ARUP

Technical Note

Project title	Hereford Education Centre
Job number	294443
File reference	4-09
cc	
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Date	19 September 2023
Subject	Connection to the new Energy Centre District Heat Network

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1. Background

The new Education Centre will be constructed within the Hereford County Hospital site, directly adjacent to a new Energy Centre. This Energy Centre is a separate project designed by Centrica for Wye Valley NHS Trust and will provide heating only to the existing main hospital via a new local District Heat Network (DHN) running between the Energy Centre and plate heat exchangers in the main hospital plantroom.

Given the very close proximity of the Education Centre to the Energy Centre, with the completion of the Energy Centre due prior to the completion of the Education Centre, careful consideration has been given to connecting into the Energy Centre's DHN to provide the heating and hot water requirements for the Education Centre. After evaluating the environmental, compliance and cost considerations, informed by workshops with the Energy Centre designers Centrica, we have concluded that it would be better not to connect into the new DHN but rather provide separate independent heating for the Education Centre.

This technical note explains in more detail the reasoning behind this decision.

2. Environmental Considerations

Based on our workshop discussions with Centrica, we understand that the Energy Centre will use Air Source Heat Pump (ASHP) technology for the heat network. ASHPs have the potential to offer a substantial efficiency saving over gas-based technology, and with it lower carbon emissions. In order to realise this efficiency, it is necessary to operate the ASHPs at a relatively low heating flow temperature, e.g. 35-45°C. The lower the temperature, the higher the efficiency, also known as Coefficient of Performance (CoP). As an example, an ASHP generating a heating flow temperature of 40°C might have a CoP of 3 – meaning that for every 1kW of input electrical power, 3kW of heating output is produced. However running it at a temperature of 70°C might mean a CoP well below 2 or even 1. Centrica have informed us that it is necessary to operate the DHN at a high temperature of around 85°C. This is because it needs to match the operating temperatures of the original main hospital radiant panels, radiators and air handling unit coils – which were based around fossil fuel heating technology. This means the Energy Centre ASHPs will have to run at an inefficient operating temperature, which would then set the operating efficiency of the Education Centre if it were to connect into it.

From an environmental perspective it is therefore better to provide the Education Centre independent ASHPs running at lower flow temperatures than connecting to a DHN powered by ASHPs running at much less efficient higher flow temperatures. The operational carbon emissions will be much lower with the optimised independent ASHPs.

3. Compliance Considerations

All new buildings in England have to comply with the Building Regulations, and specifically in terms of conservation of fuel and power, Approved Document Part L (2021).

Part L requires that the proposed design (the actual building model) be compared against a pre-determined notional design (the notional building model), and looks at both carbon emissions and energy. To comply with Part L, the calculated Building Emission Rate (expressed as $kgCO_2/m^2/yr$) and Building Primary Energy Rate (expressed as $kWh/m^2/yr$) of the actual building must be less than the notional building's Target Emission Rate and Target Primary Energy Rate.

Part L is written in a way that favours the use of Low and Zero Carbon (LZC) technologies – such as ASHPs. Therefore technologies that are not heat-pump based are at a disadvantage when trying to demonstrate compliance. Specifically, the issues are:

3.1 Not using heat pump technology (direct connected)

If the building is using a DHN, even if the DHN is ultimately served by ASHPs, Part L applies a pre-determined quantity of solar PV technology to the notional building model. This acts as an additional improvement that the actual building model would need to match. This means that any Part L compliance improvement that could have been gained by using solar PVs could be cancelled out by the PV applied by Part L to the notional building model. This acts as a penalty that in many cases could make Part L compliance impossible for non-heat pump projects that do not have solar PV or limited roof area that restricts the amount of solar PV that could be provided. This therefore presents a Part L compliance risk**.**

3.2 Connecting to a new DHN – CO_2 emission factor and primary energy factor

Where the building connects to a new DHN, the CO_2 emission factor and Primary energy factor need to be provided by the DHN designer, and is used in the Part L calculation. This was discussed with Centrica but we have not yet received any information in this regard. However, based on the known constraint of the ASHPs operating at high temperature, these factors are likely to be poor in comparison to ASHP system operating at optimised low temperatures, and therefore presents a Part L compliance risk. At the very least, we would expect the compliance margin of a DHN source building to be worse than could be achieved by an ASHP source building. This would then also have negative impact on BREEAM (Energy credit Ene01).

3.3 Connecting to a new DHN – minimum standards

Where the building connects to a new DHN, Part L applies a fix distribution loss assumption of 33% to both the notional and actual building models – ensuring parity. But this is only the case if the DHN is fully compliant with CIBSE CP1 (best practice guidance for DHNs). It is not straightforward for the DHN designer to prove compliance with CP1, and as it is guidance, may not have been designed to fully comply. Should CP1 compliance not be possible to demonstrate, Part L imposes a 50% distribution loss penalty to the actual building model, which is a significant disadvantage, and therefore presents a Part L compliance risk.

3.4 Not using heat pump technology (direct connected)

If the building is using a DHN, even if the DHN is ultimately served by ASHPs, Part L applies a pre-determined quantity of solar PV technology to the notional building model. This acts as an additional improvement that the actual building model would need to match. This means that any Part L compliance improvement that could have been gained by using solar PVs could be cancelled out by the PV applied by Part L to the notional building model. This acts as a penalty that in many cases could make Part L compliance impossible for non-heat pump projects that do not have solar PV. This therefore again presents a Part L compliance risk.

4. Cost Considerations

4.1 CAPEX

In discussion with Centrica, it was clear that their original brief (related to funding constraints) did not allow for the additional heating / hot water capacity of the Education Centre. This means that there is a cost in terms of equipment upgrading (e.g. larger model of ASHPs, pumps) in order to support the Education Centre, or any other development in the future. There may also be re-design fees associated with these changes.

In terms of major plant items, there is little difference between fully independent ASHPs for the Education Centre and a DHN connection for the Education Centre. This is because the Education Centre requires cooling as well as heating due to the heat gains from the high occupancy and ICT levels within the building. As the DHN only provides heating, the Education Centre would still require cooling in the form of an air cooled chiller(s). A chiller is comparable to an ASHP in terms of physical size and cost – but in the case of independent ASHPs, they would be used to provide both heating and cooling from the same unit. In both cases therefore the amount of major plant is the same.

4.2 OPEX

As discussed within the section on environmental considerations, the DHN would run at a much lower operational efficiency than the independent ASHPs. This translates directly to higher operational costs. As a notional example, if the independent ASHPs were to operate at an average CoP of 3, and the DHN ASHPs at an average CoP of 1.5, then the DHN operational costs will consume twice the electrical power for the same output and be double the cost to run.

5. Summary

Based on careful consideration of the environmental, compliance and economic factors in the use of the DHN, we have concluded that for all these factors the better solution is to have independent ASHPs for the Education Centre. It would produce less carbon emissions, has comparable CAPEX costs, significantly lower OPEX costs and removes a significant compliance risk.