Plymouth City-Wide District Energy Strategy

Plymouth City Wide Energy Mapping and Masterplanning

3 July 2017

Revision 02
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date 03/07/17

approved Alasdair Young

signature SUBMITTED BY EMAIL

date 03/07/17
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<td>PCC</td>
<td>Plymouth City Council</td>
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<td>HNDU</td>
<td>Heat Network Delivery Unit</td>
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<tr>
<td>DH</td>
<td>Derriford Hospital</td>
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<td>DHN</td>
<td>District Heating Network</td>
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<tr>
<td>HeatNet</td>
<td>European Union funded project to facilitate the implementation of low-carbon, energy and climate protection strategies to reduce GHG emissions.</td>
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<td>WP5</td>
<td>Work Package 5</td>
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<td>EfW</td>
<td>Energy from Waste</td>
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<td>4GDH</td>
<td>4th Generation District Heating</td>
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<td>CCS</td>
<td>Carbon Capture and Sequestration</td>
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<td>Marjons</td>
<td>University of St Mark and St John</td>
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<tr>
<td>MCA</td>
<td>Multi-Criteria Analysis</td>
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<tr>
<td>BEIS</td>
<td>Department for Business, Energy &amp; Industrial Strategy</td>
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<tr>
<td>HMNB Devonport</td>
<td>Her Majesty’s Naval Base Devonport</td>
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Executive Summary

Introduction

District Heating Networks have a key role to play in support of the UK's legally binding target to reduce the UK's greenhouse gas emissions by at least 80% in 2050 from 1990 levels (Climate Change Act 2008).

Plymouth City Council aims to deliver strategic heat network infrastructure in the City as part of its overall objectives of reducing the City’s carbon footprint, helping to lower energy costs and promoting energy security.

The key aim of this document is to identify the long term district heating network potential in Plymouth, including the short, medium and long-term strategic opportunities, identifying the key opportunity areas for district heating and developing a longer term vision to support the City's growth and low carbon transition using decentralised energy. It will provide an evidence base for the development of district heating network schemes in Plymouth, informing both policy and delivery.

Developing a District Heating Strategy for Plymouth

Heat demands, energy supply sources and constraints relating to the development of DHNs have been mapped based on the Heat Network Delivery Unit (HNDU) phases 1 and 2 (Heat mapping and masterplanning).

As part of this study, more than 2,000 data points have been plotted, representing 700 GWh of heat demand, in addition to the plotting of energy sources and constraints.

As a result of the plotting and analysis of this data, 11 clusters of interest have been identified from which a total of 6 have been selected for more detailed assessment in this study. Clusters selected for more detailed assessment are shown in Figure 0—1.

Significant areas of heat demand have been identified around Plymouth City Centre, the area surrounding Derriford Hospital and Devonport. Smaller concentrations of significant heat demands are found in Royal William Yard, Plymstock, Sherford and Langage, principally related to new developments. Barne Barton has a small concentration of significant heat demand mainly relating to existing social landlord housing and proposed new development.

District Heating Opportunity Areas have been identified by visualising the intersection between anchor point loads within other areas of high heat density. Lower super output areas adjacent to locations that show the most significant heat density have been included as District Heating Opportunity Areas due to their proximity.

Figure 0—1 shows clusters selected for more detailed assessment and District Heating Opportunity Areas.

Outside of these areas, developments may come forward with characteristics suitable for the deployment of District Heating schemes. Some generic characteristics have been set out as a guide below. The development of fourth generation district energy (to be evaluated in a subsequent strategy) may further support deployment in other areas or the use of waste or secondary heat sources.

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1 Lower Layer Super Output Areas are a geographic hierarchy designed to improve the reporting of small area statistics in England and Wales
Developments which may fall outside DHN Opportunity Areas but might be suitable for standalone DHN schemes

New development of suitable scale and/or density should undertake an assessment of the viability of using district heating and/or cooling. Schemes which should undertake such as assessment are those within the areas highlighted in the report as being suitable and developments which meet the following criteria:

- Consisting of over 100 dwellings
- Having a heat demand density of 30kWh/m² of land area
- Having a mixed use nature e.g. more than one use and being of large scale (e.g. greater than 3,000m² gross floor area)
- Including high process energy use such as data centre, swimming pool, laboratory, industry or other similar uses with high energy demand and predicted to have a total energy demand in excess of 500MWh/annum including ‘unregulated’ energy demand.

Figure 0—1 Spatial Map showing District Heating Opportunity Areas, Existing Heat Networks Strategic Heat Sources, Strategic Identified DHN Cluster Locations
This work has identified the following long term vision for the growth and inter connection of these DH opportunity areas:

![Map of Plymouth DHN clusters](image)

**Figure 0—2 Long Term Vision for DHN Cluster Interconnection in Plymouth**

**A Plymouth Wide District Heating Strategy**

The following are the strategic actions required to deliver district heating in Plymouth.

**Short Term Opportunities (2017-2020)**

- **Barne Barton**
  - Future proof upcoming Clarion scheme for DHN connection, consider standalone DH scheme that can connect into wider BB DHN in the future when it’s ready.

- **Devonport**
  - Futureproof planned new developments for DHN connection as part of planning application process.
  - Engage with HMNB Devonport to clarify contractual arrangements with the MVV Energy from Waste (EfW) plant to get better understanding of potential to amend contract and supply heat to a wider DHN scheme prior to the end of the current 25 year contract period (2015 – 2040).

- **Derriford**
- Undertake a detailed feasibility study to assess the scheme viability. This should include engaging with NHS Trust to develop proposals for heat supply from Derriford Hospital energy centre.
- Future proof planned new developments.
- Engage with potential heat customers.
- Develop business case.
- Prepare grant application for HNIP funding.

• Civic Centre
  - Undertake detailed feasibility study to assess scheme viability.
  - Develop Business case
  - Establish Starter DHN
  - Future proofing of new developments within 0.5km of Civic Centre for connection to DHN.

• Cultural Quarter
  - Undertake detailed feasibility study to assess scheme viability for Eastern and Western Extension. Potential new customers have emerged e.g Train Station development, reboiler of student residences.
  - Assess and develop business case viability for Eastern and Western Extension.
  - Continue engagement with University of Plymouth (UoP) to devise mutually beneficial scheme to extend UoP DHN.
  - Establish extension to UoP DHN beyond UoP boundary.
  - Futureproof planned new developments as part of planning application process.

• Millbay
  - Futureproof planned new developments as part of planning application process.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

• Sherford (Standalone Cluster)
  - Consider DHN as part of ongoing negotiations with developer, and any changes to previous planning approval.
  - Developer to undertake feasibility study to establish viability of DHN scheme to serve the Town Centre.

• Royal William Yard (Standalone Cluster)
  - Future proof all remaining phases of development.

Medium Term Opportunity (2020-2025)

• Barne Barton
  - Re-assess DHN scheme potential when significant new developments are proposed.
  - Future proofing of new developments.

• Devonport
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings
  - Re-assess DHN scheme potential when significant new developments are proposed.
- Futureproof planned new developments as part of planning application process.

- **Derriford**
  - Establish Starter DHN. Extend DHN to capture key anchor loads, e.g. Marjons, Nuffield Health, new developments at Seaton Barracks site.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

- **Civic Centre**
  - Extend DHN to serve economically viable connections.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings

- **Cultural Quarter**
  - Support stakeholder engagement as part of viability assessment of additional heat customers for connection to UoP DHN.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings

- **Millbay**
  - Investigate potential to connect to DHNs that may be implemented or expanded in and around the City Centre.

- **Sherford**
  - Build out the DHN to serve all buildings in the Town Centre.

- **Royal William Yard**
  - Ensure that either potential to connect to a planned or existing DHN is considered at time of plant replacement. This could entail taking opportunity of future proofing during plant replacement works.

**Longer Term Opportunity (2025-2040)**

- **Barne Barton**
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.
  - Reconsider DHN at end of HMNB Devonport contract with MVV.
  - Future proofing of new developments

- **Devonport**
  - Futureproof planned new developments as part of planning application process.
  - Development of high capacity zero carbon heat source from EfW plant that can serve other clusters.
  - Explore the potential to connect to a wider DHN which would be served by the EfW plant and serve Devonport, Barne Barton, Royal William Yard the Civic Centre, Cultural Quarter and Millbay.

- **Derriford**
- Extend DHN to serve economically viable loads in Derriford.
- Transition to zero carbon heat source(s).

- Civic Centre
  - As per medium term.
  - Transition to zero carbon.

- Cultural Quarter
  - Consider extension to link up to proposed Civic Centre DHN.
  - Transition to zero carbon heat source(s).

- Millbay
  - As for Medium Term

- Sherford
  - None specified.

- Royal William Yard
  - Assuming it has been possible to establish DHN, explore the potential to connect to a wider DHN which may exist in the future which serves the Civic Centre, Cultural Quarter and Millbay and possibly Devonport.

**Potential Costs and Benefits of DHN in Plymouth**

This study has outlined potential carbon savings of 3,500 tonnes per year assuming the 6 strategic cluster area Starter Schemes are implemented at a capital cost of approximately £18 million.

Based on a full build out of the 6 strategic Full build out DHN schemes, the carbon saving is estimated to increase to ~7,000 tonnes per year at a capital cost of approximately £30 million.

Over time, with expansion of the network and utilisation of low carbon energy sources (e.g. EfW) the estimated carbon savings could increase significantly. Mature heat networks also have the benefit of being technology agnostic, offering many benefits of fuel diversity, fuel efficiency and promoting energy security.
2 Introduction

2.1 Study Context

BuroHappold Engineering has been commissioned by Plymouth City Council (PCC) to develop a city-wide district energy strategy, mapping the heat demand across the area and identifying through an energy masterplan the opportunities for District Energy across Plymouth. This study forms Work Package 5, which is part of a wider package of low carbon development work that BuroHappold has carried out on behalf of PCC. This will act as a supporting document of evidence to support the development of individual district heating schemes as part of PCCs low carbon development drivers.

2.2 Study Objectives and Approach

2.2.1 Study Objectives

The delivery of a strategic district-heating network (DHN) in the City has been identified as a key way of meeting PCC’s low carbon development drivers.

The key objectives of this study are to:

- Underpin overall city-wide strategic vision and energy masterplan for district heating networks (DHN)
- Integrate and synthesise previous DHN work carried out by BUROHAPPOLD in Plymouth.
- Provide graphical representation of the opportunities (as a strategic heat map),
- Identify and prioritise any potential DHN scheme opportunities.
- Provide technical and economic rationale for potential DHN scheme opportunities.
- Identify opportunities for the PCC HeatNet project and 4th Generation District Heating.

This City-Wide Energy Strategy for Plymouth forms part of a wider package of work undertaken by BuroHappold for PCC to support the delivery of a strategic DHN in Plymouth. and previous work undertaken by BuroHappold has been carried out in line with Heat Network Delivery Unit (HNDU) project development stages for DHNs. A map of the study area is shown below, while previous work packages are listed in Section 2.7.1.
Figure 2—1 Map showing Study Area
2.3 National Drivers and Strategy – Why is Heat Important?

The UK enacted the Climate Change Act 2008 which sets a legally binding target to achieve an 80% reduction in carbon below a 1990 baseline.

The Government Heat strategy published in 2013, recognises there has been a historic failure to address a major part of the energy jigsaw; the supply of low carbon heat. Energy efficiency and better informed consumers help to tackle the demand for heat, and market reforms are helping to decarbonise the supply of electricity. However, alternatives to fossil fuels for the supply of heat are still lacking.

Heating and hot water for UK buildings make up around 40% of our energy consumption and 20% of our greenhouse gas emissions. It will be necessary to largely eliminate these emissions by around 2050 to meet the targets in the Climate Change Act and to maintain the UK contribution to international action under the Paris Agreement.

2.4 What is District Energy and What are the Benefits?

2.4.1 Introduction to District Heating

- In a district heating network, buildings of adequate heat load are served with hot water in a pipe network from a centralised energy centre generating heat (and often power).
- Where the demand density of heating is low, for example in a small village, an individual building approach tends to be most suitable for heating (such as individual gas boilers running a conventional wet central heating system, or small electric point heaters). Where demand density is sufficiently high, district heating can be more energy efficient, reducing costs and enabling technologies with lower CO₂ emissions to be connected, such as gas CHP and heat pumps, or utilisation of waste heat sources.
- District heating infrastructure enables a wide spectrum of opportunity for low carbon heat, by facilitating the ability to change future heat sources without modifying building design. It allows the integration of some large heat sources that require a minimum number of heat customers to be cost effective. District heating can provide cost effective and technically feasible means of achieving significant CO₂ emissions savings for a large urban development. However, care is needed to optimise the commercial and technical aspects of the network to minimise losses and maximise operational efficiency.

Figure 2—2 District Heating Network in principle

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2 Next steps for UK heat policy, Committee on Climate Change, October 2016
The deployment of DHN requires a heat network operator. Where networks are to be retrospectively developed, PCC may initially be a facilitator in network development to form an initial cluster base, although long term involvement may fit well with council aims and objectives.

2.4.2 What are the benefits of district heating?

Heat networks (district heating networks) can contribute to local authorities’ targets and aspirations for carbon emissions reduction, fuel poverty, cost reduction, increasing energy security, regeneration, local jobs and growth. In turn, local authorities have a vital role in developing heat networks; as sponsor, pivotal heat customer, heat source, planning authority and relationship brokers.\(^3\)

Specific benefits of district heating networks include:

\(^3\) [https://www.gov.uk/guidance/heat-networks-delivery-support](https://www.gov.uk/guidance/heat-networks-delivery-support)
• Energy efficient technology can result in lower carbon and lower costs to consumers if well implemented – it can be a more effective than fabric upgrading of existing buildings.

• Futureproofing for ensuring continued carbon savings in the future without altering buildings served – as new more energy efficient plant to deliver heat becomes commercially available in the future, it can replace the plant installed in the energy centre when it reaches the end of its commercial lifecycle.

• Energy Security – an energy centre can provide fuel flexibility as multiple alternative heat generating plant can be used to deliver heat to a network, based on the most efficient solution at that time. In that sense, a DHN has the potential to be technology agnostic.

• Compliance with national policy aimed at decarbonising the UK heat supply such as the Climate Change Act 2008 which sets a legally binding target of an 80% reduction in carbon below a 1990 baseline. Plymouth’s adopted policy aims to halve 2005 carbon emissions by 2034.

• Economic benefits
  o mitigate against rising energy costs and can provide attractive long term returns on investment
  o significantly reduce the developer’s cost of compliance with Building Regulations
  o reduce labour and maintenance costs compared with individual systems (evidence indicates that total operational costs can be lower than individual boiler options, with ongoing lower heat, maintenance and replacement costs).
  o provide local authorities an opportunity to address fuel poverty and give peace of mind to vulnerable residential customers by providing lower, more affordable and more stable prices.

2.5 **What is 4th Generation District Heating & Cooling?**

2.5.1 **4th Generation District Heating & Cooling (4GDHC)**

The aggregation and interconnection of heat loads can create an opportunity for low carbon technologies to be deployed at scale to share benefits and generate revenue.

A well established heat distribution system, DHN is currently evolving to what is known as “4th Generation District Heating” (4GDH). While there isn’t a simple definition, 4GDH can be encapsulated as representing the development and integration of:

• Low-energy space heating, cooling and hot water systems

• A supportive institutional framework for suitable planning, cost and motivation structures

• Waste heat recycling and integration of renewable heat

• Smart thermal grids for low temperature networks

• Integrated operation of smart energy systems including 4th Generation District Cooling systems

Note - Whilst 4GDHC does not directly form part of this study, it will inform further work to be commissioned that will explore the feasibility and implementation of fourth generation district heating & cooling (4GDHC) approaches in Plymouth, using Interreg NWE Programme 2014-2020 funding under the HeatNet NWE project.

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¹ Heat Networks: Code of Practice for the UK CP1 2015, CIBSE & ADE, 2015
² 4th Generation District Heating (4GDH) – Integrating smart thermal grids into future sustainable energy systems. Lund et al, February 2014
Figure 2—5 provides an illustration of the concept of 4GDH in comparison to the previous three generations.

Figure 2—5 – Illustration of the concept of 4th Generation District Heating in comparison to the previous three generations.
2.6 PCC Low Carbon Drivers, Development Initiatives and Policy

Plymouth City Council aims to deliver catalyst strategic heat network infrastructure in the City as part of its overall objective of reducing the City’s carbon footprint, helping to lower energy costs and promoting energy security.

This in line with and supports the UK’s legally binding target to reduce the UK’s greenhouse gas emissions by at least 80% in 2050 from 1990 levels (Climate Change Act 2008).

2.6.1 Key PCC Low Carbon Objectives

- Reduce the cost and carbon emissions associated with the supply of energy to customers connecting to the heat network. Plymouth City Council’s adopted Plymouth Plan Refresh policy GR07 aims to halve 2005 carbon emission levels by 2034.
- Enable the delivery of new low carbon development and regeneration schemes in a cost effective way, by establishing catalyst district energy schemes that can be expanded to serve other development and regeneration schemes.
- Ensure a secure supply of energy and address the constraint in electricity supply in the South West of England.
- Delivery of low carbon development that takes advantage of the natural energy resource richness of the south west of England, including solar, wind and water from the seaside.

2.6.2 PCC’s evidence-based approach to achieving CO₂ reductions in Plymouth

In 2014 PCC commissioned the Centre for Energy and the Environment to produce a city-wide baseline report on carbon emissions, including recommendations for reduction targets in support of national policy to reduce carbon emissions. This report provided evidence that supported PCC in setting a target to reduce emissions of carbon dioxide in Plymouth by 50% by 2031, from a 2005 baseline.

In a study completed in April 2017: Baselines and Trajectories for Carbon Dioxide Emissions in Plymouth, South Hams and West Devon, the Centre For Energy And The Environment reviewed this earlier evidence to update the 2014 report to reflect recent policy changes and to provide a carbon emission baseline for the West Devon and South Hams areas, in addition to the existing baseline provided for Plymouth.

This updated 2017 report upheld the recommendation for a target for a 50% reduction in CO₂ emissions for Plymouth. Salient excerpts from this report are provided below in italics.

Buildings (including the associated indirect emissions from electricity consumption) are responsible for a third of UK carbon emissions. Of these, 65% are from residential buildings, 25% from commercial buildings and 10% from public sector buildings. Direct emissions associated with buildings have fallen by 17% from 1990 to 2015, though emissions have barely changed over the period 2011 to 2015.

Past government policy has focussed on improving the efficiency of the building stock, in particular within the domestic sector where various schemes have been put in place to insulate unfilled wall cavities and loft spaces. Since the introduction of the Green Deal, installation data reveals the large reduction in the number of dwellings that have been insulated post-2013.
Looking ahead, the Climate Change Committee’s “central scenario” for abatement of direct emissions from the building sector relies on a mixture of improved efficiency (e.g. insulation) at 47%, district heating at 26%, and heat pumps and biomass boilers at 27% of abatement, spread across both the residential and non-residential sectors.

2.6.2.1 Low Carbon Approach to planned developments in Plymouth

The planned redevelopments in some areas of the City represent a significant future heat demand which will be subject to increasingly challenging CO$_2$ emissions targets under future UK government Building Regulations. Due to the size, mix, location and phasing of new development proposals, opportunities for low carbon energy supply via district heating should be explored, including combined heat and power in the short term and heat pumps in the short to medium term.

New developments in Plymouth in areas where the delivery of a heat network is considered feasible, particularly in the high density areas of the City Centre and Derriford, have been required to connect into proposed heat networks where already in place. If a heat network is not in place at the time the development is complete, the development is required to provide financial contributions towards its delivery and be to futureproofed to allow future to a heat network, in line with best practice.

Details of initiatives that PCC has carried out in support of low carbon development are shown in the section below.

2.6.3 PCC low carbon development Policy

Heat networks are a key element in Plymouth City Council’s adopted Plymouth Plan Refresh policy GR07 Reducing carbon emissions and adapting to climate change, which aims to halve 2005 carbon emission levels by 2034, but also to reduce energy costs and increase energy security.

Policy GR07 sets out the following approaches:

1. Encouraging and enabling large scale uptake of retrofit insulation, and renewable /low carbon energy generation equipment and infrastructure to existing buildings, and promoting other energy demand reduction measures.

2. Supporting and enabling the installation of renewable and low carbon energy generation capacity, including encouraging community owned installations and identifying land for large scale renewable energy installations.

3. Promoting the creation of infrastructure to supply low carbon heat through the delivery and expansion of district energy networks.

4. Support the development of resilient, efficient local energy markets through the identification and promotion of local opportunities for SMART energy infrastructure that helps to balance local supply and demand.

5. Using planning powers to promote development that reflects the risks posed by climate change and the need for society to move towards a low carbon future

The draft submission Plymouth & South West Devon Joint Local Plan 2014-2034$^6$ sets out the planning specific aspects of the Plymouth Plan policy for new developments.

$^6$ https://plymswdevonplan.co.uk/policy/s011/dev34
Policy DEV34 – Delivering low carbon development, including that developments will be required to connect to existing district energy networks in the locality or to be designed to be capable of connection to a future planned network. Where appropriate, proportionate contributions will be sought to enable a network to be established or completed.

Policy DEV35, Renewable and low carbon energy (including heat) also includes that;

8. For renewable or low carbon energy generating proposals (including energy from waste), where appropriate, the development should provide for the efficient distribution of heat off site, for the co-location of energy producers with users, and for the maximisation of energy recovery or efficiency of generation.

Supplementary Planning Guidance will also be published, providing further details about the implementation of the policy.

Many developments have agreed to be future-proofed for connection to a DH network, particularly in the City Centre, Derriford and Millbay areas. S106 funding has also been secured from developments towards delivery of the network.

District Energy infrastructure is included in Plymouth’s infrastructure Plan which sets out the infrastructure priorities for Plymouth to support the delivery of new low carbon development and regeneration schemes.

2.7 Relevant Previous Studies

A number of previous studies have been carried out by both BuroHappold and external consultants that are relevant to this study. These are detailed in the following sections.

2.7.1 Previous studies undertaken

A number of reports were prepared for PCC since 2009 and have been reviewed as part of this study. This City-Wide Energy Strategy for Plymouth forms part of a wider package of work undertaken by BuroHappold for PCC in line with Heat Network Delivery Unit (HNDU) project development stages 1 (Heat Mapping) and 2 (Masterplanning). The previous reports are as follows:

Wider CQ and City Centre Connections – Heat Mapping and Energy Masterplan, December 2016, BuroHappold Engineering

A heat mapping and energy masterplanning study in the wider Cultural Quarter (CQ) and City Centre area. The study provides information for the PCC to establish knowledge on potential connections, clusters, network routing, heat supply sources and viability of any potential district heating schemes.

Cultural Quarter (CQ) Extension Feasibility, March 2016, BuroHappold Engineering

Feasibility study to understand the expansion potential for the existing Cultural Quarter (CQ) district heating scheme, beyond the boundaries of the Plymouth University campus. This work superseded the original feasibility study undertaken by BuroHappold.

Eighteen buildings were initially assessed for inclusion in a scheme extension, of which ten have been considered for connection viability.

Key Findings

The expansion of the existing on-campus infrastructure to include interconnection and addition of further connections is feasible
The use of a biomass boiler provides a more attractive source of heat, technically and economically, than further CHP expansion at the present time due to the nature of the available heat load (relatively seasonal) and the attractive subsidy in place for biomass. Biomass also helps meet the UoP Carbon Management Plan targets.

Under current economic conditions, capital investment is needed to make the extension of the DHN beyond the Plymouth University Campus feasible.

To progress the project the development of a business case for the involvement of each stakeholder is recommended.

**Seaton Barracks – Energy Strategy Review, February 2016, BuroHappold Engineering**

Review of the new Seaton Barracks development energy statement (by Envision Energy) to explore if site-wide district energy opportunities have been maximised and if any further opportunities exist taking into account existing district energy feasibility studies. The Review provided recommended actions for the energy strategy.

**History Centre Connection Viability Study, October 2015, BuroHappold Engineering**

This report assesses the required works to connect the History Centre as a first step towards establishing a District Heating network off-beyond the Plymouth University Campus.

**South Yard District Heating Feasibility Study, September 2015, BuroHappold Engineering**

This design note looks at the feasibility of a small heat network scheme based around existing Plymouth Community Homes (PCH) buildings and the opportunity presented by the redevelopment of South Yard by Plymouth City Council (PCC).

The capital cost of the scheme is around £650k (including £160k and £60k contribution from PCH and South Yard respectively – total cost without contributions ~ £870k) for a 500kW woodchip biomass boiler, 1.2MW of new back up gas boilers and ~350m of district heating network.

Including the Renewable Heat Incentive subsidy and heat sales and costs the scheme nett annual revenue is around £31,000 p.a.

The potential for a biomass led district heating scheme was found to be financially poor when considering the proposed network without funding with an NPV of -£200k at 20 years.

If funding of ~ £353k could be found to fund the infrastructure costs for example S106 or CIL funding from the South Yard project a commercial return of ca. 8% can be achieved which could be of interest to an external party or joint venture with PCC.

The project could offer support to local energy supply chain for biomass and set high environmental performance for the South Yard development and decarbonisation of the Plymouth Community Home housing.

If financial support can be found for the project this represents a manageable and modest budget heat network scheme that has future growth potential and could serve well as a demonstrator and catalyst project for PCC to progress the district energy project.

**Millbay Heat Network Feasibility Study, November 2014, BuroHappold Engineering**

This work relates to a possible heat network connecting; viable plots within the Millbay Masterplan, updated mid-2014, developed by MUSE working for the English Cities Fund, further new developments to the south of Millbay Masterplan by Linden Homes, the redevelopment of the existing Plymouth Pavilions by Akkeron and including several existing buildings with significant energy loads.
The scope of the Millbay Heat Network Feasibility Study is to provide information to establish high level technical feasibility for a potential catalyst DE network and a high level assessment of its commercial viability.

The study provides evidence to support the development of a DE network in the Millbay area which appears feasible, subject to further development of a business case to clarify the role of capital contributions and heat pricing to underpin financial performance. However it is likely to require funding support to attract private sector investment. This network and underpins longer term planning policies under the Plymouth Plan.

**Barne Barton District Heating Feasibility Study, September 2013 – Parsons Brinkerhoff on behalf of MVV Environment**

This study assessed the financial performance of a district heat network to supply waste heat from the adjacent Energy from Waste Plant to dwellings in Barne Barton. The results of the study show that the proposed scheme has an operating profit which is too small to fund the required capital investment which leads to a negative net present value and therefore an uneconomic scheme. The study sets out a number of assumptions to review which could be revisited to improve the scheme economics.

**Update Addendum to City of Plymouth District Energy Study - Devonport, October 2012, ICE (UK) Ltd**

Excerpts from the study are shown in italics below.

*This addendum is intended to update the district energy scheme solution for Devonport that formed the basis of the ICE (UK) Ltd. report on the potential for a City Wide Energy Services Company (ESCO) in Plymouth that was commissioned in 2009 and published in January 2010. It is also intended to validate and confirm whether there is still a commercial business case to procure an ESCO to develop district energy in Devonport. ICE (UK) Ltd. have demonstrated in this addendum that despite the Royal Dockyard sourcing alternative sources of low carbon heat and power in the intervening period at North Yard, there could still be a business case for a wider district energy in Devonport.*

**Update Addendum to City of Plymouth District Energy Study, May 2012, ICE (UK) Ltd**

Excerpts from the study are shown in italics below.

*This addendum was intended to update the scheme designs that formed the basis of the ICE (UK) Ltd. Report on the potential for a City Wide Energy Services Company (ESCO) in Plymouth…and validate and confirm that there is still a commercial business case to procure an ESCO to develop district energy schemes in Plymouth. ICE (UK) Ltd. have demonstrated in this addendum that despite several core consumers choosing alternative sources of low carbon heat and power in the intervening period, there remains a business case for district energy in Plymouth.*

**City of Plymouth District Energy Study – Feasibility Study for an Energy Services Company in Plymouth, January 2010 – ICE (UK) Ltd**

Excerpts from the study are shown in italics below.

*The potential for the development of district energy with CHP in Plymouth was divided into three areas as it was necessary to focus initially on catalyst schemes that have a sufficient density of energy which enable further connections and expansion in the future. These 3 core schemes were agreed with PCC for modelling during initial discussions.*

City Centre
In the City Centre it was estimated that connecting the Council owned buildings around the Civic Centre to the University of Plymouth’s city campus was not initially feasible because of the distance and elevation between the two. However, as redevelopment of the shopping district which separates these two core consumers takes shape, then further 3rd party consumer connections can be made.

The same can be said for the other 2 areas where expansion of the core schemes suggested in this report is not only viable but strongly recommended as it adds profitability and ability for increased carbon reductions to all consumers.

Derriford

In Derriford, the Hospital has been suggested as a core consumer and the location for the Energy Centre as it has significant energy demand and a key geographical location in the centre of existing and future developments. There is a real opportunity to maximise on the timing of new development plans by laying down a foundation network of heating mains that can be utilised by new developments as and when they are built. Due to the nature of the healthcare industry as a high energy user, this area could realise some large energy cost savings and a strong scheme being developed.

Devonport

Whilst the individual energy loads (individual domestic properties) in Devonport area are not as significant as to provide a catalyst district energy scheme, the inclusion of HMNB Devonport would enable a network to be installed and funded by an ESCo. Other options for this area could include locating the Energy Centre at City College or future developments in the South Yard such as Princess Yachts and using some government funding such as the 2009 Homes and Communities Agency grant programme to fund the thermal network.

Establishing an ESCo

If Plymouth City Council is to increase its performance measured against the national indicators it needs to take a proactive role in the development of an ESCo. The market will not simply respond and establish an ESCo, unless there is a clear and secure mechanism for funding infrastructure (committed energy loads). A private sector led ESCo will not be formed on a speculative basis. Therefore it is recommended that Plymouth City Council should lead the procurement process (as being the key link between the various stakeholders) but it would also need the co-operation of the other stakeholders.
Figure 2—6 Map showing location of previous DHN studies carried out by BuroHappold in Plymouth
2.8 Study Methodology

The methodology of this study follows a logical sequence in line with Heat Network Delivery Unit (HNDU) project development stages 1 (Heat Mapping) and 2 (Masterplanning) and is summarised in Figure 2—7 below.

- **Developing a District Heating Strategy**
  - Outline of approach used to develop Plymouth Wide District Heating Strategy.

- **Energy Mapping**
  - Produce heat demand maps based on the Data Review stage.
  - Identify heat demand data according to ownership and typology.
  - Produce heat sources maps based on the Data Review stage.
  - Identify constraints, new developments, areas proposed for new developments.
  - Produce Maps showing District Heating Opportunity Areas in Plymouth.

- **Cluster Identification**
  - Identify clusters based on agreed Tiering Methodology.
  - Review possible energy centre locations for the clusters.
  - Identify “starter” and “full-build out” DH scheme for each cluster.
  - Site visits to inform cluster configuration.

- **Techno-economic modelling**
  - High level determination of costs and revenue streams for options.
  - Determine indicative IRR and NPV over 25 project life.
  - Determine CO₂ savings potential of each cluster.
  - Initial commercial options review to assess funding and operational strategies.

- **Cluster Prioritisation**
  - Prioritisation of identified clusters based on multi-criteria analysis.

- **Qualitative Opportunity Assessments**
  - Outlining of future DHN opportunities which could be developed as standalone schemes and key considerations regarding the existing HMNB Devonport DHN and the issues that need to be addressed to expand this scheme.

- **A District Heating Strategy for Plymouth**
  - Short Term, Medium and Longer Term Opportunities and Actions for DHN in Plymouth.

Figure 2—7 – Methodology
3 Developing a District Heating Strategy for Plymouth

3.1 Introduction

District heating offers a clear opportunity to deliver low carbon development in line with UK government policy and that meets the needs and aspirations of Plymouth City Council, local residents and property developers.

However, the nature of district heating is that requires the delivery of heat to a community of customers which requires planning and coordination to ensure that the necessary technical, commercial and environmental elements of a district heating network are aligned to ensure a successful scheme.

- This section / chapter sets out the methodology used to develop a district heating strategy for Plymouth including:
- The wider possibilities for DHN Plymouth wide by spatially identifying district heating opportunity areas through the plotting of heat demand data from over 2,000 data points, which represent about 700 GWh of heat demand across the district.
- Classifies area-specific strategic DHN opportunities (clusters) as either short, medium or long term opportunities and provides guidance on what is needed to deliver DHN schemes and safeguard future opportunities.
- A long-term Vision for DHN in Plymouth based on unique opportunities in Plymouth.
- Provides an evidence base to support PCC low carbon development initiatives and policy
3.2 Forming the Strategy

Spatial Mapping of Heat Demands and Sources

- Spatial Mapping of heat demands and heat sources in the study area using a combination of two methods to visualise heat demands:
  - 1) Output area based heat mapping - this shows heat demand data collected in this study according to Lower Layer Super Output Areas (LSOA’s) – administrative areas used for analysis of Census data and consisting of 400 to 1,200 household.
  - 2) Point load heat mapping – this presents significant ‘Tier 1’ heat demands as point loads.

Identification of District Heating Opportunity Areas

- Identifying District Heating Opportunity Areas based on Spatial Mapping of Heat Demands.
- Mapping of Strategic Heat Sources in Plymouth.

DHN Cluster Identification & Prioritisation

- Identification of Clusters which have the potential to form a strategic catalyst DHN scheme in specific areas in Plymouth from the Heat Mapping of Point Loads.
- Prioritisation of selected Clusters based on a Multi Criteria Analysis.
- Qualitative assessment of areas which showed significant heat demand but which were not considered as strategically significant as Clusters identified and of existing HMNB Devonport DHN and potential for future expansion.

District Heating Strategy for Plymouth

- Outline of Short, Medium and Long term DHN opportunities.
- Strategy outlining key actions and next steps in the short, medium and longer term.
3.3 Spatial Mapping of Heat Demands and Strategic Heat Sources

Output area based heat mapping - this shows heat demand data collected in this study according to Lower Layer Super Output Areas (LSOA’s) – administrative areas used for analysis of Census data and consisting of 400 to 1,200 household of heat demand data from over 2,000 data points, which represent about 700 GWh of heat demand across the district.

Point load heat mapping – this presents significant ‘Tier 1’ heat demands as point loads.

Identifying District Heating Opportunity Areas based on:
• Selection of LSOA areas that are within or adjacent to clusters with a concentration of Tier 1 loads and the LSOA areas adjacent.
• Selection of LSOAs areas that show a heat demand density greater than 30 kWh/m², and the LSOA areas adjacent.
• Mapping of Strategic Heat Sources in Plymouth

3.3.1 What are ‘Tier 1’ Heat demands?

In order to prioritise the data to be targeted for collection by PCC and to inform the heat mapping exercise, heat demand loads have been grouped into Tiers considering their DHN connection viability, based on their typology, ownership and heat demand. These tiers are based on experience from previous district heating studies and are summarised in Table 4—2 in the Heat Mapping Section of this report.
3.3.2 Plymouth Wide Spatial Heat Maps

3.3.2.1 Spatial Mapping of Heat Demands in Plymouth by LSOA

Figure 3—1 shows Spatial Mapping of Heat Demands in Plymouth by LSOA

3.3.2.2 Identifying areas of interest for district heating in Plymouth

Figure 3—2 shows a Spatial Heat Map of Plymouth showing heat demand plotted by LSOA area with ‘Tier 1’ point loads overlaid – red circles show DHN areas of interest

3.3.2.3 Identifying District Heating Opportunity Areas in Plymouth

LSOA areas which show a heat demand greater than 30 kWh/m² and contain Tier 1 heat loads have been identified as key area of interest for the development of district heating. In order to identify District Heating Opportunity Areas, LSOA’s adjacent to key areas of interest for district heating have also been selected to ensure that areas with DHN potential (due to their proximity to areas of interest) are not missed due to the limitations of LSOA resolution.

Figure 3—3 shows a Spatial Map showing District Heating Opportunity Areas, Existing Heat Networks Strategic Heat Sources, Strategic Identified DHN Cluster Locations

3.3.3 Developments which may fall outside DHN Opportunity Areas but might be suitable for standalone DHN schemes

New development of suitable scale and/or density should undertake an assessment of the viability of using district heating and/or cooling. Schemes which should undertake such as assessment are those within the areas highlighted in the report as being suitable and developments which meet the following criteria:

- Consisting of over 100 dwellings
- Having a heat demand density of 30kWh/m² of land area
- Having a mixed use nature e.g. more than one use and being of large scale (e.g. greater than 3,000m² gross floor area)
- Including high process energy use such as data centre, swimming pool, laboratory, industry or other similar uses with high energy demand and predicted to have a total energy demand in excess of 500MWh/annum including ‘unregulated’ energy demand.
Figure 3–1 Spatial Mapping of Heat Demands in Plymouth by LSOA
Figure 3—2 Spatial Heat Map of Plymouth showing heat demand plotted by LSOA area with ‘Tier 1’ point loads overlaid – red circles show DHN areas of interest.
Figure 3—Spatial Map showing District Heating Opportunity Areas, Existing Heat Networks Strategic Heat Sources, Strategic Identified DHN Cluster Locations
3.4 Strategic Heat Sources and their Potential

3.4.1 Existing Heat Sources

Secondary heat supply is heat that can be recovered as waste from environmental, industrial or commercial activities. Heat from secondary sources is typically at a low temperate and requires upgrading via heat pumps to connect to conventional district heating networks. However, heat from secondary sources could be used directly if it is supplied at a sufficiently high temperature.

A number of potential heat sources that could supply heat networks in Plymouth have been identified from a number of sources including the Environment Agency, from previous studies, from PCC and via online searches. These are summarised below. These include industrial installations such as data centres, and an Energy from Waste (EfW) plant in Devonport. A list of identified heat sources in the WP5 study area can be found in Table 10—11 in Appendix G.

3.4.1.1 Energy from Waste Plant, Devonport

There is an EfW plant located in Devonport and operated by MVV Environment, which generates electricity and heat from approximately 245,000 tonnes of waste delivered to the plant per year\(^7\). Her Majesty’s Naval Base (HMNB) Devonport is understood to have a contract to take up to 23.4 MWth of heat and up to 22.5 MWe of electricity from the EfW plant, with surplus electricity exported to the grid\(^8\).

Through engagement with MVV, there is estimated to be 7.5 MW of spare heat available, however due to the contract with HMNB Devonport only 2.6 MW is immediately available to provide heat to a potential DHN as the remaining heat is contractually obliged to HMNB Devonport. MVV are open to discussing the purchase of heat from the EfW plant, subject to agreement on technical, commercial, operational and legal considerations being agreed.

Figure 3—4 MVV EfW plant, Derriford (Photo courtesy of Google Maps)

This represents a significant long-term low carbon heat source within the City boundaries.

\(^7\) Correspondence from MVV, June 2017.
\(^8\) Barne Barton District Heating Feasibility Study, MVV Environment, *Parsons Brinckerhoff, September 2013*
A summary of the engagement with MVV Environment is shown in Appendix D.
3.4.1.2 Derriford Hospital

Derriford Hospital (DH) utilises a high temperature heating system with boiler heat provided at 177 degC to supply heat to an on-site DHN.

DH has an incinerator with a maximum capacity of 1 tonne of waste per hour, a 1.55MWe CHP and 12 MW of gas boiler capacity (with an extra 3MW to be added in late 2017). It is understood that there is no heat recovery from the incinerator and a significant proportion of the heat generated by the CHP is rejected.

The installed heating capacity at Derriford Hospital is in excess of current and anticipated future heat demands for the hospital resulting in an estimated potential of 2.5 MWth that could be used to provide heat to a wider DHN in Derriford that could be centred around the hospital.

![Figure 3—5 Derriford Hospital and surrounding area (Photo courtesy of Google Maps)](image)

3.4.1.3 Guildhall

There is an existing heat network, owned by PCC, served by recently refurbished boilers located in Plymouth Guildhall and which serve the Guildhall and Council House, adjacent to the Civic Centre.

3.4.1.4 University of Plymouth

There is an existing heat network on the University of Plymouth site in the Cultural Quarter which serves a number of University buildings. Heat is provided by CHP and gas boilers. UoP are considering options to expand their heat network to other buildings on the campus and potentially beyond to serve buildings in Plymouth.
3.4.2 Future Heat Sources Identified in Plymouth

3.4.2.1 Solar hot water powered District Heating

Plymouth has the potential to make use of solar thermal technology to harness heat to supply a district heating schemes. The largest European solar heating plant is believed to be located in Silkeborg, Denmark, with 110MWth capacity and a solar aperture area of 157,000 square meters.

3.4.2.2 Marine Heat Pumps

Plymouth’s location on the coast offers a key opportunity to use heat pumps which use water source as a source (for heating) or sink (for cooling) of heat.

As an example, the Drammen District Heating system in Norway provides 45MW of heat to supply 200 large buildings in the city. The heat was originally from a mixture of fossil fuel and biomass but a new system was designed to make a large heat pump the primary source. They now draw 75% of the network heat from the ammonia heat pumps at 90°C with 15% from biomass and 10% from gas/oil.

It draws water from the fjord at 8°C and cools it to 4°C. The heat pump boosts this energy up to 90°C and delivers 13.2MW. It is believed to be the largest system in the world operating at these temperatures and definitely the largest doing so using ammonia as the working fluid.

(Source: European Heat Pump Association

http://www.ehpa.org/technology/best-practices/large-heat-pumps/drammen-district-heating-norway/)

9 http://solar-district-heating.eu/ServicesTools/Plantdatabase.aspx
3.5 Future Heat Supply Considerations - 2050 Pathways

In selecting an appropriate heating fuel supply source it is important to consider how CO₂ emissions associated with energy production will change over the next 25 years (indicative plant lifetime) to 40 years (indicative district heating network lifetime).

A phased decarbonisation of the electricity grid is predicted to meet national CO₂ targets based on Government policy and technical feasibility. Currently a reliance on fossil fuels means that natural gas is a significantly more low carbon fuel than electricity. Therefore, utilising gas CHP to offset electricity with associated high CO₂ emissions gives significant CO₂ savings and is highlighted in national policy as a key technology as part of transition towards low and zero carbon heat.

Figure 3—6 shows how this picture may change in future years based on DECC (now BEIS) electricity grid emissions projections, assumptions regarding heat pump and CHP efficiencies and an assumption of a 10% penetration of ‘green gas’ into the natural gas network by 2050.

![Figure 3-6: Impact of DECC electricity emission factor projections on heating CO₂ emissions](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/360323/20141001_Supporting_Tables_for_DECC-HMT_Supplementary_Appraisal_Guidance.xlsx)

The grey area on the graph shows where we are today – gas CHP remains a preferable low carbon technology up until the point that the grid decarbonises to the extent that the electricity offset by a gas CHP engine is of a higher CO₂ content than the electricity grid. When this happens, using heat pumps becomes a more attractive method of reducing emissions, notwithstanding concerns around the future financing of such schemes and the vulnerability of the renewable heat incentive (RHI).

While in heat pumps should in theory become competitive with gas fired CHP by 2020 in terms of CO₂ saving, this is dependent on a number of contributing factors which are surrounded by a considerable degree of uncertainty – the timely uptake of renewables in the UK electricity generation mix, the decommissioning of fossil fuel power stations and the uptake of “green gas” that would help decarbonise the gas grid.

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Therefore, due to the current uncertainties regarding the decarbonisation of the grid, and the limitations of the grid infrastructure in the South West to supply peak heat demand, both CHP and heat pumps should continue to be considered as the likely heat supply sources for new heat in the next few years.

Gas-CHP is a commonly used energy source to help achieve CO₂ emission reductions against today’s building regulations, while heat pumps can be considered as a supply for future heat networks in line with the projected grid decarbonisation – heat networks can be designed to be compatible with both gas CHP and heat pumps to allow for flexibility of energy supply.
4 Heat Mapping

4.1 Methodology

A logical approach has been followed based on the HNDU stages 1 and 2 (Heat mapping and masterplanning) to map heat loads in the study area and capture previous work and assess the future potential of district heating in Plymouth.

The methodology reflects the importance of PCC influence and control over heat demands, which is expected to have a major impact on the deliverability of a strategic DHN in Plymouth.

Figure 4—1 provides an overview of the heat mapping process, which is explained in more detail in the following sections.

Figure 4—1 – Flow Diagram providing overview of heat mapping process

4.2 Data Sources and Benchmarking

4.2.1 Data gathering methodology

In order to prioritise the data to be targeted for collection by PCC and to inform the heat mapping exercise, heat demand loads have been grouped into tiers considering their DHN connection viability, based on their typology, ownership and heat demand. These tiers are based on experience from previous district heating studies.

A description of each tier and its priority for connection to a heat network are provided in Table 4—1, while Table 4—2 provides a breakdown of tiers, according to building type, heat demand and ownership.

The criteria for data gathering (Table 4—3) are based on tiering of loads and the rationale for prioritising DHN.

Table 4—1 – Rationale for prioritising district heating connections

<table>
<thead>
<tr>
<th>Tier</th>
<th>Details</th>
<th>Priority for connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>Large heat demand, communal heating, single ownership, PCC control</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>(existing ownership or planning control)</td>
<td></td>
</tr>
<tr>
<td>Tier 2</td>
<td>Large heat demand, communal heating, single ownership, private sector</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>loads</td>
<td></td>
</tr>
<tr>
<td>Tier 3</td>
<td>Small heat demand, future potential for communal heating, single ownership, private sector load, unlikely to catalyse or financially support a DH network but it may be viable to connect to a pre-existing network.</td>
<td></td>
</tr>
</tbody>
</table>
Table 4—2 - Load tier classification

<table>
<thead>
<tr>
<th>Ownership and typology</th>
<th>Annual heat demand (MWh/yr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-100</td>
</tr>
<tr>
<td>Public: Education / Leisure / Corporate</td>
<td>tier 3</td>
</tr>
<tr>
<td>Registered Social Landlords</td>
<td>tier 3</td>
</tr>
<tr>
<td>Private non-domestic</td>
<td>tier 3</td>
</tr>
<tr>
<td>Private multi-address domestic</td>
<td>tier 3</td>
</tr>
<tr>
<td>Sites with planning permission (non-residential)</td>
<td>tier 3</td>
</tr>
<tr>
<td>Sites with planning permission (residential)</td>
<td>tier 3</td>
</tr>
</tbody>
</table>

Table 4—3 - Criteria for data gathering

<table>
<thead>
<tr>
<th>Criteria/Datasets</th>
<th>PCC Buildings – non resi</th>
<th>Schools</th>
<th>New developments</th>
<th>BLPU(^\text{12}) datasets</th>
<th>Government buildings (e.g. military)</th>
<th>Registered social landlord data/ PCC owned residential</th>
<th>CRC energy certificates scheme database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Demand or Fuel Consumption (MWh/year)</td>
<td>&gt;=500</td>
<td>&gt;=500</td>
<td>&gt;=100</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;=1000</td>
<td>&gt;=1000</td>
</tr>
<tr>
<td>Floor area (if heat demand is not available)</td>
<td>&gt;=1000m²</td>
<td>&gt;=2500m²</td>
<td>&gt;=2000m² (both resi and non resi)</td>
<td>N/A</td>
<td>&gt;=2500m²</td>
<td>N/A</td>
<td>&gt;=2500m²</td>
</tr>
<tr>
<td>Number of residential units</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;=20</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;=100</td>
<td>N/A</td>
</tr>
<tr>
<td>Type of building/land use</td>
<td>See Note 2</td>
<td>N/A</td>
<td>N/A</td>
<td>Residential See also Note 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

4.2.2 Benchmarks

Where heat demand data for requested data was not available, but where information regarding floor areas was obtained by BuroHappold, benchmarks were used to calculate an estimated heat demand for a given building or development. Further details about assumptions are provided in Appendix F.

4.3 Heat Demand and Points Statistics

Just over 2,000 data points have been mapped representing an estimated (current and future) heat consumption of 700 GWh.

A breakdown of the number of data points plotted according to the source data set is presented in the chart in Figure 4—2.

---

\(^{12}\) Basic Land and Property Unit
Almost half of the points plotted relate to social landlords, with the public sector accounting for about a third, while privately owned buildings account for 13%. New developments account for 5% of the data points plotted. PCC has a key supporting role to play in developing heat networks as sponsor, pivotal heat customer, heat source, planning authority and relationship brokers.  

Figure 4—3 shows a breakdown of data points according to the ownership and typology of building.

Public buildings account for just under a third of the total heat demand plotted, followed by private non-domestic buildings at 24%. Registered social landlords, health and new developments each account for between 11 and 16% of the heat demand, while private homes account for 3%.

This breakdown of the percentage of heat demand plotted by ownership and typology is shown in Figure 4—4.

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https://www.gov.uk/guidance/heat-networks-delivery-support
4.4 Heat Mapping Outputs

The key outputs from the heat mapping exercise are as follows:

- Plotting of all heat load data collected based on data gathering methodology and benchmarking. This is shown in Figure 4—5.

- Plotting of Heat Sources and Constraints. This is shown in Figure 5—1.

For reference, the DECC\textsuperscript{14} heat map covering the study area is shown in Appendix A.

4.5 Heat Map Interpretation

Significant areas of heat demand ("Tier 1 loads") have been identified around Plymouth City Centre, the area surrounding Derriford Hospital and Devonport.

Smaller concentrations of significant heat demands are found in Royal William Yard, Plymstock, Sherford and Langage, principally related to new developments. Barne Barton has a small concentration of significant heat demand mainly relating to existing social landlord housing and proposed new development.

\textsuperscript{14} (Department of Energy & Climate Change became part of Department for Business, Energy & Industrial Strategy in July 2016)
Figure 4—5 - Heat Map of all data collected
5  Heat Supply Sources and Constraints

5.1  Introduction

This section covers the following:

• A review of heat supply sources in Plymouth which could be used to supply heat to a DHN.
• Mapping of heat supply sources and constraints in the study area.
• A section on Future Heat Supply Considerations taking into account the planned decarbonisation of the grid.
• The rationale behind the Heat Supply Selected for Techno-economic modelling in this study.

5.2  Review of Heat Supply Sources for District Heating Networks in Plymouth

An assessment matrix has been developed to consider heating technologies available for low carbon heat supply for district heating schemes in Plymouth, considering their viability both currently and out to 2050. This includes technologies that are expected to mature in the future.

Feasibility has been identified based on a qualitative assessment across a number of factors including

• Carbon dioxide (CO₂) emissions savings (current and future)
• Costs and revenue
• Operation and maintenance
• UK market maturity
• Planning restrictions

A number of low carbon energy sources have been considered, listed in Table 5—1. Further information about these energy sources is provided in the low carbon energy supply matrix in Appendix H.
Table 5—1 – Summary of low carbon energy source assessment

<table>
<thead>
<tr>
<th>Technology</th>
<th>Qualitative Technical Viability Assessment</th>
<th>Description and Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity (heating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water source heat pump</td>
<td>high</td>
<td>Work by extracting (heating mode) or rejecting (cooling mode) into suitable water bodies, aided by an electricity driven vapour compression cycle. Efficiency is measured by seasonal performance factor (SPF) – the higher the better. Reliant on decarbonisation of electricity grid for competitive CO(_2) savings. Plymouth has the unique opportunity as a seaside town to capitalise on this technology.</td>
</tr>
<tr>
<td>Air source heat pumps</td>
<td>high</td>
<td>As above, except extraction or rejecting of heat to the ambient air. However, typically have lower CoP than water source heat pumps and therefore marginally lower CO(_2) savings.</td>
</tr>
<tr>
<td>Process waste heat &amp; heat pumps</td>
<td>medium</td>
<td>Heat pumps that extract or reject heat from waste heat sources such as data centres. There are a number of heat sources that have been identified, including energy from waste and data centres. However there can be technical complications involved with retrofitting heat pumps to existing heat sources.</td>
</tr>
<tr>
<td>Gas CHP</td>
<td>high</td>
<td>Co-generation engine recovering heat from electricity generation. Well established technology delivering good CO(_2) savings by offsetting grid electricity supply. Efficient at district scale however it becomes less environmentally viable with the projected decarbonisation of electricity. Considered a transition technology.</td>
</tr>
<tr>
<td>Gas with Combined Capture and Sequestration (CCS)</td>
<td>low</td>
<td>Technology used in the oil and chemical sectors to remove carbon dioxide from the atmosphere/ combustion process but not proven commercially to date. Embryonic technology with significant cost and technical barriers, applicable at large scale.</td>
</tr>
<tr>
<td>Biomass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass boiler</td>
<td>high</td>
<td>Biomass technology involves the combustion of wood chips and pellets. It requires considerations of delivery logistics and its use can be constrained by air quality considerations, especially in city centre areas. High CO(_2) savings if transport and air quality concerns are mitigated.</td>
</tr>
<tr>
<td>Biomass CHP</td>
<td>low</td>
<td>Biomass technology that provides heat and electricity via use of a biomass boiler in tandem with a steam turbine. Unproven technology except at a very large scale.</td>
</tr>
<tr>
<td>Biomethane CHP</td>
<td>low</td>
<td>A mixture of methane and carbon dioxide that can be obtained from gases emitted from organic waste and combusted in a CHP unit to provide heating and electricity. Unproven technology except at a very large scale, no site identified.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep geothermal</td>
<td>medium</td>
<td>Harnessing of heat at high temperatures (&gt;100degC) that can be accessed by drilling/ tapping into suitable geographic locations. Geology in South West England suits this technology. Further investigation is required.</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>medium</td>
<td>Generation of hot water from the direct collection of energy from sunlight by solar panels. Proven technology in Denmark, but relatively unknown in the UK. A significant land area would be required. Potentially could be used as a first stage in a cascade heating system.</td>
</tr>
<tr>
<td>Industrial and process heat</td>
<td>medium</td>
<td>Usage of heat that is currently rejected from industrial plant and electrical equipment. There are a number of heat sources that have been identified, including energy from waste and data centres. Others potential sources that can be considered are electricity substations and transformers.</td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen fuel cell</td>
<td>low</td>
<td>Generation of heat and electricity via a chemical reaction that uses hydrogen, either directly, or via a reforming process that uses natural gas as an input. Unproven technology, reliant on decarbonisation of electricity grid and development of hydrogen infrastructure.</td>
</tr>
</tbody>
</table>
5.3 Constraints

There are a number of constraints which need to be taken into account in the planning and development of a DHN in Plymouth. These include:

- Crossing of roads which would require traffic management, coordination (and possible diversion) of other utilities that are buried beneath.

- Crossing of railway lines. This would require early engagement and the following of a thorough consultation and engagement procedure with Network Rail.

- Crossing of various waterways around Plymouth and areas of steeply changing terrain, for example in the area surrounding Derriford Hospital.

- Protected areas such as conservation areas (e.g. to the south of Plymouth City Centre, around Royal William Yard and some parts of Devonport) and Sites of Special Scientific Interest (SSSI). This would require engagement and coordination with the various responsible bodies regarding plans for a DHN that would pass in through these areas.

Figure 5—1 shows a map of heat sources and constraints in the study area.

5.4 Heat Supply selected for Techno-economic assessment

In order to test the feasibility of DHN clusters, gas fired CHP, with back up condensing gas boilers has been chosen as the heat supply source for the techno-economic assessment of clusters in this study. This is because it is a well understood and commercially proven technology that offers CO$_2$ emission reductions against Today’s building regulations. As the grid decarbonises, there is the potential to replace gas fired CHP with heat pumps to maximise carbon savings, subject to a well designed DHN which is able to efficiently make use of a range of heat supply technologies.
Figure 5–1 – Map showing Heat Sources and Constraints in Plymouth
6 Cluster Identification

6.1 Cluster Identification Approach

To identify clusters that would be suitable for further investigation into the potential for DHN, the following approach as detailed in Figure 6—1, was followed:

Step 1
- Plotting of Tier 1 Heat Demands (significant loads) for the study area. This is shown in Figure 5.

Step 2
- Identification of clusters based on a concentrated region of Tier 1 loads (shown in Figure 6).

Step 3
- Plotting focus maps of identified clusters, showing Tier 2 loads in addition to Tier 1 loads. Maps of these identified clusters are shown in Appendix B.

Figure 6—1 – Approach to identification of clusters for further investigation

6.2 Clusters Identified for further consideration

The clustering exercise identified 11 clusters of interest. These clusters are listed below and shown on the map in Figure 6—2.

- Derriford
- Barne Barton
- Millbay (covered in previous BuroHappold study)
- Civic Centre (covered in previous BuroHappold study)
- Cultural Quarter (covered in previous BuroHappold study)
- Her Majesty’s Naval Base (HMNB) Devonport
- Devonport (a sub-section of this area was covered in previous BuroHappold study)
- Sherford
- Royal William Yard
- Plymstock
- Langage
Figure 6—2 – Tier 1 Loads and Clusters Identified for further study
### 6.3 Clusters description

This section provides a brief description of the clusters identified from the Mapping process and indicates the type of assessment to be carried out as part of this study.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Brief Description</th>
<th>Selected for further assessment?</th>
<th>Assessment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derriford</td>
<td>There are a significant number of existing heat loads in Derriford, including Derriford Hospital, University of St Mark and St John (Marjons), Nuffield Health. There are a number of new developments underway that increase the potential for a DHN, notably at the Seaton Barracks site and North West Quadrant. Derriford has space capacity that could be used to supply heat to a DHN and Marjons has existing biomass boiler capacity which could supplement a DHN.</td>
<td>Yes</td>
<td>Techno-economic &amp; Cluster Prioritisation</td>
</tr>
<tr>
<td>Barne Barton</td>
<td>A primarily residential area north of the Energy from Waste Plant in Devonport with a mix of social housing in the south eastern area and private housing to the west and north. The close proximity to the EfW plant makes this an area of interest.</td>
<td>Yes</td>
<td>Techno-economic &amp; Cluster Prioritisation</td>
</tr>
<tr>
<td>Millbay (covered in previous BuroHappold study)</td>
<td>The Millbay marina is undergoing significant development to turn this into a new residential hub and waterside destination. A heat network investigation was carried out this revealed reasonable technical line density however significant challenges. Challenges include technical constraints for infrastructure routing, identification of energy centre locations and multiple 3rd party developer ownership. This area does have the opportunity of water access and therefore water source heat pump potential. As many development plans were underway at the start of the study in 2015 the establishment of a network is also challenged temporally. At present developments are required to comply through futureproofing for future connection and it is understood that a potential opportunity for a small network connecting the developments to the South of the marina is being considered.</td>
<td>Yes</td>
<td>Cluster Prioritisation</td>
</tr>
<tr>
<td>Civic Centre (covered in previous BuroHappold study)</td>
<td>A cluster with good potential based around the redevelopment of the Civic Centre to house an Energy Centre and supply heat to the surrounding area. Connections would include existing PCC owned buildings such as Guildhall, possible 3rd party connections Theatre Royal, Travelodge and supply low carbon heat to the significant residential new development at Colin Campbell Court and Derry’s. This scheme would capitalise on the new developments to support contributions to the capital cost of the scheme. Significant leverage can be placed on the developments for compliance due to the city centre policy and early stage of the developments.</td>
<td>Yes</td>
<td>Cluster Prioritisation</td>
</tr>
<tr>
<td>Cultural Quarter (covered in previous BuroHappold study)</td>
<td>This cluster is based around supplying heat across the campus boundary from the University of Plymouth to the surrounding PCC. The cluster has dependencies on the University consolidating on-campus infrastructure and adding to on-campus low carbon and boiler capacity. Substantial viability work has been completed to investigate the potential benefits. The challenges to delivery are complexity of off-campus supply, adequate future potential heat sales to amortise PCC investments and commercial complexity to deal with new connections.</td>
<td>Yes</td>
<td>Techno-economic &amp; Cluster Prioritisation</td>
</tr>
<tr>
<td>HMNB Devonport</td>
<td>Royal Naval Base. A heat offtake agreement is in place with the</td>
<td>Yes</td>
<td>Standalone</td>
</tr>
<tr>
<td>Cluster</td>
<td>Brief Description</td>
<td>Selected for further assessment?</td>
<td>Assessment Type</td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Devonport (a sub-section of this area was covered in previous BuroHappold study)</td>
<td>Energy from Waste plant to supply the existing steam system on the site. Due to the nature of the Naval base it is challenging to include this stakeholder into potential schemes during the agreement period up to 2040.</td>
<td></td>
<td>Qualitative Assessment</td>
</tr>
<tr>
<td>Devonport</td>
<td>This area comprises of the area to the south of HMNB Devonport and includes a mix of existing and planned developments. The Princess Yachts industrial steam system offers a potential heat supply for a DHN. New developments - Oceansgate and Princess Yachts, potentially plus an MOD site to be handed over to PCC – offer potential energy centre locations and heat demands for a DHN, if these are futureproofed for DHN connection.</td>
<td>Yes</td>
<td>Techno-economic &amp; Cluster Prioritisation</td>
</tr>
<tr>
<td>Sherford</td>
<td>Sherford is a new market town to be built in the South Hams in Devon, equidistant between Dartmoor and the south Devon coast. There are 5,500 planned for delivery pre-2026, with 1,500 post 2026, with 84,000 sqm of commercial and employment space. The construction of a new town offers a high potential for the planning and integration of low carbon energy technologies.</td>
<td>Yes</td>
<td>Standalone Qualitative Assessment</td>
</tr>
<tr>
<td>Royal William Yard</td>
<td>A range of new and refurbished residential and commercial developments to the south west of Plymouth City Centre. Unique opportunities of the specific site: Location adjacent to water source and the existing future proofing of the surrounding developments.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Plymstock</td>
<td>New developments in Plymouth suburb. 1,684 new homes and 7,825 sqm of employment uses planned partially built out to date.</td>
<td>No</td>
<td>Not assessed further</td>
</tr>
<tr>
<td>Langage</td>
<td>Planned extension to business park to provide new employment space near to Langage Power Station.</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
7 Techno-economic assessment

7.1 Approach

Based on the mapping carried out in Section 4, clusters identified for techno-economic assessment in Section 6 were further refined prior to a techno-economic assessment, taking into account constraints in the area, distance from anchor load(s) in the cluster, stakeholder engagement and contextual input from PCC.

A summary of stakeholder engagement carried out during this study is shown in Appendix C.

The techno-economic assessment for each cluster comprises:

- Outline pipe network design and energy centre sizing for:
  - starter network (short term)
  - Full build out (long term)
- Techno-economic and environmental assessment of starter and full build out scheme for each identified cluster using a bespoke MS Excel based techno-economic model developed by BuroHappold.
- Classification of Clusters as Short Term, Medium Term or Longer Term Opportunities
  - Short Term refers to opportunities that can be exploited in the next three years (2017 – 2020).
  - Medium Term refers to opportunities that can be exploited between 2020 and 2025.
  - Longer Term refers to opportunities beyond 2025
7.2 Barne Barton

7.2.1 Overview

A primarily residential area north of the Energy from Waste Plant in Devonport with a mix of social housing in the south eastern area and private housing to the west and north.

A previous study\(^{15}\) showed that the proposed scheme has an operating profit which is too small to fund the required capital investment which leads to a negative net present value and therefore an uneconomic scheme. However, this previous study did not include the opportunity to connect to a proposed larger development by Clarion Housing (formerly Affinity Sutton), which is being assessed in this study.

Through engagement with MVV, the operators of the EfW plant, there is estimated to be 7.5 MW of spare heat available, however due to the contractual obligation to supply heat to HMNB Devonport to the south of Barne Barton, only 2.6 MW is immediately available to provide heat to a potential DHN.

MVV are open to discussing the purchase of heat from the EfW plant, subject to agreement on technical, commercial, operational and legal considerations.

7.2.2 Starter Scheme

A starter scheme has been designed based on supplying existing social housing operated by Clarion Housing (formerly Affinity Sutton), Sovereign, and Sanctuary Housing plus a large new residential development by Clarion Housing closest to the EfW plant. A potential energy centre location has been shown in currently unoccupied land to the west of the EfW plant. This is understood to be the location where heat extracted from the EfW plant would exit the site to supply developments in Barne Barton.

7.2.3 Full build out scheme

The full build out scheme extends out from the starter scheme to include private housing to the north west of the EfW plant, existing social housing (Furse Park) and Riverside Community Primary School. Loads to the east of the railway line have to not been included as their magnitude at this time is not considered sufficient to justify the rail crossing.

Figure 7—1 shows the pipe network for the starter and full build out scheme.

Table 10—3 in Appendix E provides a summary of the starter and full build out cluster heat demand by building.

\(^{15}\) Barne Barton District Heating Feasibility Study, September 2013 –Parsons Brinkerhoff on behalf of MVV Environment
7.2.4 Cluster Map showing loads and pipe network for starter and full build out scheme

Figure 7—1 – Barne Barton Starter and Full Build Out Network

7.2.5 Summary of Cluster Technical Assessment

Table 7—1 Technical assessment summary

<table>
<thead>
<tr>
<th></th>
<th>Starter scheme</th>
<th>Full build out scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Demand (GWh/year)</td>
<td>4.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Network length (m)</td>
<td>440</td>
<td>1,723</td>
</tr>
<tr>
<td>Heat Line Density (MWh/m)</td>
<td>10.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Heat Source</td>
<td>Energy From Waste/ Gas Boiler</td>
<td>Energy From Waste/ Gas Boiler</td>
</tr>
<tr>
<td>Potential Energy Centre Location</td>
<td>Land adjacent to MVV EfW</td>
<td>Land adjacent to MVV EfW</td>
</tr>
<tr>
<td>% of starter scheme heat currently available (%)</td>
<td>81%</td>
<td>-</td>
</tr>
</tbody>
</table>
7.3 Devonport

7.3.1 Overview

The Devonport cluster is located approximately 1 km south of HMNB Devonport. There is also MOD land to the west (expected to be handed over to PCC control) and former MOD land to the east. Devonport is bounded by the River Tamar to the west.

Previous work concluded that despite the Royal Dockyard sourcing alternative sources of low carbon heat and power in the intervening period at North Yard, there could still be a business case for a wider district energy in Devonport.\textsuperscript{16}

There is the new Oceansgate development on the southern edge of HMNB Devonport, the first phase of which is currently being built out. Three new phases of development are planned, totalling 25,000 sqm of flexible employment space for marine and advanced manufacturing sectors.\textsuperscript{17} The area within the Oceansgate development could offer a site for an energy centre as PCC have some influence over the nature of the ongoing development here.

The Princess Yachts industrial steam system offers a potential heat supply for a DHN in this area.

While the Vision Site is classed as a new development, it is understood that it is now mostly built out and so the opportunity to future proof this development for a DHN may have been missed.

7.3.2 Starter Scheme

The starter scheme is centred around the new Oceansgate development to take advantage of an opportunity to integrate an energy centre and because the new developments can be future proofed for a connection to a DHN.

In addition, other nearby developments include Marlborough House, Marlborough Primary School and The Royal Fleet Club Hotel. However, the buildings selected as part of a Starter Scheme should be informed by further feasibility work as recommended at this end of this section.

7.3.3 Full build out Scheme

The full build out scheme extends to the south and west of the Oceansgate development and includes the Princess Yachts site and planned developments including KER Street, Vision, the former MOD Mountwise site and Market Hall. In addition some high rise housing owned by Plymouth Community Homes (with some flats privately owned) has been selected for the full build out phase.

Figure 7—2 shows the pipe network for the starter and full build out scheme.

Table 10—4 in Appendix E provides a summary of the starter and full build out cluster heat demand by building.

\textsuperscript{16} Update Addendum to City of Plymouth District Energy Study - Devonport, October 2012, ICE (UK) Ltd

\textsuperscript{17} http://www.oceansgateplymouth.com/the-site/
7.3.4 Cluster Map showing loads and pipe network for starter and full build out scheme

Figure 7—2 Devonport Starter and Full Build Out Network

7.3.5 Summary of Cluster Technical Assessment

Table 7—2 Technical assessment summary

<table>
<thead>
<tr>
<th></th>
<th>Starter scheme</th>
<th>Full build out scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Demand (GWh/year)</td>
<td>5.6</td>
<td>15.5</td>
</tr>
<tr>
<td>Network length (m)</td>
<td>861</td>
<td>1,832</td>
</tr>
<tr>
<td>Heat Line Density (MWh/m)</td>
<td>6.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Heat Source</td>
<td>CHP/ Gas Boiler</td>
<td>CHP/ Gas Boiler</td>
</tr>
<tr>
<td>Potential Energy Centre Location</td>
<td>Oceansgate Development</td>
<td>Oceansgate Development</td>
</tr>
<tr>
<td>% of starter scheme heat currently available (%)</td>
<td>33%</td>
<td>-</td>
</tr>
</tbody>
</table>
7.4 Derriford

7.4.1 Overview

The Derriford cluster offers several opportunities in terms of anchor heat customers and heat supply sources for a DHN.

Significant existing heat loads include Derriford Hospital, University of St Mark and St John (Marjons), Nuffield Health. There are a number of planned new developments underway that increase the potential for a DHN, notably at the Seaton Barracks site and North West Quadrant (NWQ). The NWQ development is a potential site for an energy centre as PCC has influence (via planning policy) over the energy strategy for the development.

Both Nuffield Health and Marjons have swimming pools which could provide a steady baseload heat demand for a DHN. Marjons has existing biomass boiler capacity which could provide a supplementary low carbon heat supply for a DHN.

DH has its own site-wide Medium Temperature Hot Water (MTHW) DHN which has the following heat sources:

- Incinerator with a maximum capacity of 1 tonne of waste per hour (heat output not confirmed at this stage),
- 1.55MWe CHP and 12 MW of gas boiler capacity (with an extra 3MW to be added in late 2017).

It is understood that there is no heat recovery from the incinerator and a significant proportion of the heat generated by the CHP is rejected.

The installed heating capacity at Derriford Hospital is in excess of current and anticipated future heat demands for the hospital resulting in an estimated potential of 2.5 MWth (under existing system peak conditions) that could be used to provide heat to a wider DHN in Derriford that could be centred around the hospital. Further work is needed to confirm the proportion of heat available from each of the heat sources.

The Science Park site to the west of DH offers a potential heat demand for the DHN – further work is needed to better understand the available heat demands and the pipe route to supply the site.

7.4.2 Starter Scheme

The starter scheme is centred around Derriford Hospital and nearby new developments. Derriford Hospital would supply the heat source for the DHN, with an energy centre located in the North West Quadrant development, near Morlaix Drive. Heat customers would include the Health and Leisure Centre and Peninsula Medical School (both located on the DH site), the Teaching Primary Care Trust, Studio School and new developments part of NWQ.

7.4.3 Full build out Scheme

The full build out scheme extends the starter scheme to the west and north east. To the west, new developments at Seaton Barracks, Hellerman Tyton would be served, plus the HMRC Tax Office, The Ship, Peninsula NHS Treatment Centre and existing private non-domestic premises on Brest Road.

To the north west, the network extends to included Nuffield Hospital, Nuffield Health (Devonshire Health & Racquet Club and the Marjons site. There is the possibility of using “soft-dig” trenching for the section of the proposed DHN that passed along Derriford Road.

Figure 7—3 shows the pipe network for the starter and full build out scheme.
Table 10—5 in Appendix E provides a summary of the starter and full build out cluster heat demand by building.

### 7.4.4 Cluster Map showing loads and pipe network for starter and full build out scheme

![Cluster Map](image)

**Figure 7—3 Derriford Starter and Full Build Out Network**

### 7.4.5 Summary of Cluster Technical Assessment

Table 7—3 Technical assessment summary

<table>
<thead>
<tr>
<th></th>
<th>Starter scheme</th>
<th>Full build out scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Demand (GWh/year)</td>
<td>7.5</td>
<td>22.1</td>
</tr>
<tr>
<td>Network length (m)</td>
<td>1,089</td>
<td>2,820</td>
</tr>
<tr>
<td>Heat Line Density (MWh/m)</td>
<td>6.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Heat Source</td>
<td>Waste heat from hospital CHP &amp; incinerator / Gas Boiler</td>
<td>Waste heat from hospital CHP &amp; incinerator / Gas Boiler</td>
</tr>
<tr>
<td>Potential Energy Centre Location</td>
<td>Morlaix Drive, NWQ development</td>
<td>Morlaix Drive, NWQ development</td>
</tr>
<tr>
<td>% of starter scheme heat currently available (%)</td>
<td>28%</td>
<td>-</td>
</tr>
</tbody>
</table>
7.5 Techno-economic Assessment

7.5.1 Key Inputs & Assumptions

The key inputs and assumptions used in the techno-economic modelling are summarised in Table 7—4 below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Input/ Assumption</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Sales - residential</td>
<td>4.3 p/kWh</td>
<td>Calculated based on heat supply to a bulk heat substation</td>
</tr>
<tr>
<td>Heat Sales - non residential</td>
<td>4.3 p/kWh</td>
<td>See Section below for more details.</td>
</tr>
<tr>
<td>Standing charges - residential</td>
<td>14.2 £/kWth</td>
<td>Calculated based on availability and maintenance costs for gas boilers</td>
</tr>
<tr>
<td>Standing charges - non residential</td>
<td>14.2 £/kWth</td>
<td>Calculated based on heat costs for gas boilers</td>
</tr>
<tr>
<td>Electricity Sales - grid spill</td>
<td>5.5 p/kWh</td>
<td>BuroHappold project experience of a PPA price with embedded benefits</td>
</tr>
<tr>
<td>Gas Price</td>
<td>2.2 p/kWh</td>
<td>BEIS Updated Energy &amp; Emissions Projections 2016, Residential. Modelling linked to BEIS projections</td>
</tr>
<tr>
<td>Electricity Price</td>
<td>10.8 p/kWh</td>
<td>DECC 2016 prices for services</td>
</tr>
<tr>
<td>Cost of purchasing waste heat from EfW or hospital</td>
<td>1.5 p/kWh</td>
<td>Based on information provided by EfW operator MVV (0.24 MWhe lost per MWh of heat at a cost of 70 £/MWhe)</td>
</tr>
<tr>
<td>Plant replacement fund</td>
<td>60%</td>
<td>60% of total energy centre capex</td>
</tr>
<tr>
<td>HIUs substation maintenance costs</td>
<td>1,500 £/connection</td>
<td>BuroHappold project experience of substation maintenance cost based on replacement after 20 years.</td>
</tr>
<tr>
<td>Heat meter maintenance costs</td>
<td>250 £/connection</td>
<td>BuroHappold project experience</td>
</tr>
<tr>
<td>Heat network maintenance costs</td>
<td>0.40 £/MWh</td>
<td>BEIS 2015 Assessment - Bulk scheme</td>
</tr>
<tr>
<td>Staff costs</td>
<td>2.50 £/MWh</td>
<td>BEIS 2015 Assessment - Bulk scheme</td>
</tr>
<tr>
<td>CHP maintenance price</td>
<td>12.3 £/MWhe</td>
<td>Edina</td>
</tr>
<tr>
<td>EC gas boiler maintenance price</td>
<td>5 £/MWhe</td>
<td>BEIS 2015 Assessment - Bulk scheme</td>
</tr>
<tr>
<td>Business rates</td>
<td>6 £/MWh</td>
<td>BEIS 2015 Assessment - Bulk scheme</td>
</tr>
<tr>
<td>Carbon Factor of Gas</td>
<td>0.216</td>
<td>BEIS</td>
</tr>
<tr>
<td>Carbon Factor of EfW heat</td>
<td>0.1</td>
<td>Range from 0.058-0.165 based on previous BuroHappold study</td>
</tr>
<tr>
<td>Carbon Factor of Waste CHP/incinerator heat at Derriford</td>
<td>0</td>
<td>Drawing heat causes no loss in performance of equipment therefore no emissions are incurred</td>
</tr>
</tbody>
</table>
7.5.1.1 Cost of Heat (Heat Sales)

The bulk cost of heat for an existing building with heat provided by a gas boiler is estimated at 2.9 p/kWh (based on a bulk gas price of 2.2 p/kWh and 75% efficient gas boiler).

BuroHappold has obtained recent costs of heat charged to new build properties of 5 p/kWh, based on supplying heat to a bulk heat substation.

Based on the range of cost of heat between existing and new build, the variation in cost of heat as the percentage of a new build in a DHN cluster varies is shown in Figure 7—4.

![Graph showing how estimated cost of heat varies with % of new build heat demand in cluster due to new build](image)

**Figure 7—4** Graph showing how estimated cost of heat varies with % of new build heat demand in cluster due to new build

The cost of heat supplied to a bulk heat substation has been assumed to be 4.3 p/kWh for the analysis carried out in this study, which relates to a scenario where approximately 65% of the heat demand of a DHN is supplied to new build properties, as shown in Figure 7—4.

This figure of 4.3 p/kWh has been used to compare the relative financial performance between clusters.
7.6 Results Summary - Techno-economic and environmental assessment

Table 7—5 details the results of initial techno-economic modelling of Barne Barton, Devonport and Derriford clusters.

Table 7—5 Results Summary of techno-economic and environmental assessment

<table>
<thead>
<tr>
<th></th>
<th>Capex (£)</th>
<th>Avoided costs (£)</th>
<th>Yr.1 Operating costs (£)</th>
<th>Yr.1 Revenues (£)</th>
<th>NPV (£,000)</th>
<th>IRR (%)</th>
<th>CO₂ saving (tonnes/yr)</th>
<th>CO₂ saving (%)</th>
<th>% of starter scheme heat demand currently available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barne Barton Starter</td>
<td>2,666,000</td>
<td>307,000</td>
<td>206,000</td>
<td>236,000</td>
<td>-1,360</td>
<td>-2.90%</td>
<td>504</td>
<td>44%</td>
<td>81%</td>
</tr>
<tr>
<td>Barne Barton full build out</td>
<td>4,760,000</td>
<td>307,000</td>
<td>327,000</td>
<td>424,000</td>
<td>-1,976</td>
<td>-1.10%</td>
<td>733</td>
<td>38%</td>
<td>n/a</td>
</tr>
<tr>
<td>Devonport starter</td>
<td>6,156,000</td>
<td>2,342,000</td>
<td>594,000</td>
<td>614,000</td>
<td>-2,228</td>
<td>-2.80%</td>
<td>387</td>
<td>27%</td>
<td>33%</td>
</tr>
<tr>
<td>Devonport full build out</td>
<td>9,822,000</td>
<td>4,125,000</td>
<td>1,447,000</td>
<td>1,645,000</td>
<td>551</td>
<td>4.30%</td>
<td>920</td>
<td>23%</td>
<td>n/a</td>
</tr>
<tr>
<td>Derriford starter</td>
<td>3,601,000</td>
<td>1,232,000</td>
<td>309,000</td>
<td>422,000</td>
<td>345</td>
<td>4.70%</td>
<td>1399</td>
<td>74%</td>
<td>28%</td>
</tr>
<tr>
<td>Derriford full build out</td>
<td>7,909,000</td>
<td>3,727,000</td>
<td>882,000</td>
<td>1,286,000</td>
<td>4,980</td>
<td>11.80%</td>
<td>4125</td>
<td>73%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

7.6.1 Financial

There is a general trend that as a cluster moves from its starter phase to full build out the economic performance of the cluster improves. This is because the majority of the scheme capital expenditure occurs during the starter scheme - initial upfront building costs, starter pipe network installation (likely to be sized for full network with some contingency), utility connections and ancillary equipment with reduced returns.

The cost of additional heat generation capacity and the extra pipe network to supply the full build out scheme is outweighed by the benefit of the increased heat demand on the DHN as part of the full build out scheme.

In financial terms, the Derriford cluster performs best with an Internal Rate of Return (IRR) of 12% for the full build out scheme.

The strong Derriford scheme financial performance can be explained by the high heat density, the opportunity to use already operational heat sources (thereby avoiding significant capital expenditure for low carbon plant) and the significant potential capital contribution from connection charges for new developments. Connection charges represent the avoided cost of low carbon heat generation plant that a development would have had to invest if a DHN is unable to provide heat to the development within timescales agreed with PCC.

Devonport shows a 4% IRR, while Barne Barton has a negative IRR (which implies that funding would be needed to make a DHN scheme viable in Barne Barton).
The relatively weak performance of the Barne Barton (− £2m NPV, − 1% IRR at full build out) cluster is attributed to the relatively low heat demand (which is reflected in the heat line density) combined with a lack of capital offset that would be obtained from connection charges from new developments (new development is a very small proportion of the overall heat demand of both the starter and full build out schemes).

**Note regarding cost of heat**

An assessment of the full build out scenario for Derriford shows that approximately 50% of the heat demand would be from new build customers. This relates to an estimated bulk supply heat cost of 4.0 p/kWh as shown in Figure 7—4. Therefore, while the relative financial performance of the various schemes assessed in this study would remain similar for a lower heat cost, the absolute financial performance (in terms of IRR and NPV) of a scheme (in this case Derriford) would reduce.

However, it is still expected that Derriford remains a favourable scheme to explore further.

Schemes taken forward for detailed feasibility will have to review cost of heat assumptions based on an understanding of the specific circumstances relating to each heat consumer.

**7.6.2 Carbon**

The Derriford cluster shows the highest CO$_2$ saving of the 3 clusters of approximately 73% against the baseline in the full build out scenario. The unusually high CO$_2$ saving is explained by the assumption that 70% of heat that would be supplied to the Derriford cluster (from the DH incinerator and CHP) would have zero carbon content as it is currently being wasted.

The Devonport and Barne Barton clusters also show significant CO$_2$ savings – 23% and 38% respectively. Barne Barton could generate a significant saving due to the lower carbon heat available from the EfW plant (assumed to be 0.1 kg/kWh – this figure will require confirmation as part of a more detailed project development phase.)
8 Cluster Prioritisation

8.1 Introduction

A multi-criteria Analysis has been applied to the 5 clusters in the Plymouth area - three that were identified for techno-economic analysis in the study and two clusters which have had techno-economic analyses undertaken in preceding Work Packages carried out by BuroHappold for PCC.

The three clusters identified for techno-economic analysis in the study are:

- Devonport
- Barne Barton
- Derriford

The three clusters previously analysed clusters in preceding Work Packages carried out by BuroHappold for PCC are:

- Civic Centre
- Cultural Quarter
- Millbay

The criteria for the MCA was developed in collaboration with PCC to capture and incorporate their key drivers and Plymouth specific DHN delivery considerations.

The criteria and associated weighting that has been agreed is presented in Table 10—1 Cluster Prioritisation Multi-Criteria Analysis Matrix

8.2 Cluster Prioritisation Results

Based on the MCA criteria and scoring of the five clusters being considered, the resultant ranking was calculated and is summarised in Table 8—1 below.

Note: 1 = Highest Ranking – Priority for DHN consideration, 5 = Lowest Ranking

Table 8—1 Cluster Prioritisation Results Summary

<table>
<thead>
<tr>
<th></th>
<th>Overall weighted score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civic Centre</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Derriford</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>Cultural Quarter</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Millbay</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Devonport</td>
<td>12</td>
<td>5(=)</td>
</tr>
<tr>
<td>Barne Barton</td>
<td>12</td>
<td>5(=)</td>
</tr>
</tbody>
</table>

The Civic Centre cluster investigated as part of WP3 comes out with the highest ranking with a score of 25, marginally higher than Derriford (22) which came second in the rankings. The Cultural Quarter scheme came third in the rankings with a score of 16 followed by Devonport, Millbay and Barne Barton which followed in the rankings with similar scores (12 to 13).
The Civic Centre coming out top in the ranking in the MCA is a reflection of higher scoring than other clusters in key criteria which relates to the deliverability of a DHN – stakeholder complexity, development risk, percentage of starter scheme heat currently available for DHN connection. The criteria in particular partly represent the perceived influence that PCC could exert to drive the delivery of a DHN for a given cluster.

However it should be noted that the Derriford Cluster scored higher than the Civic Centre cluster in categories in terms of IRR, CO₂ saving and opportunities for 4GDN. Therefore, if opportunities arise to de-risk DHN delivery in Derriford, these should be pursued. These could include detailed technical studies (e.g. underground utility surveys of proposed pipe routes), securing of Section 106 Agreements with new developments and signing agreements such as Memoranda of Understanding in the first instance.

8.3 Next Steps for Identified Clusters

8.3.1 Short Term Opportunities (2017-2020)

- **Barne Barton**
  - Future proof upcoming Clarion scheme, consider standalone DH scheme that can connect into wider BB DHN in the future when it’s ready.

- **Devonport**
  - Futureproof planned new developments as part of planning application process.
  - Engage with HMNB Devonport to clarify contractual arrangements with MVV EfW plant to get better understanding of potential to amend contract and supply heat to a wider DHN scheme prior to the end of the 25 year contract period (2015 – 2040).

- **Derriford**
  - Undertake detailed feasibility study to assess the scheme viability. This should include engaging with NHS Trust to develop proposals for heat supply.
  - Future proof planned new developments.
  - Engage with potential heat customers.
  - Develop business case.
  - Prepare grant application for HNIP funding.

- **Civic Centre**
  - Undertake detailed feasibility study to assess scheme viability.
  - Develop Business case
  - Establish Starter DHN
  - Future proofing of new developments within 0.5km of Civic Centre for connection to DHN.

- **Cultural Quarter**
  - Undertake detailed feasibility study to assess scheme viability for Eastern and Western Extension. Potential new customers have emerged e.g Train Station development, reboiling of student residences.
  - Assess and develop business case viability for Eastern and Western Extension.
  - Continue engagement with UoP to devise mutually beneficial scheme to extend UoP DHN.
  - Establish extension to UoP DHN beyond UoP boundary.
  - Futureproof planned new developments as part of planning application process.
- Millbay
  - Futureproof planned new developments as part of planning application process.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

**8.3.2 Medium Term Opportunity (2020-2025)**

- Barne Barton
  - Re-assess DHN scheme potential when significant new developments are proposed.
  - Future proofing of new developments.

- Devonport
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.
  - Re-assess DHN scheme potential when significant new developments are proposed.
  - Futureproof planned new developments as part of planning application process.

- Derriford
  - Establish Starter DHN. Extend DHN to capture key anchor loads, e.g Marjons, Nuffield Health, new developments at Seaton Barracks site.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

- Civic Centre
  - Extend DHN to serve economically viable connections.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

- Cultural Quarter
  - Support stakeholder engagement as part of viability assessment of additional heat customers for connection to UoP DHN.
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.

- Millbay
  - Investigate potential to connect to DHNs that may be implemented or expanded in and around the City Centre.

**8.3.3 Longer Term Opportunity (2025-2040)**

- Barne Barton
  - Maintain stakeholder engagement to ensure that connection to DHN is considered at times of plant replacement for existing buildings.
  - Reconsider DHN at end of HMNB Devonport contract with MVV.
  - Future proofing of new developments.
• Devonport
  - Futureproof planned new developments as part of planning application process.
  - Development of high capacity zero carbon heat source from EfW plant that can serve other clusters.

• Derriford
  - Extend DHN to serve economically viable loads in Derriford.
  - Transition to zero carbon heat source(s).

• Civic Centre
  - As per medium term.
  - Transition to zero carbon.

• Cultural Quarter
  - Consider extension to link up to proposed Civic Centre DHN.
  - Transition to zero carbon heat source(s).

• Millbay
  - As for Medium Term
9 Qualitative Opportunity Assessments

9.1 Introduction

Sherford and Royal William Yard were selected for a qualitative standalone assessment as part of the Cluster Identification process as these locations, while not considered as strategically significant as clusters selected for techno-economic assessment and cluster prioritisation, nevertheless provide an opportunity for standalone concentrated heat networks.

HMNB Devonport has been selected for a qualitative standalone development as it has an existing DHN which is served by the MVV EFW plant. While there is potential to expand this network beyond HMNB Devonport to serve Barne Barton, South Yard and potentially DHNs established in the City Centre area in the future, there are technical and commercial issues that need to be addressed first.

Sherford is a new town currently being planned and built out and therefore offers the opportunity for integrating DHN in the planning and design process.

Royal William Yard comprises of a range of new and refurbished residential and commercial developments to the south west of Plymouth City Centre and offers unique opportunities related to its location – it is adjacent to a water source and the existing developments have been future proofed for DHN.

These three areas are considered further overleaf.
9.2 Sherford

9.2.1 Introduction

Sherford is a new urban extension being built on the edge of Plymouth and in the South Hams. Sherford will occupy 1200 acres of farmland between the A38 and A379 on the eastern outskirts of Plymouth. It is 7km east of Plymouth city centre.

Construction of the planned 5,500 dwellings (pre 2026) has already begun with some already completed.

The new Greenfield development offers the opportunity to design for the inclusion of a progressive energy strategy as all developments will be new, energy efficient well insulated building stock capable of being efficiently served by low temperature heat supplies.

![Figure 9—1 Map of Sherford Masterplan](image)

To date no plans for a District Heating Network have been considered, however it is possible that sufficient heat density could be present to successfully deploy it within the area of increased density around the new high street.

The potential for a DHN powered either by gas CHP and/or biomass should be investigated. The ‘greenfield’ location of the new Town offers opportunity to source biomass for heating from the surrounding rural environment.

Opportunities that can support development include:

- Early and integrated infrastructure design to leverage cost savings through reduction in extent of gas network.
- Combined utility trench approach with installation of district heating network with comms, power and water in the same trench.
- The packaging of multi-utility packages can attract independent operators who will contribute to the scheme for the operation rights for a fixed period. This can help offset additional costs and calm developer apprehension.
• Existing policy and planning approval commitments.
• Deployment of renewables can capture the Renewable Heat Incentive to commercially support operators or potentially as a benefit to individual home owners.

Challenges that may exist include:

• Coordinating and achieving buy-in from developers who would see this ‘alternative’ strategy as risk – this could be mitigated by local authority commitment to support through leadership and funding. The system can be transferred to a 3rd party at a point in time later when established and de-risked to recover and the council return on investment.
• Programme of development – this intervention may already have missed opportunities for savings on infrastructure servicing.

Energy Assessment – Load Schedule

Table 9—1 Development details and estimated annual heat demand based on benchmark data (refer to Appendix F for benchmarks)

<table>
<thead>
<tr>
<th>Development Details</th>
<th>No. of units</th>
<th>Floor area (m²)</th>
<th>Benchmark typology</th>
<th>Total heat demand (MWh/year)</th>
<th>Typology for benchmark</th>
<th>Peak heat demand, kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>5500 homes pre 2026</td>
<td>5,500</td>
<td>412,500</td>
<td>Resi flat</td>
<td>20,434.95</td>
<td>Residential</td>
<td>20,860</td>
</tr>
<tr>
<td>Commercial &amp; office</td>
<td>n/a</td>
<td>84,000</td>
<td>Office</td>
<td>1,092.00</td>
<td>Office</td>
<td>4,704</td>
</tr>
<tr>
<td>Extension - 1500 homes post 2026</td>
<td>1,500</td>
<td>112,500</td>
<td>Resi house</td>
<td>6,318.98</td>
<td>Residential</td>
<td>5,689</td>
</tr>
<tr>
<td>Total</td>
<td>7,000</td>
<td>609,000</td>
<td></td>
<td>27,846</td>
<td></td>
<td>31,253</td>
</tr>
</tbody>
</table>

Short Term Opportunity (2017–2020)
• Consider DHN as part of ongoing negotiations with developer, and any changes to previous planning approval.
• Developer to undertake feasibility study to establish viability of DHN scheme to serve the Town Centre.

Medium Term Opportunity (2020–2025)
• Build out the DHN to serve all buildings in the Town Centre.

Longer Term Opportunity (2025–2040)
• None specified.
9.3 Royal William Yard

9.3.1 Introduction

The Grade 1 listed naval yard has been re-generated by Urban Splash as a destination for work, rest and play with offices, residential units and retail and food and beverage units.

The redevelopment is complete and operational without a District Heating Network, however it is understood that buildings were required to be future-proofed for connection to district heating as part of planning approval.

Figure 9—2 Royal William Yard (image courtesy of GHK Architects)

In consideration of opportunities for the deployment of District Heating, the site has a number of site specific characteristics which could support a system:

- Location adjacent to water source and the existing future proofing of the surrounding developments.
- Although re-generated, the old buildings stock could be heat hungry with relatively high heat density (requires confirmation from operational data) and therefore support a commercial scheme.
- More efficient use of existing plant and ability to avoid plant replacement costs.

Challenges to the development of any scheme will be:

- Programme – the developments have been recently completed therefore have heat supplies which have been paid for.
- Delivery - any scheme would require identification of an EC location, coordination and installation of network into what could be congested utility runs, Capital funding of project and an operator.
- Customer acquisition – leverage of PCC over existing users to connect into a scheme to reduce commercial risk would need significant consideration to viability.
Energy Assessment – Load Schedule

An assessment of the potential loads from an area schedule shows the scheme to be of modest size which could be small for the interest of a private 3rd party ESCo operators.

Table 9—2 Development details and estimated annual heat demand based on benchmark data (refer to Appendix F for benchmarks)

<table>
<thead>
<tr>
<th>Development Details</th>
<th>Development Details</th>
<th>No units</th>
<th>Floor area (m²)</th>
<th>Heat demand (MWh)</th>
<th>Peak load (kWth)</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Mixed</td>
<td>84</td>
<td>6,300</td>
<td>511</td>
<td>319</td>
<td>319</td>
</tr>
<tr>
<td>New Cooperage</td>
<td>Building Offices and retail</td>
<td>1,853</td>
<td></td>
<td>104</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mills Bakery Commercial and Leisure</td>
<td>4,302</td>
<td></td>
<td>138</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Melville building</td>
<td>Flats</td>
<td>20</td>
<td>920</td>
<td>46</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Flats</td>
<td>20</td>
<td>1,180</td>
<td>58</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Shops</td>
<td>345</td>
<td>8</td>
<td>28</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restaurants and cafes</td>
<td>3,100</td>
<td>72</td>
<td>248</td>
<td>248</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Office</td>
<td>9,425</td>
<td>123</td>
<td>528</td>
<td>528</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hotels</td>
<td>9,425</td>
<td>1,483</td>
<td>528</td>
<td>528</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-resi institution</td>
<td>9,425</td>
<td>226</td>
<td>656</td>
<td>656</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assembly and leisure</td>
<td>9,425</td>
<td>794</td>
<td>302</td>
<td>302</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>124</td>
<td>55,700</td>
<td>3,321</td>
<td>2,955</td>
<td>2,955</td>
</tr>
</tbody>
</table>

The Royal William Yard could be investigated for future network potential and offers the unique potential for water source heat pumps, however there are significant challenges to overcome. Due to the recent installation of plant it is likely that any system could only be considered when this plant has amortised installation costs and is up for renewal which could be upwards of 10 years time.

Short Term Opportunity (2017-2020)
- Future proof all remaining phases of development.

Medium Term Opportunity (2020-2025)
- Ensure that either potential to connect to a planned or existing DHN is considered at time of plant replacement. This could entail taking opportunity of future proofing during plant replacement works.

Longer Term Opportunity (2025-2040)
- Assuming it has been possible to establish DHN, explore the potential to connect to a wider DHN which may exist in the future which serves the Civic Centre, Cultural Quarter and Millbay and possibly Devonport.
9.4 Her Majesty’s Naval Base, Devonport

9.4.1 Introduction

The Energy from Waste (EfW) CHP plant operated by MVV is in a 25 year contract to supply heat to HMNB Devonport North Yard.

The 25 year contract with the South West Devon Waste Partnership (SWDWP) was awarded to MVV on the basis that the EfW CHP plant will supply heat and electricity to the Dockyard under a long term contract with the MOD and Devonport Royal Dockyard Limited (DRDL).

This contract is commercially confidential but obliges MVV to supply all heat (in the form of medium pressure steam) and electricity used by in the Dockyard up to the stated limits of 23.4 MWth for steam and 22.5 MWe for electricity.

9.4.2 Key Considerations regarding the Existing HMNB Devonport DHN Scheme

Heat supply to the Dockyard is through the delivery of medium pressure steam into the existing Dockyard steam system, some parts of which have been reinforced to improve efficiency. The demand of the Dockyard varies over the year and in the summer is very low.

Under current conditions the Dockyard’s heat demand is not anticipated to reduce substantially due to changes in Dockyard use although there will be expected to be some year on year reductions in demand as additional (heat) energy efficiency measures are installed by or on behalf of the MOD.

9.4.3 Next Steps

Should heat (or electricity) demand in the Dockyard’s North Yard reduce over time, either due to reduced activity or improvements in energy efficiency, more heat (and electricity) will be available either to:

- Supply low cost heat (and electricity) to areas of the Dockyard’s North Yard set aside for commercial rejuvenation (as is happening in the South Yard), or
- Supply more heat into a wider Plymouth DH scheme if developed.

It should be noted that this subject to changes in the contractual arrangement with the MOD and DRDL. Assuming that contractual arrangements could be renegotiated before the end of the 25 year contract term, up to an estimated 40 MWth of heat could be supplied to a DHN beyond HMNB North Yard, but in order to enable such additional heat to be supplied efficiently it may be necessary to increase the capacity of the steam/hot water heat exchanger and replace/upgrade the steam turbine, both of which have will have a financial impact on a DHN scheme viability.

Short Term Opportunity (2017-2020)

- PCC engagement with HMNB Devonport and MVV to clarify their contractual arrangement and get a better understanding of potential to amend contract before the end of the 25 year contract period (2015-2045).

Medium Term Opportunity (2020-2025)

- Dependent on outcome from Short Term Opportunity.

Longer Term Opportunity (2025-2040)

Explore the potential to connect to serve a wider DHN which would be served by the EfW plant and serve Devonport, Barne Barton, Royal William Yard the Civic Centre, Cultural Quarter and Millbay.
10 Conclusions and Next Steps

10.1 Why do we need District Heating for Plymouth?

The UK enacted the Climate Change Act 2008 which sets a legally binding target to achieve an 80% reduction in carbon by 2050 below a 1990 baseline.

Heating and hot water for UK buildings make up around 40% of our energy consumption and 20% of our greenhouse gas emissions. It will be necessary to largely eliminate these emissions by around 2050 to meet the targets in the Climate Change Act and to maintain the UK contribution to international action under the Paris Agreement. Heat Networks are one of the four strands for the delivery of the Government’s Heat Strategy.

Heat networks (district heating networks) can contribute to local authorities’ targets and aspirations for carbon emissions reduction, fuel poverty, cost reduction, increasing energy security, regeneration, local jobs and growth. In turn, local authorities have a vital role in developing heat networks; as sponsor, pivotal heat customer, heat source, planning authority and relationship brokers.

10.2 Relevance of District Heating to Plymouth Plan and Planning Policies.

Plymouth City Council aims to deliver catalyst strategic heat network infrastructure in the City as part of its overall objective of reducing the City’s carbon footprint, helping to lower energy costs and promoting energy security, and in line with the UK government 80% carbon reduction target as set out in the Climate Change Act.

Heat networks are a key element in Plymouth City Council’s adopted Plymouth Plan Refresh policy GR07 Reducing carbon emissions and adapting to climate change, which aims to halve 2005 carbon emission levels by 2034, but also to reduce energy costs and increase energy security.

Supplementary Planning Guidance will also be published, providing further details about the implementation of the policy.

Many developments have agreed to be future-proofed for connection to a DH network, particularly in the City Centre, Derriford and Millbay areas. S106 funding has also been secured from developments towards delivery of the network.

District Energy infrastructure is included in Plymouth’s Infrastructure Plan which sets out the infrastructure priorities for Plymouth to support the delivery of new low carbon development and regeneration schemes.

10.3 Strategic Heat Sources Identified in Plymouth

There are unique opportunities in Plymouth to explore and exploit low carbon energy sources including:

- Water bodies
- Solar insolation
- Existing Heat sources/Networks

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18 Next steps for UK heat policy, Committee on Climate Change, October 2016
10.4 Heat Mapping, Identification and Prioritisation of Cluster Schemes

As part of this study, more than 2,000 data points have been plotted as part of the mapping of heat demands, energy sources and constraints, resulting in the identification of 11 clusters of interest, from which a total of 6 have been selected for more detailed assessment. Two areas have been selected for qualitative standalone opportunity assessments and the existing HMNB DHN has been selected for a qualitative opportunity.

Based on these assessments, short, medium and long term DHN opportunities in Plymouth have been highlighted and used as a basis in the formation of a District Heating Strategy for Plymouth.

10.5 Developments which may fall outside DHN Opportunity Areas but might be suitable for standalone DHN schemes

New development of suitable scale and/or density should undertake an assessment of the viability of using district heating and/or cooling. Schemes which should undertake such as assessment are those within the areas highlighted in the report as being suitable and developments which meet the following criteria:

- Consisting of over 100 dwellings
- Having a heat demand density of 30kWh/m² of land area
- Having a mixed use nature e.g. more than one use and being of large scale (e.g. greater than 3,000m² gross floor area)
- Including high process energy use such as data centre, swimming pool, laboratory, industry or other similar uses with high energy demand and predicted to have a total energy demand in excess of 500MWh/annum including ‘unregulated’ energy demand.

10.6 Potential Costs and Benefits of DHN identified for Plymouth

This study has outlined potential carbon savings of 3,500 tonnes per year assuming the 6 strategic cluster area Starter Schemes are implemented at a capital cost of approximately £18 million.

Based on a full build out of the 6 strategic Full build out DHN schemes, the carbon saving is estimated to increase to ~7,000 tonnes per year at a capital cost of approximately £30 million.

For the full build out scenarios, this represents a cost per tonne CO₂ saved of 4,300 £/tonne, which compares favourably with other schemes that BuroHappold has been involved or is currently involved in delivering. For example, the University of Glasgow DHN scheme (now built out) shows a figure of ~7,000 £/tonne CO₂ saved while the Church St DHN in Westminster, London (currently being developed) shows a figure of 9,400 £/tonne.
10.7 Recommendations for a District Heating Strategy for Plymouth

In order to formulate a Plymouth wide district heating strategy, recommended actions and next steps have been presented for the six identified strategic clusters and for the standalone DHN opportunity areas.

The actions and next steps have been grouped into Short (2017-2020), Medium (2020-2025) and Long Term (2025-2040) time frames based on the site specific opportunities and constraints for each area.

In the longer term, there is the potential to interconnect identified schemes once they have been implemented. A potential interconnection scenario would involve using the EfW plant as a zero carbon heat supply source. This is shown in Figure 10—1 below.

Figure 10—1 – Long Term Vision for DHN Cluster Interconnection in Plymouth
Appendix A – DECC Heat Map
Appendix B Maps of Identified Clusters showing Tier 1 and Tier 2 Heat Consumption
Heat map with Tier 1 & 2 Loads – Civic Centre
Heat map with Tier 1 & 2 Loads – Cultural Quarter
Heat map with Tier 1&2 Loads – Derriford
Heat map with Tier 1&2 Loads – Devonport
Heat map with Tier 1&2 Loads – Millbay
## Appendix C – Cluster Prioritisation Summary Results

### Table 10—1 Cluster Prioritisation Multi-Criteria Analysis Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Unit</th>
<th>Weighting</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Complexity</td>
<td>No. non PCC/ public ownership stakeholders to coordinate</td>
<td>10</td>
<td>&gt;10</td>
<td>8-10</td>
<td>6-8</td>
<td>4-6</td>
<td>&lt;4</td>
</tr>
<tr>
<td>Starter Scheme IRR</td>
<td>%</td>
<td>10</td>
<td>&lt;2</td>
<td>2-4</td>
<td>4-6</td>
<td>6-8</td>
<td>8-10</td>
</tr>
<tr>
<td>Full Build Out Scheme IRR</td>
<td>%</td>
<td>5</td>
<td>0-2</td>
<td>2-4</td>
<td>4-6</td>
<td>6-8</td>
<td>8-10</td>
</tr>
<tr>
<td>% of Starter Scheme heat demand currently available</td>
<td>%</td>
<td>10</td>
<td>&lt;20</td>
<td>20-30</td>
<td>30-40</td>
<td>40-50</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Energy Centre location availability</td>
<td>Qualitative</td>
<td>10</td>
<td>No clear location available</td>
<td>Potential existing locations on third party ownership</td>
<td>New developments proposed in suitable energy centre location</td>
<td>One feasible location identified</td>
<td>More than one feasible location identified</td>
</tr>
<tr>
<td>Carbon Saving (Starter Scheme)</td>
<td>Reduction in heating CO₂ emissions (tonnes)</td>
<td>10</td>
<td>0-250</td>
<td>250-500</td>
<td>500-750</td>
<td>750-1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Potential for cluster interconnection</td>
<td>Heat line density of interconnecting pipe for full build out scheme from upstream cluster to be served from EfW plant (MWh/m)</td>
<td>10</td>
<td>&lt;5</td>
<td>5-10</td>
<td>10-15</td>
<td>15-20</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Physical constraints of Starter network</td>
<td>Qualitative based on number of road / rail / river crossings</td>
<td>5</td>
<td>Major physical constraint affecting scheme viability</td>
<td>Major road, rail or utilities crossing(s)</td>
<td>Minor road rail or utilities crossing(s), mostly 3rd party land</td>
<td>Minor road rail or utilities crossing(s), mostly PCC land</td>
<td>Majority of network developed in backstreets, minimal ownership issues</td>
</tr>
<tr>
<td>Development Risk – proportion of heat demand under direct PCC control for Starter Scheme</td>
<td>Qualitative</td>
<td>10</td>
<td>&lt;20%</td>
<td>20-30%</td>
<td>30-40%</td>
<td>40-50%</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>Opportunity for</td>
<td>Qualitative</td>
<td>10</td>
<td>Low</td>
<td>Low/Medium</td>
<td>Medium</td>
<td>Medium/High</td>
<td>High</td>
</tr>
<tr>
<td>Criteria</td>
<td>Unit</td>
<td>Weighting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------------</td>
<td>-----------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Low Temp heat networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10—2 Overall Cluster Scoring and Ranking

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Devonport</th>
<th>Barne Barton</th>
<th>Derriford</th>
<th>Millbay</th>
<th>Civic Centre</th>
<th>Cultural Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Complexity of Starter Scheme</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Starter Scheme IRR</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Full Build Out Scheme IRR</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>% of Starter Scheme heat demand currently available</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Energy Centre location availability</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Carbon Saving (Starter Scheme)</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Potential for cluster interconnection</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Physical constraints of Starter network</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Development Risk – proportion of heat demand under direct PCC control for Starter Scheme</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Opportunity for Low Temp heat networks</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Overall weighted score</td>
<td>12</td>
<td>12</td>
<td>22</td>
<td>13</td>
<td>25</td>
<td>16</td>
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<tr>
<td>Cluster ranking</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix D Summary of Stakeholder Engagement

Derriford Hospital

BuroHappold engaged with Derriford Hospital in a meeting on the 1st March 2017 in order to understand the Hospital’s appetite for involvement with a DH scheme, and to what extent the involvement could be.

• The hospital utilises a high temperature heating system with boiler heat provided at 177 degC.

• The heating plant comprises 1no CHP, 2no 6MW boilers, and a further 3MW boiler, which is yet to be brought online.

• Some areas of the Hospital require lower temperature heat and this is achieved by stepping down the high temperature water through plate heat exchangers.

• The heat losses through these processes are estimated to be 40% of heat produced.

• The CHP unit is 1.55 MWe and is well utilised however would need to operate at lower temperatures to secure Good Quality CHP status. It is operated through a Centrica contract, which can be ended at any time.

• The on-site incinerator has a maximum capacity of 1T waste per hour, it currently operates at ~35% capacity with a view to securing contracts to enable 85% capacity operation. Heat is produced at 160 degC.

• The trust would need to retain control of their heating plant to service the Hospital, but in principle the utilisation of waste heat off site was agreeable so long as the Hospital were not penalised for non-provision to the network.

• No space on site for additional heating plant for the network.

• Any connections to a network would require hydraulic separation, with a clear demarcation between systems.

• The hospital expressed interest in further exploring the Finerpol Project, an EU funded initiative about financial instruments for energy efficiency.

Energy from Waste Plant, Devonport

BuroHappold received responses to a number of questions posed to the MVV Energy from Waste plant located in Plymouth. These responses were received on the 3rd February 2017 and are summarised below.

• There is estimated to be 7.5 MW of spare heat available however the plant in contracted to the Dockyard and HMNB Devonport such that only 2.6 MW is immediately available.

• Heat availability depends on the heat demand of the Dockyards and HMNB Devonport and as such varies daily and seasonally.

• Design data suggests that 0.24 MW of electrical output is lost per MW of heat output. This figure is yet to be verified through actual data collection.

• An indication of 70 £/MWhe is given as a ‘price power lost per MW thermal produced’. This includes loss of power sales, loss of embedded benefits and loss of ROC’s.
• DHN/EfW interface points would be possible at the CHP facility or at the edge of the Dockyard site, it would depend on the location of the DHN cluster.

• Cost assumptions for a heat interface point produced in 2013 can provide an indication of cost for a heat interface point today (with indexation). However taking more heat than the 2013 plans are designed for will result in increased costs. Detailed costs would have to be developed with BuroHappold.

• There is a 6.9bar steam flow on site, which is returned as condensate.

• ~50% of the waste fuel source is renewable.
### Appendix E Technical Assessment Summary for Clusters Selected for Techno-economic modelling

#### Table 10—3 Summary of starter and full build out cluster building heat demands and peak loads – Barne Barton

<table>
<thead>
<tr>
<th>Name</th>
<th>Heat demand (MWh)</th>
<th>Peak load (kWth)</th>
<th>Description</th>
<th>Part of Starter scheme? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barne Barton_D</td>
<td>2014</td>
<td>923</td>
<td>Residential– social landlords</td>
<td>Y</td>
</tr>
<tr>
<td>Barne Barton_E</td>
<td>1663</td>
<td>428</td>
<td>Residential– social landlords</td>
<td>Y</td>
</tr>
<tr>
<td>Barne Barton_G1</td>
<td>1048</td>
<td>334</td>
<td>Residential– private developments</td>
<td>N</td>
</tr>
<tr>
<td>Barne Barton_G2</td>
<td>1246</td>
<td>535</td>
<td>Residential – private developments</td>
<td>N</td>
</tr>
<tr>
<td>Barne Barton New Development</td>
<td>880</td>
<td>1065</td>
<td>Residential – private developments</td>
<td>Y</td>
</tr>
<tr>
<td>Furse Park</td>
<td>506</td>
<td>308</td>
<td>Residential– social landlords</td>
<td>N</td>
</tr>
<tr>
<td>Riverside Community</td>
<td>285</td>
<td>206</td>
<td>Education – Public building</td>
<td>N</td>
</tr>
</tbody>
</table>

#### Table 10—4 Summary of starter and full build out cluster building heat demands and peak loads - Devonport

<table>
<thead>
<tr>
<th>Name</th>
<th>Heat demand (MWh)</th>
<th>Peak load (kWth)</th>
<th>Description</th>
<th>Part of Starter scheme? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7 Southyard</td>
<td>117</td>
<td>62</td>
<td>New development</td>
<td>Y</td>
</tr>
<tr>
<td>1.8 Southyard</td>
<td>117</td>
<td>62</td>
<td>New development</td>
<td>Y</td>
</tr>
<tr>
<td>1.1 Southyard</td>
<td>201</td>
<td>106</td>
<td>New development</td>
<td>Y</td>
</tr>
<tr>
<td>1.9 Southyard</td>
<td>164</td>
<td>96</td>
<td>New development</td>
<td>Y</td>
</tr>
<tr>
<td>Marlborough_house</td>
<td>1029</td>
<td>720</td>
<td>Residential</td>
<td>Y</td>
</tr>
<tr>
<td>Market Hall</td>
<td>161</td>
<td>102</td>
<td>New non resi</td>
<td>N</td>
</tr>
<tr>
<td>Devonport Guildhall</td>
<td>157</td>
<td>69</td>
<td>Guildhall</td>
<td>N</td>
</tr>
<tr>
<td>Mount Wise Primary</td>
<td>281</td>
<td>204</td>
<td>Primary School - Trust</td>
<td>N</td>
</tr>
<tr>
<td>Name</td>
<td>Heat demand (MWh)</td>
<td>Peak load (kWth)</td>
<td>Description</td>
<td>Part of Starter scheme? (Y/N)</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
<td>------------------</td>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Marlborough Primary School</td>
<td>172</td>
<td>125</td>
<td>Primary School - Trust</td>
<td>Y</td>
</tr>
<tr>
<td>Devonport (St Aubyns) Library, St Aubyns Church</td>
<td>151</td>
<td>82</td>
<td>Libraries</td>
<td>N</td>
</tr>
<tr>
<td>KER STREET</td>
<td>567</td>
<td>303</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>6 CORNWALL STREET</td>
<td>637</td>
<td>341</td>
<td>Residential</td>
<td>Y</td>
</tr>
<tr>
<td>Tave House</td>
<td>225</td>
<td>430</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>Tamar House</td>
<td>233</td>
<td>430</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>Lynher House</td>
<td>213</td>
<td>430</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>Cumberland Medical Centre</td>
<td>360</td>
<td>348</td>
<td>Medical centre</td>
<td>N</td>
</tr>
<tr>
<td>The Royal Fleet Club Hotel</td>
<td>621</td>
<td>161</td>
<td>Hotel</td>
<td>N</td>
</tr>
<tr>
<td>Granby Green</td>
<td>355</td>
<td>392</td>
<td>Mixed tenure and flats/apartments</td>
<td>Y</td>
</tr>
<tr>
<td>Devonport Dockyard, South Yard, (Areas 1 And 5)</td>
<td>608</td>
<td>2,276</td>
<td>Retention and conversion to mixed use//New B class (commercial) 9375m2 of B1, 6155m2 of B2</td>
<td>Y</td>
</tr>
<tr>
<td>Vision Residential</td>
<td>1720</td>
<td>2,084</td>
<td>Mixed development with resi, community, commercial uses</td>
<td>Y</td>
</tr>
<tr>
<td>Vision Retail, Offices</td>
<td>221</td>
<td>940</td>
<td>Mixed development with resi and retail</td>
<td>Y</td>
</tr>
<tr>
<td>Former Mod Site Mount Wise</td>
<td>1672</td>
<td>2,025</td>
<td>Dwellings</td>
<td>N</td>
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<tr>
<td>Former Mod Site Mount Wise</td>
<td>212</td>
<td>915</td>
<td>Commercial</td>
<td>N</td>
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<tr>
<td>Former Mod Site Mount Wise</td>
<td>84</td>
<td>90</td>
<td>Phase 2, 20 four bed houses</td>
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<tr>
<td>Mount Wise Phase 3A</td>
<td>219</td>
<td>283</td>
<td>Mixed development with resi and</td>
<td>N</td>
</tr>
</tbody>
</table>
### Table 10—5 Summary of starter and full build out cluster building heat demands and peak loads - Derriford

<table>
<thead>
<tr>
<th>Name</th>
<th>Heat demand (MWh)</th>
<th>Peak load (kWth)</th>
<th>Description</th>
<th>Part of Starter scheme? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceansgate (Southyard)</td>
<td>280</td>
<td>1,769</td>
<td>Mixed development with retail and offices</td>
<td>Y</td>
</tr>
<tr>
<td>Princess Yachts</td>
<td>1986</td>
<td>1,080</td>
<td>New luxury yachts factory</td>
<td>N</td>
</tr>
<tr>
<td>Princess Yachts - existing</td>
<td>2718</td>
<td>1,399</td>
<td>Existing Factory</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase a</td>
<td>161</td>
<td>200</td>
<td>Offices</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase b</td>
<td>271</td>
<td>264</td>
<td>Offices and residential</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase d</td>
<td>195</td>
<td>189</td>
<td>Offices and residential</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase e</td>
<td>296</td>
<td>263</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase g</td>
<td>244</td>
<td>217</td>
<td>Residential</td>
<td>N</td>
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<tr>
<td>Future Phase h</td>
<td>206</td>
<td>183</td>
<td>Residential</td>
<td>N</td>
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<tr>
<td>Future Phase j</td>
<td>148</td>
<td>131</td>
<td>Residential</td>
<td>N</td>
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<td>Future Phase m</td>
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<td>N</td>
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<tr>
<td>Future Phase l</td>
<td>187</td>
<td>300</td>
<td>Retail</td>
<td>N</td>
</tr>
<tr>
<td>Future Phase c</td>
<td>174</td>
<td>217</td>
<td>Offices</td>
<td>N</td>
</tr>
<tr>
<td>Seaton Barracks</td>
<td>1728</td>
<td>2061</td>
<td>Mix use new developments</td>
<td>N</td>
</tr>
<tr>
<td>Seaton Barracks Resi</td>
<td>358</td>
<td>276</td>
<td>Residential</td>
<td>N</td>
</tr>
<tr>
<td>Health and Leisure Centre</td>
<td>410</td>
<td>426</td>
<td>Offices/Businesses</td>
<td>Y</td>
</tr>
<tr>
<td>Peninsula Medical School</td>
<td>613</td>
<td>500</td>
<td>Education</td>
<td>Y</td>
</tr>
<tr>
<td>Name</td>
<td>Heat demand (MWh)</td>
<td>Peak load (kWth)</td>
<td>Description</td>
<td>Part of Starter scheme? (Y/N)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td>---------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Marjon Sports Centre</td>
<td>2726</td>
<td>1461</td>
<td>Education</td>
<td>N</td>
</tr>
<tr>
<td>Marjon College</td>
<td>1116</td>
<td>941</td>
<td>Education</td>
<td>N</td>
</tr>
<tr>
<td>Devonshire Health &amp; Racquet Club</td>
<td>1509</td>
<td>1283</td>
<td>Other</td>
<td>N</td>
</tr>
<tr>
<td>Nuffield Hospital</td>
<td>1337</td>
<td>365</td>
<td>Hospital</td>
<td>N</td>
</tr>
<tr>
<td>Peninsula NHS Treatment Centre</td>
<td>613</td>
<td>500</td>
<td>Hospital</td>
<td>N</td>
</tr>
<tr>
<td>PIMT Hellerman Tyton</td>
<td>450</td>
<td>520</td>
<td>New development</td>
<td>N</td>
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<tr>
<td>Wharfside North West Quarter Development</td>
<td>341</td>
<td>1621</td>
<td>New development</td>
<td>Y</td>
</tr>
<tr>
<td>Plymouth Teaching PCT</td>
<td>691</td>
<td>251</td>
<td>Public building</td>
<td>Y</td>
</tr>
<tr>
<td>H M Revenue &amp; Customs</td>
<td>393</td>
<td>184</td>
<td>Public building</td>
<td>N</td>
</tr>
<tr>
<td>24, Brest Road</td>
<td>1322</td>
<td>1076</td>
<td>Store and premises</td>
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</tr>
<tr>
<td>North West Quadrant Resi</td>
<td>1709</td>
<td>1622</td>
<td>Residential units</td>
<td>Y</td>
</tr>
<tr>
<td>North West Quadrant Health and commercial</td>
<td>3278</td>
<td>1959</td>
<td>Commercial floorspace including offices and other uses</td>
<td>Y</td>
</tr>
<tr>
<td>St Matthews Primary School</td>
<td>477</td>
<td>2901</td>
<td>3FE 3 storey primary school with nursery</td>
<td>N</td>
</tr>
<tr>
<td>Studio School</td>
<td>411</td>
<td>112</td>
<td>Erection of 2 storey studio school</td>
<td>Y</td>
</tr>
<tr>
<td>The Ship</td>
<td>558</td>
<td>677</td>
<td>Office/leisure and light industry</td>
<td>N</td>
</tr>
</tbody>
</table>
Table 10—6 Summary of Heat Sources and Pipe Network Lengths for Clusters identified for techno-economic assessment

<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Gas Boiler Capacity (kWth)</th>
<th>Ancillary equipment</th>
<th>Total Network Pipe Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barne Barton starter</td>
<td>0.53 MWth Waste heat from EFW</td>
<td>Water treatment, expansion and pressurisation. Main DH pumps. Thermal Storage. Primary boiler circuit pumps.</td>
<td>440</td>
</tr>
<tr>
<td>Barne Barton full build out</td>
<td>0.89 MWth Waste heat from EFW</td>
<td>1,278</td>
<td>1,280</td>
</tr>
<tr>
<td>Devonport starter</td>
<td>0.85 MWth CHP</td>
<td>6,705</td>
<td>860</td>
</tr>
<tr>
<td>Devonport full build out</td>
<td>1.81 MWth CHP</td>
<td>9,206</td>
<td>1,830</td>
</tr>
<tr>
<td>Derriford starter</td>
<td>0.9 MWth spare heat from incinerator/CHP</td>
<td>3,172</td>
<td>1,090</td>
</tr>
<tr>
<td>Derriford full build out</td>
<td>2.49 MWth spare heat from incinerator/CHP</td>
<td>10,782</td>
<td>2,820</td>
</tr>
</tbody>
</table>
Appendix F Benchmarks and Assumptions

Where heat demand data was not available for the datasets being considered, these have been populated using the following benchmarks.

**Existing building benchmarks**

Existing building energy demands have been benchmarked based on CIBSE Guide F Energy Benchmarks assuming all Heat is supplied by gas boilers at efficiency of 80%.

Table 10—7- Existing building benchmarks

<table>
<thead>
<tr>
<th>CIBSE Category</th>
<th>Name</th>
<th>Total heat demand (kWh/m²)</th>
<th>Space heating fraction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General office</td>
<td>96</td>
<td>0.55</td>
</tr>
<tr>
<td>2</td>
<td>High street agency</td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>General retail</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Large non-food shop</td>
<td>136</td>
<td>0.55</td>
</tr>
<tr>
<td>5</td>
<td>Small food store</td>
<td>37</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Large food store</td>
<td>84</td>
<td>0.55</td>
</tr>
<tr>
<td>7</td>
<td>Restaurant</td>
<td>296</td>
<td>0.3</td>
</tr>
<tr>
<td>8</td>
<td>Bar, pub, or licensed club</td>
<td>280</td>
<td>0.4</td>
</tr>
<tr>
<td>9</td>
<td>Hotel</td>
<td>264</td>
<td>0.45</td>
</tr>
<tr>
<td>10</td>
<td>Cultural activities</td>
<td>160</td>
<td>0.55</td>
</tr>
<tr>
<td>11</td>
<td>Entertainment halls</td>
<td>336</td>
<td>0.55</td>
</tr>
<tr>
<td>12</td>
<td>Swimming pool centre</td>
<td>904</td>
<td>0.55</td>
</tr>
<tr>
<td>13</td>
<td>Fitness and health centre</td>
<td>352</td>
<td>0.4</td>
</tr>
<tr>
<td>14</td>
<td>Dry sports and leisure facility</td>
<td>264</td>
<td>0.55</td>
</tr>
<tr>
<td>15</td>
<td>Covered car park</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Public buildings with light usage</td>
<td>84</td>
<td>0.55</td>
</tr>
<tr>
<td>17</td>
<td>Schools and seasonal buildings</td>
<td>120</td>
<td>0.55</td>
</tr>
<tr>
<td>18</td>
<td>University campus</td>
<td>192</td>
<td>0.55</td>
</tr>
<tr>
<td>19</td>
<td>Clinic</td>
<td>160</td>
<td>0.55</td>
</tr>
<tr>
<td>20</td>
<td>Hospital</td>
<td>336</td>
<td>0.55</td>
</tr>
<tr>
<td>23</td>
<td>Emergency services</td>
<td>312</td>
<td>0.55</td>
</tr>
<tr>
<td>24</td>
<td>Laboratory or operating theatre</td>
<td>128</td>
<td>0.55</td>
</tr>
<tr>
<td>25</td>
<td>Public waiting or circulation</td>
<td>96</td>
<td>0.55</td>
</tr>
<tr>
<td>26</td>
<td>Terminal</td>
<td>160</td>
<td>0.55</td>
</tr>
<tr>
<td>27</td>
<td>Workshop</td>
<td>144</td>
<td>0.55</td>
</tr>
<tr>
<td>28</td>
<td>Storage facility</td>
<td>128</td>
<td>0.7</td>
</tr>
<tr>
<td>29</td>
<td>Cold storage</td>
<td>64</td>
<td>0.55</td>
</tr>
<tr>
<td>21</td>
<td>Long term residential</td>
<td>336</td>
<td>0.55</td>
</tr>
<tr>
<td>22</td>
<td>General accommodation</td>
<td>240</td>
<td>0.55</td>
</tr>
</tbody>
</table>
**New development benchmarks**

The following tables describe new building benchmarks used and number of unit to floor area assumptions used where only unit numbers were provided.

**Table 10—8- New building benchmarks**

<table>
<thead>
<tr>
<th>Typology</th>
<th>Total heating</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>13 kwh/m²</td>
<td>Part L compliance model for typical office</td>
</tr>
<tr>
<td>Retail</td>
<td>23 kwh/m²</td>
<td>Part L compliance model for multi-use mall</td>
</tr>
<tr>
<td>Hotel</td>
<td>157 kwh/m²</td>
<td>Part L compliance model for hotel (including A/C)</td>
</tr>
<tr>
<td>Leisure</td>
<td>84 kwh/m²</td>
<td>Part L compliance model for multi-use mall</td>
</tr>
<tr>
<td>Education</td>
<td>39 kwh/m²</td>
<td>Part L compliance model for secondary school</td>
</tr>
<tr>
<td>Community</td>
<td>24 kwh/m²</td>
<td>Averaged load based on education and leisure benchmarks</td>
</tr>
<tr>
<td>Hospital</td>
<td>169 kwh/m²</td>
<td>CIBSE Guide F with 50% notional reduction to heating benchmarks</td>
</tr>
<tr>
<td>Light industrial</td>
<td>90 kwh/m²</td>
<td>TM46 workshop with 50% improvement to space heating.</td>
</tr>
<tr>
<td>Resi flat</td>
<td>50 kwh/m²</td>
<td>Part L SAP compliance model for small apartment</td>
</tr>
<tr>
<td>Resi mid terrace house</td>
<td>56 kwh/m²</td>
<td>Part L SAP compliance model for mid-terrace house</td>
</tr>
</tbody>
</table>

**Table 10—9- Unit to floor area conversion used for new developments**

<table>
<thead>
<tr>
<th>Size conversion</th>
<th>Value m²</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size per residential unit</td>
<td>75</td>
<td>BuroHappold assumption when type not specified</td>
</tr>
<tr>
<td>Size per student accommodation unit</td>
<td>20</td>
<td>BuroHappold assumption</td>
</tr>
<tr>
<td>Size per 1 -bed flat</td>
<td>46</td>
<td>Housing standards Dwelling size survey 2010</td>
</tr>
<tr>
<td>Size per 2-bed flat</td>
<td>59</td>
<td>Housing standards Dwelling size survey 2010</td>
</tr>
<tr>
<td>Size per 3-bed flat</td>
<td>90</td>
<td>Housing standards Dwelling size survey 2010</td>
</tr>
</tbody>
</table>
**Peak heat demand**

The following peak gas demand benchmarks were used to calculate peak building heat loads within the identified clusters.

**Table 10—10- Peak gas demand benchmarks**

<table>
<thead>
<tr>
<th>Typology</th>
<th>Benchmark (W/m²)</th>
<th>Benchmark Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>70</td>
<td>BSRIA 2011</td>
</tr>
<tr>
<td>Residential</td>
<td>60</td>
<td>BSRIA 2011</td>
</tr>
<tr>
<td>Leisure</td>
<td>40</td>
<td>BuroHappold past project</td>
</tr>
<tr>
<td>Retail</td>
<td>100</td>
<td>BSRIA 2011</td>
</tr>
<tr>
<td>Education</td>
<td>87</td>
<td>BSRIA 2011</td>
</tr>
<tr>
<td>Hotels</td>
<td>70</td>
<td>BSRIA 2011 Residential, slightly increased to account for higher hot water demand</td>
</tr>
<tr>
<td>Hospital</td>
<td>40</td>
<td>BuroHappold past project</td>
</tr>
<tr>
<td>Community</td>
<td>87</td>
<td>BSRIA 2011 Education</td>
</tr>
<tr>
<td>Industrial</td>
<td>80</td>
<td>BSRIA 2011</td>
</tr>
</tbody>
</table>
## Appendix G Heat Sources Identified in Plymouth

**Table 10–11 – Heat Sources Identified in Plymouth**

<table>
<thead>
<tr>
<th>Name</th>
<th>Typology</th>
<th>Address</th>
<th>Heat Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langage Power Station (Centrica)</td>
<td>Power Station</td>
<td>Holland Road, Plymouth</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Mount Wise data centre</td>
<td>Data Centre</td>
<td>Mt Wise, former Nuclear Bunker, Plymouth</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>STEM Group data centre</td>
<td>Data Centre</td>
<td>10 Thornbury Road, Plymouth</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>MVV Environment Devonport Limited</td>
<td>Energy from Waste</td>
<td>Devonport EfW CHP Facility, Creek Road, Plymouth</td>
<td>EfW</td>
</tr>
<tr>
<td>Future Industrial Services Limited</td>
<td>Industrial Installation</td>
<td>Building S167a, South Yard Lube Oil Complex, HM Naval Base, Devonport, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Plymouth City Council</td>
<td>Industrial Installation</td>
<td>Chelson Meadow, The Ride, Plymstock, Plymouth, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Silicon Sensing Products UK Ltd</td>
<td>Industrial Installation</td>
<td>UNIT 18, EASTOVER ROAD, PLYMOUTH</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Plymouth Hospitals NHS Trust</td>
<td>Industrial Installation</td>
<td>Derriford Hospital, Derriford Road, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Dartmoor Bio Power Limited</td>
<td>Industrial Installation</td>
<td>Plymouth Timber Resource Recovery Plant, Units 21-29, 1 Belliver Way, Roborough, Plymouth</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>CLP Envirosgas Limited</td>
<td>Industrial Installation</td>
<td>Chelson Meadow Landfill Gas Utilisation Plant Compound, The Ride, Billacombe Road, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Devonport Royal Dockyard Limited</td>
<td>Industrial Installation</td>
<td>Health and Safety Department, PC623, Devonport, Plymouth, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Devonport Royal Dockyard Ltd</td>
<td>Industrial Installation</td>
<td>N152, Health and Safety Department, Devonport Royal Dockyard, Devon</td>
<td>Heat recovery</td>
</tr>
<tr>
<td>Devonport Royal Dockyard Limited</td>
<td>Industrial Installation</td>
<td>Building No36, Devonport Royal Dockyard, Devon</td>
<td>Heat recovery</td>
</tr>
</tbody>
</table>
## Appendix H Low Carbon Energy Supply Matrix

### Key

<table>
<thead>
<tr>
<th>Low Viability</th>
<th>Medium Viability</th>
<th>High Viability</th>
<th>B</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Scale</th>
<th>District Scale</th>
</tr>
</thead>
</table>

### Table 10—12 - Low Carbon Energy Supply Matrix

To be inserted in Final Report