

# Transition Roadmap

Aberdeen City



Researched by	Checked by	Reviewed by	First Draft	Final Draft
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### About HeatNet NWE

*This document has been developed as part of the HeatNet NWE project, which is part-funded through the Interreg NWE programme and aims to increase the uptake of 4DHC networks across North-West Europe. As part of this project, the partners developed the HeatNet Model, which will help the public sector to begin implementing 4DHC networks, and the Transition Roadmaps, which outline the partners' experience in developing six district heating pilots across North-West Europe. The HeatNet Guide to Financing gives a broad overview of the various sources available to finance district heating schemes.*

For further information on these reports and on the HeatNet NWE project, please visit [www.guidetodistrictheating.eu](http://www.guidetodistrictheating.eu).

## Executive Summary

This document has been produced as part of HEATNET NWE to describe the transition to 4th Generation district heating and cooling (4DHC) within Aberdeen City.

In 2002, Aberdeen City Council created 'Aberdeen Heat & Power', a not-for-profit independent Company, to develop Combined Heat and Power schemes for the city. Combined Heat and Power (CHP) is a system whereby electricity is generated locally for sale and the heat emitted by the generator is captured and used to heat properties instead of being released into the atmosphere.

The HeatNet NWE project in Aberdeen is developing a network connecting three council properties to an existing network containing three multi-storey properties. The network has been designed to meet the principals of 4DHC and is the first step in a long-term plan to transition to 4DHC.

The network will initially use gas boilers with smart controllers within each of the buildings. An Energy from Waste Plant is being built following legislation imposed by the Waste (Scotland) Act (2012) close to the Torry HeatNet NWE development.

The Energy from Waste Plant will become the primary source of Heat for the HeatNet NWE project within Torry and the heat source will be used to replace the gas boilers installed for initial operation of the network.

The Network will be expanded gradually in order to meet and connect to the established networks that exist within Aberdeen. This will be carried out as a phased process.

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## Introduction

This document describes the proposed steps and structure in order to ensure a successful transition to 4<sup>th</sup> generation district heating within Aberdeen City. The structure of the document is based upon the agreed structure presented for the Interreg HeatNet NWE project. The project aim was to explore the future development of district heat within Aberdeen city as a whole taking into account the existing network and the modification of the existing network to meet 4<sup>th</sup> generation characteristics.

The transition roadmap explores the present position of Aberdeen, the aims of the city in terms of the development of a 4<sup>th</sup> Generation district heating network, the necessary intermediate steps to allow this transition to take place and the learnings from the Heatnet NWE project in Aberdeen.

Aberdeen currently has several networks that are strategically located within different areas of the city, with a long-term plan to connect each of the networks in order to form a large network covering a large area of the city. This will be carried out to link the existing energy centres.

District heating in Aberdeen presently is provided from CHP energy centres at Seaton, Stockethill, Hazlehead and Tillydrone. In addition to these networks there are stand alone gas boiler networks in a number of council owned multi storey blocks of flats, the recently expanded Torry network and private district heating networks in Aberdeen University and within the NHS Grampian site at Forresterhill.

## What is 4th Generation District Heating?

4<sup>th</sup> Generation district heating and cooling looks to improve the efficiency of district heating further by reducing the operational temperatures, having improved control over distribution systems and incorporating heat from sources that would normally be wasted along with using renewable energy sources.

4<sup>th</sup> Generation district heating was defined by Lund (2014) as having the following characteristics:

<b>Heat Carrier</b>	Low-temperature water 30-70°C
<b>Pipes</b>	Pre-insulated flexible (possible twin) pipes
<b>Circulation System</b>	Central and decentralised pumps
<b>Substation Heat Exchanger</b>	Mostly with plate heat exchangers Introduction of flat-stations (decentralised supply of hot water in new buildings)
<b>Buildings</b>	New buildings: <25kWh/m <sup>2</sup> Existing buildings: 50 -150 kWh/m <sup>2</sup>
<b>Metering</b>	Continuous reading used for continuous commissioning of customer heating system.
<b>Radiators</b>	Floor heating. Low-temperature radiators (50°C). Indirect system
<b>Hot Water</b>	Very efficient local heat exchanger heating DHW to 50°- 40°C. In district heating systems with supply temperature of 30 °C, a heat exchanger preheats DHW and a heat pump with buffer tank and heat exchanger increases DHW temperature to 40 °C by cooling down the return temperature.

Table 1 Characteristics of 4th Generation Heating System (Lund 2014)

The district heat networks that are within Aberdeen already satisfy some of the requirements of 4<sup>th</sup> generation heating. This document will explore what changes can be made within the system to further improve efficiencies. The main factor being the use of energy that would otherwise be wasted, such as the heat from the Energy from Waste Plant.

## Planning and Preparation

### Scope

In order to transition to a 4DHC Aberdeen first needed to assess the current infrastructure in place, and the steps that can be taken in order to transition to 4DHC. Transitions that need to be accommodated as part of this step change towards 4DHC include;

- Temperature - By the defined terms supplied as part of the HEATNET NWE project, current temperatures used within Aberdeen district heating networks are slightly higher than those defined for 4DHC.
- Using Low-grade heat sources - The heat source in Aberdeen is gas, which has a high calorific value and high exergy, opportunities to utilise alternate heat sources were developed as part of the expansion project, with the inclusion of heat from the energy from waste plant and the exploration of alternate heat sources.
- Capacity sharing between existing energy centre sites - Each energy supply is independent, and resource from one site cannot be shared with other centres or developments to meet energy requirements. The long-term aim will be to develop connections between existing energy centres in order to optimise supply to areas of greatest demand.
- Exploring renewable energy / waste energy sources as an option for providing additional energy resources for the network.

### Current Position

The city of Aberdeen currently has total heat demand of approximately **2468 GWh/year**. The HeatNet NWE projects main goal is to reduce the overall energy demand by reducing the heat demands of Aberdeen. Energy consumption is greatest within areas close to the city centre.

The Heat demand is dependent on several factors. HeatNet NWE explored reducing this demand with heat generated within the area that is currently wasted.

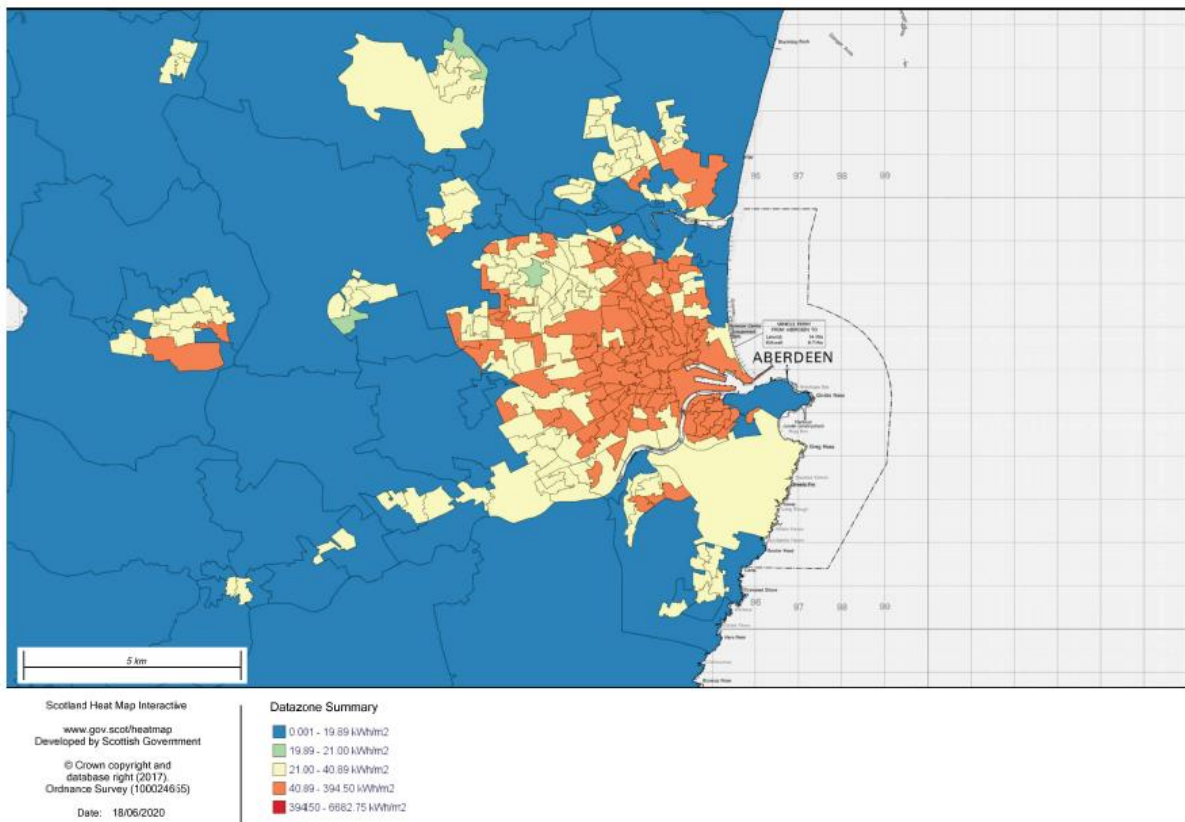
Projects that improve the energy efficiency of homes and the building of energy efficient council domestic properties will further assist in reducing the heat demand within an area.

There are several Scotland wide schemes which offer advice, financing options and assistance to reduce energy consumption and improve energy efficiency. Home Energy Scotland is the main point of contact for these schemes. Locally, within Aberdeen there is a not for profit agency called SCARF who work with residents to manage and reduce home energy costs.

From the data zone map of Aberdeen City ( figure 1), which illustrates average heat demand in each of the data zones, it is demonstrated that the Torry Area, which has been selected as a pilot for the HeatNet NWE project,



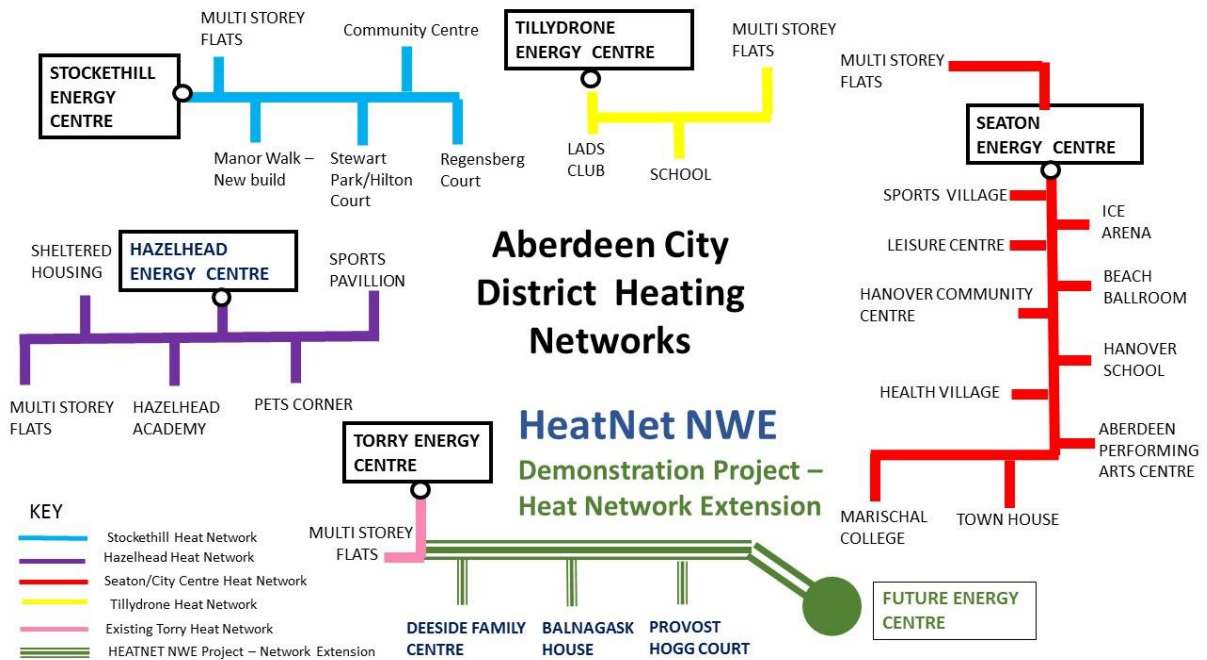
is within an area of high heat demand. Torry also has high levels of fuel poverty compared with the Aberdeen City region as a whole.



### 1. Scotland Heat Map – Aberdeen Data Zone Summary

Aberdeen Heat & Power is a 'not for profit' company that was set up by Aberdeen City Council in 2002 to develop and operate district heating and CHP schemes in the area. It has the primary aim of supplying affordable energy to hard to heat homes, predominantly in multi-storey flatted apartments. It has four energy centres within Aberdeen and currently provides over 2,350 flats and 15 public buildings with district heating. Some of the flats are currently supplied through centralised energy gas boilers. A subsidiary has been developed to target supply to commercial and private sector companies (DEAL).

Aberdeen Heat and Power's development has been centred around the provision of district heating to the Multi-storey blocks of Aberdeen (of which there are 59). Energy is fed around their district heating systems from four Combined Heat & Power energy centres at Stockethill, Hazlehead, Seaton and Tillydrone. In situations where there has been a requirement for delivery of heating to a location which is not close to a district heating network, a standalone network to serve the property has been built using standalone boilers. It is envisaged that these properties will be connected to the district heat network as the network develops.



## 2. Map of Current District Heating Networks in Aberdeen

The long-term goal of Aberdeen Heat and Power is to develop a “ring main” connecting each of the energy centres within the city centre.

The HeatNet NWE project has developed an understanding of the needs of the population in terms of energy requirements for existing and future developments as well as an understanding of how a 4<sup>th</sup> generation network can be developed to meet future energy supply needs within Aberdeen City Centre, with the primary aim of reducing carbon. The network expansion will utilise the existing framework developed by Aberdeen Heat & Power and look to build and extend the network throughout the city. This will include the addition of heat sources from renewable and existing wasted heat sources, integration of smarter controls within the network and modifications of the system to reduce operating temperatures.

## Preparation

The transition to low-carbon heat sources requires input and co-operation from multiple stakeholders throughout the city and a willingness from them to participate in the scheme as a whole. In preparation for this, Aberdeen Heat & Power and Aberdeen City Council have contacted larger stakeholders and businesses within Aberdeen. This contact has established if the stakeholder wishes to participate in the project from an early stage. This has led to initial meetings with stakeholders that act as an indication of the appetite to connect to the district heat network.

Discussion of the schemes prior to the launch of the heat network enables the early realisation of potential issues and obstacles that may arise. This will enable any issues to be identified and solutions provided at an early stage.



Aberdeen City council will highlight the development of an extended network to the community through an official launch. It will attempt to contact all members of the community who may be able to benefit from 4DHC in the future. This may also raise a general awareness of the current schemes within the city centre and encourage uptake in regions where connection is currently available.

This will be further developed by door-to-door contact and engagement with commercial and domestic properties within defined stages of the project. Within the Torry Area (which is the main focus of the Aberdeen Pilot for the HeatNet NWE Project) as part of the scheduled program of works engagement events were held with the local community to keep them informed of progress from planning through to installation.

Initially the transition to a 4DHC network in Aberdeen is relying on proven technology that has been successfully utilised in other parts of the city.

This is an initial stage in taking steps towards 4DHC. During the installation of the proven technology, the conversion to using lower operational temperatures has been incorporated into the design of the network. Some modification was required to heating systems internally to ensure that sufficient heat is delivered to individual properties at the lower temperatures, for example, modification of radiator sizes and ensuring the heat exchangers used to deliver hot water are adequate.

Within the city centre there may be an opportunity to introduce a mix of energy resources using energy that is currently wasted, renewable sources of energy, and alternate energy sources.

## **Project Team**

The project team consisted of local government officers within Aberdeen City Council. Aberdeen Heat and Power employed one member of staff specifically for the HeatNet NWE Project, who worked full time on the project in their role as a sub partner.

Both parties abide by regulatory procedures that determine decision-making processes. The procedures are documented for each with a direct chain of signatory authorisations.

In order to proceed with any operations, the team had a defined process of submitting requests and gaining permissions to develop the scheme within the Aberdeen area.

## **Key Stakeholders**

The Key stakeholders within the Transition strategy will change as the project develops with time. During the first phase of the project, the main stakeholder was Aberdeen City Council, Bon Accord Care, who manage the operation of the residential homes which were connected to the heat network, and members of the Torry community who were potentially affected by the development of the heat network .

As the project progresses, especially as the Network progresses into the city centre, additional stakeholders will become involved in the project.

Each property has individual requirements in terms of energy demand. This is determined by the peak energy use of the building, the style of the property and any additional efficiency steps that are in place, or that can be made, to improve the overall energy efficiency of the buildings.

In order to maximise savings that can be made by the addition of district heating, for each business or non-domestic property in Scotland a government led agency, Resource Efficient Scotland, is able to carry out an energy audit. Similarly, for domestic accommodation energy conservation may be maximised with the help and

advice of Home Energy Scotland. Both agencies are aware of plans to develop the heat network within Aberdeen and are happy to provide guidance and advice in maximising the benefits of the district heating system within the Aberdeen area in addition to the promotion of the existing network. Both organisations are based in Aberdeen in the SCARF offices. SCARF is a local social enterprise promoting energy efficiency and alleviating fuel poverty by providing home energy advice, energy performance certification, making residents aware of available grants and loans. SCARF also deliver energy and carbon savings by delivery of Scottish government funded programmes through Home Energy Scotland managed programmes, and Aberdeen City Council funded programs.

## Analysis

### Current Systems

Within Aberdeen City there are a range of energy sources being used. Energy sources used for space heating largely consists of gas or electricity, although there are several properties that have open fires as a secondary source of heat. It has been noted that some properties within the city centre use oil as fuel. This may be a result of difficulties with access to the properties, which ultimately would affect any plans to introduce a district heat network to the area. If there are difficulties in connecting district heating to the area, the householder or company will be referred to Home Energy Scotland / Resource Efficient Scotland as appropriate and provided with advice to reduce the carbon footprint of the property.

The city centre has a district heating system serving several municipal properties that originate at the Seaton Energy Centre. Within the city centre the shopping centres have centralised distribution of their energy, although the metering points differ in order to allow individual units to be responsible for their own energy use. It is known that communal areas share a common supply.

Within the city centre there is also a standalone heating system that serves Loch Court, and a standalone system that is managed by Aberdeen Heat and Power serving Denburn Court. These heating systems could be connected to a heat network at a future date.



### 3. Current Heat Networks in Aberdeen

In addition to facilities managed by Aberdeen Heat & Power, there are also district heating networks that are managed independently. A conversation will be held with the relevant parties to identify the age of the existing heating systems and whether there would be value in connecting these networks to the district heating network, either now, or in years to come as the existing systems age. It would also be of benefit to assess the current installations to identify any necessary changes that may be required to make the system “4DHC ready”.

The Torry area is the primary focus of the district heat network funded by the HeatNet NWE programme. The Pilot project has connected three facilities to a district heating network, taking into consideration the potential to connect to the energy from waste plant when it becomes available.

## Development Opportunities

Many opportunities for the development of the district heating Network within Aberdeen are present, for both existing properties and redevelopment projects. There are opportunities to add further capacity to the network, by working in partnership with businesses and educational establishments to develop localised energy centres, and to develop the network throughout the city. In order to build such an infrastructure, the development of understanding between a range of differing parties needs to be established along with plans to successfully develop the infrastructure within Aberdeen. These plans could include businesses constructing independent networks for eventual connection to the infrastructure as well as expansion of the current networks carried out by Aberdeen City Council and Aberdeen Heat and Power.

### Waste Heat

Within the city centre there may be opportunities to use sources of heat that are currently wasted, by collection and heat recovery systems. Within the industrial areas of Aberdeen there are cooling towers in place that could be used for heat recovery. There may also be opportunities for the use of geothermal technology which has previously been explored by the Scottish Government (2013). The location of the sea in relation to Aberdeen

city centre, as can be seen from the recently developed windfarm development just off the coast of northern Aberdeen, demonstrates the potential for the use of Tidal power and wind powered systems to be added into the energy mix.

The opportunity to benefit from renewable energy sources within Aberdeen city centre are limited. Many buildings within the city centre are listed or have protected status, and although there may be an option to use alternative energy such as solar panels, special consent may be necessary to attach panels along with structural assessment of whether the building could support the weights. The city centre would not be a suitable environment for traditional wind turbines, due to the turbulence effects of buildings, noise disruption and potential safety aspects of installation. Air and ground source heat pumps have been installed within the city, in isolated properties, and have been studied as an energy source within the Aberdeen Area. These may add to the energy mix of Aberdeen as there is further development of the 4DHC heat network.

The development of city-centre friendly renewable technologies with the advance of technology may enable an opportunity to provide an additional resource to add into the energy mix of the city and provide additional energy within the city centre.

Where individual businesses are constrained by overall policies that limit their ability to obtain heat from a district heat network, there may still be an opportunity to contribute waste heat to the heat network within the city centre, and this should be explored. This contribution would generate positive publicity for the businesses involved.

### **Overview of potential Heat Sources**

In terms of potential heat sources, the HeatNet NWE Torry development area has initially been developed with communal gas boilers to serve connected properties. The future development of the Energy from Waste plant is envisaged to connect to these properties, supplying them with the waste heat produced by the plant.

In tandem with this development, the energy plant at Seaton will continue to be developed, expanding the network in the city centre. AH&P will continue to engage and develop networks and cooperation with businesses and local companies. With the aim of developing links across the city centre to provide opportunities for expansion within the area.

The ultimate aim of the expansion will be to enlarge the network by making links between various sites across the city using the existing heat sources. This has the eventual target to connect to a range of other heat sources, including the Energy from Waste plant, energy that is currently wasted within sites and renewable energy sources as mechanisms are developed to utilise these sources.



4. Aberdeen City - Existing Energy Sources



5. Aberdeen City - Potential Energy Sources



## Heatmap

The Heat map for the area under review can be observed on <http://heatmap.scotland.gov.uk/>. For the purposes of the transition, the aim is to get increased accuracy by establishing energy use from each property. This will also identify properties able to gain the greatest benefit by connection to the district heating network. The energy supply to each of the properties will be assessed in order to establish the type and age of the heating system.

The heat sources in Aberdeen include Electric, Gas, Oil and Coal. The initial energy selection may have been based on legislation, e.g. prohibition of the use of gas in multi-storey properties, or proximity to services.

The age of the existing heating system in a property shall also be reviewed as part of a property installation assessment. For example, many homes in Aberdeen have a gas fired central heating system installed, if this is a newly installed system with a high efficiency rating and low carbon output, the carbon savings obtained by connection to the district heat network would be minimal.

Significant energy consumption may be a consequence of the property type, or a combination of factors such as an inefficient heating system combined with poorly sealed and insulated buildings. Prior to connection to a district heat network there should be a review of other potential measures that may be taken to improve the energy efficiency of a building.

Within the Aberdeen city centre part of the project there is a potential for expansion within the outskirts of the city centre, there are additional sizeable buildings on the periphery of the proposed network that may benefit from connection to a district heat network later. Some of these include council owned and municipal facilities

## Economy

The economy within Aberdeen city is supported by the Oil and Gas industry, although several other sectors are present within Aberdeen and its conurbations. Meetings have been held with organisations that Oil & Gas companies are members of, in order to raise a general awareness of the project. Within the city centre, there is a mix of businesses that will have an opportunity to connect to the district heat network in the future. These will be approached in order to ensure that the opportunity to participate is comprehensive throughout Aberdeen City.

As a first pass approach, commercial properties have been identified within the area of proposed routes for the expansion of the district heat network that have been drafted by Aberdeen Heat & Power. The commercial properties within these areas have a range of types and sizes.

As part of the economic factoring for the development of the district heating system, there should be consideration given to installation costs. Incentives for connection of commercial properties should be considered, either as award of grant funding, or as a reduction in taxes related to individual carbon consumption. This would require a clear pathway on both a local and national level to promote district heating and reduce the consumption of energy within the premises.

In addition to financial costs of system installation, there is a risk of disruption in the area during installation works having an adverse impact of businesses. The installation would need to be carried out as a managed process within the city centre, in order to avoid any major disruption that could influence the area. Detailed planning and careful management would be required to minimise potential impacts on businesses, whether they are connecting to the network or not.



## Strengths

The existing network within Aberdeen acts as a major strength and starting point for the promotion and expansion of a district heat network within Aberdeen. Existing properties connected to the network can be contacted to discuss the benefits of connection and the increase in comfort that has been experienced. Contacting existing customers is performed as part of an ongoing quality management process by Aberdeen Heat & Power.

Buildings that have been connected are able to discuss efficiencies in having heat generated externally in addition to an increase in utilised space (due to lower plant area room requirements), the improved safety aspect that results (as direct gas supply is not required to property) and the carbon savings that are a consequence of connection.

In terms of the provision of district heating, Aberdeen Heat & Power, as an energy supplier working in partnership with Aberdeen City council, has a good reputation in the provision of district heating. It is reactive to any customer concerns or issues with heating installations and manages any issues via good communication with relevant external agencies. The development of the AH&P existing network has been carried out as part of a strictly controlled process. As the network evolves over time to a 4DHC system measures will be taken to ensure the high level of service is maintained.

The development of a district heat network within Aberdeen has a clear direction through the work of Aberdeen Heat & Power supported by ACC. This will also accommodate improvements in the system that will move towards the development of a district heating network covering a wider proportion of the city.

In addition to the conservation of CO<sub>2</sub>, the ambition of increasing the network throughout Aberdeen city will enable the development of a localised energy infrastructure. Developing a localised infrastructure is in line with national policies to reduce national energy consumption and also the Low Carbon Heat and Energy Efficiency Strategy (LHEES). The development of the localised infrastructure will work in conjunction with plans to ensure a citywide strategy to reduce CO<sub>2</sub> and future aims and goals of the city centre masterplans. These focus on several aspects with the aim of improving life within Aberdeen city, one of which is reducing carbon emissions. The reduction of carbon emissions and encouraging sustainability can improve the quality of life for the people of Aberdeen, making it a prosperous and attractive place to live. There is work being carried out across several agencies and departments in order to deliver this goal. The masterplans have a holistic approach, exploring not only improvements to the energy cycle and infrastructure, but also looking at environment, development of tourism and the external investment and development of the city and environment.

In terms of the reduction in energy use, there is potential to install district heating in tandem with other heat conservation measures in properties and to provide education in minimising energy use. This would lead to a further reduction of CO<sub>2</sub> produced.

## Weaknesses

The primary potential weakness in the plan to develop a district heating network within the city centre is the uptake of the system by businesses and companies. There are a number of barriers that can prevent businesses and companies from connecting to a district heating networks. A clear understanding of these is required in order to maximise uptake.

**Business Structure** - Aberdeen has several department stores and international brands and chains. Whilst some are managed as independent franchises, some are managed via the company head office. Depending on the management structure, this can lead to additional complexities. For example, some of the businesses have

energy suppliers within their remit or have national contracts with national energy suppliers to provide energy to all their group businesses.

**Approved Vendor Schemes** - In order to provide energy to larger companies, it may be necessary to meet the quality standards of the company. These are continuing to be explored. Companies may only procure from vendors that exist on a procurement framework. If users that have existing framework agreements need to be considered as part of the energy arrangements for the city and the overall carbon reduction plans, legislative changes will need to take place in order to introduce district heating to these areas.

**Group Discount Schemes** - Local business improvement areas have worked hard in recent years to negotiate favourable, fixed price deals with energy suppliers. This has resulted in some businesses who have been approached not wishing to discuss connection at present. It has been noted that the provision through the group deals in the Aberdeen city are cheaper than the rates that Aberdeen Heat & Power can provide at present. There may be opportunity to enter a conversation once the fixed deals have finished.

**Competition** - Aberdeen Heat & Power will look to develop a price structure for commercial customers that ensures that there is sufficient available revenue to provide maintenance and development of the infrastructure and to develop the network in areas of fuel poverty. This rate needs to be comparative and competitive in order to attract private commercial properties.

**Timing** - The time schedules are critical for each business considering participating in the scheme. In some cases, this may present an opportunity. For example, if a property has an old or inefficient heating system and there is a planned budget for replacing the system the opportunity of installation to a nearby district heat network could be an alternative option. If a property is currently connected to the gas mains and is not yet in a region that can be suitably connected to a district heating network there may be an opportunity to work with owners to ensure that a heating system can be readily connected later. In the case of electric heating, this may not be so readily achieved, and the owners should be informed of when the district heat network is within close proximity to their property.

As part of timing there should also be consideration of the time of year when installation is scheduled to take place. This may not readily fit with the business plans of the establishment concerned. For example, this may be at a time, which would have the greatest impact on the smooth running of the commercial enterprise, e.g. it could coincide with a predicted time of heavy footfall in retail premises.

**Cost** - When district heating is connected to a business, there will be some financial contribution required from the business concerned. The level of financial contribution that is required in terms of the property, or the availability of funds may determine the willingness of participation. This in turn may be determined by future predictions for the company within Aberdeen. District heating cost savings result from its long-term use. Some businesses may not see that as a potential benefit in the short term, or in line with the long-term needs and opportunities of the business.

If the properties are business space lettings, there may be scope, dependant on contractual agreement to add district heating to the properties. This would need negotiation between owners and tenants, depending on how energy payments are arranged for the properties. If the tenants are responsible for payment of bills, connection would have to be mutually agreed. The exploration of this may need to wait until the current contract between owner and tenant has passed. This may lead to a delay in the progression of the district heat network within Aberdeen as the majority of large commercial properties are commercially rented.

**Cost / benefit** - Each business would have to evaluate carefully whether connection was financially beneficial, this would be based on their existing heating costs and type. This may be influenced through legislation, such as

carbon tax, which would incentivise businesses to reduce their carbon emissions. The use of district heating is considered as low carbon, carbon can be reduced further with newer technologies and these will be explored as part of plans to develop the network into a 4th generation network. There may be further incentives offered to businesses in order to make connection favourable in terms of grants and incentives at a local or national level.

It was noted that as part of initial contact made with businesses, there was some scepticism that arose relating to the validity of the project. Questions about the benefits of district heating as a concept were also raised.

## Opportunities

There are opportunities within the area not only to introduce district heating, but also to engage with businesses to ensure that the scheme can be developed with future planning in mind. Future proofing needs to be performed by looking at ways to introduce diversity of supply and mix of energy types in addition to reducing the circulation temperature of systems, whilst still ensuring the comfort of users.

Opportunities may be assisted greatly by local planning strategies and regulations along with national and international regulations that seek to develop the uptake of district heating.

In order to maximise the uptake of district heating in Aberdeen City centre, contact has been made with all large stakeholders within Aberdeen city centre. The responsible parties for each of the city centre business and commercial properties was established by the use of internet research. Contact was initially via email, in order to provide stakeholders with an opportunity to find out more about the scheme. This has been further promoted by local business organisations in order to raise an awareness of the schemes. Initial email correspondence has been followed up with posted correspondence, to larger stakeholders.

Known new developments were also contacted by carrying out searches on new planning applications and contacting relevant parties. These also include redevelopment works. In these cases, the infrastructure may not be in place to enable immediate connection, however guidance can be provided about connection at a later stage in the project.

## Threats

Plausible threats to the future growth and development of a 4DHC network may be connected to a number of potential causes;

- Financial
- Supply issues
- Lack of project understanding
- Lack of communication with appropriate stakeholders
- Negotiations and cooperative working with third party agents
- Delays in schedules or agreements

**Financial issues** - may be critical to the project proceeding with time. This can be broken down into a number of potential issues related to not only the infrastructure as a whole but also operational costs and modifications to the system. In terms of energy, as 4DHC evolves throughout the city, and the potential of alternate heat sources is explored, the financial costs of heat generation in the area will be reduced. Initial investment in capturing this energy in some cases may be high, such as the building of an energy from waste plant, and a large initial investment needs to be allocated for projects.

It should be noted that the payback time for a district heating scheme would be higher than, for instance, the installation of an individual domestic boiler within a property, due to the greater level of infrastructure that needs to be put in place. However, the lifecycle of the heat network and its flexibility to add or modify components independently with minimal effect to the end user, means that in the long-term outlook the overall cost comparison would be lower per property.

In the case of development of a network within Aberdeen city, if there is seen to be a high level of uptake within the area, based upon scheduling and planning there may be a potential to reduce costs on initial installation, through negotiation and procurement of bulk purchases of materials, and through carrying out groundwork and installation as a single stage.

**Supply issues** - may relate to energy supply or gaining a sufficient number of end users. If there is a risk to obtaining energy at a competitively priced rate or if there is difficulty in getting end users, there is a possibility that the project will be at risk.

In terms of existing users, the connected properties at present are council managed or municipal and public sector properties. These operate through different means to privately managed and commercial businesses.

In order to provide confidence to commercial ventures there must be an acceptance that any work practices will need to be closely scrutinised prior to making a decision. This may be done by the potential connection carrying out a documentation audit of company practices. It should be noted also that some businesses would not enter into agreements without meeting necessary criteria, i.e. ISO 9001. In terms of entering into long term contracts, the businesses also need to have some confidence in their long-term outlook within Aberdeen. There has been a decline in the Oil and Gas industry in the last few years, and this has had an adverse effect on trade and commerce in the area leading to some market uncertainty. This could have a knock-on effect for the development of a district heat network, as properties may be reluctant to commit long term.

**Lack of Project Understanding** - In terms of the project and its development, in order to promote 4DHC, how to educate the general public about the current district heating system within Aberdeen and plans to develop it further needs to be explored. This needs to start at a high level within local government, but also needs to filter through to potential stakeholders for the current and future development of district heating within Aberdeen, and potentially the wider community. Providing further education about district heating will also enable the community as a whole to be more engaged in the project.

In order to develop a network throughout the city centre, the appropriate stakeholders for each property should be identified. This, in some instances, may be complex in itself as there may be several layers of management of the property and it may not be clear who is ultimately responsible for the property. From an initial review of commercial properties, we have found that there can be several layers of stakeholders, such as tenant, management agency and pension fund. In each case the relationship with stakeholders needs to be clearly understood and managed in order to effectively proceed to the level at which contracts and agreements can be signed to proceed to installation.

In order to develop the project, there is also a need to develop good lines of communication and build good relations and project understanding with external agencies. External agencies may include other departments within the council who are not familiar with the proposed work but require to be consulted prior to starting any work, or external bodies such as Historic Scotland who may act to protect listed buildings within the area. In parts of Aberdeen in which we are looking at installation works, being carried out there may also be the need for archaeological review as part of the groundworks. This needs to be considered at an early stage, and slack needs to be built into the system so that there is minimal schedule impact should work need to be temporarily halted.

Due to the financial investment required to deliver the network throughout the city, development can only proceed when there are contractual agreements in place with connecting stakeholders. Legal structures need to be in place to allow connection to go ahead. Once installation is in progress, there needs to be a structure in place which ties the user to staying connected for a certain length of time and once the form of heating is in place there may be complexities in changing supplier or type of energy supplied (such as thorough a “switching process”). Prior to entering into a contract, this needs to be clearly understood by the signatory party.

It should be highlighted to the customer that they will effectively be tied to price changes within connections for a period, and any contract should consider including a minimum number of years that a company needs to be connected for in order to allow all parties to benefit from the relationship. This could potentially be seen as a risk to some consumers, such as private domestic customers, who are unable to guarantee whether they will remain in a property for a fixed length of time. In this instance, there should be a facility to change energy contract ownership and a legal framework in place to ensure a smooth transition of contract, such as is currently used within domestic council managed properties.

**Lack of Communication with Appropriate Stakeholders** – Ensuring relevant stakeholders are kept fully informed of the project ensures a good working relationship. The stakeholders that need to be kept informed may change as the project develops. Initial stages may involve planning and works contractors as the main stakeholders, whereas during the works stage of development, the local community will need to be involved with any communications that take place. Being aware of the need to remain engaged with Stakeholders and ensure that they are kept aware of changes that have an impact upon them is important in the implementation of a successful project.

**Cooperative Working with Third Party Agents** – Working on a District heat network often involves several contractors. To ensure work is carried out in an efficient manner planning and negotiation skills are essential in the project management team. Scheduling and phasing of work may be required in order to co-ordinate the different teams involved and ensure the project is completed on time and all objectives are achieved.

**Delays in schedules or Agreements** – Sometimes delays in projects are unavoidable. Potential causes of the delays should be realised at an early stage by the project manager who will ensure that there is necessary slack within the system to account for potential delays. Delays can be related to lead-time on materials, planning consent issues and legal agreements. Identifying and reacting to issues at an early stage is key to ensuring the smooth progress of a project. Stakeholders should be kept fully informed of any delays that occur.

## Stakeholder analysis

The city centre area has a mix of stakeholder types. Within the area proposed for development there are the following types of properties;

- Privately owned flats
- Council owned flats
- Housing association flats
- Privately owned houses
- Commercial tenanted property (council)
- Commercial tenanted property (private sector)
- Universities and colleges
- Municipal properties (Schools, offices, libraries)
- Churches and Cathedrals

- Privately owned stores
- Shopping Centres
- Hotels
- Student Accommodation
- Residential care

Each of these stakeholder groups will be contacted in due course. It is noted that different types of users will use a maximum amount of energy at different times in the day. This will ensure the system can be managed in a balanced way between the different types of property.

In order to maximise the efficiency of the network and minimise potential cost implications, properties will be contacted that require a high-energy demand. This will include larger spaces as well as housing complexes, owned either by the council or under private management.

Connection of larger properties may provide some level of risk from both the stakeholder and the energy provider. Investment priorities of large stakeholders may change with time, and this could leave an energy provider with loss of revenue and loss of income if a large property was vacated for a significant length of time. Within Aberdeen city, this is the case for several larger office buildings, following development of newer and more competitively priced rental properties.

## Communication with Stakeholders

In order to effectively manage stakeholder expectations, information about developing the district heat network within the respective property should be provided. This could be generic or be more specific in nature, such as being related to the type of premises. This will discuss things such as:

- Scope of the works
- How the installation will be carried out
- Who will carry out the installation?
- Timescales
- Potential costs for work
- Benefits of installation, community benefits & environmental benefits
- Potential sources of funding
- Financial and CO<sub>2</sub> savings
- Contact numbers details.

In terms of commercial properties, if there is an understanding that they would like to pursue an installation, costings will be provided on a case by case basis which will be comprehensive and include not only the potential costs but also potential savings. This will assist the company in building a business case for the installation so that there is a full transparency of costs prior to supply agreements being made.

## Financing mechanisms

The current infrastructure within Aberdeen relies on Gas CHP. The income generated has two main streams; the monthly customer billing and the revenue from the production of electricity, which is fed back to the national grid.

With the developing of infrastructure and the Energy from waste plant being incorporated into the heat network within Aberdeen, there is an awareness that the CHP engines eventually may be used as a backup rather than the primary heat source in the future. The move away from CHP is considered a very long-term plan and will not



only depend upon identification of alternative technologies but will depend on available funding. Providing a link to the Energy from waste plant is one scenario for the wider Aberdeen area that is dependent upon funding. The plans are critical in determining how revenue will be made and maintained for AH&P once the Energy from Waste plant is operational.

As AH&P have experience in delivering and overseeing the management works required for development of the network, it may be possible for the company to develop sufficient revenue via delivery and management of necessary infrastructure works required, and the everyday management of the network and end user needs. A long-term outlook needs to be considered to ensure sufficient revenue can be generated to allow for long-term development and maintenance of the infrastructure and to ensure the necessary means to reduce energy in years to come.

Through the introduction of business users, a rigid framework is required to ensure that connection to properties is the most economically viable option for all parties involved prior to commencement of work. This would consider financial considerations as well as the amount of CO<sub>2</sub> produced initially upon connection and following a future transitioning of the network to 4<sup>th</sup> or 5<sup>th</sup> generation networks.

Although there may be access to funding and schemes for the financing of connection for businesses and properties in the area, it should be noted that some of the financing will need to come from the stakeholder themselves in development of the project. This may prove difficult without a solid plan for progression in the city centre.

It has been noted that city centre stakeholders would like certainty in several factors prior to entering into any agreements to connect to the network. These include costs, timescales, disruption and energy savings. The primary considerations for the majority of businesses interviewed were the potential direct costs that could result from being part of the network. This includes looking at the overall connection costs as well as long term running costs of the system.

In the current model within the city centre, the district heat network will not be completed until there are sufficient numbers of high demand users confirmed to install the network. There is still uncertainty with respect to final routing plans. Confirmed plans are preferred by city centre stakeholders as they provide a good indication of when connection would be likely for the parties involved. In terms of costs to buildings for connection, this may only be approximated at present. A detailed survey would need to be carried out in order to establish the installation costs for each building. This would look at the current heating system in order to establish the type of infrastructure required. If the existing heating is a wet central heating system, there may be opportunity to use the existing internal pipework and network in order to develop the infrastructure, depending on its compatibility with the district heat network. In some cases, such as in listed buildings where using the existing radiators or pipework may be a necessary condition when supplying the premises.

Within domestic properties, such as multi-storey properties, that have electric storage heaters the greatest efficiencies are seen when these are exchanged for a wet heating system. In retrofit properties this is currently done by installation of room radiators.

It should be noted that larger commercial properties generally use electric based or air-based heating. Where this form of heating is commonplace additional options may be explored for reducing carbon emissions. This can involve discussion with external agencies such as Resource efficient Scotland or Home Energy Scotland to advise on best practice. There may be the opportunity for larger developments that rely solely on electricity to consider private wire connection to the premises.

## Overview of Possible Heat Clients

There is a large potential range of clients that are suitable for connection to a district heat network within Aberdeen. This will assist greatly in the balancing of the system, as peak energy use will vary between the different user groups within a 24-hour timeframe.

There are several council owned and managed residential and commercial properties that will be approached via ACC in the first instance, and ACC will hold the final decision in whether a district-heating scheme should be added to the area. Work will not proceed until any agreements are finalised.

Residential properties are managed in a different department to commercial properties within the council. Commercial property space is rented on the understanding that the tenants arrange their own energy supply. In this instance, should connection to a district heat network proceed, negotiation will need to be carried out with the tenants. In addition, the contracts may need to be checked and, in some instances, renegotiated in order to ensure that there is the necessary access to facilities as well as that the council is able to make the change in heating type.

## Economic Viability of Different 4DHC Approaches and Typologies

Aberdeen has localised district heating networks in several areas which are best classed as highly developed 3<sup>rd</sup> Generation district heating facilities that have some characteristics in common with 4<sup>th</sup> Generation facilities. The approach to develop a district heat network could have the following approaches:

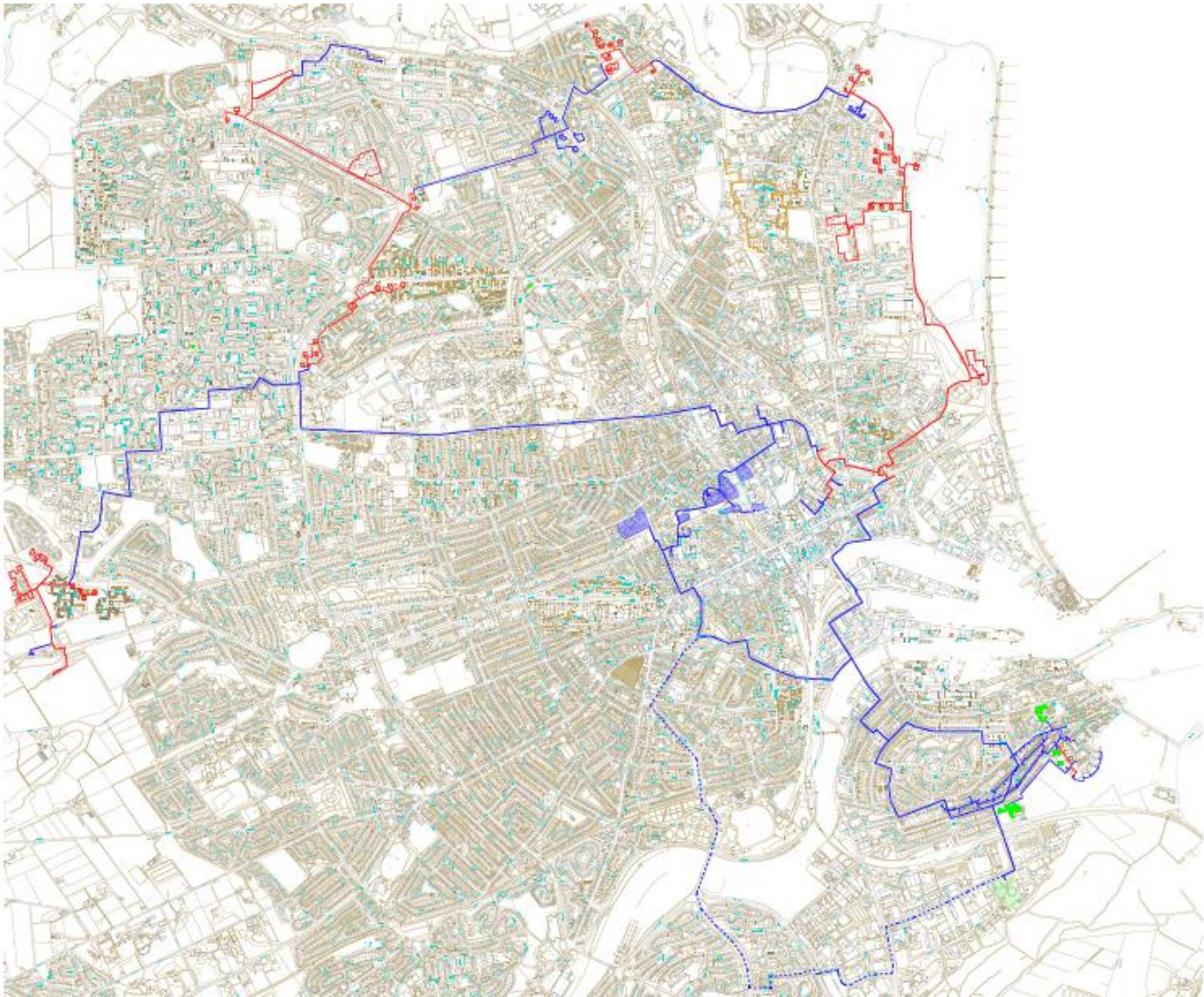
1. Use the existing infrastructure as a framework to develop and upgrade the system to a 4<sup>th</sup> generation system.
2. Develop a new system with the aim of looking to build a new 4DHC network.
3. Maintain the existing system without plans to extend or develop.

The existing plan is to develop the existing infrastructure with the long-term aim of integrating 4<sup>th</sup> generation principles into the existing network. In terms of economic viability of the system, this is a balanced approach to ensure that the development can be carried out to a timescale with minimal requirements for investment, as development of the system can progress when there is sufficient revenue generated from existing developments. This can be done in conjunction with any additional funding streams that can be used to build the network.

By looking to a progressive and gradual development of a scheme, there is also opportunities to review available energy sources in the vicinity that may contribute to the energy source mix within Aberdeen. It will also enable the system to be sufficiently flexible to add further energy sources when they become available.

## Future Vision & Goals

The future vision of Aberdeen is to have an expansive citywide district heat network that will be able to use all the principles of 4DHC. This includes minimising the use of heat using smart controls, reducing the overall network temperatures, ensuring that wasted heat is captured and integrated into the system. The capture and recycling of wasted heat can be from properties that are connected to the existing network or through industrial plants in close proximity to the city centre (i.e. Altens, Tullos or Nigg industrial estates). Wasted heat may be collected from a range of premises for utilisation as an energy resource elsewhere in the city. A framework would be required to collect this heat, there would also need to be a benefit to the businesses involved in this project. The figure below demonstrates a scenario for network growth in the coming years.



6. Aberdeen Heat & Power existing network (red) and planned growth (blue)



Current developments have been carried out strategically in each of the areas. The energy centres have been built in locations close to high concentrations of multi-storey blocks. The development of the current network also correlates to areas identified as experiencing fuel poverty. When building the network an awareness of nearby properties that have a high heat demand has also been taken into consideration and connected where strategically advantageous to the development of the city network. This includes municipal properties, a Health Village, a Sports Village and several local community facilities.

Aberdeen Heat and Power only consider developments if they are able to contribute to the reduction of fuel poverty within Aberdeen. The aim to reduce fuel poverty of its citizens is also shared by Aberdeen City Council, which has led to the close working relationship between Aberdeen City Council & Aberdeen Heat & Power.

The initial phase of the HeatNet NWE project looks at the planned connection of an energy from waste facility which will be built south of the city to be used as a heat source.



#### 7. Map showing site of Energy from Waste plant

The site is adjacent to the community of Torry. This area of the city is identified as having high levels of poverty, (Torry Strategic Assessment 2016), where 22% of children are living in Poverty. The heat network that has been developed as part of the HeatNet NWE programme has installed a central spine emanating from a current energy centre using gas boilers which provides heat to three multi-storey blocks.

## Phase 1 - HeatNet NWE

The route for the initial phase of the HeatNet NWE development is as shown below. The buildings that have been connected as part of the pilot are Deeside Family Centre and two Residential Care facilities Balnagask House and Provost Hogg Court. All of these properties are owned by Aberdeen City Council. The buildings were selected taking into consideration the long-term expansion of the network within Torry.

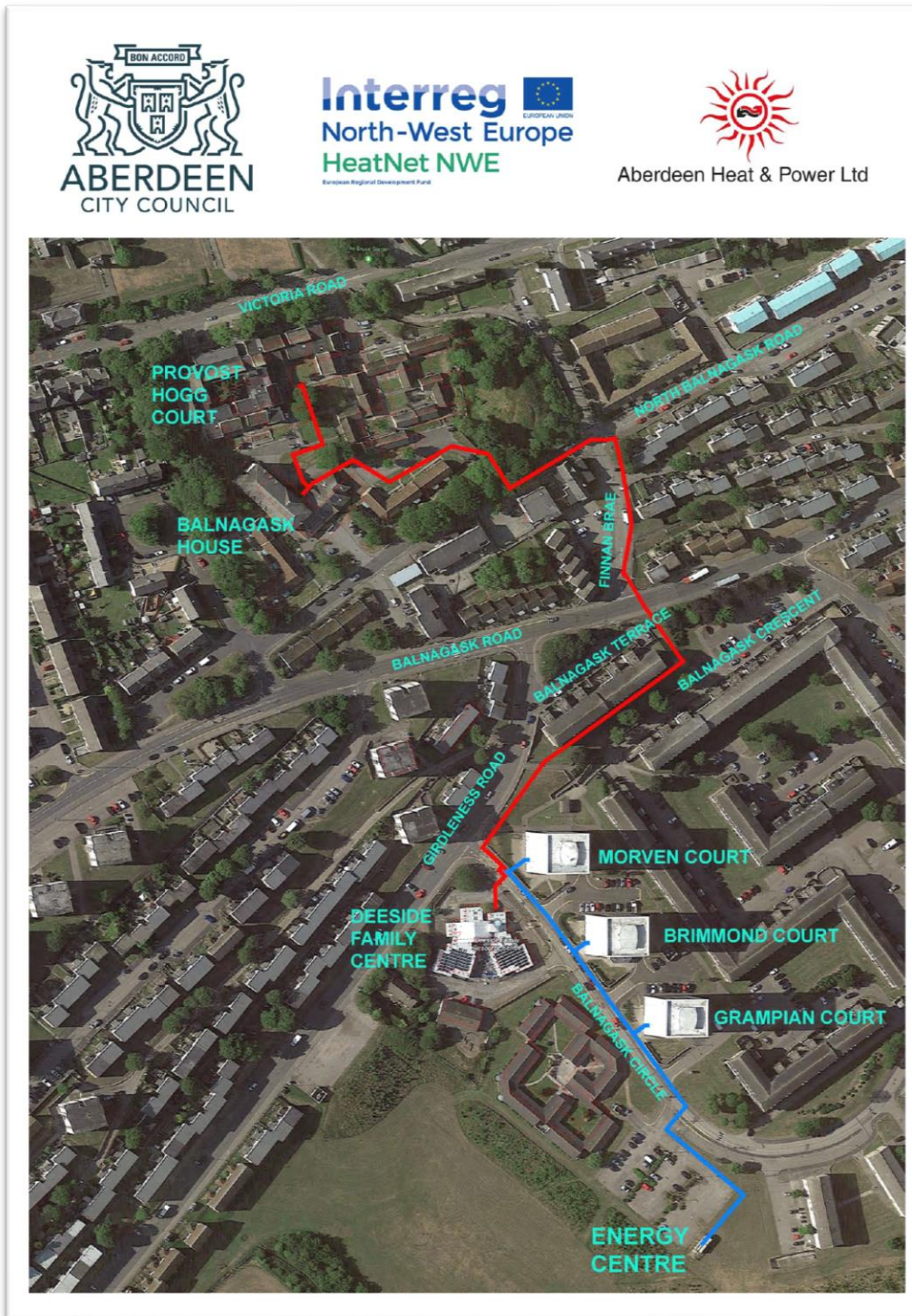
The buildings were selected from the Torry area as a foundation to build and develop the heat network for a number of reasons;

1. The area uses a high heat load;
2. Proximity to the proposed EFW which can be used as a heat source;
3. The Area has been identified as an area which has a high level of fuel poverty;
4. The area predominantly contains social housing;
5. The initial pilot can be developed to connect to other areas which have high-energy usage as the project progresses.

The energy centre that is being used was initially built as a standalone centre to serve the three multi-storey properties – Grampian, Brimmond and Morven Court



8. HeatNet NWE pilot project connections a) Deeside Family Centre b) Provost Hogg Court c) Balnagask house



9. Route of HeatNet NWE pilot project - Poster produced as part of communications campaign

A connection is planned from phase 1 network to the EFW plant, following its proposed completion in 2022.

The phase 1 network shall be used in order to test the use and control of the heat output from the EFW plant, and as a starting point for the development of a low carbon heat source for heat generation throughout the city centre.



The initial connection to the district heating system (which initially will be gas based) has resulted in a saving of **89 Tonnes of CO<sub>2</sub> per year**.

Following connection to the EFW plant energy savings for the connected buildings have been calculated as **675.8 Tonnes of CO<sub>2</sub> per year**.

## Phase 2 – HeatNet NWE Torry

The current plan is to extent the phase 1 network developed within the HeatNet NWE pilot project to connect further residential dwellings as well as non-residential properties within the Torry Area. The outline plan is for 800 residential properties and 5 non-residential buildings to be connected. Timescales for this will be subject to ACC budgetary constraints but are proposed to be connected within the next five years.

The projected Carbon Savings of the connection of these further properties being connected would be approximately **1790 Tonnes of CO<sub>2</sub> per year**.

## Phase 3 – Expanding the Network within the City

Additional expansion will be explored within the City Centre. The connection to the city centre will require a river crossing. Although this has been considered within an early stage for citywide project expansion, this river crossing will be explored at a later date when the network has been developed closer to the river. The Learnings of Boulogne sur Mer will be used in the crossing of the river.

It should be noted that development of the district heat network within Aberdeen city centre is also developing independently from the HeatNet NWE project within several areas of the city. There may be opportunities for the separate networks to meet at points within the 4DHC journey to exploit a range of differing heat sources within the long term.

From review of previously collected data, energy generation sites within Aberdeen were also reviewed as part of the production of this document in addition to exploring opportunities for energy recovery within the city. With this in mind, there is scope for the network to be developed further utilising these sources as part of a 4DHC network.

The introduction of the heat network, and its subsequent changes to meet the requirements of 4DHC network will need to be carried out to minimise potential disruption in order to maximise customer confidence in the network provision.

To ensure this is the case, there will be a detailed assessment carried out of the existing infrastructure and network and property internals to assess the system changes necessary to move to a 4DHC system. This will include an assessment of any necessary radiator or heat exchanger requirements in addition to reviewing whether the changes would necessitate a requirement to make other changes to the property, such as improving the insulation on the property as the circulating heat will be of a lower temperature.

Discussions about potential benefits of a sharing economy to businesses should be discussed at an early stage in order for them to gain an understanding of how they may be able to contribute to the future needs of the city and the security of its energy supply. The current source of energy within Aberdeen for standalone district heating systems and CHP generation is Gas. As this is a high calorific resource, alternate energy sources are being explored, for example hydrogen and photovoltaic cells. By developing a pipework infrastructure across the city, a framework will be introduced in order to add alternate energy sources as and when these become available and provide the city with an opportunity to exploit currently wasted heat.

## Transition Strategy

The development of district heating within Aberdeen city has been carried out with an approach that looks towards the future development of the network and its expansion. Aberdeen Heat and Power have infrastructure in place that can be used as a foundation upon which to build and develop the district heating network and also allow for the gradual reduction of energy use by the adaptation with time to incorporate lower temperatures. The reduction in system temperature will need to be carried out using a controlled process. This would ensure that any transitioning process could be carried out with a minimal impact on the end users in terms of thermal comfort and hot water supply. For properties that are currently connected to the district-heating network, there may be a need to modify existing internal structures, such as radiator panel sizes in properties.

As part of the transition strategy towards CO<sub>2</sub> reduction, and the improved use of energy resources the HeatNet NWE project aims to use control and monitoring of the energy use within the heat network to minimise the overall amount of energy used within the system. In accordance with metering regulations passed, new build installations have all been fitted with individual metering points. In addition to this, controls that can be accessed remotely have been installed to review the running of CHP engines. Without automation of process, AH&P carry out monitoring on a monthly use of energy consumption within the system, as part of their regular monitoring processes. Additional controls are being assessed in order to enable greater control within in each property. Monitoring and making consumers conscious of their energy use is a large component of conservation of energy.

In terms of spatial progression of the district heat network within Aberdeen, the current framework relies on the locations of AH&P energy centres and the eventual plan to form an energy ring around the city. In this way, energy can be conveyed around the city dependent on energy needs. With the addition of an energy from waste plant as a heat source to be incorporated into this mix, there is a potential for the heat produced to be delivered by the existing and proposed AH&P network. The contribution of the EFW plant into the energy mix of the city will add a large additional resource to the network.

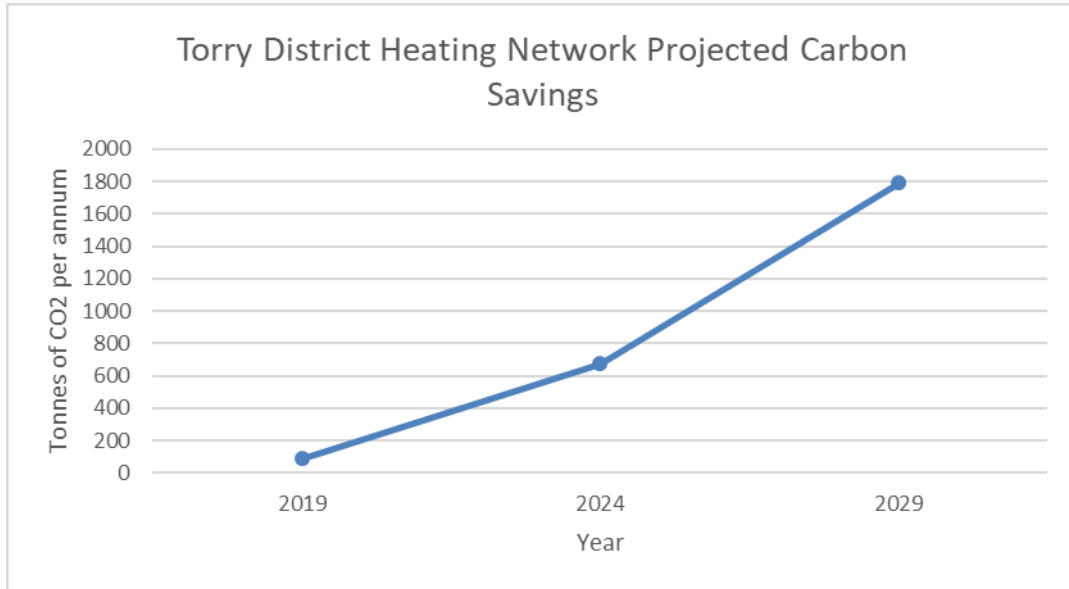
Any previous or current capital infrastructure cost for district heating mains distribution pipes have been fully funded by ACC. AHP have not invested in infrastructure to date, the connection to the Aberdeen College will be the first one to be funded by AHP. Currently revenue from heat sales is not used for DH infrastructure, it is used for operational costs and cyclical maintenance. AH&P works as a not for profit organisation. All projects that are developed have the primary aim of reducing fuel poverty within the city of Aberdeen. As a result, any projects need to be carried out using proven technologies. Development will also be carried out by a means that continues to provide security of supply to customers at a cost that effectively reduces the risk of fuel poverty in customer's homes.

Developing the existing scheme to a 4DHC network would require a number of key changes within the network and infrastructure as a whole. The necessary changes will be carried out progressively throughout the network, as opportunities arise. For example, radiator sizes within a district heating system may need to be changed in order to provide an effective amount of heat for room sizes.

Many of the gradual changes to make the system have greater efficiencies can be carried out whilst exploring the development of the network.

The pilot area has had a feasibility study carried out, which has explored all potential ways to progress with 4<sup>th</sup> generation district heating in that area. This recommends a measured approach, and looks at ways to develop and integrate measures such as improvements to controls and metering

The projected savings within the Torry HeatNet NWE project are 89 tonnes CO<sub>2</sub> per year from 2019, 675 tonnes CO<sub>2</sub> per year at 5 years, once the network has been connected to EFW. If planned expansion of the Torry heat network goes ahead then savings at 10 years would be 1790 tonnes CO<sub>2</sub> per year.



## Delivering the transition to 4DHC district Heating: Action Plan

In order to work towards the use of 4DHC throughout the city, planning and delivery is centred around the Torry

	Short Term 2020-2021	Medium Term 2022-2024	Long Term 2025-2027
<b>Planning</b>	Business case for connection to EFW approval.	Feasibility plans made for further connections to Heatnet NWE pilot network	Explore river crossing options to connect with wider network
	Feedback process to Scottish Heat Map, and ACC CO <sub>2</sub> emissions.		
	Review potential connection opportunities and extensions to additional heat networks throughout city		
	Review of how renewable resources may fit with the heat map of the city		
<b>Delivery</b>	Work to start on connection from Heatnet NWE pilot network to site of EFW	EFW centre completion and connected to Heatnet NWE pilot network	Connection of further properties to Heatnet NWE pilot network
<b>Stakeholder engagement</b>	Maintain engagement with businesses and community stakeholders		
	Through stakeholder engagement identify new connections and potential prosumers within the city		
	Increase profile of district heating within Aberdeen		
<b>Legal</b>	Explore legal relationship between connecting new and existing network.		
<b>Policy</b>	Lobby for favourable policies for the expansion of District heating to be adopted, locally and nationally		
<b>Technical</b>	Testing of HeatNet NWE pilot network, recording and monitoring of energy data.	Testing and optimisation of HeatNet NWE pilot following connection of EFW centre	Explore current technological options for crossing river with network
<b>Capacity Development</b>	Review how nearby developments could connect to Heatnet NWE pilot network	Feasibility study connection of existing networks within Aberdeen city	
	Feasibility studies for further expansion of network and the potential of using waste heat from businesses		

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## Experiment

The Aberdeen pilot of the heat net project looks towards the development and delivery of a 4th generation district heat system and the possibilities in making its development a reality. The primary focus in moving towards 4<sup>th</sup> generation in that area is through preparation of a system that can be readily connected to an additional heat source, as and when it becomes feasible and available.

The future vision within Aberdeen is to connect all of the existing networks, in order that district heating can be provided to an extended area of the city. By establishing whether a valid model can be developed in order to provide energy to a range of different types of users, with suitable contracts and controls being drawn up with both the connecting parties and between Aberdeen Heat & Power and Aberdeen City Council.

## Conclusions

4<sup>th</sup> generation district heating looks at using a mix of energy sources including renewable energy sources and waste heat sources such as those being used in the energy from waste plant or nearby factories able to provide heat.

The initial Phase of development within Aberdeen is the development of an area within Torry. Torry was selected as an area to develop the 4<sup>th</sup> Generation District Energy network in Aberdeen for the following reasons:

1. Ability to adapt existing connections to 4DHC
2. Clear pathway for local area development of district heat Network
3. Identified area of fuel poverty within city
4. High density of social housing and municipal care facilities
5. Proximity of heat resource (EFW)
6. Potential to expand network
7. Potential to connect to industrial waste heat sources

There are four operational energy centres within Aberdeen, operated by Aberdeen Heat & Power which are planned to connect to each other in the long term and over time may connect to the Torry district heating network.

Exploring the addition of a range of heat sources to this developing network in addition to increasing monitoring and feedback mechanisms on this system will enable working towards a 4DHC network.

As a means of continuous improvement, a monitoring and feedback process will be present that will continually look to reduce the overall energy consumption within Aberdeen City. This will include the review of additional low energy heat that may be integrated into the network, and the overall reduction of the temperature of the existing heat distribution network

The carbon savings resulting from the installation of the district heating network will fit into the overall plans to reduce carbon within Aberdeen. Projected carbon savings for the project area of Torry are:

89 tonnes CO<sub>2</sub> per year from 2019;

675 tonnes CO<sub>2</sub> per year at 5 years

1790 tonnes CO<sub>2</sub> per year at 10 years

Additional savings will be made throughout Aberdeen city but this will rely on the connection of other properties to the AHP district heating Network.

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