by West Dunbartonshire Council

Queens Quay District Heating Project

West Dunbartonshire Council (WDC) have an ambition to shape the future, with three core objectives. Firstly, they want to lower energy bills for domestic and non-domestic buildings, including reducing heating fuel costs for existing and new residents – contributing towards the alleviation of Fuel Poverty. Secondly, they want to reduce carbon emissions using innovative technologies and finally to increase the security of energy supply.

A major step forward in these ambitions is the introduction of the Queens Quay District Heating project. Queens Quay is an area in the town of Clydebank. Historically used as a ship building location, the ground has lain derelict since the closure of John Browns ship yard during the 1970s. The redevelopment of the entire site features a ground-breaking project of Scotland's largest Water Source Heat Pump (WSHP) installation to date, taking water from the nearby River Clyde at between 6 and 12 degrees centigrade and using it to generate heat which is distributed to customers through an underground district heating pipe network. To oversee the strategic development of the district heating network the Council established a wholly public owned energy company, West Dunbartonshire Energy LLP.

Project background

The ambitious £20million project, was supported with £6.1m funding from the Low Carbon Infrastructure Transition Programme (LCITP) and was completed in December 2020. The main heat supply pipes have been laid across the entire length of the Queens Quay site and have been designed with future extension in mind. The initial phase provides heat to Council offices at Aurora House, the Titan Enterprise Centre, Clydebank Leisure Centre and the new care home at the site, Queens Quay House. Points of connection for additional phases are also in place ready to supply a new NHS Health Centre, over 140 flats with ancillary retail units, as well as Clydebank Library and Clydebank Town Hall. Future connection of West College Clydebank campus and other commercial uses to be delivered are under active consideration.

The introduction of the network makes a major contribution towards West Dunbartonshire Council's climate change targets of net zero by 2045. Residents of more than 1,000 proposed new homes due to be built on the site will be able to enjoy reliable low carbon heating as the district heat network provides an alternative to individual gas boilers at a similar or lower cost. The low carbon system has also been designed to enable future expansion beyond Queens Quay, with scope to heat the Golden Jubilee Hospital some two miles away. Savings are already predicted to be the equivalent to the total carbon footprint of 1,240 local homes using fossil fuels as a primary source of domestic heating. In addition to these savings it has the added benefit of providing clean, inexpensive energy to residents as well as providing a comfortable place to live and enhancing the health and wellbeing of the local residents. Based on heating demand estimates and with a focus on encouraging expansion within the network, it could be able to deliver a cumulative reduction of at least 130,000 tonnes of CO_2 by 2040.

Project execution

To design the system there had to be a mixture of actual data and modelled data as much of the site was either yet to be finished or still to have plans approved. Historical heating data was reviewed to provide WDC with accurate profiles for the new build and in-design sections of the land development. For the existing buildings, gas consumption data was utilised and modelled for future energy needs. The analysis showed that while peak demand would reach approximately 20 Megawatt Thermal (MWth), this load would typically only be required for 25 hours per year. This analysis provided a clear picture of current and future heat requirements and therefore ensured the right decisions were made in relation to the size of the heat pumps. It was however clear that a large amount of preliminary work would be required for the existing building stock if this was to work efficiently with a new heating source. The older buildings on the proposed network were designed for historic heating systems favouring a higher 82°C flow and 71°C degree return, which differ from the new builds, typically based around a 75°C flow and 45°C

return or in some cases lower. To allow the older buildings to operate with lower flow and return temperatures provided by a WSPH, WDC carried out a retrofit of the heating systems by modifying the heating controls and radiators. This enabled a site-wide uniform flow and return temperature, giving the heat pumps a higher coefficient of performance and making the overall system more efficient. Over time with fabric improvements, it may be possible to achieve improved network efficiency by further reducing flow and return water temperatures.

With this work completed, the system could be designed as two 2.65 Megawatt (MW) WSHPs which are intended to run as close to maximum output as possible to optimise efficiency, while in turn delivering most of the annual heat demand. This configuration means that in the summer months, when demand is low, one heat pump can be taken offline at any given time to perform scheduled maintenance, with the other still providing heat. The scheme also has added resilience of two gas boilers installed within the energy centre which, when used, can deliver an additional 15 Megawatt (MW) to meet peak demand. These boilers are only expected to be used during peak demand times or as a backup option. The heat pump process uses ammonia as a refrigerant, therefore an emergency ventilation scheme had to be developed to ensure it met relevant legislation as well as safeguarding anyone in the energy centre or further afield. An internal enclosure which also provides acoustic attenuation was installed to house the heat pumps and associated plant. This is vented via the 30m flue together with flues for the gas boilers. The chimney design was informed by a flue dispersion model which considered the future surrounding residential developments.

WSHPs rely on electricity but have a high coefficient of performance. This means for every MW of electricity used, the heat pumps produce approximately 3MW of heat. One of the biggest challenges faced during the development of the project was designing a system which would maximise the use of the WSHPs and use off-peak decarbonised grid electricity as a primary energy source to ensure maximum carbon emissions reductions. This was made possible in part by utilising a 120,000 litre thermal store which allows the system to optimise off-peak energy supplies and the relatively slow heat pump reaction times to deliver a constant supply of heat to meet fluctuations in demand.

Project evaluation

While the system is already effective at reducing carbon emissions, it will become even more environmentally friendly as the electricity grid continues to decarbonise in the future. Because of the increase of renewable electricity generation contributing to the grid, it is expected that the grid carbon factor should decrease by over 87% between the years 2018 and 2044, with the heat pumps carbon emissions decreasing by a similar amount over that period.

WDC made a firm commitment that the system would not damage the river's ecology, and a comprehensive study was undertaken to ensure consideration of key factors including water temperature, wildlife, eco structure and average flow rate. As well as preserving the river's ecology, the average flow rate was important in determining the distance between where water is taken from for the WSHP supply and where the water is returned, the WSHP return. This was to ensure the system did not collect cooler water which had already been through the system. The abstraction system feeds the heat pumps with 125 litres of water per second each and so ensuring that accuracy of design calculations and providing an effective filtration system were extremely important.

Future plans

The Energy Centre is designed to include future phases and planned expansion, creating an easily expandable district heating network. Extra capacity has been catered for with space inside for a third and fourth heat pump, and an additional thermal store, to be installed as required. To achieve net zero aspirations, the natural gas boilers will be replaced in due course with suitable low-carbon alternatives.