HEAT NETWORKS

Options for providing heat locally

A GUIDE BY:
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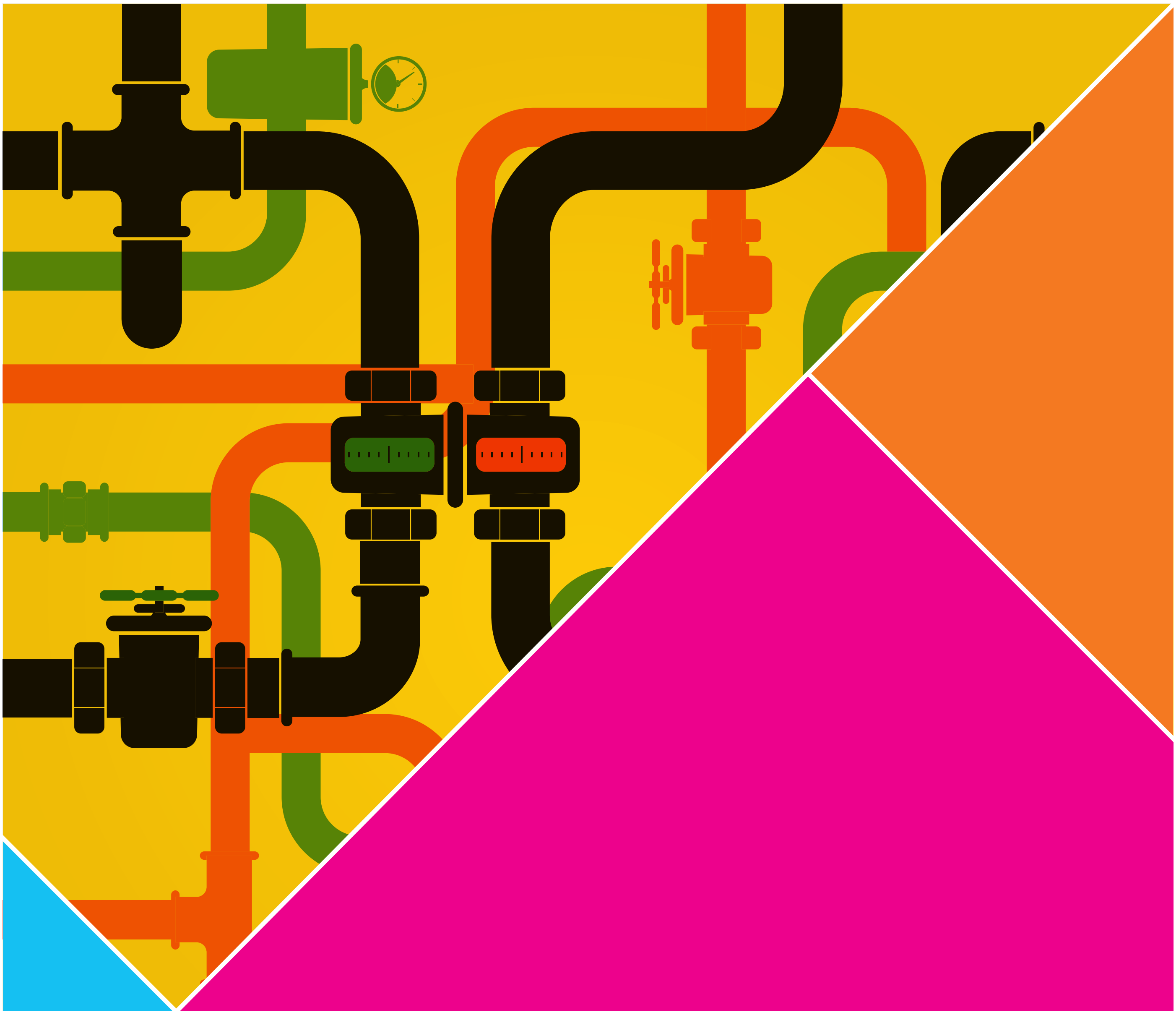
PUBLISHED:
OCTOBER 2017



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Introduction

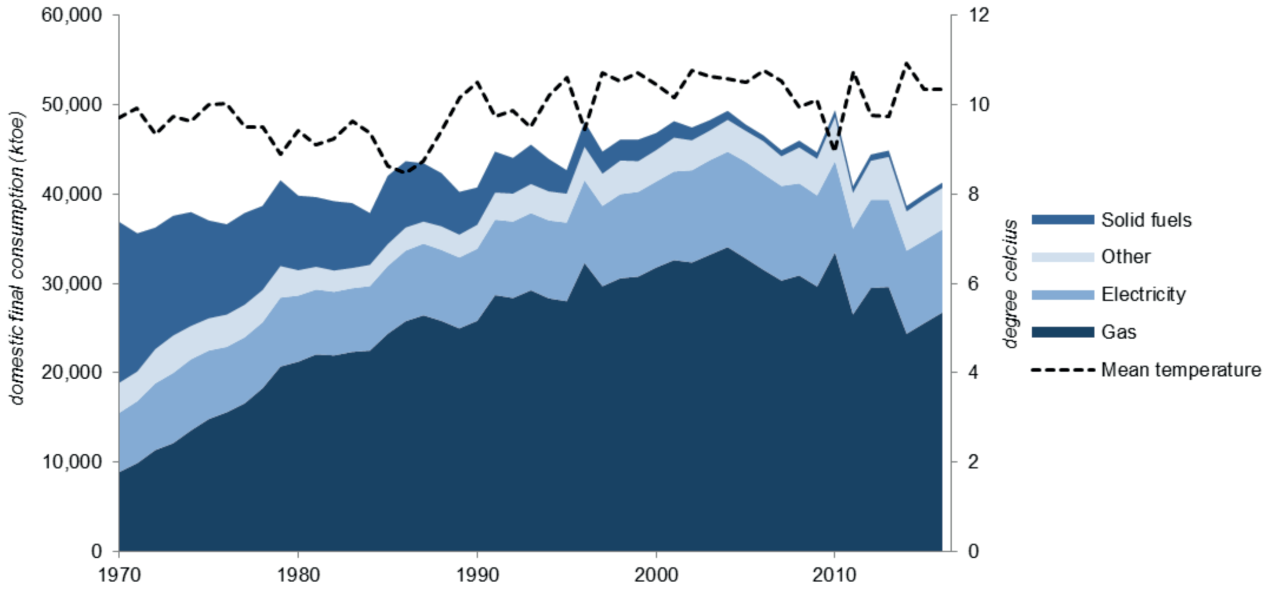
Our energy mix is changing

The UK is undergoing a revolution in how our electricity and heat are supplied. For many years we have enjoyed a plentiful domestic supply of oil and gas, with supplies being significant enough to meet our own needs as well as the nation becoming a major exporter. However, since the early 2000's levels of oil and gas production in the UK have fallen, whilst our internal consumption of fossil fuels has remained fairly stable. With continuing dependence upon oil and gas from areas of the world which are politically unstable there has been a movement towards finding alternative means of satisfying our increasing demands for heat.

Nearly half of the energy we consume in the UK is spent on heating our homes and businesses and the bulk of this heat is produced by boilers in each building fuelled by natural gas. As this commodity continues to get scarcer and more expensive, greater emphasis is being placed on more efficient solutions that do more with less.

Introduction

Domestic energy consumption by fuel type



Note; "Other" includes petroleum, bioenergy, and heat sold. Source; BEIS ECUK Table 3.01

Why heat networks, why now?

By 2050, the UK government expects gas to play a much smaller role in heating our buildings, preferring to use it for electricity generation instead. This means that we will have to embrace technologies such as heat pumps, use our existing gas network in a new way, or centralise and share our heat within networks. In reality, the UK will probably adopt a mixture of all three. The UK government is actively encouraging change by injecting £320million into heat schemes between 2017 and 2021; a welcome move given the large scale financial commitment that is required for many schemes.

Many local authorities and private sector companies are already exploring and implementing heat network projects, particularly in urban environments where there is a mix of residential and non-residential buildings. But small scale community-led heat network projects are far less prevalent, as heating projects are capital intensive and will not succeed unless there are customers willing to connect. Currently there is no national market that heat can be sold to. Despite this, many smaller towns and villages would benefit from hosting a heat network and this guide aims to show the benefits of such schemes and some of the legal issues to consider.

About the authors

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Stephens Scown's energy team has worked on hundreds of renewable energy projects of all types and sizes throughout the UK and is recognised by independent legal guide, Legal 500, which highlights the expertise of the team's head Sonya Bedford. The firm has worked with major developers such as IB Vogt, ReneSola, Anesco, British Solar Renewables, Sun Farming and Bath and West Community Energy, and has experience in heat supply contracts through advising suppliers and community energy groups.

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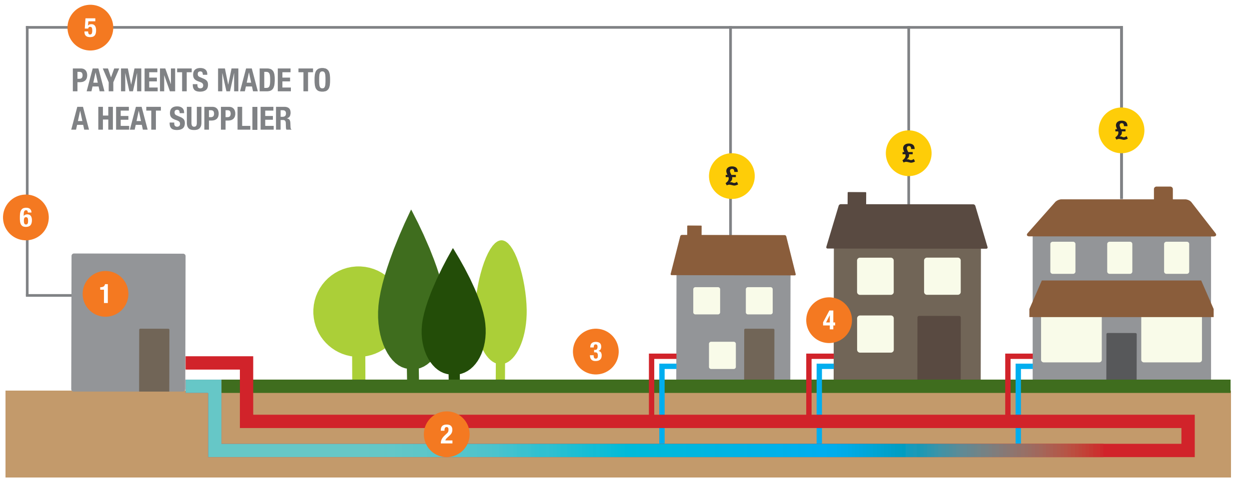
Anatomy of a heat network

Heat networks are not complicated; they are simply a number of buildings or units that are connected by hot water pipes to one or more heat sources, normally a large boiler, rather than each of them having their own boilers.



1 Generate heat and/or gather waste heat to provide hot water

2 Pump hot water through a pipeline

3 Getting the heat into homes and businesses

4 Using the heat

5 Providing bills to each customer for their heat consumption

6 Paying for the system

A. District heating - how does it work?

1 Generate heat and/or gather waste heat to provide hot water

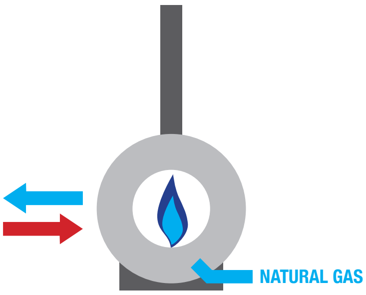
One of the key benefits of a heat network is its ability to use heat from different sources such as biomass, biogas or consumer waste. Depending on where the network is located, it may be possible to use waste heat from a local factory to provide heat to the network and then top this up with heat from another source, often a gas powered boiler. Mixing heat sources in this way provides flexibility for the future should new sources of heat become available or existing sources become unavailable.

Currently, the majority of heat networks have a single heat generator, such as a gas Combined Heat and Power (CHP) or biomass boiler, that is housed in its own energy centre. The energy centre itself is likely to house more than one boiler in order to accommodate peak winter heating loads and provide additional capacity if one of the boilers requires maintenance. This energy centre may also house some or all of the large pumps required to move the hot water around the network, plus a fuel store if it runs on biomass. Depending on the scale of the network, some energy centres are large and therefore consideration has to be given as to whether there is space for such a building within urban areas.

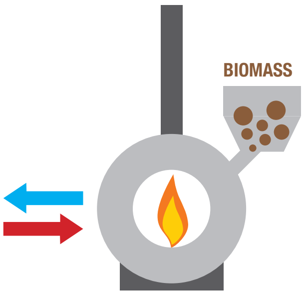
Anatomy of a heat network

Heat networks are not single fuel dependent. The network itself is simply hot water being pumped around a network of pipes and delivered to customers, and the heat can be generated in any number of ways that are suitable for that scheme and its location. The most common currently are:

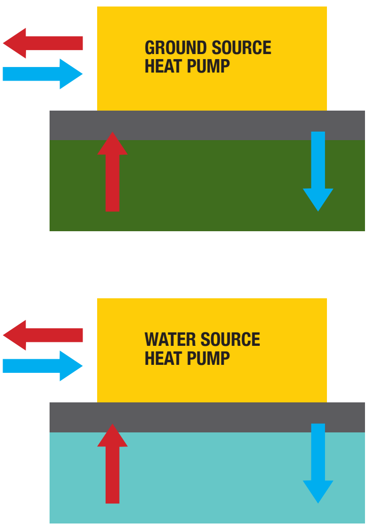
NATURAL GAS COMBINED HEAT AND POWER



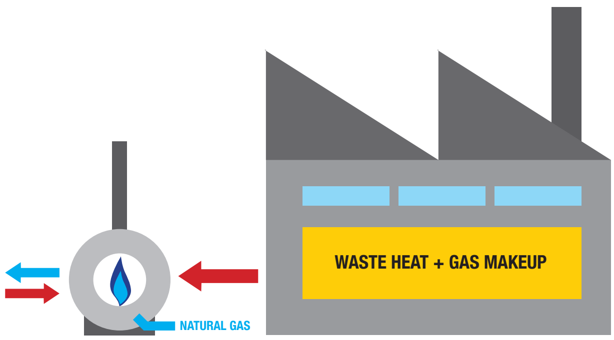
BIOMASS



HEAT PUMPS



WASTE TO HEAT



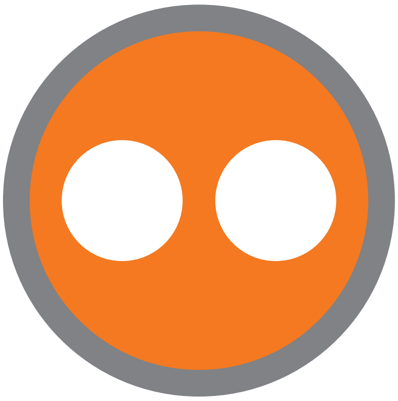
Of these heat generating plants, the natural gas, biomass and waste heat options can also produce electricity and this is known as Combined Heat and Power (CHP). Heat pump systems do not produce enough heat to enable them to create electricity and are therefore more limited in scope, although they are used in small scale domestic heat networks such as Devon & Cornwall Housing Association's housing scheme in Penzance, Cornwall.

Anatomy of a heat network

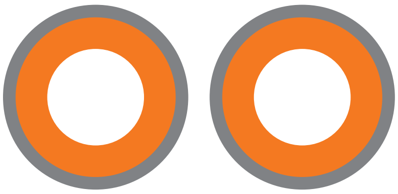
2 Pump hot water through a pipeline

Once hot water is generated by the energy centre, it must be pumped around the network through a system of pipes known as 'heat mains' in order to deliver the heat at the required temperature to each customer. For most customers, this will typically be at around 70-80 degrees Celsius. Pumps will vary their pumping speed in order to keep the pressure and temperature constant, ensuring everyone connected to the network receives the same service.

The pipeline itself is simply a pair of insulated tubes that are normally buried underground. There are a range of options for pipe types and designs, the choice of which will depend upon project scale but which will have an impact on the project costs and the ease of installation. There are two fundamental types of pipe system that can be used:



Twin pipe: both the feed and return pipes are contained in one insulated casing. Twin pipe is currently always a polymer (plastic) pipe and there are two types of insulation that can be chosen, PU foam (polyurethane) and PEX foam (cross-linked polyethylene).



Single pipe: the feed and return pipes have their own separately insulated pipe. Single pipe systems can be either steel, or polymer with PU foam insulation. Steel single pipe systems are often used in larger schemes where a greater diameter of pipe is needed, but are more expensive to buy and install.

Sometimes a third pipe is introduced for reduced summer use but this is not the case on all networks.

In all cases, the pipes are normally buried underground in order to maintain water heat and pipes will only come above ground at the point at which they connect to each building.

Anatomy of a heat network

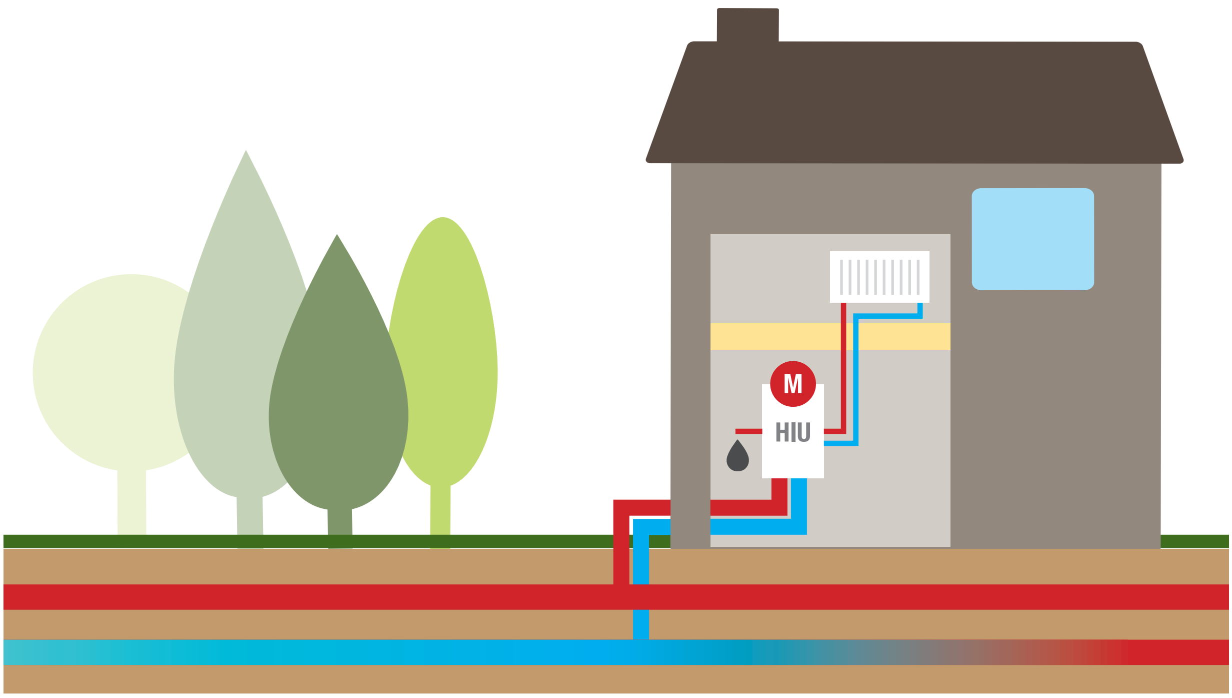
3 Getting the heat into homes and businesses

One of the most persistent myths about heat networks is that customers have no control over the heat they receive; nothing could be further from the truth. With modern heat networks, each customer is connected to the heat network through an interface (or bridge) known as a 'Heat Interface Unit' or HIU, of which there are a number of different types. This box (about the size of a domestic condensing gas boiler) provides the customer with complete control over their space heating, as well as providing domestic hot water on demand.

Indirect HIUs work on the basis that there is a separation between the primary heat system (the network) and the secondary system in the customer's building. Heat is extracted from the water that has come from the primary system and that heat is then transferred via a plate heat exchanger to the water that flows within the building. In this way the hot water circulating inside the building or coming out of the hot water taps never mixes with the water that flows around the rest of the heat network. The two systems are entirely separate.

Direct HIUs allow hot water from the primary system to flow into the secondary system and these can either be thermostatically controlled or be controlled using a proportional hydraulic control. These systems are useful where underfloor heating has been installed.

The HIU will usually include a heat meter that works just like a gas or electricity meter so that the more heat you extract from the heat network the higher the recorded number on your heat meter will be. Not all network schemes include metering however, as heat can be bundled within rents and this is often the case within social housing schemes or where there is a desire to control expenditure for occupiers and enable tenants to make just one monthly payment.



Anatomy of a heat network

4 Using the heat

The majority of homes built today have radiators sized to work with 70-80 degree Celsius water circulating around the house. Many retrofit heat networks are designed to be able to deliver this heat temperature, which means that the internal plumbing of the home can remain largely untouched (other than the replacement of the boiler with an HIU). This obviously keeps the cost of installation/connection to the heat network down for the home owner.

New build homes sometimes have underfloor heating or oversized radiators that can deliver the same heat output but with a lower input temperature. If all of the connections on the network are designed to have this lower input temperature, then the boilers and energy centre can be smaller and cheaper and thus the initial costs of building the network will be commensurately lower. When making a decision whether or not to install a heat network there is therefore a three-way balance to be struck between (1) the temperature of the heat delivered; (2) the cost of altering internal plumbing; and (3) the overall cost of the network.

5 Provide bills to each customer for their heat consumption

On those networks where heat is charged as an individual item, every customer connected to the network will have a meter that measures how much heat has been consumed. These meter readings will be used to generate a bill by the organisation operating the billing arrangements for the network. The Heat Network (Metering and Billing) Regulations 2014, which are applied through the BEIS Regulatory Delivery directorate, provide a set of rules on network metering and billing in order to provide additional customer protections for those paying for heat through networks. These regulations whilst welcome, are not however as stringent as the consumer protections for other types of utilities. The regulations do however have cost and regulatory implications for smaller organisations looking to develop and run a heat network themselves and thus can impact upon whether a proposed scheme will be viable or not.

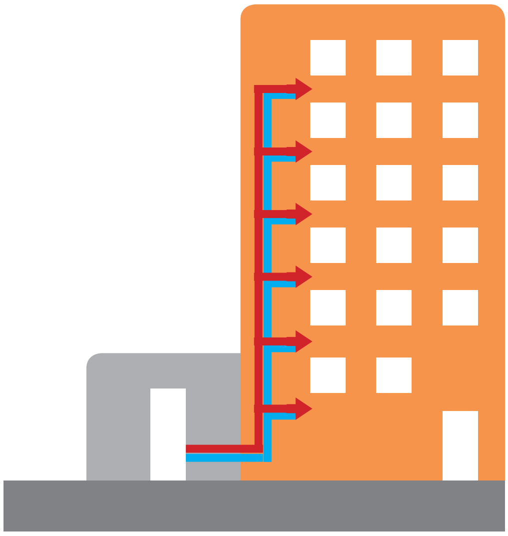
6 Paying for the system

The income streams attached to a heat network are simple. Customers will be billed for the heat they use or the building owner will allocate an element of rent as being for heat production in those systems where metering is not applied. The income from heat sales goes to the owner/operator of the heat network to pay for fuel, maintenance and the costs associated with billing and customer interactions. In addition, if the heat is generated from heat pumps or biomass, then the scheme could qualify for the UKs Renewable Heat Incentive (RHI) scheme, thereby generating an additional revenue stream.

The income streams attached to a heat network are simple

Anatomy of a heat network

B. Communal Heating



For many people, it is communal heating they think of when hearing about heat networks. Communal heating is a very simple form of heat network that supplies a single building with the hot water being drawn from one boiler and pumped around the building. Older communal heating systems often had no controls on the heating for individual housing units, with the building owner deciding when the space heating should be switched on and off and this method of heating was not popular and often not efficient. This version of communal heating does not measure how much heat is used by each housing unit, instead each user pays the same flat rate, normally bundled up within other building and service charges.

Modern communal heating systems continue to be installed in large buildings with multiple tenants, but all new schemes will be now built to the same standards and customer protections as any other type of heat network, with each customer having full control over the heat they receive and controls being administered via an HIU. Supplies may or may not be metered and the decision on this will depend upon the type of building that is being served and the nature of the occupiers. Often larger local authority schemes that supply social housing blocks will not be metered, whereas buildings where there are owner/ occupiers will have metering.

CASE STUDY: Sleaford district heat network

Sleaford is a market town in Lincolnshire with a population of just under 20,000. In 2014, a straw-bale fuelled power plant was constructed and it now supplies electricity to 65,000 homes. As part of this process, large quantities of waste heat are produced.

This 'waste' heat is piped underground to five local public buildings (a school, leisure centre and sports clubs and local district council offices) via 2.4km of pipework. The heat is provided to these buildings free of charge, with the local community seeing about £2 million in energy cost savings in these buildings over a 25 year period.

The project was not without its difficulties and included a requirement to drill and lay pipes beneath the river Slea in order to ensure additional buildings could be connected to the network.

Building a portfolio of heat demand into a network is critical to achieving an efficient system. Avoiding peaks and troughs of demand is a hallmark of successful schemes and this can be done by mixing types of buildings with different demand profiles.

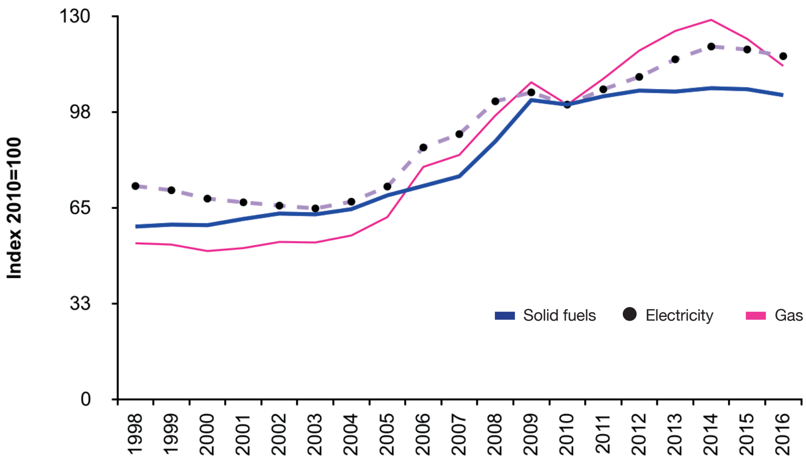
Drivers for heat projects

Every home and business needs heating of some sort. In fact, nearly half of all the energy consumed in the UK is used to heat spaces or provide hot water[1] and most of this comes from natural gas. Currently, much of this heat is provided through individual boilers and plant which serves just one property. This means that each customer must pay for maintenance of their heating plant, the fuel used and also the cost of replacing each heating plant.

Greater efficiencies = lower costs?

Gas prices have more than doubled in real terms since 2000 (as highlighted by the graph below), therefore anything that can help reduce consumption of gas is going to make a real difference to a household's energy costs.

Consumer price index for gas and electricity



It is clear that the UK will depend on natural gas as a source of energy for many years to come, but with dwindling reserves and insecure supplies, it is imperative that gas is burned with maximum efficiency. CHP heat networks can go some way towards achieving this, as by generating power and heat simultaneously they can save between 10-30% in fuel. In addition it is generally assumed that CHP boilers will be 80-90% efficient in use, which compares favourably to the average efficiencies of 90% for individual gas powered boilers.

District heating systems do come with some challenges however, including loss of heat to the surrounding soil (sometimes as large as 40% if poorly insulated pipes are used) and the plant being operated in a suboptimal manner. Suboptimal operation means that boilers are being modulated (continually turned up and down) instead of running at full load. This continuous modulation may be as a consequence of insufficient users on the system, low heat demands or homogeneity of users, leading to enormous peaks and troughs of demand. Heat loads and customer demand peaks are thus critical to enabling the design of an effective and efficient district heating system It is important that systems are designed so that they can not only produce heat but also electricity and have thermal stores or batteries within the system in order to hold surplus heat and extra capacity. This will ensure maximum efficiencies and reduce CO_2 emissions.

1 https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

Drivers for heat projects

Lowering carbon emissions

CO_2 in the Earth's atmosphere acts as a greenhouse gas which plays a major role in global warming and climate change. Over one third of the carbon dioxide emissions produced by the UK come from hot water and space heating and one way of addressing these emissions is to reduce the number of boilers and heating plant by using heat networks. The generation of electricity at the Pimlico District Heat Undertaking (see case study) has been calculated to save up to 11,000 tonnes of carbon emissions per annum - the equivalent of taking just under 4,000 cars per year off the road and this does not take into account the CO_2 savings for the heat generation from the plant.

Potential to address fuel poverty

Domestic households meet their heating needs through buying gas/electricity through the open market and are in effect 'price takers' with limited influence over the amount they pay. The utility companies offer a myriad of flexible and fixed rate contracts and although the consumer does have a wide choice, there remains risk exposure to price fluctuations.

Conversely, heat networks operate by selling the heat direct to the customer and usually at a fixed price. This can potentially provide a route for the operator of the heat network to identify and support vulnerable customers, in particular, those households that are in fuel poverty. Indeed many heat networks on social housing developments are operated with this social benefit as a guiding principle.

The benefit for customers is that they will no longer have to worry about their boiler breaking down or paying for repairs (other than possibly the Heat Interface Unit (HIU) which is situated in their home) as the repair costs of the system are wrapped up in the cost of the heat they purchase. This can potentially lead to more certainty in customers' heating bills but it should be borne in mind that the costs of heat networks are not always predictable and the price paid per unit of heat will also be influenced by the network operator's approach to returns on investment, the age of the network and the type of fuel used in the central plant.

CASE STUDY: Pimlico District Heat Undertaking (PDHU)

Unsurprisingly, London has the highest number of heat networks of any UK city. This is partly due to the popularity of district heating in the 1950's when large parts of the city were rebuilt after the Blitz, and also because of the high density of buildings, which makes pipe-runs short and therefore cost effective.

The UK's earliest heat network, the Pimlico District Heating Undertaking (PDHU), was first commissioned in 1950 using waste heat from Battersea power station and the driving force behind its construction was the poor air quality across London caused by widespread coal burning. In 1980 the power station closed and a coal fired boiler was installed which was later changed to a CHP unit run on gas. The system continues today and is testament to the enduring nature of heat networks.

The PMDHU is currently connected to over 3000 homes, 50 businesses and three schools. It is owned by Westminster City Council but managed by CityWest Homes, a separate organisation that manages delivery of landlord services for the Council. The system now has a computerised control system which monitors and controls temperatures at buildings throughout the network. This aids reliability and reduces costs within the system. It is estimated that the cost of heat to customers is around 20% lower than if those customers had their own boiler.

Costs

Building a business case for a heat network will depend heavily on four factors:

1
How many of the connections are going to be 'new build'?

2
What demands (other than residential) can be connected to the network?

3
The energy mix generating the heat (gas, biomass, heat pumps, etc) and associated incentives

4
How many connections will there be overall?

Costs

1 How many of the connections are going to be new build?

Many heat networks only become viable through economies of scale with numerous buildings of differing types and usage being connected. This may mean some or all of the homes or commercial buildings that are to be connected to a network have not yet been built.

So why would a developer want to install a new heat network or connect to an existing one?

- Since most new buildings in the UK will require heating of some description developers will generally make provision for new properties to be connected to the gas grid if there is a gas main nearby, as this is the “known” and quantifiable default position. However, if the developer connects to a heat network instead, there will be some monetary savings for the developer in not having to install individual boilers and mains gas pipes into each building. There will of course still be the cost of installing the HIU and any internal pipework that is needed as part of the heat network or internal heating system, but the possible cost reductions may be sufficient to persuade the developer of the merits of a heat network. This, of course, still leaves significant investment in the energy centre and auxiliary costs to be found, and this will often be by a third party investor.

- The “avoided” costs of each home running and maintaining a gas boiler can be used as a selling point by the developer when selling new properties. It is important to note however that simply comparing the cost per unit of heat produced by a heat network to the cost per unit of gas does not normally stack up financially, but once boiler replacement and maintenance costs are included, the economics look much better. This is something that a developer would need to consider when marketing its units and persuading occupiers of the merits of a heat network.

- In tenanted or serviced housing estates a driver to connecting to a network is improved access for maintenance of boilers and other heat sources. This can lead to significant cost savings in avoidance of visits to individual flats to carry out routine maintenance or to respond to boiler malfunctions, particularly in situations where tenants are not at home at the time of the visit and multiple abortive visits occur.

- It is important to remember that with a standard gas heating system the home owner has not only to buy the fuel, but he must use that fuel to create heat and this leads to a reduction of overall efficiency per litre of fuel purchased. In district heating systems however the consumer pays purely for the heat itself and thus the energy being purchased at the meter by the consumer is entirely ‘useful’ energy.

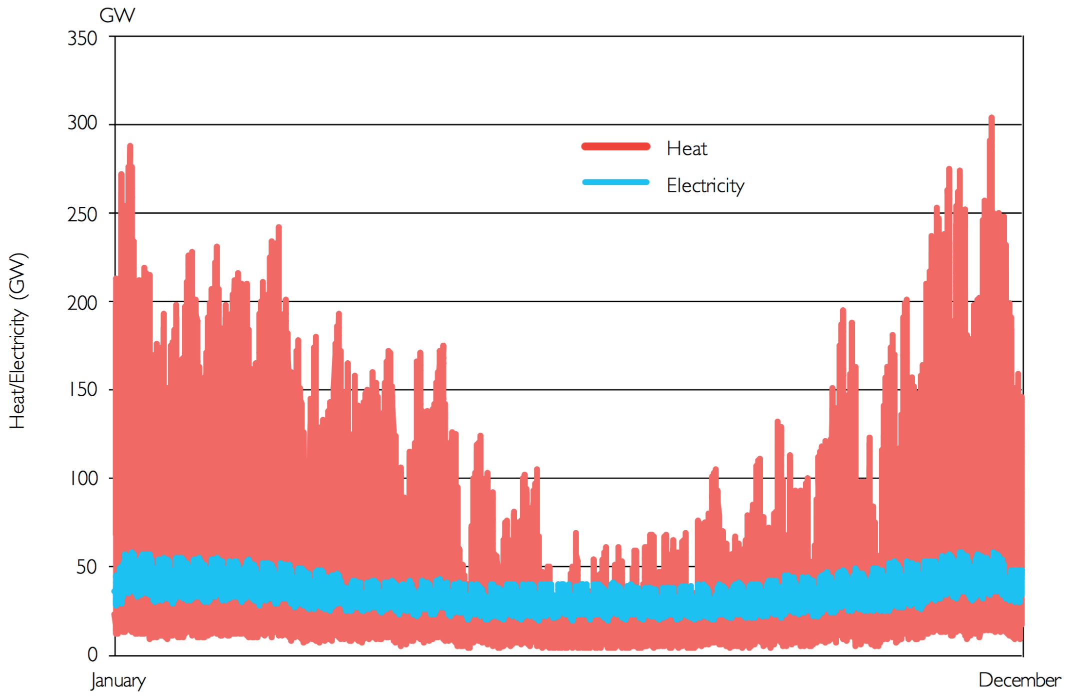
- One should always bear in mind that heat networks linked to CHP or a waste heat recovery plant will be creating ‘better value’ heat, because the heat is a by-product of a primary purpose (creation of electricity or a manufacturing or recycling process) and the heat is thus a secondary use derived from the same fuel source.

Costs

2 What demands other than residential can be connected to the network?

Just connecting homes to a network is often not sufficient to support an economically viable heat network. Most homes will use space heating and hot water at similar times (such as early morning and between 5pm and 9pm) and this causes large peaks and troughs in heat use, and of course means that the heat network is not doing very much outside of these peak hours nor during the summer months. This will lead to a very inefficient and costly scheme.

Department for Energy and Climate Change 'The Future of heating, meeting the challenge' 2011. Variation of domestic and commercial heat and electricity across a year



A heat network is more likely to be financially viable if it has a mixture of demands, both residential and commercial, which cumulatively have heat demands throughout the day and night rather than just at peak times. By having a more constant stream of demand, the network can work efficiently throughout each 24 hour period and maximise the heat use that is being delivered. Larger public buildings such as hospitals, care homes and leisure centres are ideal buildings to connect to a heat network as they have more constant 24 hour demand for heat.

Costs

3 The energy mix generating the heat and associated incentives

Currently the cheapest form of generating heat on a network (other than any 'waste' heat from local sources that may be available) is gas CHP. Many heat networks start life as gas fired CHP as this a proven, low risk technology that is relatively easy to finance. Of course, if the heat network is being proposed for an off-gas area, this is unlikely to be an option.

But heat networks can be run on a variety of heat sources, and these may be chosen for their carbon credentials rather than economics alone. The key features of the main heat generating technologies are summarised below:

	NATURAL GAS CHP	BIOMASS	GROUND SOURCE HEAT PUMPS	WASTE HEAT
Indicative cost of heat provision £/kW	750	250	1025	Site specific
Most suitable for	Locations with a gas grid connection close by	Rural locations with good transport links	High density housing, with low peak heat demand. Requires lower network temps	Developments close by
Risk and incentives	Lowest risk investment but not eligible for RHI support	Eligible for RHI support	Eligible for RHI support	Source of waste heat diminishes or stops
Running costs	Minimal maintenance requirement	Relatively high maintenance requirement	Minimal maintenance requirement	Typically slightly less than natural gas
KgC02e/kW	0.18	0.01	0.45	0 for the kW being gathered purely from waste sources

Costs

4 How many connections will there be overall?

Heat networks require more than one building to be connected together via a centralised system, but clearly the more buildings you can connect to the network the more cost efficient it is likely to be. Therefore the ability to encourage, or force buildings to connect, is a fundamental driver in taking the idea off the drawing board and making it a reality.

The technical and economic viability of a scheme depends on a mix of other factors, such as how close together the properties connected to the network are, the demand profiles of the non-residential connections and how much pumping is required. Other influential factors in viability are the pay back period for the project and whether there are requirements for it to help those in fuel poverty to keep their heating costs to a minimum. All of these factors must be considered collectively in deciding whether a heat network should be installed.

The decision to install such a network will always be on a case by case basis, and although the general principles of a heat network are simple, the levers in decision making can vary to such an extent that a network for 2,000 houses in one location may be financially viable, whilst one of the same size in another location may not be. "One size fits all" clearly does not apply to heat networks.

.....the more buildings you can connect to the network the more cost efficient it is likely to be

Who would want a heat network?

There is no one target audience for a heat network project. Heat networks come in all shapes and sizes, ranging from just two properties connected to a single heat source, to new-build housing developments of thousands of homes. The one common factor across all heat networks is the need for local customers to connect, as there is currently no efficient way to move heat across long distances if local customers cannot be found.

Figures released in 2017 from The Department of Business, Energy & Industrial Strategy (BEIS) show that there are over 17,125 existing community heat schemes in the UK benefiting some 210,000 households, with the government predicting this could rise to eight million by 2030.

Heat networks can be designed in at the planning stage of new developments, but they can also be retrofitted to supply existing homes, businesses and communities.

Heat networks and new developments

Many local authorities are encouraging developers to consider installing heat networks for new housing projects as they can form part of a low carbon offering on a development, as well as offer the opportunity in the future to connect to wider networks. However, concerns have been raised by developers and consumers that heat networks do not deliver the energy bill savings that are promised at the outset. The possible reasons for this are many and varied and could include poor design, greater on-site capital costs than envisaged leading to a higher price per unit of heat, a reduced number of buildings connected to the network initially, poor insulation in the system or the buildings, or poor negotiation of contract documentation for the lifetime operation and maintenance of the network.

These concerns may consequently have a negative impact on house prices on a new development, particularly where purchasers of houses find they are tied into an exclusive arrangement (often for many decades) with the heat network provider and they make their grievances known publicly on internet forums. Developers will need to take a measured approach to installing heat networks in order to reassure their customers and to protect their ‘bottom line’. By insisting that installers and contractors follow industry standards (as described later in this paper) developers can provide some protections for themselves and their buyers.

Retrofitted heat networks

Increasingly, housing associations, local authorities and community energy groups are exploring how heat networks could bring value to their buildings and communities for the reasons outlined in the table on the following page.

Around 80% of the houses which will exist in 2050 are already built, therefore retrofit heat network projects will inevitably play an important role in decarbonising our homes.

This coincides with heat networks appearing in more urban areas, where there is the benefit of a high density of buildings. Some buildings might have high heat demands (schools, leisure centres, care homes) and provide a valuable mix of heat consumption across the day. However, there is still significant opportunity for heat networks to be installed in smaller more rural locations.

Who would want a heat network?

Typically, those interested in what heat networks may bring to a community fall into the categories below:

	Lower carbon emissions	Lower heating bills	Improve efficiency	Generate revenue	Fund local benefits	Eliminate boiler maintenance and repair for individual properties
Domestic heating bill payers	■	■	■	□	□	□
Community energy groups	■	■	■	■	■	■
Private estate owners	□	■	■	■	□	□
Housing Associations	□	■	■	■	□	■
Local authorities	■	■	■	■	■	■

Introduction to heat network business models

The generation, transportation and supply of heat are far less regulated than the electricity market despite the fact that recent regulation has been introduced. As a consequence there are no set rules about the best types of business model for heat provision, or who can set up a project. The reduced regulation and fewer licences that are required to own and operate a heat network can however mean that the project development costs could be lower than other energy regulated markets.

Project developers are more or less free to come up with their own business models, however there are a few structures which are usually employed:

ENERGY SERVICES COMPANY (ESCo)

An energy services company (ESCo) (which could be a housing association, local authority, community group or other organisation with a common goal), will agree to supply heat to the customers (domestic and/or commercial). The ESCo will build and operate the district heating system and supply the heat. The ESCo may supply a defined set of buildings or have an agreement to supply heat to developments within a defined area.

WHOLESALE SUPPLY

A single contractor is appointed to design, build, operate and supply wholesale heat. The supplier of the project will sell the heat to the consumers and may be a consumer themselves.

NETWORK DELIVERY AND OPERATION

A developer (such as a property landlord) appoints one or more contractors to design, build, operate and maintain a District Heat Network but the developer remains the asset owner. The developer will also be responsible for the supply of heat to consumers.

NETWORK OPERATION

An operator is appointed to run a District Heating System that has already been constructed and is owned by a party who does not wish to undertake its operation. The contract with the operator may include metering, billing and customer services.

An existing energy supplier (such as SSE) can take on the role of network operator and undertake the management of the heat supply.

How do you choose which of the four models above is most appropriate for a given situation?

Detailed overleaf are some of the considerations which inform a decision on which business model to use. This information is of course not exhaustive and a more detailed assessment would always be needed before a decision is finally made.

Introduction to heat network business models

ESCo

If a developer or project sponsor does not wish to have to design and install a system, because perhaps it does not have the expertise, experience or consumer charging systems to do so, then an ESCo will be a suitable mechanism to use instead. The project sponsor (perhaps a housing developer) will engage with the ESCo and contract it to provide the system to a particular specification and within a particular time frame. The system will be owned by either the developer or the ESCo, but the developer will have no responsibilities for the system.

The contract will need to be of sufficient length to enable the ESCo to be able to fund the development and obtain a return on its investment. There will need to be customers who are of sufficient financial strength to enable a funder to be confident that the project will be financially viable and there must be controls over the ability of customers to disconnect from the system and obtain an alternative supply.

Generally the main contract will have a demand guarantee or some other means of addressing demand risk so that the ESCo can have certainty about the demands of the system and the sizing of the plant that will be required as a consequence. If heat is unpredictable, or it is not possible for a heat demand guarantee to be given, then a concession which provides for exclusivity over a defined area or period of time may be required.

The project sponsor may be required to make capital contributions to the network at the outset, or provide loan financing for it in order that the ESCo can enter into the commitment to supply and run the network.

Consideration needs to be given to scenarios where more than one developer or house builder is to connect to the District Heating System, and in these cases there will need to be a template connection contract which all parties agree to adhere to. This contract will include the connection process and the cost of doing so. Template heat supply contracts will also have to be created at the outset for residential and commercial customers and these will include the prices that can be charged, the service levels that will be delivered, complaints procedures and penalties that apply if service levels are not met.

A Service Level Agreement (SLA) will need to be established between all parties – project sponsor, ESCo, developers and customers. This document will ensure the interests of all parties are aligned and will agree such things as how the network as a whole is to be built and operated, carbon performance, temperatures, reliability and downtime, how connection is to be achieved (including lead times and penalties for any delays) and compensation levels for non-performance. In addition contractual documents must also provide for what happens in the event of default or failure by the ESCo - the project sponsor or a management company will need to have step-in rights in that situation in order to protect the consumer.

Typical contracts required under an ESCo:

- Master/main agreement
- Connection contract
- Heat supply contract
- Service Level Agreement (SLA)
- Property leases

Introduction to heat network business models

WHOLESALE SUPPLY

Under this arrangement the developer contracts with a single party to design, build and operate the plant and supply heat. The plant and network will be owned by that operator as well as the developer will have no further involvement in the network other than a contractual right to demand that heat is being provided for a given period of time. The contractor is often someone that can utilise some of the heat itself for its own business purposes but who also has the desire and capability to become a supplier of heat to consumers.

The main consideration under these types of arrangements is for the developer to be able to ensure that the network will be constructed and for there to be guarantees in regards to supply and pricing. The main contract between the parties will echo a good deal of the issues that apply to the ESCo arrangement, save for the fact that the developer will not have an ongoing involvement with the plant once it has completed the sale of all houses.

All risk for this system lies with the operator.

Typical contracts required under a wholesale supply:

- Master/main agreement
- Connection contract
- Service Level Agreement (SLA)

NETWORK DELIVERY AND OPERATION

This type of arrangement can apply where heat demand is from a limited number of customer types such as council owned buildings, social housing or a shopping centre.

The project sponsor (typically the landlord) will be responsible for the pricing of the heat, the customer interface and usually owns (and pays for) the actual assets.

The owner therefore takes the operating risks of the service, but design risk would sit with the supplier of the system.

This type of arrangement means that the sponsor retains control over the prices paid by customers for the heat and the sponsor, from other activities, may be able to bring economies of scale to bear through lower fuel costs or lower capital costs.

Performance guarantees will be built into the contractual arrangements between the parties and there should be separate design and build (D&B) and operations and maintenance (O&M) contracts, sometimes with different contractors for each contract.

With the sponsor bearing the majority of the risk, the specifications of the D&B and the O&M need to reflect this and be more detailed than under an ESCo arrangement. The system design must be consistent with the sponsor's objectives but the sponsor must bear in mind that the supplier will be designing to the minimum cost to meet the D&B specifications but in a way that will provide the highest possible O&M fees.

Introduction to heat network business models

To mitigate design risk issues an independent review of any designs may be appropriate. If a separate O&M provider is to be used, then consideration should be given to appointing them in sufficient time for them to approve the chosen design and to be involved in the commissioning process. Consideration should also be given to obtaining detailed warranties from the D&B contractor for the operational efficiency of the plant.

Connection and supply contracts will also need to be in place between the project sponsor and the energy customers.

Typical contracts under a Network Delivery and Operation arrangement:

- D&B contract
- O&M contract with SLA
- Metering and billing contract
- Connection contract

NETWORK OPERATION (O&M)

O&M contracts can be appropriate when an existing District Heating Scheme is being upgraded or when a new scheme is being installed by the developer. O&M contracts usually leave the principal risks with the owner of the scheme and are typically of limited duration – this acts as an incentive for the O&M contractor to run the scheme efficiently.

These types of contract tend not to have any link to the maximisation of revenues and therefore, alternative ways of incentivising the O&M provider need to be found. ESCo and Design Build and Operate (DBO) contractors usually face penalties for poor performance but it would be unusual for an O&M contractor to agree to penalty clauses as contract values tend to be smaller.

Combined Heat and Power (CHP) units can be complex to operate efficiently and require careful attention to detail so agreeing an O&M contract to cover these issues will require detailed negotiation.

Typical contracts under an O&M operation are:

- O&M contract with SLA
- Metering and billing contract

O&M contracts usually leave the principal risks with the owner of the scheme

Consumer protection and the Heat Trust

Once a customer has connected to a heat network, there is likely to be no opportunity for them to switch to a different supplier for their heat. This is different to a situation where each person has their own boiler plant which may be run on electricity, gas or any other fuel such as LPG, biomass or oil. This has recently raised concerns that there are insufficient protections for customers who use heat networks. In addition there is a lack of transparency around whether customers connect to heat networks on the presumption of making savings on their energy bills or whether the motivations lie around the environmental benefits that may be achieved. There has also been much discussion about whether individual networks actually achieve the savings that are initially forecast.

In 2015, a voluntary scheme was launched to help protect the interests of households and small businesses that are connected to heat networks. Heat Trust[2] protection is aimed at heat energy suppliers who hold the contracts with the customer and although voluntary, is backed by the UK government and industry. The scheme sets customer service standards and consumer protection requirements that heat suppliers are expected to meet, including an independent process for settling disputes.

The scheme has established Compliance Criteria in the following areas:

- Heat Supply Agreements
- Complaints and the Energy Ombudsman
- Faults and interruptions
- Billing and payments
- Vulnerable customers
- Customer communication

It is a reasonable expectation that all new District Heating Schemes should meet the standards laid down by the Heat Trust and if a heat supplier does not aspire to these standards one would question why not. Whilst adherence to the Heat Trust Scheme will not provide any guarantees about the size or reasonableness of the energy bills that consumers will pay, it is hoped that adherence to the minimum standards will go a considerable way towards keeping bills at an affordable level for the average consumer.

The scheme sets customer service standards and consumer protection requirements that heat suppliers are expected to meet

2
http://www.heattrust.org/

Understanding the legal landscape

With any District Heating Scheme there are complex legal contracts to be entered into and legal structures to be created. These will cover a significant number of different issues, but generally speaking will fall within two different categories:

Works elements

- Design
- Construction and connection of premises
- Financing

Services elements

- Energy purchase
- Generation of heat
- Operation and maintenance
- Metering and billing
- Connection of new customers
- Supply of heat to connected customers
- Customer services

Some common contractual issues

1 Metering and billing

Where an ESCo contract is not in place, separate contract documents are required to manage metering and billing and the relationship with the customer.

Local authorities and large scale landlords may already have the existing infrastructure to organise metering, billing, payment and customer services, but there are a number of specialist firms who provide these services – for a fee. What the specialist providers will not do however is accept any credit risk.

2 New connections

The connection contract will set out the terms on which new connections can be made. New connections can involve disruption to operations and put performance standards at risk, which means that complex contract negotiations can be required to ensure that later connections to a system can be made. Performance targets for new connections should therefore be included within the contract.

There are strong policy drivers to encourage the growth of heat networks once they are up and running. What the contracts must do is ensure that all stakeholders are incentivised to extend a District Heating Scheme. The ways of doing this can include:

- Planning conditions for new developments that require them to connect to an existing District Heating Scheme (assuming it is nearby of course)

- Placing an obligation on the operator to connect new customers on standard terms where the premises to be connected are within a set distance of the existing scheme. This spreads the additional costs of new connections over all connected customers

- Providing finance for the cost of new connections

Understanding the legal landscape

3 Contract boundaries

Defining the point of connection between the District Heating Scheme and the customer's own heating scheme is an essential component of all contracts.

Usually under an ESCo arrangement the ESCo will own, and be responsible for, the whole network up to and including the HIU. It is in the financial interests of the ESCo to ensure the network is operating efficiently and to be responsible for its maintenance. Under this arrangement the point of connection is the valve on the customer side of the HIU.

A developer may decide to own the secondary network and therefore have control over all the building services. The point of connection under this arrangement would be a valve on the building side of the substation serving the building.

DBO and O&M contractors are not in the same position as ESCos and therefore responsibility for HIU maintenance should lie with the building management who are likely to be responsible for the distribution of heat within the building. Structured in this way DBO or O&M providers do not require access rights to the actual building.

Commercial properties are more likely to expect the point of connection to a District Heating Network to be a substation in the basement of the premises and from this point the distribution of heat around the building will take place as part of the duties of the property managers. The point of connection will thus be the building side of the substation.

Schematic drawings of the District Heating Scheme should identify where contract boundaries will exist and it is important that these drawings are reviewed as part of the contract process.

A developer may decide to own the secondary network and therefore have control over all the building services

Understanding the legal landscape

4 Heat supply agreements

There are standard terms that should be included in any agreement where the heat supply is through an ESCo. These standard terms include:

SUPPLY AGREEMENT HEADING	OUTLINE OF CONTENTS
The served premises	Identification of the address to be supplied and contact details of the customer.
Supply dates	Date of the Agreement; date of first supply, if different; duration of the Agreement.
Charges for heat	Fixed charge; variable charge; other charges that may be applied e.g. in the event of temporary disconnection.
Annual price review procedure	Description of the procedure the ESCo will follow each year to revise the charges. This will typically be a formula linked to the prevailing rate of price inflation and/or gas price inflation, and the price of a comparable boiler maintenance contract with equivalent terms (e.g. no excess).
Reading the meter	Frequency and method of meter reading; customer access to the meter and to consumption data; what to do if the meter reading is disputed, or the meter fails.
Billing procedure	Frequency of billing (not necessarily the same as for the meter reading); content and format of the bill; methods of payment; time to pay; penalty for late payment; what to do if the amount owed is disputed. Where credit risk is a concern; it is important to provide some means of pre-payment, either through pre-payment meter or a method of keeping an account in credit. The Agreement would specify the conditions which would trigger a switch from payment in arrears to an in-credit arrangement. In general, pre-payment should not result in a higher charge.
Data protection	What the ESCo may do with the consumption data, with the customer's payment information and the contact details.
Standards of service	The temperature of the heat to be supplied and permitted variation; permitted downtime and notification process; other performance standards; method of reporting performance; penalties for non-compliance. It is usual for standards of service and penalties for non-compliance to be set out in a separate document which can be updated without requiring all supply agreements to be revised. It is also good practice to make this information available in plain language for residential customers.
Changes to the service	Procedure for the ESCo to notify changes in the service to be provided (other than a price change). Procedure for the customer to request a change to the service to be provided, and the method for calculating any charges that may apply.

Understanding the legal landscape

SUPPLY AGREEMENT HEADING	OUTLINE OF CONTENTS
Moving house	Procedure for the customer to follow when leaving the premises and handing over the Agreement to another person.
Access	Procedure for the ESCo wishing to gain access to the served premises (if necessary).
Liabilities	Listing of the liabilities of the ESCo and the customer (e.g. for death or injury, for damage to the property) and any limits on liability.
Suspension and termination	The reasons and procedure for suspending the Agreement (e.g. due to absence from the property or failure to pay bills. The reasons and procedure for terminating the Agreement (e.g. ESCo's failure to perform). Protection for vulnerable customer groups.
The District Energy System	Description of the District Energy System and of the connection of the premises to it (e.g. capacity).
Residential HIU	Whether the HIU will be located inside or outside flats and houses. Whether the ESCo, the landlord or the customer will be responsible for the maintenance, repair and replacement of the HIU. Arrangements for inspection, repair and replacement of the heat meter if attached to the HIU.
Quality of service	• Flow temperature of heat • Supply interruptions • Response time to reports of supply failure • Aspects of billing performance

Technical standards for heat networks

Historically District Heating Schemes in the UK have encountered some common challenges, including:

- Heat costs to customers not clear at the beginning of a project
- Minimising initial capital costs at the expense of long term operating costs
- High heat losses within the network
- Project assets incorrectly sized
- Poor communication and strategic working between the stakeholders in a network (contractor, heat supplier, customer and building operator)

The Heat Network Code of Practice has been established to address these issues and has been developed by Chartered Institution of Building Services Engineers (CIBSE) and The Association for Decentralised Energy (ADE) and was launched in June 2015.

The Code of Practice is ‘work in progress’ as no formal accreditation process, nor accountability path, is yet in place. However developers, Planning Authorities and ESCos can specify that the Code of Practice is going to be followed.

The Code of Practice breaks a District Heating Scheme project into seven key stages:

1. Preparation and brief
2. Feasibility
3. Design
4. Construction
5. Commissioning
6. Operation and maintenance
7. Customer expectations and obligations

The objective of the Code is to deliver safe, high quality schemes that have been correctly sized and with low heat network losses. This should lead to cost efficiencies being achieved for the project and ultimately the consumer.

A developer would be prudent to include the Code of Practice in project briefs and specifications and ESCo’s in particular may want to do this to demonstrate the quality of their offering.

CIBSE and ADE have developed a Code of Practice checklist which:

a. Provides a methodology that clients and their advisers can use to assess if the Code of Practice standards have been met

b. Creates an audit trail and evidence pack across all stages of a development which makes integration of the supply chain easier

c. Provides for performance measurement against targets throughout the project

The future of heat

In the 200 years since gas was first introduced into the UK, it has become the primary source of heating for the bulk of householders and many businesses. In the 1970's, just a quarter of homes had central heating, but by 1990 this had risen to nearly three quarters and by 2011 90% of homes had installed central heating.

Because of of the UK's access to North Sea natural gas, low-cost home grown sources of alternative relatively cheap heat have been more restricted. But in 2014, the UK imported 57% of the 70 billion cubic meters of total gas consumed, with imports likely to increase as more UK natural gas fields are closed. This has a direct impact on the energy trilemma often highlighted by government and industry - providing secure, cost-effective and sustainable energy. Clearly, there has to be a transition from natural gas providing the bulk of our heating to more sustainable solutions.

This is likely to mean a more portfolio based approach to our heating needs which uses the assets that UK PLC already has and embraces a more 'multi-vector' attitude to our infrastructure and their interconnection, thinking holistically about our electricity, gas and heat networks working together.

In this sense, heat networks are an enabling technology as they are a heat generator that has no preference for the fuel that drives the central boiler plant. They can be used to provide not only heat but also electricity and they can reduce our dependence upon imported gas.

The UK is already steadily increasing the proportion of biogas which flows through the gas grid and is exploring how this country-wide network could be re-purposed to continue providing fuel on-tap.

More immediate targets are continuing to drive innovation and investment in renewable and more efficient heating in the UK. The Renewable Heat Incentive (RHI) has been confirmed to run until 2021 and is tasked with increasing the share of heat generated from renewables from just 2% (2015) to 12% by 2020.

The recent upheaval in UK politics has created many uncertainties around the future of energy policy and the relationship with international energy markets. But critically, two facts remain:

1. The UK continues to have a high heat demand to meet and an obligation to meet it with increasingly sustainable fuels.

2. Heat networks are long term assets that as at the date of this guide continue to receive incentives (unlike other renewable technologies such as solar and wind). As at September 2017 heat networks are attracting official support through the government's Heat Network Infrastructure Project which will deliver £320M of funds up until 2021 to build new heat networks and there is also additional funding available through the Energy Company Obligation scheme which is available until September 2018 and which is administered by OFGEM.

The future looks positive.

Conclusion

Heat networks can provide a viable low carbon solution to the heat demand issues that the UK faces, particularly in light of the reduction of natural gas supplies within UK shores and the demand for more heat as a greater number of houses are built. These systems are capital intensive and can be complex to set up, but with the right ethos and a determination to see these projects from a long term perspective rather than a short term financial viewpoint, heat networks surely must be viewed as a viable and realistic solution to the needs of the country.

The growth of heat networks will require successive governments to provide encouragement and support by implementing changes in central and local government policy and the continued use of financial levers such as subsidies and grants.

With the challenges of climate change it has never been more important for the UK to have a co-ordinated energy policy which takes a 50 year view of our energy needs rather than a five year parliamentary cycle viewpoint. With this long term plan UK PLC would become more energy self-sufficient and also more efficient in its use of world’s finite resources.