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Accurate Energy Assessment Technique for Mine-Water District Heat Network

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Abstract : UK buildings and energy infrastructures are heavily dependent on natural gas, a large proportion of which is used for domestic space heating. However, approximately half of the gas consumed in the UK is imported. Improving energy security and reducing carbon emissions are major government drivers for reducing gas dependency. In order to do so there needs to be a wholesale shift in the energy provision to householders without impacting on thermal comfort levels, convenience or cost of supply to the end user. Heat pumps are seen as a potential alternative in modern well insulated homes, however, can the same be said of older homes? A large proportion of housing stock in Britain was built prior to 1919. The age of the buildings bears testimony to the quality of construction; however, their thermal performance falls far below the minimum currently set by UK building standards. In recent years significant sums of money have been invested to improve energy efficiency and combat fuel poverty in some of the most deprived areas of Wales. Increasing energy efficiency of older properties remains a significant challenge, which cannot be achieved through insulation and air-tightness interventions alone, particularly when alterations to historically important architectural features of the building are not permitted. This paper investigates the energy demand of pre-1919 dwellings in a former Welsh mining village, the feasibility of meeting that demand using water from the disused mine workings to supply a district heat network and potential barriers to success of the scheme. The use of renewable solar energy generation and storage technologies, both thermal and electrical, to reduce the load and offset increased electricity demand, are considered. A wholistic surveying approach to provide a more accurate assessment of total household heat demand is proposed. Several surveying techniques, including condition surveys, air permeability, heat loss calculations, and thermography were employed to provide a clear picture of energy demand. Additional insulation can bring unforeseen consequences which are detrimental to the fabric of the building, potentially leading to accelerated dilapidation of the asset being ‘protected’. Increasing ventilation should be considered in parallel, to compensate for the associated reduction in uncontrolled infiltration. The effectiveness of thermal performance improvements are demonstrated and the detrimental effects of incorrect material choice and poor installation are highlighted. The findings show estimated heat demand to be in close correlation to household energy bills. Major areas of heat loss were identified such that improvements to building thermal performance could be targeted. The findings demonstrate that the use of heat pumps in older buildings is viable, provided sufficient improvement to thermal performance is possible. Addition of passive solar thermal and photovoltaic generation can help reduce the load and running cost for the householder. The results were used to predict future heat demand following energy efficiency improvements, thereby informing the size of heat pumps required.

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