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Retrofitting heat pumps in nondomestic buildings: lessons from Project 60

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Abstract

Decisions about retrofitting heat pump systems to non-domestic buildings are complex because of the interplay between the numerous system options; the variety of building type; the need for compatibility with and existing HVAC systems; differing levels of building refurbishment, and users' aspirations for carbon efficiency. This paper is an Applied Research Paper in the Conference Pillar "Heat Pumps for accelerated decarbonisation", relating to the theme. "Heat pumps in building renovations". It provides an overview of the guidance tool developed by Project 60 of the IEA Technology Collaboration Programme on Heat Pumping Technologies: "Retrofitting Heat Pump Systems in Large Non-domestic Buildings". More detailed information can be found on the project website [2]. Insight was also gained into the current structure and size of the market, principally in the UK. The project was led by the UK, with participation from research and industry-based organisations and individuals in Austria, Canada, Ireland, Italy. Netherlands and Sweden.

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Keywords: Non-domestic; Retrofit; Deployment;

Introduction

The use of heat pumps to heat buildings is now an established practice: the principal policy issue is how to accelerate deployment without compromising quality and thus using low-carbon electricity to abate carbon emissions [1]. Most policy activity has been focussed on applications in dwellings, which constitute the majority of buildings. Less attention as been given to the less numerous but larger non-domestic buildings, which typically account for about one third of national heated floor area. Non-domestic buildings are more varied in size and usage than dwellings and contain a wider variety of heating and cooling systems. Replacement of fossil-fuel HVAC systems by heat pumps is inherently more complex than like-for-like boiler replacement, or installation in new buildings, largely through the need for compatibility with the existing HVAC systems. With the market still at an "early adopter" stage, this results in a complicated and unfamiliar landscape for decision-makers in businesses and other organisations that own or occupy non-domestic buildings. The project's literature review found few examples of technical guidance on retrofitting heat pumps to nondomestic buildings though more is now becoming available. Heat pump manufacturers can provide product information including on some aspects of system design and may recommend installers who have received product training, but they are generally reluctant to involve themselves with other aspects of system design.

The objective of Project 60 “Retrofitting Heat Pump Systems in Large Non-domestic Buildings” [2], [3] is to provide these decision-makers with initial guidance on the viable options for the early, strategic design stages, when they have decided that they should consider retrofitting a heat pump but are unclear about which systems may be suitable for their circumstances. Its principal deliverable is an interactive on-line guidance tool, linked to examples of existing retrofit projects. This is intended to encourage deployment by providing an initial selection of system options for more detailed consideration. This is far from being “investment-grade” advice and users of the guidance need to be clear that assessment of the building by experienced suppliers and designers is necessary before taking any firm decisions.

Target Users

The purpose of the guidance is to help decision-makers within organizations that own or occupy non-domestic buildings to prepare themselves for detailed discussions with suppliers, installers, and designers of retrofit heat pump systems. The need for this will depend on individuals’ roles in the decision-making process: these roles will vary between businesses of different size and complexity and their procurement procedures.

The main procurement routes in the nondomestic HVAC market are:

- *Install Only*. The default route for like-for-like boiler replacements
- *Design & Install.* Common for medium sized non-domestic HVAC projects
- *Design–Bid–Build*. Common for public sector projects and larger private projects
- *Performance/Service Contract.* Most commonly for public sector buildings

In general, public authorities and larger private businesses use the more formal routes, which include competitive tenders based on system specifications written by professional engineers. Decision-makers in these bodies should have access to specialist advice, though some individuals in the approval chain may benefit from early-stage guidance. Large organizations account for the majority of energy consumption in the non-domestic building sector, but only a small proportion of the customers. The building stock is similarly characterized by relatively few large buildings that collectively contain most of the heated space and a large number of smaller buildings.

There is evidence from the UK that about one third of large organizations have considered installing a heat pump (but generally not proceeded to do so) while only 7% of the smaller ones have [4] - about the same as the number of replacement boilers sold. This suggests that larger organizations are already aware of heat pump retrofit options. Nevertheless, the lower interest from the large number of small businesses means that, on aggregate, they account for most of the potential market – with scope for further expansion if awareness and motivation increase. Smaller businesses are thought to be more reliant on “design and install” or “install only” procurement for their HVAC services – typically maintenance or boiler replacement. An increasing number of these providers have experience of heat pumps – and some can offer excellent guidance - but in the present “early adopter” state of the heat pump market, it is inevitable that many do not. A UK survey of installers [5] showed that their main source of work was by word-of-mouth referrals, though slightly less so for larger businesses (10+ employees), who were more likely to also obtain work via maintenance contracts or competitive tenders. The larger installers were also more likely to work in existing nondomestic buildings. Installers who offered heat pump services had a similar profile to the larger installers but were more likely to obtain work from manufacturers’ referrals. Only 20% of installers had installed a heat pump within the previous two years, though an additional 14% said that they had received training to do so. Some raised concerns that they did not install regularly enough to retain the knowledge they learned through training.

This suggests that on-line early-stage guidance will be most useful to small and medium-sized businesses who have responsibility for their own heating, to professional engineers in their early discussions with clients, and to other, non-technical decision makers within the approval chain of larger organizations. Other decision-makers are likely to find the information helpful, so it is important for the guidance to be accessible and understandable to a wide range of users. Heat pump retrofit an important element of building decarbonization but not the only one, and this guidance provides is only the initial step.

Overview of the Tool

Figure 1 provides an overview of the structure of the tool. Users can access the information sheets (case studies) or system descriptions directly or can use the "Smart Guide" logic to obtain a tailored shortlist. Fig 2 presents more detail of the filtering process. The tool user answers 14 questions relating to their building, its current heating system and the anticipated level of alteration to the building fabric or the existing HVAC system. These are used to progressively eliminate options from an initial list of 27 possible types of system, which leaves the short-list of options for further consideration.

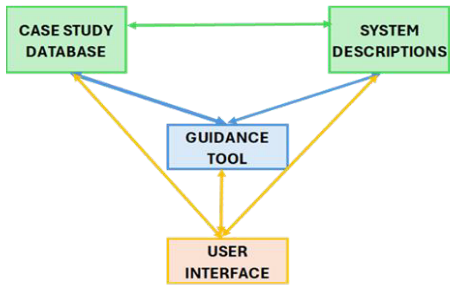

Figure 1 Tool Structure

System Filtering Questions (Yes/No) – Note: some questions are contingent on others
Is there a suitable space outside or on the roof for the outdoor units of an air-source heat pump?
Is their a suitable space for boreholes or ground trenches?
Is there access to a suitable aquifer?
Is there a suitable open water source (river, lake or sea)?
Is there an accessible source of warm exhaust air?
Is there a nearby source of suitable waste heat?
Is the electricity supply to the building sufficient for a heat pump system?
Is the heating system a centralised hydronic fossil fuelled system?
Does the heating system use ducted warm air? (Including RTUs)
Is the heat provided by a hydronic subsystem
Is heating provided by fossil fuelled or direct electricity individual room units?
Does the air conditioning system include a water chiller?
Is the heating systems a fossil fuelled high temperature radiant system?
Is the heating system a steam system?
Is the building located in a very cold climate?

Table 1 System Filtering Questions

Most of the questions require a "yes" or "no" response: if the tool user is unsure how to respond, they are recommended to make enquiries or to explore how sensitive the shortlist is to alternative responses. The shortlist is accompanied by information sheets on realised projects of similar buildings. Users can directly interrogate the database of information sheets ("case studies") or the system descriptions.

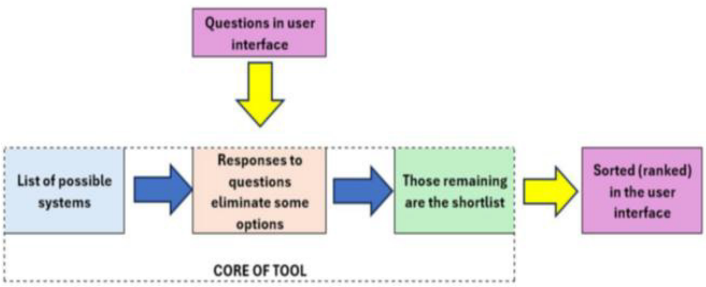

Figure 2 Filtering process

Case studies (information sheets)

For demonstration purposes, the database in the tool has been initially populated with 60 information sheets, chosen to represent a wide range of buildings and systems. This will be expanded: the project has collected over 200 case studies from which information sheets can be produced. These are automatically selected by the "Smart Guide" according to whether they represent short-listed system options and how well they reflect the building type and size, the existing HVAC system, and the anticipated level of fabric upgrade of the building. Each information sheet contains a short description and a photograph of the building, and its original and new heating system. Links to published descriptions of the projects are provided. Detailed descriptions can be included when they are available.

The distributions of sectors and systems in the database provide some market insight but the sample is not statistically structured, and three-quarters are from the UK, so this can only be illustrative. Nearly half of the retrofits are in public buildings, notably in healthcare and education, reflecting the impact of the UK Public Sector Decarbonisation Scheme (PSDS), which provides financial support to the sector. In the private sector the most commonly publicised heat pump retrofits are in office buildings, especially in locations where substantial refurbishment motivated by higher rental values for good energy and environmental ratings. Just over half the systems located were air-source systems of which a quarter were identifiably hybrid or high temperature systems. Informal feedback from suppliers suggests that the potential share of hybrid systems may be under-represented. About one quarter of the systems (by number) were ground- or aquifer systems: as these are typically much bigger than air source systems, this will under-represent their contribution in terms of power and energy consumption. Although exact numbers are unknown, ground-source systems are more common in countries with colder climates such as Sweden and Canada, and aquifer systems are more widely used in the Netherlands.

Ranking the Options

Figure 3 shows relative levels for capital cost and carbon savings (to remove the impact of the carbon intensity of electricity the scales are indices relative to the best-performing system for each metric). The systems with the best financial payback would be in the bottom right segment. The figure is based on sparse data and only shows broad generalisations; namely that many systems can provide broadly similar savings: the final choice will depend on features specific to a particular site and building. Different users may also have different priorities when ranking the system options: for example, some may prioritise capital cost and others carbon reduction.

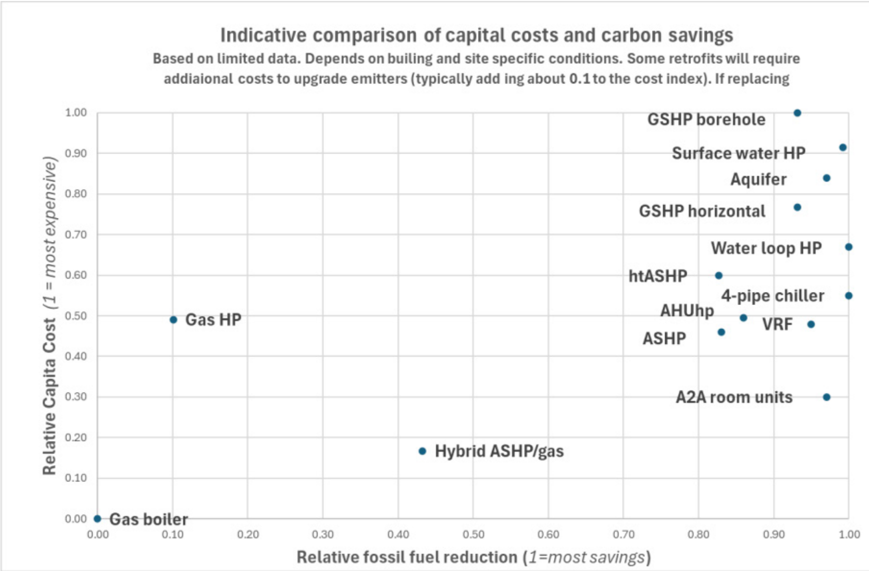

Figure 3 Indicative Relative System Characteristics

Tool Status

As of November 2025, the implementation of the procedures as an online tool is in progress, to be followed by testing and evaluation. It will then be accessible via the TCP website. There is scope for potential development will beyond this project: for example, individual countries or regions may wish to create their own versions.

Information Gaps

The project revealed several areas where important information was missing or not accessible. Fundamentally, there is a scarcity of national information on the structure and size of non-domestic building stocks and retrofit markets which makes it difficult to see how effective, robust policy instruments can be devised for this complex but important market sector. The aims of the project were directly impacted by a shortage of information on the actual costs and levels of system performance of completed installations, and the limited number of accessible design studies that had evaluated alternative solutions to the same design challenge. There were also very few detailed "deep dive" case studies that explored system operation and performance in detail: a few possible future studies have been identified. An initial literature review found very little guidance for building owners or system designers on nondomestic heat pump retrofit. During the life of the project more has appeared and is noted in the references [6, 7, 8, 9, 10, 11, 12, 13]. As with this project, they are mostly based on estimates and product data rather than on in-use experience.

Project Outcomes

The project has categorised the different types of heat pump system that can be retrofitted to nondomestic buildings and has developed a systematic procedure for identifying those most suitable for specific buildings, subject to further on-site assessment. This has been implemented in an online guidance tool, which also provides information sheets describing existing retrofit projects of similar buildings that use systems that appear in the shortlist. It also provides generic descriptions of the systems. The database of information sheets includes examples from each participant country, but the majority are currently from the UK. The tool will be usable for other projects and can be modified in the light of experience and for application in a wider range of countries. It had been hoped to provide detailed performance and cost data for the case studies, but the necessary information was not available. It was also hoped to provide "deep dive" insights into the detailed performance of a range of systems, but this proved to be impossible

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