by Joel Kirby and Ned Maynard

Heat Decarbonisation at University Hospitals Bristol and Weston (UHBW)

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Introduction

Bristol City Council is arguably the UK leader at a local authority level in their response to the Climate Emergency. They were the first council to declare a Climate Emergency in November 2018, the first to embed leadership of the New Green Deal in their Cabinet structure, the first to review their progress against the United Nations' Sustainable Development Goals, and the driver of a motion to the Local Government Association which saw 435 additional councils declare a Climate Emergency.

Since then, the council has expanded the vision in their "One City Climate Strategy", released on 26th Feb 2020, outlining ambitious targets for carbon neutrality by 2030, significantly faster than national 2050 legislation. A key emphasis of this plan is that it is a "shared vision for Bristol in 2030" that "will need the collaboration of multiple partners across the city to reach our goals". University Hospitals Bristol and Weston NHS Foundation Trust (UHBW) is one such partner. With a workforce of over 13,000 staff, the Trust delivers over 100 different clinical services across 10 different sites, serving a core population of more than 500,000 people. The trust has two main campuses in Bristol city centre and in Uphill, Weston-Super-Mare.

The strong push from the Council was a key enabler to help write the internal business case for the Trust's own Climate Emergency declaration in October 2019, and development of our Sustainable Development Strategy. Despite the challenges of the pandemic, we have appointed a new Head of Sustainability and recruited both of the authors' roles, dedicated to the delivery of our ambitious target for carbon neutrality by 2030.

Current Set-Up

When starting at the Trust in the summer of 2020 we were shown the energy centre for the Bristol city centre campus, containing duel-fuel steam boilers in combination with a 3.6MW gas-fired CHP unit. These heat sources feed a lower temperature hot water (LTHW) district heating system (85C/75C) to four buildings on the northern half of the campus closest to the energy centre.

The rest of the southern half of the site is fed via a steam-based district heating system that serves the majority of the total annual site thermal demand of 36,800 MWh. There are also a number of stand-alone gas supplies feeding local boilers in areas difficult to reach with district heating. All of this is controlled via a building management system (BMS).

Weston General has previously had the existing steam system removed, replaced with LTHW fed by a 550kW gas-fired CHP and condensing boilers which supply the main hospital building with an annual thermal demand of 4,600MWh. There are also various other smaller buildings with

their own gas-fired boilers. The majority of the site is controlled by a central BMS, however some of the smaller outbuildings have local controls.

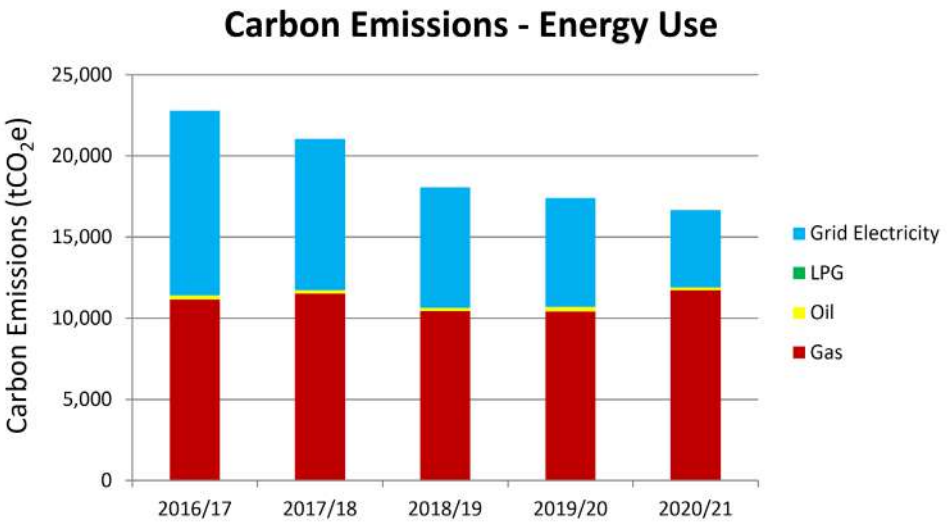
Historic Emissions

You can see from the graph on the right that emissions from energy use have been decreasing slightly over the past five years, primarily driven by the wider decarbonisation of the national electricity grid. This shows the key challenge for any heat decarbonisation project. The national grid future scenarios place full decarbonisation of electricity somewhere around 2034, but unlike electricity, the national gas network is not on a decarbonisation trajectory, meaning the only way to reduce emissions is to reduce or generate locally on-site.

Over the past five years heat-based emissions (gas and LPG) have actually increased, due to the introduction of a new CHP at Bristol, and the merger with Weston in 2020/21. Gas-fired CHP technology is financially lucrative due to the comparatively cheap price of gas yet does not offer a pathway to decarbonisation.

The Plan

To achieve net zero emissions across our scope 1 and 2 carbon emissions, there are many elements we will need to tackle as a Trust - the main one being around our heat and how we supply this around the various hospital buildings in the Trust. This relates to number of elements, from technology selection, building controls and improved efficiency within the buildings.



Both CHPs are 'hydrogen-ready', meaning we could switch the fuel source from natural gas to emissions free hydrogen. This is the optimal solution as it would mean we could keep the existing engines and continue to generate electricity on-site. Unfortunately, it does not look likely that hydrogen will be a technologically or economically viable fuel source in time. The UK government recently released a paper on plans to accelerate hydrogen fuel generation, starting with industrial clusters in the North of England, but the same paper estimates we will not see nationwide adoption until approximately 2050.

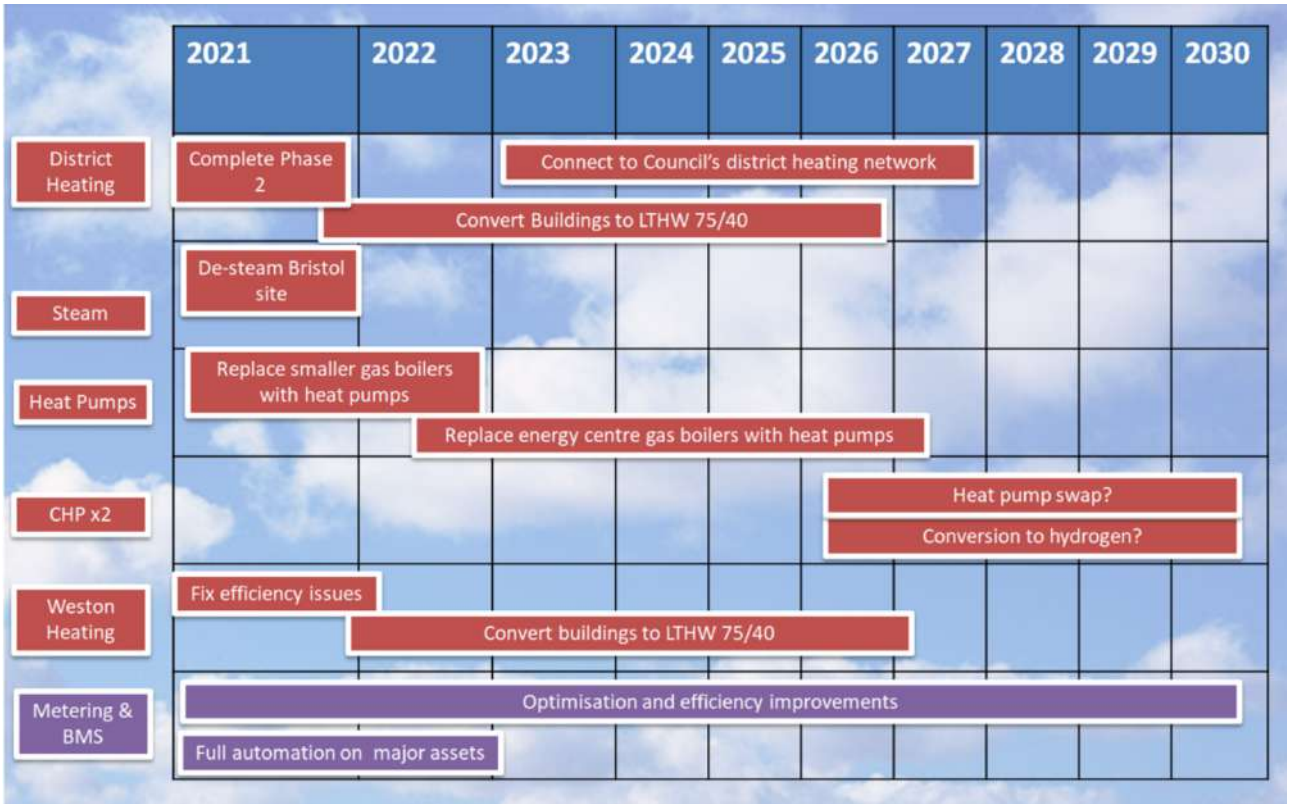
Really, this only leaves one technologically viable option, removing both CHPs and replacing them with heat pump technology. Initial assessments using the British Geological Survey's "Open-loop GSHP screening tool" showed that both sites sit on a low productivity aquifer and may not achieve the required borehole flowrate to make ground source viable, meaning we are most likely looking at the introduction of air source heat pumps (ASHPs) to replace the CHPs and gas boilers.

With ASHPs in mind, we worked backwards to establish a road map for heat decarbonisation. The technology could come from two sources, either we install them ourselves, or we connect to Bristol City Council's (BCC) network and take advantage of the fact that they are working to achieve the same decarbonisation timescales as us. We could also see a hybrid situation where we connect with BCC and also have our own heat pumps on site to feed into the wider city network ourselves.

With any heat pump option there are however technological limitations. In order to get an efficient and cost viable system, the coefficient of performance (CoP) of the system needs to be over 3.0. This dictates specific lower flow and return temperatures and a major blockade to achieving this at the Bristol Precinct is the steam system which remains across a large section of the portfolio, as well as large sections of older obsolete Sigma BMS controllers. These will all need to be considered in the Trust's plan to decarbonise heat in the future.

Recent Progress – Salix

In November of 2020, we made a successful bid to the Public Sector Decarbonisation Scheme (PSDS) via Salix Finance and were awarded £17m



for a range of works centred on our heat decarbonisation road map.

Bristol Salix Projects

At Bristol, the bulk of the funding is going towards converting the remaining steam district heating on the southern half of the site to a LTHW system to match the existing four buildings near the energy centre. The remaining steam boilers will also be replaced with duel-fuel gas boilers for LTHW. This is estimated to result in an emissions reduction of 2,122 tCO2e per year.

Removing the steam supply does however result in the need to maintain hospital services that use steam. The chief consideration on this project is the Central Sterile Services Department or CSSD, which operates near 24/7 critical sterilisation services for the Trust. The initial design to electrify CSSD used electrode boilers to generate steam, but we realised we could pre-heat the feed water intake of the washers via the new LTHW district heating and generate steam within the washers themselves, removing the need for external steam boilers. There is a significant power draw to electrify the steam generation, requiring a new 1.7MVA transformer to supply the building, but the LTHW system should be able to provide about 63KW of pre-heat.

Some of the smaller external buildings were not feasible to connect onto the newly expanded district heating network. For these, funding has been secured to convert the supplies to standalone ASHPs, achieving around 6.97 tonnes of CO2e in its first year of operation and permanently removing the gas supplies from the buildings.

Weston Salix Projects

Weston General Hospital comprises of a main hospital building with smaller external buildings delivering clinical care and admin/training space. Where the main hospital building has already undergone the process of de-steaming, funding was focused on improving efficiency across the site and to connect external buildings to the existing LTHW system to utilise a higher proportion of the available CHP heat.

The current set up at the hospital comprises of a main CHP and 4 boilers providing hot water for DHW and LTHW across the main hospital. This is split into 4 circuits within the boiler room:

- Domestic hot water supplying heat plate exchangers at both ends of the hospital;
- LTHW circuit to a small private ward on the premises;
- LTHW circuit to estates and facilities and several other smaller support offices;
- A main LTHW header in the roof space providing heating for Constant Temperature (CT) and Variable Temperature (VT) systems across the main hospital.

Existing flow testing and low differential temperature (dT) flow and returns have highlighted on many occasions that there are existing

issues with hydraulic separation between the various secondary circuits in the roof space, owing to heat losses and poor heat utilisation from the CHP and boilers during the early and latter stages of winter and fringe months. The funding granted from Salix is being used to rectify these existing issues, as well as to replace existing fixed speed pump sets to re-balance the system and improve the heating control strategy around the hospital. In addition to this, the new heating has been designed to incorporate new secondary circuits to supply LTHW to the external buildings, thereby removing additional gas assets and utilising additional CHP heat when available. The net carbon savings annually are expected to be in the region of 129 tonnes CO2e.

In addition to the new heating system, the Salix funding also allowed for the installation of an air source heat pump in the Academy building, which was deemed too far away to be connected to the new LTHW heating system; a new BMS to resolve any remaining site-wide control issues; and lagging remedials across the entire site to reduce overall heat demands. The projects together will save in excess of 250 tonnes CO2e and align Weston General to the Trust's overall heat decarbonisation road map.

Challenges for Continuing Heat Decarbonisation

Once the Salix projects have been completed, we will have successfully prepared the distribution systems for both sites to switch the heat source from CHP to a lower/net zero carbon alternative. The next stage will be to reduce the temperatures of the network. We are currently looking into how this will be achieved, but in its simplest form will involve reducing the heat demand of our buildings and lowering building-side temperatures.

The current plan is to survey each building to identify the most cost-effective schemes to reduce energy consumption. This might include things like double glazing, insulation, changes to building fabric, or other 'deep-retro fit' measures. The surveys will also look at the possibility of increasing the size of local heat emitters such as radiators or coils.

Another looming challenge will be the increasing demands for electrification from the heat pumps and other sustainability initiatives such as electric vehicle charging. Both Bristol and Weston have very little spare capacity, so we have established an 'Increasing Electrification Working Group' to gather key stakeholders around the Trust to forecast future electricity demand and begin making bids for infrastructure capital to start upgrading the capacity now, in preparation for the expected increasing demands.

Authors' Profiles:

Joel Kirby has worked in the industry since 2015, working with The Restaurant Group, The Celtic Collection and International Convention Centre Wales before his current role as Energy and Sustainability Manager at University Hospitals Bristol and Weston NHS Foundation Trust, working towards the Trusts' Net Zero Carbon targets.

Ned Maynard has worked as a directly employed sustainability professional in a number of industries including records management, construction, and most recently in healthcare. As Senior Energy and Sustainability Manager at University Hospitals Bristol and Weston NHS Foundation Trust, his main focus is on driving progress towards their carbon neutral objectives.