City	Inverness, UK
Supporting partner	BRE

1 Introduction

Scottish local authorities are the nerve centres for planning and implementation of low carbon energy systems underpinning national climate change mitigation/adaptation and sustainability targets. Additionally, such projects can provide social, economic, environmental and socio-economic benefits.

As local authorities are usually constrained in the planning, delivery and management of large low carbon projects, the support is offered under the EU-funded Stratego project in order to improve local heating and cooling plans. The BRE and The Scottish Government are the national partners supporting the councils and co-funding the project in Scotland. The following report has been prepared and written by BRE.

This report outlines the support provided to Scottish local authorities to assist in the implementation of district heating (DH) projects. The report covers the deliverables from Stratego Work Package Three (WP3) under consideration of specific requirements and progress of development in each of the seven Scottish Local Authorities[1] participating in the project.

In consultation with each local authority, requirements have been established for each project support through BRE. Early stakeholder engagement has been carried out by BRE where agreed with the local authority. BRE's support builds up on the work and tools provided by The Scottish Government and Heat Network Partnership.

Where energy Masterplanning activities have been required/requested, BRE utilised the Scottish Heat Map local authority data set and the Scotland District Heating Opportunity Assessment Tool. Additional information such as energy data has been requested from the local authority where required.

The report identifies preferred DH projects and early characteristics outlining benefits and costs. Analysis on key factors influencing the choice of business/delivery model has been carried out.

The document also contains a summary of the Stratego council/stakeholder workshops which have been organised by the Scottish Government with support of BRE.

As an early Masterplanning document with input data remaining to be verified, it is strongly recommended that the authority carry out detailed feasibility work before the project identified is taken to investment stage.

2 Legislative framework and current situation

Section summary. Section 2 provides a summary of policies, targets and ambitions for low carbon heat projects in Scotland on national and local level. Through comparison of both, areas for improvement in local and national heating (and cooling) plans can be identified.

Data sets and indicators that could be used to develop and inform heating (and cooling) strategies/plans in councils are presented or referenced.

[1] Edinburgh, Perth, Stirling, Inverness, Dundee, Glasgow and Aberdeen

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National framework for low carbon heat projects

In order to break down national CO_2 emissions, BEIS (The Department for Business, Energy & Industrial Strategy) publishes local annual CO_2 emission estimates for all UK local authorities. The data set could be used as a starting point to inform low carbon strategies in councils as it breaks down emissions by end user types, i.e. industry/commercial, domestic, transport (excluding emissions from shipping, aviation and exports)and energy type **[1].**

Scotland's Heat Policy Statement. In Scotland heat generation accounts for about half (47%) of total CO_2 emissions or about 85 to 96 TWh_{th} per year **[2]**. The main ambitions are published in the Heat Policy Statement **[3]** as follows:

- 11% (or about 9 TWh_{th}) of non-electrical heat demand is to be covered by renewable heat by 2020 (Renewable heat ambition – RHA)
- 1.5 TWh_{th} heat demand is to be delivered by district or community heating schemes (District heating ambition - DHA)
- 40,000 homes to be supplied with low cost, low carbon heat through heat networks by 2020 (Fuel poverty ambition – FPA)
- 12% of total final energy consumption is reduced through energy efficiency measures (baseline average consumption 2005-2007) (Energy Efficiency Ambition – EEA)
- Heat vision according to the Heat Hierarchy: 1) Demand reduction, 2) Energy efficiency improvements, 3) Use of renewable and low carbon heat sources
- By 2050 the heat sector will be largely decarbonised

The contribution towards above ambitions could be used when appraising low carbon projects by local authorities.

In the following, DH networks are the focus of analysis in this report.

Planning support. The government's economic strategy provides the basis for a range of policies (refer to Figure 1). Previously elaborated Heat Policy Statement, the Low Carbon Scotland reports and accompanying updates on heat action plans such as the "Update on Renewable Heat Target and Action – 2015" **[4]** can provide strategic guidance and a vision for local planning of low carbon heat projects. The National Planning Framework (NPF3) and Scottish Planning Policy (SPP) feed into local planning and find consideration in Strategic and Local Development Plans. The council can support the development of specific DH network options in an area through area masterplans, supplementary planning documents and energy/environmental statements.

Due to the complexity around planning and delivery of DH networks, it is recommended that the technical, financial and environmental viability of specific heat

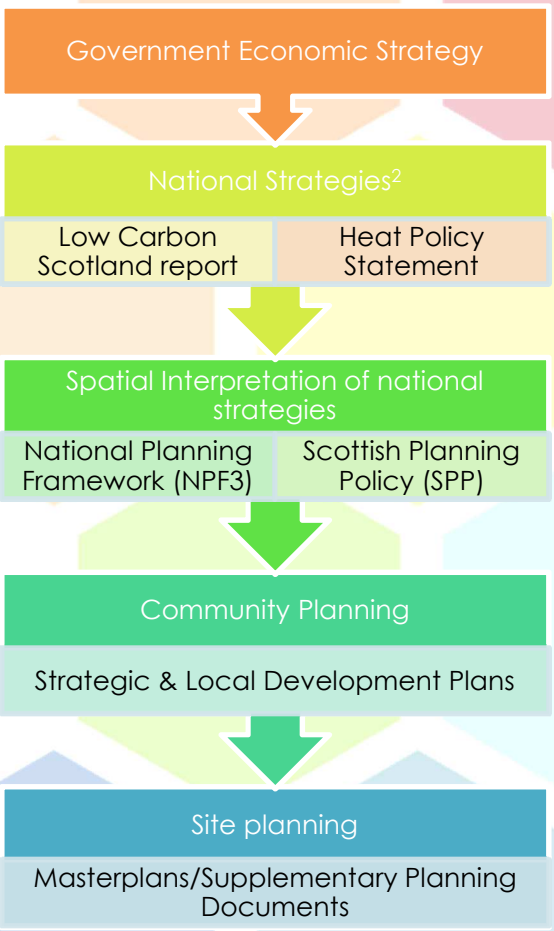

Figure 1: Extract of national, local and site-specific frameworks supporting low carbon energy projects (other policies not listed here might influence a local low carbon project)

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network options is determined by external consultants before site planning documents are amended.

Technical and financial support. The government provides online planning advice for local authorities on how to deal with DH network proposals. There is a range of organisations[2] who support local councils with leadership, planning, technology, procurement, delivery and financing tasks surrounding low carbon energy projects. The most notable one for DH is the Heat Network Partnership which brings together above support and organisations. More recently the partnership run a strategy support programme for 29 Scottish Local Authorities. More information can be retrieved from the Heat Network Partnership website[3].

Local framework for low carbon and energy projects

A council-wide Local Development Plan (LDP) for the Highland Council adopted in 2012 provides the over-arching document including intentions to tackle climate change, increasing energy security and contributing to local economies.

A specific LDP for the Inner Moray Firth outlines the development for Inverness. A sustainable design guide (supplementary guidance) provide a checklist to planners/developers covering DH/community heating schemes.

A renewable energy strategy is in place but there is no direct reference to the utilisation of DH/community heating systems. A development brief for the city centre of Inverness is in place that outlines the vision but does not go into detail about energy/heat strategies for the area. No area masterplans currently envisage the development of DH in Inverness.

The Highland Council has a carbon management plan and so-called Carbon CLEVER programme which pursues the target of making Inverness carbon neutral by 2025 under incorporation of DH networks where practical. There is no action plan regarding the carbon emissions reduction across the whole council area.

Inner Moray Firth Local Development Plan, July 2015	The use of the former Longman Landfill site is proposed as an energy from waste facility. The council proposes to produce a masterplan/development brief for the area which will be adopted as Supplementary Guidance.
Sustainable Design Guide, adopted 2013	Community heating schemes should be considered for small and large-scale developments (under the use of CHP among others)
	Checklist for planners/developers that recommends DH in conjunction with low carbon/waste heat
Carbon CLEVER Programme Plan	The Carbon management plan sets out the plan to reduce carbon emissions by at least 3 per cent a year during 2013 to 2020. The Carbon CLEVER initiative builds up on the plan and sets out Inverness to be carbon neutral in 2025.
	DH networks are recommended where practical and possible. It is referred to the central government advice to connect up estates of local authorities, NHS Scotland and the higher education sector.

[2] Organisations such as the Energy Saving Trust, Resource Efficient Scotland, Scottish Enterprise and Scottish Futures Trust

[3] http://www.districtheatingscotland.com/ visited 19/09/16

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Current progress towards a low carbon transition

DH networks (as one kind of low carbon projects examined in this report) not only contribute to overarching climate targets through the reduction of carbon emissions or improvement of resilience to current heat and electricity systems. DH networks could also provide extended energy security, additional local revenue streams for stakeholders and affordable heat for people in fuel poverty. Another key benefit can be the creation of employment and new business in the supply chain. All in all, the benefits of DH networks can align with many of the objectives on the development agendas of local authorities.

Due to the nature of DH projects, partnerships and collaboration across the public and private sector can be beneficial or required. The last published estimates indicate that 10,000 homes are connected to district heating in Scotland, with 0.2 TWh (DH ambition: 1.5 TWh) of heat being provided to domestic and non-domestic users through district heating. [3] (Based on 2014 data).

Depending on project delivery and operation business model, the Scottish private sector could benefit from an uptake in DH too. It is forecast that the demand for lower carbon heat technologies should increase and economics/markets change in response to increasing fuel/carbon costs and to low carbon regulations [3]. Estimates from the Scottish Renewables Forum suggest that £2.7 billion turnover per annum could be generated through the renewable heat sector [2].

3 Early stage energy Masterplanning

Section Summary. Heat mapping/energy masterplanning provides the first step in the identification of DH network/system opportunites. The early stage energy masterplanning carried out by BRE uses heat mapping data from the Scottish Heat Map Local Authority data sets.

In consultation with the Highland Council it has been established that a city-wide masterplanning exercise could support the team best. BRE carried out a heat demand and energy source analysis using the heat map and additional sources of information.

As part of the process, information from key stakeholders has been acquired. The report outlines benefits for the preffered DH option.

Additional data validation work should be carried out for buildings incorporated in the analysis[4]. Due to limited data confidence and availability of data during any DH masterplanning, it is recommended to commission a detailed DH/energy network feasibility study.

Map showing local heating and cooling demand and supply (D3.1)

Heat map data sets provide a spatial overview of heat demand and energy sources superimposed with information on development areas, existing infrastructures, renewable energy availability etc. This allows initial identification of opportunity areas across a large area and early project prioritisation.

The figures below give an overview of settlement topography (left) and building heat demand density (right) as per public domain version of the Scottish Heat Map. Analysis of demand density is one of the first masterplanning steps and followed by assessment of heat and electricity anchor loads. BRE compiled a document outlining early masterplanning recommendations for one Stratego council which is available on request.

[4] There are limitation to the accuracy of building heat demand. Data confidence level for each building should be reviewed.

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The areas of highest heat density highlighted in the map are: a) NHS Raigmore Hospital (right square) and b) City centre (left square).

Mapping methodology (D3.1)

		City only	Neighbour-hood only	Individual installation		
				No details	Additional Info	Monitored data
H/C demand				x	x	x
H/C infrastructure					x	x
Sustain-able H/C potential	Energy efficiency				x	
	Excess heat				x	
	Geothermal					
	Bio-energy				x	
	Solar thermal				x	

The Scottish heat map data uses specified confidence levels per data record. The higher the level the more accurate the heat demand data are deemed to be. A large number of Scottish public bodies have provided actual energy billing data which represents confidence level five (highest).

Demand data from lower levels are based on building floor area, building type and age where available. Data records for level two or one (lowest) use assumptions to estimate building heat demand. Thus, it is suggested that the council reviews building heat demand in this report through requesting measured energy data in conjunction with established energy modelling methods such as benchmarking with CIBSE Guide F. Also, level three and four data records should be verified to whether the applied energy benchmarks or EPCs fall in line with anticipated consumption.

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Current challenges – opportunities (D3.2)

In the Highland Council area, several community projects have been implemented over the years. The council offers good strategy support.

After an initial review, BRE has considered the following areas for further investigation: a) Leisure centre/council buildings at the Bught Park, b) connection between a local wood panel manufacturer and the airport, c) the area around the Raigmore Hospital and the d) the centre of Inverness.

A report for a small DH system for the Bught Park has been received from the Council and it was established that the area hosts some of the highest gas/electricity consumers. The area has a good energy density due to an ice rink/leisure centre, swimming pool and more council-owned buildings. The area was discarded from analysis as it is too remote from additional thermal loads or DH opportunity areas.

Another area surrounding a wood panel manufacturer representing a larger CO_2 emitter (EU ETS) in the council area was considered to provide heat to a local airport in about 3.5km distance. No information on excess heat potential or actual consumption data at the airport has been considered at this stage.

The Raigmore Hospital has upgraded its energy centre with a large scale biomass boilers recently. Additional large thermal loads have been identified in the area such as a pharmaceutical company, NHS administrative buildings, hotels, council offices, police headquarters and the new University of Highlands (UHI) Inverness College Campus. There is also a large shopping centre and areas allocated for development in the vicinity. The appetite for expansion to adjacent loads could not be ascertained. Also a DH feasibility study for the area went into detail with the loads and interconnection with the NHS energy centre.

A high level energy source/centre review has been conducted by BRE to examine where sources could be connected to other areas of high heat density. The findings are presented below (the list is not meant to be complete):

- The east of Inverness has extended gas infrastructure which is anticipated to be reinforced when settlement development plans along the A96 corridor vision take shape
- The rest of the city has poor gas distribution network connections
- Industrial excess heat potential in Stirling identified in conjunction with EU ETS register:
    - Local wood panel manufacturer between Inverness and Nairn but no thermal loads in direct vicinity
- Energy from waste facilities have been considered in the past and are in the current LDP for the former Longman Landfill – no clearly defined projects envisaged so far
- Water source heat pumps could be considered due to the central location of the river in the city

Areas of priorities (D3.2)

The independent heat mapping/early Masterplanning exercise carried out by BRE identified the city centre of Inverness as current opportunity area for DH development.

The area has highest heat demand density in the city and an energy centre location has been identified at the defunct Longman Road Campus of the UHI Inverness College.

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The city centre has been highlighted in the map overleaf together with the other areas (except the one surrounding the local wood panel manufacturer). Potential energy sources identified are highlighted as triangles. Housing developments with significance for a DH development are marked with a black hatched area.

It should be noted that the Scottish Multiple Deprivation Index data set displayed as a hatched magenta area would require review. Members from the councils housing team might be best suitable to discuss likely areas of fuel poverty which could benefit from DH development.

The depiction of heat demand density over a 50m heat demand density grid in the map omits any values below 65,000 kWh.

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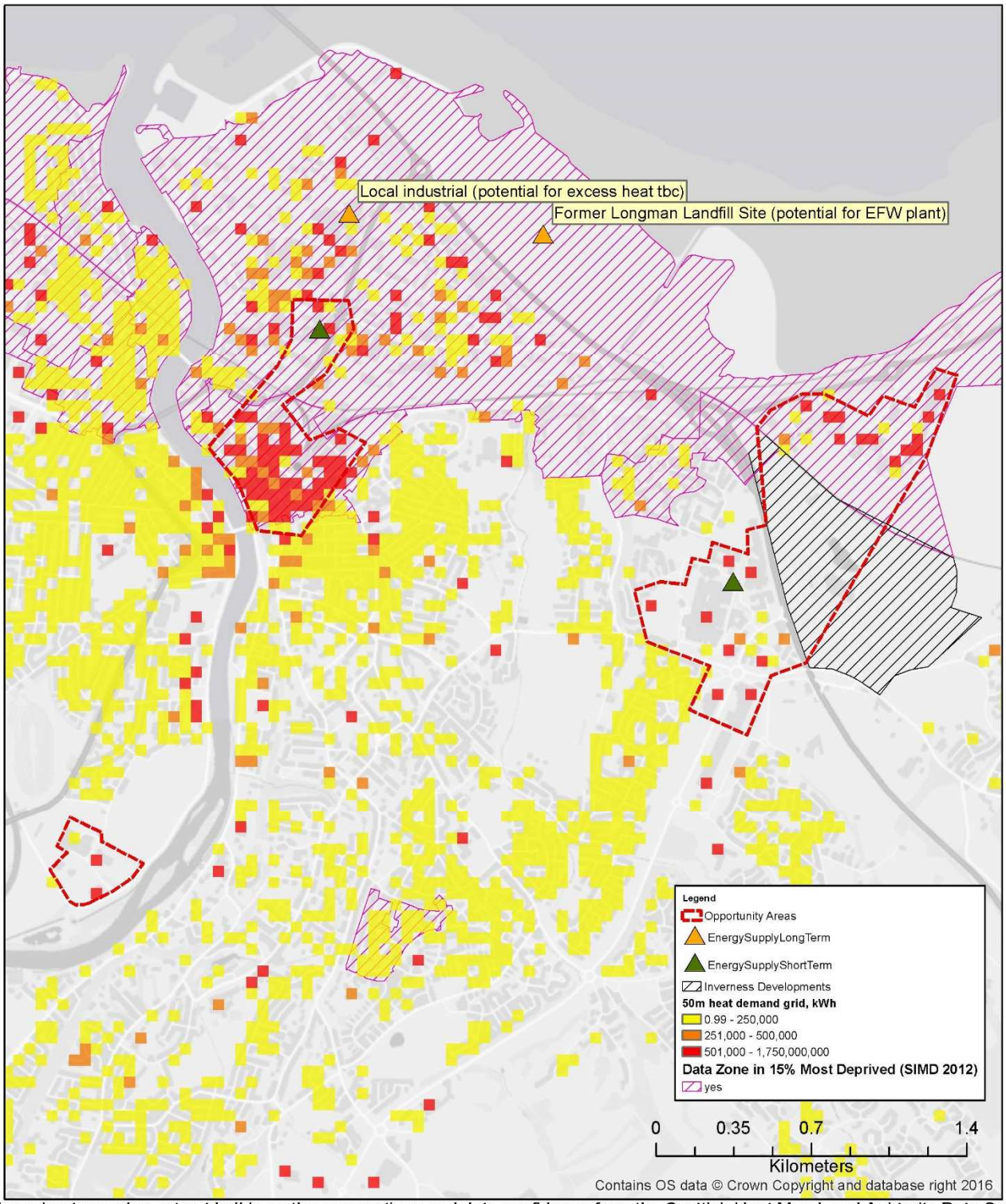
Heatmap Scotland 2014



Above heat mapping extract builds on the assumptions and data confidence from the Scottish Heat Map Local Auhtority Data Set.
Additional review of underlying data should be conducted to appraise all potential heat network opportunites.
A feasibility study should be conducted before investement descision-making is undertaken.

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Identified projects (D3.2)

Project description. BRE identified potential for a DH scheme in the centre of Inverness mainly focused around commercial heat and electrical loads served by an energy centre at Longman Road. Due to the proximity of the potential energy centre to local industry and the envisaged Longman Landfill Energy from Waste plant the DH systems would provide heat with reduced carbon emissions at stable prices. A low carbon DH network could reduce carbon emissions from the large number of historically listed buildings in the centre of Inverness that might otherwise be hard to treat with external wall insulation.

The initial centre DH scheme could be established from an energy centre at the defunct UHI Inverness College Campus at Longman Road. The university had a generously sized energy centre in place with large stack. As there are early plans for multi-purpose redevelopment of the area (LDP IN4), the energy centre would need to be incorporated in masterplans and design.

Heat Load Identification. Main loads identified are the Longman Campus redevelopment, police station, retail centre, public library, hotels, supermarkets and a large shopping centre. Heat loads have been extracted from the heat map data and where not available have been approximated based on floor area. The total approximated heat demand for the system is 16.3GWh. The linear heat density of the proposed network (1.9km length) equates to about 8.6 MWh/m which is high compared to other UK networks. Despite a moderate number of connection points which could lower initial network costs, the high number of different and commercial consumers could become challenging.

The supermarkets in the scenario have high levels of electricity consumption due to the requirement for freezing and chilling food. Additionally, it is anticipated that the large shopping centre has electrically heated store units and significant air handling/cooling units which usually are electrically powered. The approximated electricity consumption from these type of shops is about 10GWh. A CHP plant together with private wire connection could displace parts of the grid electricity currently used, resulting in lower energy costs for consumers and payback for DH developers.

The city centre's key quality is the diverse stock of more than 130 historically listed buildings which could be connected to a low carbon heat network if a switchover of the current heating system to DH was feasible.

Energy Supply Assessment. A CHP solution could provide enhanced payback through the sale of both heat and electricity to consumers of the DH network. Depending on the type of fuel used, investment costs, revenue and overall scheme risk will change. In conversation with a stakeholder from a local factory, openness towards DH development has been indicated. As the factory would be in the proximity of the proposed energy centre (see map), excess heat could be incorporated in the heat production mix. For the highest heat sales profit margins and largest CO_2 emissions reduction the integration of an energy-from-waste plant would be advisable.

According to the latest LDP, the former Longman Landfill site would be suitable for such a plant. It would be in the vicinity of the proposed energy centre. It was reported that the Council currently exports waste incurring considerable costs to meet Scottish Landfill targets which will increase due to a Zero Waste to Landfill targets in 2021. There have already been considerations for energy from waste facilities to be established but no projects have followed.

Network Routing Constraints. As big parts of the centre are within a conservation area, any DH trenching would need to fit in with visual criteria as any other utility trenching. The crossing of a railway bridge at Longman Road might require additional considerations.

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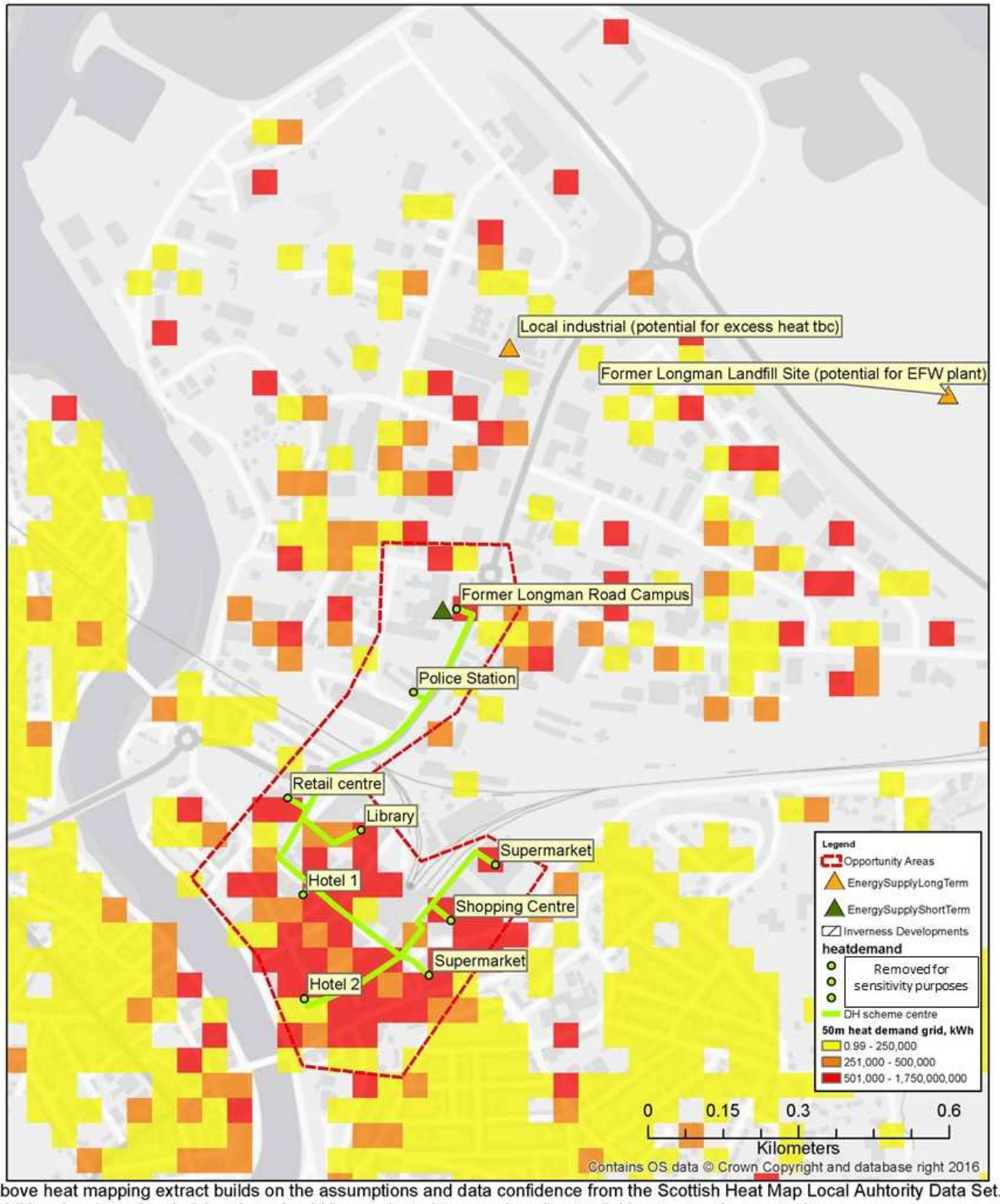
Heatmap Scotland 2014



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Potential costs and benefits. The Scotland District Heating Opportunity Assessment Tool V4.1 was chosen to produce early stage network characteristics under a standardised approach which could be revisited for analysis by the council at a later stage.

The network characteristics from the analysis are not intended, and should not be used as the basis for investment decision making. Any recipient should conduct additional feasibility studies in order to verify the functionality and/or performance (e.g. through an external technical advisor).

Total overall project costs for DH network, energy centre, private wire network and customer connections are estimated to about £7,169k. A heat and electricity centre for central business and residents for Inverness could yield a net benefit of about £644k. This equates an indicative project payback of 11 years.

The carbon savings for the proposed system (gas CHP) are expected to be about 2,397 t CO_2 per year. Primary energy savings are estimated to 16,690 MWh.

Business model of project (D3.3/D3.4)

There are a range of possible ownership and management models used for heat network projects in the UK. These models vary between being purely public sector ventures or purely private sector ventures and can provide different levels of control, degree of risk, required rates of return, investment costs and existing experience and skills sets required.

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

At this stage, prior to a detailed feasibility study and finalisation of a heat network opportunity, a suitable business model approaches cannot be finalised. However, the business approach below could fit for the centre DH opportunity area.

Due to the anticipated high linear heat density and the presence of displaceable electricity loads, relatively high revenues (electricity in addition to heat sales) are expected from the envisaged scheme. As the length of the proposed network is only about 2km, initial development costs will be moderate which would lead to a relatively short payback period.

The preferred DH option suggests the provision of heat and electricity to a number of different commercial customers. It is anticipated that this diverse group of stakeholders requires special consideration of an appropriate and effective business/governance model compared to traditional DH schemes that typically envisage the connection of buildings from public bodies in the first instance.

As the council has no track record in delivering or operating area-wide DH schemes, it is suggested to form a public/private partnership with a company experienced in the delivery, financial, legal and operative aspects of distributed energy networks. This is important as it is anticipated that a scheme serving such a number and range of commercial companies would need to be backed by strong expertise and experience in resilient delivery to encourage connection.

An Energy Service Company (ESCo) could be formed in which the council makes sure the DH vision is kept. The council could also take over business areas that might be close to their core business such as the management of DH consumers and marketing activities (which can steer the vision).

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If high scheme revenues were proven to be viable (i.e. through a DH feasibility study paired with close stakeholder engagement), increased project risk could be absorbed and an increased appetite for DH development would result. There could be the potential that the DH energy system might co-finance an energy from waste plant.

The local generated heat and electricity could form part of the councils city centre regeneration plans as an own "brand".

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Key Partnerships
Public/private sector:

Council to partner with experienced energy service company to provide locally generated low carbon energy to businesses at competitive rates

The council could invest in the network infrastructure to secure asset in the business model

It is anticipated that best practice delivery and O&M requires the council to acquire additional expertise through partnering

Key Activities
- Efficient system operation/optimisation (emission reduction)
- Best practice O&M for energy centre and heat/electricity network
- Strategic network expansion to city centre historically listed buildings

Key Resources
Energy centre, heat network, private wire network, fuel purchase, consumer management (billing)
- Council to part-finance feasibility study
- Best practice O&M for energy centre and heat/electricity network

Value Proposition
Segment 1:
Provision of locally generated, low carbon heat and electricity (baseload) at low and stable costs

Segment 2:
Provision of low carbon heat to address the requirement to meet emissions reductions targets.

Segment 3:
Development of local heat and electricity infrastructure with profit potential for local authority, energy security and potential co-financing of energy from waste plant

Customer Relationships
To all customer segments:
Current relationship between provider and customer is relevant.

Relationships will need to be built with new customers

Channels
Information on new heating system and carbon reduction compared to business as usual;
Creation of a brand for local heat and electricity that forms part of the council's city centre regeneration plans.
Similar to other pioneering local authorities

Customer segments
Segment 1:
Paid for by commercial customer:
- Supermarkets
- Shopping centres
- Hotels

Segment 2:
Paid for by local/national government:
- Police station
- Library

Segment 3:
Scheme owner /operator

Cost structure
A cost-driven structure should be chosen as it is anticipated that commercial consumers belong to large chains with centralised energy procurement contracts. The localised energy needs to be commercially competitive to justify the displacement of current suppliers required to make the network viable.

Revenue Streams
- Revenue from heat sales produced at low levelised energy costs through the use of CHP technology, excess heat from local industrial and energy from waste in long term
- Revenue from displacement of grid electricity with CHP generated electricity for commercial consumers with predictable electricity consumption
- Investment in heat network infrastructure will result in substantial fixed assets

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Results from key stakeholder meeting (D3.5)

BRE carried out stakeholder engagement in order to identify preferable existing energy centre locations and potential sources of excess heat. Attempts have been made to contact and engage a number of key stakeholders on numerous occasions.

Conversations with a manager from a local factory producing goods for distilleries indicated openness towards DH. It was established that the factory with facilities for drying crops has energy recovery measures to some degree in place. The remaining excess heat potential could not be identified.

Attempts have been made to contact a large EU ETS CO_2 emitter in the east of Inverness. No data was provided to allow assessment of excess heat potential.

Attempts have been made to contact the local hospital. No information have been provided that allow the suitability for expansion of the existing energy centre.

Additional information such as email/conversation transcripts can be requested by the council.

4 Input into the local heating and cooling plan (D3.6)

The Highland Council has extensive strategies in place and staff engaging from different departments engaging in DH. As next steps BRE gives the following recommendations to the council, focused around further analysis of a DH scheme for the centre of Inverness:

A) Soft-test with the significant number of stakeholders to a centre DH scheme and test their appetite for a DH network providing heat and electricity to local businesses e.g. in the form of an open day.

B) Review anticipated heat and electricity demand under usage of actual billing data from stakeholders and identify additional buildings in the centre that could be connected.

C) Determine space and planning considerations around a DH energy centre being part of any redevelopment plans at the defunct Longman Road campus. Determine the availability of gas connection in the area.

Regeneration plans for the Longman Road campus as well as the centre of Inverness could incorporate the overall vision for a DH network. If support from local stakeholders could be secured, a DH feasibility study would provide insight into the technical, environmental and economic scheme viability. Where a viable scheme has been determined, area masterplans and development briefs could be adopted to provide supplementary guidance to support DH development.

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Additional resources

National legislation and frameworks

- National legislation on climate change duties and implementation (last visited 02/06/2016): http://www.gov.scot/Topics/Environment/climatechange/legislation
- Latest GHG emission statistics for Scotland (last visited 02/06/2016): http://www.gov.scot/Publications/2015/06/1939
- Heat Policy Statement for Scotland (last visited 02/06/2016): http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/Heat

Energy Masterplanning

- CIBSE Code of Practice
- Decentralised Energy Masterplanning, A manual for local authorities
- Assessment of the Costs, Performance, and Characteristics of UK Heat Networks

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Stratego
ENHANCED HEATING & COOLING PLANS

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