

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. [1 July 2014 Cabinet Report ‘District Heating Phase 1’](#)
 2. [7 June 2016 Heat Networks Phase 2](#)
 3. [4th September 2018 Bristol Heat Network](#)

Contents:

[Why heat networks are being installed](#)

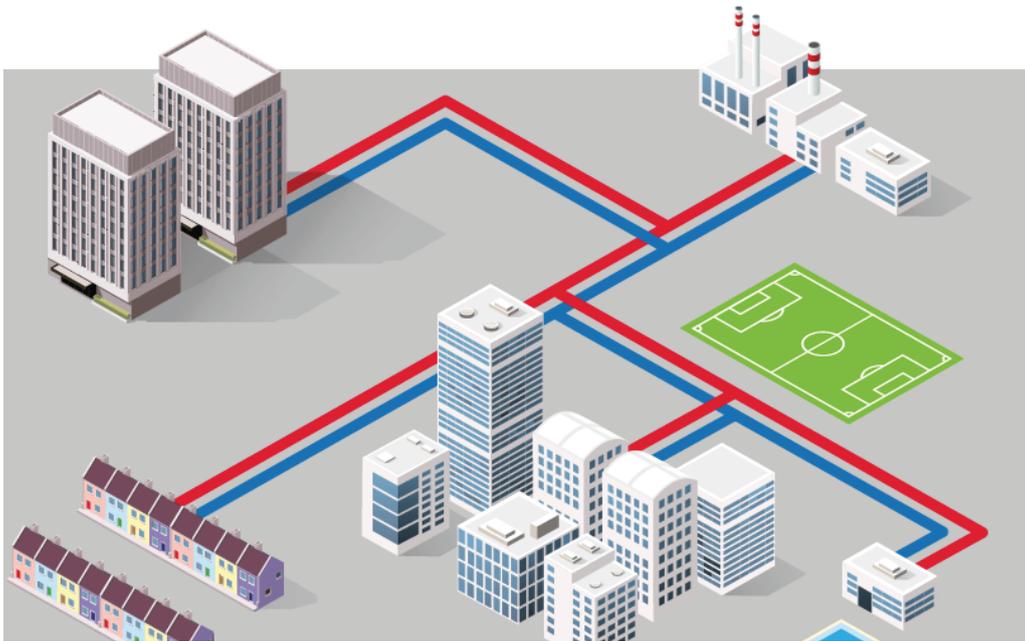
- a. [Old Market Network](#)
- b. [Redcliffe Network](#)
- c. [St Pauls Network](#)
- d. [Temple Network](#)
- e. [Heat Network Delivery Unit \(HNDU\)](#)
- f. [Heat Network Investment Project \(HNIP\)](#)

[Seeking approval](#)

- a. [Old Market Network \(Inc. WSHP\)](#)
- b. [Redcliffe Network](#)

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 will be incorporated including water source heat pumps (WSHP) supplying heat from the floating harbour, Gas CHP and the currently operating biomass boiler within the Broughton House Energy Centre. The wider network will also be investigating other heat sources such as heat from mines and sewers.
4. Heat Pump Technologies - take heat typically from the ground, water or air although Energy Services are also investigating using them to obtain heat from sewers. The heat obtained is then transferred into buildings or a district heating system. The technology used is the same 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.
5. At Castle Park Depot 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.
6. 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.
7. 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.

8. 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.
9. BCC's Sustainable City team appointed Element Energy Ltd to assist in developing the evidence base for the policies required to provide zero carbon heat in the city. 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 CO₂ emissions with the goal to be carbon neutral by 2050 (now brought forward to 2030), and to provide affordable and secure energy.
10. The findings of the study show that heat networks, distributing renewable and very low carbon heat (including energy from waste from plants located in Avonmouth), in combination with the installation of energy efficiency measures, are critical for achieving zero carbon heat in new and existing buildings. For residential parts of the city located away from the main heat network routes, other forms of renewable heat will be required. These are most likely to be ground, air and water source heat pumps. BCC is currently investigating the use of ground source heat pumps for new residential developments; as a result they are being installed as part of the Alderman Moores development.
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 contains a Water Source Heat Pump which draws waste heat from the floating harbour along with gas peak and reserve boilers. The Old Market Network begins life as two separate smaller networks (Phase 1a) either side of the A4044 each with its own 375 apartment Private Rental Schemes. Phase 1b crosses the A4044 and links the two smaller networks together as well as picking up a number of other developments including offices, schools, student housing and hotels.
14. One of the apartment blocks, Castle Park View will be Bristol's tallest building and is the first commercial connection to sign up to the Bristol Heat Network. It has been designed in accordance with council's design guide to ensure low energy costs to end customers.
15. Following the completion of master planning and detailed feasibility studies Cabinet approval was given in September 2018 to install the Old Market Network with the budget to install as set out in Table 1, this covers the first phases of the network installation and temporary energy centres to heat initial developments and further design work for the Water Source Heat Pump only.
16. In December 2018 the first commercial heat network agreement was finalised with Castle Park View. Therefore Bristol City Council is required to provide the development with heat. BCC are also working on a commercial agreement with Linear Park which is similar sized development on Avon Street. As the funding for the Water Source Heat pump led energy centre was not previously requested it is now being sought as part of this Cabinet Paper.
17. While the Permanent Energy Centre is being designed and built, heat will be provided by interim Gas Boilers, one at Castle Pak Depot and the other at Gardiner Haskins car park (the lease for this is currently being finalised). This however is not a low carbon solution and therefore increases the need for the Water Source Heat Pump which will ultimately replace the use of the gas boilers at Gardner Hoskins which will then be removed with gas boilers at Castle Park Depot retained as peak and reserve boilers only.
18. Since September 2018 the Old Market network has been taken to developed design for the network, temporary and permanent energy centres, which is currently in its final stages. The next step following this design work is to progress to the construction of the network.
19. On 5th July 2019 a Heat Networks Investment Project (HNIP) funding grant application was submitted to support the cost of constructing the network and energy centres.

b. Redcliffe Heat Network

20. 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 CO₂ 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



21. 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. These works are progressing as part of the highway works to ensure travel disruption is reduced to a minimum. These works were part funded by EU REPLICATE which hopes to share learning on smart cities across the continent. REPLICATE is a collaboration with the cities of San Sebastian in Spain and Florence in Italy

22. Redcliffe Phase 2. 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. Some of this work is underway including part of the connection between Broughton house and 100 Temple Street.
23. In April 2019 a Heat Networks Investment Project (HNIP) funding grant was submitted to support Phase 2 of the network. This also included grant funding for additional new developments being built in the Temple Back area of Redcliffe. This additional extension was not requested within the Sep' 18 cabinet report as these developments were still awaiting planning permission so is being sought as part of this cabinet report.

The additional works on Redcliffe will extend the Heat Network from 100 Temple Street into the Temple Back area to provide heat to mixed use planned developments including affordable housing, private residential, a commercial office block and a refurbished office. The extension of the heat network will be 810 metres in length and will cost £2.1 million

c. St Pauls Network

24. Following masterplanning of the City Centre Phase 2, Cabinet approval was given in September 2018 for the further development of the St Pauls network. £1,619,230 capital funding was allocated to this.
25. Further feasibility was carried out and completed in January 2019 to identify energy centre technologies, site locations and potential network routes. However, during this time a major development within the network area proceeded without the requirement to connect to the heat network. This put the financial viability of the network into question as the development was a key site for the St Pauls Network.
26. Further to this, alternative low carbon technologies, such as heat from sewers, were coming forward as potentially better options for the St Pauls area and required further study
27. For the reasons above it was necessary to return to feasibility design stage of the St Pauls Network and assess how the St Pauls area is incorporated into the City wide plans for heat networks. HNDU funding has been successfully applied for to fund this work which is currently underway.
28. Therefore the St Pauls Network is currently on hold and part of this Cabinet Report is requesting the reallocation of the remaining capital funding of £1,554,993 from St Pauls to the WSHP on the Old Market Network.

d. Evolving networks - Temple and Bedminster

29. Feasibility work is currently underway to identify the next expansion of the Bristol Heat Network. This includes heat networks in the Temple and Bedminster areas. The Temple Network is currently going through feasibility work to confirm sizing and location of energy centres and the network build out in light of the developments coming on line. The options include considering a 5th Generation network for Temple Island, which means that cooling as well as heat could be provided in this location improving the

efficiency of the network. The area covered by this network is one going through a period of rapid development with a number of proposed developments coming forward in line with the new University of Bristol campus next to Temple Meads station.

30. We are working closely with the University as their development is likely to house one of the energy centres. In order to support the decarbonisation of the heat network the heat sources for this network are expected to include heat pumps and the feasibility study is looking at air, water and sewer sources for these, in addition to the necessary peak and reserve gas boilers.

Delivering Heat networks

Information relevant to all networks:

31. 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)
32. 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.
33. 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.
34. 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 and expenditure and Phasing

35. 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

36. 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.
37. 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 CO₂ saved per £ of expenditure
 4. Critical connection/future proof opportunity lost

Financial viability

38. 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

39. 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.

Bristol Heat Network – Central Bristol

40. Following the completion of master planning studies and detailed feasibilities, detailed design are currently underway to determine the exact sizing of energy generation equipment, underground pipework and the associated final heat network routing that will provide the most technically and financially viable heat network.
41. 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 likely capital cost for delivering the full build out of this central network is likely to be around £50 million.
42. The main reasons for delivering an expanded heat network prior to the completion of the City Leap programme are as follows:
43. A number of new developments are currently under construction which will require heat in 2019/20/21. 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.

44. The outcomes of the City Leap programme and the associated timeframe for potential investment/delivery partners are not finalised.
45. The financial case for the WSHP relies on obtaining RHI funding which is time limited as the WSHP needs to be commissioned and application approved by March 2021 if this is not achieved then BCC will lose a 20 years income worth £12.5million. We intend to install in advance of January 2021 and therefore will be able to apply for a tariff guarantee to secure the funding prior to installation.
46. Whilst a flexible approach to delivery is required, the current heat network activity is focused in the following areas of central Bristol and capital funding as sought within this Cabinet Report is likely to be used to deliver the heat network and associated energy centres:
 - a. Old Market Network: WSHP led energy centre – initially servicing Castle Park View and later the rest of the Old Market and wider networks.
 - b. Redcliffe Network: Phase 3 extension (to Temple Back) - This area incorporate new developments including Avon Fire Rescue and existing building of the Crescent

a. Old Market Network (OMN)

47. The Old Market Network Phase 1 is shown in Figure 2 below. Construction for this network will begin November 2019 starting with installation of pipework and temporary boiler at Gardiner Haskins supplying heat to Linear Park closely followed by Castle Park depot supplying the Heat Networks first signed commercial customer Castle Park View. Summary of phasing is shown in Table 1.

Figure 2: Map showing Old Market Network*

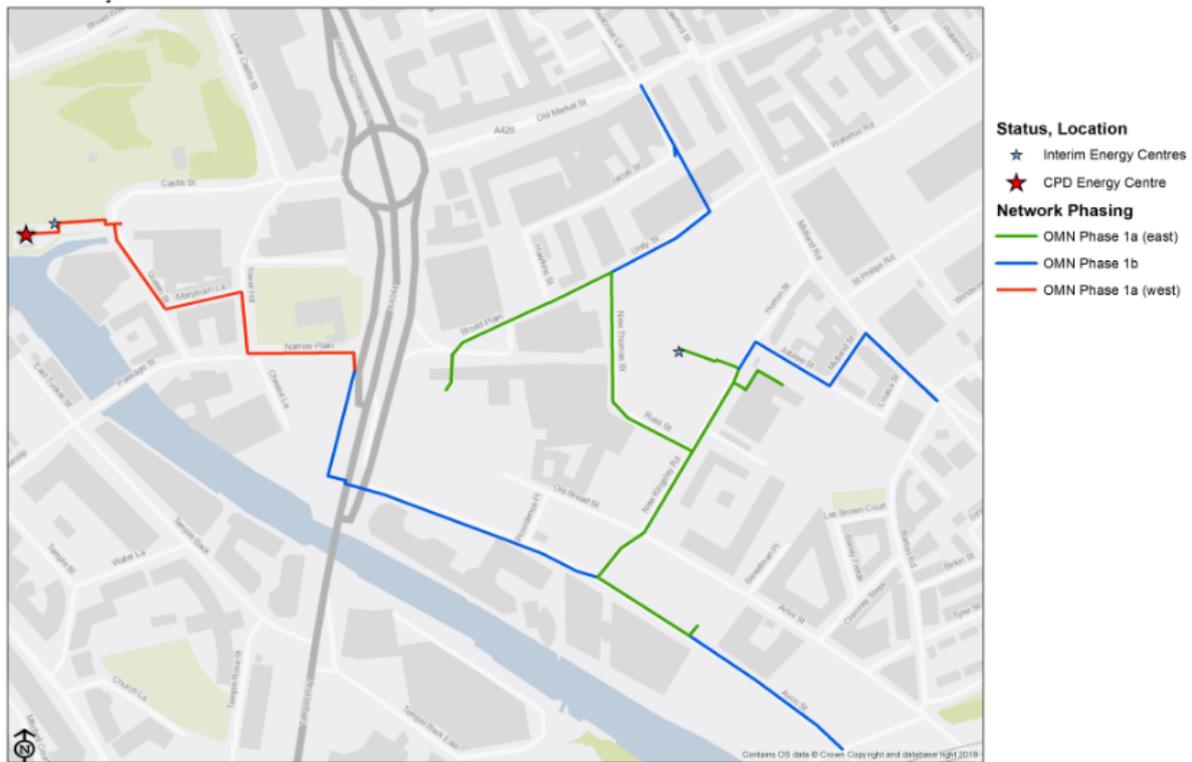


Table 1: Summary Phasing of Old Market Network

Phase	Year(s)	Summary Network	Summary Energy Centre
Phase 1a	2019-2020	830m of pipe installed either side of the A4044 to connect the two key load of Castle Park View and Linear Park	2 x 2MW Interim gas boilers at Castle Park Depot and Gardiner Haskins
Phase 1b	2020-2021	The two sides of the pipeline linked via a crossing of Temple Way, expansion of the networks to include additional new developments at Midland Road and Unity Street	3 MW Heat Pump and gas CHP at Castle Park Depot, Interim Gas Boilers incorporated for Peak and reserve
Phase 1c	2021-2024	The connection of existing buildings on Avon Street and around Castle Park View as well as further new developments	Potential for additional Gas Boilers at Days Road and Connection to the Redcliffe Network

Table 2 - Summary of Financials - Old Market heat network

RESULTS		
	September 2018 Cabinet	September 2019 Cabinet
	25 years	25 years
Internal rate of return (IRR)	11.0%	8.1%
Net present value (NPV)	£ 5,577,179	£4,931,463
Simple payback	9 years	11 years
Net income	£ 17,503,519	£21,659,786

CAPITAL COSTS		
	September 2018 Cabinet (Heat network only)	September 2018 + 2019 Cabinet combined (Heat network & energy centre)
Total CAPEX	£ 8,961,141	£18,171,730
Previous Cabinet Approval	-	£2,445,581
Re-allocation from St Pauls Network	-	£1,554,993
Grant funding	£ 2,688,342	£8,177,278
Connection charges	£ 370,099	£596,056
Remaining CAPEX (to be funded via Prudential Borrowing)	£ 5,902,700	£5,397,822

Low and Zero Carbon heat generation technology proposals

48. Due to the strategic importance of decarbonising the network, alongside the limitations of generating zero carbon heat from City Centre locations, the proximity of Castle Park Depot to the floating harbour makes it a priority site a installing water source heat pumps.
49. Water source heat pumps are currently in the final stages of design for Castle Park Depot utilizing **zero carbon** heat from the Floating Harbour.

Water Source Heat Pump led Energy Centre

50. A vital part of delivering zero carbon heat as part of the Old Market heat network is the installation of Water Source heat Pumps (WSHP) at Castle Park Depot. The first WSHP will receive government Renewable Heat Incentive (RHI) income over 20 years totalling £12.5 million as long as a successful application is submitted prior to March 2021.
51. Through working with technical consultants and discussions with Property the Castle Park Depot site has been identified as a critical site for installation of a water source heat pump due to its size and proximity to water in the floating harbour. It is recognised that the Castle Park Depot is however suitable for wider development we are therefore working with colleagues including Housing Delivery, City Design, Property and Parks to carry out feasibility for a mixed use development where an energy centre will be combined with housing and/or commercial uses. Due to the March 2021 deadline for the RHI the WSHP led energy centre cannot wait for the wider development to progress as it will not be constructed in time.
52. Approval is therefore sought to carry out the installation of the WSHP to ensure the 2020/21 deadline for funding is achieved. This will mean that the energy centre will be developed prior to the wider mixed use development for the site. The design of the energy centre will be future proofed to enable the wider development and the Energy Service team will continue to work with the wider development team to enable this to happen.
53. Other technologies such as ground source heat (including from old mine workings) have been investigated in central Bristol and have been discounted as being financially unviable for these networks requesting support in this report. However these are being reviewed for further phases of other networks.

b. Redcliffe Network

54. In order to extend this network to meet timelines for new developments coming forward additional funding of £815,737 is sought in this Cabinet report as match funding from the connection fees and HNIP grant funding.

Table 3 - Summary of Financials - Redcliffe heat network

RESULTS		
	September 2018 Cabinet	September 2018 & 2019 Cabinet combined
	25 years	25 years
Internal rate of return (IRR)	10.9%	8.1%
Net present value (NPV)	£ 1,904,621	£1,668,950
Simple payback	9 years	11 Years
Net income	£ 6,334,436	£7,221,699

CAPITAL COSTS		
	September 2018 Cabinet	September 2018 & 2019 Cabinet combined
Total CAPEX	£ 4,003,704	£8,061,225
Grant funding	£ 1,201,111	£3,627,551
Connection charges	£ 384,116	£1,199,460
Remaining CAPEX	£ 2,418,477	£3,234,214

55. Programme of Works Summary

Phase	Year(s)	Summary Network	Summary Energy Centre
Redcliffe Extension Stage 1	2019-2020	Heat Network installation from 100 Temple Street to Redcliffe Wharf via Redcliffe Quarter and 21 St Thomas Street. This network shall be commissioned by March 2020	100 Temple Street Energy Centre to install 550kW gas CHP and 3000kW peak & reserve gas boilers. This Energy Centre shall be commissioned by November 2019
Redcliffe Extension Stage 2	2020-2021	Heat Network installation from 100 Temple Street to Temple Back	N/A the new developments will be able to use the heat generated from 100 Temple Street and Broughton House Energy Centres.

CO₂ Savings

56. Assuming the first phase of each of the heat networks supply the existing and new developments as proposed, the total CO₂ savings will be greater than 90,000 tCO₂e over 25 years.

CO ₂ e SAVINGS		
	Redcliffe	Old Market
25 years, tCO ₂ e	7,618	87,152
40 years, tCO ₂ e	7,385	136,862
First year, tCO ₂ e	623	3,631

57. A key reason for installing the Bristol Heat Network and renewable technologies, such as the WSHP, 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.

58. 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 proposals set out in this cabinet report.

59. 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 carbon heat and power but this may need to be replaced as gas is removed from the City.

60. In the medium and long term, the Bristol Heat network will 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

61. 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.
62. 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-items/detail?id=a0q200000090MYHAA2>). 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)

63. 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)

64. 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

65. 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.