Clyde Mission

Energy Masterplan

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Energy and Low Carbon Heat

Clyde Mission

Energy Masterplan

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1 Executive Summary

Background

Clyde Mission aims to make the Clyde "an engine of sustainable, inclusive economic growth for the city, the region and Scotland". The five Missions intended to deliver against this "Grand Challenge" are:

- Create new, good and green jobs and a workforce with the skills to secure those jobs
- Use vacant and derelict land for the benefit of the economy, the environment and communities.
- Adapt to climate risks, especially flooding.
- Accelerate Scotland's progress to net zero.
- Use the river to create better places for people and communities

This Energy Masterplan was commissioned for Clyde Mission by Zero Waste Scotland to support the strategic development of low carbon heat and energy infrastructure projects that align to the goals of the Clyde Mission. It also supports wider strategic Scottish Government targets such as reducing greenhouse gas emissions by 75% by 2030 and achieving net zero by 2045.

The Energy Masterplan aims to support the identification and development of a portfolio of heat and energy related investment opportunities within a subset of the Clyde Mission boundary[1] ("the Energy Masterplan boundary") which have the potential to contribute to the aims of Clyde Mission, deliver an economic stimulus and contribute to the National Outcomes set out in Scotland's National Performance Framework (NPF).[2]

The Energy Masterplan outlines a list of potential and actual projects at various stages of development, these were identified through stakeholder engagement, energy mapping, and modelling. A further shortlisting process, which considered the specific ambitions of Clyde Mission (as outlined above) identified four early stage projects to take forward to detailed feasibility studies.

The Energy Masterplan includes both sides of the River Clyde from the tidal reach near Clyde Gateway in the East of Glasgow, through to the opening of the river between Gourock and Dunoon. The Energy Masterplan boundary is approximately 500 m from the North and South banks of the River Clyde. An additional 2,000 m buffer was included to

[1] The overall Clyde Mission footprint was expanded after this Masterplan was commissioned; thus, this report does not refer to the areas of Clyde Mission which sit between Clyde Gateway and the river's source.
[2] https://nationalperformance.gov.scot/

support the potential for future extensions of successful low carbon energy and infrastructure projects. The Energy Masterplan should be viewed as a resource to support investment in low carbon heating and energy infrastructure in the Energy Masterplan area.

The Energy Masterplan presents:

- The Energy Masterplan area and boundary, including a buffer for future project expansion
- Existing energy demand locations (heating, cooling, and power) as well as existing sources of low-carbon energy
- Low carbon and energy infrastructure technologies suitable for the area
- Energy project long list, including:
    - Stakeholder-proposed projects.
    - Heat demand clusters and the spatial relationship of the clusters to the stakeholder-proposed projects.
    - Low carbon heat and energy resource opportunities and high-level constraints.
- Highlighted pre-feasibility projects which could potentially proceed to the feasibility study stage.

Key Findings

The energy mapping work examined existing energy demands including heating, cooling, and power in the Energy Masterplan area, along with relevant energy supply opportunities and constraints. It also identified heat demand clusters which could potentially support the development of district energy networks.

Within the extended (2,500m) Energy Masterplan boundary, there are 317,540 domestic properties and 36,245 non-domestic properties with a total heat demand estimated to be 7,117 GWh/a. Notably, 41% of the domestic properties on the Home Analytics database have an EPC Band D or below. This highlights the extent of the challenge associated with reaching net zero emissions by 2045 within the built environment.

Within the core (500m) Energy Masterplan boundary, there are 73,489 domestic properties and 12,646 non-domestic properties with a total heat demand of 2,044 GWh/a; 1,338 GWh/a are used by non-domestic properties, with the remaining 706 GWh/a being used by domestic buildings. In the Draft Heat in Buildings Strategy, the Scottish Government set-out its target for Scottish homes to meet a minimum energy efficiency standard equivalent to an EPC rating of a C by 2035 where technically feasible and cost-effective. Within the Energy Masterplan boundary, if the residential properties with an EPC rating less

than a C improved their EPC rating to a C, this would translate into an estimated 9% reduction in residential heat demand equivalent to 62 GWh/a.

The recently passed Heat Networks (Scotland) Act aims to support Scottish Government's ambition to connect the equivalent of 650,000 homes to heat networks from the current base of 32,000 homes.[3] The Act provides that local authorities may identify suitable areas for the development and operation of heat networks called "Heat Network Zones". The Energy Masterplan identifies a number of heat demand clusters in heat-dense areas in Glasgow City, Renfrewshire, South Lanarkshire, and Inverclyde, which may assist these local authorities to draw up Heat Network Zones.

Cooling and electricity demands were also mapped, however there is limited data available relating to non-domestic cooling demand. Electricity demand mapping highlighted that the highest electricity demand density exists in Renfrewshire and Glasgow City followed by Inverclyde, West Dunbartonshire, Argyll and Bute, and South Lanarkshire.

Sources of low-grade waste heat and existing networks were also mapped. Low-grade waste heat refers to heat that is rejected from industrial or other processes into the atmosphere or waterways. This included the location of wastewater treatment plants, SEPA waste incineration sites, and large combustion sites as well as existing and in-development heat networks. This allows for identification of where heat demand clusters overlap with low-grade waste heat sources which could potentially supply a heat network. Existing heat networks were also mapped, to identify opportunities to extend these where they border heat demand clusters.

Suitable Technologies

There are a variety of technologies that might be used to provide low carbon heat within this area, including heat pumps, waste-heat recovery, renewable electricity generation, electric boilers, biomass and biofuel, hydrogen, energy infrastructure, and energy storage technologies. A qualitative technology assessment using a Multi Criteria Analysis (MCA) was undertaken to establish the overall suitability of these various technologies for deployment within the Energy Masterplan boundary.

The technology assessment highlighted the importance of reducing the energy demands associated with the existing and proposed building stock, but also identified technologies which offer a high level of

[3] https://www.gov.scot/news/new-measures-to-accelerate-greener-cheaper-heating/

suitability for adoption within the Energy Masterplan boundary. Suitable technologies identified within the Energy Masterplan boundary included:

- large-scale water-source heat pumps (WSHP) serving heat-demand clusters via district heating networks with large scale thermal storage. It is estimated that the River Clyde could serve a peak heat load of 51 MW using large WSHPs connected to heat networks. This equates to 11% of the existing residential heat demand or 7,733 new residential 3-bed semi-detached dwellings. It is estimated that the equivalent of 134 Queens Quay heat networks would be required to serve the total heat demand within the Energy Masterplan boundary;
- electric boilers offering economic demand side flexibility when integrated into district heating networks using cheap electricity. Electric boilers could deliver 46% reduction in carbon emissions compared to a gas boiler based on the current grid carbon intensity;
- air-source heat pumps can reduce carbon emissions by 79% compared to gas boilers based on the current grid carbon intensity;
- waste-heat recovery from Energy from Waste (EfW) plants and industrial processes in close proximity to heat demand clusters. It is estimated that the South Clyde EfW energy centre could support the heat and electricity demand of an estimated 9,733 and 55,157 average domestic properties respectively;
- roof mounted solar photovoltaic (solar PV) as well as opportunities for large-scale solar PV installations coupled with battery storage where they could use vacant and derelict land in areas which are not in close proximity to major settlements.

The study found limited suitable land available for wind developments within the Energy Masterplan boundary, as much of the land area is classed as either Group 1 (areas where wind farms will not be acceptable) or Group 2 (areas of significant protection) under the Wind Turbine Spatial Framework.

Engagement, Request for Information and Feasibility Studies

A stakeholder meeting was held, attended by a wide range of stakeholders from the public, private, and third sectors. After this, stakeholders were requested to provide information on heat and energy network proposals within the relevant area, which resulted in a project longlist of over thirty infrastructure projects. From this list, a multi criteria analysis (MCA) approach, agreed with the Clyde Mission Team, was used to prioritise four projects, with potential to deliver against the five Clyde Missions, which would benefit from development support:

Scottish Event Campus (SEC)
The SEC has ambitions to become a net-zero events campus. As part of this, it has proposed to reduce its current natural gas consumption for heat generation through the development of a water-source heat pump project, which could meet a portion of the SEC's heating and cooling demand. Potentially, this could be part of a wider project which also serves the wider area, including planned developments downriver – and a feasibility study will examine this possibility.

Fortum, Energy-from-Waste (EfW) Heat Network
The Fortum EfW is in close proximity to large potential heat consumers such as Glasgow's Queen Elizabeth University Hospital, which lies to the north of the site. The recovery of heat from the EfW for distribution to nearby heat consumers could improve the efficiency of the EfW plant and offset the consumption of fossil fuels for heat generation on neighbouring residential, commercial, and industrial sites.

Kilcreggan/Rosneath Low Carbon Heating – community scale, off-gas communities
Kilcreggan and Rosneath are looking to adopt suitable low-carbon heating and energy solutions to decarbonise council owned non-domestic properties as well as social housing in these areas which are off-gas grid. The project will focus on potential low-carbon energy solutions at an individual property level.

Former Exxon Site Redevelopment, the former Exxon site
The former Exxon site is a £34m City Deal project. The land is currently undergoing remediation works and will then be transferred to West Dunbartonshire Council to be developed for commercial and industrial purposes. A variety of low-carbon technologies have been proposed for the site, and the project will focus on determining the most suitable.

There are several commercial structure options which the interested parties at these sites might consider for procurement, construction, ownership, and operation of the shortlisted energy systems. Suggested commercial structures for the shortlisted options are explored further in the report. A risk register was also prepared to provide an overview of the risks that should be considered in the delivery of the shortlisted options, including technical, commercial and procurement risk along with risk mitigation measures.

It is envisaged that this Energy Masterplan can be used as an evidence base for consideration of where proposed low carbon and energy infrastructure projects could be implemented to make best use of resources available in the area. Furthermore, it can support the development of future feasibility studies and business cases - and to

promote the adoption of, and investment in, low carbon heat and energy infrastructure throughout the Clyde Mission footprint.

2 Introduction

2.1 Overview of the Clyde Mission Energy Masterplan

This Energy Masterplan provides a strategy to identify potential projects on the Clyde to assist in meeting the Clyde Mission ambition to make the Clyde "an engine of sustainable, inclusive economic growth for the city, the region and Scotland" and ultimately contribute towards the Scottish Government's targets to reduce greenhouse gas emissions by 75% by 2030 and to achieve net zero by 2045.

The Clyde Mission[4] area includes both sides of the River Clyde from the tidal reach near Clyde Gateway in the east of Glasgow through to the opening of the river between Gourock and Dunoon.

The Energy Masterplan is a resource which aims to inform strategy and decision-making relating to low carbon heating and energy infrastructure within the Energy Masterplan boundary.

2.2 Aims of the study

The aims of the Energy Masterplan are:

- To support the strategic development of low carbon heat and energy infrastructure projects
- To identify and present a set of projects that could potentially be developed to enable the Clyde Mission to maximise its contribution towards the Scottish Government's target of net zero greenhouse gas emission by 2045
- To provide partners across the public, private and third-party sectors with information to support the transition to support the transition to net zero within the Energy Masterplan area

2.3 Scope

Buro Happold was contracted by Zero Waste Scotland to produce an Energy Masterplan in November 2020. The Energy Masterplan is part of Phase 1 of an overall study with two Phases. Phase 2 will develop feasibility studies for an initial set of early-stage potential projects.

The Energy Masterplan is a strategic document that identifies low carbon energy infrastructure projects that could potentially be developed to deliver against the Clyde Mission's aim to become 'an engine of sustainable and inclusive growth'. It includes the following aspects:

- Alignment to the objectives and aspirations of the Clyde Mission

[4] Gov.Scot. Clyde Mission. URL: https://www.gov.scot/publications/clyde-mission/ Accessed February 2021

- An energy mapping and modelling study along the River Clyde from Greenock in the west to Clyde Gateway in the east to assess energy demand density and thereby identify potentially significant existing and new heat network opportunities and power demand loads
- Identification of potentially useful heat supply opportunities adjacent to the river for the purposes of Heat Network (HN) scheme development, including but not limited to: Surface water bodies (e.g. River Clyde); secondary heat (e.g. wastewater treatment plants, electrical infrastructure); industrial heat (e.g. Energy from Waste)
- Develop a portfolio of heat and energy-based investment opportunities based on stakeholder input and as a result of the energy mapping
- Identify an initial four schemes to take forward from the pre-feasibility stage to complete detailed feasibility studies in Phase 2 of the project.

2.4 Methodology

The approach taken to produce this Energy Masterplan has two streams: the energy study and stakeholder engagement.

An accompanying document details the multi-criteria analysis approach for shortlisting energy projects to take forward to Phase 2 of the study.

Energy Study:

1. Confirm Clyde Mission Energy Masterplan boundary
2. Energy Demand Analysis and GIS spatial mapping
3. Identification of key residential and non-residential development areas
4. Technology Multi Criteria Assessment (MCA) Identify suitable technologies
5. Stakeholder-proposed projects, and energy project clusters to be considered in the long-term
6. Identify pre-feasibility stage projects which could be progressed to feasibility stage, applying the agreed project short-listing MCA factors
7. Commercial models and contracting.
8. High-level description
9. Risk considerations.
10. Critical mitigation measures for key risks.
11. Feasibility study definition
12. Delivery of GIS data to form basis of Clyde Mission database

Stakeholder Engagement

1. Regular progress meetings with the Clyde Mission Team and Zero Waste Scotland
2. Stakeholder briefing meeting and Request for information for stakeholder proposed-projects
3. Collect and summarise information about stakeholder-proposed projects
4. Workshop with Clyde Mission Team, agreeing project shortlisting Multi Criteria Assessment (MCA) factors
5. Review results of project shortlisting with the Clyde Mission Team

2.5 Background and Vision

This section provides an overview of the Clyde Mission and the extent of existing regeneration along the River Clyde and the City Deal initiative.

2.5.1 The Clyde Mission

The Clyde Mission is a national, place-based Mission to make the Clyde an engine of inclusive and sustainable growth for Glasgow, the city-region, and Scotland. A key objective of the Clyde Mission is to maximise the potential and impact of the River Clyde and immediate surrounding land as a national strategic asset.

The Clyde Mission is led by the Scottish Government in partnership with local authorities (Argyll & Bute, Glasgow City, Inverclyde, Renfrewshire, North Lanarkshire, South Lanarkshire and West Dunbartonshire), Clyde Gateway, Scottish Enterprise, Scottish Environment Protection Agency, Skills Development Scotland, the University of Glasgow and the University of Strathclyde.

2.5.2 Existing and ongoing regeneration projects along the River Clyde

Key examples are given in Table 2.1 of projects in the region which contribute greatly to the vibrancy and economic life around the River Clyde.

Table 2.1. A sample of projects which are in development or have been developed along the Clyde

Project	Description
Glasgow Riverside Innovation District (GRID)	GRID is a partnership between the University of Glasgow, Scottish Enterprise, and Glasgow City Council. GRID will be home to the world-leading Clinical Innovation Zone based around the Queen Elizabeth University, the largest hospital campus in Europe. GRID will see the development of a £144 million clinical and research facility.
Scottish Event Campus (SEC)	The Scottish Event Campus has plans to expand its existing event campus with a £200 million investment.
Advanced Manufacturing Innovation District (AMIDS)	AMIDS neighbouring Glasgow Airport will be home to a number of internationally renowned manufacturers as well as the £65 National Manufacturing Institute Scotland and the £56 million Medicines Manufacturing Innovation Centre.
Queens Quay	The Queens Quay District Heating Network is the first large-scale water source heat pump scheme of its kind in Scotland. The system works by extracting water from the Clyde to generate heat

Project	Description
	for buildings on the site of the former John Brown Shipyard, now known as Queens Quay. The ambitious £20million project to create a state-of-the-art Energy Centre and lay 5km of below-ground pipework was recently completed on behalf of West Dunbartonshire Council.

These projects contribute to one or more of the Scottish Government's five National Outcomes that underpin the Clyde Mission:

- We have a globally competitive, entrepreneurial, inclusive, and sustainable economy.
- We tackle poverty by sharing opportunities, wealth, and power more equally.
- We value, enjoy, protect, and enhance our environment.
- We live in communities that are inclusive, empowered, resilient and safe.
- We have thriving and innovative businesses, with quality jobs and fair work for everyone.

The Clyde Mission Fund[5] provided over £11 million of funding in 2020-21 to support capital projects that deliver economic stimulus and jobs and contribute to one or more of the National Outcomes.

These projects aim to build upon the River Clyde's industrial legacy. To address these challenges, the Clyde Mission aims to optimise the impact of private and public investment in the area, putting vacant and derelict land to beneficial use.[6]

2.5.3 Support for development along the River Clyde

Glasgow City Region City Deal[7]

The Glasgow City Region City Deal is an agreement between the UK Government, the Scottish Government and the eight local authorities across Glasgow and Clyde Valley. It sets out how the region will create economic growth through:

- Setting up a £1.13 billion fund for the delivery of an improved transport network, key development, and regeneration sites
- Supporting growth in the life sciences sector

[5] Gov. Scot. Clyde Mission Fund. URL: https://www.gov.scot/publications/clyde-mission/ Accessed February 2021
[6] Gov. Scot. Clyde Mission. URL: https://www.gov.scot/publications/clyde-mission/#:~:text=The%20Mission%2C%20led%20by%20the,economic%2C%20social%20and%20environmental%20benefits%20. Accessed February 2021.
[7] Glasgow and Clyde Valley City Deal, accessed 29th January 2021

- Helping small and medium enterprises to grow and develop
- Setting up programmes to support unemployed people
- Testing new ways of boosting the incomes of people on low wages

Several projects have already been identified as part of the City Deal, listed in Appendix A.

2.5.4 Vision

Table 2.2 summarises the types of energy projects within the Clyde Mission Energy Masterplan boundary that were proposed by stakeholders during the engagement phase of the project. Typically, projects proposed were applications of heat generating technologies that are well-established in the Scottish market, such as heat pumps.

Table 2.2 Summary of low carbon technologies proposed by stakeholders

Type	Technology
Energy efficiency	Low-energy building design for new-builds Building fabric improvements for existing residential and commercial buildings
Heat pumps	Water source heat pump (WSHP) - River Clyde or another surface water source Ground Source Heat Pump (GSHP) Air Source Heat Pump (ASHP) Steam raising high temperature heat pump (distillery) Deep geothermal
Waste heat recovery	Energy from Wastewater Treatment works (WWTW) Energy from Waste (EfW)
Renewable energy	Wind turbine, Roof-top solar PV, Solar PV carport
Biomass and biofuel	Biomass boiler
Hydrogen	Produce hydrogen from industrial process (gasification)
Energy infrastructure	Heat network Steam network Ambient loop heating and cooling network (5th generation)

Type	Technology
	Smart grid Electric Vehicle (EV) charging E-bike charging

2.6 Energy Masterplan boundary

The Energy Masterplan area covers the River Clyde and land beside the Clyde from the tidal reach near Clyde Gateway in the East of Glasgow through to the opening of the river between Gourock and Dunoon. The Energy Masterplan boundary is approximately 500 m from the North and South banks of the river.

For the Energy Masterplan, potential projects are identified inside the Energy Masterplan boundary and also within an additional buffer of 2,000 m. This is to support considerations around future extensions of successful low carbon energy and infrastructure projects.

3 Policy review

Clyde Mission

Clyde Mission's purpose is to use the Clyde to drive sustainable and inclusive growth for the city, the region and Scotland. The Clyde Mission Fund provided £10 million of funding in 2020-21 to support capital projects that deliver economic stimulus and jobs and contribute to one or more of the Scottish Government's five National Outcomes as set out in Scotland's National Performance Framework (NPF). Scotland's NPF reflects Scotland's values and aspirations for the future as a nation and to help achieve its purpose, the framework sets out "National Outcomes". The outcomes provide a vision of the type of Scotland the NPF aims to create. These five National Outcomes underpin the Clyde Mission.

Local Authorities

The Local Authorities (LAs) within the study area for the Clyde Mission Energy Masterplan are the following: Argyll & Bute, Glasgow City, Inverclyde, North Lanarkshire, Renfrewshire, South Lanarkshire, and West Dunbartonshire.

Glasgow City, North Lanarkshire and Renfrewshire aim to meet a target of achieving net zero GHG emissions by 2030. The other LAs aim to meet Scotland's target to reach net zero GHG emissions by 2045.

Emissions reduction targets for each of the Local Authorities are discussed in Table 3.1.

Table 3.1. Local Authority target years to achieve net zero carbon, from a 1990 baseline year

Local Authority	Target Description	Target Net Zero GHG emission year
Glasgow City	Glasgow City has set a target to achieve net zero carbon by 2030, in the Energy and Carbon Masterplan from Sustainable Glasgow	2030
Renfrewshire	In Renfrewshire Council's 2019 Climate Change Emergency Report, the Council sets out a target to achieve net zero GHG emissions by 2030.	2030
South Lanarkshire	In a South Lanarkshire Council (SLC) Statement in 2019, the Council recognised its role to reduce greenhouse gas emissions. SLC proposed to meet or exceed Scotland's	2045

	goal to reach net zero GHG emissions by 2045.	
North Lanarkshire	In North Lanarkshire Council's (NLC) "Response to declaring a climate emergency", the Council approved a target to move to net zero emissions by 2030.	2030
Inverclyde	The Inverclyde Council is anticipated to update its Climate Change Plan (2018) to align with Scotland's net zero target.	2045
West Dunbartonshire	West Dunbartonshire Council has set out plans to achieve net zero emissions by 2045.	2045
Argyll and Bute	Argyll and Bute Council set out in their Decarbonisation Plan an intention to meet Scotland's net zero target.	2045

Scotland

The Scottish Parliament has set a target date for net zero emissions of greenhouse gases by 2045. In 2019, the Scottish Parliament passed the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, amending the Climate Change (Scotland) Act 2009. The Climate Change (Scotland) Act 2019 presents interim targets of 75% and 90% reductions by 2030 and 2040 respectively.

The "Draft Heat in Buildings Strategy: Achieving Net Zero Emissions in Scotland's Buildings Consultation" was released in February 2021 to collect evidence and views on the proposed actions and proposals to ensure all buildings reach zero emissions by 2045. The draft strategy highlights the delivery programmes proposed to stimulate the mass adoption of low and zero emissions heating systems over fossil-fuel heating systems for over two million homes and 100,000 non-domestic properties by 2045, and to support energy efficiency improvements across all buildings.

The Heat Networks (Scotland) Bill was passed unanimously by the Scottish Parliament on the 23rd February. The Heat Networks (Scotland) Act will create a new licensing system with the aim of improving standards across the sector in an effort to improve consumer confidence. It will also provide similar rights to heat network developers and operators to those which exist for other utilities including compulsory acquisition of land, wayleaves, survey works and access to land for

repairs etc. A new consents system will be introduced to ensure that heat networks are developed in areas which have been identified as being suitable for heat network deployment.

United Kingdom

In 2019, Parliament passed legislation requiring the government to make the UK a net zero emitter. This was done by amending the Climate Change Act (2008) target from 80% to a 100% reduction in greenhouse gas emissions (GHG) by 2050, compared to the 1990 baseline. The aim is to end contributions to global warming, keeping warming to 1.5°C – below the 2°C limit as set out in the Paris Agreement, signed in 2015.

- **2050 Target:** Net zero emissions from greenhouse gas emissions. Any emissions to be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere[8].
- **Carbon Budget:** 78% reduction in UK territorial emissions between 1990 and 2035[9], as set out in the Sixth Carbon Budget as a path to Net Zero and contribution to tacking climate change.

Policy Target Summary

The UK is targeting net zero greenhouse gas emissions by 2050, Scotland by 2045, and the Local Authorities of Glasgow City, North Lanarkshire and Renfrewshire by 2030 (Table 3.2).

Table 3.2. Greenhouse gas reduction targets, from a 1990 baseline year

Location	Source	Target 2030	Target 2035	Target 2040	Target 2045	Target 2050
UK	Climate Change Act 2008 (2050 Target Amendment)		78%			Net Zero
Scotland	Climate Change (Emissions Reduction Targets)	70%		90%	Net Zero	

[8] Gov.UK. UK becomes first major economy to pass net zero emissions law. URL: https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law Accessed: February 2021

[9] Climate Change Committee. Sixth Carbon Budget, December 2020. URL: https://www.theccc.org.uk/publication/sixth-carbon-budget/ Accessed: February 2021

	(Scotland) Act 2019			
South Lanarkshire Inverclyde West Dunbartonshire Argyll & Bute	Climate Change (Emissions Reduction Targets) (Scotland) Act 2019	70%	90%	Net Zero
North Lanarkshire	Response to declaring a climate emergency	Net Zero		
Glasgow City	Energy and Carbon Masterplan	Net Zero		
Renfrewshire	Climate Change Emergency Report	Net Zero		

4 Energy mapping

A primary aim of this Energy Masterplan is to support the identification and development of a portfolio of heat and energy related investment opportunities. This energy mapping section presents maps illustrating existing energy demands for heating, cooling, and power in the Energy Masterplan area, along with relevant energy supply opportunities and constraints – for example, waste heat sources, and energy infrastructure. This information is then analysed using Geographic Information System (GIS) techniques to identify potential heat network clusters which could be brought forward for potential development and investment.

Core datasets used in the analysis are presented in Table 4.1.

Table 4.1. Datasets used in energy mapping

Type	Data sets
Existing buildings and projects	• Scotland Heat Map • Home Analytics • EPC Lodgement Register • Scotland Address Gazetteer
Future buildings and projects	• Planning applications

The following sections discuss the outcomes of the energy mapping exercise, identifying areas of dense demand and opportunities for the deployment of low and zero carbon technologies.

4.1 Energy demand

4.1.1 Heat demand

Heat demand in the Energy Masterplan area has been mapped using the data available from the Scotland Heat Map and Home Analytics datasets.

There are high heat demand-dense areas along the Clyde in Glasgow City, followed by the neighbouring areas in Renfrewshire and South Lanarkshire as well as around Inverclyde, compared to the rest of the study area.

In the western portion of the study area, the towns of Dunoon, Greenock and Helensburgh stand out as the more heat dense areas in this section of the Energy Masterplan boundary, which is generally the more rural end of the Clyde Mission boundary.

Around Dalmuir, Erskine and Renfrew, Renfrew is the most heat dense area in this portion, becoming more heat dense towards the south of the Energy Masterplan boundary towards the centre of Paisley.

There is also significant heat demand north of the river along Clydebank towards the Golden Jubilee Hospital.

Glasgow City Centre is the most heat dense portion of the Energy Masterplan boundary, particularly to the north of the river.

Heat demand clusters

Using this heat demand information, potential opportunities can be identified using GIS to show areas where it may be economical to connect properties to heat networks.

Clusters were identified through a process of identifying anchor loads, setting buffers around these, and then grouping overlapping buffer areas to form zones with potential for heat network development.

These clusters were then filtered to include only those with 20 or more properties and two or more anchor loads.

In the Energy Masterplan area, there are several clusters with significant heat demands:

- Four between 50-100 GWh/year
- Three between 100-200 GWh/year
- One greater than 200GWh/year

Clusters of interest are found mainly in the dense urban areas of Glasgow, as well as Renfrewshire, South Lanarkshire, and Inverclyde. There are some additional clusters in West Dunbartonshire and Argyll and Bute. Section 6 of this report looks at each cluster in more detail.

4.1.2 Cooling demand

Along the River Clyde, there are significant cooling demand-dense areas in Renfrewshire, Glasgow City, South Lanarkshire, West Dunbartonshire, and Inverclyde.

The cooling demand was estimated for non-domestic buildings with reference to the building type, floor area, and benchmarks for annual energy consumption for cooling. Domestic buildings are assumed not to

have cooling. Not all buildings in the area have enough data available to include them in the analysis – these have been excluded.

Data sources are presented in Table 4.2.

Table 4.2. Cooling demand data sources

Type	Datasets
Building Typology	• EPC Lodgement Register • Scotland Address Gazetteer dataset
Floor area	• Scotland Heat Map (matched by UPRN to EPC Lodgement Register and Scotland Address Gazetteer dataset)
Cooling energy benchmark	• Building Energy Efficiency Survey

The building typology is used as an indicator for energy usage intensity for cooling – for example, some building typologies have a higher demand per unit floor area than others.

The datasets available for non-domestic buildings in Scotland are of varying quality, and those with detailed information about the building systems (for example, the EPC dataset), generally have limited coverage.

The Scotland Heat Map is the most complete dataset; however, it does not contain typology categorisation of non-domestic buildings.

Therefore, the EPC Lodgement Register and Scotland Address Gazetteer dataset have been matched to the Scotland Heat Map by UPRN to indicate the property type.

Many buildings present on the Scotland Heat Map could not be matched to the Scotland Address Gazetteer and therefore have no cooling demand assigned to them.

As noted in the introduction to this section, data availability for non-domestic buildings is poor. As such, areas that would be expected to have significant cooling demand, such as Glasgow City Centre north of the river, are not shown in this analysis to have a particularly large cooling demand.

There is a large challenge in Scotland relating to collecting data from non-domestic buildings.

In the meantime, energy projects coming forward should engage directly with stakeholders in the surrounding areas to determine the scale of cooling demand.

In the western portion of the masterplan boundary, the analysis has picked up some significant cooling demand in Greenock, particularly in the area around the Waterfront Leisure Complex, where there are a number of supermarkets and leisure buildings that may be expected to have cooling demand.

Analysis in the middle portion of the Energy Masterplan boundary picked up areas of dense cooling demand in Renfrew, around the Golden Jubilee Hospital and around Clydebank, including the Clyde Shopping Centre.

Typically, it would be expected that there would be higher cooling demand in Glasgow City Centre, particularly in offices, but this was largely not represented in the results.

This demonstrates the poor availability of data upon which to draw conclusions about cooling demand.

4.1.3 Power demand

Power demand density is highest along the River Clyde in Renfrewshire, followed by Glasgow City, Inverclyde, West Dunbartonshire, Argyll and Bute, and South Lanarkshire.

The power demand was estimated for all buildings with reference to the building type, floor area, and benchmarks for annual energy consumption for electricity.

Data sources are presented in Table 4.3.

Table 4.3. Power demand data sources

Type	Data sets
Building Typology	• EPC Lodgement Register • Scotland Address Gazetteer dataset
Floor area	• Scotland Heat Map (matched by UPRN to EPC Lodgement Register and Scotland Address Gazetteer dataset)
Electricity benchmark	• Building Energy Efficiency Survey

Analysis showed that Glasgow City Centre and Greenock are areas with the highest density of electricity demand.

Energy generation opportunities

In this section, existing and proposed energy resources within the energy masterplan area are presented in a series of maps which highlight specifically:

- Potential low-grade waste heat sources available
- Existing renewable energy assets
- Potential future renewable energy projects which are in the planning process
- Areas which offer the highest potential for wind and solar PV generation within the energy masterplan area

The aim of this section is to assist in identifying potential future energy projects and highlight opportunities for collaboration.

Section 5 discusses the range of technologies applicable in the Clyde Mission area in more detail.

4.1.4 Existing energy installations

Low-grade sources of waste heat – those that are at a low temperature, usually considered to be below 50°C – can be upgraded to higher temperatures for use in heat networks by heat pumps. This includes sources such as effluent from wastewater treatment plants and heat rejected from refrigeration systems.

The Building Research Establishment published a paper[10] in September 2020 indicating that the scale of waste heat availability in Scotland accounts for approximately 3% of national heat demand.

Information in the GIS dataset for the Energy Masterplan includes existing installations of renewable technology, in addition to indicators of potential waste heat that could be used in heat networks.

Sites not included in the mapping for the Energy Masterplan, but that have been identified by the research as considerations for incorporation into heat networks include:

- Data centres
- Supermarkets
- Bakeries
- Breweries
- Distilleries
- Paper and pulp factories

[10] Potential sources of waste heat for heat networks in Scotland, accessed 29th January 2021

When proposing heat networks in a particular area, it is useful to consider these types of energy installation already in the installations:

- Wastewater treatment plants
- SEPA waste incineration sites
- Large combustion sites
    - Sites indicated by the National Atmospheric Emissions Inventory (NAEI) as large point sources which result in high carbon emissions through combustion
- Existing heat networks
    - Operational and in-development heat networks, as indicated by the Scotland Heat Map

The Scotland Heat Map includes information on existing renewable energy installations.

It is important to consider what other low carbon and renewable energy installations are already present within the area, as an indication of the types of technologies to consider implementing as well as potential sites for connection to if the site has enough headroom to support additional connections.

There is a need to make the best use of existing energy, such as unused excess heat and renewables. The energy supply layer highlights these opportunities, with the data having been identified from a range of sources that include existing and planned sites for energy generation.

The 2020 Scotland Heat Map is a useful dataset to visualise renewable installations from, as the dataset also provides the user with the site name, location, capacity in kW_e, technology type, and status as example fields.

In addition to the Scotland Heat Map, information on future energy installations has been drawn from planning application data made available by the Improvement Service.

Whereas the Scotland Heat Map only includes operational sites, this dataset includes sites that have been refused planning permission or where applications have been withdrawn.

4.1.5 Wind turbine opportunities

The Wind Turbine Spatial Framework classifies areas by their suitability for onshore wind turbine development, falling into one of three groups as described in Table 4.4.

Table 4.4 Wind Turbine Spatial Framework Groups

Group	Description
Group 1	Areas where wind farms will not be acceptable: National Parks and National Scenic Areas
Group 2	Areas of significant protection: Recognising the need for significant protection, in these areas wind farms may be appropriate in some circumstances. Further consideration will be required to demonstrate that any significant effects on the qualities of these areas can be substantially overcome by siting, design, or other mitigation.
Group 3	Area with potential for wind farm development: Beyond groups 1 and 2, wind farms are likely to be acceptable, subject to detailed consideration against identified policy criteria. Reference should be made to Scottish Government planning and renewable energy policy. In the first instance, this is Scottish Planning Policy (June 2014) paragraphs 161 to 174, in the context of the overarching policy of "A Low Carbon Place".

Much of the area of the Energy Masterplan falls into Group 2, indicating areas of significant protection – where wind farms may be appropriate in some circumstances.

Generally, wind speeds around the Energy Masterplan boundary are between 5 and 6 m/s at a 50m hub height.

Generally, a wind speed of 6.5m/s or greater us considered to be required for wind turbine viability. Therefore, there may be some localised opportunities for wind turbines in the Energy Masterplan; however, these opportunities are not as great as in other areas of Scotland.

4.1.6 Solar PV opportunities

Solar PV can be deployed at a small scale, for example domestic-scale roof-mounted panels, or at a large scale, such as in solar farms.

The Clyde Valley has solar global horizontal irradiation (GHI) in the region of 900-1000 W/m^2 on a horizontal plane, indicating good potential for yield from solar panels.

More detailed studies would be required to determine the yield at a building level, considering roof orientation and overshadowing, however the high GHI in the area indicates that solar PV would generally be a viable technology.

The map also indicates sites of Vacant and Derelict Land. Some persistent sites of Vacant and Derelict Land, or those with difficulties regarding flood and other environmental risks, may be considered as potential sites for large-scale solar development, for example PV farms.

4.2 Strategic land use opportunity areas

The aim of this section is to provide context to the types of land that may be suitable for low carbon energy projects. Alongside seeking to accelerate Scotland's progress to net zero, the Clyde Mission is seeking to use vacant and derelict land for the benefit of the economy, the environment, and communities. Energy projects may form part of this.

Energy projects may be especially appropriate for sites of vacant or derelict land, aiding in bringing the land back into productive use and supporting the Clyde Mission and Scotland's decarbonisation and development goals.

City Deal projects could offer opportunities for low-carbon technology deployment especially in new developments. The deployment of low-carbon technologies could then be extended to encompass existing developments surrounding the new development.

Other land classes also important to consider include land zoned for business and industrial use, housing, community growth areas, and strategic economic investment (priority locations to promote the Scottish Government's key economic sectors and Scottish Enterprise's locational priorities.)

In the western portion of the Energy Masterplan boundary. There are a number of strategic sites around Inverclyde, including large sites of vacant and derelict land, that may be suitable for low carbon energy projects.

There are several key sites in the middle portion of the Energy Masterplan boundary, including the large Community Growth area near Bishopton, part of which is also designated as Vacant or Derelict Land.

In Glasgow, there are large portions of Strategic Economic Investment Land, and a network of Vacant and Derelict Land sites.

4.3 Constraints

Energy project-specific constraints considered, which may include aspects such as:

- Electricity substation headroom
- Protected sites and ecology
- Air quality management areas (AQMAs)
- Major roads and railways

4.3.1 Protected sites and ecology:

Protected areas pose a major constraint for the implementation of low carbon projects. Protected areas to consider include the following:

- Sites of Special Scientific Interest (SSSI)
- National Nature Reserves (NNR)
- Areas of Outstanding Natural Beauty (AONB)
- Special Protection Areas (SPA)
- RAMSAR sites

4.3.2 Air Quality Management Areas (AQMAs):

Each local authority within the UK is required to carry out a review and assessment of air quality within the LA area, which involves measuring air pollution and predict how it will change. This is undertaken to ensure that the national air quality objectives will be achieved, objectives that have been put in place to protect people's health and the environment.

If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area there. This area could be just one or two streets, or it could be much bigger. 90% of AQMAs declared within the UK are related to traffic emissions.

AQMAs will affect the implementation of some combustion related energy generation systems such as Biomass, which may not comply with the Air Quality Management Plan for the designated AQMA.

4.3.3 Major roads and railways:

Major roads and railways also pose a constraint to some low carbon projects due to restrictions on connecting properties either side of the constraint. Major roads can be defined by the user but typically include motorways and A-roads.

4.3.4 Electricity substation headroom

This is important to consider as a constraint to low carbon energy projects, as many of these will be based on electrically driven technologies such as heat pumps. If there is insufficient grid capacity or substation headroom in the area, then reinforcement of the electricity grid will be required to support the deployment of such projects.

5 Technology assessment

The Energy Masterplan area has a wealth of resources available which could be developed into low carbon heat and energy projects. This section of the document presents a qualitative technology assessment, which provides an indication of the overall suitability for several technologies in the Energy Masterplan area.

5.1 Technologies

Technologies are presented in the following groups:

- Energy efficiency
- Heat pumps
- Waste heat recovery
- Renewable energy
- Biomass and biofuel
- Electric boilers
- Hydrogen
- Energy infrastructure
- Storage
- Traditional fuels

Energy Efficiency

More than 40% of Scotland's GHG emissions are as result of the heating, lighting, and ventilation of buildings. Retrofitting existing buildings to reduce heat demands is an important step alongside transitioning heating systems to low and zero carbon heating technologies. The energy efficiency improvement of buildings in Scotland is supported by the Energy Efficient Scotland Programme. Pre-1919 tenements and other stone constructed houses and commercial buildings which are commonly found within the Energy Masterplan area are the most difficult to treat in terms of developing and implementing appropriate and cost-effective energy efficiency solutions. These properties are often not suited to cavity wall insulation or external wall insulation. There are also other significant issues such as ownership titles, common ownership, turnover and obtaining financial contributions from multiple different owners. The replacement of single glazed windows can also be problematic and expensive in conservation areas.

Heat Pumps

Heat pumps are a proven low carbon heat technology for the Energy Masterplan area. By extracting the low-grade heat from different sources through an electrically-driven compression cycle, heat pumps can deliver very efficient electrical heating – typically more than three times more efficient than conventional electric resistive heaters.

Water Source Heat Pumps

Surface-water heat pumps can play an important role in decarbonising the Energy Masterplan's heat sector particularly when connected to a district energy network in a densely populated urban environment. Water-source heat pumps can be a more efficient alternative to air source heat pumps as the River Clyde remains warmer than air on the coldest days.

There are several technical, economic, and environmental considerations which need to be accounted for when assessing the feasibility of a river-source heat pump, these include:

- **Tidal or not:** The River Clyde is tidal up to the Weir at Glasgow Green in the heart of the city. The minimum water level will need to be established to determine the feasibility of abstraction from the river.
  If the river is tidal at the point of abstraction under consideration, the Crown Estate Scotland may own the seabed and/or the foreshore, therefore an occupancy agreement may be required from the Crown Estate Scotland. Permission from the harbour/port authority may also be required. A marine licence is required for construction, alteration or improvement works required below the mean water high springs (MHWS) tide.
- **SEPA:** For inland open loop surface water heat pumps, the abstraction volume will determine the level of authorisation required under Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR). A point source simple licence would be required if the temperature change exceeds 3°C.
  For coastal and transitional abstractions, an abstraction registration is required and a point source simple licence if the ΔT between the abstraction and discharge exceeds 3°C.
- **Water salinity and quality:** The water quality in the area will determine the filtration requirements. The abstraction of seawater, for example, locations on the River Clyde downstream of the weir at Glasgow Green where seawater is present, will require the use of more expensive corrosion resistant equipment on the abstraction-side of the heat pump.
- **Filtration requirements:** A very fine filter is likely to be required to prevent fish abstraction, mussel seed entering and fouling the heat exchanger as well as silt.
- **Preferred abstraction and discharge structure:** a bank-side intake structure will be less complex and costly compared to a submerged "in-river" intake.
- **River temperature profile and variability with depth:** The source-temperature will influence the efficiency of the water-source heat pump therefore the temperature profile may dictate the

location of the abstraction point from the river. The source temperature will also influence the running hours and heat output. According to CIBSE CP2 for the purpose of feasibility studies assuming a ΔT of ±3°C is a reasonable starting point. This will need to be discussed in more detail with SEPA as projects progress.

- **Heat network flow and return temperatures:** the river-source heat pump will operate more efficiently, the smaller the temperature difference between the source and load-temperature.

Other factors which should be considered include the ground conditions where the energy centre will be located. Ground conditions near the riverbank tend to be poor and often require extensive piling to enable construction. These challenges are not unique to water-source heat pumps but rather riverside developments in general.

Waste Heat Recovery

There are assets along the River Clyde that produce waste heat. These assets could potentially provide low carbon heat to buildings, particularly where they are located in close proximity to clusters of high heat demand density where a heat network may be viable.

- Wastewater Treatment Works (WWTW)
- Industrial process heat recovery
- Energy from Waste (EfW)

Heat can be recovered from wastewater and upgraded using water-source heat pumps. Scottish Water Horizons are actively identifying opportunities to serve heat demand clusters in close proximity to their wastewater treatment works using water-source heat pumps. The benefits of using wastewater from WWTWs include the stable year-round temperature which can deliver high seasonal COP as a result.

The recovery of waste heat from industrial processes can provide a cost-effective heat source to heat networks and also an additional revenue stream for the industry providing the waste-heat. An important consideration when exploring waste-heat recovery opportunities from industrial processes is the quality and quantity of heat available to the heat network and also the proximity of the waste-heat source to the heat demand cluster.

The Draft Heat in Buildings Strategy specifically references the important role which heat recovered from EfW will play in Scotland's heat networks. The Scottish Government has set out in Scotland's Fourth National Planning Framework: Position Statement that a potential change to planning policy will be to encourage applications for EfW facilities to provide a connection to a heat network. The Scottish

Government will consult in 2021-2022 on whether there is need for further regulatory measures or support measures to increase the capture of waste or surplus heat, for example from Energy from Waste plants, to be supplied and/or used through heat networks. There are two EfW plants in close proximity to the Energy Masterplan area. The South Clyde Energy Centre which is not yet operational lies in close proximity to the Queen Elizabeth University hospital as well as the proposed Glasgow Riverside Innovation District. It will have the capability to export up to 35 MW_e and up to 12MWth. The Glasgow Recycling and Renewable Energy Centre at Polmadie operated by Viridor handles 350,000 tonnes of waste each year and can generate up to 11 MW of electricity.

Renewable Energy

There are natural resources available in the Energy Masterplan area which could be used to generate renewable heat and/or electricity.

- Ground mounted solar photovoltaics could potentially be situated in areas of vacant or derelict land to generate renewable electricity.
- Roof-mounted solar photovoltaics could be installed at the building level, where there are accessible, unshaded, south-facing roof area. Local Authorities, Social Housing organisations could consider a programme of roof-top solar PV for their building estates.
- Solar PV carports could be considered in areas where there are carparks, especially where there are Electric Vehicle (EV) charging points.
- Solar thermal collectors may be appropriate for buildings with significant domestic hot water demands, such as pools, gyms, and hotels.
- Wind turbines could potentially be located in rural locations where there are suitable windspeeds and few planning constraints (Section 4.1.5 wind turbine opportunities.)
- Hydroelectric (run of river) projects could be considered where there are suitable flow rates on the River Clyde.

Electric Boilers

- Electric boilers may form part of a low carbon heating solution. As the electricity grid decarbonises with increasing renewable and low carbon technologies electricity supply to the grid, carbon emissions associated with electric heating are reducing.
- Electric boilers at the building level can remove the need for a natural gas connection however the operating costs of such a system in a residential setting is likely to be high. As part of a low

carbon heating approach, electric boilers are likely to provide top-up or backup heating for heat networks where the primary heat supply may be a heat pump or other technology. Power-to-heat technologies such as electric boilers and heat pumps have the potential to enable the integration of large shares of variable renewable energy e.g. wind and solar. Electric boilers offer demand side flexibility particularly when integrated into district heat networks, they can be utilised when there is excess electricity generation and the price of electricity is low and turned off when electricity demand is high, and the cost of electricity is high. Electric boilers are inexpensive but can only generate heat on a ratio of 1:1. In Denmark, there is over 400 MW of electric boilers used in the district heating sector.

Biomass and Biofuel

Biomass and biofuel can form part of a sustainable energy strategy for the Energy Masterplan area – where it is sourced sustainably. Biomass is often purchased as wood chips or wood pellets, while biogas is a gas fuel derived from organic matter such as food scraps or animal waste. These fuel sources can be used in Combined Heat and Power (CHP) units or boilers.

The advantage of a CHP, also known as co-generation, is increased fuel efficiency - heat and power are generated from the fuel, and there are no (or low) transportation losses to the location where it is used, in contrast to a traditional distribution grid with losses over distance. CHPs require a steady base heat load to operate, so tend to be used in energy centres serving distilleries, hospitals, hotels, swimming pools, and other buildings with a steady, diverse heat load.

Tri-generation, delivering electricity, heating, and cooling, is also an option. This can be done by adding cooling to the system, for example, by adding absorption chillers.

- Biomass could potentially be used in the Energy Masterplan area – outside areas where there are air quality concerns such as air quality management areas, and in locations where there is space and access for a woodchip or wood pellet store.
    - Biomass CHP capacity is generally in the order of megawatts (MW). These are suited to energy centres with significant heat demands
    - Biomass boilers are available in a range of capacities, and they require regular maintenance by a trained service provider to operate well
- Biogas

- Biogas CHPs often use methane gas produced from an anaerobic digestion process
- Biogas boilers are also often paired with an anaerobic digestor. In cases where biogas is flared from sources such as landfills, there could be an opportunity to use a biogas boiler to provide heat instead – where the biogas is of an appropriate quality and flow

Hydrogen

Hydrogen is noted in the draft Heat in Buildings Strategy as a longer-term option, best deployed where there is a local supply and/or a concentration of industrial demand. It is likely to play only a limited role before 2030. Therefore, this strategy does not focus on hydrogen as a low carbon heat source for deployment in projects in development. Hydrogen offers opportunities as a fuel and energy store. At the point of use, the combustion of hydrogen produces no carbon dioxide. Over time, hydrogen is anticipated to play an increasing role in the transition to a low carbon economy. In theory, 39 kWh of electricity and 8.9 litres of demineralised water are required to produce 1 kg of hydrogen at 25°C and 1 atmosphere pressure. Typical commercial electrolyser system efficiencies are 56%–73% and this corresponds to 70.1–53.4 kWh/kg. Using water from the River Clyde is likely to require significant treatment prior to its use in hydrogen production. This treatment is likely to increase the cost of the installation and also adversely affect the system efficiency.[11]

- Hydrogen can be produced from industrial processes. One of the proposed projects in the Energy Masterplan area is to produce hydrogen from an existing process. This hydrogen could then be used as a fuel
- Hydrogen fuel cells use an electromagnetic cell to convert the chemical energy of hydrogen into electricity using an oxidation reaction. Fuel cells are useful to generate electricity where hydrogen is available as a fuel
- Hydrogen fuel cell CHPs provide combined heat and power, and are available at the utility, industrial, and commercial scale
- Hydrogen-ready boilers can use either natural gas or hydrogen. These could be used as part of a transition from a natural gas network to a future hydrogen network.

[11] NREL. (2004). Technology Brief: Analysis of Current-Day Commercial Electrolyzers. Available: https://www.nrel.gov/docs/fy04osti/36705.pdf. Last accessed 04/03/2021.

Energy Infrastructure

- Electric Vehicle (EV) charging infrastructure, including EV charging points and electricity cabling is useful to consider as part of a programme to transition to EV transportation
- Heat network infrastructure, such as energy centres, networks for heating and cooling, and building connections is integral to low carbon energy plans serving clusters of buildings with dense energy demands
- Private wire, for example, an electricity connection from wind turbines, ground mounted solar arrays, or CHPs to the point of use can be economically beneficial where a direct connection over a relatively short distance is needed

Storage

- Building-scale
    - Thermal Energy Stores (TES) are normally included in heat network projects. They allow heat to be stored when more heat is generated than used, and this heat is used later. TES help to balance demand by allowing a lag between the time of heat generation and heat use.
    - Batteries can be useful for small energy consumers where the aim is to maximise onsite use of onsite energy generation from sources such as photovoltaics. In cases where there is some electricity export, batteries could be used to charge during the day and discharge in the evening.
    - Hydrogen can act as an energy storage fuel. In the future, hydrogen may play a stronger role in the route to decarbonisation
- Large-scale. In terms of electricity infrastructure, there is a space for energy storage. When grid infrastructure is considered, in the Energy Masterplan area, the following types of storage could be considered in creating a more robust and adaptable energy grid:
    - Batteries. This could include Lithium ion batteries, lead batteries, redox flow batteries, vanadium redox flow batteries, nickel-cadmium batteries, sodium sulphur batteries, and others
    - Mechanical – Flywheels can be used when short-term backup power is required because utility power fluctuates or is lost

- Mechanical - Compressed Air Energy Storage (CAES) can store energy at a utility scale, using energy generated at periods of low energy demand at times of higher demand

Traditional Fuels

Traditional fuels including natural gas (and natural gas CHP), coal, oil, and nuclear are available; however, they are not recommended as low carbon fuels or low carbon technologies to situate in the Energy Masterplan area. Natural gas, coal, and oil have relatively high greenhouse gas emissions compared to low or zero carbon technologies. A nuclear project would have its own issues around safety, scale, safe storage of waste as well as associated environmental considerations related to waste.

5.2 Qualitative technology multi-criteria analysis

This section assesses potential energy technologies that could be used to supply energy in the area, using a Multi Criteria Analysis (MCA). A range of available heat sources and technologies have been reviewed.

The categories against which the technologies have been assessed are:

- **Capital costs**: Cost of buying and installing the equipment, with high capital expenditure shown as red and low capital expenditure shown as green
- **Operational costs**: Typical cost of operating and maintaining the technology, including fuel costs
- **Decarbonisation**: Impact on carbon emissions. Zero carbon technologies are scored green, whilst technologies that result in carbon emissions above the baseline are scored red.
- **Technology risk**: Indicating technology maturity in the Scottish market.
- **Local environmental impact**: Including impacts on local air quality and ecology
- **Overall suitability:** Technologies suitable in the Energy Masterplan area

Table 5.1 provides a qualitative review for each technology in the context of the Energy Masterplan. A 1-3 scale is used to indicate positive, neutral, and possible negative aspects of the technology that must be considered in the context of the area. The scale is as follows:

- 3 indicates a positive impact, opportunity of advantage of using the technology
- 2 indicates a medium or neutral impact
- 1 indicates potential large challenges and considerations of using the technology

Table 5.1 Technology Multi Criteria Analysis

			Capital costs	Operational costs	Decarbonisation	Technology risk	Local environmental		**Overall suitability**
Energy efficiency									

			Capital costs	Operational costs	Decarbonisation	Technology risk	Local environmental		**Overall suitability**
		Retrofit buildings to reduce heat demand	2	3	3	3	3		**3**
Heat pumps									
		Air source (ASHP)	3	2	3	3	3		**3**
		Ground source (GSHP) - Closed loop	2	2	3	3	3		**3**
		Ground source (GSHP) - Open loop	2	2	3	3	3		**3**
		Water source (WSHP) - Closed loop	2	2	3	3	2		**3**
		Water source (WSHP) - Open loop	2	2	3	3	2		**3**
Waste heat recovery									
		Industrial process heat recovery	3	3	3	3	3		**3**
		Wastewater Treatment Works (WWTW)	2	2	3	3	3		**2**
		Energy from Waste (EfW)	1	2	3	2	2		**2**
Renewable energy									
		Solar photovoltaics	3	3	3	3	3		**3**
		Solar thermal water heaters	3	3	3	3	3		**3**
		Wind turbines	3	3	3	3	2		**2**

			Capital costs	Operational costs	Decarbonisation	Technology risk	Local environmental		**Overall suitability**
		Hydroelectric (run of river)	2	2	3	3	2		**2**
Biomass and biofuel									
		Biomass Combined Heat and Power (CHP)	2	2	3	1	2		**2**
		Biogas Combined Heat and Power (CHP)	2	2	3	2	2		**2**
		Biomass Boiler	2	2	3	2	2		**2**
		Biofuel Boiler	2	2	3	2	2		**2**
		Anaerobic digestion	2	2	3	2	2		**2**
Electric boilers									
		Electric boiler	3	1	3	3	3		**3**
Hydrogen									
		Hydrogen produced from industrial process	1	2	3	2	3		**3**
		Fuel cell	1	1	2	2	3		**2**
		Combustion Combined Heat and Power (CHP)	1	1	2	2	3		**2**
		Boiler	2	1	2	2	3		**2**
		Industrial uses	2	1	2	2	3		**2**
Energy infrastructure									
		EV charging infrastructure	2	3	3	3	3		**3**

			Capital costs	Operational costs	Decarbonisation	Technology risk	Local environmental		**Overall suitability**
		Heating or cooling network infrastructure	2	3	3	3	3		**3**
		Private wire	2	3	3	3	3		**3**
Storage - building scale									
		Thermal Energy Store (TES)	3	3	2	3	3		**3**
		Batteries	2	3	2	2	3		**2**
		Hydrogen	1	2	2	1	3		**2**
Storage - utility scale									
		Batteries	1	2	2	2	3		**2**
		Mechanical - Flywheel	1	2	2	2	3		**2**
		Mechanical - Compressed air	1	2	2	2	3		**2**
Traditional fuels									
		Natural Gas CHP	2	3	1	3	2		**2**
		Natural gas	2	2	1	3	1		**2**
		Coal	2	2	1	3	1		**1**
		Oil	2	2	1	3	1		**1**
		Nuclear	1	1	3	2	3		**2**

6 Energy project long list

The energy project long list includes projects proposed by stakeholders, heat demand clusters where projects could be extended or considered in the future, and a list of suitable low carbon and energy infrastructure technology types that could be considered overall in the Energy Masterplan area.

From the energy project long list, four pre-feasibility stage projects have been highlighted for consideration to progress to the feasibility study stage, with both Scottish Government and private funding (Section 7 Feasibility study definition).

6.1 Stakeholder engagement process

Stakeholders have provided input into the energy project long listing for the Energy Masterplan area. From the beginning of the Energy Masterplan project, the Clyde Mission Team shared the aim to consider low carbon technologies and energy infrastructure, with the potential to accelerate Scotland's progress to net zero while contributing to the Clyde Mission's other aims, including bringing vacant and derelict land back into productive use and creating new, good and green jobs. Regular progress meetings with the Clyde Mission Team, Zero Waste Scotland, and Buro Happold informed the development of the masterplan.

A stakeholder briefing workshop, held on 10th December 2020, was well attended by Clyde Mission partners, Local Authorities, and interested stakeholders from across the public, private and third sectors. Over 100 delegates attended the online workshop, from the organisations listed below.

At the stakeholder briefing workshop, a short presentation about the Energy Masterplan was made, followed by an initial request for information to the stakeholders about potential projects in the Energy Masterplan area.

- Clyde Mission Partners
  - Scottish Government (LCITP), Clyde Gateway, Scottish Enterprise, Strathclyde University, and Glasgow University
- Local Authorities
  - Glasgow City, South Lanarkshire, Inverclyde, West Dunbartonshire, Argyll & Bute and Renfrewshire
- Non-governmental organisations
  - Scottish Futures Trust (SFT)
- Stakeholders
  - Scottish Event Centre (SEC), NHS Greater Glasgow and Clyde (GCC)
- Environmental

    - British Geological Survey
- Infrastructure
    - Scottish Water Horizons, Scottish Gas Networks (SGN), Scotland 5G Centre, BBC, STV, Peel Energy, Peel Land and Property, Barclays
- Knowledge and skill transfer
    - University of West Scotland (UWS), Scottish Engineering, Energy Technology Partnership, Energy Skills Partnership (ESP), Skills Development Scotland (SDS)
- Media
    - Glasgow Clyde Radio (GCR)
- Consultancies
    - Jacobs, Arup, BAE systems, Ramboll, Sniffer, Stantec, Vital Energi

The response from stakeholders was very positive, with information provided for over 30 potential low carbon and energy infrastructure projects in the Energy Masterplan area. Following this, stakeholders provided additional information in response to a supplementary request for information.

6.2 Stakeholder-proposed projects

Stakeholders provided information for 37 potential projects in the Energy Masterplan area, as detailed in Appendix A. They are at varying stages of development: concept idea, pre-feasibility, feasibility, Outline Business Case (OBC), pre-planning, contract awarded, and construction.

Stakeholders proposed a variety of projects based on a wide range of low carbon technologies and infrastructure, which are summarised in Table 6.1.

Table 6.1. Low carbon technologies proposed by stakeholders

Type	Technology
Energy efficiency	Energy efficient building fabric for new builds DHW and pool pump optimisation Refurbishment for school
Heat pumps	Water source heat pump (WSHP) using the River Clyde Ground Source Heat Pump (GSHP) Air Source Heat Pump (ASHP)

Type	Technology
	Steam raising high temperature heat pump (distillery) Deep geothermal
Waste heat recovery	Energy from Wastewater Treatment works (WWTW) Energy from Waste (EfW)
Renewable energy	Wind turbine, Roof-top solar PV, Solar PV carport
Biomass and biofuel	Biomass boiler
Hydrogen	Produce hydrogen from industrial process (gasification)
Energy infrastructure	Heat network Steam network Ambient loop heating and cooling network (5th generation) Smart grid Electric Vehicle (EV) charging E-bike charging
Storage	Building-level battery storage
Traditional fuels	Natural gas-fired CHP, Natural gas-fired boilers

6.3 Heat demand clusters as locations for potential projects

This section presents heat demand clusters in the Energy Masterplan area. In Appendix A, each cluster is shown as a one-page summary including maps and information on stakeholder-proposed projects in or near the cluster, low carbon heat opportunities, and high-level constraints.

Where there are proposed projects in or near the heat demand clusters, this could offer an opportunity to expand the project, based on awareness of nearby heat demands.

Where there are not yet any proposed projects in or near the projects, these clusters could be treated as future locations to consider exploring low carbon or energy infrastructure projects.

Where there are resources present in the clusters which could be used with low carbon technologies, these are presented in the information for each cluster. Resources highlighted include access to the River Clyde for water source heat pumps, waste heat recovery opportunities, where anaerobic digestion plants are present, and stakeholder-proposed projects. For the heat demand clusters, heat networks could be considered along with storage in the form of thermal energy stores (TES).

The criteria for considering resources in heat demand clusters is presented in Table 6.2.

Table 6.2. Technologies identified by resource opportunities in clusters

Type	Technology	Criteria
Heat pumps	Water source heat pumps (WSHP)	Access to River Clyde
Waste heat recovery	Industrial process heat recovery	Industrial process with waste heat
	Wastewater treatment works (WWTW)	Presence of WWTW activity
	Energy from Waste (EfW)	Presence of EfW activity
Biomass and biofuel	Anaerobic digestion (AD)	Presence AD activity Not in Air Quality Management Zones
Hydrogen	Hydrogen produced from industrial processes	Presence industrial process and proposed project
Energy infrastructure	EV charging infrastructure	Presence of proposed project
	Heating or cooling network infrastructure	Presence of heat-dense cluster

	Private wire	Presence of proposed project
Storage - building scale	Thermal Energy Store (TES)	Presence of heat-dense cluster

6.4 Other potential projects

In the Energy Masterplan area, there will be opportunities for other low carbon and energy infrastructure projects, in addition to the stakeholder-proposed projects and the heat demand clusters.

Technologies which could be considered in other areas are presented in Table 6.3. The Multi Criteria Analysis of energy technologies undertaken in Section 5.2 can be used to identify potential future low carbon and energy infrastructure projects.

Table 6.3. Technologies with overall suitability for the Energy Masterplan area

Type	Technology	Criteria
Energy efficiency	Retrofit buildings to reduce demand	Buildings with high heat demands
Heat pumps	Air source heat pump	Access to airflow, noise considerations
	Ground source heat pump	Area for boreholes or ground loop
Renewable energy	Solar photovoltaics - roof mounted	Consider on building-by-building basis
	Solar photovoltaics - ground mounted	Consider on vacant and derelict land
	Solar thermal water heaters	Consider for buildings with significant DHW demand
	Wind turbines	Areas with few planning constraints and sufficient wind resource
	Hydroelectric (run of river)	Requires sufficient flow rate
Biomass and biofuel	Biomass Combined Heat and Power (CHP)	Locations where air quality constraints not high, capacity in MW scale, Projects with sizable steady base heat load
	Biogas Combined Heat and Power (CHP)	Projects with sizable steady base heat load
	Biomass Boiler	Locations where air quality constraints not high

Type	Technology	Criteria
	Biogas Boiler	Sustainable source
Electric boilers	Electric boilers	Consider on building-by-building basis, or as energy centre top-up for heat
Hydrogen	Fuel cell	Cost of “green hydrogen” will need to be reduced
	Combustion Combined Heat and Power (CHP)	Cost of “green hydrogen” will need to be reduced
	Boiler	Cost of “green hydrogen” will need to be reduced
	Industrial uses	“Green hydrogen” may be viable for high-temperature industrial processes. Hydrogen is used in the production of chemicals, intermediates, and speciality chemicals. This is predominantly “brown hydrogen”, this could be replaced by “green hydrogen”
Energy infrastructure	EV charging infrastructure	Presence of proposed project
	Heating or cooling network infrastructure	Presence of heat-dense cluster, or cooling-dense cluster
	Private wire	Presence of proposed project
Storage - building scale	Thermal Energy Store (TES)	Presence of heat-dense cluster, heat network component
	Batteries	Cost of domestic scale electric batteries will need to reduce for wide-scale deployment
	Hydrogen	Cost of “green hydrogen” will need to reduce for wide-scale deployment

Type	Technology	Criteria
Storage - utility scale	Batteries	Excess renewable generation and grid constraints, cost of Li-ion batteries are expected to decline by 54-61% by 2030 and this will be required to enable wide-scale deployment
	Mechanical - Flywheel	Short-term storage applications, cost and efficiency improvements required for wide-scale deployment
	Mechanical - Compressed air	Existing reservoir likely to be required to enable economic storage

7 Feasibility study definition

The Energy Masterplan shows where existing energy demands are located (heating, cooling, and power), locations where stakeholder projects have been proposed, their spatial relationship to clusters of heat demand, as well as spatial relationships to high-level resource opportunities and constraints.

This section presents a short selection of pre-feasibility stage projects. From the energy project long list, four pre-feasibility stage projects have been highlighted for consideration to progress to the feasibility study stage, with Scottish Government funding.

The shortlisted pre-feasibility stage projects are summarised in Table 7.1.

A multi criteria analysis (MCA) approach, agreed with the Clyde Mission Team, was used to identify projects to propose to progress to the next stage. The process is covered in the accompanying Project Shortlisting MCA report.

The highlighted projects are:

- Scottish Event Campus
- Fortum, EfW Heat Network
- Kilcreggan/Rosneath Low Carbon Heating – community scale
- Former Exxon Site Redevelopment

Table 7.1. Highlighted pre-feasibility projects

ID	Working Title	Stakeholder Title	Organisation	Location	Cluster ID	Cluster Location
1	Scottish Event Campus	Scottish Event Campus Energy Strategy	Scottish Event Campus (SEC)	SEC, Exhibition Way, Glasgow, G3 8YW	26	Glasgow
4	Fortum, EfW Heat Network	Low Carbon District Heat and Steam supply to local real estate and industrial customers	Fortum Glasgow LTD	Bogmoor Road, Glasgow, G51 4SJ	23	Hillington

18	Kilcreggan/Rosneath Low Carbon Heating – community scale	Heat from Wastewater Treatment Works	Argyll and Bute	Kilcreggan and Rosneath	N/A	No cluster identified
8	Former Exxon Site Redevelopment	Low Carbon Commercial and Industrial Estate - Former Exxon Site	West Dunbartonshire Council	Bowling Harbour, Dumbarton Road, Bowling, G60 5AF	N/A	No cluster identified

7.2 Scottish Event Campus (SEC), Glasgow

Project Name: Scottish Event Campus

Stakeholder Title: Scottish Event Campus Energy Strategy

Proposed Project ID: 1

Location: SEC, Exhibition Way, Glasgow, G3 8YW

Technologies: Wind turbine, PV and WSHP/GSHP connected to a heat network with battery storage and smart grid

Scale: 12,000MWh power, 7,000MWh heating and cooling

Heat Demand Cluster: Glasgow (Cluster ID: 26)

Description

The SEC is Scotland's largest exhibition and event centre. The SEC has proposed to reduce its current natural gas consumption for heat generation through the development of a water-source heat pump project which will meet a portion of the SEC's heating and cooling demand. Potentially, heat could be drawn from the heat pump which will be part of the Glasgow Harbour project.

There is potential to expand the scheme to include the adjacent Clydeside Distillery who are currently looking at the feasibility of a high-temperature heat pump to meet their process heat demands. SEC have ambitious targets for the campus to become net zero.

The project scored highly in terms of deliverability as the project is surrounded by parties interested in reducing their GHG emissions. Clydeside Distillery also proposed their project separately however there may be potential to form a communal heat network. The project has a significant potential positive economic impact due to the ambitious nature of the project. The scheme has the potential to significantly reduce carbon emissions associated with the SEC, the distillery and the Glasgow Harbour development and improve energy efficiency across these sites.

Key stakeholders:

- SEC Event Centre
- Surrounding hotels
- Clydeside Distillery
- Glasgow Harbour

Buildings:

- SEC conference centre
- The SSE Hydro
- SEC Armadillo
- Crowne Plaza Glasgow
- Hilton Hotel
- Radisson Red Glasgow Hotel
- Campanile Glasgow SECC Hydro
- Clydeside Distillery

Energy Masterplan area

The SEC is in area 4 of the Energy Masterplan (the easternmost), and is in Cluster ID 26 in Glasgow

There are multiple potential heat network anchors in the cluster

The SEC is located on strategic economic investment land

Proposed Project ID: 1

The SEC (1) is close to proposed projects: 5 and 11.

5. Glasgow harbour heat network (feasibility study)

11. Clydeside Distillery HTHP (Clydeside GreenStills Demonstrator) (pre-feasibility)

7.3 Fortum EfW Heat Network, Glasgow

Project Name: Fortum EfW Heat Network

Stakeholder Title: Low Carbon District Heat and Steam supply to local real estate and industrial customers

Proposed Project ID: 4

Location: Bogmoor Road, Glasgow, G51 4SJ

Technologies: Heat and steam generation from EfW plant, and distribution in district heat and steam networks

Scale: >20MW, 160,000MWh/a

Heat Demand Cluster: Hillington (Cluster ID: 23)

Description:

Fortum Oyj and Verus Energy recently purchased the proposed South Clyde EfW from Peel Environmental. The plant will have the capacity to treat up to 350,000 tonnes per annum of municipal, commercial, and industrial waste. According to Fortum, the Facility has been designed to export power to the National Grid. The turbine has been designed to generate up to 40 MWe of electricity (design maximum) and up to 12 MW_{th} of heat. The Facility will have a parasitic load of 5 MW_e. Therefore, the maximum export capacity of the Facility is 35 MW_e. However, as the fuel quality will fluctuate and if heat is exported from the facility to local heat users in the future, the power exported will fluctuate. The EfW is in close proximity to large potential heat consumers such as Glasgow's Queen Elizabeth University Hospital which lies to the north of the site. The EfW site and the hospital are separated by the M8 motorway and A8 Shieldhall Road. The recovery of heat from the EfW for distribution to nearby heat consumers will improve the efficiency of the EfW plant and will offset the consumption of fossil fuels for heat generation on neighbouring residential, commercial, and industrial sites. Fortum have proposed the district heating project.

This project is likely to create several hundred jobs through the construction of the EfW, the heat network, as well as the operation and maintenance of the EfW and heat network. The construction of the EfW alone is due to create an estimated 350 jobs. This project scored highly on its capacity to generate new jobs in the region. It also scored moderately on its use of a vacant "brownfield site" for the benefit of the economy, the environment, and communities. The recovery of heat from the EfW for distribution via a district heating network will improve the efficiency of the EfW. Neighbouring heat consumers who connect to the

network will offset fossil fuel consumption for heat generation and therefore reduce carbon emissions in the area. Therefore, this project scored highly in terms of energy efficiency and carbon emission reduction potential.

Key stakeholders:

- NHS Greater Glasgow and the Clyde
- Glasgow City Council
- Fortum Oyj and Verus Energy

Buildings:

- Queen Elizabeth University Hospital Campus
- Other industry nearby including Princes Soft Drinks

Energy Masterplan area

Fortum EfW Heat network is in area 3 of the Energy Masterplan boundary, and is in heat cluster 23: Hillington.

There are potential heat network anchors in the cluster, however, the proposed project is at the edge of the cluster

The proposed project includes some vacant or derelict land

Proposed Project ID: 4

The Fortum EfW Heat Network (4) is close to proposed project: 31

31. Queen Elizabeth Hospital (Feasibility Study)

7.4 Former Exxon Site Redevelopment, West Dunbartonshire

Project Name: Former Exxon Site Redevelopment

Stakeholder Title: Low Carbon Commercial and Industrial Estate - Former Exxon Site

Proposed Project ID: 8

Location: Bowling Harbour, Dumbarton Road, Bowling, G60 5AF, West Dunbartonshire

Technologies: Various, Heat Pumps, PV, energy efficient building fabric, EV charging infrastructure, heat recovery from waste plant, and others

Scale: TBC

Heat Demand Cluster: No cluster identified

Description:

The former Exxon site, one of the City Deal projects, is currently undergoing remediation works and will then be transferred to West Dunbartonshire Council. The site is attracting a £34 million investment for business and office development. A variety of low-carbon technologies have been proposed for the site. This project scored highly for its use of vacant land, its potential to harness both public and private investment as well as its potential to deliver significant carbon emission reductions compared to the business-as-usual.

Key stakeholders:

- West Dunbartonshire Council

Buildings:

- TBC

Energy Masterplan area

The proposed project is in area 3.

There is no heat demand cluster identified where the proposed project is located.

Proposed Project ID: 8

The proposed project (8) is close to proposed project 9.

9. Bowling Active/Sustainable Travel Hub (PV, EV, and E-bike charging, pre-feasibility)

7.5 Kilcreggan/Rosneath Low Carbon Heating – community scale, Argyll & Bute

Project Name: Kilcreggan/Rosneath low carbon heating

Stakeholder Title: Kilcreggan/Rosneath Low Carbon Heating - community scale

Proposed Project ID: 18

Location: Kilcreggan and Rosneath, Argyll & Bute

Technologies: Building fabric improvements, low carbon heat technologies for off-gas buildings incl. ground, air and water-source heat pumps, biomass boilers, electric storage heaters, heat storage, roof-mounted solar PV, electric battery storage and EV charging.

Scale: Community scale

Heat Demand Cluster: No cluster identified

Description:

This project relates to the coastal village communities of Rosneath and Kilcreggan, both off-gas communities looking for low-carbon heating solutions. They are located on the Rosneath Peninsula which, unlike most of the River Clyde area, is currently off mains gas grid. Rosneath has a high concentration of social housing stock, some retained by Dunbritton Housing Association (DHA) and Argyll Community Housing Association (ACHA). In Kilcreggan, the focus will be on examining low-carbon heating solutions for the primary school and local social housing. There are currently a mix of heating solutions deployed in Rosneath and Kilcreggan including direct-electric, biomass, and LPG. The project will focus on low-carbon energy solutions at an individual property level. The project will examine the potential to improve building fabric, electrify the property's heating systems, examine the potential for roof-mounted solar PV as well as suitable energy storage solutions. The project scored highly in terms of its capacity to reduce carbon emissions, whilst also improving both energy efficiency and local air quality.

Key stakeholders:

- Argyll & Bute Council

Rosneath Buildings:

- Social Housing – generally terraced
- Private Housing – including former Social Housing
- Primary School/Library – Argyll and Bute Council (Pellet Biomass)

- 2no. Places of Worship
- Bed & Breakfast Establishment
- 3no. Small Scale Retail – terraced
- Local Grocery Shop (Coop)
- 2no. Halls
- Sports Pavilion
- Boatyard
- Small Business inc. Sailmakers
- Scottish Water waste handling

Kilcreggan Buildings:

- Kilcreggan Primary School
- Kilcreggan social housing

Energy Masterplan area

The proposed project is in area 2

There is no heat demand cluster identified where the proposed project is located.

Proposed Project ID: 18

8 Commercial models and procurement

This section provides a review of options for delivery of energy projects, to inform the Clyde Mission of possible routes to procurement for the short-listed energy projects.

8.1 Commercial structures

The commercial case for any district energy project in the respective council areas should demonstrate that the scheme will have a viable procurement and contractual strategy that provides a sustainable basis for the long-term operation of the system.

Objectives

A commercial strategy needs to ensure that the project delivers an optimal return while aligning with the respective council's drivers for low carbon development. As such it needs to consider the commercial arrangements between principal parties including the council, any potential funders / investors, contractors, suppliers, and customers.

Key roles to be allocated for the development of a district energy network are given in Table 8-1. The allocation of these roles is dependent on the allocation of risks, ability to fund and requirements for participation and control.

Role	Explanation
Property developer	Often has a limited engagement with a decentralised energy project and is mainly concerned with delivery of a real estate project including compliance with planning conditions and net floor area for revenue generation.
Asset owner	The party that owns the physical assets, such as the generation technology and associated infrastructure.
Operator	Responsible for the technical operation of the energy scheme.
Retailer	The party responsible for the retailing of energy, i.e. purchasing it from the generator, arranging transportation to the consumer and sale to the consumer.

Table 8-1 Key roles associated with a heat network

Options available

In development of scheme options, the councils in the Clyde Mission area will decide the formal role they will take in the design, installation, commissioning, and long-term operation of the system. If no private sector involvement is possible (e.g. due to lack of commercial performance for private sector involvement) or desired, then the council can choose to self-deliver and operate the network. Councils have access to low cost finance through the Public Works Loan Board as well as other potential sources of public funding such as the Low Carbon Infrastructure Transition Programme (LCITP) and could benefit from the revenue generation of the scheme.

The commercial structure options are outlined in Table 8-2. This table, provided in Code of Practice Heat Networks (CIBSE), shows that the system can be broken down as required.

Option	Energy centre		Heat network		Heat Supply
	Own	Operate	Own	Operate	
A	PSCo	PSCo	PSCo	PSCo	PSCo
B1	LA	LA	LA	LA	LA
B2	LA	PSCo	LA	PSCo	LA
C	SPV	SPV	SPV	SPV	SPV
D1	PSCo	PSCo	LA	LA	PSCo
D2	PSCo	PSCo	LA	LA	LA
D3	PSCo	PSCo	SPV	SPV	PSCo
E1	LA	LA	PSCo	PSCo	PSCo
E2	LA	LA	PSCo	PSCo	LA
F	COCo	COCo	COCo	COCo	COCo

LA – Local Authority

PSCo – private sector company

SPV – public-private special purpose vehicle

COCo – community owned company

Table 8-2 Ownership and operation options (Heat Networks Code of Practice CP1)

The possible structures are summarised in Table 8-3.

Commercial structure	Description
Private ESCo	Common approach whereby a private ESCo company installs, owns, and operates the district

Commercial structure	Description
	heating network and acts as the energy service provider. Where the scheme is likely to be attractive to a private ESCo, this can remove any burden of operation and maintenance from the Council.
Council owned (direct involvement)	Council undertakes delivery and operation of the project in its entirety. This will include sourcing all necessary funds, undertaking procurement, and owning and operating the scheme including acting as heat supplier to end customers. Any capacity the Council does not have in house would be contracted to third parties, e.g. through operating and maintenance contracts with equipment suppliers, and billing and metering with a dedicated company. The Council gains more strategic control, but also takes on more risk.
Council owned (DBOM)	If there is not appetite for the Council to operate the network directly, this can be done via a Design, Build, Operate and Maintain (DBOM) contract in which a private entity is responsible for design and construction as well as long term operation and maintenance. The public sector secures the project's financing and retains the operating revenue risk and any surplus operating revenue.
Council Joint Venture	Council enters into a formal agreement with a third party for supply of funding and / or operational and technical expertise. A Joint Venture can bring significant benefit by bringing expertise in the sector by managing delivery and operation however there needs to be a clear benefit to all JV partners.

Table 8-3 Potential commercial structures

The fundamental issue facing local authorities should they invest directly in the district energy scheme, is what the relationship is with the private sector.

The evaluation of the options usually revolves around a number of considerations: Table 8-4.

Consideration	Explanation
Control vs. risk	The tensions between the desire for control over project outcomes and the willingness to take on project risk.
Commercial attractiveness	The rate of return the project will actually support and whether this will be acceptable to the private sector.
Cost of raising capital	The recognition that the cost of raising capital for the private sector is generally greater than for the public sector which, on a capital-intensive project, has a major impact on viability and ultimately on cost of heat supply.
Availability of capital	The availability of capital to both public and private sector is limited but is also closely linked to the degree of risk involved and the organisations' understanding of the risks involved.

Table 8-4 Considerations for Council involvement

The amount of control that the council or the various stakeholders have over the scheme may be important in achieving their overall objectives. Similarly, drivers to participate may not be sufficiently strong to ensure agreements for connection are reached. For private sector developers it is likely that some form of compulsion will be required to ensure connection, through planning conditions which require this and safeguard infrastructure and heating system types to enable future connection.

In relation to the preferred project vehicle, particularly whether or not to set up a separate operating company (Special Purpose Vehicle), it is recommended that legal advice is obtained during the initial stages of design development prior to proceeding. Issues such as State Aid, legal authority for the council to undertake various activities, continued stakeholder engagement, flexibility, and implications for an exit strategy

will need to be considered. Where a JV was taken it is likely that establishment of an SPV would be the preferred route.

9 Contracting Strategy

The contracting strategy for any of the proposed projects will need to address all works and services required to deliver the projects, considering risk allocation and mitigation.

Successful delivery of a project will require careful identification, description, design, and installation of the scheme followed by effective operation. The responsibility for ensuring an efficient affordable system changes during the implementation of the project (initially being with the project owner, then technical advisors, then the contractors' designers, installers and operators) and care needs to be taken to ensure the efficiency of the project remains intact.

Alternative contracting routes ranging from self-delivery where the project owner retains most risk through to DBFOT (Design, Build, Finance, Operate, Transfer) where the project owner passes as much risk as possible to a third party.

Contracting options

- Self-Delivery
  - Developer-sourced design
  - Sub-contracted construction
  - In-house operation and maintenance
- Design & Build
  - Contractor appointed to design & build based on Employer's Requirements
  - Constructed to a price
- EPC
  - Engineering, Procurement & Construction
  - Price & Performance guarantee
  - Often a turn-key contract with less input by employer than under Design & Build
- Operate & Maintain
  - Operate & Maintain
  - Infrastructure & plant design / construction by others
  - Guaranteed availability & standards
- DBOM
  - Design, Build, Operate, Maintain
  - Guaranteed price, performance, availability & standards
- DBFOT
  - Design, Build, Finance, Operate, Transfer

- Funded solution with guaranteed performance availability & standards asset transfer at end of contract

10 Potential Commercial Structure and Contracting Strategies for Shortlisted Schemes

There are several commercial structure options which the respective councils can consider for procurement, ownership, and operation of the shortlisted energy systems. The preferred commercial structures for the shortlisted options are explored below based on the high-level information available.

Following the completion of the initial feasibility study, it is recommended that further stages of detailed project development (DPD) and an outline business case (OBC) are considered to fully explore the preferred commercial structures and delivery models.

10.1 Scottish Event Campus (SEC)

A council-owned Design, Build, Operate and Maintain (DBOM) contract may be a suitable commercial structure for the SEC project. There is a high degree of complexity associated with this district energy scheme due to the different low-carbon technologies proposed for the scheme therefore the council may prefer not to have a direct involvement in the DBOM. It is envisaged that the SEC centre will receive heat from a water-source heat pump (WSHP) via a district heating network (DHN). There will be renewable electricity generated on-site using roof-mounted solar PV. The renewable electricity will be consumed by the heat pumps and/or on-site consumers. Excess renewable electricity will be stored using an onsite electric battery. The battery will enable the SEC to participate in grid services, ensure security of supply for the site, and potentially reduce peaks in electrical demand. There is also potential for a council joint venture between the SEC and The Clydeside Distillery. The distillery is adjacent to the SEC site and they are currently assessing the feasibility of a high-temperature heat pump (HTHP).

10.2 Fortum Glasgow EfW

A Council Joint Venture (CJV) may be a suitable commercial structure for this project. Under this commercial arrangement, Fortum Oyj and Verus Energy’s South Clyde Energy from Waste plant (EfW) would supply low carbon heat to the district heating network. The council could form an Energy Services Company (ESCo), a 50/50 joint venture with Fortum and Verus Energy. The council could potentially benefit in this arrangement by securing an attractively priced long-term supply of low-carbon heat for new and existing public buildings. This commercial structure has recently been demonstrated by Midlothian Council.

Midlothian Council and Vattenfall formed an ESCo, a 50/50 joint venture which will provide low-carbon heat from the Millerhill EfW to the new Shawfair town.

10.3 Kilcreggan/Rosneath Low Carbon Heating - community scale

A council and an Energy performance Contract (EPC) provider could form an ESCo. The ESCo would be responsible for producing the investment grade proposal (IGP) detailing the Energy Conservation Measures (ECMs), energy savings guaranteed, tonnes of CO_2 saved each year, capital costs, maximum payback period and a measurement and verification (M&V) plan along with a delivery plan. The mix of property tenure, construction, and age within the Kilcreggan and Rosneath town boundaries will impact upon the preferred commercial structure.

10.4 Former ExxonMobil Site Redevelopment

A council-owned Design, Build, Operate and Maintain (DBOM) contract could be a suitable commercial structure for the former ExxonMobil site redevelopment project. Of the 150-acre site, 45 acres will be developable land. The development will be predominantly office and industrial development. The council wish to examine the use of several LZC technologies in conjunction with building fabric energy efficiency measures.

11 Short form risk register

This section provides an overview of the risks that should be considered in delivery of the shortlisted options, including technical, commercial and procurement risk. The risk register will inform critical mitigation requirements for different risks to be reviewed during the Stage 2 feasibility studies.

DHNs require collaboration with multiple stakeholders which introduces complexity during development, from feasibility stage through to operation. This introduces inherent risks that need to be overcome, particularly surrounding ownership structures and heat supply regulations. The risks relating to developing a DHN have been identified and ranked based on their likelihood and potential impact to the progression of the scheme. Some risks are applicable to all the shortlisted projects.

The risks have been split into the following categories:

- Technical
- Business case
- Planning Consents, Permitting and Environment
- Stakeholders
- Construction and procurement
- Operation and maintenance.

11.1 Quantifying the risk

Scores are developed on a scale from 1 to 5.

- 1 indicates an unlikely event, or a mild level of severity
- 5 indicates a likely event, or a severe consequence of such an event

The risks are quantified based on their impact and probability of occurring. The impact of the risk is the outcome that may occur if the risk is not properly managed. Mitigating measures are suggested to reduce the impact and probability of each risk. Table 11-1 shows the matrix used to assess the risk. The product of impact and probability dictates the overall risk level and is presented both pre and post mitigation in Table 11-2.

Table 11-1 Risk ranking matrix

Risk ranking		Probability				
		1	2	3	4	5
Impact	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

Table 11-2 Risk register

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
1	**Technical**								
1.1	Heat consumption estimates vary vs actual consumption. If heat loads do not materialise the scheme may become difficult to operate economically	4	3	12	Heat demand confidence level included in feasibility study. Demands are derived from existing building data where possible. Recommend locking non-council customers into long term contracts where possible (e.g. in planning agreements for new builds)	Engineering Consultant / Project Sponsor(s)	3	2	6
1.2	Existing developments make like-for-like replacement of heating asset when the existing asset reaches its end of life, reducing the incentive for connection to DHN	4	2	8	Maintain communication with stakeholders identified in feasibility study to discuss alternative strategies in case of plant failure and update existing plant replacement strategies.	Project Sponsor(s) / Council	4	1	4

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					Ensure the Project Sponsor is aware of any planned upgrades to building secondary systems to ensure DHN connection capability. Suggest deferring any replacements where possible and use funds for DHN connection. New development connections to be ensured through planning policy				
1.3	Heat load insufficient to justify running of LZC plant during the summer	4	3	12	Obtain hourly heat profiles where possible. Measure heat loads over long period of time for best possible design information. Provide large thermal store or heat pump modulation for lower summer loads	Project Sponsor(s)	3	2	6

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
1.4	LZC technology availability - if the plant does not achieve the required availability it may impact running costs and carbon emissions. Significant plant failure may leave customers without heat	5	3	15	Transfer risk to operation and maintenance contractor via guaranteed minimum availability contract provisions and penalties. Back-up boilers (or alternative) provided for resilience and fuel flexibility	Project Sponsor(s)	2	2	4
1.5	Large heat network distribution losses may lead to substantial loss in value if heat network is not adequately designed or insulated	3	2	6	Transfer risk to O&M contractor - specify high performance as per CP1 guidance and ensure detailed approval, inspection, testing, and acceptance process including penalties for under performance. Minimise route lengths where possible at the detailed design stage	Project Sponsor(s)	3	1	3

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
1.6	Ground source heat potential not certain	5	2	10	Consult relevant literature as to ground conditions in the Clyde area (e.g. British Geological Survey maps and existing borehole data). A detailed ground survey is recommended once a suitable scheme is developed	Engineering Consultant	3	2	6
1.7	River source heat potential not certain	5	2	10	Recent projects on the Clyde such as Queen's Quay WSHP project will assist in providing temperature data from the River Clyde and heat pump performance data	Engineering Consultant	3	2	6
1.8	Lack of capacity to supply electricity required for heat pumps or natural gas for peaking boilers	4	3	12	Check utility plans to identify if there are power cables in the area near to EC locations. Get indicative connection quote from gas/power provider to suggest fee for	Engineering Consultant	4	2	8

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					connection. Connection cost allowance included in techno-economic model				
2	**Business case**								
2.1	**Funding**								
2.1.1	Failure to identify funding sources adequate to meet the capital costs of the scheme. Scheme performance reliant on grant funding	5	3	15	Do not proceed if adequate funding cannot be secured	Project Sponsor(s)	2	2	4
2.1.2	Lack of interest from commercial developers	5	3	15	Establish what IRR/ NPV values would attract commercial investment through soft market testing	Engineering Consultant	4	2	8
2.2	**Capital costs**								
2.2.1	Budget overspend due to poor cost controls	4	2	8	Undertake design reviews with relevant stakeholders. Consider appropriate procurement	Project Sponsor(s)	2	2	4

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					options which limit risk				
2.2.2	Budget underestimated due to unforeseen issues	5	3	15	10% contingency added to cost estimates	Project Sponsor(s)	4	2	8
2.2.3	Cost increases due to connection works at each property	5	3	15	Engage with planned developments to ensure secondary systems are connection ready to DHN. Cost of secondary system retrofit already estimated in CAPEX, however surveys of each connection required is needed for detailed costing	Project Sponsor(s)	3	2	6
2.3	**Revenues**								
2.3.1	Resulting cost of heat too high for residents	5	2	10	Tight control on scheme costs is required through detailed business case development	Project Sponsor(s)	4	1	4
2.3.2	Information not forthcoming from potential heat	2	2	4	Metered data should be used where available. Schemes which	Project Sponsor(s)	2	1	2

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
	consumers to include in the study				rely on involvement from non-council consumers will be riskier				
2.3.3	Changes to energy taxes could impose costs on the energy business	3	2	6	Any increase in tax will be transferred to customer - include change of law provision in heat contracts that adjusts charges to reflect new taxes	Project Sponsor(s)	2	2	4
2.3.4	Occupancy risk - takes longer to build up heat demand than anticipated	3	2	6	Difficult to mitigate as dependent on housing market	Project Sponsor(s)	3	2	6
3	**Stakeholders**								
3.1	Stakeholders oppose street-works or propose onerous requirements	4	2	8	Project Sponsor(s) to manage interface through normal channels	Project Sponsor(s)	3	2	6
3.2	Private developments not interested in connecting to DHN	5	3	15	Early engagement with developers, improved planning policy to include connection obligation. Ensure scheme	Project Sponsor(s)	3	2	6

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					is viable that is not reliant on developments who are not obliged to connect				
3.3	Failure to gain potential consumer's support for the scheme	4	2	8	Structure proposal to make it attractive to residents and other potential customers. Ensure a communications plan is enacted for local consumers. Ensure customers are no worse off and bring savings where possible through the cost of heat	Project Sponsor(s)	4	1	4
3.4	Council's lack of expertise to carry project forward	4	3	12	External project manager recommended to lead the scheme. DBOM can be contracted out	Project Sponsor(s)	3	1	3
3.5	Low support from within council	5	3	15	Identify a "champion" from within council to take project forward and increase	Project Sponsor(s)	4	2	8

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					awareness. Council to manage ongoing discussions with Buro Happold input				
3.6	Council's ability to invest in the 'leg work' in setting up a DHN	4	2	8	Involve relevant council internal departments from project outset to raise awareness of project. Apply for funding/support from relevant body.	Council	2	2	4
3.7	Third party negotiations	4	3	12	Early stakeholder involvement in proposed schemes once identified. Discussions with third parties as to acceptable IRRs	Project Sponsor(s)	3	2	6
3.8	South Clyde EfW not interested in supplying heat to the wider network	5	3	15	Early engagement to assess likelihood. This is a significant risk however there will be a considerable benefit to Fortum in supplying waste-heat from the EfW to	Council	5	2	10

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					nearby consumers.				
4	**Planning consents, permitting and environment**								
4.1	Failure to obtain planning permission for energy centre	5	2	10	Project Sponsor(s) to manage planning concerns going forward through engagement with local stakeholders and the planning team. Option to house ECs below ground, however this would incur increased civils cost – alternative locations to be considered	Project Sponsor(s)	5	1	5
4.2	High noise levels from energy centre	4	3	12	Acoustic impact managed through using proven compliant heat pumps and noise insulating casing	Project Sponsor(s)	3	2	6
4.3	High level of visual impact from energy centre	3	2	6	Flues from the gas boilers may cause concern in built-up areas. Long term energy centre façade	Project Sponsor(s)	2	1	2

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					concept to be created for communication to planning team to ensure clarity of the intent. Where possible, flues integrated into building development to reduce visual impacts				
4.4	Planning permission required for heat network	3	2	6	Council to confirm whether permitted development rights cover installation of heating pipework in the public highways	Council	2	2	4
4.5	Air quality issues increase cost or result in restriction on operation of energy centre	4	2	8	Air quality impact managed by ensuring flues extend to a higher level than the surrounding buildings. Early consultation with planning team advised. De-risk by installing high efficiency gas boilers in conjunction with LZC technologies	Project Sponsor(s)	3	2	6

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
4.6	Failure to negotiate use of land for energy centre	4	3	12	Engagement with landowners	Project Sponsor(s)	2	2	4
4.7	Failure to obtain planning permission for WSHP	5	3	15	Early engagement with the Scottish Environmental Protection Agency (SEPA) on acceptable discharge temperatures and flow rates	Project Sponsor(s)	5	1	5
5	**Construction and procurement**								
5.1	Asbestos present in existing plant rooms	3	3	9	Obtain Asbestos Register from stakeholders and council and factor into construction programme.	Project Sponsor(s)	2	2	4
5.2	Contract choice inappropriate and prevents project aims from being delivered	5	3	15	Review contract choice as part of the development of the business case. Ensure wide engagement in bid process to attract range of contractors	Project Sponsor(s)	4	2	8
5.3	Redevelopment time windows missed	4	4	16	Early and continued engagement with	Council	4	3	12

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
					all major stakeholders identified to ensure they are aware of a potential project and potential to connect to a DEN. Promotion of work from within council so that future developers are aware of proposed scheme				
6	**Operation and maintenance**								
6.1	Heat delivery failure	5	4	20	Design resilience into system including redundancy for pumping, boilers etc. Make plans and procedures for emergency boiler hire for connection at building level.	Project Sponsor(s)	3	1	3
6.2	Lack of clarity over the department within council who is responsible for	3	2	6	Council to make a clear statement of responsibility as part of internal business case. Particularly important for	Council	2	2	4

Item ref.	Risk description	Pre-mitigation			Mitigation measure	Lead by	Post-mitigation		
		Impact 1-5	Probability 1-5	Risk level			Impact 1-5	Probability 1-5	Risk level
	operation and maintenance				schemes where energy is being supplied by third party (South Clyde EfW)				
6.3	High losses in primary or secondary network negate cost savings and create inefficient system	4	3	12	Commissioning and ongoing monitoring conducted to ensure performance is achieved	Project Sponsor(s)	3	2	6

12 Feasibility studies definition

For each of the four potential projects under consideration to progress from the pre-feasibility to the detailed feasibility stage, a potential feasibility study scope was prepared. The scope includes a stepwise consideration of technical requirements, economic and commercial requirements, and environmental requirements.

Technical Requirements:

- Step 1. Existing information review
- Step 2. Site surveys
- Step 3. Data Assessment
- Step 4. Energy centre(s) / Plant room
- Step 5. Heat supply technology
- Step 6. Network
- Step 7. Technical modelling
- Step 8: Outline energy centre design

Economic and commercial requirements:

- Step 1: Financial model development
- Step 2: Capital and operational cost assessment
- Step 3: Future price forecasting
- Step 4: Sensitivity testing and risk management
- Step 5: Initial commercial structure

Environmental requirements:

- Step 1: Input data confirmation
- Step 2: Carbon assessment
- Step 3: Additional environmental impacts

13 High level delivery plan

The Clyde Mission Team is in the process of agreeing their overall capital funding timeline.

Projects in the Clyde Mission area could potentially access the £25 million announced in the 2020/21 Programme for Government (PfG). Eligible projects would be delivered within a five-year timeframe. The formal application process for accessing this capital support has yet to be defined.

A typical heat network project timeline is around four years from development, through commercialisation to operation: with around five months for feasibility and options assessment, 12 months for detailed feasibility and project development, a further 12 months for finance, procurement and contract negotiation, before 18 months of design and build. These key steps are common to the development of any large energy infrastructure project. In the sections below, the key steps associated with procuring the different heat and electricity-supply options under consideration for the four shortlisted projects are presented as road maps.

13.1 District Energy Network Roadmap: EfW Heat Recovery

The following is a strategy for procuring the heat from an EfW and details for each stage.

- EfW Heat Recovery Opportunity
  - Identify EfW operator
  - Identify EfW's peak electricity and heat production
  - Examine the waste-heat production profile
  - Undertake detailed feasibility study
  - Negotiate heat-supply agreements with EfW as well as identified heat consumers
- District Energy Network Design & Construction
  - Commence design of district energy network and energy centre within the EfW
  - Tender and procurement of district energy network
- Completion of District Energy Network
  - District energy network completed and ready for connection
  - Network to building connections to be commissioned
  - Onsite connections and equipment commissioned
  - Testing and commissioning programme in-line with required construction programme and operational date.

13.2 District Energy Network Roadmap: Water-Source Heat Pump

The following is a strategy for procuring a water-source heat pump district heating network and details for each stage.

- Water Source Heat Pump Opportunity
  - Examine temperature variability of water source and the corresponding variation in heat pump performance
  - Undertake detailed feasibility study
  - Negotiate a heat-supply agreement with consumers
- District Energy Network Design & Construction
  - Commence design of district energy network and energy centre
  - Tender and procurement of energy centre and district energy network
- Completion of District Energy Network
  - District energy network completed and ready for connection
  - Network to building connections to be commissioned
  - Onsite connections and equipment commissioned
  - Testing and commissioning programme in-line with required construction programme and operational date.

13.3 Onsite Roof-top Solar PV

The following is a strategy for procuring the onsite Solar PV.

- Onsite solar PV Design Stage
  - Provide renewable energy targets to Architects / Design Team as part of council's client brief.
  - Co-ordination with Architects/Design team to incorporate Solar PV
- Onsite solar PV Tender Stage
  - Produce performance specifications and tender drawings to procure Solar PV on site
  - Finalise Solar PV connection application with Scottish Power (local Distribution Network Operator)

- Onsite solar PV Construction Stage
    - DBOM Contract
    - Installation of Solar PV as part of build
    - Connection to site LV infrastructure

13.4 Onsite wind turbine, ground-mounted PV, solar carport

The following is a high-level strategy for setting up onsite renewable energy generation.

- Onsite Renewable Energy Design Stage
    - Provide renewable energy targets to Architects / Design Team as part of council's client brief.
    - Detailed feasibility study
    - Co-ordination with Architects/Design team to incorporate renewable electricity technologies
- RFP
    - Issue RFP to pre identified potential partners
    - Conduct Due Diligence on the capabilities of partners
- Tender Negotiations
    - Select partner(s) based on the technical and commercial consideration
    - Negotiation and finalising PPA Agreements
- Construction
    - Partners to construct and commission renewable generation in line with required operational dates

14 Next steps

The Energy Masterplan presents:

- The Energy Masterplan area and boundary, including a buffer for future project expansion
- Existing energy demand locations (heating, cooling, and power),
- Low carbon and energy infrastructure technologies suitable for the area
- Energy project long list, including:
    - Stakeholder-proposed projects
    - Heat demand clusters and the spatial relationship of the clusters to the stakeholder-proposed projects
    - Low carbon resource opportunities and high-level constraints
- Highlighted pre-feasibility projects (4 No.) which could potentially proceed to the feasibility study stage

This Energy Masterplan can be used as an evidence base to consider where proposed low carbon and energy infrastructure projects could collaborate to incorporate resources available in the area. It can also be used as a reference when considering future projects, for example, in the context of heat demand clusters – consider where stakeholder interest is present to progress with projects, coinciding with heat demand.

Suggested next steps:

- Consider reviewing the stakeholder-proposed projects presented in the Energy Masterplan, with an eye to identifying mechanisms that may be available to reduce barriers to project establishment. If appropriate, communicate findings to stakeholder project-proposers
- Clyde Mission Team consider holding a workshop with the stakeholders who have proposed projects, sharing information about proposed project proximity. This would support spontaneous collaboration between engaged stakeholders who are working towards shared goals such as heat networks
- Stakeholders who have proposed projects - Consider reviewing the information in the project long list to identify opportunities for collaboration to strengthen proposed projects
- Clyde Mission Team and Zero Waste Scotland - Consider the highlighted list of pre-feasibility projects proposed to progress to feasibility stage. Decide if one, some, or all may be able to progress with any identified potential support.

Appendix A Stakeholder projects

Table 14.1. Area 1, Stakeholder-proposed projects

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
19	Strone Primary School - Low Carbon Heating Solution	Argyll and Bute Council	Strone, Dunoon, PA23 8RV	Heat pump	50kW	Pre-Feasibility	School currently has a combination of oil-fired warm air heating and electric storage heating; proposal to convert to full wet heating system with heat pump solution.	N/A	-
20	Kirn Primary School - Solar PV	Argyll and Bute Council	Park Road, Kirn, Dunoon, PA23 8EH	Solar PV	50kW	Feasibility Study	Roof mounted solar PV.	N/A	-
21	Dunoon Pier - Various Climate Change Aspects	Argyll and Bute Council	Argyll Street, Dunoon, PA23 7HH	TBC	TBC	Pre-Feasibility	Continued opportunities for further regeneration of the Dunoon Pier will	19	East Dunoon, Argyll & Bute

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							provide opportunities.		
22	Dunoon Car Parks (esp. waterfront) solar pv canopies and EV charging	Argyll and Bute Council	Argyll Street, Dunoon, PA23 7HH	Solar PV carport and EV charging	TBC	Pre-Feasibility	Two car parks at the site, both of which provide opportunities for solar PV canopies and EV charging infrastructure. Note - other town centre car parks are prospects too.	19	East Dunoon, Argyll & Bute
23	Riverside Pool - Carbon Reduction Solutions	Argyll and Bute Council	Moir Street, Dunoon, PA23 8AA	ASHP, Solar PV and Pool AHU optimisation	TBC	Contract Awarded	Provider delivers a range of energy efficiency/renewables projects to reduce carbon emissions on a performance contract basis.	19	East Dunoon, Argyll & Bute

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
24	Dolphin Hall - Low Carbon Heating/Cooling Solution	Argyll and Bute Council	Manse Avenue, Dunoon, PA23 8DQ	Heat Pump	32kW	Concept Idea	Dolphin Hall is a hub office; it consists of a gas heated Victorian villa and a more modern annexe with standard electric heating; the annexe building would benefit from a heat pump solution to provide low carbon heat and to offer cooling mode to mitigate summer overheating.	19	East Dunoon, Argyll & Bute
25	Rothesay Pool - Carbon Reduction Solutions	Argyll and Bute Council	High Street, Rothesay, Isle of Bute, PA23 8AA	Solar PV, DHW/Pool Pump optimisation	TBC	Contract Awarded	Provider delivers a range of energy efficiency/renewables projects to reduce carbon emissions on a	19	East Dunoon, Argyll & Bute

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							performance contract basis.		

Table 14.2. Area 2, Stakeholder-proposed projects

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
13	Cardross Crematorium - Heat Recovery	Argyll and Bute Council	143 Mollandhu, Cardross, Helensburgh, G82 5HD	Waste heat recovery	TBC	Pre-Feasibility	Heat recovery from heat rejection gases of crematorium	N/A	-
14	Cardross Primary School - Solar pv	Argyll and Bute Council	Kirkton Road, Cardross, Helensburgh, G82 5PN	Solar PV	75kW	Feasibility Study	Roof mounted solar PV on the school site.	N/A	-
15	Helensburgh Waterfront Development - Various Climate Change Aspects	Argyll and Bute Council	West Clyde Street, Helensburgh, G84 8SQ	TBC	TBC	Construction	Re-development at the Helensburgh pier head. Includes construction of new swimming pool complex, sea defence works, new retail units. There was a high-level	17	Helensburgh, Argyll & Bute

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							consideration for heat from sewer for the new pool before opting for natural gas provision. There are electrical infrastructure limitations for the overall site and so electrical generation opportunities might be beneficial (e.g. car park solar PV canopies). EV charging infrastructure consideration also.		

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
16	Graham Williamson IT Centre - Carbon Reduction Solutions	Argyll and Bute Council	64A John Street, Helensburgh, G84 8XJ	Solar PV, Server Cooling and LED lighting	TBC	Contract Awarded	Provider delivers a range of energy efficiency/renewables projects to reduce carbon emissions on a performance contract basis.	17	Helensburgh, Argyll & Bute
17	Blackhill Depot	Argyll and Bute Council	Luss Road, Helensburgh, G84 9FB	Solar PV	52kW	Feasibility Study	Roof mounted solar PV and prospects for EV charging.	N/A	-
18	Kilcreggan/Rosneath Low Carbon Heating - community scale	Argyll and Bute Council	Kilcreggan/Rosneath	Low carbon heat for off-gas buildings	TBC	Pre-Feasibility	These are off-gas communities looking for low carbon heating solutions.	N/A	-
33	Inverclyde Public building area heat network	Inverclyde Council	-	WSHP	3.8MW WSHP 2.8MW	Concept Idea	WSHP and back-up gas boilers to	21	Greenock West

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
					gas boilers		provide heating and hot water to Inverclyde Council buildings.		

Figure 14.1. Area 3, Stakeholder-proposed project locations

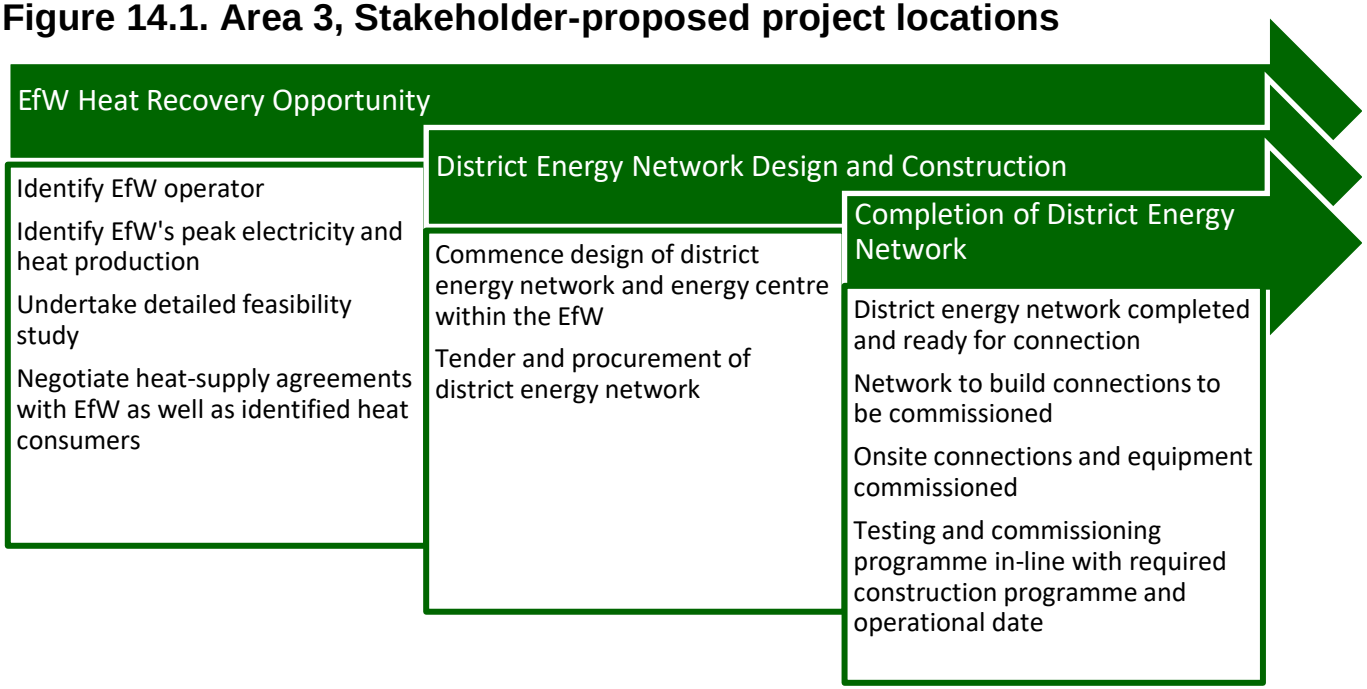


Table 14.3. Area 3, Stakeholder-proposed projects

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
2	RenWest District Energy Network	Scottish Enterprise	Westway Business Park, Renfrewshire, PA4 8DJ	DHN, 2x Gas CHP and PV	TBC	OBC	Development of a heat network supplying the Westway Business Park and an adjacent care home (85 rooms).	5	East Abbotsinch
4	Low Carbon District Heat and Steam supply to local real estate and industrial customers	Fortum Glasgow LTD	Bogmoor Road, Glasgow, G51 4SJ	Heat and steam generation from EfW plant, and distribution in district heat and steam networks	>20MW, 160,000 MWh/a	Pre-Feasibility	Supply LC district heat to real estate customers and high parameter steam to industrial customers. Heat and steam generation by thermal treatment of	23	Hillington

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							waste from South Clyde EfW facility.		
6	North Clyde Plastic to Hydrogen Facility	Peel NRE Environmental Limited	Dock Street, Clydebank, G81 1LX	Gasification	2 tonnes/ day of vehicle grade hydrogen , 2MW heat and 1MWe	Pre-Planning	Convert end of life plastic waste to a syngas that can be used to produce hydrogen, heat, and electricity. Process 35 tonnes of plastic per day, c.12,250 tonnes per annum.	11	South Clydebank

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
7	Heat from Wastewater Treatment Works	Scottish Water Horizons	Beardmore Street, Clydebank, G82 5HG	WWTW heat recovery	TBC	Pre-Feasibility	Heat recovery from Dalmuir WWTW. Hopes to expand Queens Quay DHN & EC also include Golden Jubilee Hospital, Clydebank library, Clydebank town hall, Future and existing housing and local businesses.	13	South Dalmuir

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
8	Low Carbon Commercial and Industrial Estate - Former Exxon Site	West Dunbartonshire Council	Bowling Harbour, Dumbarton Road, Bowling, G60 5AF	Various, Heat Pumps, PV, energy efficient building fabric, EV charging infrastructure, heat recovery from waste plant, and others	TBC	Pre-Feasibility	Development of a high-level net zero strategy and design code for former Exxon site. Site currently under remediation for £34m project to create a major industrial and commercial development.	N/A	-
9	Bowling Active/Sustainable Travel Hub	West Dunbartonshire Council	Bowling	E-bike charging points, PV, EV charging infrastructure	TBC	Pre-Feasibility	For the development of a sustainable active travel hub in Bowling along the NcN7 route from	N/A	-

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							Glasgow to Balloch.		
28	AMIDS District Heating Network	Renfrewshire Council	Adjacent to Glasgow Airport	WSHP and ambient loop network	16MW	OBC	Develop the ambient loop networks for the upcoming Advanced Manufacturing Innovation District Scotland (AMIDS). Will house companies harnessing new technologies and accessing cutting edge research. A waste heat offtake from the treated	4,5	Gallowhill / East Abbotsinch

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							sewage effluent (TSE) river outfall at the Laighpark Paisley WWTWs.		
31	Queen Elizabeth Hospital	ZWS	1345 Govan Rd, Glasgow G51 4TF	WSHP	6MW	Feasibility Study	Assessment of the feasibility of supplying heating and hot water to the Queen Elizabeth University Hospital using a water-source heat pump using the River Clyde	22	Linthouse

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
35	Potential opportunities between Renfrewshire Council and Scottish Water Horizons within the River Clyde corridor (A)	Renfrewshire Council	-	WSHP and PV	TBC	Pre-Feasibility	SW have a large service reservoir (clean water storage) near Park Mains High school. There is a cluster of potential off takers of heat in the area including 2 primary schools to the north of the tank and a high school, leisure centre and supermarket to the east. The tank top could also house solar power to help	12	South Erskine

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							run the heat pump.		
36	Potential opportunities between Renfrewshire Council and Scottish Water Horizons within the River Clyde corridor (B)	Renfrewshire Council	-	WSHP	TBC	Pre-Feasibility	With less than 2km from the Erskine WWTW to the Inchinnan Industrial park there may be potential to look at an ambient loop system to serve the industrial users and perhaps over time link up to the ambient loop at the AMIDS side (<2km away	11	South Clydebank

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							from Erskine WWTWs. There is also a potential opportunity to link the two ambient loops via the airport and extend the network to existing and new businesses in Renfrew.		

Table 14.4. Area 4, Stakeholder-proposed projects

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
1	Scottish Event Campus Energy Strategy	Scottish Event Campus (SEC)	SEC, Exhibition Way, Glasgow, G3 8YW	Wind turbine, PV and WSHP/GSHP or waste heat generation for heat network with battery storage and smart grid	12,000 MWh power, 7,000 MWh heating and cooling	Pre-Feasibility	Aim for net zero campus, seeing a 95% reduction in carbon, and shifting from gas to electrical heating and cooling.	26	Glasgow
3	Case Study - A District Heating Network for Glasgow	Heat Vision 2030	Glasgow City Centre	DHN and river source heat pump	49 MW_{th} heat from heat pumps required, 140 GWh_{th}/yr from RSHP	Concept Idea	Glasgow City centre divided into 4 sections each with own heat pump, with over 1300 buildings	26	Glasgow
5	Glasgow Harbour heat network	Peel Energy - Peel Land and Property	Yorkhill, Glasgow, G3 8QQ	WS Heat Pump	12MW – 28 GWh at full build	Feasibility Study	Provide low carbon heat to planned development at Yorkhill, 1100 residential units with hotel	26	Glasgow

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							and leisure outlet.		
10	Integrated Energy Strategy: Community Energy Project, Dalmarnock	Clyde Gateway	Cotton Street, Glasgow City, G40 4HW	CHP District Heating	2,400 MWh initial up to potential 5,041 MWh	Construction	EC being delivered by Scottish Water Horizons, using gas fired CHP at Dalmarnock WWTW. WWTW will use power with heat by-product used in DHN that is being delivered across central Dalmarnock area.	26	Glasgow

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
11	Clydeside Distillery HTHP (Clydeside GreenStills Demonstrator)	Morrison Glasgow Distillers (Supported by Allen Associates and Star Refrigeration Ltd)	Clydeside Distillery (100 Stobcross road), Glasgow, G3 8QQ	Steam Raising High Temperature Heat Pump (HTHP)	500 kW (Heating capacity 442 kW, cooling 350 kW)	Pre-Feasibility	Reduce onsite energy demands by 62%, water footprint by 75%, carbon emissions by 80% (PPA to make 100%).	26	Glasgow
12	D2Grids - Renewable Energy Project	Clyde Gateway	Glasgow Road, G73 1UZ	5th Gen District Heating & Cooling. Ambient Loop / Heat Pumps	1,888 MWh heating 1,027 MWh cooling	OBC	Develop 5th Generation District Heating and Cooling (5GDHC). Will integrate with other energy projects in Dalmarnock by utilising the SMART Bridge to deliver low temperature ambient loop to serve Magenta business park.	26	Glasgow

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
							The proposed energy source is Dalmarnock WWTW in arrangement with Scottish Water Horizons with potential integration of their EC.		
26	New City Centre PS	Glasgow City Council	Florence Street (banks of the Clyde), Glasgow	TBC	In use consumption 67kwh/sqm/annum	Contract Awarded	Refurbishment of former Govan Parish school for new school to accommodate increased school rolls.	26	Glasgow
27	New Gaelic Medium School	Glasgow City Council	Former St James PS, corner of Green Street/Stevenson	TBC	In use consumption 67kwh/sqm/annum	Concept Idea	Refurbishment of a currently disused, partially dilapidated Govan Parish	26	Glasgow

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
			Street, Glasgow				sandstone former school in North East of the City.		
29	Collegelands Geothermal Plant	ZWS	10 Havannah Street, Glasgow G4 0UB	Heat to Power Generation and DHN	16MWe	Feasibility Study	-	26	Glasgow
30	River source heat pump feasibility study for the University of Glasgow	ZWS	1 University Ave, Glasgow G12 8QQ	WSHP	10MW	Feasibility Study	WSHP on River Kelvin for low temp DHN system with additional 3.2MW CHP	26	Glasgow
32	Townhead, Drygate & Charles Street	ZWS	Townhead, Drygate & Charles Street	CHP, Biomass and/or gas boilers	4.4-13.2MWe	Feasibility Study	-	26	Glasgow
37	Glasgow Cathedral heat off-take from Glasgow	ZWS	Rue End St. Greenock, PA15 1HX	Gas fired CHP and boiler heating. With LTHW heat network	TBC	Pre-Feasibility	90% demand supplied with WSHP with additional by gas boilers.	26	Glasgow

ID	Stakeholder Title	Organisation	Location	Technology	Scale	Project Stage	Description	Cluster ID	Cluster Location
	Royal Infirmary steam network								

Appendix B: Heat demand clusters

Clusters are presented in geographical groups – these are the same geographical groups in which the stakeholder-proposed projects exist which have been expanded to include surrounding heat demand clusters.

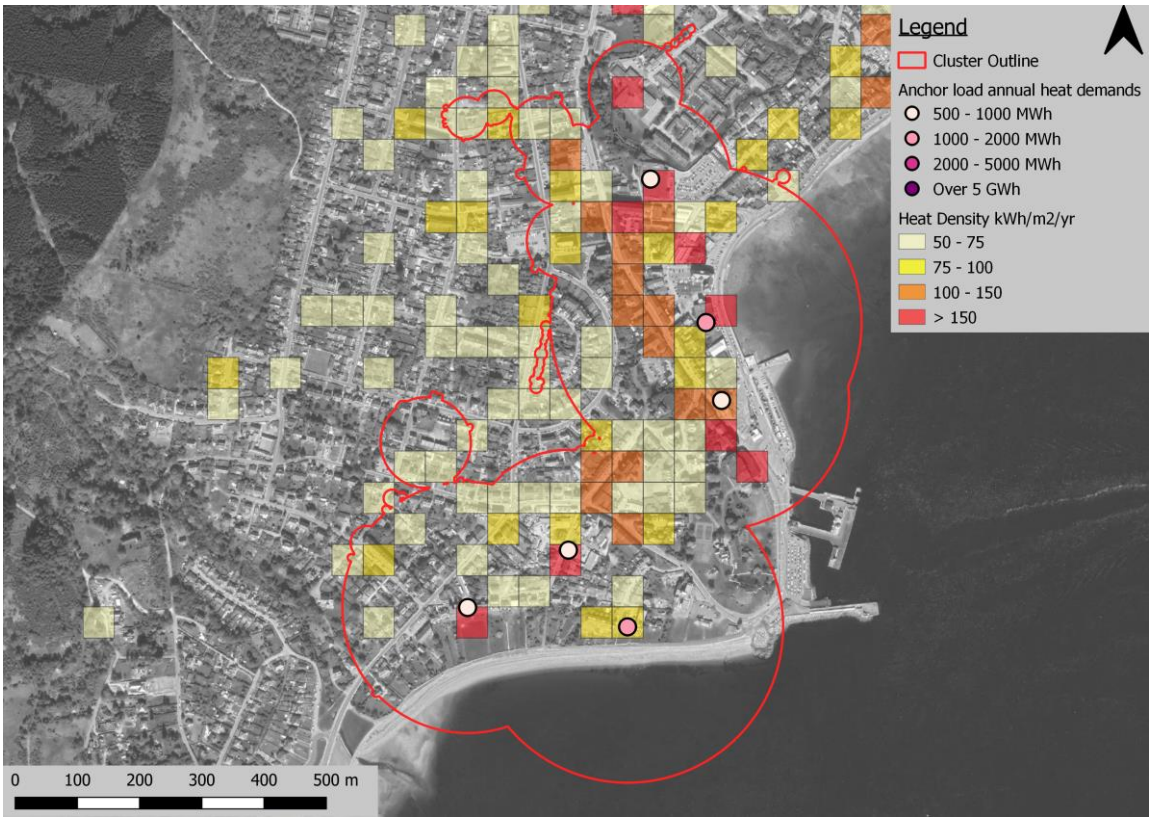
- Area 1. The mouth of the River Clyde where it joins the Firth of Clyde, including the west-most bank of Argyll and Bute and a portion of the north bank of Inverclyde.
- Area 2. The widest point of the River Clyde, including the south bank of Argyll and Bute, and the north bank of Inverclyde
- Area 3. The mid-section of the Energy Masterplan area, covering the south bank of West Dunbartonshire, the north bank of Renfrewshire, and a portion of the north and south banks of Glasgow City
- Area 4. The beginning of the Energy Masterplan area, including the rest of the north and south banks of Glasgow City and the north and south banks of South Lanarkshire

Table 14.5. Area 1, Heat demand clusters

Cluster ID	Location	Connections	Heat Demand (MWh/yr)	Stakeholder-proposed Projects	
				ID	Stakeholder Title
19	East Dunoon, Argyll & Bute	1134 Total 6 Anchors	27,329	21	Dunoon Pier - Various Climate Change Aspects
				22	Dunoon Car Parks (esp. waterfront) solar PV canopies and EV charging
				23	Riverside Pool - Carbon Reduction Solutions
				24	Dolphin Hall - Low Carbon Heating/Cooling Solution
				25	Rothesay Pool - Carbon Reduction Solutions
None				19	Strone Primary School - Low Carbon Heating Solution
				20	Kirn Primary School - Solar PV

Cluster ID: 19

Cluster Name: East Dunoon



Cluster Summary:

Anchor Loads: 6 loads identified. Key anchor loads include: Selborne, Esplanade & SGE Argyll hotels, Morrisons, swimming pool, building supplies store

Total potential property connections - 1134 within cluster

Total cluster heat demand - 27,329 MWh/yr

Size of cluster - ~58.9 ha

Cluster typology – Primarily domestic with some non-domestic properties

Opportunities and Constraints

Opportunities:

- Stakeholder projects; Rothesay Pool, Riverside Pool, Dunoon Pier and Dunoon Car Parks
- River Clyde and surface waterbody

Constraints:

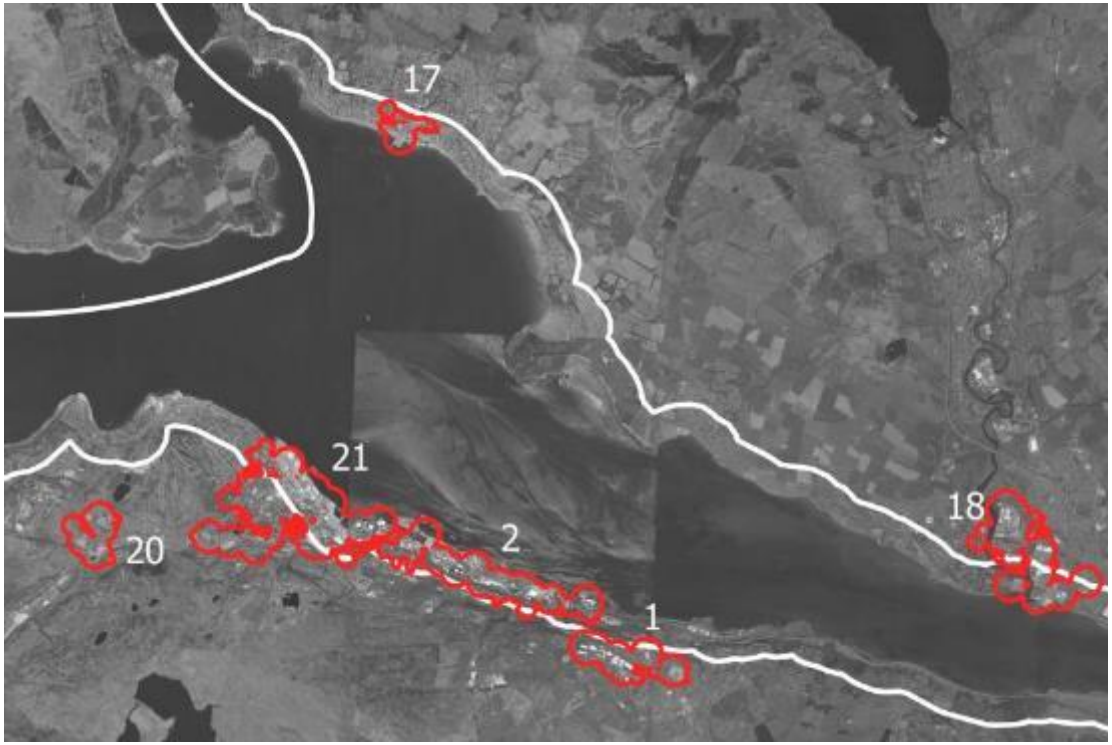
- A-road intersects North to South

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

14.1.1 Area 2

Figure 14.2. Area 2, Heat demand cluster locations



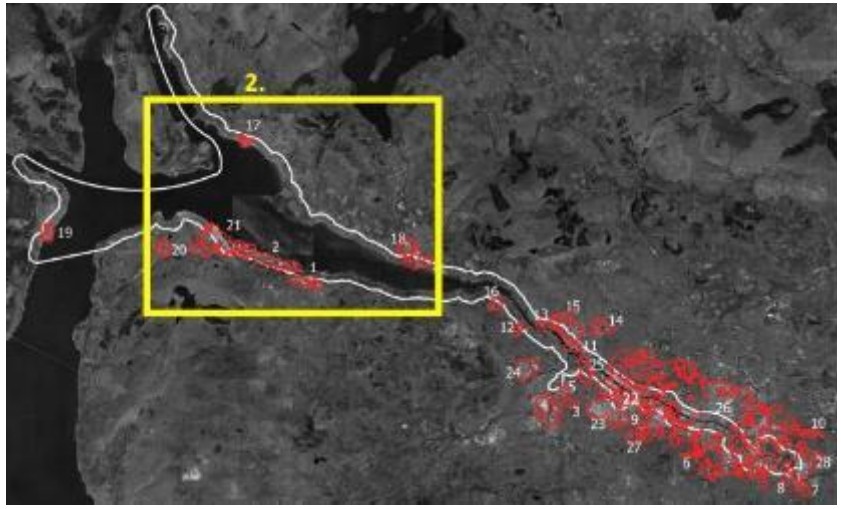
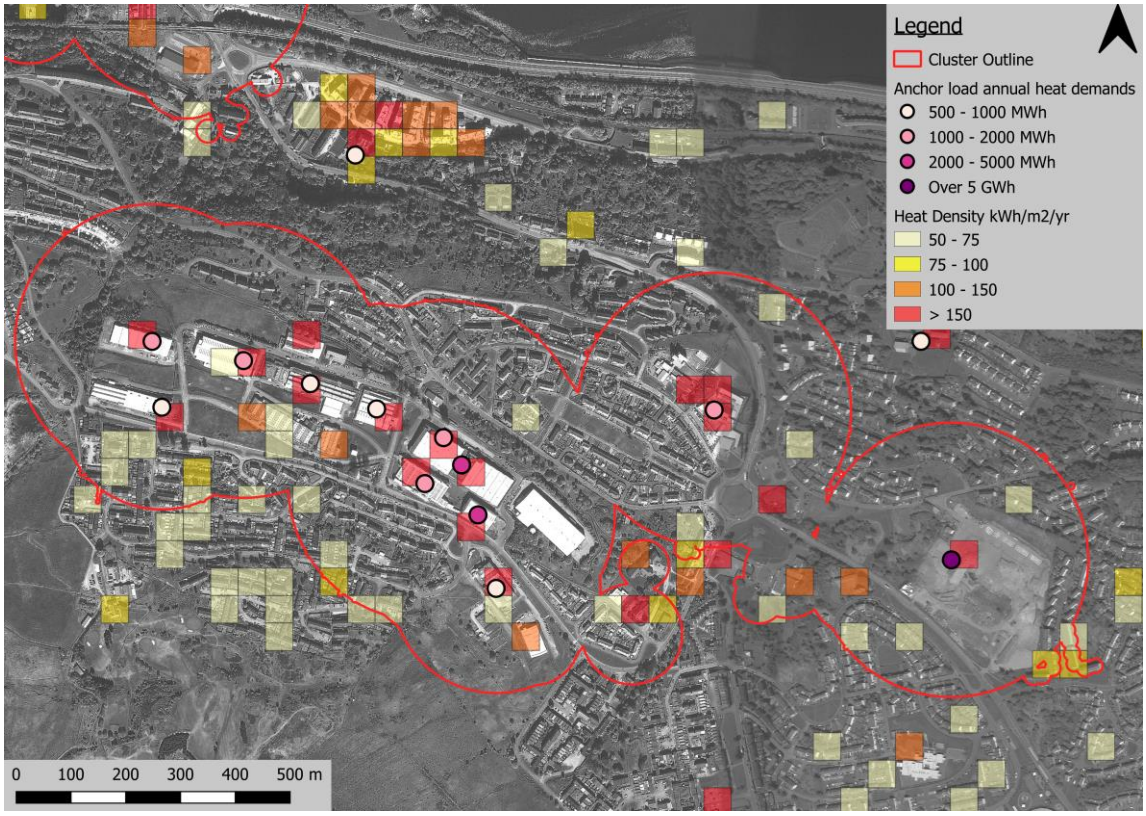


Table 14.6. Area 2, Heat demand clusters

Cluster ID	Location	Connections	Heat Demand (MWh/yr)	Stakeholder-proposed Projects	
				ID	Stakeholder Title
1	Clune Brae, East of Port Glasgow	1493 Total 12 Anchors	48,676		
2	Port Glasgow	2994 Total 20 Anchors	70,116		
17	Helensburgh, Argyll & Bute	1571 Total 2 Anchors	25,933	15	Helensburgh Waterfront Development - Various Climate Change Aspects
				16	Graham Williamson IT Centre - Carbon Reduction Solutions
18	Dumbarton	2993 Total 15 Anchors	68,825		
20	Branchton	864 Total 5 Anchors	26,295		
21	Greenock West	10,543 Total 37 Anchors	191,128	33	Inverclyde Public building area heat network
None				13	Cardross Crematorium - Heat Recovery
				14	Cardross Primary School - Solar PV
				17	Blackhill Depot
				18	Kilcreggan/Rosneath Low Carbon Heating - community scale

Cluster ID: 1

Cluster Name: Clune Brae, East of Port Glasgow



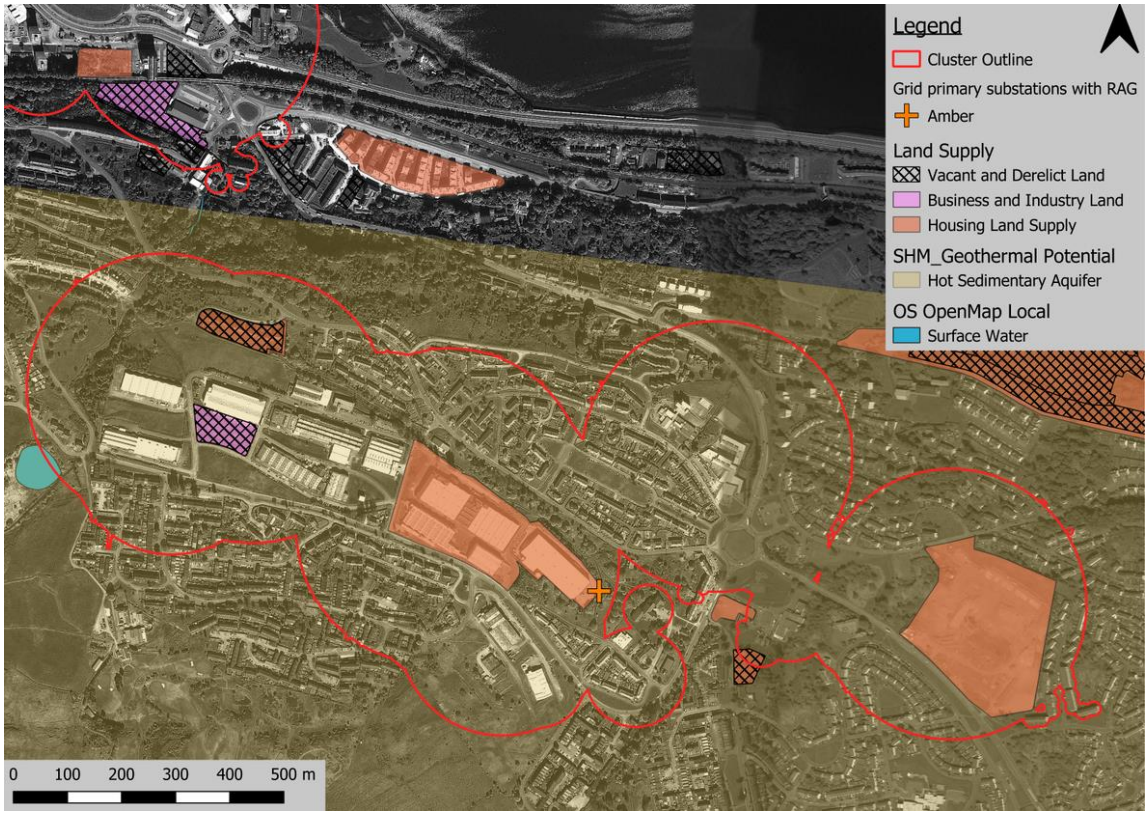
Cluster Summary:
Anchor Loads: 12 loads identified. Key anchor loads: St Stephens high, Newark primary school

Total potential property connections - 1493 within cluster

Total cluster heat demand - 48,676 MWh/yr

Size of cluster - ~103 ha

Cluster typology - Mix of non-domestic anchor loads, industrial buildings, and domestic properties



Opportunities and Constraints

Opportunities:

- South of the River Clyde
- Hot Sedimentary Aquifer
- Surface water bodies
- Vacant & derelict land
  Business and industry land
- Housing land supply

Constraints:

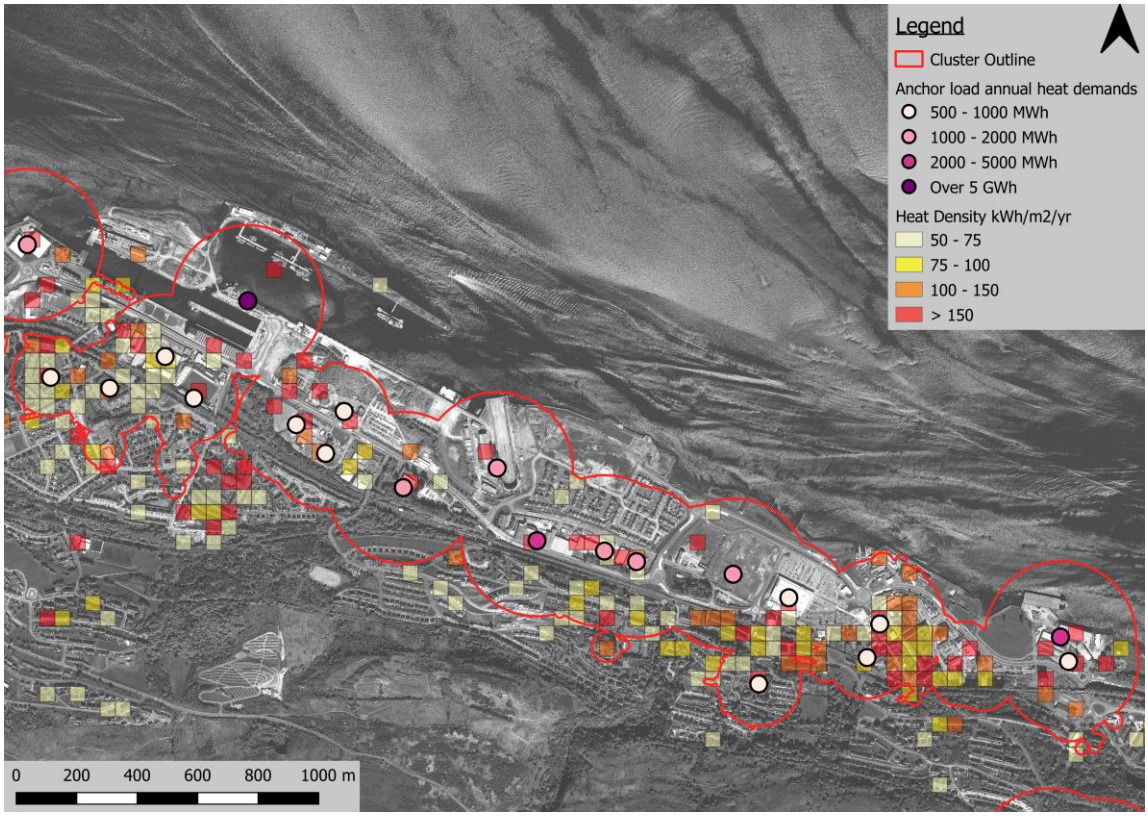
- Grid primary substation RAG: Amber
- A-road and roundabout to the East of cluster

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 2

Cluster Name: Port Glasgow



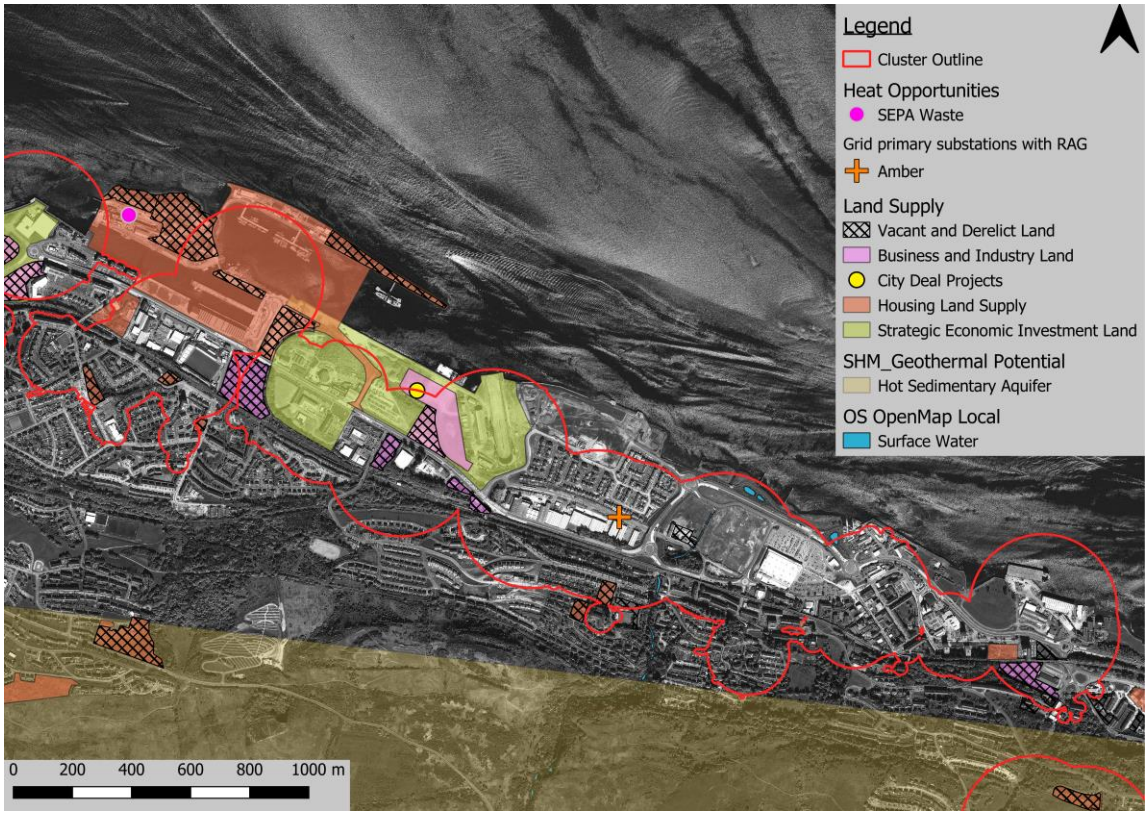
Cluster Summary:
Anchor Loads: 20 loads identified. Key anchor loads include: Ladyburn business centre, Cappielow Park Stadium, dock and harbour, shopping centre, Fergusons shipyard

Total potential property connections - 2994 within cluster

Total cluster heat demand - 70,116 MWh/yr

Size of cluster - ~195 ha

Cluster typology - Mix of non-domestic anchor loads, industrial buildings, and domestic properties



Opportunities and Constraints

Opportunities:

- On the River Clyde bank
- Hot Sedimentary Aquifer
- SEPA waste heat site
- Surface water bodies
- Vacant & derelict land
- Business and industry land
- City deal project
- Housing land supply
- SEI land

Constraints:

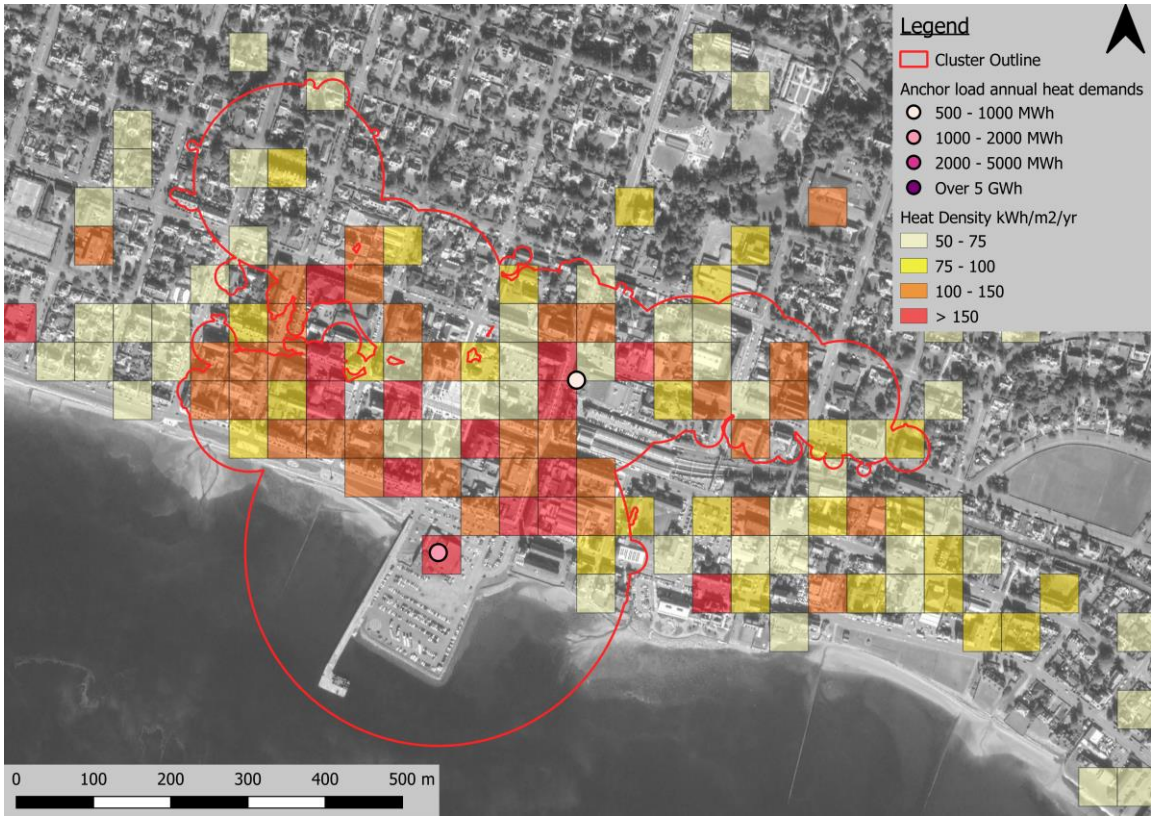
- Grid primary substation RAG: Amber
- Railway intersects from West to East.

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

Cluster ID: 17

Cluster Name: Helensburgh



Cluster Summary:
Anchor Loads: 2 loads identified. Key anchor loads include: Helensburgh swimming pool, Co-op store

Total potential property connections - 1571 within cluster

Total cluster heat demand - 25,933 MWh/yr

Size of cluster - ~41.0 ha

Cluster typology – Primarily domestic loads, with additional non-domestic anchor loads and properties

Opportunities and Constraints

Opportunities:

- Stakeholder projects; Helensburgh Waterfront Development and Graham Williamson IT Centre
- River Clyde
- Solar Thermal technology within cluster

Constraints:

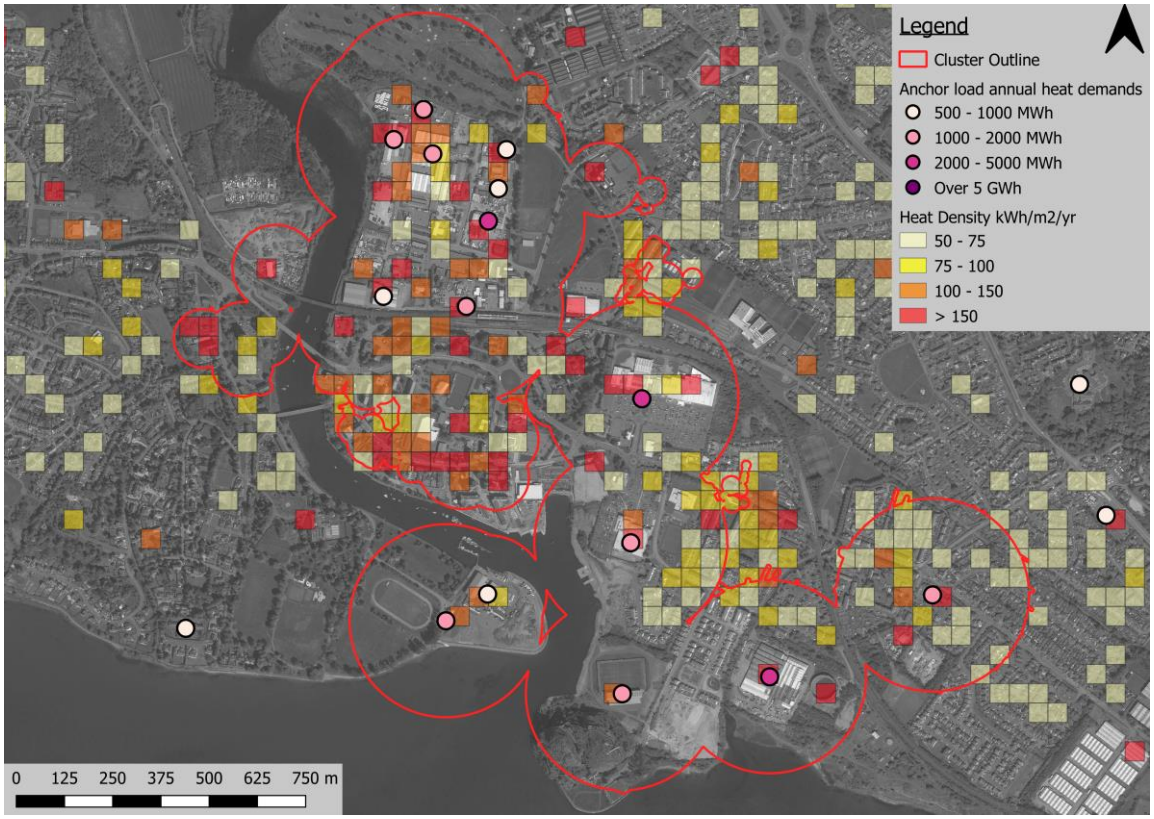
- A-road intersects West to East and North.

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

Cluster ID: 18

Cluster Name: Dumbarton



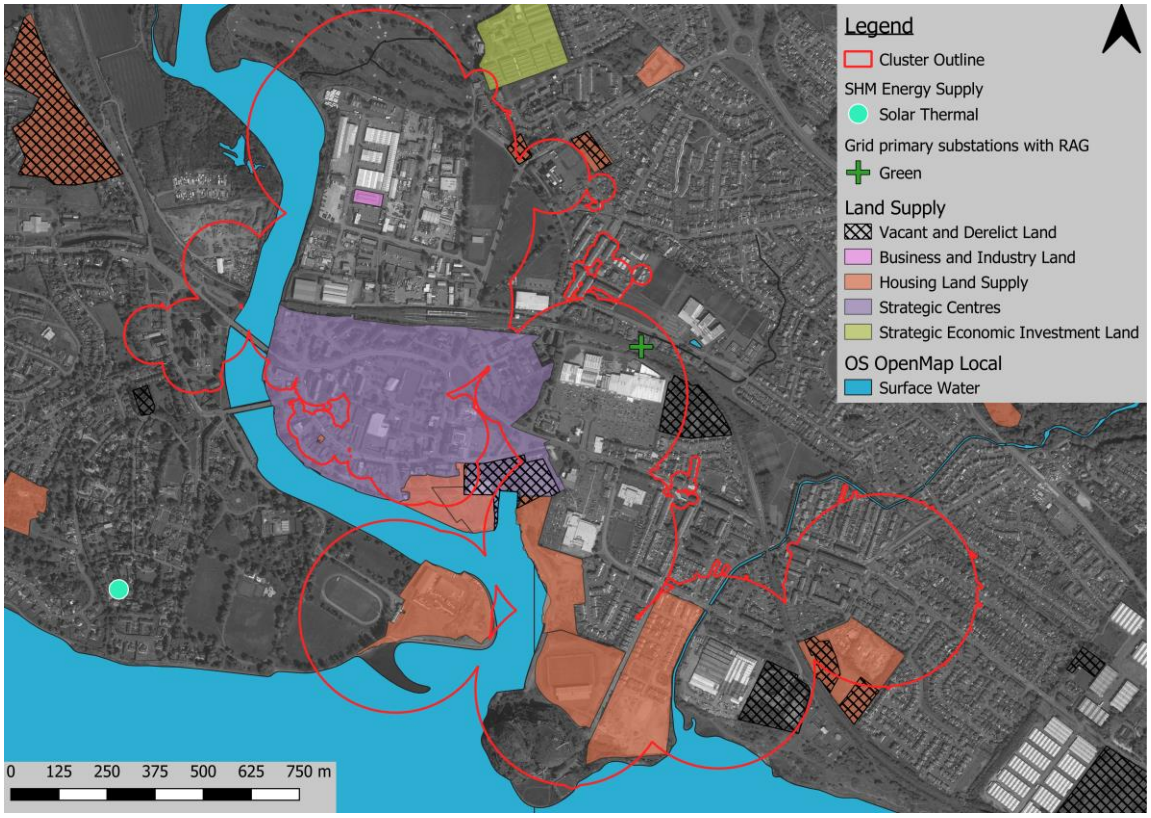
Cluster Summary:
Anchor Loads: 15 loads identified. Key anchor loads include: Sandpoint marina, Dumbarton FC stadium, Broadmeadow industrial estate, retail park, care home

Total potential property connections - 2993 within cluster

Total cluster heat demand - 68,824 MWh/yr

Size of cluster - ~198.0 ha

Cluster typology – Primarily industrial anchor loads, with additional non-domestic and some domestic properties



Opportunities and Constraints

Opportunities:

- Solar Thermal technology within cluster
- Unconstrained power substation
- Vacant & derelict land
- Business & industry land
- Housing land supply
- Strategic Centre
- SEI Land
- River Clyde and surface waterbody

Constraints:

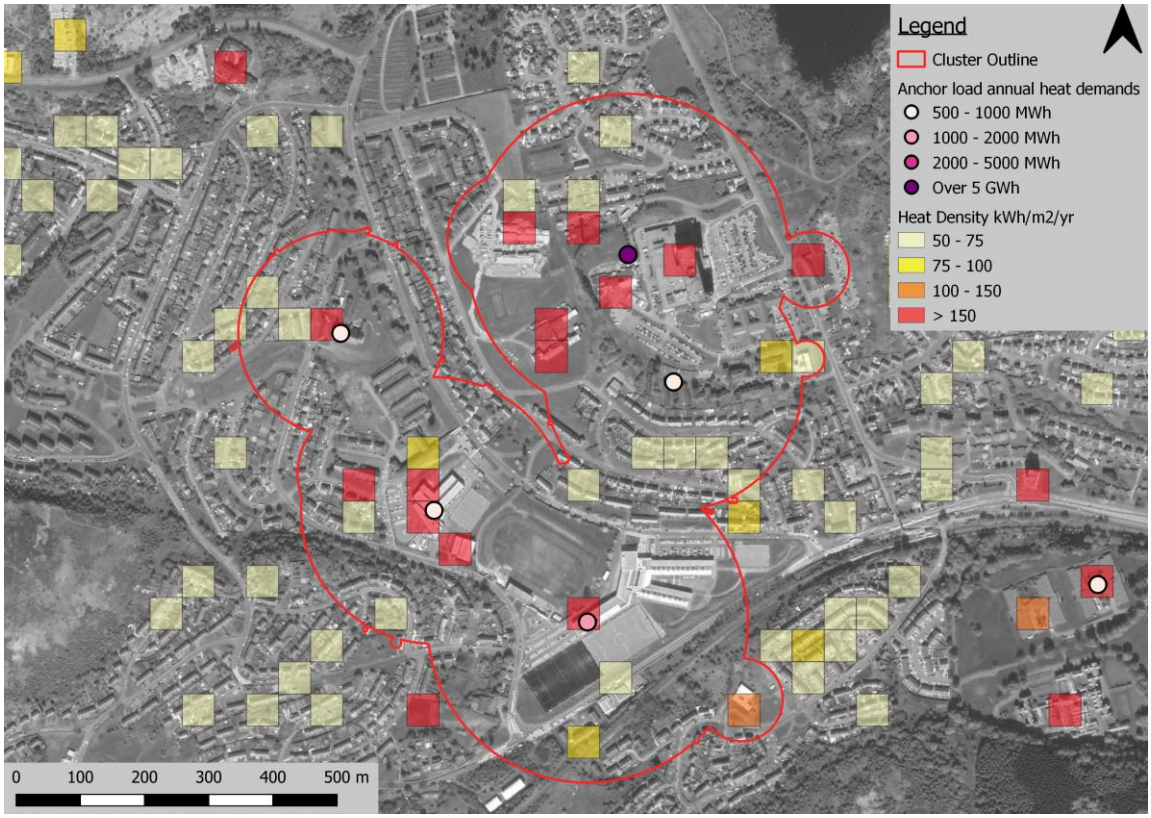
- Railway West to East
- A-road West to East

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Biomass
- Wind
- Hydroelectric

Cluster ID: 20

Cluster Name: Branchton



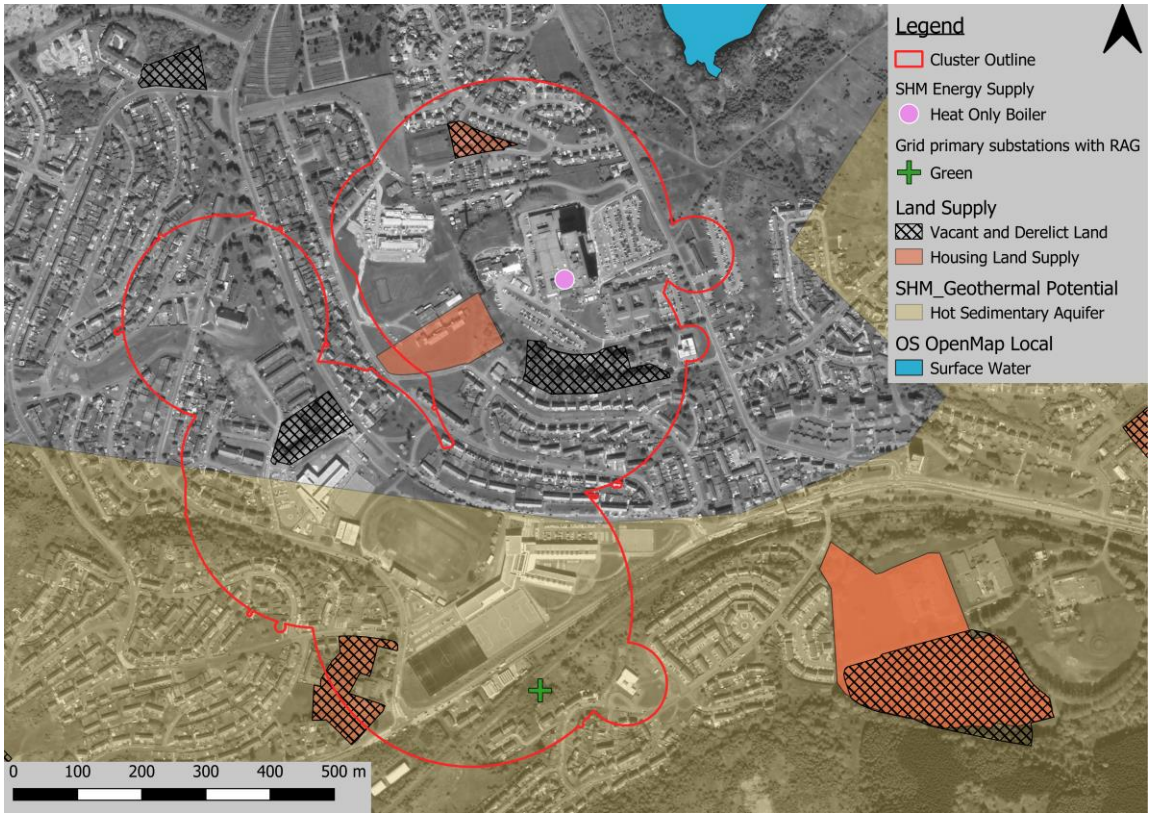
Cluster Summary:
Anchor Loads: 5 loads identified. Key anchor loads include: Orchard View hospital, Inverclyde Royal hospital, Inverclyde academy, Aileymill campus, St Andrew's church

Total potential property connections - 864 within cluster

Total cluster heat demand - 26,295 MWh/yr

Size of cluster - ~64.0 ha

Cluster typology - Primarily non-domestic with additional domestic properties



Opportunities and Constraints

Opportunities:

- Heat only boiler active within cluster
- Unconstrained power substation
- Vacant & Derelict land
- Housing land supply
- Hot Sedimentary Aquifer
- Surface waterbody

Constraints:

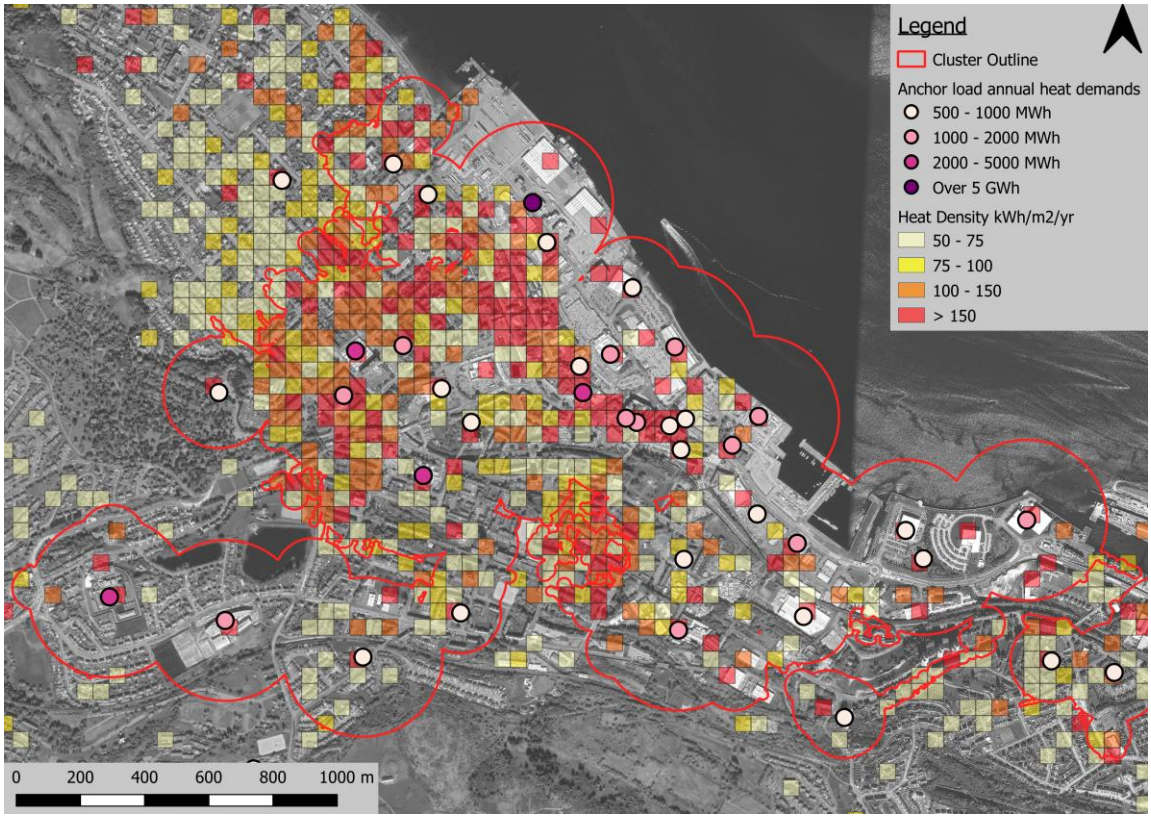
- Railway to very South of cluster

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Biomass

Cluster ID: 21

Cluster Name: Greenock West



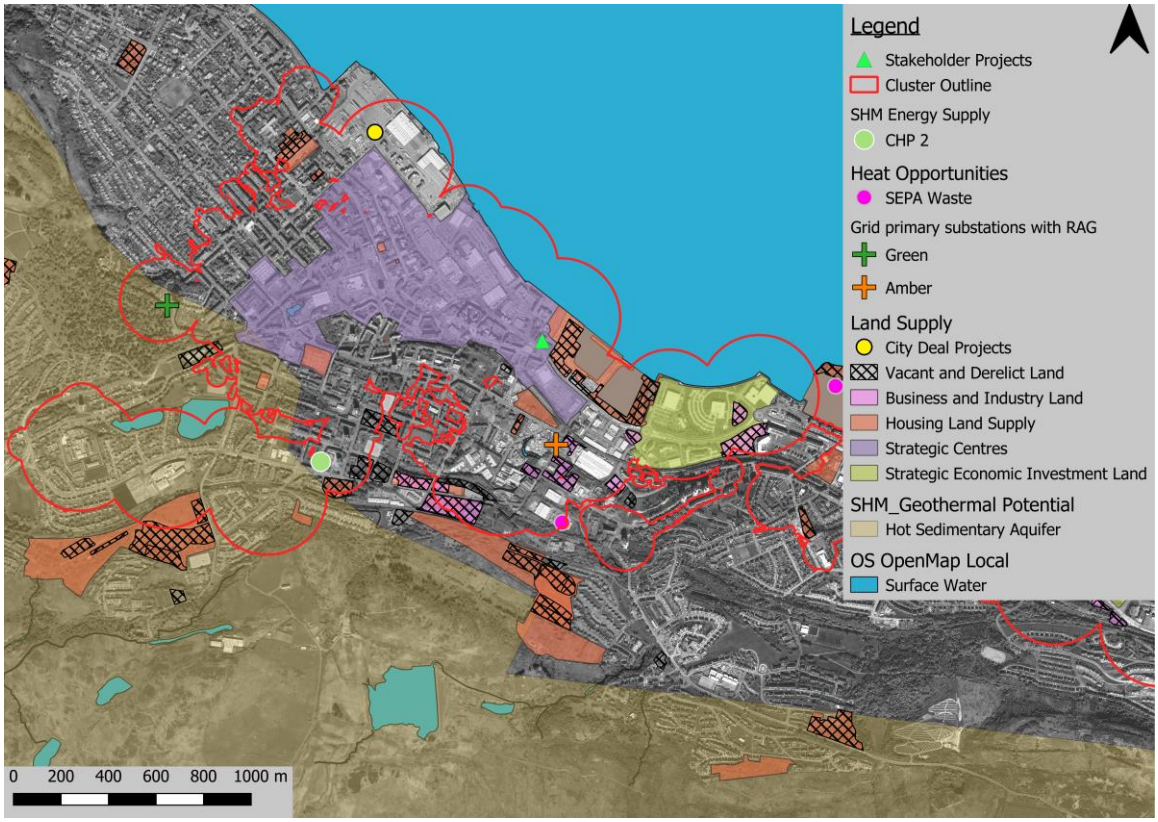
Cluster Summary:
Anchor Loads: 37 loads identified. Key anchor loads include: Greenock prison, Notre Dame high school, crematorium, Town hall, police and fire stations, residential units

Total potential property connections – 10,543 within cluster

Total cluster heat demand - 191,128 MWh/yr

Size of cluster - ~341.4 ha

Cluster typology – Primarily non-non-domestic anchor loads with additional domestic properties



Opportunities and Constraints

Opportunities:

- Stakeholder project; Inverclyde public building network
- CHP active within cluster
- SEPA Waste heat
- Unconstrained power substation
- City Deal Project
- Vacant & Derelict land
- Business & Industry land
- Housing land supply
- Strategic Centre
- SEI Land
- Hot Sedimentary Aquifer
- River Clyde

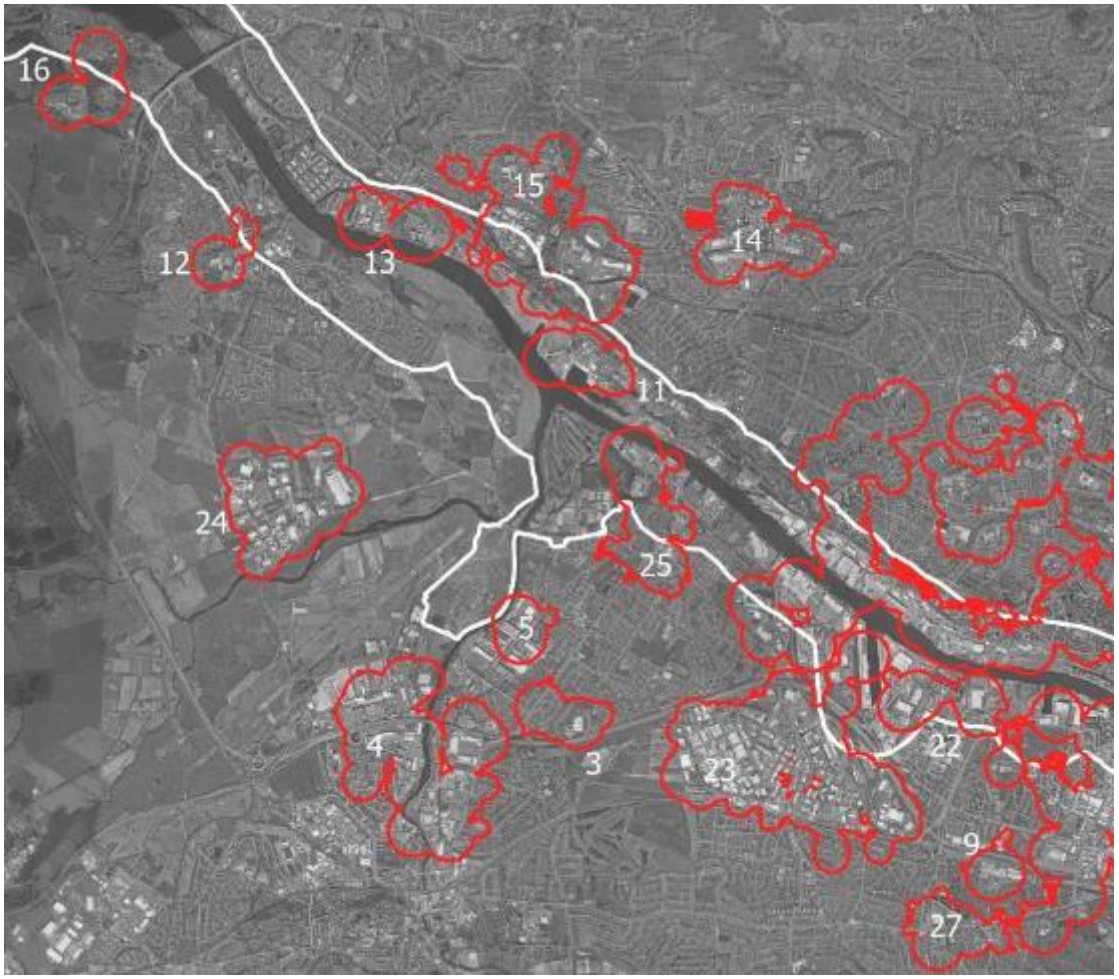
Constraints:

- Railway intersects West to East
- Amber constrained power substation

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Biomass

Figure 14.3. Area 3, Heat demand cluster locations



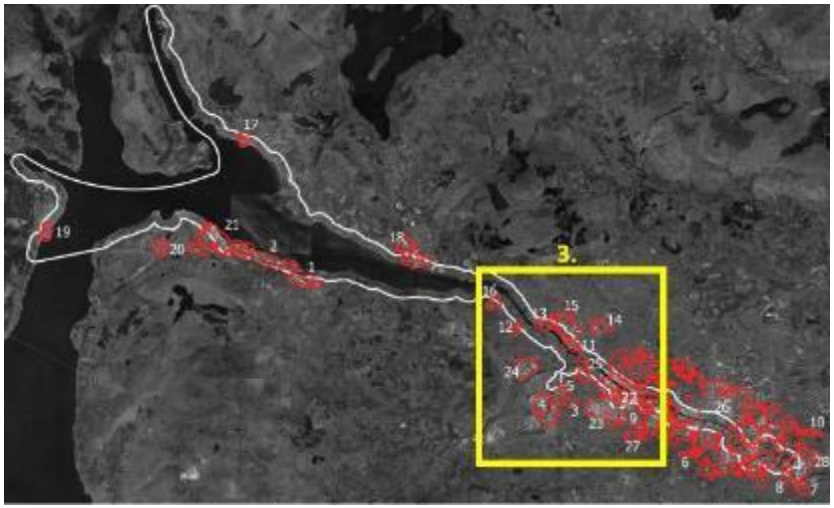


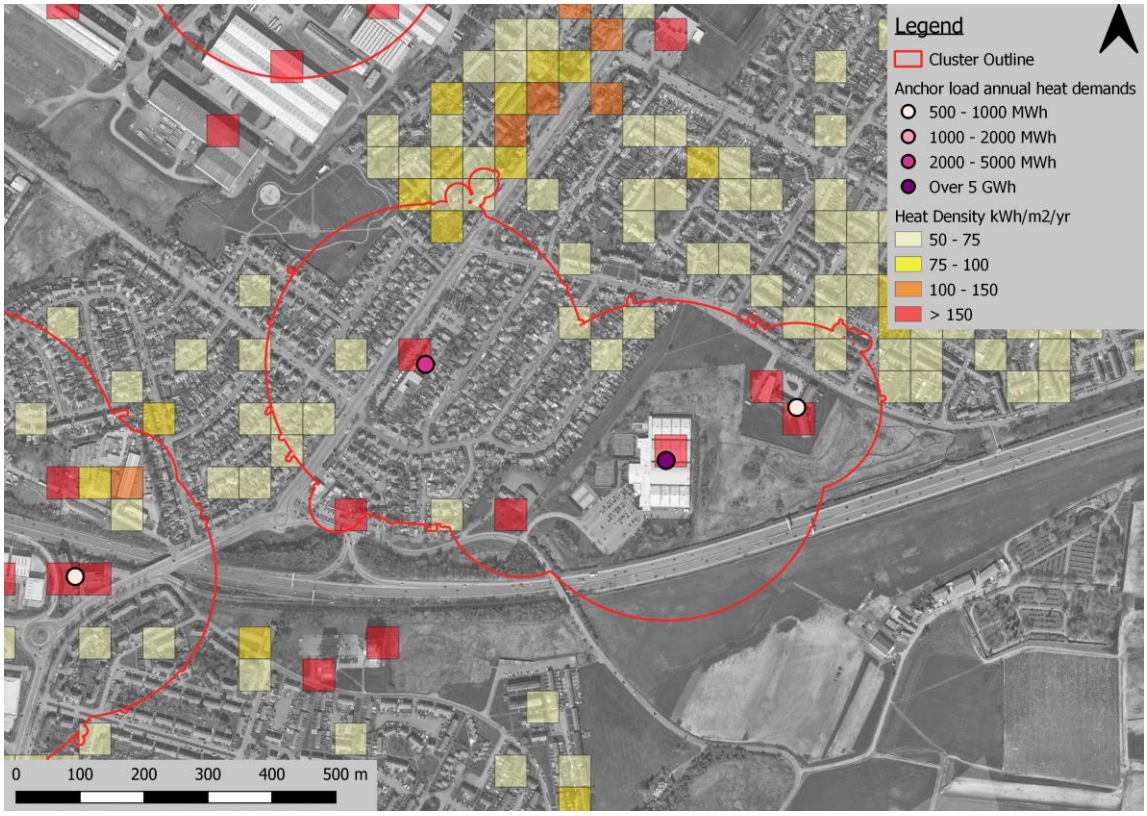
Table 14.7. Area 3, Heat demand clusters

Cluster ID	Location	Connections	Heat Demand (MWh/yr)	Stakeholder-proposed Projects	
				ID	Stakeholder Title
3	East Abbotsinch (1)	538 Total 3 Anchors	18,546		
4	Gallowhill	2269 Total 26 Anchors	104,317		
5	East Abbotsinch (2)	43 Total 3 Anchors	44,714	2	RenWest District Energy Network
				28	AMIDS Heat Network
9	North Halfway	197 Total 2 Anchors	9,366		
11	South Clydebank	598 Total 6 Anchors	19,995	6	North Clyde Plastic to Hydrogen Facility
				36	Potential opportunities between Renfrewshire Council and Scottish Water Horizons within the River Clyde corridor (B)
12	South Erskine	174 Total 2 Anchors	14,479	35	Potential opportunities between Renfrewshire Council and Scottish Water Horizons within the River Clyde corridor (A)
13	South Dalmuir	577 Total 7 Anchors	38,637	7	Heat from Wastewater Treatment Works
14	Drumchapel	980 Total 8 Anchors	34,275		
15	Clydebank	4174 Total 24 Anchors	90,462		

16	North East Erskine	90 Total 3 Anchors	14,104		
22	Linthouse	423 Total 4 Anchors	16,340	31	Queen Elizabeth Hospital
23	Hillington	1744 Total 50 Anchors	133,392	4	Low Carbon District Heat and Steam supply to local real estate and industrial customers
24	South Inchinnan	185 Total 19 Anchors	34,436		
25	North Renfrew	2560 Total 9 Anchors	41,705		
27	Halfway	1437 Total 4 Anchors	21,369		
None				8	Low Carbon Commercial and Industrial Estate - Former Exxon Site
				9	Bowling Active/Sustainable Travel Hub

Cluster ID: 3

Cluster Name: East Abbotsinch (1)



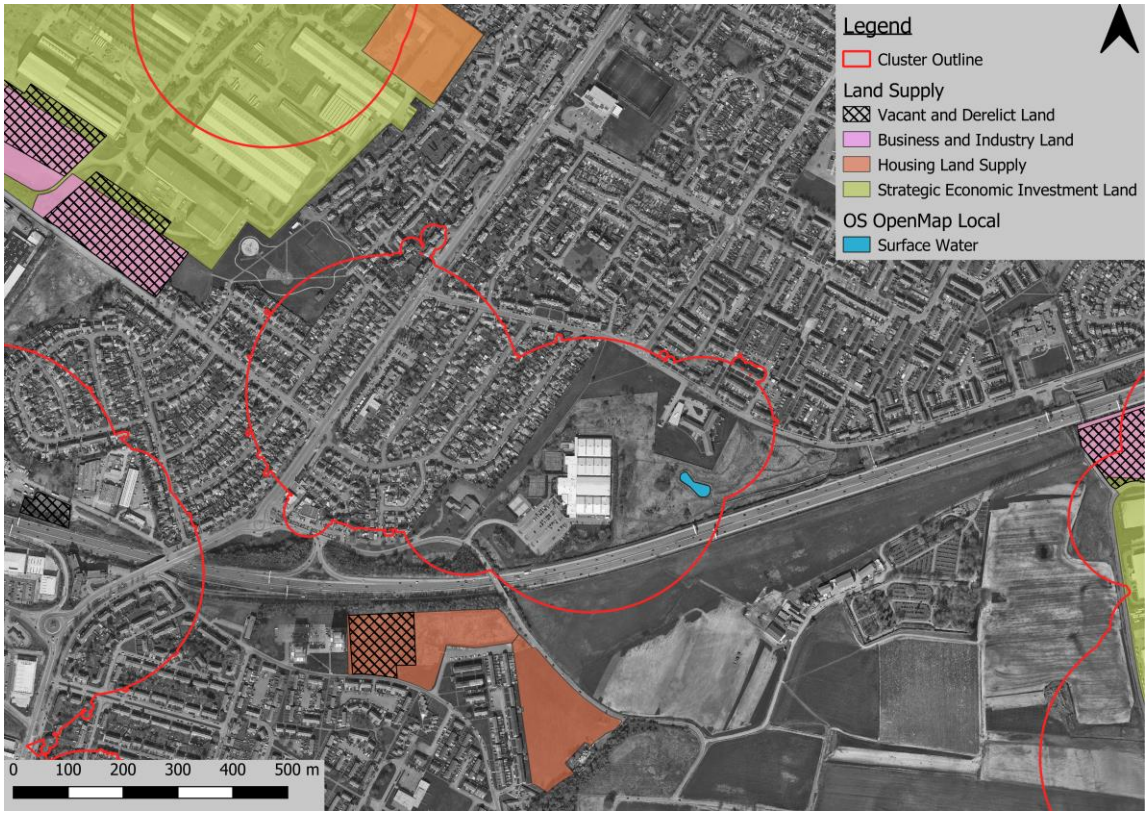
Cluster Summary:
Anchor Loads: 3 loads identified. Key anchor loads include: Glynhill hotel, Renfrew care home & David Lloyd sports club

Total potential property connections - 538 within cluster

Total cluster heat demand - 18,546 MWh/yr

Size of cluster - ~41.6 ha

Cluster typology - Mix of non-domestic and domestic properties



Opportunities and Constraints

Opportunities:

- Surface water body
- Vacant & derelict land
- Business and industry land
  Housing land supply
- SEI land

Constraints:

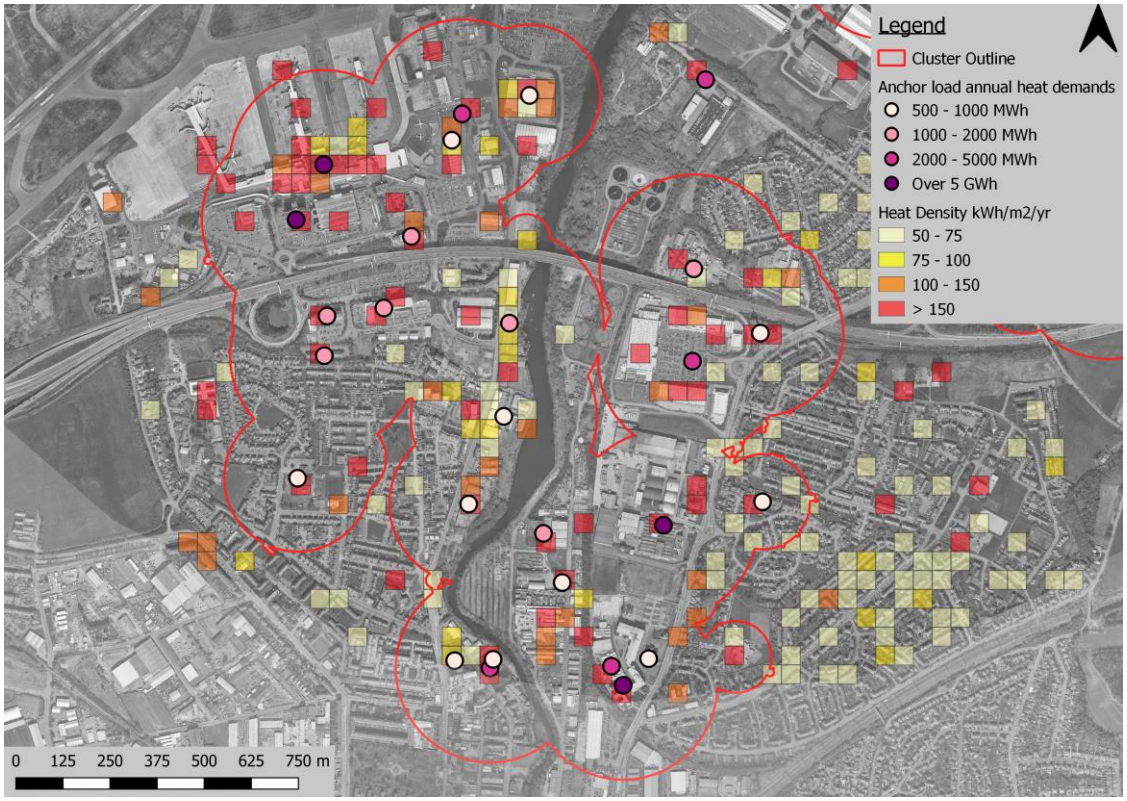
- A-road intersects to the West of cluster
- Motorway to South

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Anaerobic Digestion

Cluster ID: 4

Cluster Name: Gallowhill



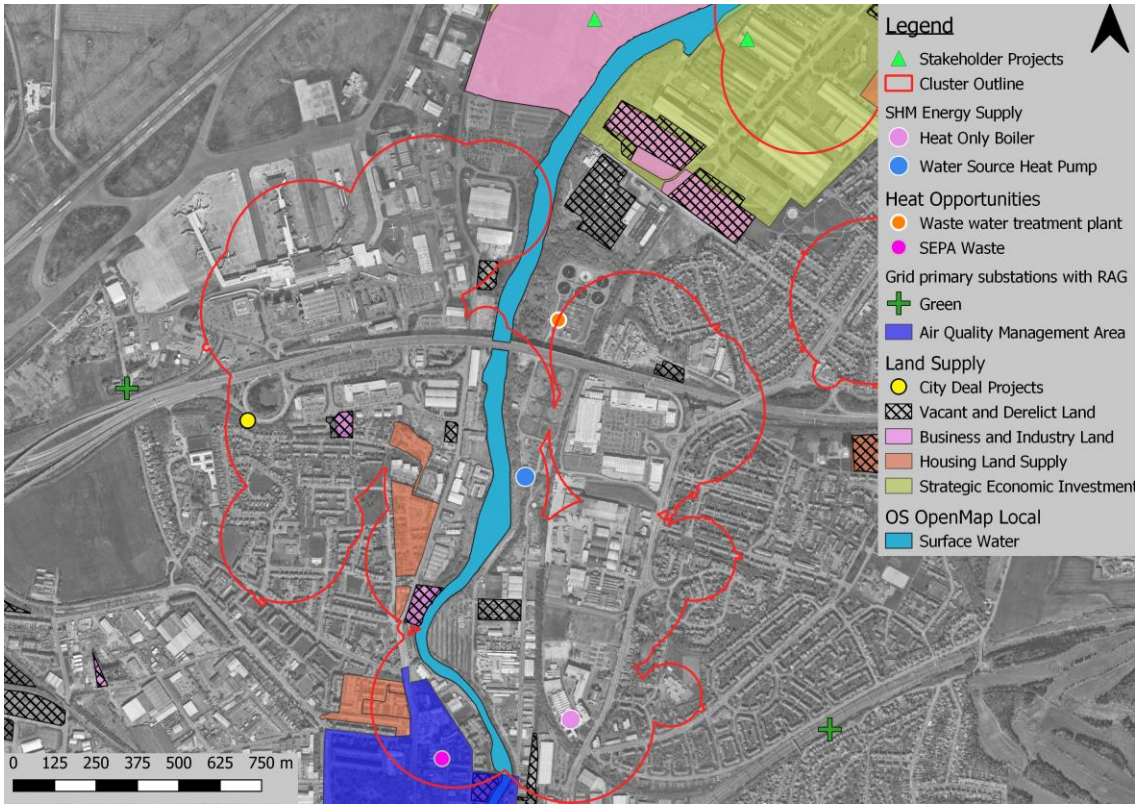
Cluster Summary:
Anchor Loads: 26 loads identified. Key anchor loads include: Glasgow airport, Abbotsinch retail park, West College Scotland, Mossvale primary school, Taylor & Fraser engineering, and Scapa winery.

Total potential property connections - 2269 within cluster

Total cluster heat demand - 104,317 MWh/yr

Size of cluster - ~220 ha

Cluster typology – Primarily non-domestic anchor loads mixed with industrial and domestic properties too.



Opportunities and Constraints

Opportunities:

- Stakeholder projects; AMIDS and RenWest.
- Heat only boiler & WSHP within cluster
- SEPA waste heat site
- WWTWs
- Both substations aren't constrained
- Surface water bodies
- Vacant & derelict land
- Business and industry land
- City deal project
- Housing land supply
- SEI land

Constraints:

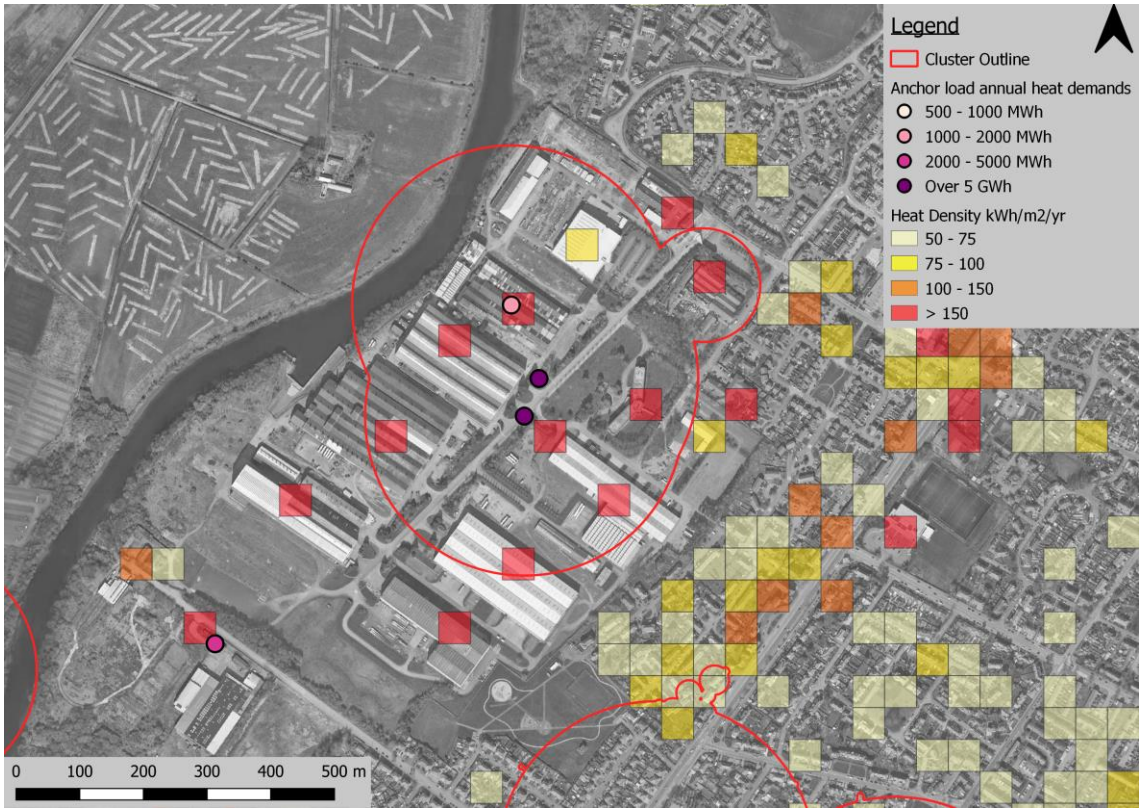
- White Cart Water (river) intersects the cluster
- Motorway West to East
- A-road North to South on East side
- Air Quality Management Area to South

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Anaerobic Digestion

Cluster ID: 5

Cluster Name: East Abbotsinch (2)



Cluster Summary:
Anchor Loads: 3 loads identified. Key anchor loads include: Lightweight manufacturing centre

Total potential property connections - 43 within cluster

Total cluster heat demand - 44,714 MWh/yr

Size of cluster - ~30.8 ha

Cluster typology – Cluster solely includes industrial anchor loads and properties.

Opportunities and Constraints

Opportunities:

- Stakeholder projects; Renwest (within), AMIDS across waterbody.
- WWTWs
- Surface water bodies
- Vacant & derelict land
- Business and industry land
- City deal project
- Housing land supply
- SEI land

Constraints:

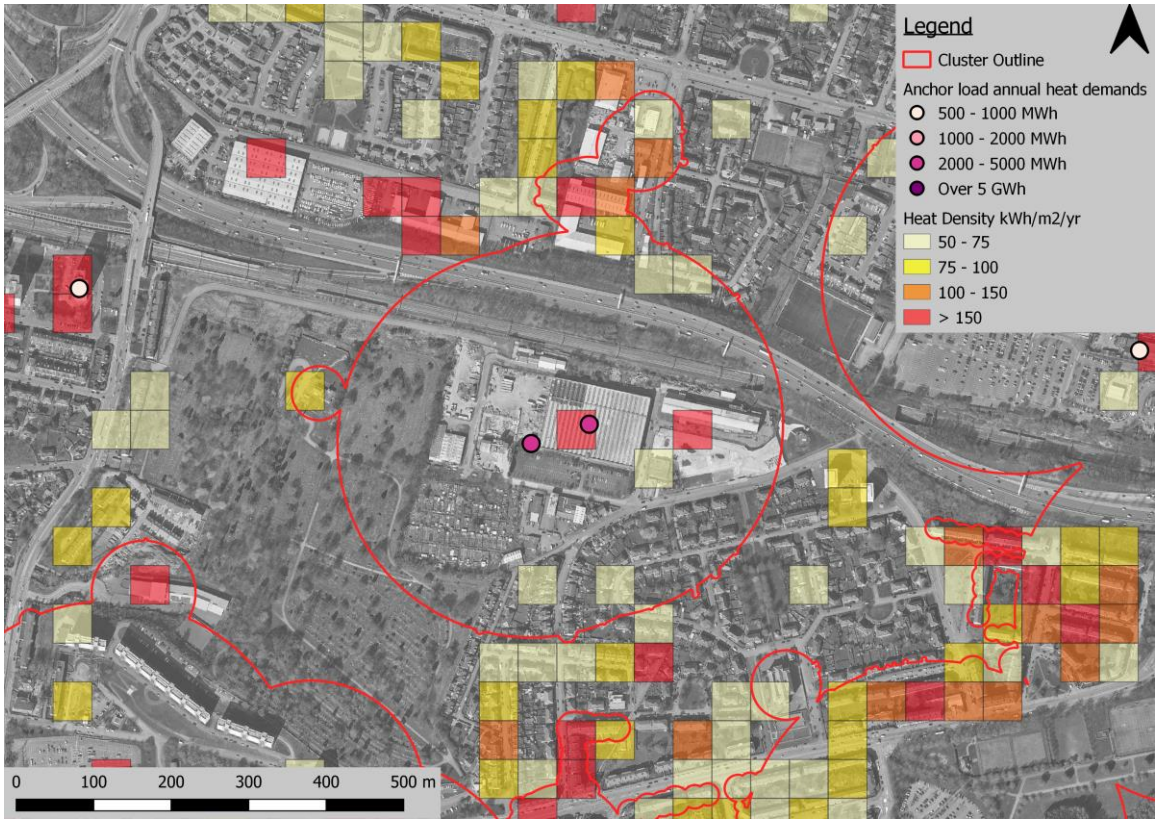
- No major constraints

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 9

Cluster Name: North Halfway



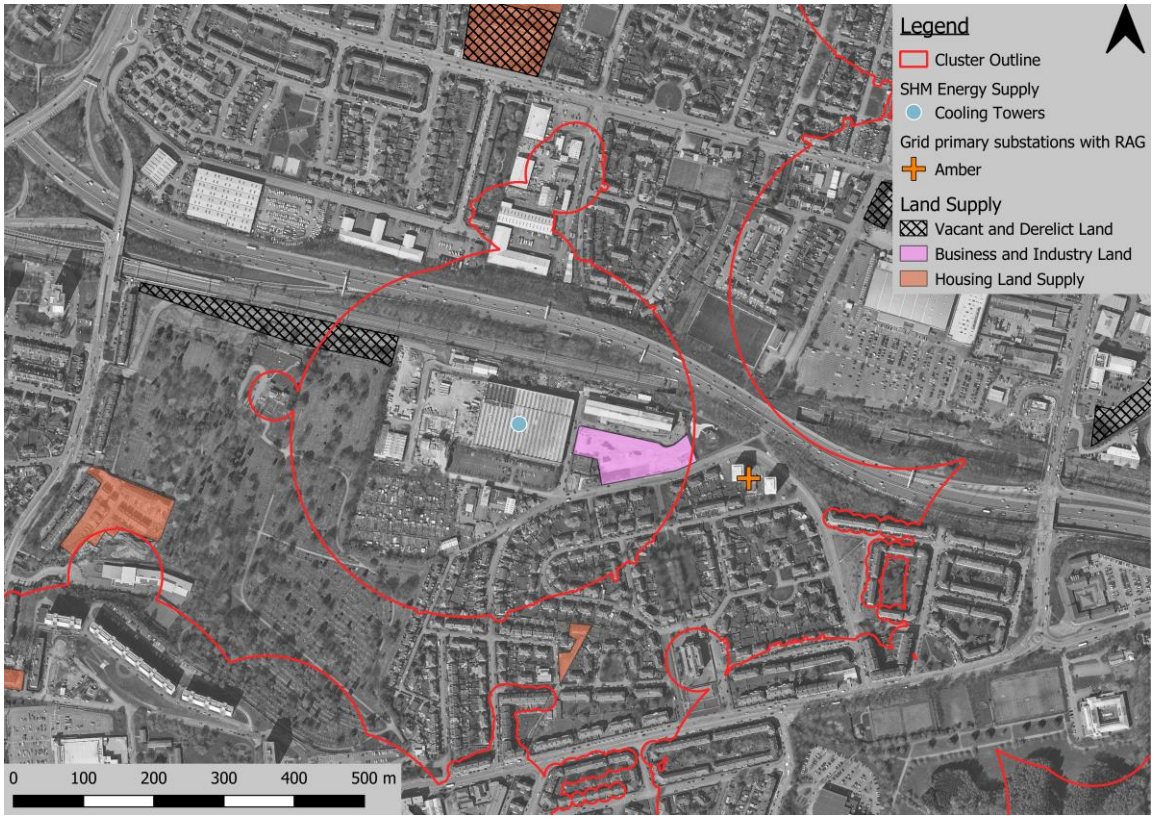
Cluster Summary:
Anchor Loads: 2 loads identified. Key anchor loads include: WM Watson Packaging Scotland Ltd

Total potential property connections - 197 within cluster

Total cluster heat demand - 9,366 MWh/yr

Size of cluster - ~26.1 ha

Cluster typology - Cluster solely includes industrial anchor loads and properties.



Opportunities and Constraints

Opportunities:

- Cooling tower energy supply within the cluster
- Vacant & derelict land
- Business and industry land
- Housing land supply

Constraints:

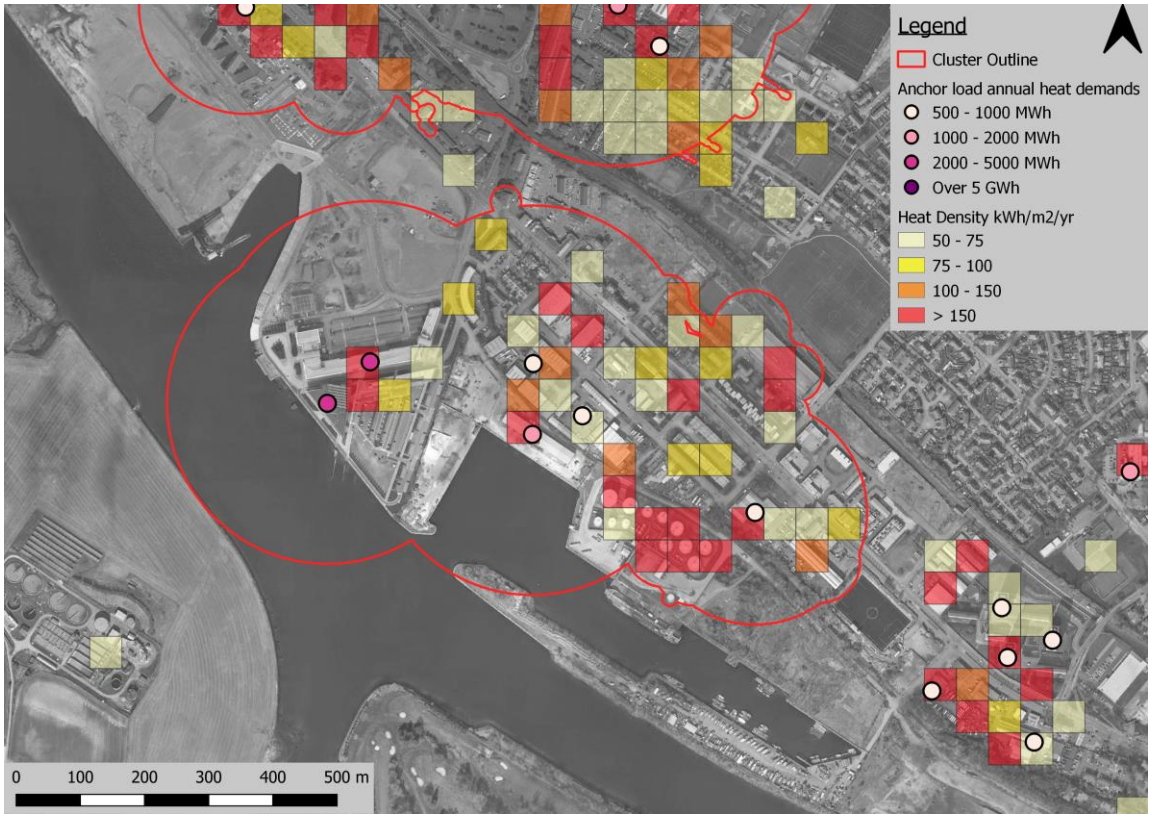
- Amber constrained substation
- Motorway West to East
- Railway track intersects and stops at anchor load site

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 11

Cluster Name: South Clydebank



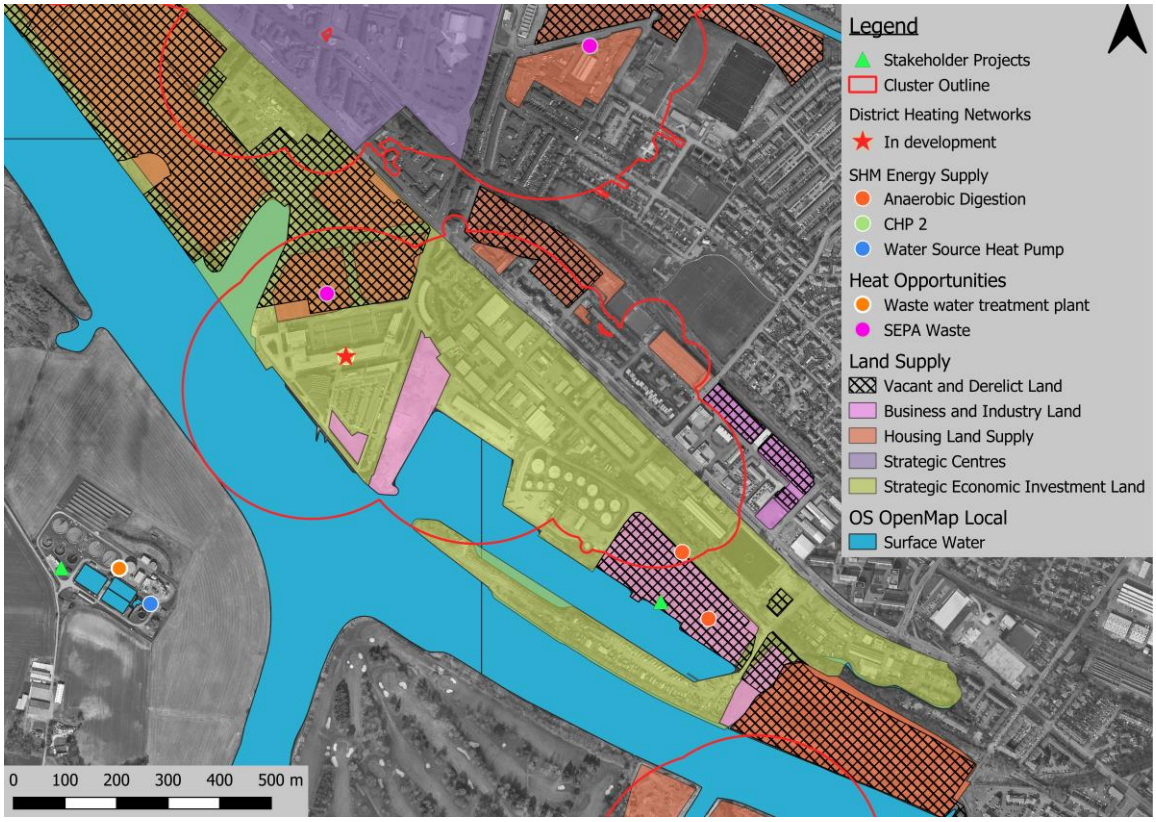
Cluster Summary:
Anchor Loads: 6 loads identified. Key anchor loads include: West Rothesay dock, Clydebank leisure centre, West College Scotland

Total potential property connections - 598 within cluster

Total cluster heat demand - 19,995 MWh/yr

Size of cluster - ~52.8 ha

Cluster typology - Mix of non-domestic and industrial anchor loads



Opportunities and Constraints

Opportunities:

- Stakeholder projects; North Clyde Plastic to Hydrogen Facility and Scottish Water Horizons (B) (across waterbody).
- HN in-development
- Anaerobic digestor, CHP and WSHP technologies present
- WWTWs
- SEPA waste site
- Vacant & derelict land
- Business & industry land
- Housing land supply
- Strategic centre
- SEI land

Constraints:

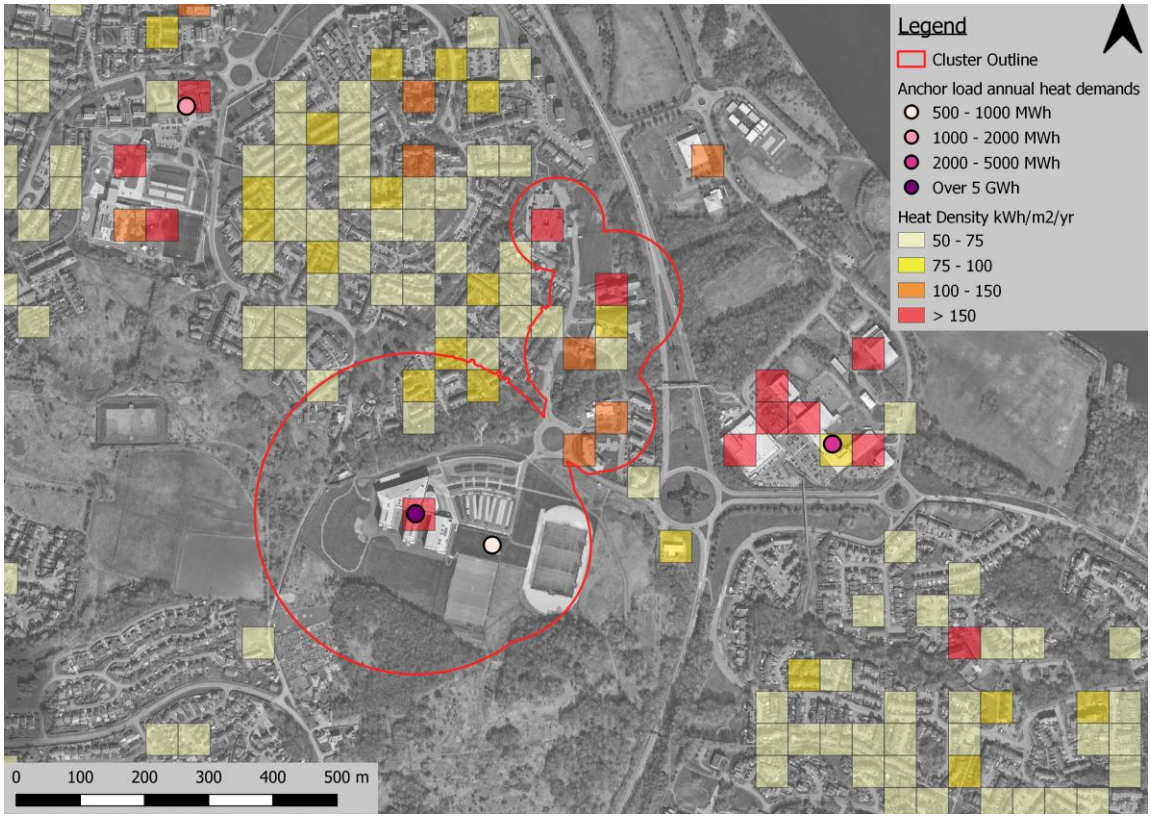
- A-road intersects to North of cluster

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Anaerobic Digestion

Cluster ID: 12

Cluster Name: South Erskine



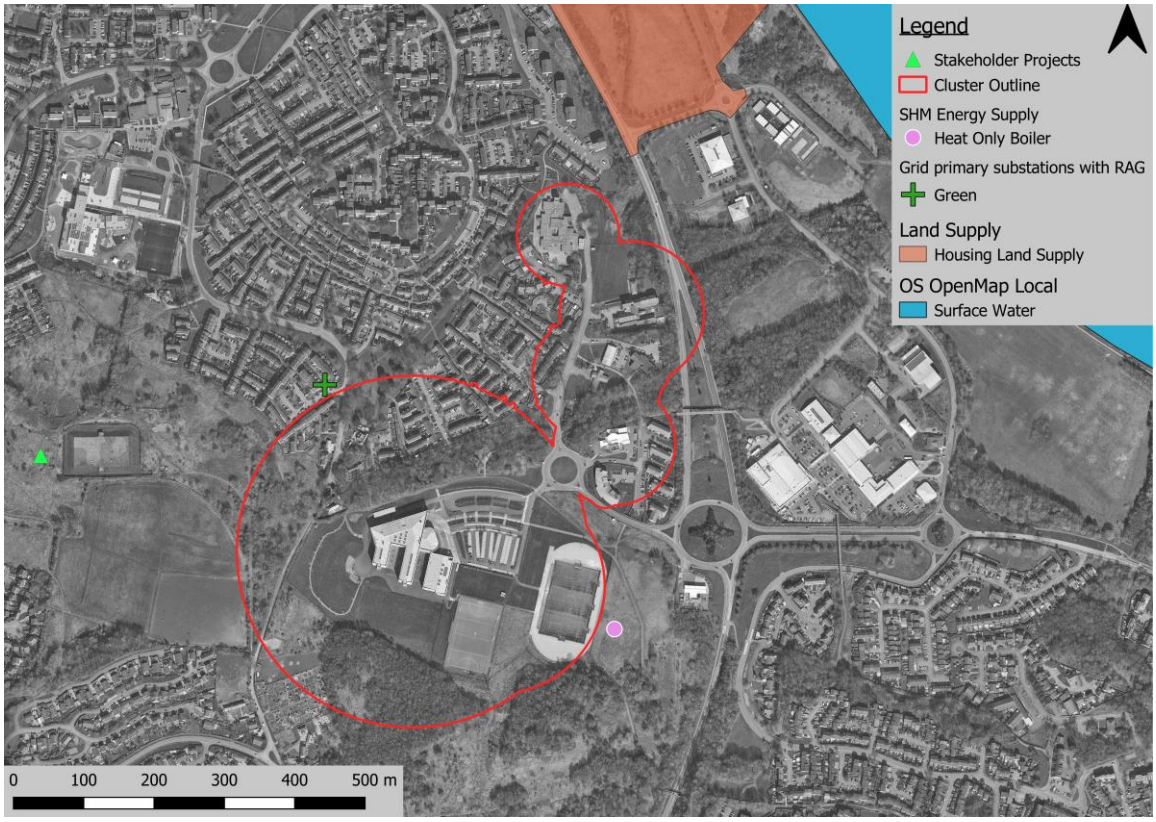
Cluster Summary:
Anchor Loads: 2 loads identified. Key anchor loads include: Park Mains high school

Total potential property connections - 174 within cluster

Total cluster heat demand - 14,479 MWh/yr

Size of cluster - ~28.1 ha

Cluster typology – Mix of non-domestic and domestic property loads



Opportunities and Constraints

Opportunities:

- Stakeholder projects; Scottish Water Horizons (A)
- Unconstrained power substation
- Heat only boiler present
- Housing land supply
- Close proximity to river Clyde

Constraints:

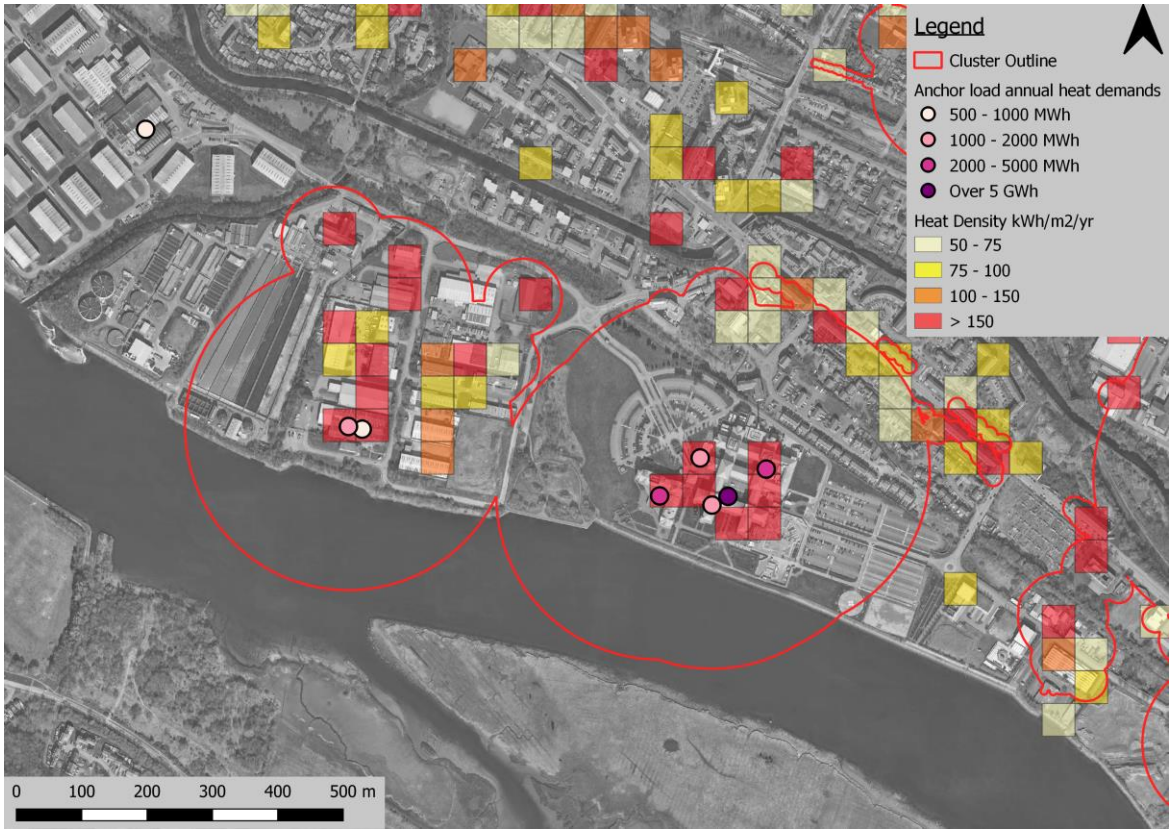
- No constraints to note

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 13

Cluster Name: South Dalmuir



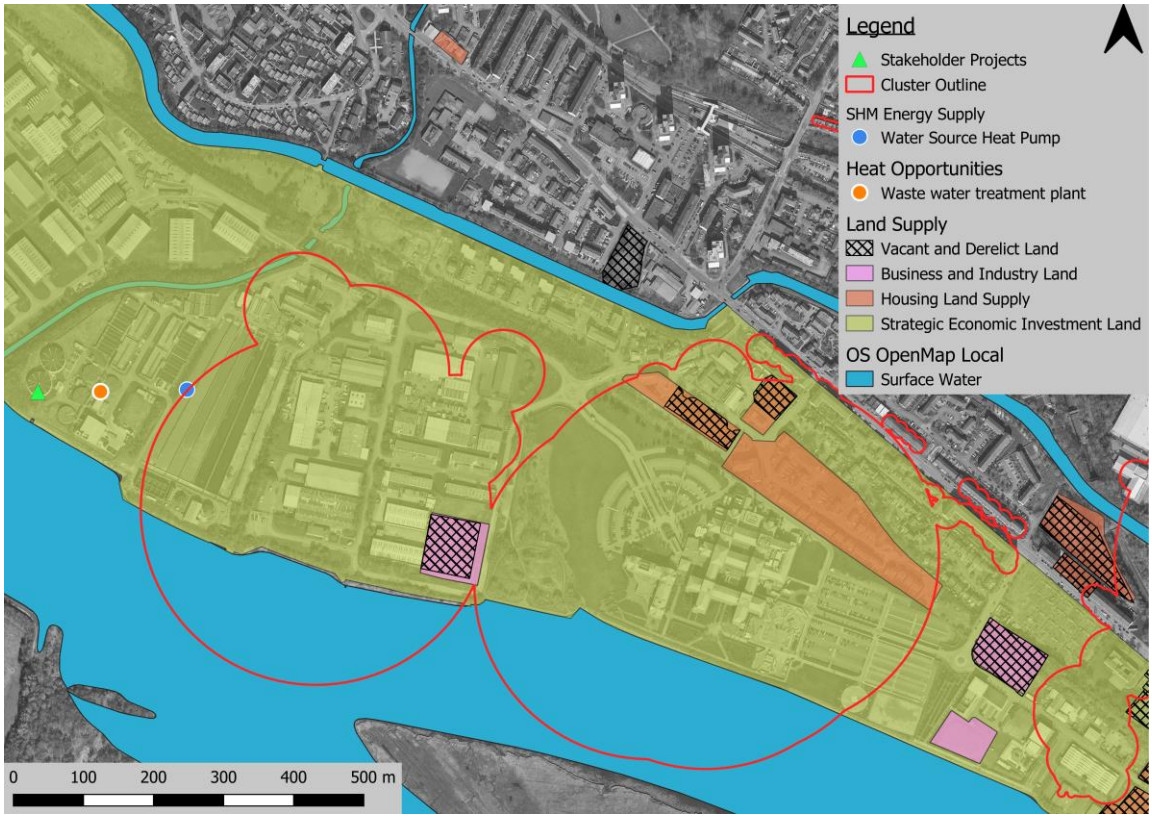
Cluster Summary:
Anchor Loads: 7 loads identified. Key anchor loads include: Golden Jubilee Hospital & conferences, Powerhouse fitness block

Total potential property connections - 577 within cluster

Total cluster heat demand - 38,637 MWh/yr

Size of cluster - ~55.1 ha

Cluster typology - Mix of non-domestic and industrial property loads



Opportunities and Constraints

Opportunities:

- Stakeholder projects; Heat from Dalmuir WWTWs
- River Clyde
- WSHP present
- WWTWs close by
- Vacant & derelict land
- Business & industry land
- Housing land supply
- SEI land

Constraints:

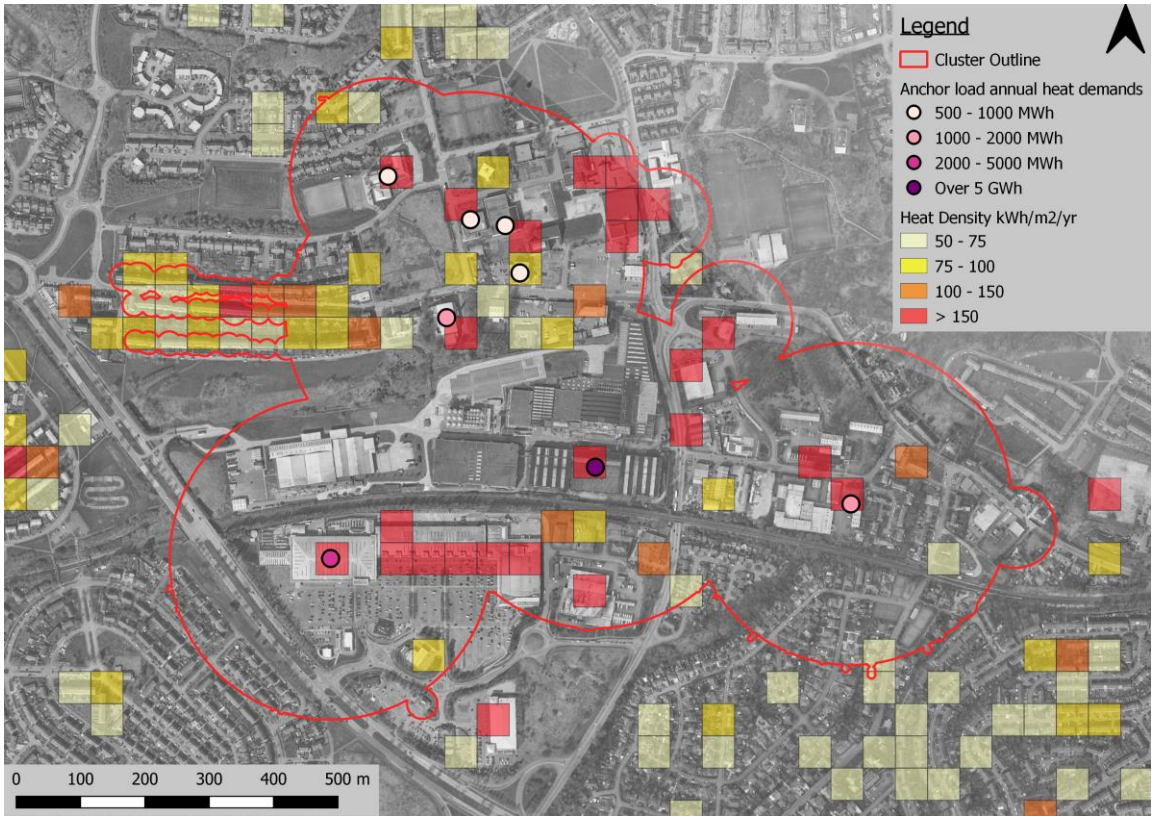
- No constraints to note

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Anaerobic Digestion

Cluster ID: 14

Cluster Name: Drumchapel



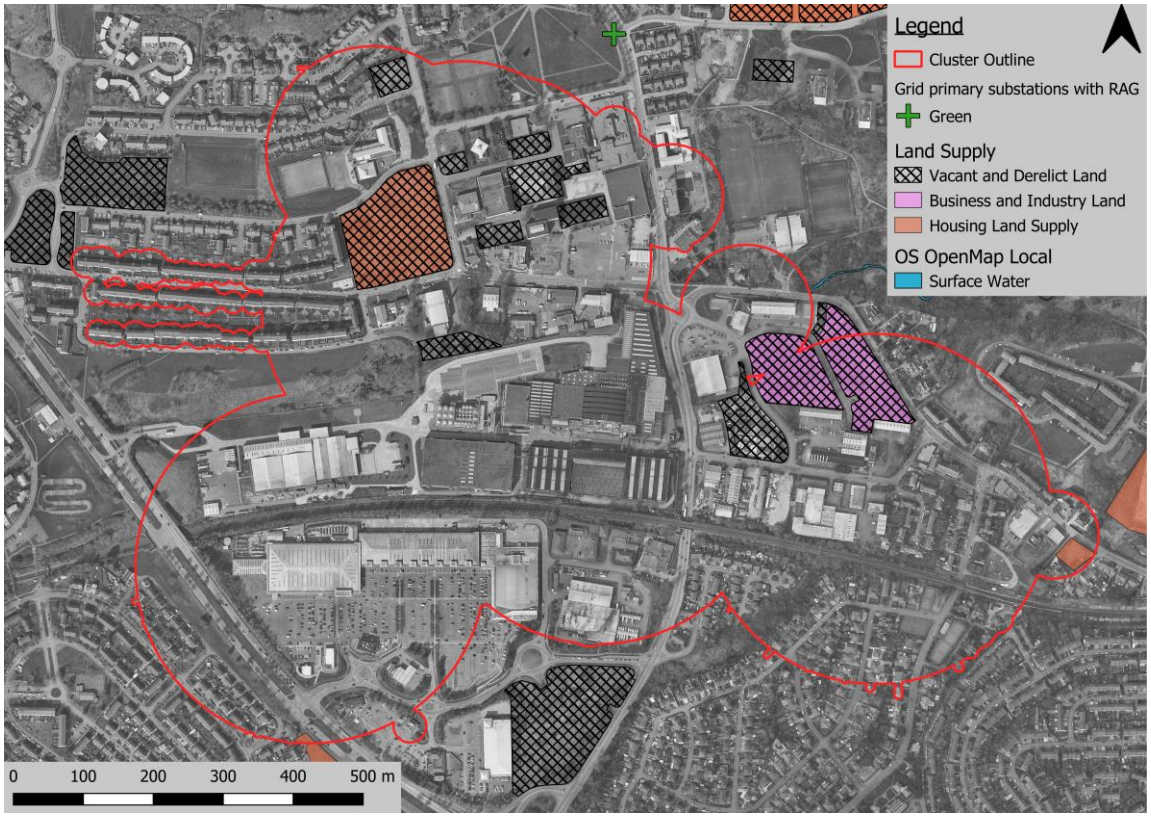
Cluster Summary:
Anchor Loads: 8 loads identified. Key anchor loads include: Drumchapel swimming pool, police station, Antonine primary school, retail park & Edrington manufacturer

Total potential property connections - 980 within cluster

Total cluster heat demand - 34,275 MWh/yr

Size of cluster - ~84.8 ha

Cluster typology – Primarily industrial loads, with additional non-domestic and domestic properties



Opportunities and Constraints

Opportunities:

- Unconstrained power substation
- Vacant & derelict land
- Business & industry land
- Housing land supply

Constraints:

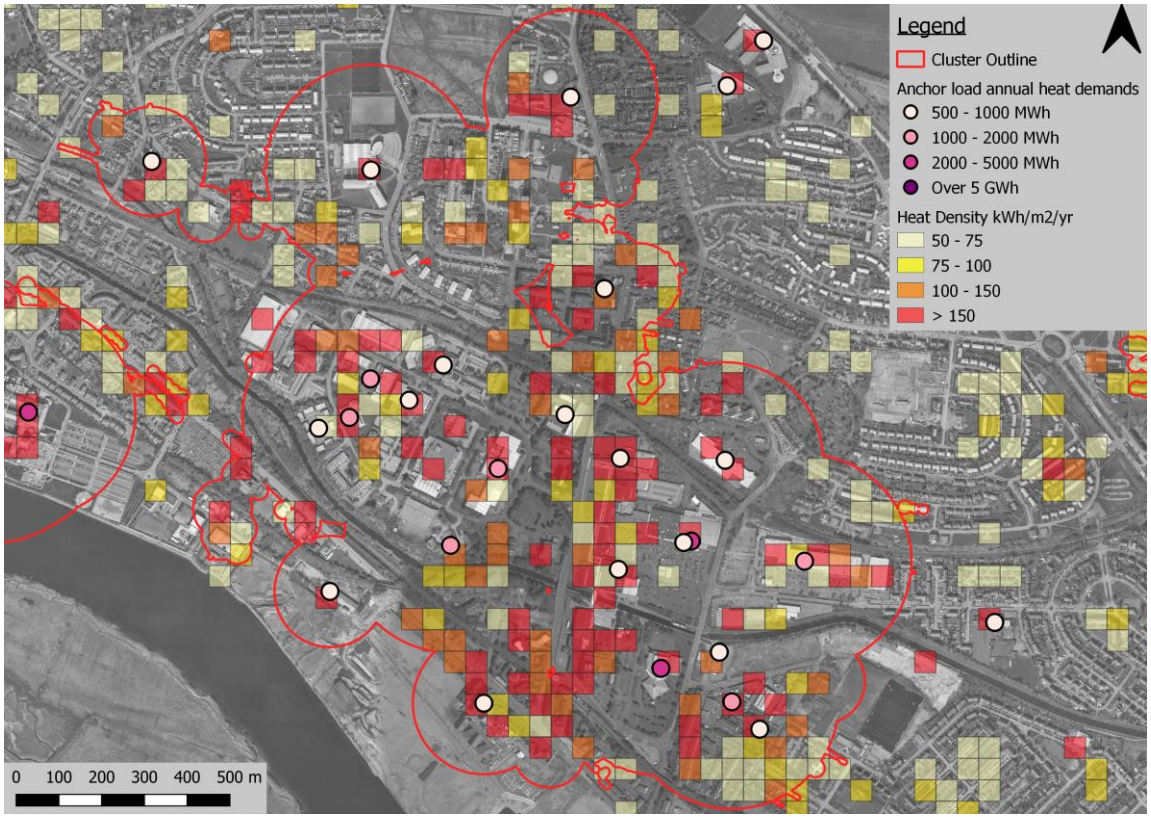
- Railway intersects West to East

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 15

Cluster Name: Clydebank



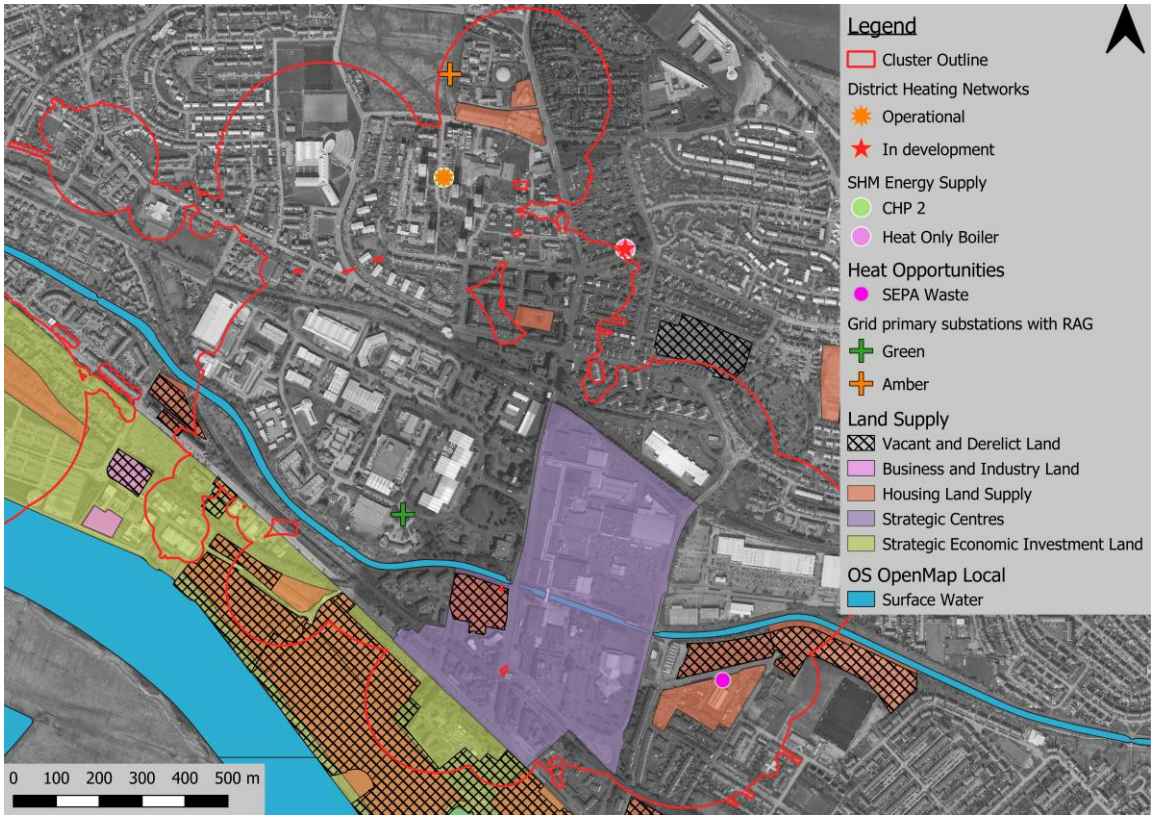
Cluster Summary:
Anchor Loads: 24 loads identified. Key anchor loads include: Clyde & Kilbowie retail parks, Clydebank high school, Hotel, Kilbowie Court residential housing, Play Drome Aqua Sports.

Total potential property connections - 4174 within cluster

Total cluster heat demand - 90,462 MWh/yr

Size of cluster - ~193.5 ha

Cluster typology - Primarily industrial and non-domestic loads, with additional domestic properties



Opportunities and Constraints

Opportunities:

- Operation and in-development HN networks
- CHP and Heat only boiler present.
- SEPA waste site
- Unconstrained power substation
- Vacant & derelict land
- Business & industry land
- Housing land supply
- Strategic Centre
- SEI Land
- River Clyde and surface waterbody

Constraints:

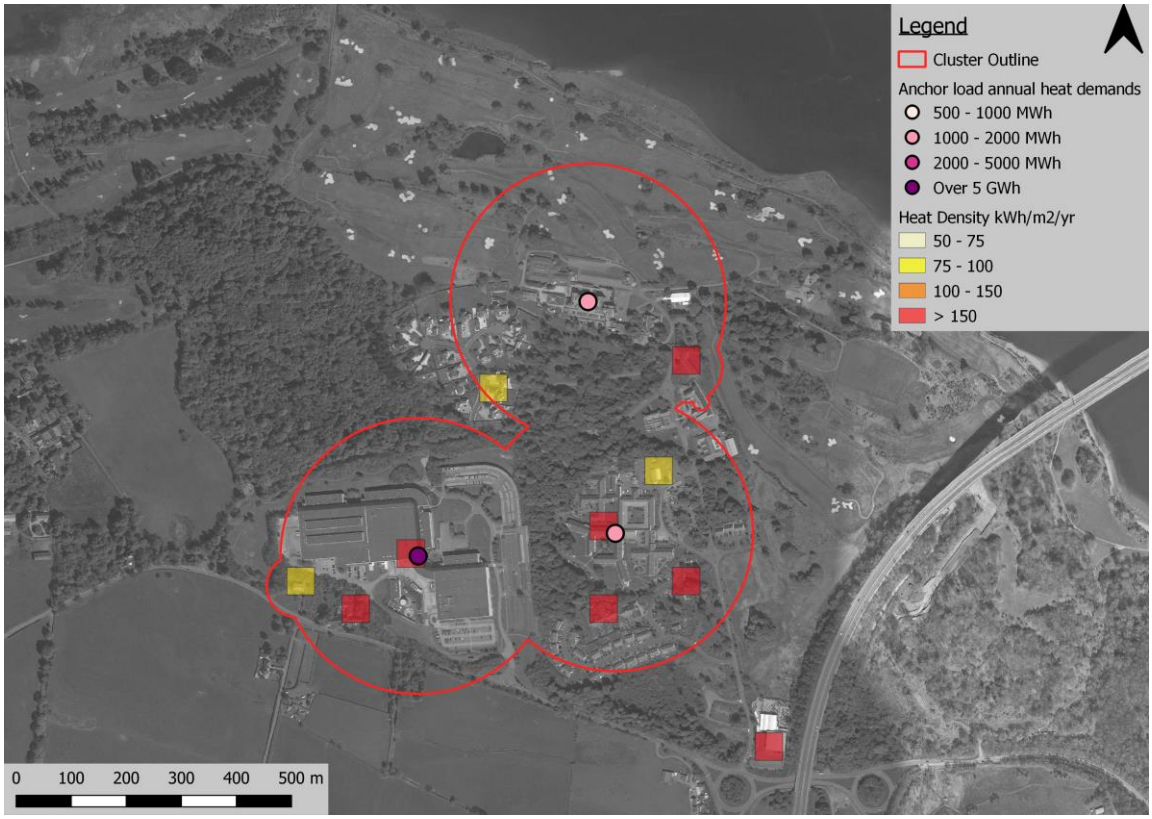
- Amber constrained power substation
- Two railways West to East
- A-road North-South

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

Cluster ID: 16

Cluster Name: North East Erskine



Cluster Summary:
Anchor Loads: 3 loads identified. Key anchor loads include: Hewlett Packard factory, Mar Hall hotel & spa report, Erskine care home

Total potential property connections - 90 within cluster

Total cluster heat demand - 14,104 MWh/yr

Size of cluster - ~54.7 ha

Cluster typology – Non-domestic and domestic property loads

Opportunities and Constraints

Opportunities:

- Hot Sedimentary Aquifer
- River Clyde

Constraints:

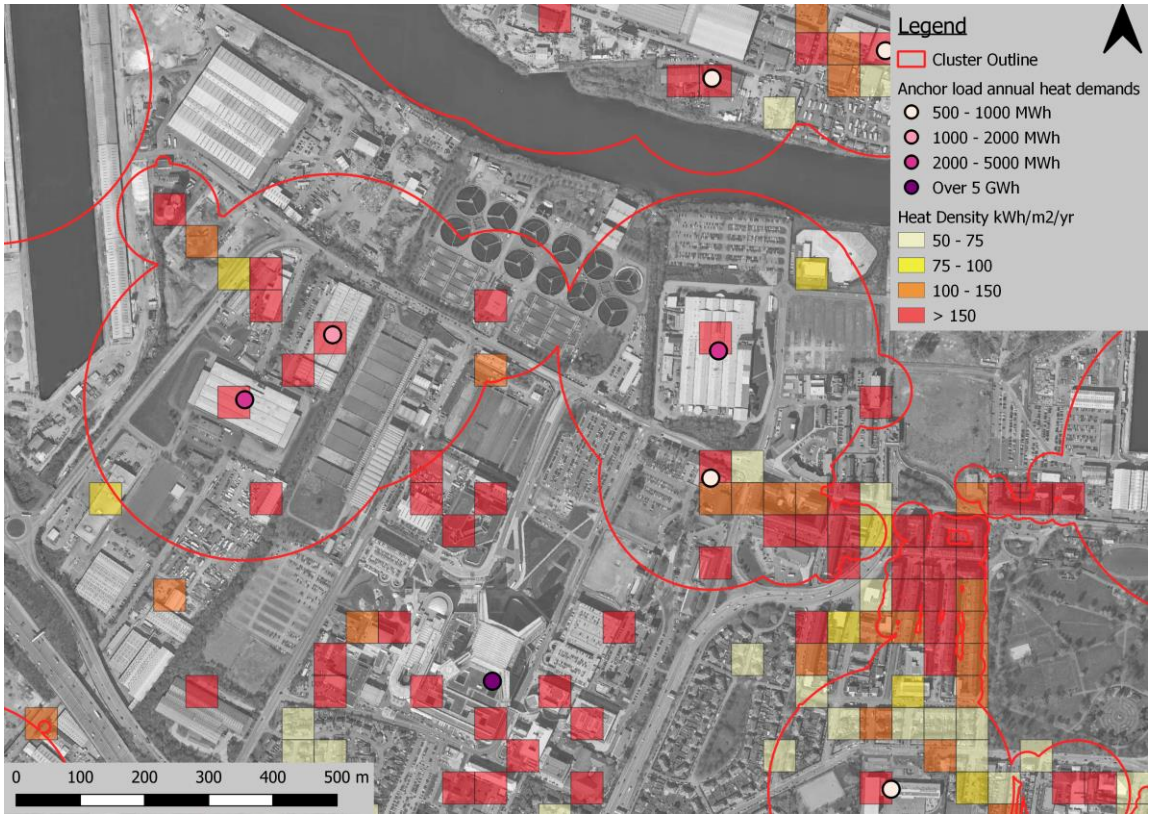
- No constraints to note

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Biomass
- Wind

Cluster ID: 22

Cluster Name: Linthouse



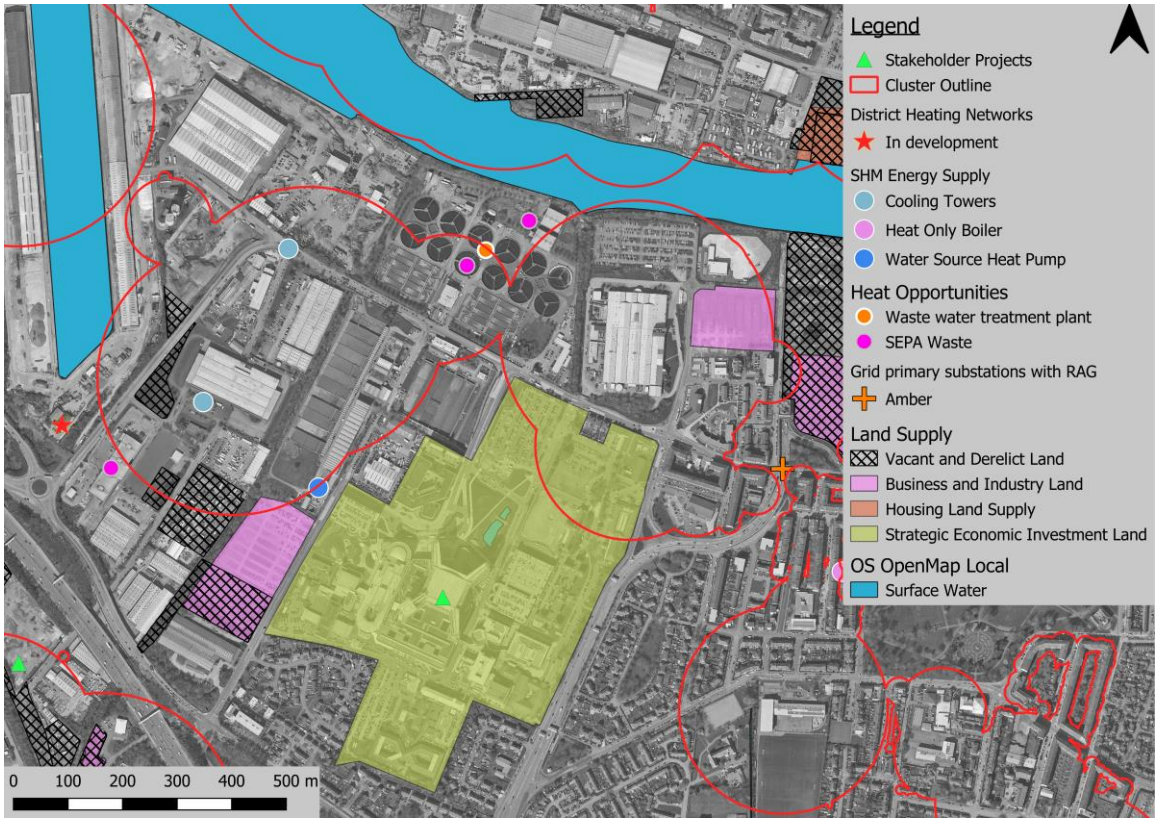
Cluster Summary:
Anchor Loads: 4 loads identified. Key anchor loads include: Princes Soft Drinks, Marshall Wilson packaging supply, THALES, Ronald McDonald house accommodation

Total potential property connections – 423 within cluster

Total cluster heat demand - 16,340 MWh/yr

Size of cluster - ~57.6 ha

Cluster typology – Almost entirely industrial loads



Opportunities and Constraints

Opportunities:

- Stakeholder projects; Queen Elizabeth Hospital and Fortum Glasgow Ltd
- In-development HN
- Cooling towers, heat only boiler and WSHP active within cluster
- WWTWs
- SEPA Waste heat
- Vacant & Derelict land
- Business & Industry land
- Housing land supply
- SEI Land
- River Clyde

Constraints:

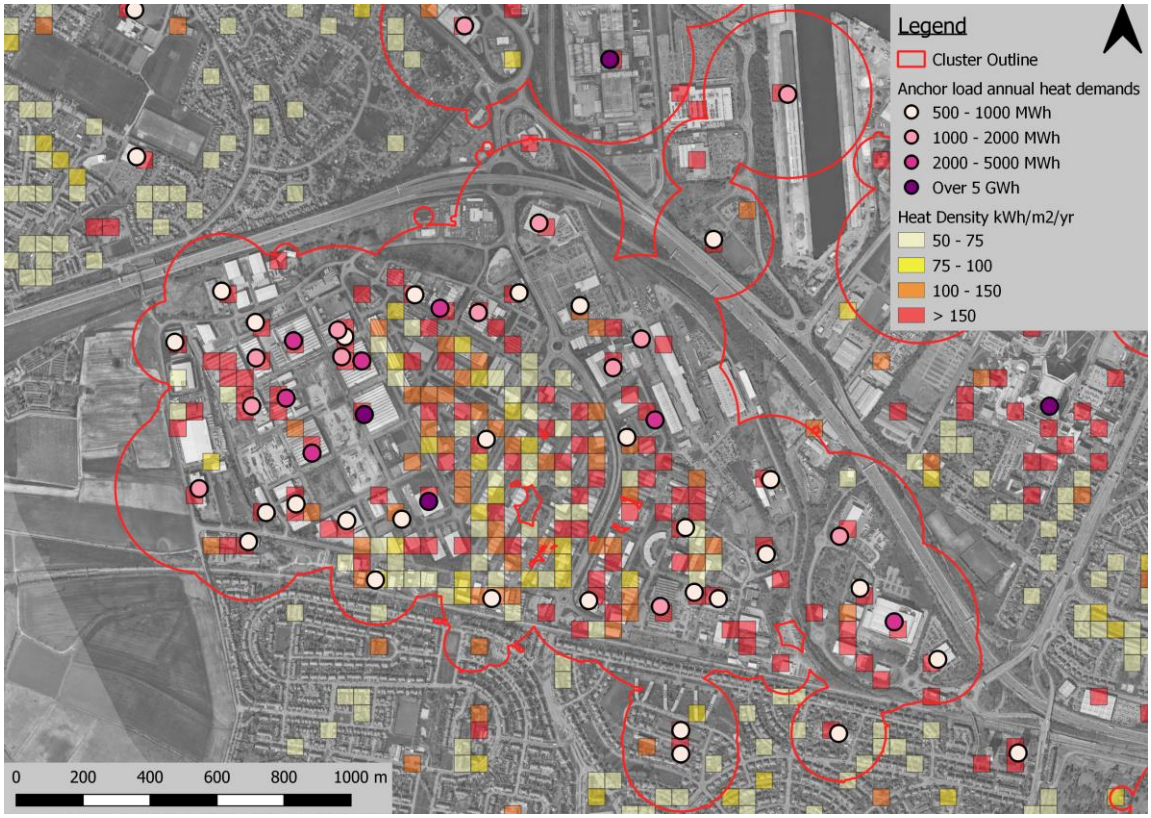
- Amber constrained power substation

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Anaerobic Digestor

Cluster ID: 23

Cluster Name: Hillington



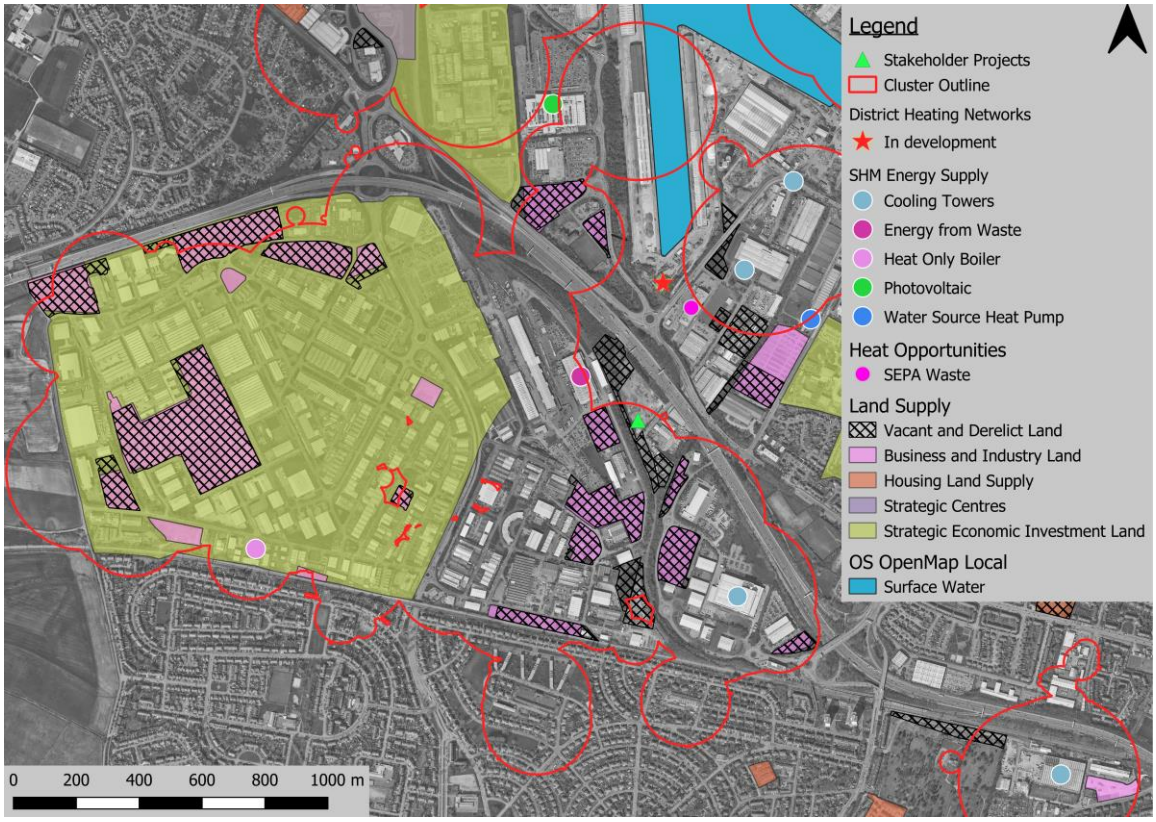
Cluster Summary:
Anchor Loads: 50 loads identified. Key anchor loads include: All anchor loads are industrial units (Hillington industrial/trading estate)

Total potential property connections – 1744 within cluster

Total cluster heat demand - 133,392 MWh/yr

Size of cluster - ~309.4 ha

Cluster typology –Entirely consists of industrial anchors and heat loads



Opportunities and Constraints

Opportunities:

- Stakeholder project; Fortum Glasgow Ltd
- In-development HN
- Cooling towers, EfW plant, heat only boiler PV and WSHP active within cluster
- SEPA Waste heat
- Vacant & Derelict land
- Business & Industry land
- Housing land supply
- Strategic Centres
- SEI Land
- River Clyde

Constraints:

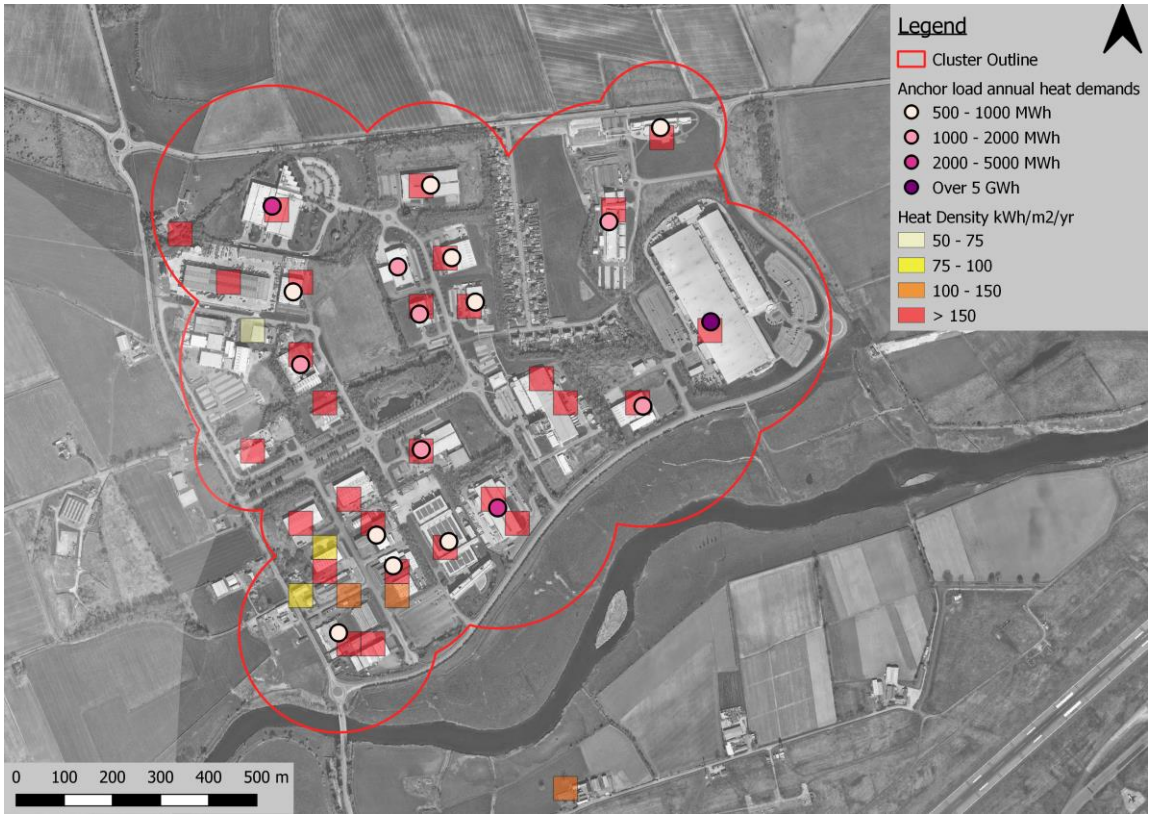
- A-road intersects North to South
- Railway West to East at South of cluster

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Ground Source Heat Pump (GSHP)

Cluster ID: 24

Cluster Name: South Inchinnan



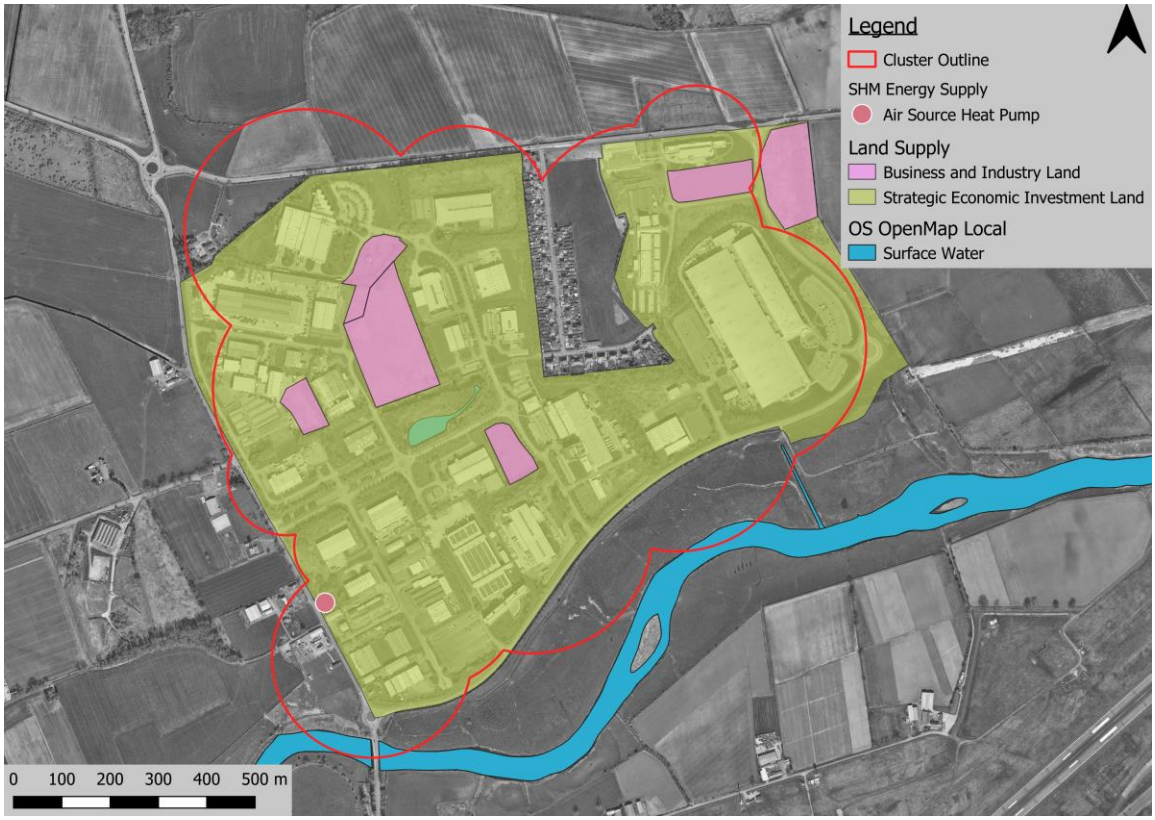
Cluster Summary:
Anchor Loads: 19 loads identified. Key anchor loads include: Rolls Royce factory, AFRC research institute, Thermo Fisher Scientific, National construction college

Total potential property connections – 185 within cluster

Total cluster heat demand - 34,436 MWh/yr

Size of cluster - ~129.6 ha

Cluster typology – Entirely consists of industrial anchors and heat loads



Opportunities and Constraints

Opportunities:

- Air Source Heat Pump developed within cluster
- SEPA Waste heat
- Business & Industry land
- SEI Land
- Surface waterbody

Constraints:

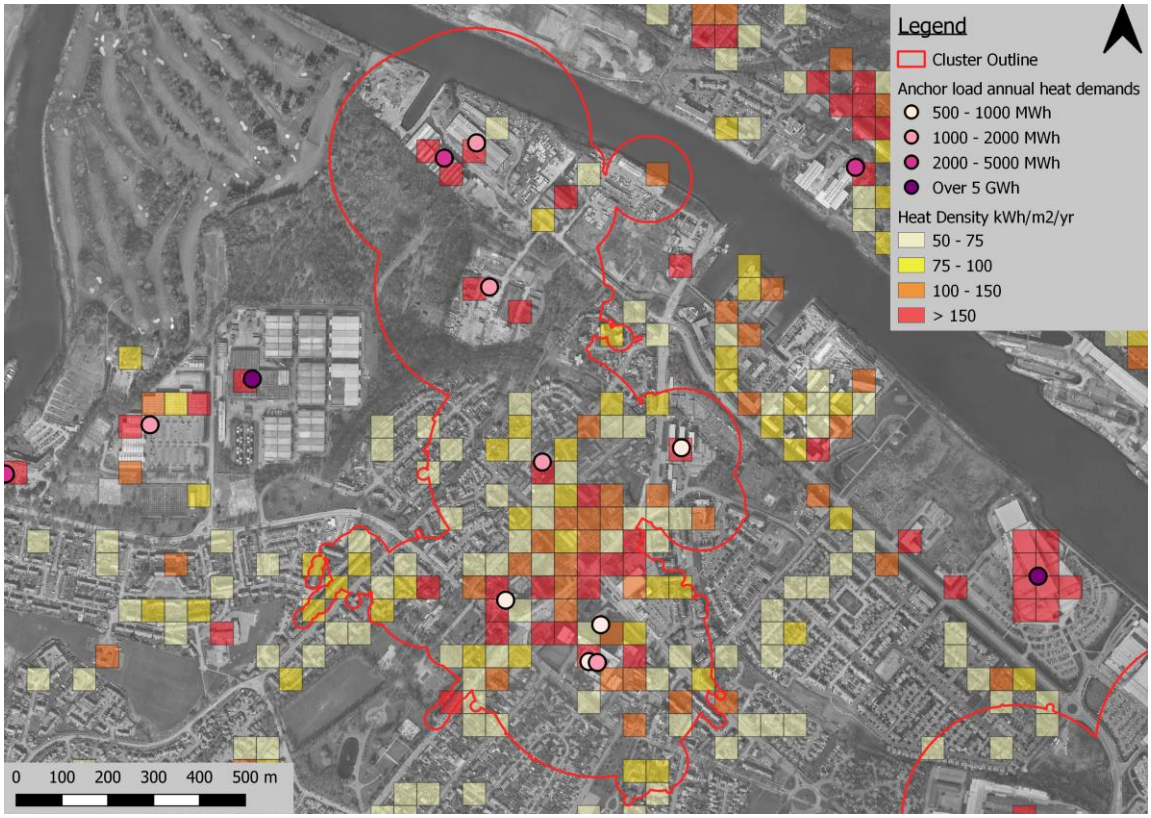
- No constraints to note

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Ground Source Heat Pump (GSHP)
- Hydroelectric

Cluster ID: 25

Cluster Name: North Renfrew



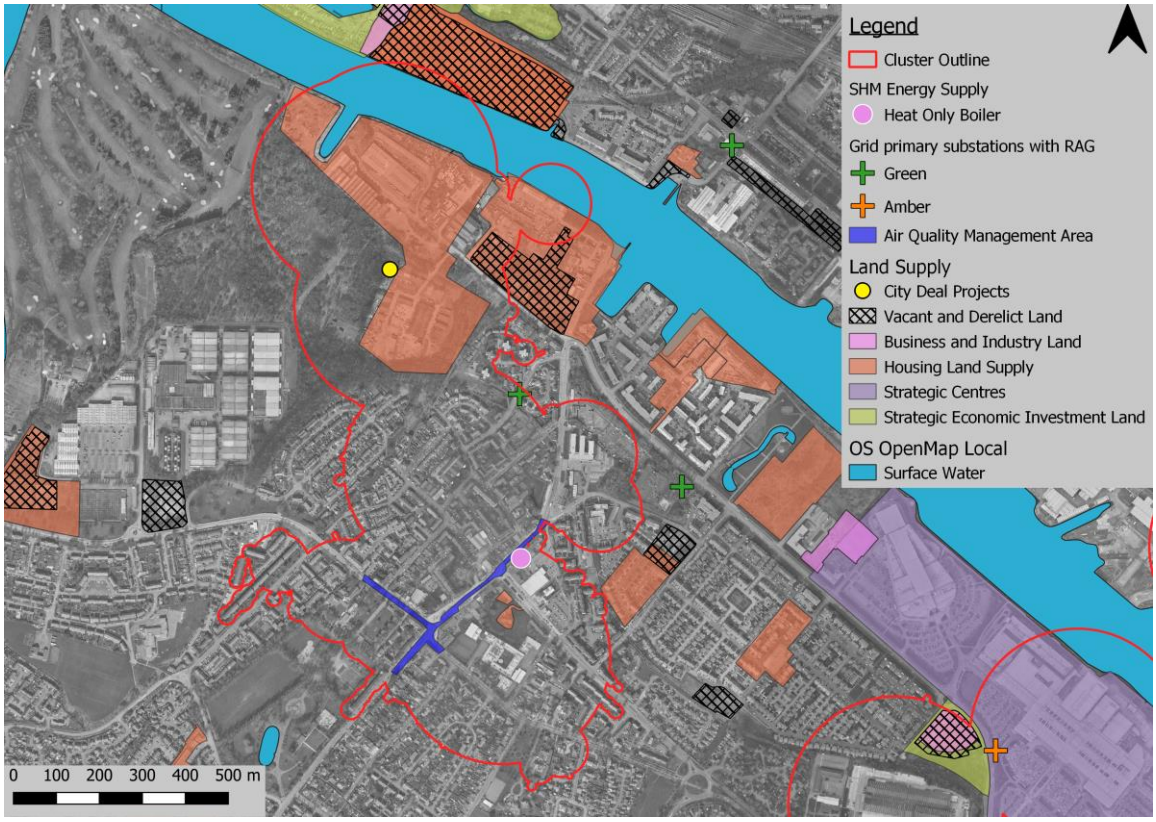
Cluster Summary:
Anchor Loads: 9 loads identified. Key anchor loads include: Trinity high school, Renfrew Old Parish Church, Braehead medical practice, Blythswood House, Stagehire Scotland Ltd

Total potential property connections – 2560 within cluster

Total cluster heat demand - 41,705 MWh/yr

Size of cluster - ~95.0 ha

Cluster typology – Mix of non-domestic anchor loads, industrial buildings, and domestic properties



Opportunities and Constraints

Opportunities:

- Heat only boiler active within cluster
- Unconstrained power substations
- City Deal Project
- Vacant & Derelict land
- Business & Industry land
- Housing land supply
- Strategic Centres
- SEI Land
- River Clyde

Constraints:

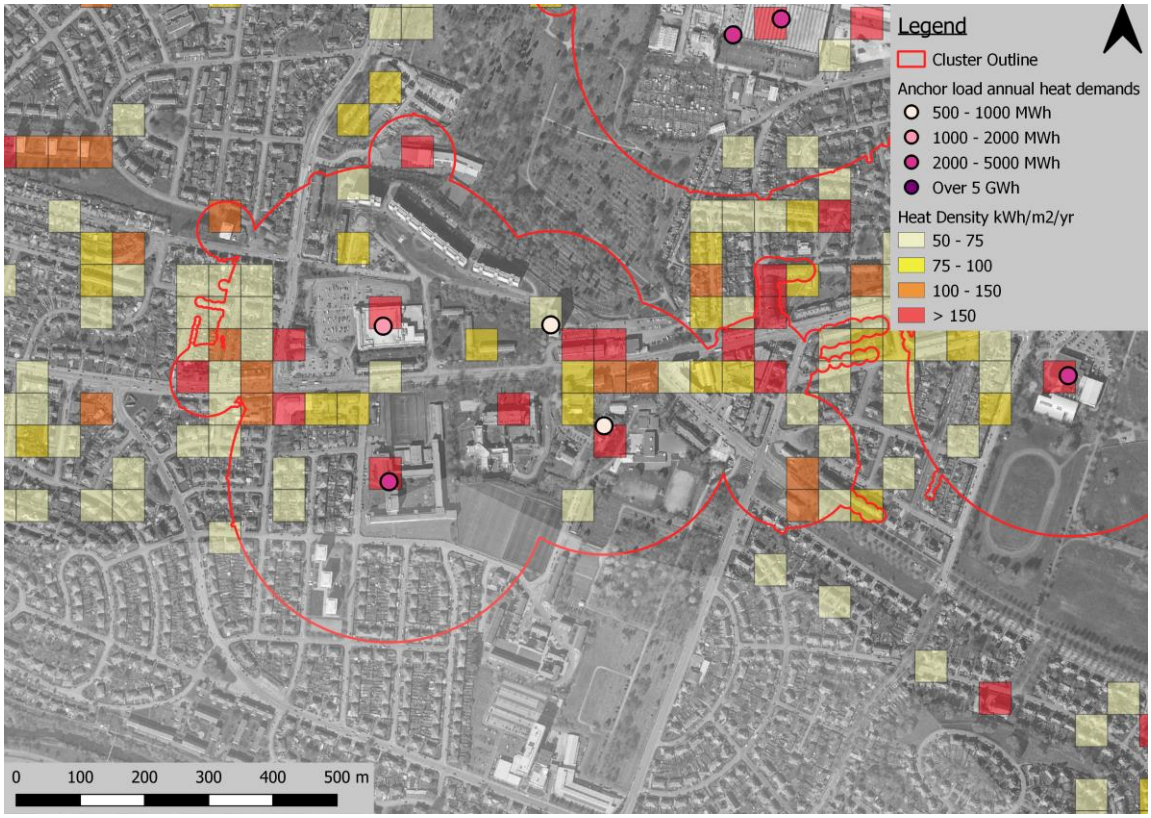
- A-roads intersect North, South, East and West
- AQMA align to some areas of A-roads
- Amber constrained power substation

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Ground Source Heat Pump (GSHP)

Cluster ID: 27

Cluster Name: Halfway



Cluster Summary:
Anchor Loads: 4 loads identified. Key anchor loads include: Morrisons, Lourdes secondary school, large residential tower blocks, Lady Lourdes church

Total potential property connections – 1437 within cluster

Total cluster heat demand – 21,369 MWh/yr

Size of cluster – ~51.8 ha

Cluster typology – Mix of non-domestic and domestic properties

Opportunities and Constraints

Opportunities:

- Cooling tower and heat only boiler active within a close proximity to cluster
- Vacant & Derelict land
- Business & Industry land
- Housing land supply

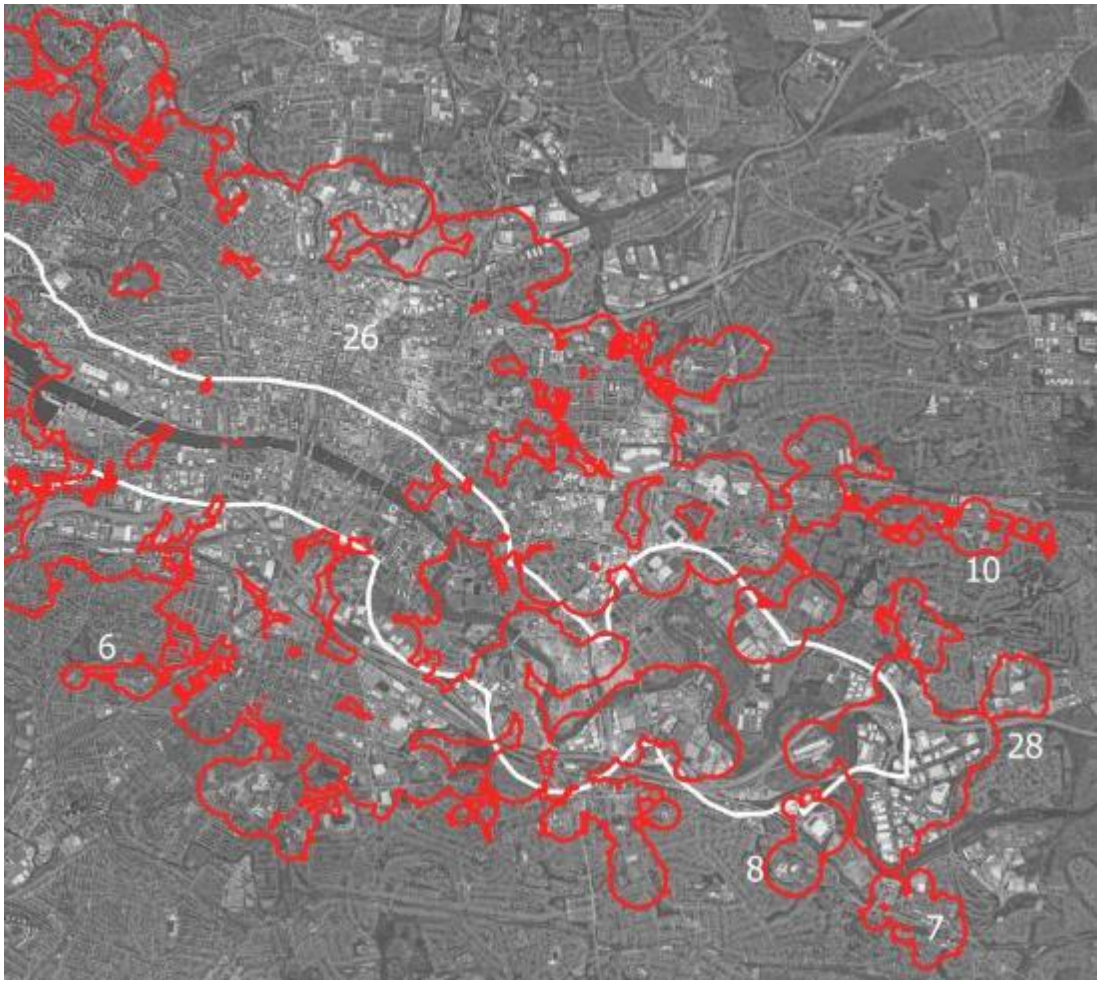
Constraints:

- A-road intersects West to East
- Amber constrained power substation

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Figure 14.4. Area 4, Heat demand cluster locations



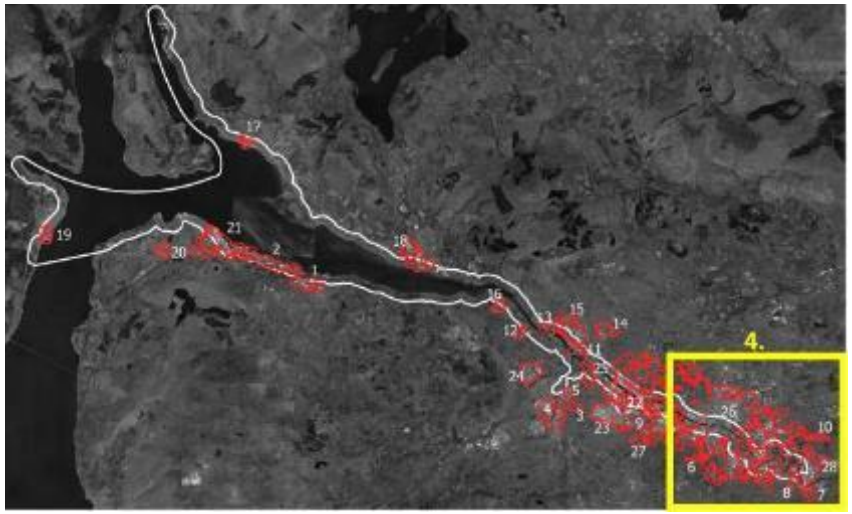


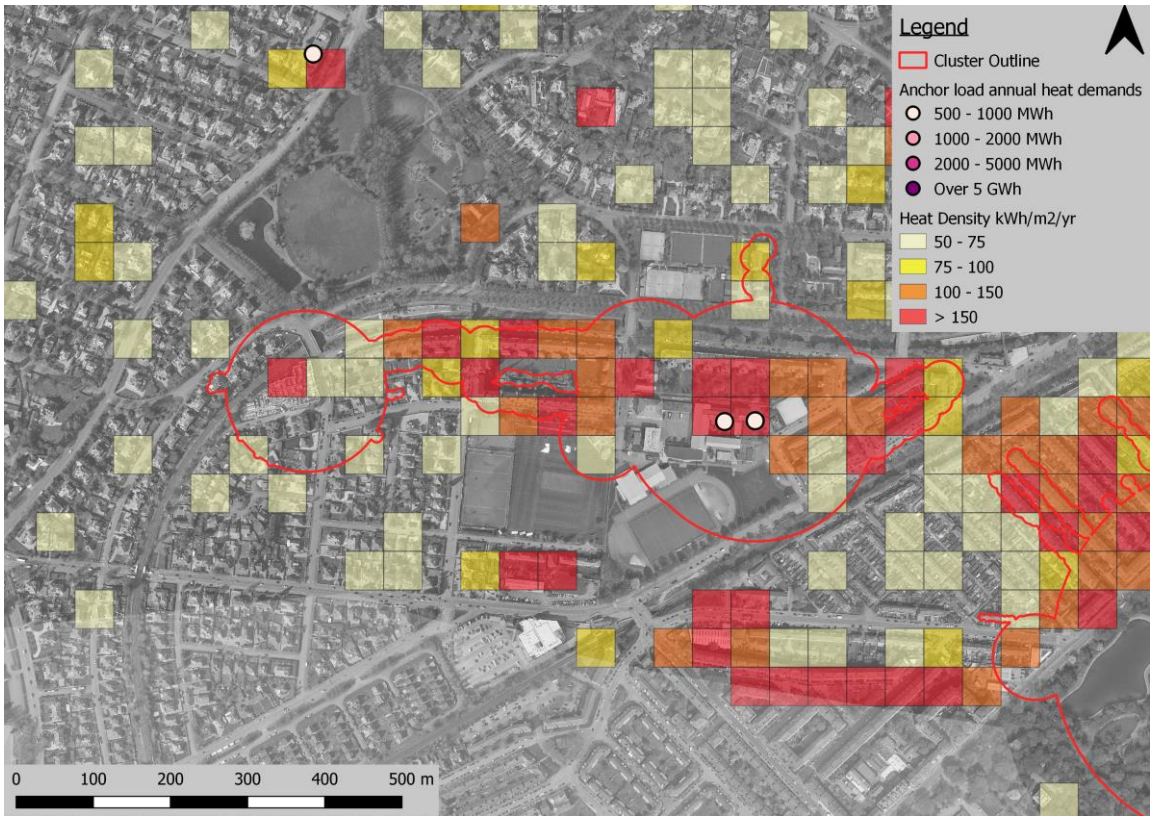
Table 14.8. Area 4, Heat demand clusters

Cluster ID	Location	Connections	Heat Demand (MWh/yr)	Stakeholder-proposed Projects	
				ID	Stakeholder Title
6	West Strathbungo	485 Total 2 Anchors	10,154		
7	Cambuslang	1404 Total 8 Anchors	25,103		
8	North Eastfield	357 Total 4 Anchors	16,156		
10	Shettleston	2284 Total 2 Anchors	28,383		
26	Glasgow	151,916 Total 792 Anchors	3,562,148	1	Scottish Event Campus Energy Strategy
				3	Case Study - A District Heating Network for Glasgow
				5	Glasgow Harbour heat network
				10	Integrated Energy Strategy: Community Energy Project, Dalmarnock
				11	Clydeside Distillery HTHP (Clydeside GreenStills Demonstrator)
				12	D2Grids - Renewable Energy Project
				26	New City Centre PS
				27	New Gaelic Medium School
				29	Collegelands Geothermal Plant

				30	River source heat pump feasibility study for the University of Glasgow
				32	Townhead, Drygate & Charles Street
				37	Glasgow Cathedral heat off-take from Glasgow Royal Infirmary steam network
28	Clydesmill Industrial Estate	1357 Total 34 Anchors	82,381		

Cluster ID: 6

Cluster Name: West Strathbungo



Cluster Summary:
Anchor Loads: 2 loads identified. Key anchor loads include: Hutchesons grammar school

Total potential property connections - 485 within cluster

Total cluster heat demand - 10,154 MWh/yr

Size of cluster - ~16.7 ha

Cluster typology – Mix of non-domestic and domestic properties

Opportunities and Constraints

Opportunities:

- Solar thermal developed in cluster
- Surface water bodies
- Housing land supply
- Strategic centre land

Constraints:

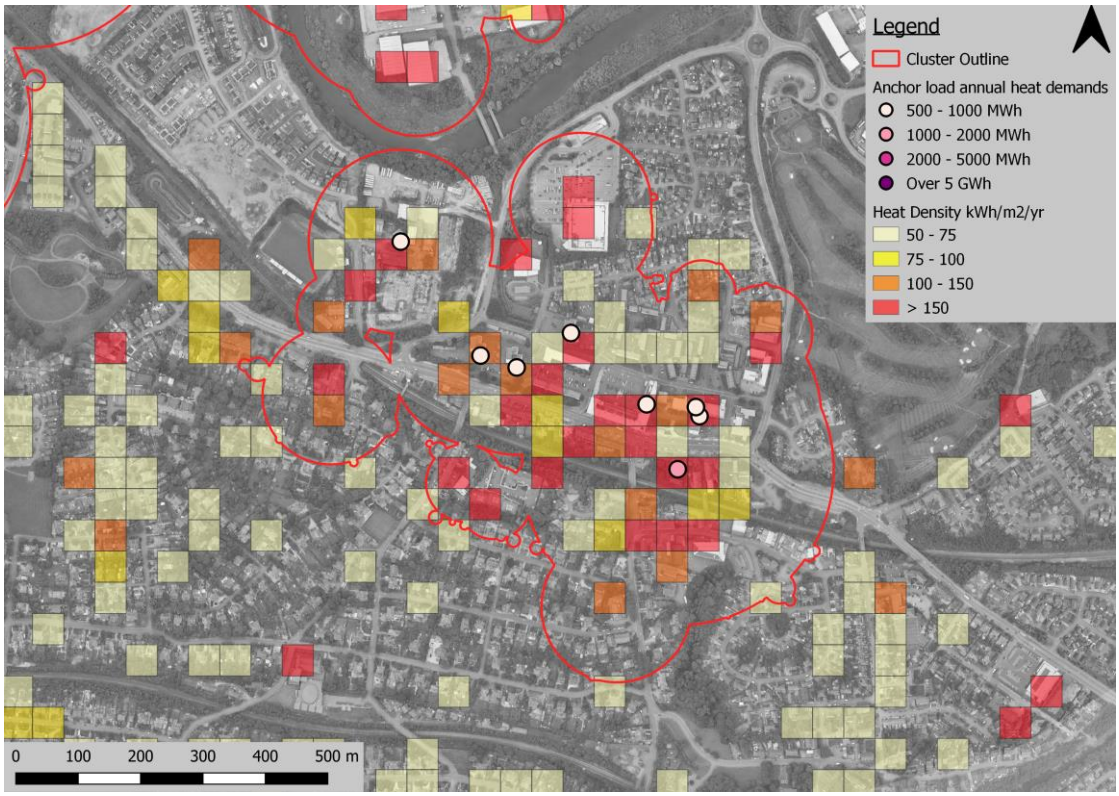
- Constrained power substation close (Red)
- Railway to North of cluster

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 7

Cluster Name: Cambuslang



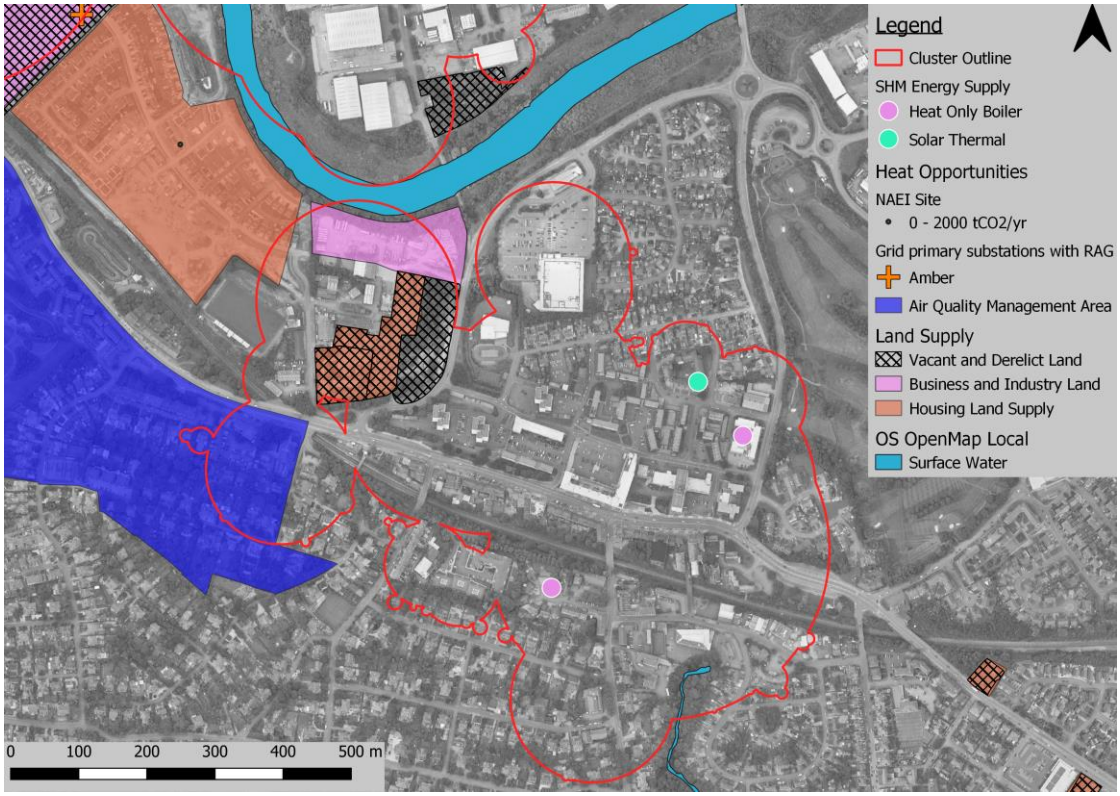
Cluster Summary:
Anchor Loads: 8 loads identified. Key anchor loads include: Cambuslang medical practice, multiple housing tower blocks and Somervell trading estate.

Total potential property connections - 1404 within cluster

Total cluster heat demand - 25,103 MWh/yr

Size of cluster - ~48.7 ha

Cluster typology - Mix of non-domestic anchor loads, industrial buildings, and domestic properties



Opportunities and Constraints

Opportunities:

- Solar thermal and heat only boiler technologies developed within cluster
- NAEI site within close proximity
- Vacant & derelict land
- Business and industry land
- Housing land supply
- On the river Clyde

Constraints:

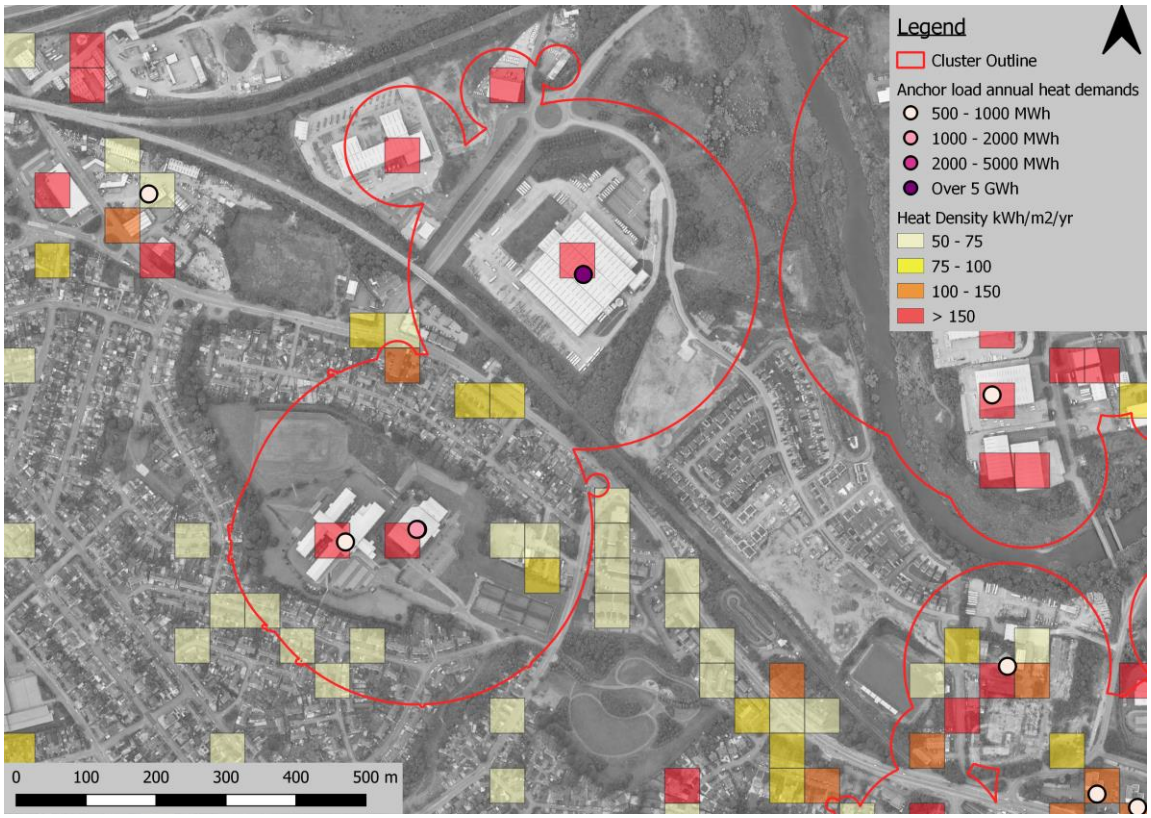
- Amber constrained substation nearby
- Railway West to East
- A-road West to East and North
- AQMA to West

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

Cluster ID: 8

Cluster Name: North Eastfield



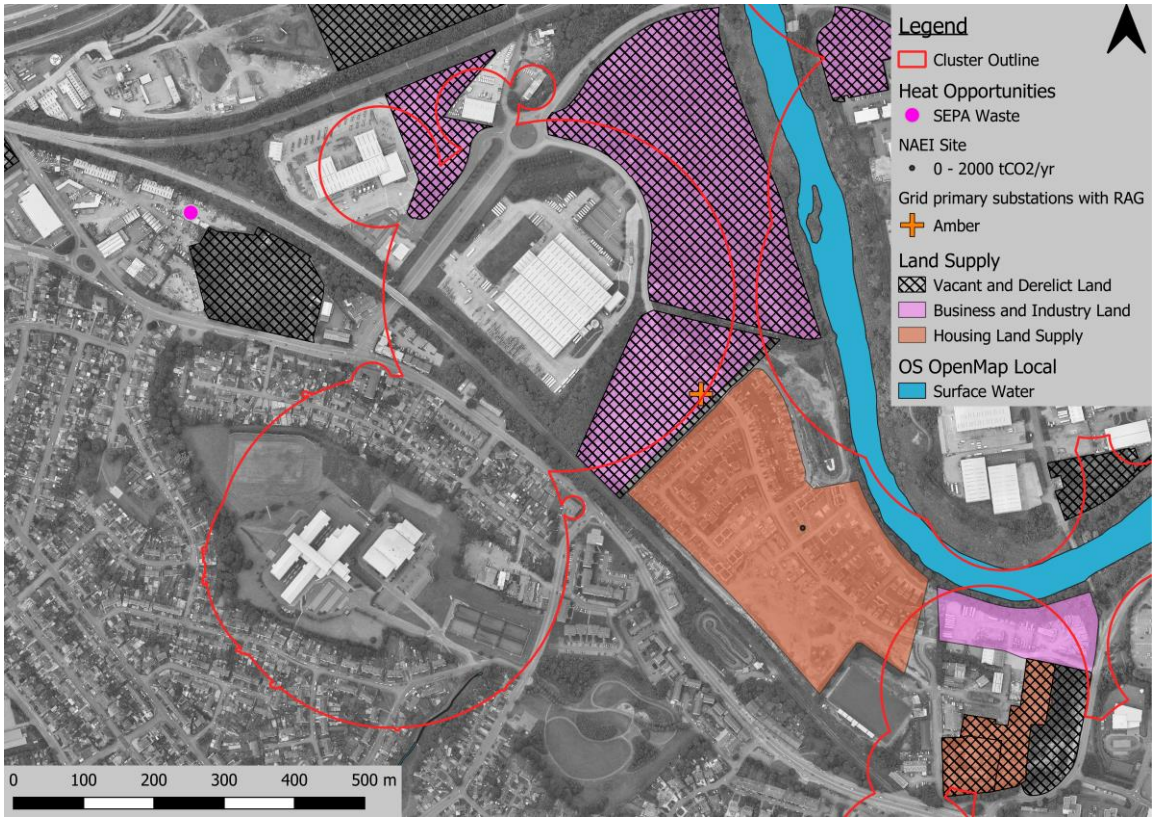
Cluster Summary:
Anchor Loads: 4 loads identified. Key anchor loads include: Tennents warehouse, Trinity High school, South Lanarkshire lifestyle / gym

Total potential property connections - 357 within cluster

Total cluster heat demand - 16,156 MWh/yr

Size of cluster - ~42.1 ha

Cluster typology - Primarily non-domestic loads, with additional industrial and domestic properties



Opportunities and Constraints

Opportunities:

- SEPA waste site
- NAEI site within close proximity
- Vacant & derelict land
- Business and industry land
- Housing land supply
- Very close to the river Clyde

Constraints:

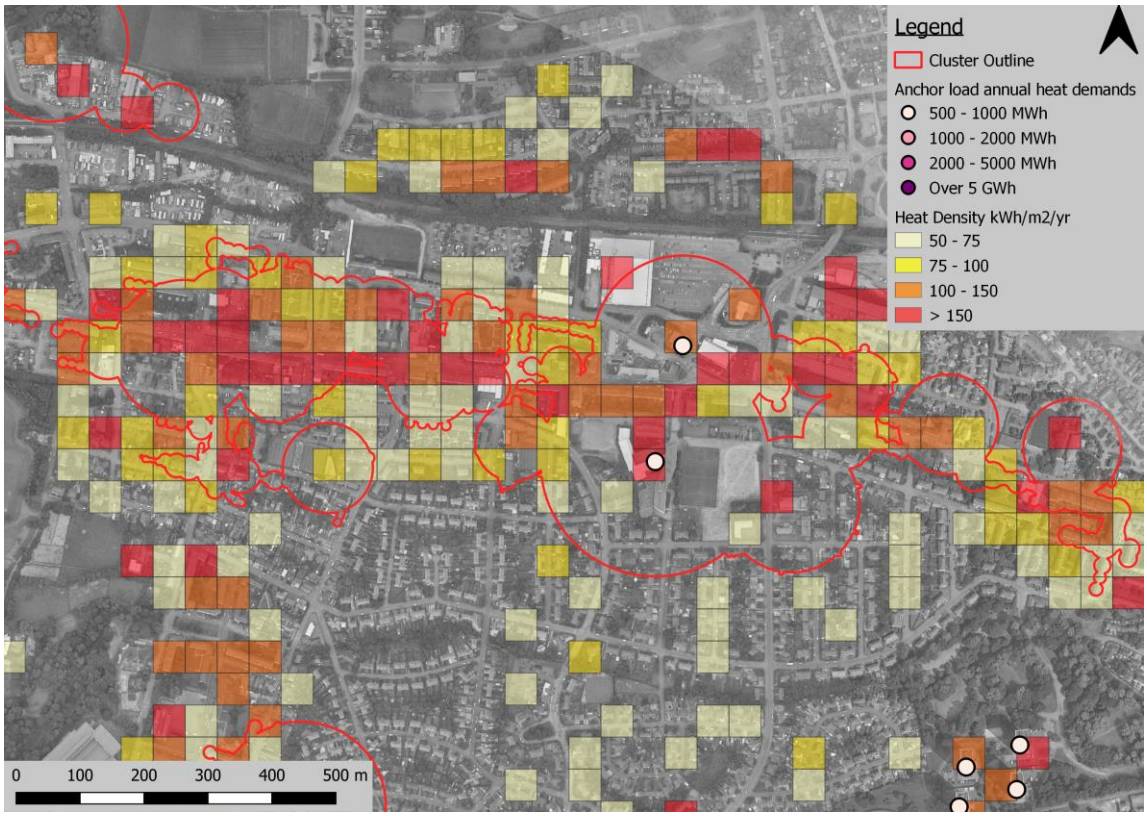
- Amber constrained substation
- A-road intersects cluster
- Railway West to East
- Almost entirely within an AQMA

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)

Cluster ID: 10

Cluster Name: Shettleston



Cluster Summary:
Anchor Loads: 2 loads identified. Key anchor loads include: Eastbank academy and Shettleston New Parish church of Scotland

Total potential property connections - 2284 within cluster

Total cluster heat demand - 28,383 MWh/yr

Size of cluster - ~42.3 ha

Cluster typology - Mix of non-domestic anchor loads and domestic properties

Opportunities and Constraints

Opportunities:

- Operational HN present
- WSHPs present within cluster
- Vacant & derelict land
- Housing land supply
- Unconstrained substation within cluster

Constraints:

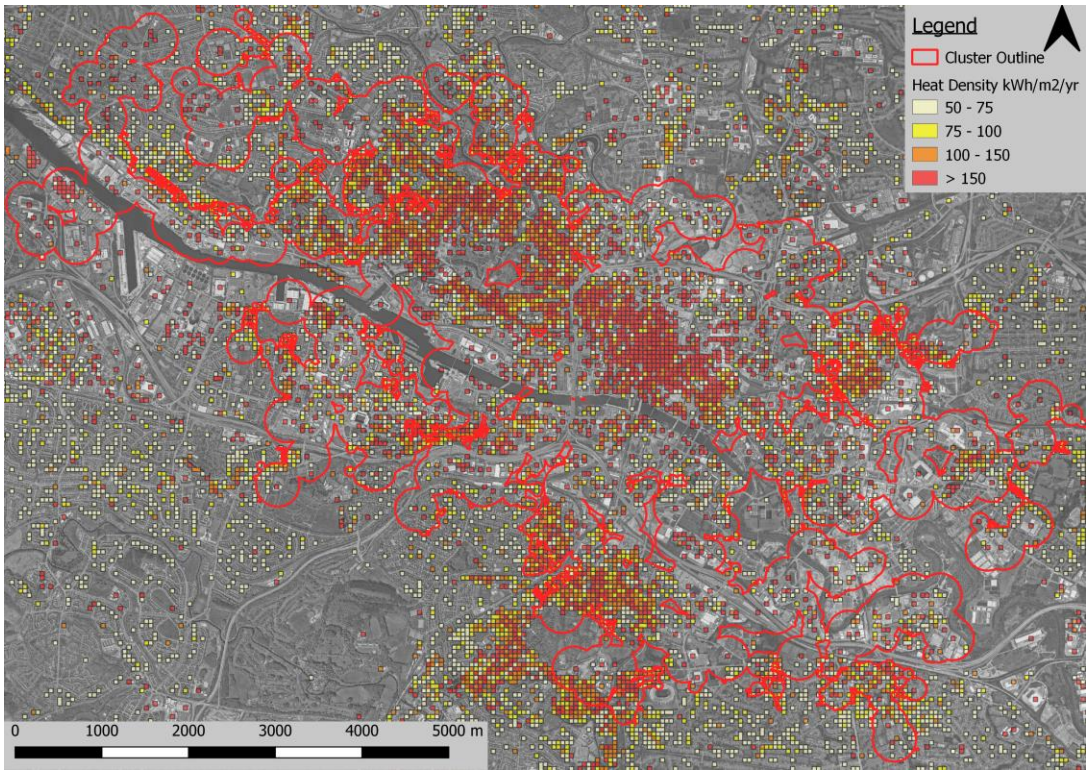
- A-road intersects cluster West to East

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)

Cluster ID: 26 (**Please note only certain attributes were mapped due to the size of this cluster**)

Cluster Name: Glasgow



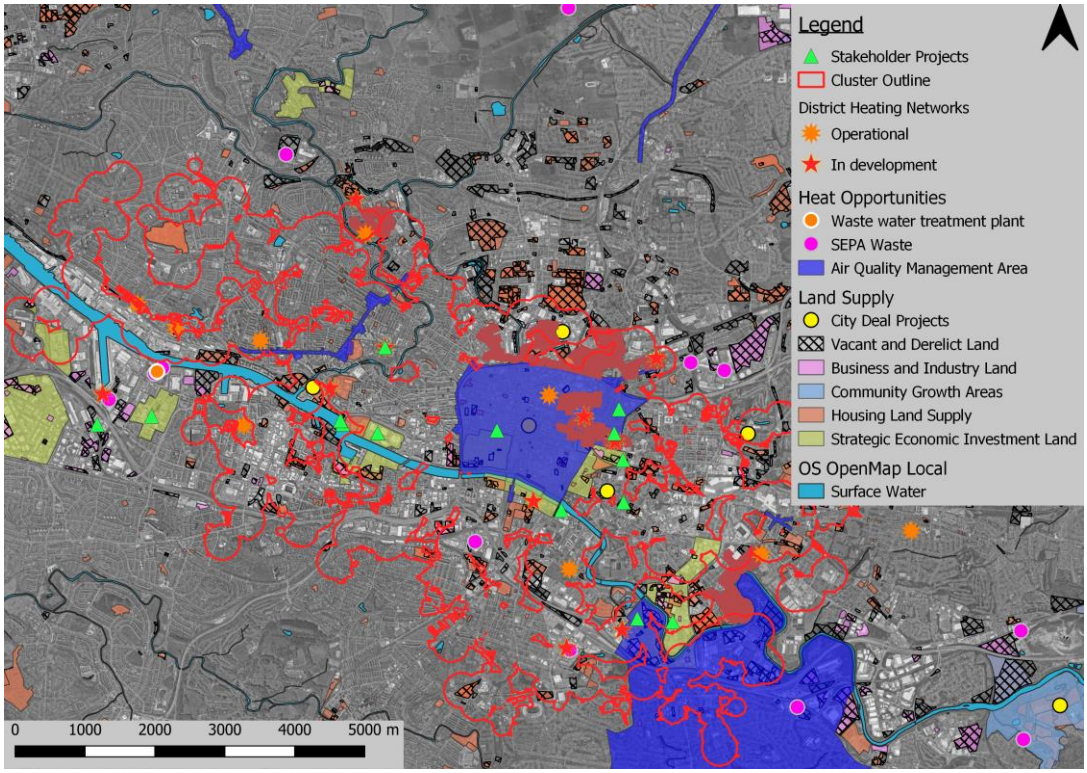
Cluster Summary:
Anchor Loads: 792 loads identified. Key anchor loads include: Various anchor loads

Total potential property connections – 151,916 within cluster

Total cluster heat demand – 3,562,148 MWh/yr

Size of cluster - ~4048.0 ha

Cluster typology – Mix of non-domestic, industrial buildings and domestic properties



Opportunities and Constraints

Opportunities:

- Various Stakeholder projects located
- WWTWs
- SEPA waste
- Operational and in-development HNs
- City Deal Projects
- Vacant & Derelict land
- Business & Industry land
- Housing land supply
- SEI Land
- River Clyde

Constraints:

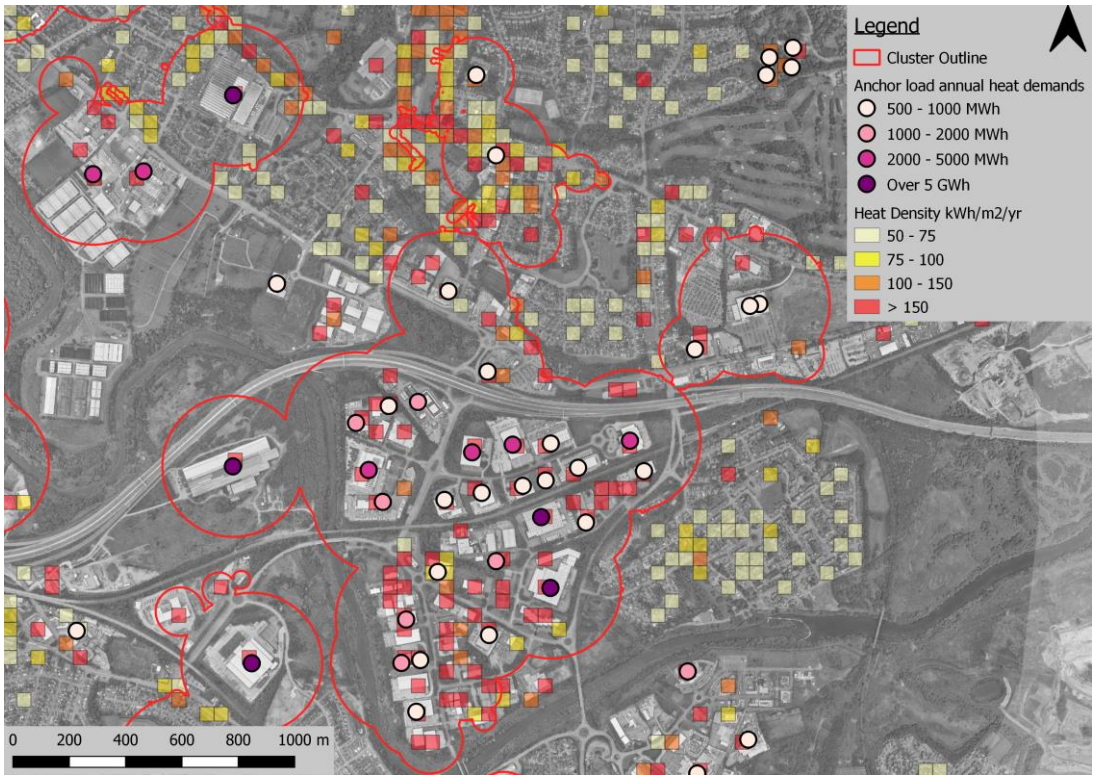
- Large AQMA
- River Clyde intersects cluster

Potential Low Carbon Technologies:

- Water Source Heat Pump (WSHP)
- Ground Source Heat Pump (GSHP)

Cluster ID: 28

Cluster Name: Clydesmill Industrial Estate



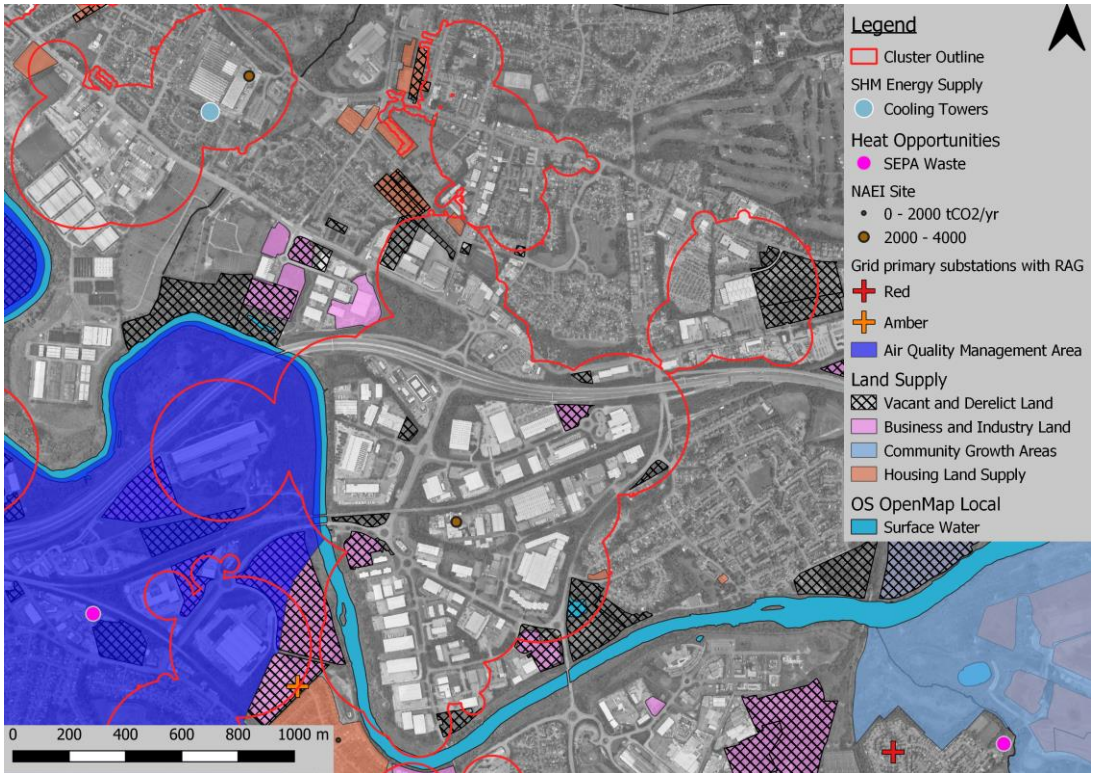
Cluster Summary:
Anchor Loads: 34 loads identified. Key anchor loads include: Clydesmill industrial estate

Total potential property connections – 1357 within cluster

Total cluster heat demand – 82,381 MWh/yr

Size of cluster – ~232.9 ha

Cluster typology – Entirely consists of industrial anchors and heat loads



Opportunities and Constraints

Opportunities:

- Cooling tower within a close proximity to cluster
- SEPA waste site
- NAEI sites
- Vacant & Derelict land
- Business & Industry land
- Community Growth Area
- Housing land supply

Constraints:

- Motorway West to East
- Railway West to East
- A-road West to East at top of cluster
- AQMA West of cluster
- Red and Amber constrained power substations

Potential Low Carbon Technologies:

- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Hydroelectric

Appendix C Feasibility Studies Definition

This appendix presents the proposed spatial and technical feasibility study scope for each of the four proposed projects under consideration to progress from the pre-feasibility to the feasibility study stage.

This section is subject to agreement on scope with Zero Waste Scotland.

For each of the four potential projects under consideration to progress from the pre-feasibility to the detailed feasibility stage, a potential feasibility study scope was prepared. The scope includes a stepwise consideration of technical requirements, economic and commercial requirements, and environmental requirements.

Technical Requirements:

- Step 1. Existing information review
- Step 2. Site surveys
- Step 3. Data Assessment
- Step 4. Energy centre(s) / Plant room
- Step 5. Heat supply technology
- Step 6. Network
- Step 7. Technical modelling
- Step 8: Outline energy centre design

Economic and commercial requirements:

- Step 1: Financial model development
- Step 2: Capital and operational cost assessment
- Step 3: Future price forecasting
- Step 4: Sensitivity testing and risk management
- Step 5: Initial commercial structure

Environmental requirements:

- Step 1: Input data confirmation
- Step 2: Carbon assessment
- Step 3: Additional environmental impacts

Options Appraisal - SEC

For the SEC, it is proposed that there be an initial options appraisal before moving on to the full detailed feasibility study. This would allow the energy opportunities to be more clearly identified, and potentially also some key stakeholder engagement.

Scottish Event Campus (SEC) – Technical Requirements

Step 1: Existing information review

Included in Scope

- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.) associated with the SEC Centre buildings and Clydeside Distillery
- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.) associated with other potential anchor loads within the red-line boundary including Crowne Plaza Hotel, Campanile SECC Hydro Hotel, Radisson Red Glasgow in connecting to the DEN.
- Gap analysis for missing data

Comments

Request for information will be provided to collect information about buildings within the red-line boundary including the SEC conference centre, The SSE Hydro, SEC Armadillo, Clydeside Distillery, Crowne Plaza Glasgow, Hilton Hotel, Radisson Red Glasgow Hotel and the Campanile Glasgow SECC Hydro: Rough floor area for each typology

Step 2: Site Surveys

Potentially in scope (see comments)

- Conduct non-intrusive surveys to main plant rooms (The site visit will comprise contacting the estates management team at the buildings in question).
  The outputs of the site visits will include sketches/schematics of the main heating system and plant rooms, key photographs and brief report of the location, capacity, constraints, and feasibility of a connection to the building.
  A brief assessment of the condition of the existing plant will also be made as boiler replacement can be a key driver for connection to a heat network for existing buildings.
  Identify high level retrofitting required for particular buildings e.g. change to secondary system, insulation.

- If information regarding existing buildings and site are not available, site survey to be carried out. However, its envisaged that this data should be obtainable without a site visit.

Step 3: Data Assessment
Included in scope

- Energy demand data will be compiled for heating, cooling, and electricity. The focus will be on using good quality billing data or other metering source rather than benchmarks.
- Gap analysis for missing data to determine hourly heating demand profiles using BH heat profiling tool and in-house benchmarks by building typology and floor areas.

Comments
Preference to use existing billing data if available otherwise online databases, benchmarks, and degree data will be used to calculate demand.

Step 4: Energy centre(s)/ Plant Rooms
Included in scope

- Review any proposals for a new energy centre or plant room based on the outcome of the demand assessment update.
- Discussions with relevant teams to review the energy centre and discuss size, constraints, and opportunities.

Step 5: Heat Supply Technology
Included in scope

High level assessment and recommendation of all feasible heat supply sources and heat storage options relevant to identified energy centre locations.

Step 6: Network
Included in scope

- Assess different routes and perform site walkover to assess preferred network route and identify barriers and constraints including but not limited to road and major utilities infrastructure
- Record asset search for key areas (budget £500 subject to survey company quotation)
- Identify point of connection per building and the feasibility of connection including any retrofitting requirements

- Develop indicative network routing for heating as relevant including any opportunities for soft dig and coordination with highways and urban realm developments
- Network technology selection and outline specification
- Outline network design and sizing – district heating.
- Development of interfaces including simplified schematics and outline plant sizing

Comments
This will be completed using satellite imagery only, e.g. Google Earth. As the network routing will be predominantly on the existing SEC site, it will be predominantly a hard dig, although it is assumed that there will not be any major utilities or underground constraints as SEC is likely to have access to site utility maps which should be used when identifying the preferred DEN route. This will need to be checked at the next stage.

Step 7: Technical Modelling
Included in scope

The energy demand information and connection feasibility will be fed into a detailed hourly energy model to simulate the energy demands. This will be used to test the proposed energy sources against these demands in order to select and optimise the plant type, size, location and use of thermal energy storage.

Step 8: Outline Energy Centre Design
Limited inclusion in scope

The energy centre design will be developed to a sufficient level to assess spatial implication and basic civil works required to be undertaken. We will also consider technology flexibility to allow future transition to alternative technologies if they are not currently deemed practical, mature enough or economic.

Comments
An indication of the spatial implications of the preferred heat-supply technology will be assessed in order to identify potential energy centre location(s).

No layout schematics or civil works assessment will be completed.

Scottish Event Campus – (SEC) Economic and Commercial Requirements

Step 1: Financial Model Development

Included in scope

Develop a financial model (MS Excel) that is sufficiently flexible to enable the viability of a number of options to be assessed. These options will be driven both by the technical analysis – considering physical and operational constraints.

Comments

This will be a simplified model to account for the options detailed in the brief only.

Step 2: Capital and operational cost assessment

Included in scope

Determine costs from manufacturer quotes and previous BH cost models developed for other district heating feasibility studies. To include:

- Capital cost for heating plant, ancillary plant, thermal storage and energy centre
- Capital costs for network and trenching (based on costs per metre based on pipe diameter)
- Capital costs for building connections and substations
- Operation and maintenance costs, staff costs, plant replacement costs

Comments

High-level costing will be completed using currently available data and through engaging with heat pump suppliers along with other relevant technology providers.

Provisional sums will be used for civils works and building connections.

Step 3: Future price forecasting

Included in scope

Assessment of energy price inflation and indexing in line with BEIS projections and current rates for energy purchase and retail values. Projections beyond 2030 to be fixed at 2030 retail values.

Step 4: Sensitivity testing + risk management
Not included in scope

Sensitivity to key inputs will be tested based on appropriate low, baseline and high values for each input. This will support an assessment of key risks to the project and enable an understanding of how to enhance viability e.g. through capital costs, heat pricing, electricity sales contract arrangements, operational tactics (electricity v heat led).

Comments
It is suggested this should be included in future feasibility study and business case modelling.

Step 5: Initial commercial structure
Limited inclusion in scope

Review commercial options with the client, considering stakeholders, potential sources of funds, delivery timeframes etc. Through this exercise, we will confirm scheme boundaries and governance options. Review of funding options including:

- Assessment of opportunities for offsetting capital through grant funding
- Assessment of financial incentives available for low carbon heat generation
- Assessment of opportunities for private wire heat sales for CHP and retail rates.
- Review of lifetime of financial incentives and risk to project delivery and supply source selection.

Comments
Study will consider:
Capex, OPEX and REPEX funding requirements if necessary

Some general advice will be provided on possible procurement routes and funding opportunities.

Scottish Event Campus (SEC) – Environmental Requirements

Step 1: Input Data Confirmation
Included in scope

All major assumptions will be tested to show their degree of influence on scheme paybacks and CO2 savings.

Step 2: Carbon Assessment
Included in scope

We will provide a detailed assessment of the CO2 emissions for different options. Emission factors based on BEIS/DEFRA projections or selected heat supply source(s) will be used at time steps (e.g. 2025,2030,2040), to test CO2 savings over business as usual scenario.

Step 3: Additional Environmental Impacts
Potentially included in scope

In addition to assessing CO2 emissions we will also review other potential impacts and regulatory consent requirements for the following as a minimum:

- Air quality as a result of different technologies (NOx, PM10 etc.)
- Scottish Environmental Protection Agency regulation and approvals
- Local Authority policy alignment

Fortum EfW Heat Network – Technical Requirements

Step 1: Existing information review

Included in scope

- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.)
- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.) associated with other potential anchor loads within the red-line boundary
- Gap analysis for missing data

Comments

Request for information will be provided to collect information about buildings within the red-line boundary, the main focus will be on the Queen Elizabeth Hospital campus but their interest in connecting to the DEN needs to be established first: Rough floor area for each typology

Step 2: Site Surveys

Potentially included in scope (see comments)

- Conduct non-intrusive surveys to main plant rooms (The site visit will comprise contacting the estates management team at the buildings in question).
- The outputs of the site visits will include sketches/schematics of the main heating system and plant rooms, key photographs and brief report of the location, capacity, constraints, and feasibility of a connection to the building.
- A brief assessment of the condition of the existing plant will also be made as boiler replacement can be a key driver for connection to a heat network for existing buildings.
- Identify high level retrofitting required for particular buildings e.g. change to secondary system, insulation.

Comments

If information regarding existing buildings and site are not available, site survey to be carried out. However, its envisaged that this data should be obtainable without a site visit through engagement with the relevant stakeholders.

Step 3: Data Assessment
Included in scope

- Energy demand data will be compiled for heating, cooling, and electricity. The focus will be on using good quality billing data or other metering source rather than benchmarks.
- Gap analysis for missing data to determine hourly heating demand profiles using BH heat profiling tool and in-house benchmarks by building typology and floor areas.

Comments
Preference to use existing billing data if available otherwise online databases, benchmarks, and degree data will be used to calculate demand.

Step 4: Energy centre(s)/ Plant Rooms
Included in scope

- Review any proposals for a new energy centre or plant room based on the outcome of the demand assessment update.
- Discussions with relevant teams to review the energy centre and discuss size, constraints, and opportunities.

Step 5: Heat Supply Technology
Included in scope

High level assessment and recommendation of all feasible heat supply sources and heat storage options relevant to identified energy centre locations.

Step 6: Network
Included in scope

- Assess different routes and perform site walkover to assess preferred network route and identify barriers and constraints including but not limited to road and major utilities infrastructure
- Record asset search for key areas (budget £500 subject to survey company quotation)
- Identify point of connection per building and the feasibility of connection including any retrofitting requirements
- Develop indicative network routing for heating as relevant including any opportunities for soft dig and coordination with highways and urban realm developments
- Network technology selection and outline specification

- Outline network design and sizing – district heating.
- Development of interfaces including simplified schematics and outline plant sizing

Comments
This will be completed using satellite imagery only, e.g. Google Earth. Its envisaged that it will be predominantly hard dig due to the built-up nature of the site. This will need to be checked at the next stage.

Step 7: Technical Modelling
Included in scope

The energy demand information and connection feasibility will be fed into a detailed hourly energy model to simulate the energy demands.

Comments
This will be used to match the waste heat produced from the EfW appropriately with the local heat demand.

Step 8: Outline Energy Centre Design

The energy centre design will be developed to a sufficient level to assess spatial implication and basic civil works required to be undertaken. We will also consider technology flexibility to allow future transition to alternative technologies if they are not currently deemed practical, mature enough or economic. Limited Discussions with Fortum will take place to establish whether space can be allotted on the Fortum site for district heat network infrastructure such as back-up boilers etc.

No layout schematics or civil works assessment will be completed.

Fortum EfW Heat Network – Economic and Commercial Requirements

Step 1: Financial Model Development
Included in scope

Develop a financial model (MS Excel) that is sufficiently flexible to enable the viability of a number of options to be assessed. These options will be driven both by the technical analysis – considering physical and operational constraints.

Comments
This will be a simplified model to account for the options detailed in the brief only.

Step 2: Capital and operational cost assessment
Included in scope

Determine costs from manufacturer quotes and previous BH cost models developed for other district heating feasibility studies. To include:

- Capital cost for heating plant, ancillary plant, thermal storage and energy centre
- Capital costs for network and trenching (based on costs per metre based on pipe diameter)
- Capital costs for building connections and substations
- Operation and maintenance costs, staff costs, plant replacement costs

Comments
High-level costing will be completed using currently available data and through engaging with relevant technology providers.

Provisional sums will be used for civils works and building connections.

Step 3: Future price forecasting
Included in scope

Assessment of energy price inflation and indexing in line with BEIS projections and current rates for energy purchase and retail values. Projections beyond 2030 to be fixed at 2030 retail values.

Step 4: Sensitivity testing + risk management
Not included in scope

Sensitivity to key inputs will be tested based on appropriate low, baseline and high values for each input. This will support an assessment of key risks to the project and enable an understanding of how to enhance viability e.g. through capital costs, heat pricing, electricity sales contract arrangements, operational tactics (electricity v heat led).

Comments
It is suggested this should be included in future feasibility study and business case modelling.

Step 5: Initial commercial structure
Limited inclusion in scope

Review commercial options with the client, considering stakeholders, potential sources of funds, delivery timeframes etc. Through this exercise, we will confirm scheme boundaries and governance options. Review of funding options including:

- Assessment of opportunities for offsetting capital through grant funding
- Assessment of financial incentives available for low carbon heat generation
- Assessment of opportunities for private wire heat sales for CHP and retail rates.
- Review of lifetime of financial incentives and risk to project delivery and supply source selection.

Comments
Study will consider:
Capex, OPEX and REPEX funding requirements if necessary

Some general advice will be provided on possible procurement routes and funding opportunities.

Fortum EfW Heat Network – Environmental Requirements

Step 1: Input Data Confirmation
Included in scope

All major assumptions will be tested to show their degree of influence on scheme paybacks and CO2 savings.

Step 2: Carbon Assessment
Included in scope

We will provide a detailed assessment of the CO2 emissions for different options. Emission factors based on BEIS/DEFRA projections or selected heat supply source(s) will be used at time steps (e.g. 2025,2030,2040), to test CO2 savings over business as usual scenario.

Step 3: Additional Environmental Impacts
Potentially included in scope

In addition to assessing CO2 emissions we will also review other potential impacts and regulatory consent requirements for the following as a minimum:

- Air quality as a result of different technologies (NOx, PM10 etc.)
- Scottish Environmental Protection Agency regulation and approvals
- Local Authority policy alignment

Kilcreggan/Rosneath Low Carbon Heating – Community Scale

Kilcreggan/Rosneath Low Carbon Heating – Community Scale – Technical Requirements

Step 1: Existing information review

Included in scope

- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.)
- Gap analysis for missing data

Comments

Request for information will be provided to collect information about the building stock within the red-line boundary. Argyll and Bute Council will be consulted to gain insight into the housing stock under their ownership.

Step 2: Site Surveys

Potentially included in scope (see comments)

- Conduct a review of the make-up of the building stock in both towns (tenure, age, construction type, energy improvements conducted, fuels used etc.)
- Identify high level retrofitting required for particular buildings e.g. change to secondary system, insulation.

Comments

Its envisaged that this data should be obtainable without a site visit through engagement with the relevant stakeholders and using existing public databases.

Step 3: Data Assessment

Included in scope

- Energy demand data will be compiled for heating, cooling, and electricity. The focus will be on using good quality publicly available information.
- Gap analysis for missing data to determine hourly heating, electricity demand profiles using BH profiling tool and in-house benchmarks by building typology and floor areas.

Comments
Online databases, benchmarks and degree day data will be used to calculate demand.

Step 4: Heat and Electricity Supply Technology
Included in scope

High level assessment and recommendation of all feasible heat supply sources and heat storage options as well as electricity generation and storage options relevant to the different types of buildings within both towns.

Comments
The study will focus on a wide variety of technologies which are best suited to the type of property, the property location, and other location-specific resources. Properties will be grouped by category in terms of tenure, age, type of property, construction type.

Step 5: Technical Modelling
Included in scope

The energy demand information will be fed into a detailed hourly energy model to simulate the energy demands.

Comments
The feasibility of different heat and electricity technologies will be assessed for different property categories.

Kilcreggan/Rosneath Low Carbon Heating – Community Scale – Economic and Commercial Requirements

Step 1: Financial Model Development
Included in scope

Develop a financial model (MS Excel) that is sufficiently flexible to enable the viability of a number of options to be assessed for different property categories. These options will be driven by the technical analysis – considering physical and operational constraints.

Comments
This will be a simplified model to account for the options detailed in the brief only.

Step 2: Capital and operational cost assessment
Included in scope

Determine costs from manufacturer quotes and previous BH cost models developed. To include:

- Capital cost for heating plant, ancillary plant, thermal storage, electricity generation etc.
- Operation and maintenance costs, plant replacement costs.

Comments
High-level costing will be completed using currently available data and through engaging with relevant technology providers.

Provisional sums will be used for civils works.

Step 3: Future price forecasting
Included in scope

Assessment of energy price inflation and indexing in line with BEIS projections and current rates for energy purchase and retail values. Projections beyond 2030 to be fixed at 2030 retail values.

Step 4: Sensitivity testing + risk management
Not in scope

Sensitivity to key inputs will be tested based on appropriate low, baseline and high values for each input. This will support an assessment of key risks to the project and enable an understanding of how to enhance viability e.g. through capital costs, heat pricing, electricity sales contract arrangements, operational tactics (electricity v heat led).

Comments
It is suggested this should be included in future feasibility study and business case modelling.

Step 5: Initial commercial structure
Limited inclusion in scope

Review commercial options with the client, considering stakeholders, potential sources of funds, delivery timeframes etc. Through this exercise, we will confirm scheme boundaries and governance options. Review of funding options including:

- Assessment of opportunities for offsetting capital through grant funding

- Assessment of financial incentives available for low carbon heat generation and electricity generation
- Review of lifetime of financial incentives and risk to project delivery and supply source selection.

Comments
Study will consider:
Capex, OPEX and REPEX funding requirements if necessary

Some general advice will be provided on possible procurement routes and funding opportunities.

Kilcreggan/Rosneath Low Carbon Heating – Community Scale – Environmental Requirements

Step 1: Input Data Confirmation
Included in scope

All major assumptions will be tested to show their degree of influence on scheme paybacks and CO2 savings.

Step 2: Carbon Assessment
Included in scope

We will provide a detailed assessment of the CO2 emissions for different options. Emission factors based on BEIS/DEFRA projections or selected heat supply source(s) will be used at time steps (e.g. 2025,2030,2040), to test CO2 savings over business as usual scenario.

Step 3: Additional Environmental Impacts
Potentially included in scope

In addition to assessing CO2 emissions we will also review other potential impacts and regulatory consent requirements for the following as a minimum:
- Air quality as a result of different technologies (NOx, PM10 etc.)
- Scottish Environmental Protection Agency regulation and approvals
- Local Authority policy alignment

Former Exxon Site Redevelopment

Technical Requirements – Former Exxon Site Redevelopment – Technical Requirements

Step 1: Existing Information Review

Included in scope

- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.)
- Review existing systems, energy usage data (half-hourly data preferably) and Buildings Schedule (GFA, typology, occupancy etc.) associated with other potential anchor loads within the red-line boundary
- Gap analysis for missing data

Comments

Request for information will be provided to collect information about proposed buildings: Rough floor area for each typology

Step 2: Data Assessment

Included in scope

- Energy demand data will be compiled for heating, cooling, and electricity. The focus will be on using good quality benchmarks.
- Gap analysis for missing data to determine hourly heating demand profiles using BH heat profiling tool and in-house benchmarks by building typology and floor areas.

Comments

Online databases, benchmarks and degree data will be used to calculate demand.

Step 3: Energy centre(s)/ Plant Rooms

Included in scope

- Review any proposals for a new energy centre or plant room based on the outcome of the demand assessment update.
- Discussions with relevant teams to review the energy centre and discuss size, constraints, and opportunities.

Step 4: Heat and Electricity Supply Technologies

Included in scope

High level assessment and recommendation of all feasible heat supply sources and heat storage options relevant to identified energy centre locations.

Comments
The feasibility of a variety of potential heat-supply technologies will be assessed along with the feasibility of a large-scale solar PV installation.

Step 5: Network
Included in scope

- Assess different routes and perform site walkover to assess preferred network route and identify barriers and constraints including but not limited to road and major utilities infrastructure
- Record asset search for key areas (budget £500 subject to survey company quotation)
- Identify point of connection per building and the feasibility of connection including any retrofitting requirements
- Develop indicative network routing for heating as relevant including any opportunities for soft dig and coordination with highways and urban realm developments
- Network technology selection and outline specification
  Outline network design and sizing – district heating.
- Development of interfaces including simplified schematics and outline plant sizing

Comments
This will be completed using satellite imagery only, e.g. Google Earth. Its envisaged that it will be predominantly soft dig as it is a brownfield site. This will need to be checked at the next stage.

Step 6: Technical Modelling
Included in scope

The energy demand information and connection feasibility will be fed into a detailed hourly energy model to simulate the energy demands.

Step 7: Outline Energy Centre Design
Limited inclusion in scope

The energy centre design will be developed to a sufficient level to assess spatial implication and basic civil works required to be undertaken. We will also consider technology flexibility to allow future transition to alternative technologies if they are not currently deemed practical, mature enough or economic.

Comments
Discussions with SW will take place to establish whether space can be allotted on the Dalmuir WWTP site for the energy centre.

No layout schematics or civil works assessment will be completed.

Former Exxon Site Redevelopment – Economic and Commercial Requirements

Step 1: Financial Model Development
Included in scope

Develop a financial model (MS Excel) that is sufficiently flexible to enable the viability of a number of options to be assessed. These options will be driven both by the technical analysis – considering physical and operational constraints.

Comments
This will be a simplified model to account for the options detailed in the brief only.

Step 2: Capital and operational cost assessment
Included in scope

Determine costs from manufacturer quotes and previous BH cost models developed for other district heating feasibility studies. To include:

- Capital cost for heating plant, ancillary plant, thermal storage and energy centre
- Capital costs for network and trenching (based on costs per metre based on pipe diameter)
- Capital costs for building connections and substations
- Operation and maintenance costs, staff costs, plant replacement costs

Comments

High-level costing will be completed using currently available data and through engaging with relevant technology providers.

Provisional sums will be used for civils works and building connections.

Step 3: Future price forecasting
Included in scope

Assessment of energy price inflation and indexing in line with BEIS projections and current rates for energy purchase and retail values. Projections beyond 2030 to be fixed at 2030 retail values.

Step 4: Sensitivity testing + risk management
Not in scope

Sensitivity to key inputs will be tested based on appropriate low, baseline and high values for each input. This will support an assessment of key risks to the project and enable an understanding of how to enhance viability e.g. through capital costs, heat pricing, electricity sales contract arrangements, operational tactics (electricity v heat led).

Comments
It is suggested this should be included in future feasibility study and business case modelling.

Step 5: Initial commercial structure
Limited inclusion in scope

Review commercial options with the client, considering stakeholders, potential sources of funds, delivery timeframes etc. Through this exercise, we will confirm scheme boundaries and governance options. Review of funding options including:

- Assessment of opportunities for offsetting capital through grant funding
- Assessment of financial incentives available for low carbon heat generation
- Assessment of opportunities for private wire heat sales for CHP and retail rates.
- Review of lifetime of financial incentives and risk to project delivery and supply source selection.

Study will consider:
Capex, OPEX and REPEX funding requirements if necessary

Some general advice will be provided on possible procurement routes and funding opportunities.

Former Exxon Site Redevelopment – Environmental Requirements

Step 1: Input Data Confirmation
Included in scope

All major assumptions will be tested to show their degree of influence on scheme paybacks and CO2 savings.

Step 2: Carbon Assessment
Included in scope

We will provide a detailed assessment of the CO2 emissions for different options. Emission factors based on BEIS/DEFRA projections or selected heat supply source(s) will be used at time steps (e.g. 2025,2030,2040), to test CO2 savings over business as usual scenario.

Step 3: Additional Environmental Impacts
Limited inclusion in scope

In addition to assessing CO2 emissions we will also review other potential impacts and regulatory consent requirements for the following as a minimum:

- Air quality as a result of different technologies (NOx, PM10 etc.)
- Scottish Environmental Protection Agency regulation and approvals
- Local Authority policy alignment

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