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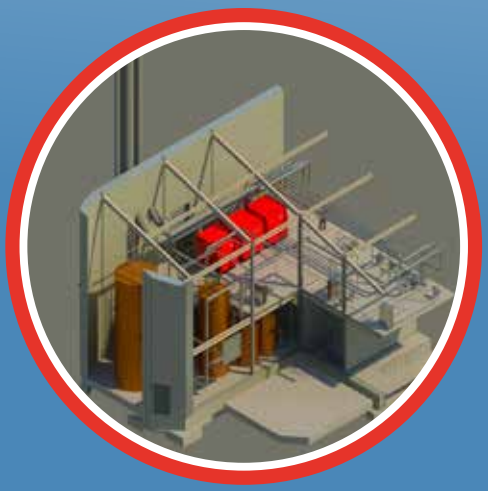
District Heating Strategy 2018-2028



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FOREWORD

Dundee has a clear role to play in rising to the challenges climate change will present to the local area. Reducing our greenhouse gas emissions ahead of national targets, adapting to the effects of climate change and re-asserting our low carbon credentials will mark the next phase in our transition to a low carbon future. Achieving this will require a transformational change in our energy use by reducing demand and encouraging local generation through investment in infrastructure that will deliver a long-term affordable, low carbon heat supply.

District heating, the supply of heat by hot water to a number of buildings through a heat network of underground pipes, is an effective way of making the most of our heat resources, reducing the carbon intensity of heat and reducing fuel costs. We are already seeing its benefits in Dundee and there is even greater opportunity for expansion to create integrated heat networks that will generate real social, economic and environmental benefits for the city through tackling fuel poverty, creating new jobs and reducing our carbon emissions. This will require new partnerships between the public and private sector to explore innovative solutions and most of all, long-term strategic planning to deliver the investment required.

We are therefore pleased to welcome this, the first District Heating Strategy for Dundee City Council, which aims to respond to these challenges and opportunities by setting out our long-term ambitions to build on our existing schemes and deliver new projects in the pursuit of a city-wide district heating network.

John Alexander
Leader of the Administration

David Martin
Chief Executive

1 BACKGROUND AND OBJECTIVES

1.1 Introduction

This document aims to identify potential district heating networks in Dundee, including the short, medium and long-term strategic opportunities and the development of a long term vision to support the City's growth and low carbon transition using decentralised energy. It will provide an evidence base to advance district heating network schemes in Dundee, informing both policy and delivery. The Strategy has been prepared with assistance from Resource Efficient Scotland and Ramboll and informed by a range of stakeholders.

Heat accounts for more than half of the energy consumed in Scotland[1], with the majority of homes, businesses and public buildings using conventional gas boilers. This dependence on fossil fuels, coupled with old and poorly-insulated building stock, means that heating also accounts for half of Scotland's total carbon dioxide emissions. Heat must therefore be at the centre of our move to a low carbon economy.

Scotland aims to decarbonise its heating by 2050 and district heating is seen as a crucial technology in enabling this to happen. The Scottish Government recognise that district heating could make an important contribution to meeting Scotland's future heat demand in areas where heat density is sufficiently high to develop networks that can provide heat at an affordable cost. Where allied to a low carbon heat source, it also offers the potential to meet heat decarbonisation objectives[2]. The national vision is to achieve a significant transformation in the deployment of affordable low carbon district heating as part of the route to a largely decarbonised heat system, moving from the current approach to a more strategically planned, integrated and comprehensive system that is attractive for investors and takes into account the needs of the heat user.

Scottish Public Sector Bodies have a key leadership role to play in developing district heating through the actions they take on their own estates to minimise heat demand; transforming the district heating market by providing 'anchor' loads (buildings with major heat requirements); and identifying partnership opportunities for utilising unused excess heat. Three specific roles have been identified for local government:

[1] The Scottish Government, (2015) 'Heat Policy Statement Towards Decarbonising Heat: Maximising the Opportunities for Scotland' (www.gov.scot/Publications/2015/06/6679)

[2] The Scottish Government, (2017) 'Consultation on Heat & Energy Efficiency Strategies, and Regulation of District Heating' (www.gov.scot/Resource/0051/00513244.pdf)

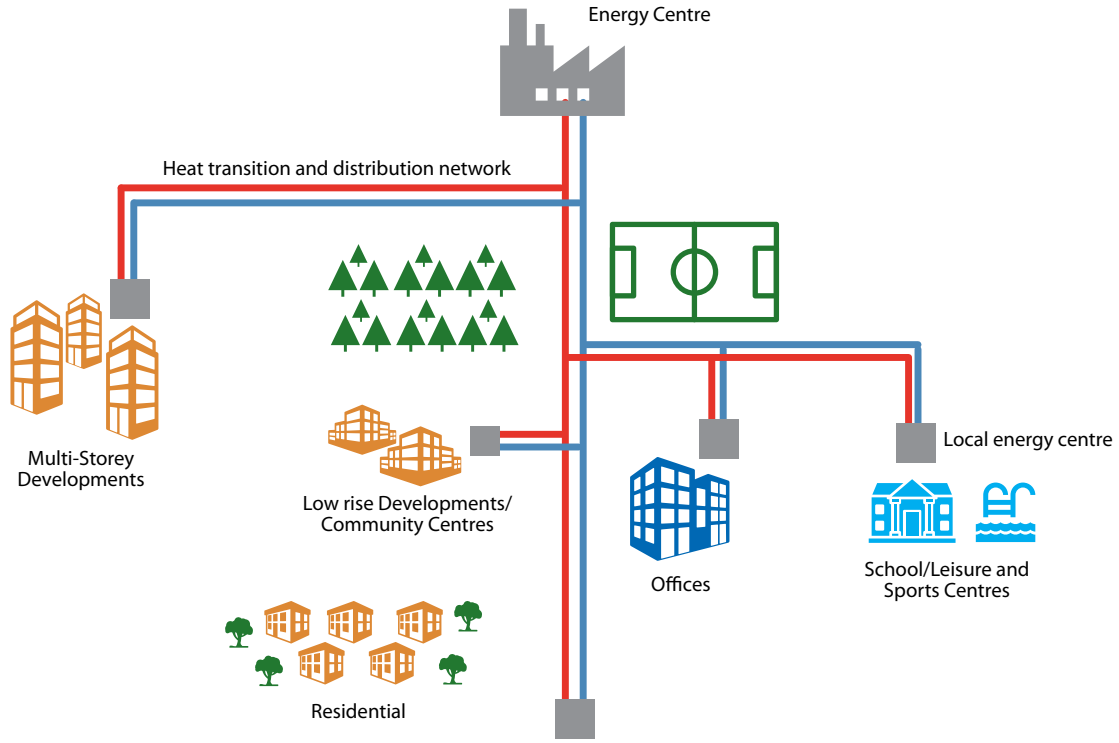
- encourage developers to focus on alternatives to fossil fuel heating through the planning process.
- use heat maps to plan decarbonisation initiatives in their local areas.
- establish frameworks to encourage businesses, industry and homeowners to minimise heat demand.

1.2 What is district heating?

District heating systems use a network of pipes to deliver heat from a place where heat is generated to multiple customers where heat is used (Figure1). The heat is typically in the form of hot water and is transported through a network of pre-insulated underground pipes. The heat may be generated in an energy centre using any of a range of technologies (e.g. surplus heat recovered from an energy from waste facility or other industrial plant, water source heat pump, gas combined heat and power (CHP), solar thermal, etc.), and could change over time as lower carbon/ renewable heat sources emerge.

Buildings are connected to the heat network through a substation where the heat used is metered. Buildings may have an associated energy centre which at times provides heat to the building, but at other times feeds heat into the wider district heating network. As the district heating network expands, higher levels of efficiency and resilience are achieved through the incorporation of multiple heat sources supplying multiple and varying demands.

Figure 1: Diagram of a district heating network



Whilst the scope of district heating projects can vary considerably, the vast majority of heat networks in the UK are relatively small-scale; in which these elements are under a high degree of common ownership or control. In many cases, generation, transmission and management is carried out by a single organisation supplying properties on a single site, typically a local authority or housing association.

As small-scale island networks gradually expand and integrate to form larger scale networks and recovery of low-grade heat from industry becomes more widespread, the various elements will become increasingly 'unbundled' (i.e. under separate ownership). Where this happens (e.g. dense urban areas), the delivery structures need to evolve to manage the different ownership of generation, transmission and distribution assets.

Modern district heating networks allow heat to be efficiently transferred for up to 30km from a single heat source. The pipe network infrastructure may also be combined with the provision of other utilities such as electricity and data. With multiple heat sources, district heating networks, such as those in continental European countries, can be hundreds of kilometres long. In some northern European countries more than 50% of the building stock is connected to a district heating system; in Copenhagen this figure is in excess of 95%.

1.3 Benefits of district heating

District heating systems usually offer benefits deriving from economies of scale. Even a local (building-scale) district heating system is usually operating at a greater scale than the alternative heating systems it replaces. District heating may also result in heat production efficiencies, reduced operating costs to customers and higher levels of reliability and quality of heat as outlined below.

Efficiency

CHP technologies are more efficient in their use of energy than the combination of centralised power generation plant (electricity) and gas boilers (heat) they typically replace. A CHP system may operate at 80-90% overall efficiency, providing heat and electricity with a lower carbon footprint. Modern, large scale extraction plants have heat efficiencies of up to 300 to 400%, when compared directly with the equivalent quantity of electricity generated by thermal power plant (with no heat recovery) and heat generation from boilers. District heating systems are also very reliable. The International District Energy Association (IDEA) report that most district energy systems operate at a reliability of 'five nines' (99.999 percent) and to their knowledge, there have been no rolling 'heat-outs' related to district energy systems.

Emissions

District heating networks offer the potential to reduce emissions from existing boiler installations. Air quality in Dundee is poorest in the city centre and along the strategic road network. A city-wide Air Quality Management Area (AQMA) has been declared for exceedances of the statutory European and National air quality objectives for nitrogen dioxide (NO_2) and fine particulate matter (PM_{10}).

Fuel Poverty

District heating systems have the potential to help address fuel poverty by providing secure heat at prices lower than alternatives. Whilst the development of a district heating system may be capital intensive, district heating systems have the potential to offer stable financial returns to investors, which may then allow access to finance at low rates. This, together with the ability to use efficient heat generation and to feed in low cost heat (for example waste heat from industrial processes), can result in the ability to supply heat at a relatively low cost, with the security of long-term contracts and the security of a local energy supply giving some protection from the volatility of energy markets. To date in the UK, however, access to suitable finance has remained a barrier to developing some district heating projects.

Integration

The 'economy of integration' derives from the ability to balance different heat loads which have peak requirements at different times. It is typical for maximum heating and cooling loads to fluctuate significantly, with maximum demand occurring for short periods of time. When loads with different peak demand times are served by the same network, the total heat capacity required can be significantly less than the sum of each individual heat capacity requirement. The more diverse the heat loads on a system (mixing commercial, domestic and public buildings, for example), the greater the benefit.

Renewables

District heating networks offer opportunities to use renewable and/or low carbon sources of heat (for example heat pumps, heat from water and sewage, geothermal, solar thermal, biomass, hydrogen fuel cells, waste heat from industrial processes, energy from waste) and heat storage technologies that may otherwise not be viable, especially as networks grow. They do so as the network is 'technology agnostic', meaning that any source, and combination of sources of heat can be fed into the network without the operation of the network being dependant on any one heat source.

Connectability

The ability to connect to an existing district heating system can be very attractive to developers. Firstly, they can avoid the high capital costs of installing standalone building heat generation equipment. Secondly, they can make productive use of the space that would otherwise be required for the boiler house or energy centre. Thirdly, because large scale district heating systems support the use of low and zero carbon energy sources, the carbon footprint of the building can be significantly reduced, enabling them to meet any obligations in connection with building standards and/or planning. Lastly, they may be able to offer the building occupiers the opportunity to take heat supply contracts at a lower cost than the alternative cost of a building-scale supply, especially when maintenance and refurbishment costs are taken into account.

[3] www.districtenergy.org

[4] City Plan 2017-2026, Dundee Partnership: Results from the Scottish House Condition Survey 2013-2015 found that levels of fuel poverty 37% of all households in Dundee were fuel poor. Since then, the rapid rises in the cost of energy have outstripped any rises in household income resulting in the probability that levels of fuel poverty will have increased.

1.4 Policy context

The development of district heating in Dundee is informed and supported by national, regional and local strategic policies, including:

National

- Climate Change Plan - the Third Report on Policies and Proposals (2018)
- The Future of Energy in Scotland: Scottish Energy Strategy: The Future of Energy in Scotland (2018)
- Energy Efficiency Scotland Programme (2018)
- Consultation on Heat and Energy Efficiency Strategies, and Regulation of District and Communal Heating (2017)
- The Heat Policy Statement (2015)
- National Planning Framework 3

Regional

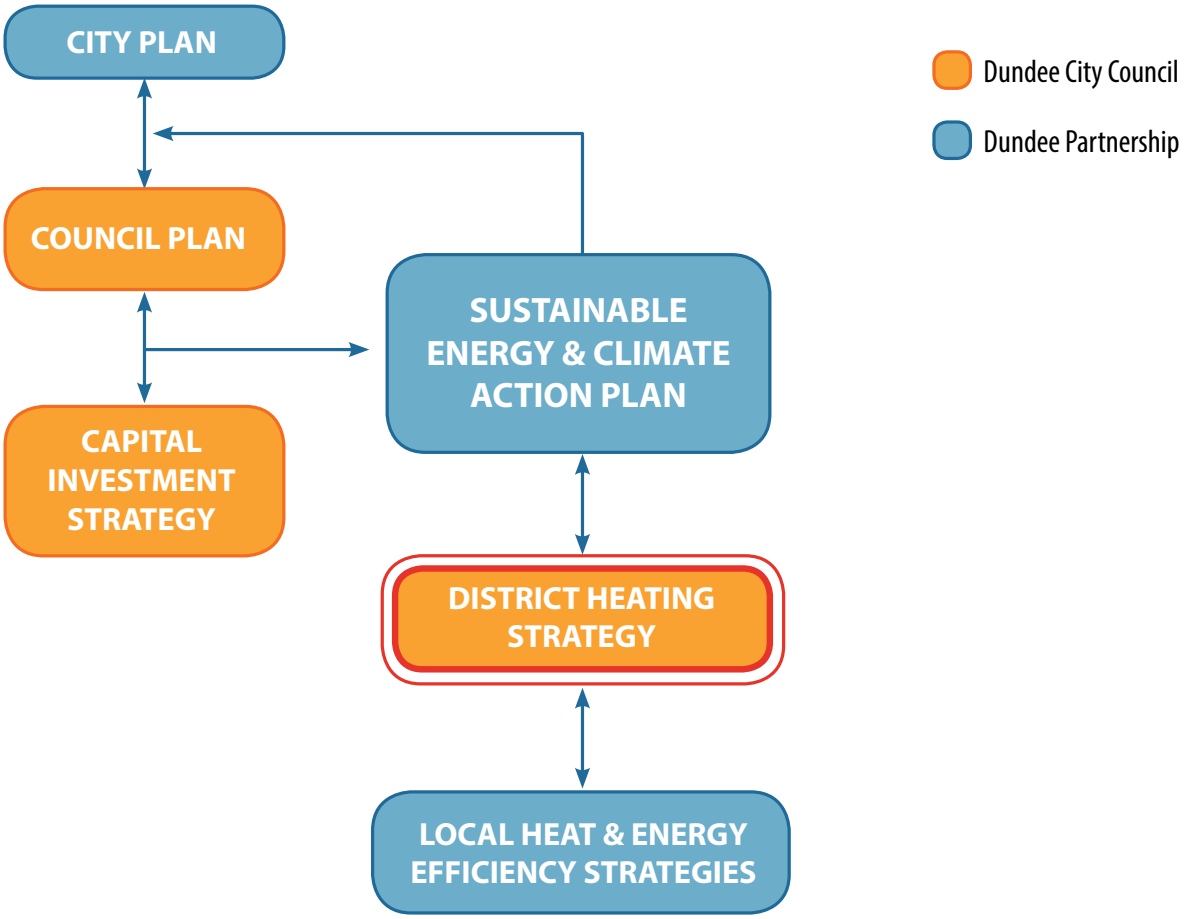
- TAYplan Strategic Development Plan (2016-2036)
- Tay Cities Deal

Local

- City Plan (2017-2026)
- Council Plan (2017-2022)
- Capital Investment Strategy (2018-2028)
- Dundee Local Development Plan (2014-2019)
- Proposed Local Development Plan 2 (2017)
- Local Housing Strategy (2013-2018)
- Dundee Fairness Action Plan (2018)
- Air Quality Action Plan (2011)
- Local Heat and Energy Efficiency Strategies (2018 - pilot)

The figure below outlines where the District Heating sits within the Dundee hierarchy.

Figure 2: Dundee Plans hierarchy



Local Heat and Energy Efficiency Strategies (LHEES)

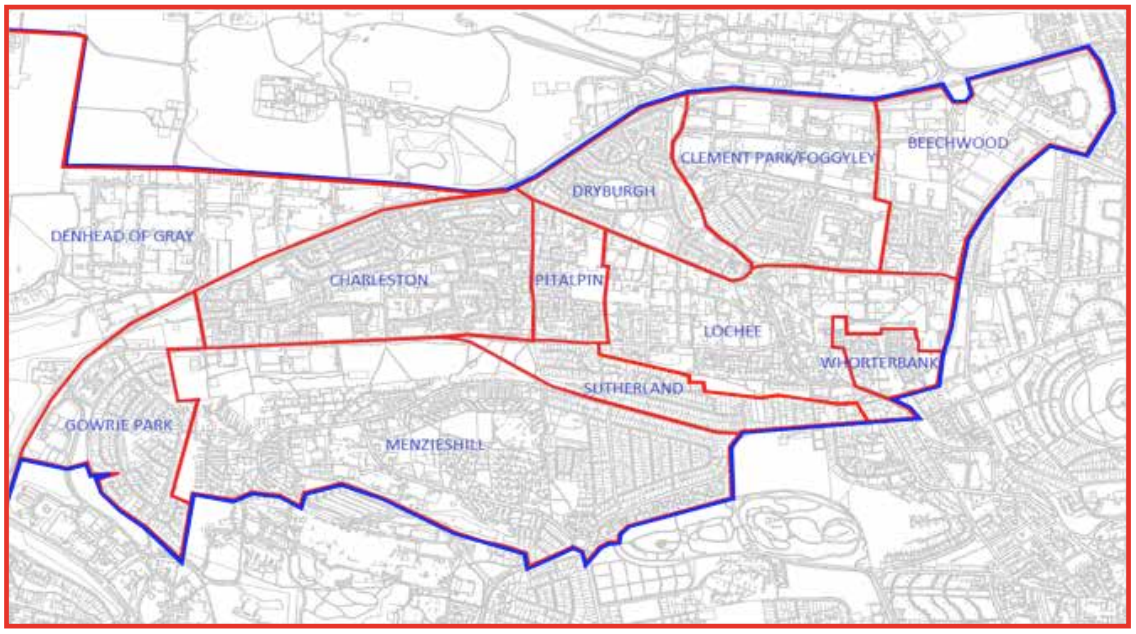
As part of the suite of consultations first launched in January 2017, the Scottish Government has been consulting on a high level policy scoping paper on 'Local Heat & Energy Efficiency Strategies (LHEES), and Regulation of District and Communal Heating'. Within the document is the proposal that local authorities be given a statutory duty to develop LHEES to support the delivery of heat decarbonisation and energy efficiency objectives of the new 'Scotland's Energy Efficiency Programme' (SEEP). Covering a period of 15-20 years, the LHEES would determine zones which set out the most appropriate energy efficiency, district heating and heat decarbonisation options for geographical areas.

From November 2017, the Council has been working with the Scottish Cities Alliance and Resource Efficient Scotland to pilot a LHEES development in the Lochee Local Community Planning Partnership (LCPP) area. The study focuses the step-by-step practicalities of developing a LHEES, the data and other requirements necessary to develop meaningful implementation plans, the technology solutions that are likely to be applicable in the area as well as an understanding of the challenges and lessons on how the wider development of LHEES can best be delivered if the Council is mandated to do so in the future.

The Lochee LCPP area has been chosen as it has a diverse range of buildings and construction types, and varying socio-economic factors, and therefore cover a range of scenarios to help inform a wider LHEES. It is a mixed use area similar to other areas in Dundee so elements of the LHEES are likely to be replicable. Fuel poverty levels are high, and the neighbourhoods of Lochee and Menzieshill are currently in the process of regeneration which will include new developments in the near future providing the opportunity to test the development of a LHEES in a developing community.

There are also some more unique aspects of the chosen Ward. There are three existing district heating schemes owned by Dundee City Council and a separate district heating project at Ninewells hospital, which borders this LCPP area. There may be the potential for integrating and extending these to transition a larger section of the community away from directly supplying heat to buildings from a gas network.

Figure 3: LHEES Pilot Area



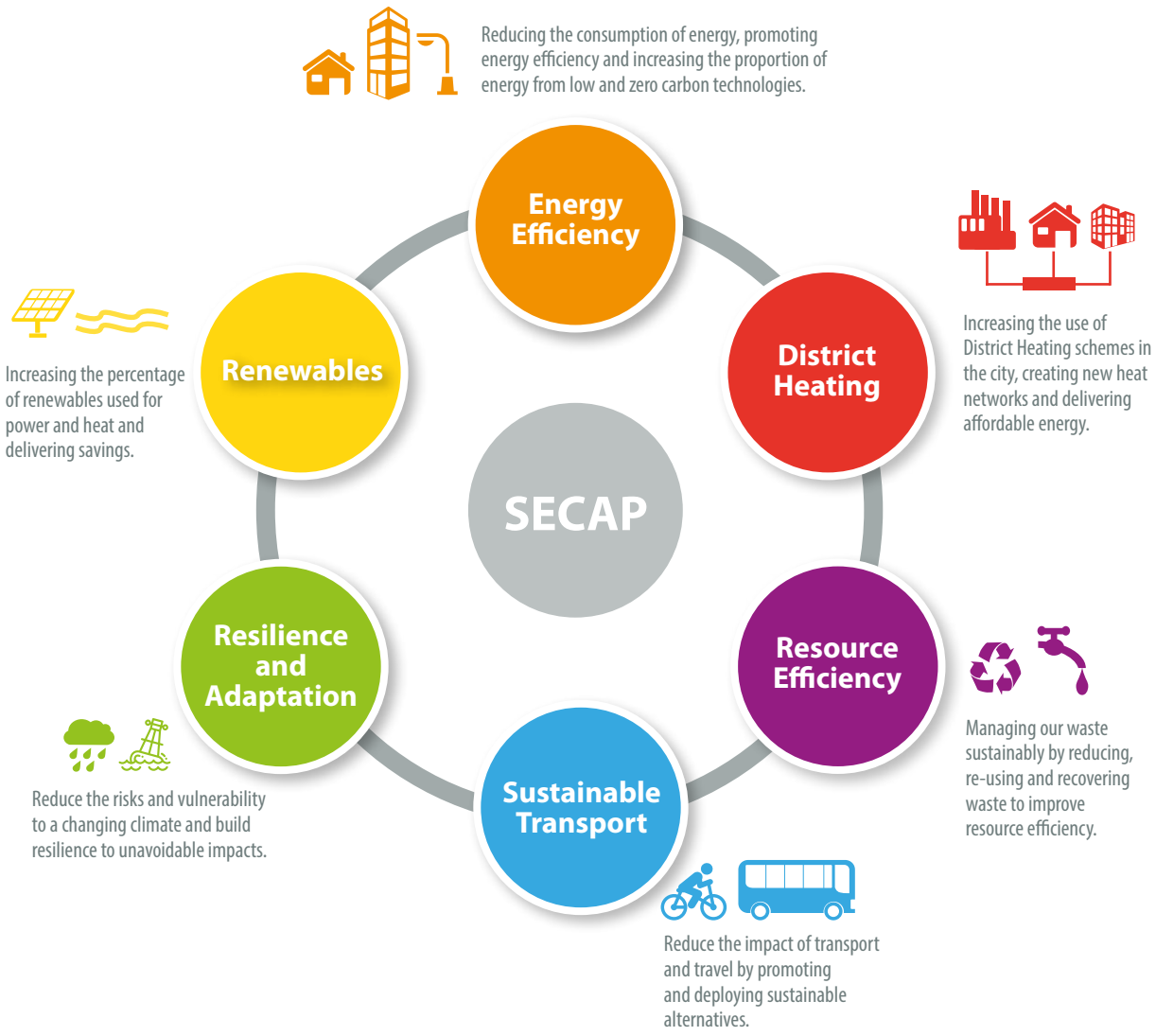
'Bringing it all together' – the Sustainable Energy and Climate Action Plan

The Council's District Heating Strategy is intended to directly contribute to the city's wider low carbon ambitions. The Dundee Partnership are currently developing an overarching 'Sustainable Energy and Climate Action Plan' (SECAP) for the city as part of the global Covenant of Mayors movement which will provide the leadership, commitment and planning necessary for the transition to a low carbon Dundee.

The city-wide strategy will align with the Scottish Government's new 'Climate Change Plan' and 'Scottish Energy Strategy' and the Cleaner Air for Scotland Strategy. It will have a shared vision and objectives with the Tay Cities Deal of supporting sustainable economic growth, reducing social inequality, and enabling entrepreneurship and innovation.

Six Strategic Programme Areas have been identified which will combine to form a single integrated plan for Dundee. These work programmes reflect the priorities of the SECAP to maximise emissions reduction and tackling climate change.

Figure 4: Proposed Strategic Programme Areas of the Dundee City SECAP



1.5 District heating in Dundee

The city has long held a reputation for energy conservation and generation and a history of district heating. With the introduction of the first public sector social housing developments in the 1920's and 1930's, the then Council built the Logie Housing estate and Hospitalfield Housing estate often referred to as "The Steamies" on account of the high temperature steam engines serving low rise units.

The University of Dundee has its own district heating system which has served their campus since the early 1970's. This scheme, considered as integral to a city-wide network, has four large engines and is about to undertake a refurbishment survey looking to incorporate the University of Abertay initially, with capability of future expansion.

More recently the Council has delivered a number of domestic district heating installations within ten multi storey developments at Dallfield, Lansdowne, Lochee and Whorterbank.

Each site has its own designated plant room situated separate from the living areas with a purpose built centralised boiler house containing boilers, pumps, pressurisation units and controls. Heating is provided via steel panel radiators and indirect hot water cylinders for hot water. The heat itself is distributed to radiators within living areas by a domestic pump situated in a Heat Interface Unit (HIU) and each flat has its own Energy Billing smart meter so that tenants are only charged for the energy they use.

These existing examples of heat networks demonstrate an early commitment to the implementation and encouragement of the use of heat networks within housing. The Council has also identified additional areas for potential district heating schemes, discussed later in the Strategy.

Case Study: District Heating with Dallfield Multi-Storey Development

Dallfield consists of four 14-storey tower-blocks in central Dundee and lies within the poorest 10% of data zones in the Scottish Index of Multiple Deprivation (SIMD). Prior to the project, 70% of tenants were on housing benefit, 70% had pre-payment fuel meters and fuel poverty was high.

To comply with the Scottish Housing Quality Standard (SHQS), the flats were to receive new heating, kitchens and bathrooms through the Council's capital programme and even the best available electric heating would not have brought many of the flats up to the required energy efficiency rating. Exploratory talks with Scottish Gas raised the possibility of external funding for over-cladding the blocks in insulated render and developing a gas-fired district heating scheme which, combined, would greatly improve the energy efficiency rating.

Whilst the flats offered reasonable space standards, a central location and spectacular views over the River Tay, they were unpopular and turnover was high. The blocks suffered high levels of anti-social behaviour and vandalism and their reputation amongst existing tenants and the wider community was very poor. If investment in the fabric and physical regeneration of the area was to take place then housing management, safety and security issues had to be addressed first. To this end, a multi-agency group was set up to address these issues and by autumn 2011 when the physical works went on site, the blocks had stabilised, turnover had decreased and a waiting list for the flats had been established.

As well as helping the Council to achieve the SHQS and climate change targets, it was vital that efforts had a major impact on fuel poverty of tenants by reducing fuel bills. Gas was therefore procured at commercial rates through a Tayside consortium which the Council utilises in obtaining fuel for its own buildings. It was decided early on that a flat-rate heat-with-rent scheme was not appropriate as such a scheme would discourage energy-efficient behaviour by tenants. This meant that supplies had to be metered and using wireless technology, a pay-as-you-go system was developed. A unit

rate for heat was set by taking the commercial rate and adding allowances for distribution losses, management charges and delinquency. The overall cost to tenants is less than the cost of domestic gas. In going from electric heating and no insulation to gas-fired district heating and insulation, tenants could expect their fuel bills to be reduced by at least 30%. Energy ratings improved from E to B and carbon emissions were cut by 60%. The scheme was so successful that it was replicated at a further six high-rise blocks in three locations each with their own energy centres.

1.6 Objectives for district heating in Dundee

Tackling fuel poverty, reducing CO2 emissions and decentralising energy are key issues for the city as identified in the City Plan, the Council Plan and the Capital Investment Strategy.

The Dundee Fairness Commission report 'A Fair Way to Go'[5] published in 2016 identifies district heating as a means to provide affordable energy and recommended that Dundee should "expand the availability and viability of district heating systems" to help address fuel poverty within the city.

The District Heating Strategy has therefore been brought forward to deliver these commitments and aims to provide another step forward in the Council's long standing aspiration for the city framed around jobs, social inclusion and quality of life.

The District Heating Strategy will follow the Scottish Government's Heat hierarchy of:

1. Reducing the need for heat
2. Supply heat efficiently and at least cost to consumers
3. Use renewable and low carbon heat resources

The Strategy aims to achieve the following objectives:

- Deliver sustainable and affordable energy to reduce fuel poverty and energy costs.
- Achieve reductions in the Council's CO2 emissions and contribute to the city's emissions reduction target of 40% by 2030.
- Develop the city's heat network at a pace which is financially and practically viable and which improves economic efficiencies from assets.
- Develop the knowledge and skills base to facilitate heat network delivery.
- Foster collaborative partnerships and agreements for heat network delivery.

[5] www.dundeepartnership.co.uk/sites/default/files/fairnessreport-screen_0.pdf

2 OPPORTUNITY ASSESSMENT OF DISTRICT HEATING LOADS

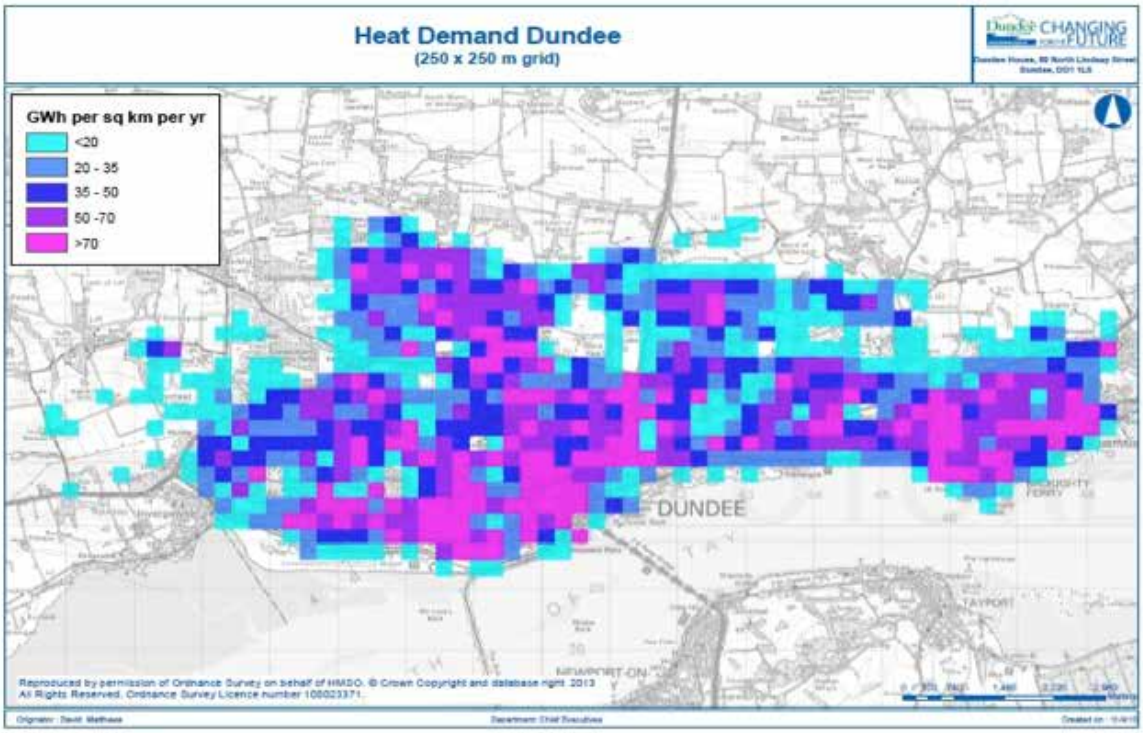
The opportunities for district heating networks in Dundee are characterised by their role in delivering:

- Reduced energy costs and customer protection – addressing fuel poverty.
- Carbon savings – from a mix of technology solutions.
- Energy security – multiple technology options supplying into the network.
- Revenue generation – through owning and operating district heating networks.
- Economic development - Dundee as an attractive place for businesses to locate and invest.

2.1 Data collection

A key starting point in developing a long term strategy for heat, at both a local and national level, is to understand where heat need is (demand) and opportunities to generate and provide heat (supply). Dundee City Council has been working with the Scottish Government's Heat Mapping programme to support the development of a local GIS based heat map. The local system means local data and priorities, such as fuel poverty, planning, economic opportunity or public sector estate, can be considered at the same time.

Figure 5: Dundee Heat Demand Map



Heat mapping provides a fundamental tool in this process by providing valuable information on current heat loads within the city. It can also assist in delivering projects on the ground by modelling future heat supply and demand scenarios for investment in new developments. It will provide a means for the Council to identify links between heat sources and heat demand to optimise resources and maximise investment opportunities.

The initial stage involved the collection of key data sets to:

- Characterise properties within the local authority area in terms of their building type, tenure and heat demand which were initially estimated from the Scotland Heat Map[6] and then enhanced with supplementary local data.
- Identify initial groups of properties by ownership or property type that can be aggregated together under one company or community group to facilitate future stakeholder consultation activity.
- Identify information on proposed new developments in the area, including information on proposed floor areas/number of dwellings and planned energy supply plant.
- Collate additional GIS information to assist with the understanding of opportunities including: information on fuel poverty indices, proposed infrastructure works, utilities where available etc.

The heat map will be updated regularly as the Council's district heating strategy is being delivered. This will ensure that the mapping is informed and refined to provide continued clarity and guidance on the scope of heat network solutions for future development.

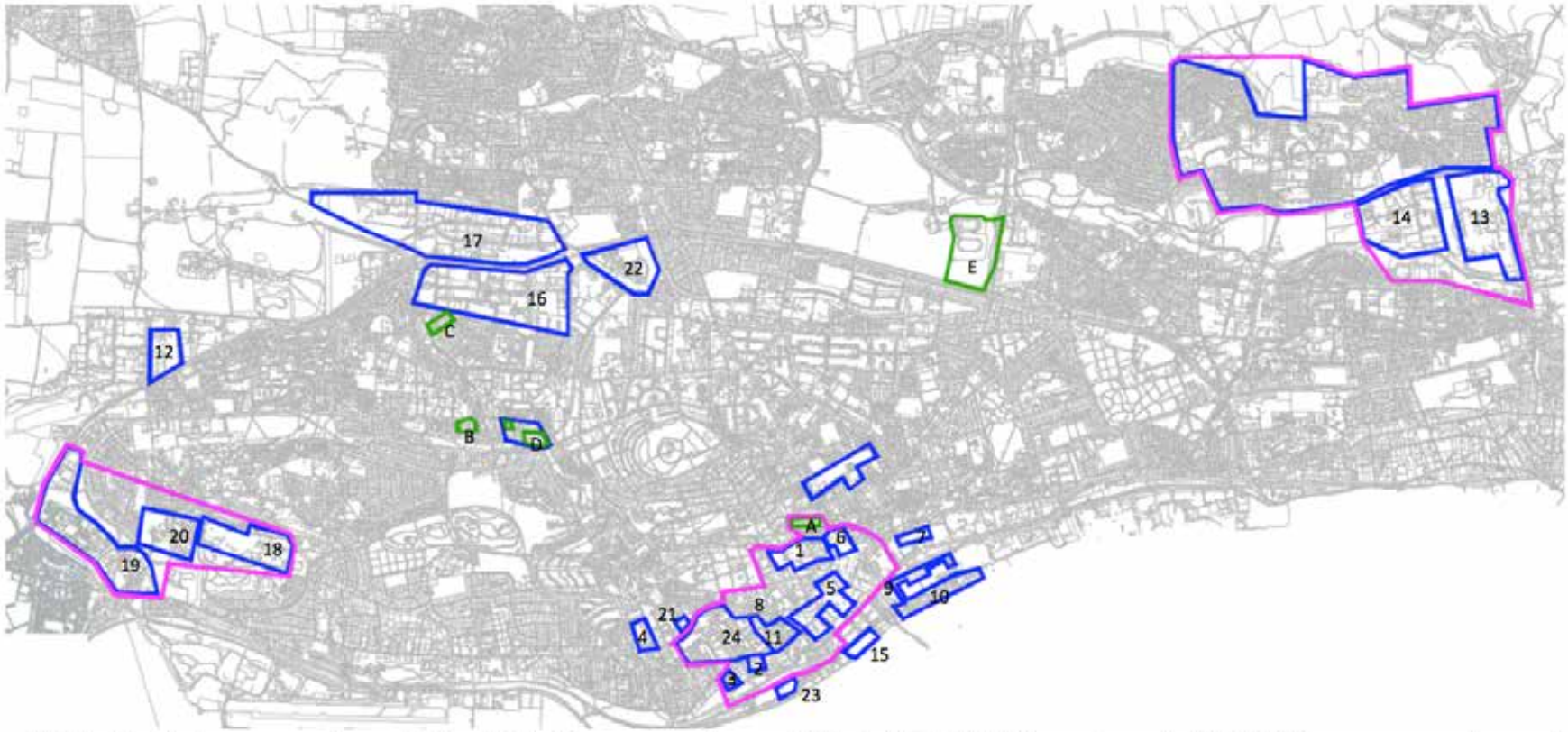
2.2 Identification of potential clusters

Opportunities for district heating were identified through workshops in 2017, combining the interests of Planning, Property, Housing and Energy Management. Participants reviewed the Heat Map and in particular the layers showing the heat demand data, proportion of social rented properties (as a proxy for fuel poverty), and future development proposals and constraints maps from the Local Development Plan.

Cluster opportunities were further assessed where situated in areas of existing high density heat loads, as illustrated in Figure 6. It is worth noting that this does not represent the limit of the opportunity in Dundee, rather these are the areas where Council or other public sector anchor loads were identified and where clusters could initiate.

[6] www.scotland.gov.uk/heatmap

Figure 6: Heat demand clusters



1 University of Abertay		9 Apex Hotel and Spa		17 Dryburgh Industrial Estate		A Dalfield MSD	
2 Seabraes Yard		10 City Quay and Merchant Quay		18 Ninewells Hospital		B Kirk Street MSD	
3 Tayside Digital Media Park		11 Cultural Quarter		19 Dundee Technology Park		C Lansdowne MSD	
4 Hawkhill Medical Centre		12 NCR Financials		20 Dundee MediPark		D Whorterbank MSD	
5 Overgate shopping centre		13 Michelin Tyre Ltd		21 Dundee Technopole Park		E Caird Park	
6 Wellgate shopping centre		14 Baldovie Industrial Estate		22 Kingsway West Retail Park			
7 Gallagher Retail Park		15 Discovery Quay		23 Tesco Riverside		Cluster	
8 Hampton by Hilton		16 Dunsinane Industrial Estate		24 University of Dundee			

3 OPPORTUNITIES FOR HEAT SUPPLY

This section reviews the potential opportunities that exist in Dundee for heat generation including dedicated heat plant and recovery of heat from existing industry. It also considers on-site or near-site natural resources that could be utilised for heat production.

3.1 Heat supply resources mapping

Based on local knowledge, Scotland's heat map and public data sets, the following resources have been identified. These technologies can be characterised in the groups shown in Table1 that can be combined with thermal storage to provide sustainable heat supply.

Table 1: Heat generation technology options identified

Group	Technology	Description and examples
Existing heat production	Energy from Waste (EfW) Plant	The EfW plant at Baldovie is located close to Whitfield and has high potential heat production that could supply a substantial number of customers
	Industrial plants where heat may be available from recovering heat from cooling towers, flues and effluent discharge	There are various industrial areas in Dundee where existing industry may have excess heat that could be recovered, alternatively, industrial land could be repurposed for heat generation
Potential new production within the City	Combined heat and power (CHP)* and boilers using natural gas grid infrastructure	The natural gas supply will allow CHP and back-up and peaking boilers to be located strategically within the City
	Rivers and surface water supplying heat via heat pumps	The tidal River Tay, its tributaries and the Port of Dundee offer significant heat resource
	Ground conditions that could support ground source heat pumps*	Sustainable heat recovery from the ground and groundwater using closed or open loop boreholes
	Sewer Heat Recovery	Heat recovery from the sewer network to provide heat via heat pumps
	Effluent Heat Recovery	Heat recovery from wastewater treatment sites to provide heat via heat pumps
Potential new production on the perimeter of the City	Biomass	Biomass boiler plant using forestry and agricultural land to grow short rotation coppice
	Anaerobic Digestion	Use of industrial, agricultural and other waste material to generate biogas
	Solar Thermal*	Potential for large scale heat generation, combined with seasonal heat storage in pit, borehole or aquifer thermal energy stores where conditions are favourable

* Examples of these technologies have already been developed in Dundee or are in detailed design phases.

The opportunities listed above are presented without detailed consideration of the potential viability of each option. The inclusion of any potential heat supply assets and their location will depend on a number of challenges associated with technological, environmental, financial and commercial considerations including:

- The capital investment and operation and maintenance costs will have to be carried by the project and justified through a robust business case.
- Environmental impacts associated with the deployment of technology which may be permitted will be mitigated through planning and environmental permitting regulations (noise, air quality, visual impact, ecology, etc).
- The establishment and development of supply chains for the supply and installation of technology, which may impact on the cost and quality of solutions.
- Resilience of the technology to deliver reliable power and heat to customers.
- The selection of suitable locations for deployment of solutions within local planning policy.

3.2 Energy Centres

The Council has already established communal heating systems based on a number of the technologies listed in Table 1 including CHP supply to multi-storey developments. Approval has also been secured to develop an innovative multi-technology solution combining CHP, ground source heat pumps and solar thermal at Caird Park Regional Performance Centre for Sport. The energy centre design combines heat pumps, gas CHP, Solar Thermal, PV'S, and large thermal stores for low grade and higher grade heat combined with gas boilers for peaking and backup (see appendix 1). This model will be piloted initially at Caird Park where the CHP is modelled to supply the base load covering 35% of the load throughout the year. The Ground Source Heat Pumps would contribute a further 55% leaving the Gas Boilers with only 15% of the projected load.

Other technologies, listed in Table 1, are suited to the site and location of multiple energy centres within the city and on industrial and brownfield land at the perimeter of the city to supply heat towards the centre. This could allow more of the suburban areas to connect in the future. Renewable technology, such as anaerobic digestion and solar thermal may be able to utilise rural land in the perimeter of the city and provide diversification to the agricultural sector.

3.3 Energy from Waste

Energy from Waste (EfW) is the process of creating energy, in the form of electricity

and/or heat, from the thermal treatment of waste. EfW facilities can be designed to provide power (electricity) and/or heat, and the ratio of heat compared to power can be split to favour either. The distance you can send heat in a district heating scheme depends on how much energy is in the steam or hot water being sent out. The greater the energy content, the further it can be transported before system losses make it unsuitable. An existing EfW facility in Lerwick provides heat to properties over 6km away whilst in Denmark booster stations are used to reduce energy losses when transmitting heat over 80km.

It is recognised that whilst EfW itself is not a renewable energy source, the energy produced by EfW facilities replaces that generated by other fuels such as coal, oil and natural gas. Scottish Planning Policy 6: Renewable Energy[7] identifies that energy from waste, landfill gas and other technologies will be used to help meet Scotland's targets for increasing the amount of electricity generated from renewable energy sources, as this is a vital part of the national response to sustainable development and climate change.

A long term strategic opportunity for supplying a district heating network in Dundee City is a connection to the Combined Heat and Power (CHP) facility about to enter construction at Baldovie. MVV Environment Baldovie Ltd (MEB) have recently been awarded a twenty eight year contract by Dundee City Council and Angus Council to treat residual waste from the two authorities. The contract will be delivered by the construction and operation of a new plant on a site at Baldovie, adjacent to the existing EfW plant formerly operated by DERL.

The waste will be combusted and the heat will be used to generate steam. The steam will drive a steam turbine and generate renewable electricity for use at the facility, to supply the Michelin tyre factory and for export to the grid. Steam will also be extracted from the turbine and fed into the Michelin tyre factory steam network to be used for process and heating purposes. The EfW facility will therefore incorporate Combined Heat and Power (CHP) technology. On average approximately 10 MW of steam will be exported to Michelin for use within their factory for production and heating purposes. A new pipeline will be installed to connect to the existing heat distribution system and some existing pipework will need to be replaced. A separate planning approval has been awarded for the steam connection.

By taking steam from MVV's EfW CHP facility, Michelin will be able to place their boilers, which are currently gas fired, on standby mode; and to be kept warm using steam, and only used when the Energy from Waste Combined Heat and Power facility is not producing energy. Approximately 5MW of potential steam would be available after supply to Michelin, which could be linked to a wider heat network.

[7] http://www.gov.scot/Resource/Doc/171491/0047957.pdf

4 HEAT NETWORK OPPORTUNITIES

The demand and supply opportunities outlined in section 2 and 3 have been combined to identify the scope and extent of potential heat networks. This includes the geographical extent, potential infrastructure routes, proposed connections and the location and technology for the heat supply.

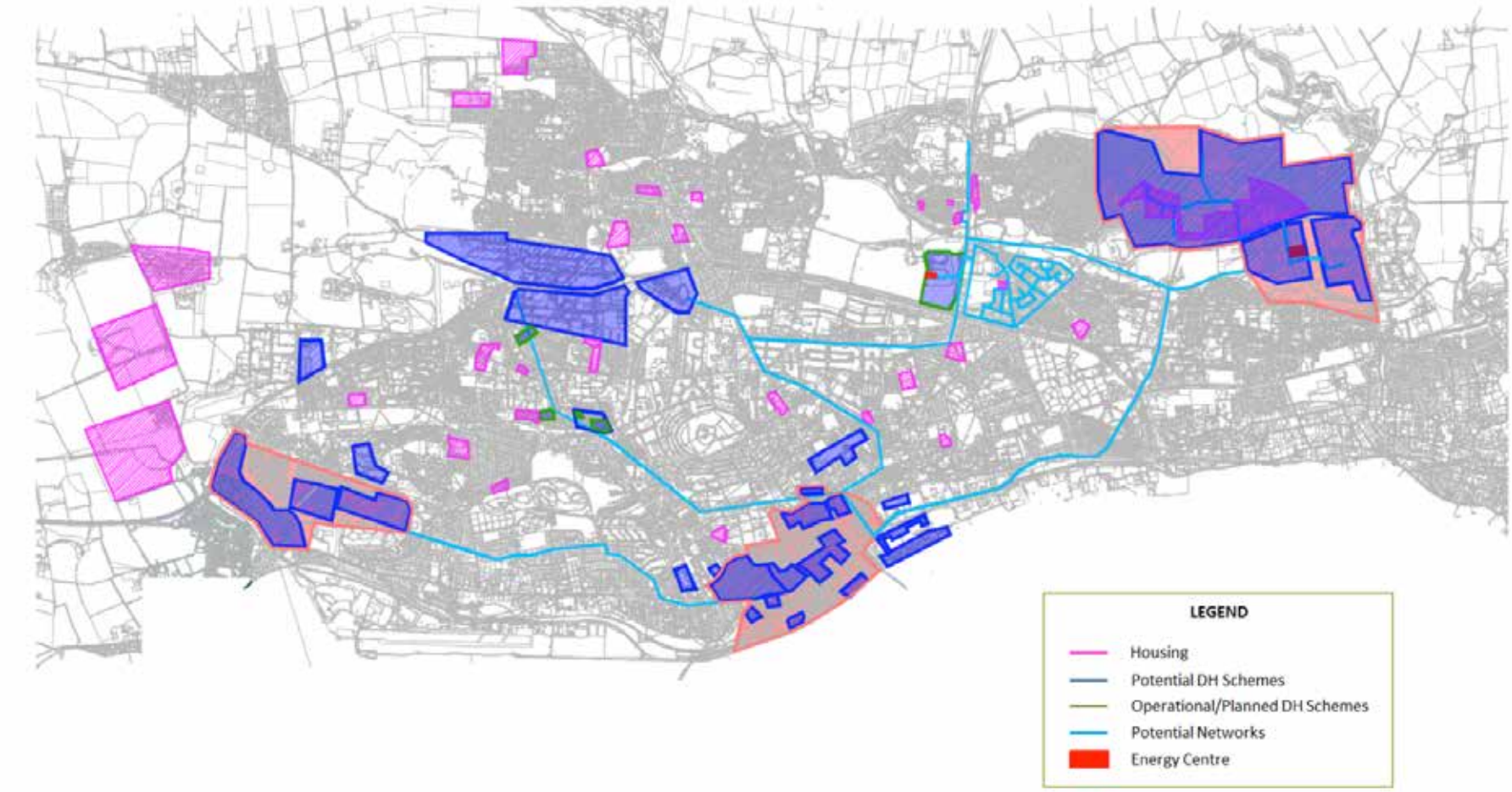
The Council has worked with Ramboll to test a number of modelling scenarios and key economic performance indicators derived for each scenario. These key indicators were weighted to assess the relative ranking and priority for developing the opportunities identified.

4.1 Mapping of heat supply and demand

Opportunities for individual district heating networks have been mapped in GIS and are illustrated in Figure 7 below. Further details on four of these are presented in Appendix 1.

These individual district heating networks can be designed to adopt compatible heat specifications and developed, in the short term, to operate as island clusters. In the medium to long term it is intended that these individual networks be expanded and connected to one another in order to create a city-wide district heating system. A suitably designed city-wide system could benefit from greater demand, economy of scale and overall system efficiency.

Figure 7: GIS mapping of existing and potential heat network opportunities in Dundee

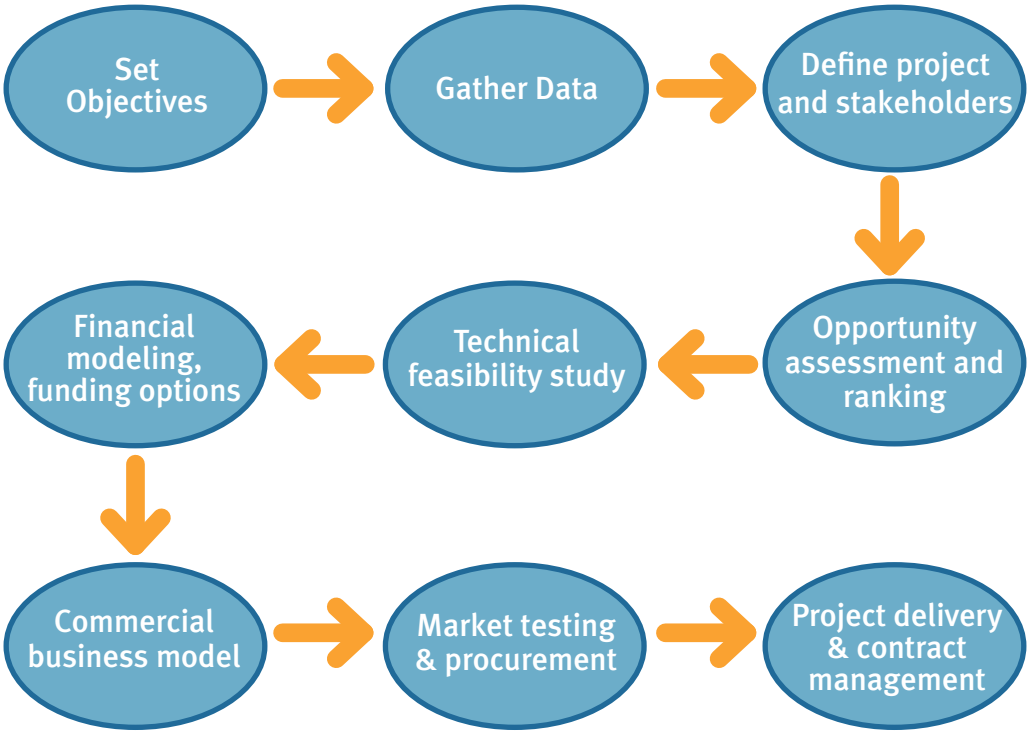


5 PROGRAMME DELIVERY

The Strategy seeks to initiate a programme of low carbon district energy projects, related by technology and location which can deliver transformational change in Dundee. Each project will be delivered following the approach set out in figure 8. The principal themes to be taken forward in the programme delivery phase are:

- Delivering significant reductions in CO_2 emissions and greenhouse gases;
- Fostering and formalising collaborative partnerships that deliver qualitative solutions and additional investment;
- Engaging with the communities to develop local support and benefits from community investment and participation and directly reducing fuel poverty;
- Delivering a range of project specific and longer term benefits to employment and business development;
- Delivering sustainable and resilient solutions that provide a secure local energy supply.

Figure 8: Steps in delivering a district heating project[8]



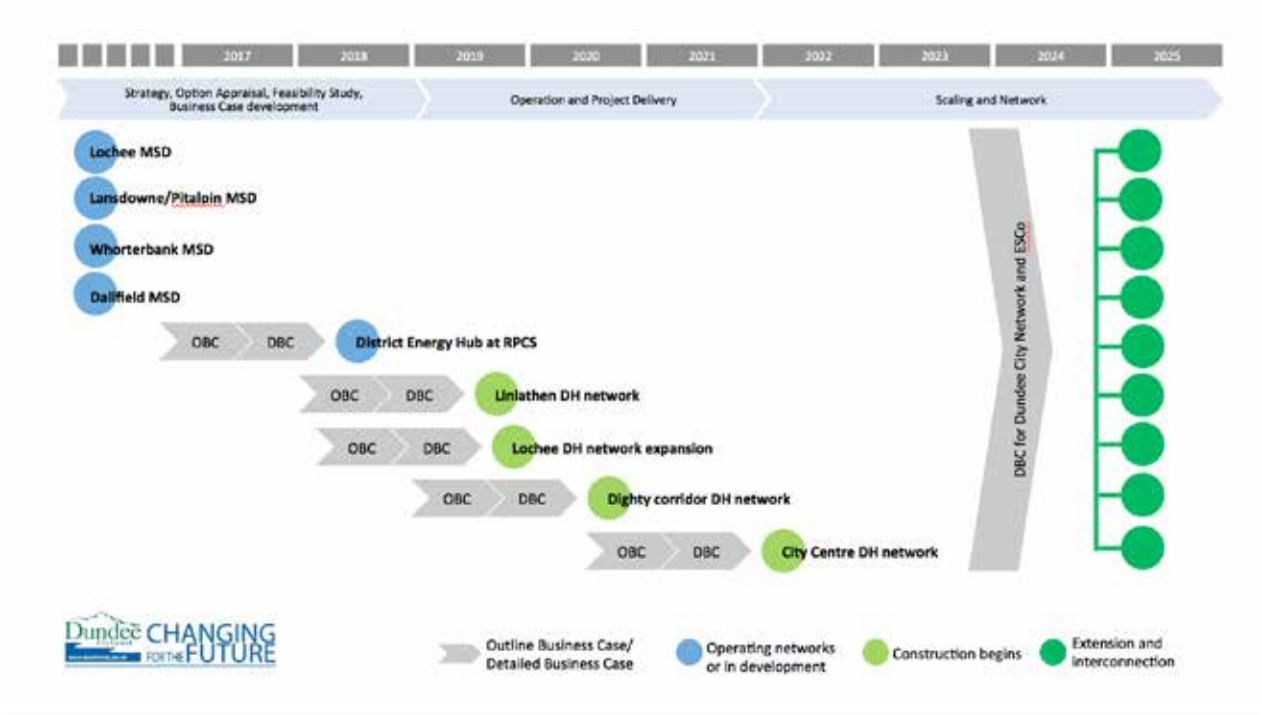
[8] Based on "Community Energy", King & Shaw (www.districtheatingscotland.com/wp-content/uploads/2015/12/CommunityEnergyPlanningDevelopmentAndDelivery.pdf)

5.1 Preliminary Assessment of Delivery Programme

The preferred method of delivering projects schemes is through a programme of work managed by the Council. This programme management approach will take an overarching and long term view of the City to ensure that energy centres and networks are sized to safeguard future expansion and interconnection.

The indicative programme is shown in Figure 9 and defines the strategic ambitions of the cluster development and interconnections. The proposed delivery vehicle is discussed later and the identification of the most appropriate model, governance structure and implementation would evolve with the emerging clusters. The operating model would be fully implemented prior to significant interconnection of clusters and roll-out of the city wide network.

Figure 9: Initial delivery programme to create a city wide district heating network in Dundee



5.2 Technology scenarios

A mix of suitable technologies for the supply of heat to the district energy network will be considered. This will be based on utilising available excess heat from industry, such as Energy from Waste, proposed hydrogen production and fuelling station and other industrial parks in the city. It will also include dedicated low and zero carbon energy centres with suitable back-up and peaking boiler plant capacity.

5.3 Development of Business cases

This strategy does not define the business case, however it sets out the objectives and requirements for presenting a business case for the overall programme and for individual projects within the programme.

The intended approach to investing in and connecting a city wide district energy project is through a vehicle that identifies individual district energy clusters and delivers them through a programme of district heating development. This ensures that:

- There is an overarching design basis to ensure compatibility of all systems;
- Reduces the capital cost and risk of infrastructure investment by sharing the cost across a number of projects;
- May allow alternative options for innovative funding and delivery that can be integrated contractually and commercially later.

5.4 Stakeholder Engagement

The engagement and active participation of stakeholders is critical to the success of the strategy. It is anticipated that business property owners and tenants in the study areas will become customers of the system where appropriate. As a result, the strategy defines a presumption that the network operator will offer customers the best value against alternative energy supply options. Each district heating project will require collaborative partnering between energy generation suppliers, the network operator and investors.

5.5 Risk appraisal

The key risks for developing district heating projects are outlined in Table 2. The Council will explore a variety of ways to help de-risk projects where required, making them more investible for developers and financiers, including:

- facilitation – co-ordinating and brokering commitments from third parties.
- regulation – e.g. through the planning system.
- committing public sector buildings as long-term anchor loads.
- underwriting certain project risks[9].

[9] Scottish Futures Trust: Guidance on Delivery Structures for Heat Networks (www.districtheatingscotland.com/sites/default/files/SFT%20DH%20Delivery%20Structure%20Report%20%28v1%20-%2016%20Mar%2020015%29_0.pdf)

Table 2: District Heating Risk Appraisal

Risk	Description	Mitigation measures during current phase or included in Design, Build, Operate or Maintain
Timescales	• Timescales for new developments are expected to be fixed and any heat must be available at handover	• Range of potential technology options • Requirement for a systematic options appraisal
Customer uptake	• Low customer engagement and willingness to participate in projects would result in lower than expected revenues	• Ensure property landlords and tenants are engaged and ensure that full benefits are clearly communicated and reasonable concerns are addressed
Project data availability	• Information provision • Continuity of support/ Availability for consultation • Influence (positive/ negative)	• Early engagement with stakeholders and supporting Council through commercial discussions • Procurement to identify key client issues such as critical timescales or periods when works should be avoided
Network route constraints	• Physical barriers, ground conditions, etc	• Identification of route constraints • Risk assessment to identify any unknowns
Below ground utility routes	• Gas, electricity, water, communications	• Obtain information internally and undertake utility searches if information not available • Preparation of information pack to include full set of utility information
Planning Procedures	• Local Development Plan policy requirements • Planning application process	• Heat network feasibility statement, air quality assessment etc • Early engagement with Planning Division
Commercial	• The overall commercial viability of the individual projects or city wide network • Risk strategy: risk appetite of the delivery organisation	• The outline business case for the overall programme and the detailed business case for individual projects should be based on appropriate quality of cost data for the technology proposals • The strategy should define an appropriate scaling & flexibility of technology design • Clear schedule of technical requirements and associated bills of quantities at procurement

5.6 Delivery vehicles and Funding

Delivery structures for district heating projects can range from fully public sector led to fully private sector led, or include a variety of joint public/private or 'hybrid' arrangements according to each part of the design, build, financing and operation (DBFO) of the project. Each approach provides different levels of control, degree of risk, required rates of return, investment costs and existing experience and skills sets required.

Typically private sector development models require higher project return rates (IRR) to enable development but absorb much of the risk. Public models may enable development of projects with lower IRRs and allow focus on alternative priorities such as carbon reduction, fuel poverty and scheme expansion.

During the early stages of strategy implementation, Dundee City Council will be the programme lead for the identified schemes and in taking these forward will consider collaborative investment opportunities within the public and private sector where it provides commercial or economic benefit. In the short-term the Council will seek to secure external capital through existing funding schemes on a project by project basis including the Scottish Government's 'Low Carbon Infrastructure Transition Programme' and where allied to domestic energy efficiency improvement, the new 'Scotland's Energy Efficiency Programme'. An internal revenue budget for the design and development of future schemes will be explored.

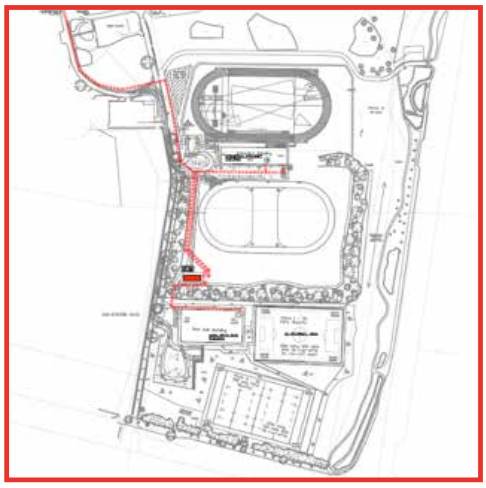
In parallel, the Council will consider the options for creating an Energy Services Company (ESCo) to provide a clear delivery model for planning, developing and operating new schemes over the longer term. An organisation that was able to offer this wider overview could help ensure that best practice is made available, that the technologies used are scalable and compatible and that economies of scale are utilised. Over time, the ESCo could seek to create the district heating network across the city, working with other partners to create the financial model and seeking out interest from the wider investment community. The Council's recent heat network developments represent an investment of around £27M, which could potentially be transferred to an ESCo to operate, and form part of its asset base.

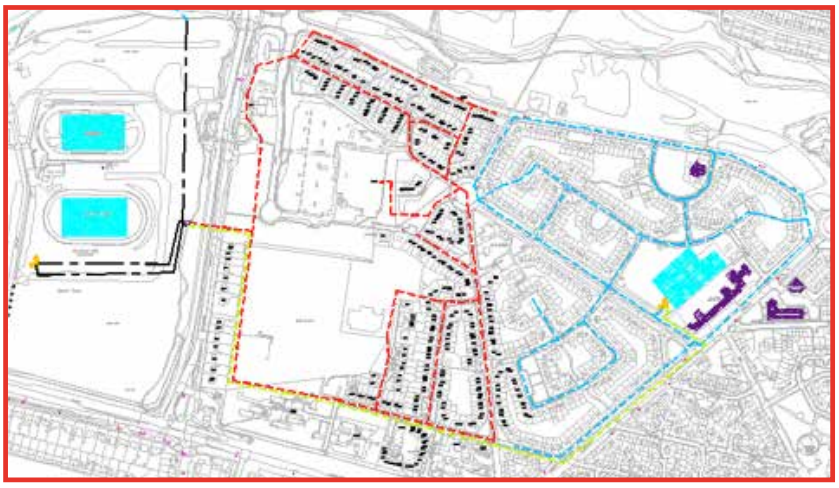
6 ACTION PLAN

Action	Timescale
Short Term (2018-2020)	
Deliver the Council's first non-domestic district heating scheme via the **Low Carbon District Energy Hub** at the Regional Performance Centre for Sport.	August 2019
Seek to secure **funding** for district heating projects through LCITP2 and ongoing SEEP programme and internal budgets.	December 2018
Develop feasibility studies for district heating projects and networks within the **Lochee Corridor** and **Dighty Corridor**.	December 2018
Encourage the delivery of district heating within the city through proposing new **District Heating Planning Policy** in the Local Development Plan 2.	December 2018
Medium Term (2020-2024)	
Liaise with the Scottish Government to **embed Local Heat and Energy Efficiency Strategies** within national and local policy.	March 2022
Deliver district heating projects and networks within the **Lochee Corridor** and **Dighty Corridor** subject to funding.	March 2021
Support the expansion of a district heating network within the **city centre** in partnership with other local public and private stakeholders.	December 2022
Work with public and private sector partners to explore district heating opportunities in and around **Menzieshill** and **Coldside**.	April 2023
Seek to establish a Dundee City **ESCo**.	March 2024
Longer Term (2024-2028)	
Assess options on how district heating can be utilised in the development of integrated energy hubs with **hydrogen** provision for transport and fleet.	2024
Investigate possible **connections** between established district heating schemes to improve operational efficiencies.	2024 - 28
Continue to support the expansion of a **city centre district heating network** in partnership with other local public and private stakeholders.	April 2028
Explore alternative methods of heat generation to decarbonise district heating networks in line with **emerging technologies**.	April 2028

APPENDIX 1

Project: Low Carbon District Energy Hub at Regional Performance Centre for Sport





Description

Dundee City Council and sportscotland are partners in the project to create a Regional Performance Centre for Sport at Caird Park in Dundee to serve Tayside and Fife. Also involved are Dundee University, Abertay University and Dundee & Angus College. A Low Carbon District Energy Hub will be built as part of the project to feed two buildings, the Regional Performance Centre and Dome, the Athletic Straight and Dome. The hub has been designed in such a way to have future capacity to feed approximately 220 houses in Mill of Mains or Linlathen housing developments adjacent to the site over the next ten years and other possible interested parties. By delivering a low and zero carbon solution, the fully integrated district energy Hub will be operational in 2019 and will significantly lower carbon emissions whilst providing key infrastructure that will act as the catalyst to accelerate the city's ambitions for the development of a city-wide energy network.

Technical Information

The energy centre will have 600kW of heat pumps, 236kW of heat by a gas CHP, 50kW of Solar Thermal, 63kW of PV'S, 2400kW of gas boiler backup and two large thermal stores for low grade and higher grade heat. GI Energy (who were working on an energy centre for the V&A Museum), and Ramboll, (who had undertaken work for the Scottish Government on prospects for district heating in Dundee), have assisted the Council with this project. Ramboll have projected the usage of plant within the site and the viability of the proposed heating elements finding that the CHP would be the base load covering 35% of the load throughout the year. The Ground Source Heat Pumps would contribute a further 55% leaving the Gas Boilers with only 15% of the projected load.

Projected Cost

The Council applied for funding from the Scottish Government's Low Carbon Infrastructure Transition Programme (LCITP), which subjected the proposals to further rigorous testing of the financial and technical viability of the scheme. The Council successfully secured £2.9 million funding from the LCITP in March 2017, together with an allowance of £100,000 towards enabling works.

Estimated Pay Back

The estimated payback period for this project is 11 years.

Project Delivery

Site Start May 2018, Completion August 2019.

Case Study: Low Carbon District Energy Hub at RPCS

Part of the Council's design proposals for the new Regional Performance Centre for Sport (RPCS) at Caird Park include a 'Low Carbon District Energy Hub' (LCDEH). The driver for this was the change to the Scottish Building Standards in October 2015 which require an improvement in energy conservation/efficiency for new buildings by reducing carbon emissions by approximately 43% compared to the previous 2010 standards (60% compared to the 2007 standards). Such a significant reduction in carbon emissions necessitates the utilisation of Low or Zero Carbon Technologies.

The Council's proposed to utilise 'low grade' heat (circa 8°C to 10°C) from below ground and to convert this into a higher temperature of heat (70°C), which becomes useful in providing the heat demands of the various buildings. This is achieved using a device known as a 'heat pump'. The heat pump runs on electricity, and for every 1kW of electrical energy consumed, it will produce 3.61kW of heat energy, due also to the heat obtained from below the ground. Due to the relative cost of gas (3p/kWh) and electricity (11.3p/kWh), a further proposal was agreed to use a Combined Heat and Power (CHP) unit to generate the electricity consumed by the heat pumps. This enables financial benefits from the significantly cheaper cost of gas, whilst using electrically powered heat pump units. The CHP unit will also contribute useful heat to the system, as will solar thermal panels, which also form part of the proposals.

Heat from these three sources (ground source heat pumps, CHP unit, and solar thermal panels) is combined into an integrated circuit within an Energy Centre building, and is then distributed to the different buildings on site. This is the most cost effective way of using these Low or Zero Carbon Technologies in different buildings on the same site, and altogether forms the district heating system. Another advantage of using a district heating approach, is that capacity has been included within the system to provide heat to social housing (in Mill o' Mains or Linlathen), which will help to alleviate fuel poverty in these areas. Note - the final connection to this housing would form a future phase of works.

Taking a holistic approach to the energy demands of the project, Photovoltaic (PV) solar panels will be used to generate electricity for use in the buildings. The buildings will also benefit from 'enhanced' thermal insulation and triple glazed windows, to help lower heat losses.

In the designs for this project, the size and usage of each item of equipment have been optimised to achieve the best possible carbon emissions reduction for the lowest consumed fuel costs.

The Low Carbon District Energy Hub was designed by the Design & Property Division within the City Development Department, and the plant designs were subject to an independent professional peer review by a specialist consultant in this field, Ramboll Energy.

Project: Lochee Development

Description

The Lochee Proposal encompasses Kirk Street MSD (with 550 flats) and Whorterbank MSD (with 168 flats), both with a centralised boiler plant and total connected load 4,500kW (both installed by British Gas in 2014 under a SESP funded initiative), West Area Housing Office, St Marys Primary School and Lochee Leisure Centre and Pool. Analysis has been undertaken to explore ways to improve and enhance the performance of the MSD's by linking these buildings through an energy centre. Subject to an R&A Legacy agreement and support from Doosan, it is proposed to install a hydrogen fuel cell local to the vehicle charging station as the base load energy provider. This will then link the boiler rooms within the buildings and at the base of the MSDs. The Fuel cell will be used to feed both heat and power to all the buildings but also assist with the car charging points. Along with this the fuel cell will also provide Hydrogen which can be stored and used for hydrogen vehicles thus providing a true energy hub. This will enable the Council to improve energy costs within the system and reduce the fuel bills for tenants even further thus removing them further from fuel poverty.

Technical Information

The Hydrogen Fuel Cell would provide approx.1200 kW Thermal and 900kW Electric. This would be linked to the 1,000kW boilers at Whorterbank and 3500kW boilers at Kirk Street. Lochee Leisure Centre and Pool has two Hoval SR-plus Boilers model 700kW total output with 2 Dachs (Baxi Sener Tech) CHP units each with a 750 litre buffer vessel each unit rated at 31kW thermal/11kW electrical total output. St Marys Primary School connected load 525kW (these boilers are due for replacement and thus would simply be removed).The West area housing office has no thermal heating system but is heated with a VRV air conditioning system with Air Source Heat Pumps.

Projected Cost

The high level estimated overall cost of the Plant, infrastructure, and HIU's in each building will cost in the region of £3m.

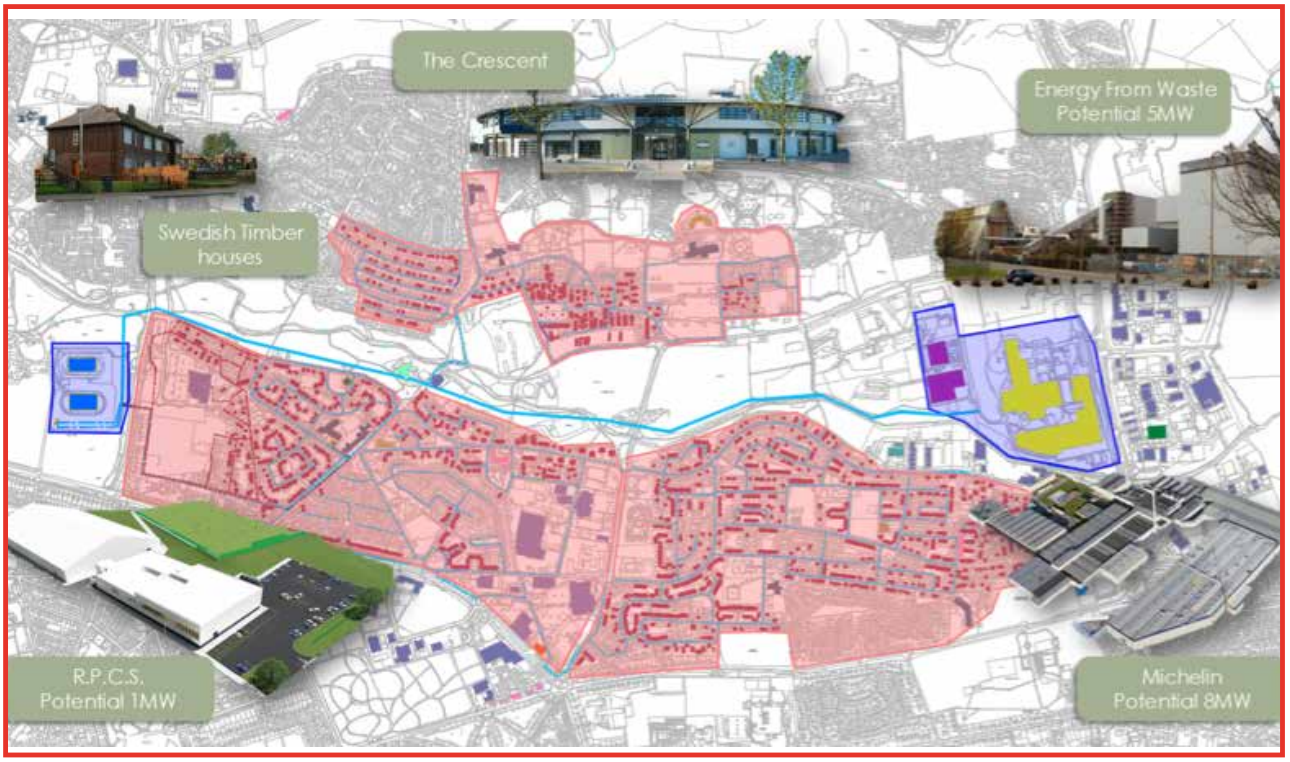
Estimated Pay Back

The current estimated payback period for this project is 5-6 years (This could increase slightly once more detailed surveys are complete).

Project Delivery

It is anticipated to have this on site late 2018 with completion 2019 subject to funding.

Project: Dighty Corridor Development



Description

Whitfield is an old social housing development which is undergoing regeneration with new private developments already in place and additional homes planned for the future. There is also a new Primary School, 1960's style Secondary School with a swimming pool and a new Community Hub. The principal would be to take the waste heat produced at the Baldovie Energy from Waste plant to the east of the site to an energy centre and pipe this to a series of heat exchanger centres distributed throughout the development. These centres would then distribute to the individual buildings. The energy centre would also require alternative heat sources to ensure continuity of supply as the heat from the Energy from Waste plant would only be available around 80% of the year.

The inclusion of Michelin's waste heat into the energy centre would greatly increase the capability of the energy centre. With this arrangement, the sites at Douglas and Mid Craigie could be included with a possible link to the RPCS site in Caird Park. The Waste to Energy plant will be upgraded over the next few years by its new owners MEB which could allow consideration of fitting an electrolyser into the energy centre to supply a Hydrogen Generator for transport refuelling.

Technical Information

The energy centre will have approximately 9,000kW waste heat, Gas CHP, Solar Thermal, PV'S, gas boiler backup & a large thermal stores.

Projected Cost

Not known at present.

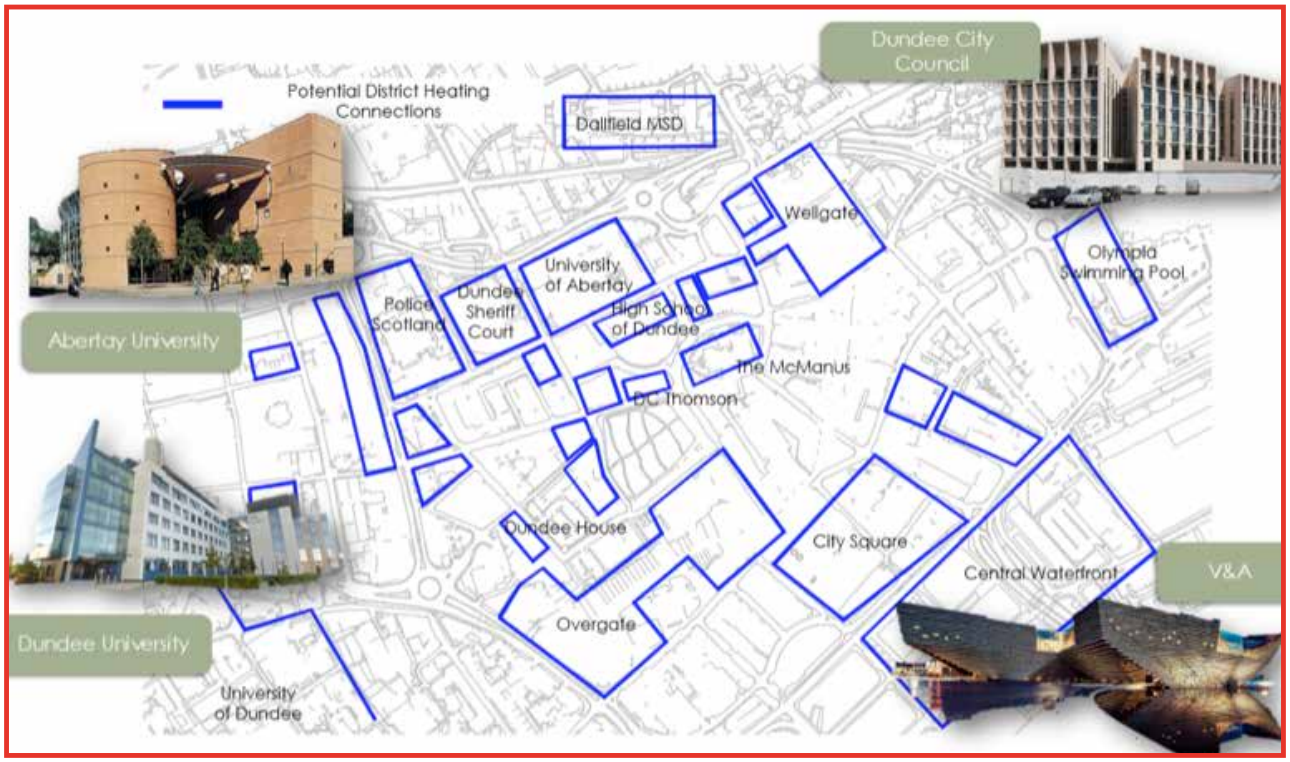
Estimated Pay Back

Not known at present.

Project Delivery

No programme dates set at present.

Project: City Centre Development



Description

The city centre is ideally suited for district heating, consisting of Dundee City Council buildings, the central waterfront, docks, Universities of Abertay and Dundee, High School of Dundee, Police Scotland and Court, D.C. Thompson's, Student Accommodation and the Wellgate and Overgate shopping centres. The site is compact and placed on the waterfront it opens various possibilities for heat generation and distribution. Abertay University and the University of Dundee are currently exploring the technical and economic opportunities for a district heating scheme to link their respective campuses. This would give the initial kick start to a larger project and would enable other interested parties in the vicinity to feed into the network.

Technical Information

To supplement the University of Dundee's energy centre, four energy centres are envisaged in a ring within the centre comprising heat pumps, gas CHP, Solar Thermal, PV'S, gas boiler and two large thermal stores one for low grade and one for higher grade heat. Those nearer the river utilising water heat pumps and the ones inland ground or air source. The Energy Centre layout to be standardised at RPCS where applicable to make further maintenance and plant replacement easier and allow for a standard stock of spares to be kept which will work in any centre. Ramboll, who are supporting with the feasibility study have projected that 80% of the energy could come from renewables would still be a conservative estimate at this time for this site also.

Projected Cost

Not known at present.

Estimated Pay Back

Not known at present but would require to be within the 20 year life of the plant.

Project Delivery

No programme dates set at present.

For more information:-

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