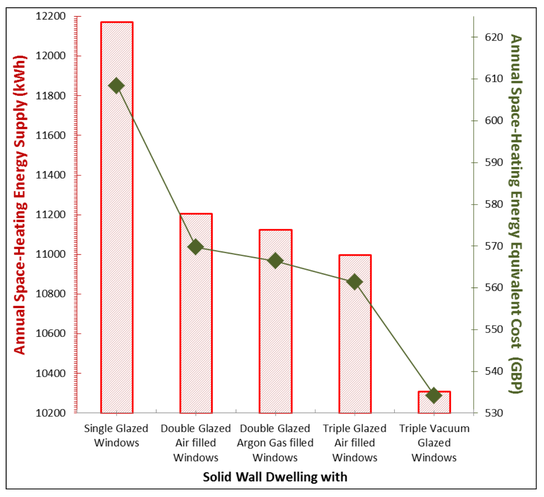


RESULTS

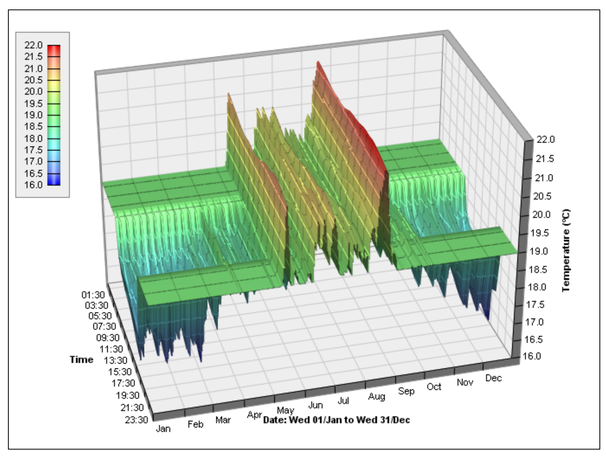
The Space- Heating Degree Day Analysis



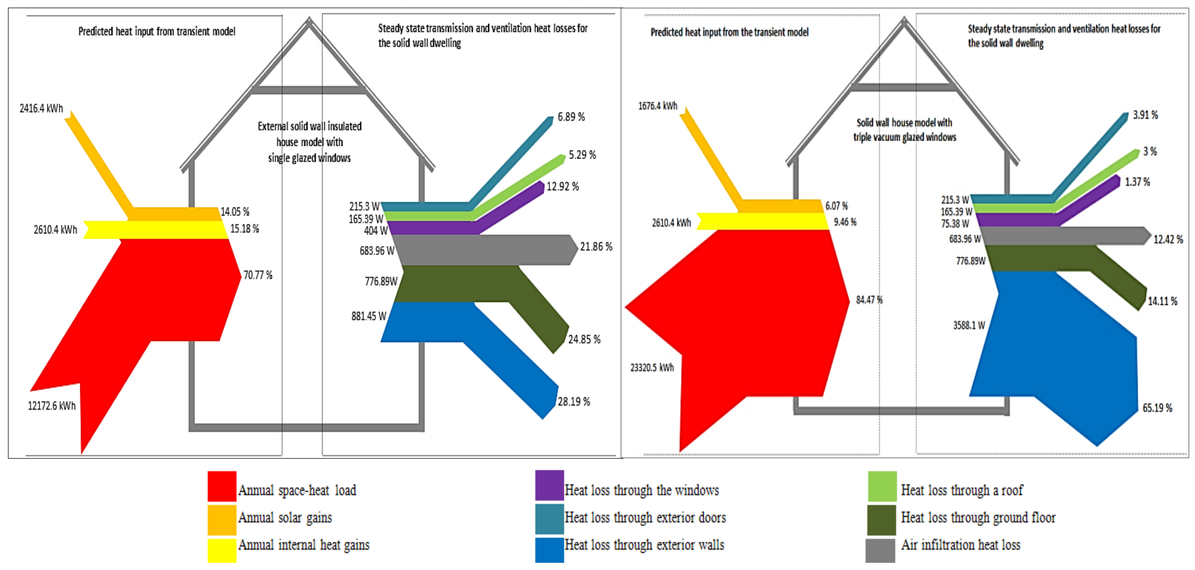
Annual Energy & Cost Savings Analysis



Inside Dry Resultant Air Temperature with Triple Vacuum Glazed Windows



Analysis of Changes in Heat Flows



CONCLUSIONS

The triple vacuum glazing, if manufactured at the mass production level with cost-effective airtight sealing materials and improved fabrication methods, is a great opportunity in reducing building energy consumption and carbon emissions and has a potential to increase window-to-wall area ratios for more solar gains, specifically in the cold arid climates.

ACKNOWLEDGEMENTS

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III. Memon, S. 2014. Analysing the potential of retrofitting ultra-low heat loss triple vacuum glazed windows to an existing UK solid wall dwelling. Int. Journal of Renewable Energy Development, 3(3), 161-174. DOI: 10.14710/ijred.3.3.161-174.