

Investment in heat networks in Scotland



A programme from



District Heat Investment Opportunity

Introduction

Using the database maintained by the Scottish Government's Heat Network Partnership, combined with analysis performed by various research organisations and DECC, this document estimates the investment opportunity represented by the proposed expansion of Scotland's heat networks.

The Scottish Government's Heat Policy Statement (HPS)^[1] outlines ambitions for a substantial expansion of the district heat network capacity in Scotland, offering a significant opportunity for investors, equipment vendors and network operators. Currently in Scotland around 0.3 TWh of heat is delivered by heat networks per annum, less than 1% of Scotland's total heat demand^[1]; a 5-fold increase to 1.5 TWh is proposed by 2020. Over 9,000 domestic properties are currently connected to a heat network in Scotland; the HPS outlines the Scottish Government's ambition for 40,000 connected homes by 2020.

The Heat Network Partnership database maintained by Resource Efficient Scotland details 103 proposed heat network projects in Scotland, representing around 1.02 TWh of additional heat which could be delivered given appropriate support and investment. At a Scottish and UK level, heat network data is limited and costing models to date have been based on a few existing systems.

Background on heat networks

District heating is a form of heat delivery system which can operate for 20-40 years or more. A typical heat network requires relatively high initial capital expenditure for the heat plant and distribution system, off-set by secure and stable long-term profitable operations for multiple decades. Well designed and maintained heat networks operating at high utilisation throughout the year can reduce carbon emissions compared to other forms of heating, reduce fuel bills and tackle fuel poverty, as well as contributing to energy security. Over half (55%) of Scotland's energy use is for heating^[2]; therefore the heat sector will have to radically decarbonise over the next 35 years if Scotland and the UK are to meet climate change ambitions of 80% carbon reductions by 2050, relative to a 1990 baseline. The installation of heat networks has been identified as one of several key methods of reducing Scotland's heat related emissions^[1].

A heat network is a set of insulated pipes which take heat from a central source to supply heating and/or hot water to buildings - it is essentially a distribution infrastructure and as such the system itself can work with any heat source. As well as conventional fossil fuel boilers, viable heat sources include low carbon and renewable sources such as industrial waste heat, biomass boilers, heat extracted from bodies of water or the ground via a heat pump and geothermal. Heat can be provided by boilers, or as a dual output from combined heat and power (CHP) plants where both electricity and heat are generated as co-resources. A heat network can also incorporate a heat store to a much larger extent than tanks in individual buildings, which can help manage intermittent supplies of heat until the demand arises.

In Scotland, the Heat Network Partnership brings together the Scottish Government agencies which provide financial and technical support and guidance to businesses, the public sector, communities and households, working with a wider partnership of key stakeholders to deliver a step change in the scale of heat networks in Scotland. The Scottish Government supports district heating through its District Heating Loan Fund, which has committed £7 million in loans since 2011, with a further £5 million available in 2015/16. A number of other programmes can also provide financing for district heating including the Energy Company Obligation (ECO), Renewable Energy Investment Fund (REIF) and Green Investment Bank.

Heat networks role in improving overall resilience of the energy system

Through approaches such as the deployment of CHP plants, heat networks can provide valuable services to the electricity grid such as storage and balancing, and improving the resilience of the overall energy system. A heat network with a CHP plant can sell electricity to the grid, and any excess heat generated can be captured in a heat store on the network for later use. Conversely, with an electrical heat source on the network, e.g. a heat pump, excess electricity on the grid can be converted to heat and stored to meet heat demand when required.

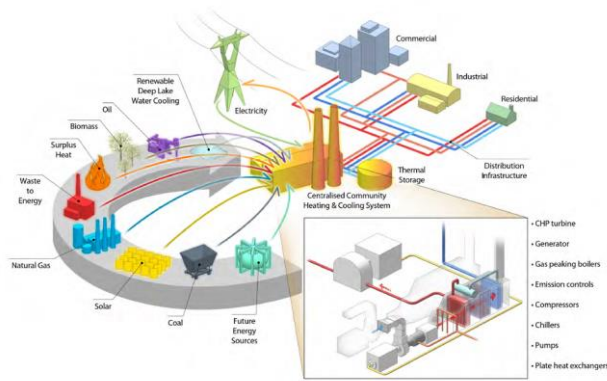


Figure 1. Illustration of a heat network using a variety of energy sources to produce hot/cold water in a centralised energy centre and distributed to a variety of buildings for heating, cooling and/or hot water, courtesy of AEI/Affiliated Engineers, Inc.

Deployment of heat networks in the UK and Scotland

Deployment of heat networks has been slower in the UK than other markets, in part due to the supply of indigenous North Sea natural gas supplies from the 1960s onwards and the success of a mature and reliable gas network which currently supplies around 78% of Scotland's domestic properties^[2]. Barriers to heat networks identified by the UK Department of Energy and Climate Change (DECC) include:

- Starting from low base – currently less than 1% of heat demand in Scotland is delivered by heat networks;
- Lack of capability and capacity in Local Authorities, which are often instrumental in establishing heat networks;
- Lack of low cost finance for Local Authorities;
- Need for better design / innovation;
- Lack of heat consumer protections.

Until relatively recently, there has been little assessment of the UK potential for heat networks and minimal strategic vision for their development – something both the UK and Scottish Governments are addressing:

- In 2015 the Scottish Government published the Heat Policy Statement setting the level of ambition for district heating: to have 40,000 homes connected to a heat network by 2020, and an annual total of 1.5 TWh of heat supplied to homes, businesses and public buildings by heat networks.
- At a UK level, DECC's 2015 documents analyse heat network costs via two reports: "*Delivering UK Energy Investment: Networks*"^[3] and "*Assessment of the Costs, Performance, and Characteristics of UK Heat Networks*"^[4].

Previous estimates of the value of the heat network sector within the UK

A study by research organisation BSRIA estimated the value of the total UK district energy market would rise from about £350m annually in 2010 to about £530m in 2015^[5]. This includes an increase in total capital investment from c. £115m in 2010 to c. £215m in the year 2015. In England and Wales, Local Authorities have created a portfolio of Heat Network Delivery Unit (HNDU) projects of between £400m to £800m of capital investment opportunity over the next 10 years (on an assumption of 25% to 50% of current projects coming to fruition). This estimation does not include heat networks being developed by other means e.g. the private sector, or future projects supported by further HNDU funding rounds.

Scottish heat network landscape in 2015

Resource Efficient Scotland manages a database for the Heat Network Partnership which covers known existing and proposed heat networks in Scotland under the following categories of development and with a varied range of heat sources, including:

Operational – extension ongoing	CHP/Trigeneration	Biomass
Operational – extension being developed	Heat only boiler	Landfill gas
Operational – extension potential	Energy from Waste	Flue gas heat recovery
In development - procurement	Anaerobic Digestion	
In development - financing	Heat pumps: river, ground, air, geothermal	
In development - technical feasibility	Recovery from waste water treatment works	
In development - proposal stage		

As of June 2015, the Heat Network Partnership database indicates that Scotland currently has nearly 10,000 properties connected to a heat network, with over 13,000 domestic connections in planning or under consideration (c. 23,500 in total). In addition, around 10% of the current homes connected are on small-scale rural networks, but projections for the number of small-scale heat networks are not captured in the database.

Currently the database details 103 extensions to existing heat networks or new proposed heat networks in Scotland. If all known projects with the status “In Development” or “Operational with potential extension” progress to implementation, it is estimated they will deliver an additional 1.02 TWh of heat annually:

Current Scottish heat network (June 2015 figures):

- Connected domestic properties = 9,886
- Delivered annual heat = 0.33 TWh

Additional heat network capability proposed in Heat Network Partnership database:

- Additional capacity = 248 MW
- Additional annual heat output = 1.02 TWh
- Additional domestic connections = 13,707

Projected Scottish heat network capacity if all proposed projects are delivered:

- Connected domestic properties = 23,593
- Delivered annual heat = 1.35 TWh

Potential investment opportunity

The costs for a district heating system comprise: (1) the heat distribution network, (2) the heat generating plant, and (3) the end-user connections.

1. Heat distribution networks vary significantly in topology (e.g. supplying a university campus, an industrial estate, or multiple tower blocks), and each proposed scheme has to be evaluated on a case-by-case basis in terms of economic viability and practicalities of installation. At an average cost of around £1m per km (source: DECC^[4]), the heat distribution network can be a dominant part of the overall heat network investment (specific costs were found to range from £0.4m to £1.4m per km in the UK). The Heat Network Partnership database estimates of the order of 190 km of new heat network may be required for the 103 potential Scottish projects. Based on DECC’s figures, and assuming £0.5m to £1m per km, this requires an investment of between £85m to £190m in Scotland’s heat distribution network.

2. Heat plants: typical CAPEX figures per MW by heat source technology (source: Refs [6,7]):

Technology	Gas boiler	Biomass boiler	Gas CHP	Heat pump	Mine-water	Waste heat	Deep geothermal	EfW
Cost (£ million / MW)	0.42	0.62	0.66	1.20	1.2	1.2	2.0	8.75-12.75

Based on these figures, CAPEX of £0.42m to £1.2m per MW of installed capacity was considered representative for heat plant installations, excluding Energy from Waste (EfW).

Energy from Waste (EfW) needs to be considered separately as plant costs are significantly higher at between £8.75m to £12.75m per MW, and also EfW plants represents around a relatively large 26% of the proposed new Scottish capacity (64 MW out of the proposed 248 MW new plant capacity).

The Polmadie EfW plant is a 200 kilo-tonne per annum (ktpa) facility with a 12 MW heat capacity, expected to deliver 102 GWh of heat per annum when it is commissioned in 2016; it will operate a three-step process, Figure 2. The total plant cost is quoted as £154m, giving a CAPEX of £12.75m per MW of heat capacity. The Polmadie plant costs are consistent with a DEFRA analysis of plant construction costs: £145m - £200m for moving grate EfW facilities of 150ktpa – 350ktpa capacity. A 2009 report^[7] quoted a lower cost of £8.75m per MW of heat capacity. Therefore EfW plants are significantly more expensive than alternative heat sources, with installation costs of the order of 8-30 times higher. The primary function of modern waste treatment facilities such as that at Polmadie is the process of recycling the waste, followed by treatment of the residual waste in the EfW plant which provides electricity and heat production. The potential future penetration levels for EfW as a heat provider is therefore a complex cross-sector issue.

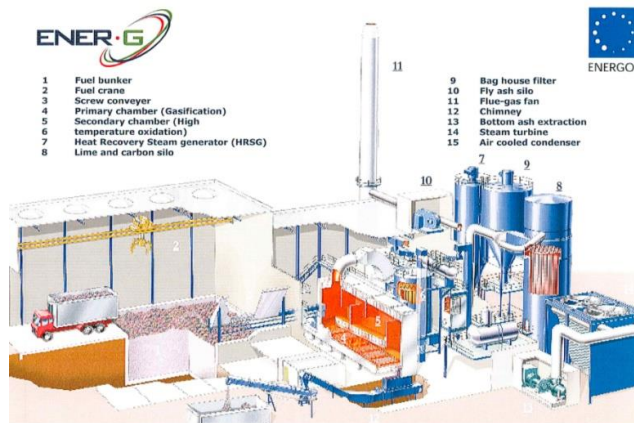


Figure 2. Overview of the Polmadie three-step process comprising a Smart Materials Recycling Facility to enhance recycling, Anaerobic Digestion to capture food and organic material and an Advanced Conversion Facility to recover energy from post-recycling material that remains, in order to generate electricity and heat.

An additional heat plant capacity of 248 MW (26% of which is EfW) offers an investment opportunity of:

- £74m to £223m for the 186 MW of non-EfW heat plant
- £388m to £636m for the 64 MW of EfW plant (excluding Polmadie which is already funded)

3. End-user connections: each end-user requires a Hydraulic Unit Interface (HUI) connection to the heat network, a heat metering system and a wet radiator system (if not already installed). DECC quotes^[4]:

- The cost of the HUI connection to each end-user as £1-2k
- Heat meter installation is of the order of £1k
- Each individual property's wet radiator system – a typical urban property c. £2k

Therefore the cost of a domestic network connection is of the order of £2k to £5k per home. Depending on whether new internal radiator systems are required, the 14,000 new domestic connections in the database will require investment of the order of £28m to £70m.

Summary of Scottish district heat network investment opportunity

The delivery of all 103 proposed district heating schemes in the Heat Network Partnership database offers a total investment opportunity of between £600m to £1100m, including heat plants, heat distribution networks and end-user connections.

The total investment opportunity is heavily dominated by around £400m to £600m of proposed Energy from Waste (EfW) plants, including the £145m for the proposed 250 ktpa South Clyde Energy Centre. The overall investment case for EfW plants is complex and may primarily involve avoiding significant waste charges elsewhere (e.g. landfill tax), with renewable heat and electricity as a secondary benefit rather than the primary function of the plant.

Heat distribution networks:	£85m - £190m
Heat plants, excluding EfW (74% of new capacity):	£74m - £223m
Heat plants, EfW (26% of new capacity):	£388m - £636m
End-user connections:	£28m - £70m
Total opportunity excluding EfW plants:	£187m - £483m
Total opportunity including EfW plants:	£575m - £1119m

Excluding the EfW plant investment requirements, which account for 26% of the proposed new heat capacity, but including their associated heat network and end-user installations, the remaining proposed new capacity offers an investment opportunity of the order of £190m-£480m. Of this total, around £100 million of uncertainty arises from the costs of installing the heat distribution networks, which are site specific and dependent on current land use and infrastructure. An additional £150 million of uncertainty arises from the heat plants other than EfW, with prices based on a limited number of examples in Scotland and the UK.

The analysis of HNDU schemes for England and Wales, assumes 25% to 50% of current projects will come to fruition. Similarly, some of the schemes currently on the Heat Network Partnership will experience unforeseen difficulties, whilst new projects will most likely emerge, underpinned by support for the development of local strategies for district heating..

The delivery of 50% of the known heat network projects in Scotland offers an investment opportunity of around £300m to £550m including EfW plants, and £100m to £240m excluding EfW plants.

Acronyms

DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
EfW	Energy from Waste
GWh	gigawatt hour
HNDU	Heat Network Delivery Unit
HPS	Heat Policy Statement
HUI	Hydraulic Unit Interface
ktpa	kilo-tonne per annum
MW	megawatt
REIF	Renewable Energy Investment Fund
TWh	terawatt hour

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