# Appendix A- Further essential background / detail on the proposal

- 1. This report is seeking additional funding and approvals to expand Bristol's heat network and provides an update on heat network installation work carried out to date previously approved by Cabinet (see Cabinet report links below)
  - 1. <u>1 July 2014 Cabinet Report 'District Heating Phase 1'</u>
  - 2. 7 June 2016 Heat Networks Phase 2
  - 3. <u>4<sup>th</sup> September 2018 Bristol Heat Network</u>
  - 4. <u>3<sup>rd</sup> September 2019 Bristol Heat Network further expansion</u>

## <u>Contents</u>

- 1. Rationale for installing heat networks in Bristol
- 2. Heat networks to date/in progress
- 3. New heat networks seeking approval as part of this Cabinet paper:
  - a. Temple
  - b. Bedminster
- 4. Capital Investment Requirements and City Leap

#### Why heat networks are being installed

- 1. Heat networks, also known as district heating, are systems for distributing heat generated in a centralized location via a network of pipes for domestic and commercial space heating and water heating.
- 2. As the heat network is agnostic to the type of heat generation installed, it can supply heat from a variety of energy generation technologies from Gas combined heat and power (CHP) to water source heat pumps as well as biomass and waste heat from industrial processes. This ensures heat networks are a 'no regrets' technology able to deliver heat whatever the heat generation technology available.



- 3. Heat networks using low or zero carbon energy technologies are amongst the cheapest methods of cutting carbon emissions. In regards to the Bristol Heat network, various low and zero carbon heat sources are being incorporated including water source heat pumps (WSHP) supplying heat from the floating harbour as part of the Old Market Heat network.
- 4. The Temple and Bedminster networks will also be developed to take waste heat from data centres, Bristol's sewer network and potentially heat from mines through the installation of large heat pumps.
- 5. Heat Pumps use the same technology as that used in refrigerators. Just as a fridge extracts heat from the food and transfers it into the kitchen, so a water source heat pump extracts heat from the water and will transfer it to the heat network. For every unit of electricity used to power the heat pump, approximately 3-4 units of heat are captured and distributed.
- 6. At Castle Park Depot for example, the water will be abstracted from the floating harbour. A heat exchanger then extracts the heat from the water and transfers it to the heat pump which uses a fluid that evaporates at a very low temperature. This heat from the water abstracted from the harbour causes the fluid to evaporate and the subsequent gas is then condensed to increase the temperature further. From here the gas moves to a further heat exchanger to release this heat to the network.
- 7. Although only 2% of heat in the UK is currently supplied by heat networks, this is rapidly increasing, particularly in cities. They are supported by UK government who have recognised that around 20% of heat could be supplied by heat networks across all five future energy supply scenarios contained in the Clean Growth Strategy, which was published by Central Government in 2017. Major European cities like Vienna and Copenhagen have installed heat networks supplying over 95% of homes. Consequently, Copenhagen is on track to be carbon neutral by 2025.
- 8. In the UK, almost all cities have either installed or are looking to install heat networks. London currently has the greatest number of heat networks with London boroughs such as Enfield and Islington taking a lead. A number of large towns are also installing heat networks. For example, Gateshead has completed a £25 million heat and power network supplied from a Gas CHP energy centre and like Bristol are also installing water source heat pumps.
- 9. Heat networks are central to achieving the Mayor's goal for Bristol to be a carbon neutral city by 2030 as well as help to tackle fuel poverty by providing heat to residents at lower prices. In confined urban areas like central Bristol, it can be argued that heat networks provide the only financially and technically viable solution for zero carbon heat.
- 10. BCC's Sustainable City team appointed CSE to identify how Bristol could decarbonise its energy system. In regards to the decarbonisation of Bristol's heat this requires the end of mains gas as the prime heat supply to homes and business and for it to be replaced by either heat networks or individual heat pumps. While still in the review and consultation

phase, the CSE study identified where in the city these technologies should be adopted. This is needed to meet the Corporate Strategy commitment (2018-2023) to keep Bristol on course to be run entirely on clean energy by 2050, and to continue to reduce  $CO_2$  emissions with the goal to be carbon neutral by 2050 (now brought forward to 2030), and to provide affordable and secure energy.

- 11. Installing heat networks will also support the following corporate strategy key commitments:
  - a. Improve our environment to ensure people enjoy cleaner air through supporting the further deployment of renewable heat generation.
  - b. Improve physical and mental health and wellbeing by making residents' homes warmer and cheaper to heat, reducing inequalities and the demand for acute services.
  - c. Tackle food and fuel poverty by reducing energy bills.
  - d. Create jobs, contributing to a diverse economy that offers opportunity to all and makes quality work experience and apprenticeships available to every young person.

12. Installing heat networks will also provide the following benefits for the City of Bristol:

- Provide an independent revenue stream to the Council from the sale of heat and power to connected buildings.
- Reduce fuel bills for businesses connected to the network through lower prices
- Provide an opportunity to build partnerships with other public sector bodies and the business community.
- Reduce energy consumption and operating costs for building occupiers, improving Bristol's competitiveness for attracting new businesses to the City.
- Reduce costs for developers as they no longer need to install and maintain expensive heat generation plant and equipment.
- Increase the City's energy security and resilience.
- Support the City Leap Prospectus

## Work to date / in progress

#### a. Old Market Heat Network

- 13. The Old Market Network forms part of the overall Bristol Heat work and is a new district heat network in the east of the city bordered by Castle Park, Bristol Temple Meads the A4032 & A4320 and crosses the A4044 and A420. The network is designed to supply low carbon heat from an Energy Centre at Castle Park Depot. The Energy Centre will contain a Water Source Heat Pump which draws waste heat from the floating harbour along with peak and reserve gas boilers.
- 14. Following the completion of detailed feasibility and design studies Cabinet approval was given in September 2019 to install the Old Market Network and water source heat pump energy centre on the Castle Park depot site. The Old Market network will begin to supply heat to in the first phase to new developments currently under construction including Castle Park View and Linear Park with construction commencing in January 2020.

#### b. Redcliffe Heat Network

15. Completed in March 2016, Phase 1 of the Redcliffe heat network was completed which included the installation of a 1MWth biomass energy centre at Broughton House (Redcliffe) supplying low carbon heat via underground heat mains to 13 social housing blocks. This is currently saving around 1,000 tonnes of CO<sub>2</sub> per annum and a reduction in tenant heating bills by around 10%.

# Image 1: Biomass energy Centre Broughton House and Laying of Rehau PEX pipe as part of Redcliffe Phase 1



Figure 1: Redcliffe Heat Network Phases 1 - 3



- 16. Heat network installation has also taken place as part of the Temple Gate highway works in order to enable the Redcliffe heat network to ultimately be connected to a city wide heat network that also includes buildings adjacent to Temple Meads.
- 17. <u>Redcliffe Phase 2.</u> In September 2018 Cabinet approved the expansion of the Redcliffe heat network to supply a number of new commercial developments in the area and connection of BCC's 100 Temple St office. This project also included the installation of a 1 MW Gas CHP engine (subsequently reduced to 0.55MW following detailed design) which will provide low carbon heat to 100 Temple St and a number of new developments in Redcliffe such as Redcliffe Quarter, R Wharfe, and Engine Shed 2.
- 18. The construction of this phase is currently underway with the energy centre at 100 Temple St set to be complete by February 2020. The heat network is currently being installed in phases depending on the heat requirements of new developments in the area but the majority is likely to be completed by the end of 2020.

#### New heat networks – seeking approval as part of this Cabinet paper

- 19. BCC's Energy Service is seeking approval to begin the initial design and installation of the first phases of the **Temple** and **Bedminster** heat networks. Given that these networks focus on connecting new developments, the timeframe for capital investment is subject to rapid change that is outside BCC's control.
- 20. Should Government HNIP grant funding applications be successful, it is also possible that the prudential borrowing allocation sought within this paper is not required until post City Leap (HNIP funding can be used first).

#### a. Temple Heat Network

21. The Temple Heat Network will provide zero carbon heat to new developments on the Temple and St Philips areas of Bristol. Construction for this network will begin in 2020 with the installation of pipework and peak and reserve gas boilers on Temple Island in time to supply heat to the new University of Bristol's Temple Quarter Enterprise Campus and other new developments in the area.



## Figure 2: Map showing Phases of Temple Network (Phase 1 – in blue)\*

Table 2 - Summary of Financials – Temple Heat Network (Phase 1)

		Phase 1
Phase start year		2021
Network length		542 m
No. heat connections		5
Network heat demand		9,598 MWh
Network linear heat density		18 MWh/m
Heat pump capacity		1.5 MW
% network heat demand met by heat from UoB		34 %
% network heat demand supplied by WSHP		55 %
Phase capital costs		£5,634,631
Total capital costs (including previous phases)		
25 years	NPV (at 3.5%)	-£61,602
	Social IRR	8.3 %
	Carbon savings	42,847
	Indicative IRR with 30% HNIP grant funding	8.9 %

The heat network will initially be supplied from waste heat generated from the University of Bristol's TQEC cooling demand with further heat being supplied by an additional water source heat pump.

## b. Bedminster Heat Network

The Bedminster heat network will initially supply new developments in the Bedminster area in addition to existing BCC heat loads including Bristol South Pool, Holy Cross Primary School and adjacent social housing blocks.

Further discussions are required with BCC Housing as to when the current electrically heated blocks could be converted to a wet heating system that would deliver significant savings to tenants as electric heating is often 3 times the cost of a wet heating system.



	Phase12
Phase start year	2020/21
Network length	2,824 m
No. heat connections	1,588
Network heat demand	15,615 MWh
Network linear heat density	5.5 MWh/m
MWSHP capacity	1,446 kW
% network heat demand supplied by MWSHP	83%
Phase 1 capital cost	£6,141,000
25 IRR	2.1%

		Phase12
years	NPV (at 3.5%)	-£1,226,429
	Social IRR	5.8%
	Carbon savings	46,400
	Indicative IRR (dependant on grant funding and RHI income)	9-12%

High level assessment of the prioritised network phases indicates that they are unlikely to be economic without subsidy and / or grant funding.

The renewable heat incentive (RHI) scheme is due to close in March 2021. If it was to continue or an alternative heat pump subsidy was available, this would improve the economics of the network.

A HNIP grant funding application will therefore be taken forward whilst BCC await BEIS providing further details on what sort of RHI replacement or extension is likely to be available.

In addition, as waste heat from sewers is being investigated with Wessex Water, it is a possibility that some or all of the energy centre works are carried out by Wessex/Geneco and not BCC, hence cabinet approval is sought to negotiate with Wessex Water on a possible joint energy centre scheme.

#### **Bedminster Green II**

Bedminster Green II is a potential extension of the current Bedminster Green Framework Zone and has been assessed as a potential longer term connection i.e. phase 4. The plans for Bedminster Green II are currently very high level and therefore, the potential heat demand is unknown. An additional heat demand equal to that of the developments within the Bedminster Green Framework Zone has been assumed and the technology sizing has been reassessed. It has been assumed that Bedminster Green II connection date is 2028

## **Delivering Heat networks**

#### Information relevant to all networks:

- 22. Following heat demand and master planning assessments, feasibility and design of the Bristol Heat network is currently focussed on the following areas:
  - 1. Areas of the city with a large heat demand (such as central Bristol),
  - 2. New development areas of a sufficient size that a heat network is financially viable (such as the TQEZ)
  - 3. Areas of the City within an acceptable distance from the proposed Strategic Heat main supplying waste heat from industrial processes at Avonmouth to the Bristol heat network.
  - 4. City Centre Renewable Energy Centres to provide low carbon heat onto the network (WSHP)
- 23. Whilst existing buildings are being investigated for connection, the attention is currently on connecting new private developments to the network through Bristol's planning policy requirements as they provide an upfront connection fee that helps the financing of the heat network whilst also avoiding the need for new developments to install costly and ultimately redundant fossil fuel heat generation equipment.
- 24. Heat network routing and associated timescales will be dependent on when new developments are constructed which is outside BCC's control. This requires a flexible approach to delivery to ensure newly completed developments are supplied by heat from the Bristol heat network in time. This may require temporary or interim energy centres to be installed in the short term until the build out of the heat network is sufficient for them to be removed or retained for resilience purposes only.
- 25. Bristol's Energy Service therefore require the ability to re-programme the installation of heat networks and associated energy centres to meet developer timeframes as well as work with BCC Transport teams to ensure disruption is minimised.

# **Capital Expenditure and Phasing**

26. Capital expenditure is based on a combination of detailed feasibility or master planning and so is subject to change as projects progress into the detailed feasibility stage where this has yet to commence &/or procurement and construction. However, contingencies have been incorporated within the cost estimates based on appropriate risk levels. For example, heat network pipe work within a utility congested road includes a higher level of contingency.

# Phasing of heat network & Energy Centre delivery

27. Given the high upfront capital cost and complexity of installing heat networks without a negative impact on traffic congestion, the Bristol heat network is proposed to be built out on a phase by phase basis, the ultimate end goal being a city wide heat network delivering low cost, zero carbon heat from a number of energy generation sources

including waste heat from Avonmouth.

- 28. Phasing of heat networks is typically carried out as below:
  - 1. Networks that meet the net positive cash flow requirement
  - 2. New development connections as required by planning
  - 3. Highest  $CO_2$  saved per £ of expenditure
  - 4. Critical connection/future proof opportunity lost

#### **Financial viability**

29. BCC Energy Service has employed external consultants to produce a heat network financial model to ensure the Bristol Heat Network meets the BCC Finance requirement of generating a positive financial benefit to the Council once prudential borrowing repayments have been taken into consideration. Each of the different heat network phases and Energy Centres meet this requirement.

#### Heat networks revenue streams

30. Within Heat Priority Areas, new developments must connect to Bristol's heat network as part of planning requirements (once the financial and technical viability have been demonstrated). As well as providing an upfront connection fee, these new connections will provide long term revenue to BCC through heat sales but only if BCC can demonstrate its ability to connect a new development within the developers timeframe. Failure to do this not only increases the risk of lost revenue but the ability of the heat network to generate associated carbon savings.

#### **Capital Investment Requirements and City Leap**

- 31. The current areas of investigation are mostly confined to areas of high heat demand and new development within the city centre to enable the heat network to provide a net positive income to the council. The final capital cost of delivering these fully built out heat networks is likely to be in excess of £50 million. Given the limited BCC prudential borrowing funding available to finance this, ultimately this will need to be delivered as part of the City Leap programme.
- 32. However, early phases of the Bristol heat network will need to be commence prior to the completion of the City Leap programme for the following reasons:
  - i. A number of new developments are currently under construction which will require heat in 2020/21. Delays in installing the heat network will result in BCC not achieving the required heat-on dates and these new developments having to install fossil fuel boilers instead. Not only will this prevent BCC from receiving a connection fee, it also makes the task of converting these buildings to a zero carbon heat source in the future much more difficult.

- ii. Through BCC signing connection agreements with new build developers and commencing the early phases of heat networks means that potential City Leap investors view City Leap much more favourably as their investment would be in part de-risked.
- 33. However, the CSE net zero study identified a much larger heat network that would need to be installed if Bristol were to achieve its 2030 ambition. Early findings of the study identify over 65,000 homes and businesses that would need to be connected to the Bristol Heat Network with a resulting capital cost of this likely to be in excess of £500 million.
- 34. A key reason for installing the Bristol Heat Network and renewable technologies, such as WSHPs, is to reduce the carbon emissions of the city and ultimately provide zero carbon heat as part of the Mayoral goal of carbon neutrality by 2030.
- 35. The Bristol heat network already provides low carbon heat due to the installation of a 1MW biomass boiler within the Broughton House energy centre, with water source heat pumps also providing significant low carbon heat generation as part of the Old Market heat network.
- 36. However, delivering a zero carbon heat network from Day 1 for all the proposed heat networks is currently not financially viable given the low cost of fossil fuels versus limited government grant funding and other financial incentives available to offset the installation of zero carbon energy installations. In the short term, parts of the Bristol heat network will therefore need to rely on mains gas to supply low cost peak and reserve energy centres which will need to be replaced as gas is removed from the City.
- 37. In the medium and long term, the Bristol Heat network will also be supplied from zero carbon heat generation sources as part of the installation of the Strategic Heat Main.

#### Bristol Heat Network Design Guidance and BCC Planning Policy

- 38. Bristol Planning Policy BCS14 expects new developments in the heat priority area to connect to a heat network where technically and financially feasible or where a heat network is not being installed to be 'DH ready' to enable connection at a later date. Where possible BCC are working with developers to provide a 'day 1' heat network connection to enable the benefits of heat networks to be realised sooner rather than later.
- 39. To ensure new developments connected to the Bristol Heat Network provide residents with low cost heat, the City Council has released a guide for developers, architects and building designers to ensure new developments connecting to the Bristol heat network are designed and operated in line with the latest CIBSE guidance

(https://www.cibse.org/knowledge/knowledge-

<u>items/detail?id=a0q20000090MYHAA2</u>). The CIBSE guidance reduces the likelihood of high heat losses and associated higher energy bills for residents currently not addressed within Building regulations.



## Figure 4 – Bristol Heat Network Design Guide

#### Notes

#### Heat Network Delivery Unit (HNDU)

40. The Heat Networks Delivery Unit provides grant funding and guidance to local authorities in England and Wales for heat network project development. In January 2019 Bristol City Council were successful in obtaining a further £500k of funding from this department to support the feasibility and design work to develop the Bristol Heat Networks.

#### Heat Network Investment Project (HNIP)

- 41. The Heat Networks Investment Project (HNIP) is a government funding programme that aims to:
  - increase the number of heat networks being built
  - deliver carbon savings
  - help create the conditions necessary for a sustainable heat network market to develop
- 42. HNIP will provide £320 million of capital funding to gap fund heat network projects in England and Wales. This funding is available to support the commercialisation and construction stages of heat network projects. Bristol City Council has made two applications to date, one for Redcliffe network and one for the Old Market Network.