HARROW
FUTURE BUSINESS MODELS

Developed for Harrow Council
By Michael King,
District Energy Development Ltd
August 2016

HARROW:
Future Business models

Developed for Harrow Council
By Michael King, District Energy Development Ltd

August 2016

This report was written by Michael King, District Energy Development Ltd, with Martin Crane, Carbon Alternatives.

We are grateful for the advice and assistance of David Hughes and Philip Crowther.

Contents

Executive Summary

Harrow Council acknowledges the impact of climate change on the borough. It has been building a policy approach to addressing this challenge through the Local Development Framework, which complements the London Plan in seeking to promote the development of decentralised energy. In particular the intensification within the Harrow & Wealdstone area is considered to offer the potential for district heat networks. An Area Action Plan has been developed that requires major new buildings in the area to contribute to the provision of a heat network and connect to it if proven to be feasible. Prior to the network's development or extension new buildings must make provision for later connection.

In order to test the feasibility Harrow Council obtained support from the GLA's DEPDU Programme and DECC's HNDU to commission an Energy Master Plan for the area. Although outside the Harrow & Wealdstone area the Grange Farm Estate development was included within the study as significant development is planned in the near future.

The Energy Master Plan indentified two clusters – North and South - in the Harrow & Wealdstone area as feasible and potentially viable. Although they did not deliver sufficient returns on capital to attract interest from commercial energy services companies they could potentially be delivered with municipal investment.

A heat network serving the Grange Farm development barely provided a positive return on capital. As such it was considered not to be an opportunity for municipal investment. However, the size of the development was over the threshold for reference to the GLA and under the London Plan a heat network will be required. As this development is due to commence this year the Council's Housing Department is therefore proceeding with the procurement of the commercial energy services company to provide it. The drivers for this approach are the speed of delivery and to secure an investment contribution to the overall project budget.

The Council's Planning Department wished to consider the most appropriate approach to develop the North and South Clusters within the Harrow & Wealdstone action area. As such there is the potential to link with the approach being developed at Grange Farm. In order to address these opportunities Harrow Council engaged Michael King (District Energy Development Ltd) and Martin Crane (Carbon Alternatives) to consider the most appropriate organisational structure to take forward heat networks on both a site-wide basis and at a broader area level and to provide advice on a route forward including key tasks, timeframes and resources required to advance the preferred option. Additionally they were invited to work with the Grange Farm engineering consultants to provide technical and other input into the Grange Farm tender to commercial energy services companies.

Michael King and Martin Crane met with various stakeholders within the Council and hosted a workshop. This presented the range of business models currently used to deliver and operate heat network projects elsewhere within the UK along with the advantages and disadvantages of each approach. The workshop also explored the stakeholders' attitude to risk and desire for control and undertook an exercise to determine the overall Council objectives for the heat network projects. These were identified in priority as:

- Providing revenues stream to the Council (scoring 4.5 out of 5 marks)
- Providing affordable heat for customers (scoring 4.0 out of 5 marks)
- Deliver carbon reductions (scoring 2.0 out of 5 marks)

Taking these findings into account it was determined that a **wholly-owned external special purpose vehicle** was the approach best suited to the Council's objectives and attitudes as well as the nature of development within the cluster areas. The reasons being:

- The rate of return provided by both clusters was below the threshold for commercial investors but above the threshold for municipal investors able to access the PWLB
- The Council is prepared to borrow to invest and accept risk if the project is right
- The Council has adopted an arm's length approach on other ventures
- This approach allows focussed management, a separate budget an isolates risk
- The desire to secure revenues mitigates against sharing ownership with a 3rd party
- The desire to provide affordable warmth requires the cheapest cost of capital and the ability to exercise control over the charging and tariff structure (note that the desire for revenues and the provision of affordable heat conflict and will need to be balanced in the construction of the charging and tariff structure).
- The contractual inflexibility of a commercial energy services approach does not fit well with the incremental evolution of heat networks on the North & South Clusters

The procurement of a commercial energy services company for the delivery of the heat network at Grange Farm should proceed in order to meet the timelines of the Housing Department for the project. However, whilst it is considered highly unlikely that a commercial energy services company will invest to fully fund the heat network via a '*design, build, finance & operate'* contract due to the very low rate of return available, that this approach should continue in order to understand what contribution it is willing to make. This will allow a much more robust assessment of the project's financial and commercial aspects.

In parallel the Council should recognise the project budget has a hole and provide the necessary funding as it can access the capital more cheaply than a commercial company. The procurement should then proceed as a *'design, build'* contract with a separate *'operate and maintain'* contract for a short term up to 10 years. To this end Martin Crane met with the technical consultants for the project to align the technical specification. Thereafter the assets should be rolled into the wholly-owned special purpose vehicle which will then be sufficiently well established to take over its operation and management.

1. Background

1.1 What is district heating?

District or community heating is a system for providing space heating and domestic hot water to buildings from a central heat generator or heat source via a network of highly insulated pipes, usually buried underground. By aggregating the varying but complimentary demand loads of different types of building users (residential, commercial and institutional) heat networks are able to optimise the efficiency of the central plant.

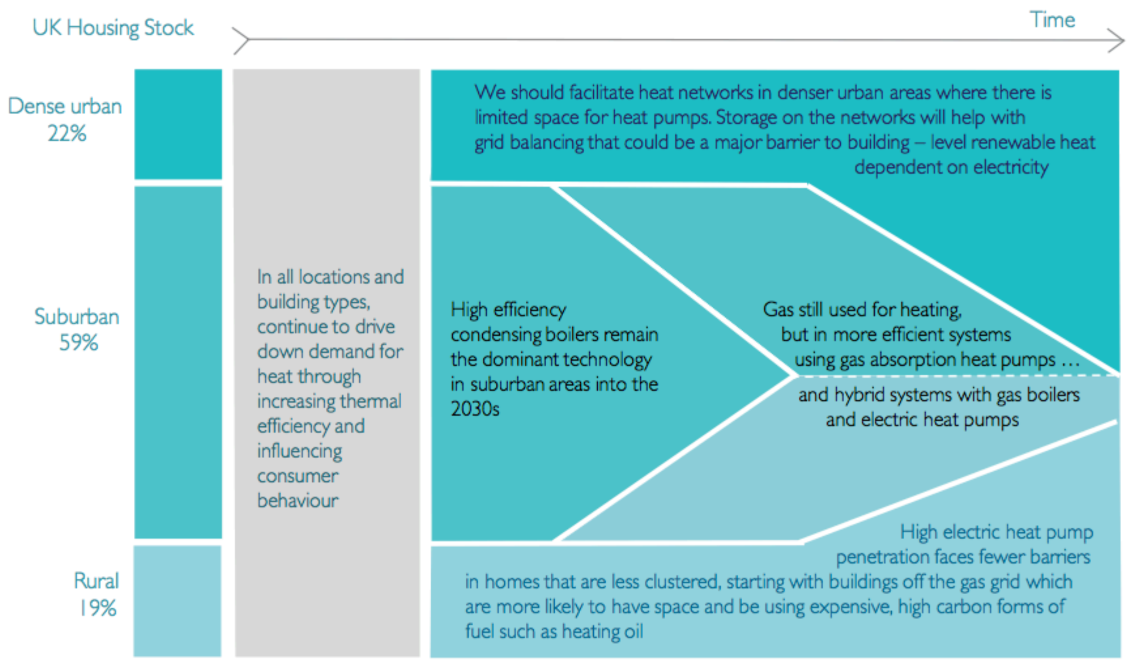
The key requirements for heat networks are:

- Sufficient heat density that is analogous to building density. Close proximity of buildings reduces the length of pipe runs to connect them and consequently increases potential revenues relative to the capital investment required. Studies have identified the critical threshold to be heat densities above 3MW/km^2 (*Poyry/Faber Maunsell 2011*)
- Demand diversity with a range of users with complementary load profiles. Different types of consumer – such as residential, commercial or leisure - have consumption profiles specific to them over the course of a day and over the seasons of a year. These typically complement each other, for example residential demand is highest in the early morning and evening whereas commercial demand is during office hours of the day. Such complementing load profiles smooth out peaks and troughs in overall demand reducing the need for capital investment to meet it.
- The presence of anchor loads. These are buildings with a large steady demand for heat such as hospitals, hotels and swimming pools. These allow the smooth and steady utilisation of generation plant, such as boilers and CHP, optimising their fuel efficiency and reducing '*wear and tear*' maintenance requirements.

Typically such networks are served by high efficiency Combined Heat and Power units (CHP), which produce electricity as well as heat. They can also be used to exploit renewable sources of heat such as geothermal wells, solar thermal arrays and heat pumps as well as waste heat produced as a by-product of power generation including energy from waste plants. Heat networks can exploit such heat sources that are otherwise too large to connect to individual buildings. The Greater London Authority (GLA) has published a study that has found that there is enough waste heat available from industrial or commercial activities or present in the natural environment to supply more than London's total heating demand (*London's zero carbon energy resource: Secondary Heat* GLA July 2013).

1.2 Government policy and support.
These features of efficiency and scale mean that district heating can potentially reduce the carbon emissions associated with the provision of heat in buildings. It has therefore been identified by the Department of Energy & Climate Change (DECC) as a means of delivering the Government's ambition to substantially de-carbonise the heat sector by 2050 (*The Future of Heating* DECC 2013). At present it is estimated that only 2% of buildings in the UK are connected to heat networks. Whereas in other Northern European countries it is much higher, reaching over 90% of all buildings in Scandinavian cities such as Copenhagen, Helsinki and Stockholm. DECC modelling suggests district heating could supply 7% of domestic space heating and hot water demand by 2030 rising to 14% by 2050 and 7% of space heating and hot water demand in non-domestic buildings by 2030 rising to 9% by 2050, a total of 27 TWh by 2030 and 52 TWh by 2050 (RESOM, DECC 2013).

DECC anticipates that heat networks will develop in densely populated urban areas which contain the three requisites for their development identified above. In sparsely populated rural areas it expects that the dominant heating technology will be electrically driven heat pumps, made possibly by the de-carbonisation of the electricity supply system. There will be a residual role for gas-fired boilers in medium density suburban areas until heat networks and heat pumps expanding out of their core areas squeeze these out. This vision is illuminated in the following diagram.



DECC has identified a critical role for local authorities in achieving this ambition. In 2013 it established the Heat Networks Delivery Unit (HNDU) to support councils in identifying opportunities for heat networks within their areas and for their initial development. HNDU are supporting over 180 projects across England and Wales. DECC are currently developing a Heat Network Investment Programme to provide £320m of capital funding for such projects.

1.3 Greater London Authority
Greater London Authority (GLA) is the strategic regional authority for London. It has an overarching spatial development strategy known as the London Plan. This provides a London-wide strategic context which boroughs must reflect in their local plans and covers a wide range of issues including energy. New buildings must conform to a hierarchy to be:

- lean (by using less energy),
- clean (by supplying energy efficiently) and
- green (by using renewable energy).

It also sets out a policy target to achieve 25% of heat and power in London to be supplied through local decentralised energy systems by 2025. In support of this policy new building over 30m in height or over 150 residential units are referable to the GLA for a decision. An energy statement detailing how the building will be supplied with energy must accompany planning applications. This should conform to the following heat hierarchy:

- connect to existing heating and cooling networks
- site wide CHP networks
- communal heating and cooling

Below the threshold for reference to the GLA the London Plan provides guidance for boroughs on the development of their local development framework. This suggests policies that:

- identify and safeguard existing heating and cooling networks
- identify opportunities for extending existing networks & establishing new networks
- develop energy master plans for specific decentralised energy opportunities
- require developers to prioritise connection to existing or planned decentralised energy networks where feasible

GLA also instituted a support programme to assist boroughs in the development of decentralised energy projects. Known as the Decentralised Energy Project Support Unit (DEPDU) this 3-year ELENA-funded programme provided support in heat mapping, master planning, policy development and high level feasibility studies. DEPDU has now ended and the GLA is developing a successor programme to be called *Energy for London*.

1.4 Harrow Core Strategy
Harrow Council acknowledges the impact of climate change on the borough. It has developed a local development framework, which complements the London Plan in seeking:

> "*to promote and secure opportunities for decentralised energy, especially within the Harrow and Wealdstone Intensification Area*"

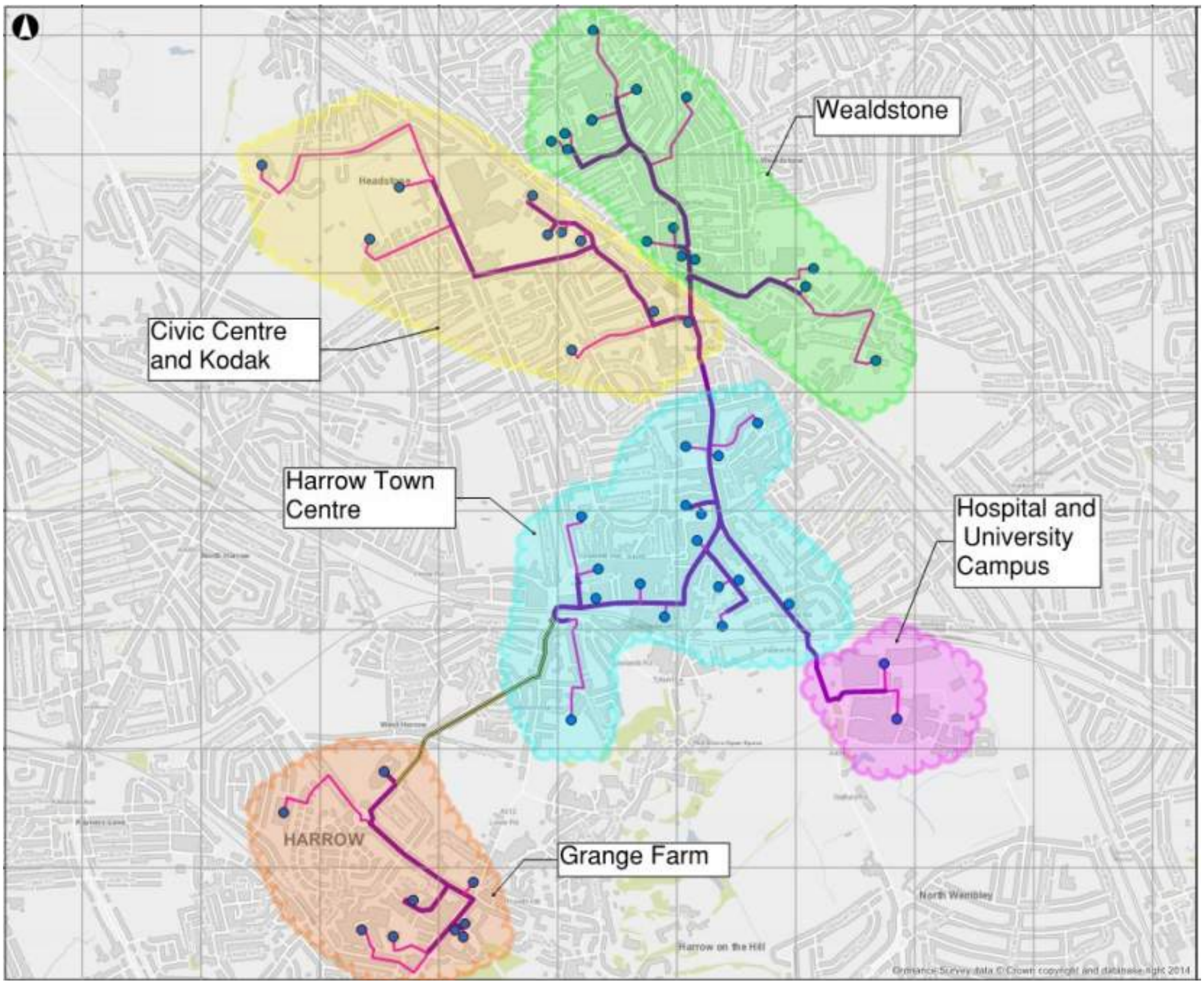
Within the Area Action Plan for Harrow & Wealdstone it has stated:

> *"The physical and financial feasibility of an area-wide CHP scheme will be explored as part of the work to prepare the Harrow & Wealdstone Area Action Plan. In the event that the feasibility of the scheme is proven, major new development will be required to connect to the network unless there are demonstrable viability or other practical reasons not to do so".*

Consequently the Council has adopted as Core Policy CS2 in the Area Action Plan:

> *"Subject to feasibility being proven through the Area Action Plan, all major development within the Intensification Area will be expected to contribute to the provision of a district-wide combined heat and power network. Prior to the network being installed or extended, new development will be required to make provision for future connection to the network"*

1.5 Energy Masterplan for Harrow & Wealdstone and Grange Farm
In order to investigate the feasibility of a district heating network within the Harrow & Wealdstone Opportunity Area as outlined in the Action Area Plan the Council obtained support from the GLA's DEPDU programme and HNDU to commission engineering consultants Ove Arup to undertake an energy masterplan for the area. The Grange Farm housing estate lies outside the area but was included as it will be the subject of major re-development in the near future. This study was completed in January 2016.



It concluded that whilst heat networks serving two clusters with the Harrow & Wealdstone Opportunity Area are technically feasible and financially viable, they are not at present able to provide a return on capital that is sufficiently high enough to attract the interest of commercial Energy Service Companies. Whilst this modelling is necessarily high level and further detailed analysis is likely to improve the rate of return it is unlikely to achieve the hurdle rates required for private sector investment. However, it could be possible to proceed with a project to develop these opportunities if they were able access to lower cost public funding. Therefore the study concluded that the Council would need to take the lead with a municipal-owned delivery option.

A heat network at Grange Farm was found to deliver a positive rate of return, but below municipal thresholds. Although it is anticipated detailed design will improve the rate-of-return, as the re-development of Grange Farm will provide 550 new homes it will be above the GLA's threshold and will consequently be obliged by the London Plan to include a site-wide heat network. Whilst currently proposed to be a completely separate network, it could potentially be included within the delivery option focussed on the two more attractive heat clusters.

1.6 Objectives

In order to consider the available delivery options in more detail, Harrow Council engaged Michael King (District Energy Development Ltd) and Martin Crane (Carbon Alternatives) to:

- Consider and provide recommendations on the most appropriate organisational structure or form of ESCO to take forward heat networks on both a site-wide basis on the larger Council owned sites, and at a broader area level.

- Provide advice, including key tasks, timeframes and resources required to advance the preferred option.

- Work with the Grange Farm engineering / energy consultants to provide technical and other input into the Grange Farm ITT based on the outcomes of the above.

2. Business Models – key concepts

2.1. There are a wide range of ownership and management models for a heat network project. They essentially range from a purely public sector venture to a purely private sector project. In between, a range of hybrid options involving both private and public sector financing, design, operation, fuel supply, day-to-day management and decision-making are possible.

2.2. The key differentiating factors are:

- The degree of control required via governance to direct the project towards its objectives (for example, maximising revenue streams, addressing fuel poverty, carbon reduction etc).
- The degree of risk the project sponsor is willing to carry in order to exercise that control.
- The return on investment the project is able to deliver relative to the sources of capital available.

Fig 1 below summarises this range.

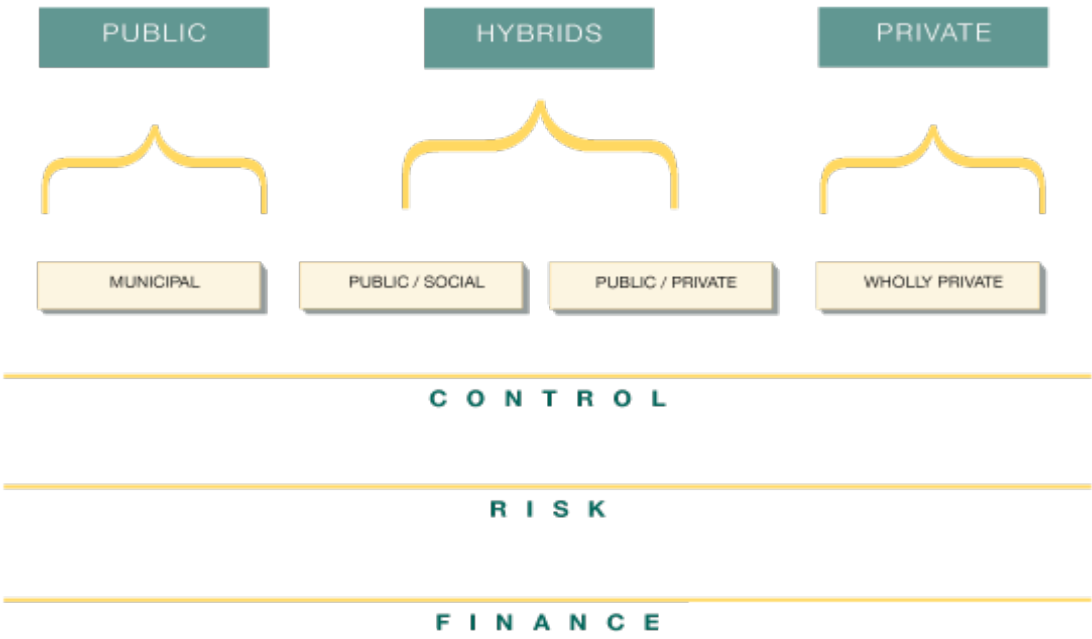


Fig 1: Ownership and management options

As this **Fig 1** indicates, the level of control / risk / investment required, and expected rates of return define the choice of delivery model. There are examples of all three main models – public, private and hybrids – in the UK with a number of variations according to local circumstances.

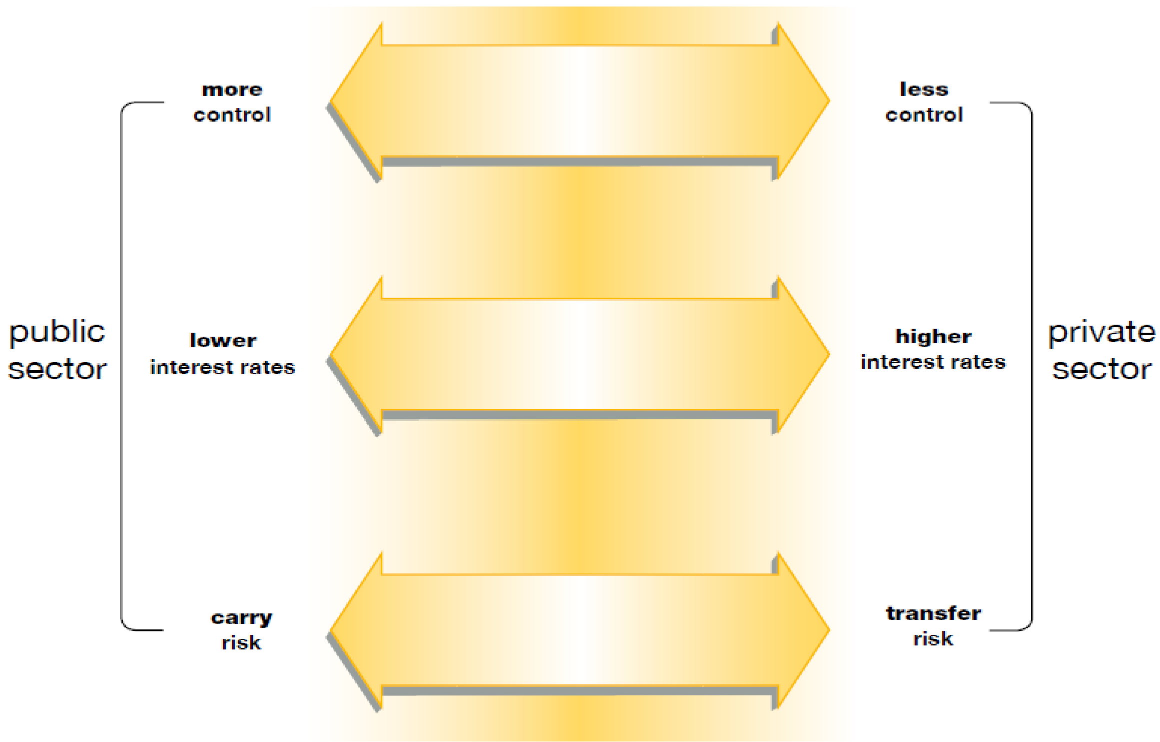
Essentially, the critical decision is identifying the objectives for the project. These may be carbon reduction, affordable energy or economic development with local jobs. Increasingly local authorities are concerned with energy security to improve the resilience of their areas in the face of a variety of challenges ranging from severe weather events to economic volatility. For others it may be a purely commercial enterprise to secure revenues for the host local authority. Whilst localised energy can contribute to achieving all of these objectives it is important to prioritise them, as this will define the degree of control that needs to be exercised over the project in order for it to deliver the desired outcomes.

For local authorities the degree of control is maximised the closer ownership sits to them and minimised the further away it resides. Within London the key objective may be to deliver the GLA requirement for district heating, such that planning permission is granted, at minimum additional cost to the development.

Thereafter the model chosen is fundamentally about access to and use of capital for the initial and subsequent investments. Private-owned ESCO's will use commercial or corporate debt and will therefore require a return on capital in the range of 12 – 15%. If the project cannot physically deliver an IRR to match this expectation then this route is closed off unless the host organisation is prepared to make a capital injection to improve the rate of return. In contrast local authorities and universities can access low cost capital through the PWLB (3.5%) and therefore projects with a 6% IRR will be financially viable. Hybrids sit between these two positions and will depend on the structuring of debt and equity particularly if it is split between two or more parties (such as a joint venture).

Investors, lenders and contractors participating in a project take account of risk when calculating their fee or return on capital. Lowering specific or overall risk will therefore reduce costs and managing the risks of a project is therefore an important activity that needs to be addressed in a dedicated workshop. Risk is a good thing conceptually because it focuses attention on the important aspects of the project, whether that is the initial design, the technology choice and performance of the technology, the access and guarantees over fuel prices and supplies, the level of maintenance, heat pricing formula, or dealing with bad debts and uncertain heat loads. This helps to prioritise actions to mitigate these risks. It is important to note that risks can be managed for all of these and other risks.

In conclusion, the decision on the choice of governance model is mediated through these three elements of control, cost of capital and risk and can be summarised in the following diagram.



3. Business Models – main types in use

3.1 Private Commercial Approach

There are two approaches to heat network projects favoured by private commercial energy companies. Such companies will be seeking returns on capital between 12 – 15% on both approaches. Based on work to date, and whilst more detailed work is likely to result in improved rates of return, it is unlikely that the clusters will achieve this level.

Full ownership

This option is generally only open to fully built-out projects with a number of years' operational track record. By this point costs and revenues variations characteristic of the development phase have stabilised and the project has been de-risked. Investors will easily be able to determine whether the project will provide a stable return on capital for their investment. However, as heat networks are unregulated they will require a higher rate of return than is typical for other energy investments. The project will be owned in perpetuity by the investors. If that is a large energy company the management and operation & maintenance of the project will be taken in house. Non-energy company investors will typically contract out activities to specialist companies.

In a recent example Ignis Energy, the owner and operator of the Wick District Heating Scheme, was bought out 100% by the Green Investment Bank and Equitex for £10 million. Management and operation & maintenance have been contracted out. http://www.theade.co.uk/gib-and-equitix-commit-10m-to-expansion-of-wick-district-heating-scheme_3870.html

This approach is a fully private model as the public sector has minimal involvement.

Concession approach

Under this approach project sponsors, typically public sector organisations such as local authorities, procure a commercial energy services company (ESCO) to provide heating for a specified number of their buildings over a fixed term of 20 – 40 years. Guaranteeing the heat demand over a long period allows the commercial energy services companies to design build finance and operate & maintain (DBFO) the project over the course of the term. At the end of the term the assets revert to the project sponsor who then has the option on whether to: re-tender for a fresh concession; take direct control of the project; sell it to a private sector investor. Examples of this approach are the Birmingham District Energy Scheme (BDES) http://www.cofely-gdfsuez.co.uk/solutions/district-energy/district-energy-schemes/birmingham-district-energy/ and the Leicester District Energy Scheme (LDES) http://www.cofely-gdfsuez.co.uk/solutions/district-energy/district-energy-schemes/leicester-district-energy/

This approach can be considered a public/private model as the public sector initiates the project, undertakes initial development before procuring a private operator. Furthermore it will typically guarantee the long-term heat loads. Lastly, the assets are returned at the end of term.

Advantages

- External financing
- Achieves carbon savings
- Technical and commercial risk transferred to external operator
- Third party provides necessary skills
- Private sector procurement (shorter)

Disadvantages

- Loss of control – operator typically does not want to extend beyond original specification
- High heat charges for users – more expensive overall because of need provide high returns
- Reputational risk – users see project sponsor as guarantor of last resort in conflict situations
- Reputational risk – sponsor promotes building connections that operator fails to take up
- Loss of flexibility – operator not willing to accept heat from sources not under its control or connect customers where cost of connection exceeds higher hurdle rate.

3.2 Public Sector approach

There are two potential models: fully integrated within the sponsoring organisation as an internal department or; as a wholly owned special purpose vehicle (SPV).

3.2.1 *Internal Department*

The former can accept a low return on capital due to its ability to access low cost public finance such as the Public Works Loan Board (3.5%). Consequently projects can be viable with an IRR as low as 6% - although the threshold varies between different public bodies. Whilst this approach provides perfect alignment with the project sponsor's strategic objectives it must also carry the risk of project development and operation, although risk can be contractually offset to commercial sub-contractors procured to deliver specific tasks. As risk is retained within the host organisation cost is reduced, particularly if design and construction are separated in a design bid build contract (DBB) where one contractor according to a design specification provided by a separate contractor carries out construction. Alternatively, they can be packaged into a design build (DB) or design build operate & maintain (DBOM) contracts but the greater risk carried in these contracts, by the contractor, will result in a higher cost.

An example is Bunhill Heat & Power, which is a recent heat network project, developed internally by Islington Council. http://www.islington.gov.uk/services/parks-environment/sustainability/energy-services/Pages/bunhill-heat-power.aspx Initial design and build and thereafter operation and maintenance of the plant and network have been contracted out to specialist companies in two separate contracts (design & build and operate & maintain).

If the heat customers are other public sector entities then the project could be exempted from the need to competitive tendering by invoking a Teckal exemption under OJEU requirements. This will reduce commercial risk.

Advantages

- Can access lower cost public sector financing
- Delivers affordable tariffs
- Achieves carbon savings
- High degree of control allows flexible development
- Avoids Corporation Tax
- Technical risk contractually outsourced to external operator

Disadvantages

- Must provide financing
- Relies on budget and covenant strength of host organisation
- Must carry commercial and reputational risk
- Political risk (e.g. policy shifts due the changes in political administration or central government policy regarding local government)

- Need to develop internal skills
- Public sector procurement (longer)

3.2.2 *Wholly owned Special Purpose Vehicle (SPV)*
This is typically established as a company limited by guarantee based on shares owned by the sponsoring organisation. It can also secure low cost public finance via its public sector owner, particularly if its heat customers are other public entities. But in order to capture this advantage the sponsoring public body must put in place an explicit guarantee to underwrite the SPV. However, if heat customers are private entities then any on-lending will be subject to State Aid Rules http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52008XC0119(01). An example is Upper Lee Valley Heat Network Ltd http://www.enfield.gov.uk/lvhn/

Advantages

- Can access lower cost public sector financing
- Delivers affordable tariffs
- Achieves carbon savings
- High degree of control allows flexible development
- Technical risk contractually outsourced to external operator
- Arms length nature insulates against political risk
- Separate business plan and budget from host organisation and focussed management

Disadvantages

- Must provide financing
- Must carry commercial and reputational risk
- Must comply with public sector procurement methodologies
- Liable for corporation tax

3.3 Joint venture
This is typically established as a company limited by guarantee based on shares with ownership of those shares allocated to one or more partners dependent on equity invested by each partner. This equity may take the form of cash, other forms of equity such as land, or expertise and skills.

The advantages and disadvantages of this approach will depend on the nature of the partners. For example, a public sector partner may contribute equity in the form of land and may provide access to lower cost debt capital. A private sector partner, typically an energy company, may provide skills and expertise, shorter private sector procurement and access to external capital. Although such capital will be at a higher cost it can be mixed with public sector capital to achieve a blended rate.

An example of this approach was Thameswey Energy Ltd. http://www.thamesweyenergy.co.uk/

This was established as a joint venture between Woking Council and a Danish investment foundation originally owned on a 20/80% equity split. However, Woking Council progressively bought out its private sector partner and Thameswey is now a wholly owned municipal SPV.

Advantages

- Can draw on public and private sector financing to achieve a blended rate
- Achieves carbon savings
- Medium degree of control allows flexible development
- Risk shared between partners
- Arms length nature insulates against political risk
- Separate business plan and budget from host organisation and focussed management
- Can choose private sector procurement route (dependent of equity division)

Disadvantages

- Legal complexity in set up and negotiating the relationship between partners
- Possible early exit by partner may compromise strategic objectives and constrain flexibility
- Tariffs reflect return on capital required
- Must comply with public sector procurement methodologies (dependent of equity division)
- Liable for corporation tax

3.4 Community ownership

This approach could be considered a public/social model. It is more common in other European countries such as Denmark where heat customers become members of a cooperative that owns the physical system. They can vote for representatives who select the board members that control the company. This can also be formed as a company limited by guarantee that is a mutual company similar to a building society that does not need to comply with all the conditions necessary to be a cooperative. An example in the UK is Aberdeen Heat & Power Ltd. http://www.aberdeenheatandpower.co.uk/

Advantages

- Achieves carbon savings
- Not-for-profit approach allows low tariffs
- Allows flexible development
- Risk shared between partners
- Arms length nature insulates against political risk
- Separate business plan and budget from host organisation and focussed management

Disadvantages

- Cannot rely on covenant strength of sponsoring organisation
- Cannot exit to other owners – owned in perpetuity by members
- Potential for members to starve company of investment funds be voting for very low tariffs
- Liable for corporation tax

4. Comparison between Municipal and Commercial ESCO approaches

Where the return on capital a project can deliver are too low for an ESCO to fully fund the heat network the project can still be developed by a commercial ESCO through a '*design build and operate*' contract where the capital is provided by the Council. Or through a '*design build finance and operate*' contract in which it contributes the maximum possible capital sum to the project based on the future revenue. This will need the Council to contribute the outstanding portion of the costs for the heat network. The following section details the how such a financial contribution arises and shows the how it is affected by a range of factors such as tenure and the investment hurdle rate.

4.1 District heating incomes and costs

There are two approaches to the pricing of heat from a district heating scheme, prices based on cost of district heating operation or costs based on the common alternative heating source. For residential flats the alternative would most probably be a gas combi boiler. If the district heating costs are based around the costs of a combi boiler then there is a transparent route to demonstrating the costs of district heating are fair in comparison to the alternative. This approach also allows a benchmarking basis for future cost increases.

The costs are split into two components; firstly the variable element based on heat used and secondly fixed costs that relate to the cost of ownership and system maintenance.

Approximate variable heating cost for domestic gas boiler for typical new flat		
Heat demand	3500	kWh/yr
Gas	2.7	p/kWh
Boiler efficiency	80%	
Heat cost	3.4	p/kWh
Variable heat cost	£118	Per year
Approximate variable cost for customer with district heating		
Heat demand	3500	kWh/yr
Average cost of heat from CHP	1	p/kWh
Average cost of heat from boilers	2.5	p/kWh
Proportion of heat from CHP	75%	
Average cost of heat at energy centre	1.4	p/kWh
District heating heat losses	1000	kWh/flat/yr
Average cost of heat at flat	1.8	p/kWh
Cost of district heating heat delivered to flat	62	£/yr
Profit if heat sold as domestic gas boiler price	56	£/yr

Table 1: Variable heating costs comparison[1] – *source market knowledge*

The variable costs detailed in **Table 1** show the cost of heat from a gas combi boiler and the equivalent cost for supplying heat from a heat network. For the gas boiler the cost of heat is higher than the cost of gas as the boiler only converts 80% of the energy in the gas into heat. 80% is a measured annual efficiency – which is lower than the manufacturer's stated efficie-ncy that doesn't include such things as the losses when the boiler cycles on and off.
The variable costs of the district heating are the cost of the gas for the CHP and boilers minus the revenue from the sale of the electricity from the CHP. It is the value from the sale of the electricity

[1] Source: Crane, M (2016) Energy efficient district heating in practice – the importance of achieving low return temperatures. *CIBSE Technical Symposium*, Edinburgh and market knowledge

generated by the CHP that makes the cost of the CHP heat cheap. The heat cost from the district heating boilers is lower than for the combi boilers as the price for gas used in the energy centre is significantly cheaper than domestic customers can access.

The CHP is the source of 75% of the heat supplied from the energy centre. The higher the proportion the CHP delivers the better – as it is cheaper heat. Although there are significant heat losses on the district heating network between the energy centre and the customers and these need to be taken into account. The resulting cost of delivered heat is significantly lower than for heat from an individual gas boiler.

Various fixed costs need to be added to these variable heating costs related to actual usage. These fixed costs for both a domestic gas boiler and district heating are shown in **Table 2**.

Approximate fixed cost - Private flat with gas boiler		
Gas standing charge	7	£/month
Boiler cover and service	13	£/month
Boiler replacement every 12 yrs @ £2500	17	£/month
Fixed costs district heating income private flat	37	£/month
Total annual fixed costs	563	£/yr
Approximate fixed costs District heating		
CHP O+M	£34	Per year/flat
EC O+M	£40	Per year/flat
Capital replacement fund	£100	Per year/flat
Total annual fixed cost	£294	Per year/flat
Total fixed cost each month	£24.50	£/month/flat

Table 2: Fixed heating costs comparison[2]

To use a domestic gas boiler a customer would need to pay the standing charge for the gas supply, pay to maintain and service the boiler and every 10-15 years replace the boiler. For a district heating operator there are similar costs to maintain the energy centre plant, the heat interface unit (HIU) in the customer's flat, to collect the heat meter readings, generate bills and collect payment. Money also needs to be set aside to fund plant replacement as the boilers and CHP age and need replacement. Whilst the cost estimates presented are roughly accurate for a district heating scheme of the size of Grange Farm they would be higher (on a per flat basis) for smaller district heating schemes.

For a flat that the Council rents outs the fixed costs are different. The tenant in a flat with a gas boiler would pay the gas standing charge and the Council would be responsible for the maintenance, servicing, gas safety check and end of life boiler replacement. These costs are presented in **Table 3**. It is assumed the Council's costs for boiler maintenance and replacement would be significantly lower than for a private flat due to economies of scale.

[2] Source: market knowledge

Fixed cost - Resident at Council flat		
Gas standing charge	£7	/month
Avoided cost for Council at flat - historically paid for in rent		
Boiler replacement every 12 yrs @ £1500	10	£/month
Boiler cover, safety check and service	9	£/month
Fixed costs district heating income council flat	26	£/month

Table 3: Fixed heating cost for Council flat[3]

The provision of heating from an installed district heating network is lower cost than for heating from and individual gas boiler. If the total heating cost for resident is set to equal the costs as for the presented individual gas boiler the surplus generated thought the district heating each year per flat would be:

Private flat £207 per year

Council flat £76 per year

These annual cost savings can be used to part fund the additional capital cost of installing the district heating or to reduce the heating costs to residents or a mixture of the both of these. The private sector ESCO model uses the savings from district heating operation to fund a capital cost contribution to part finance the initial cost of the district heating installation. Typically an ESCO's heat charges will be only a little cheaper than the customer's cost of owning and operating a gas boiler. In this way the ESCO can maximise their capital contribution. A private sector ESCO would typically be looking for a 14% return on their investment. Based on discussions with the Council's Director of Finance the Council's hurdle rate for investment is 7% IRR. Based on a 40 year term of the loan the district heating surplus could fund the following initial capital:

	Annual surplus per flat	@7%	@14%
Private flat	£207	£2745	£1470
Council flat	£76	£1012	£538

Table 4: Annual surplus generated by district heating and capital this can raise

Typically district heating costs £6000-7000 per flat more to install than an individual gas boiler. A commercial ESCO may be able to fund between 8 – 25% of the additional capital costs of district heating. Using Council investment rate of 7% then 17- 45% of the additional capital cost could be funded. The Government's proposed Heat Network Investment Project could be the source of the remaining funding requirement.

4.2 Private sector ESCO

Typically a private sector ESCO will operate the district heating, manage and bill the customers. Commonly the ESCO will 'own' the energy centre plant, district heating pipework and customer HIU for the duration of their contract. Some ESCOs may also build the energy centre and heat network, and others adopt networks and energy centres built by others. If the ESCO is adopting the energy centre and DH network it will look closely at the technical performance of the design, installation and commissioning. The capital contribution is dependent upon the ESCO's view of how the plant will operate. The ESCO may suggest design changes – some optional but which could improve the capital contribution payable and some changes may be required by the ESCO as a condition of the ESCO taking on the system. Such requirements would likely be to give the

[3] Source: Market knowledge and discussion during workshop

ESCO their required level of confidence that the system has sufficient levels of redundancy to always be able to deliver heat or to address safety concerns.

The ESCO would typically own and be responsible for the performance of the HIU in each customer's flat. This is because the HIU set up and operation can have quite a significant impact on the overall heat network performance and also because the customers would find it difficult to find other plumbers who could service and repair the HIUs. The HIU also contains the customer's heat meter that would be owned and operated by the ESCO.

ESCO typically take on a number of the risks. These include:

- Design risk – ESCOs will know what designs and technologies work well in practice
- Technical risk of the economic performance and reliability of the system including CHP reliability as the CHP that is generating much of the economic benefit
- Demand risk – estimating what amount of heat the customers will buy
- Commercial risk including wholesale gas prices and CHP electricity export value
- Operational risk - managing customers, metering and billing including bad debt, plant operation and maintenance to achieve lowest operating costs

Established ESCOs may manage these risks better as they operate many systems.

4.3 Council run district heating

If the Council were to own and operate the district heating the Council would need to take on all the risks that the ESCO would take on, but there would be a range of advantages and there are options to manage many of the risks.

Council run district heating advantages

- Cheaper money to finance the capital cost of district heating
- Flexibility to change heat prices as situations change
- Much easier assessment of benefits (or not) of expanding network
- Although the customers are tied to take heat from the district heating Council operation should provide a more open book / not for profit approach giving customers more confidence that the heat prices are fair.
- Many of the function of the district heating operation can be out sourced, which should allow control of services and management of the risks.
- Over time the Council can decide to undertake more of the required district heating operation functions in house- potentially lowering the costs / bringing operating profits to the Council rather than a private contractor.

  The economics of individual district heating schemes are very sensitive to scale, larger schemes are technically more cost effective and hence give greater scope for lowering the cost of heat / funding more of the capital cost. For example ESCOs tend not to bid for schemes with less than 400 domestic customers, as the operating costs cannot be covered by a heat charges that are not higher than for ownership of individual gas boilers. Grange Farm having 550 domestic is of sufficient size to attract proposals from private sector ESCOs were it not for the poor rate of return it currently provides. A number of the benefits of Council operation of the district heating relate to making the scope to expand the district heating network easier and expansion will commonly reduce costs per customer and hence generate additional savings that the Council could pass on as reduced heating costs to customers.

4.4 District heating services the Council could undertake

To run the district heating, provide a reliable service and bill the customers there are range of activities that need to be undertaken. These services in the main are covered by the fixed charges paid by customers and are around £300 per flat per year. The district heating industry in the UK is still fairly small and these services represent a bit of a niche market and as such are not the most cost competitive. All these services can be contracted out or the Council could look to undertake some of them in-house and keep the revenues and profits. For many of the tasks the Council already may have experience in very similar undertakings and so the provision of some of these services could be just a development of existing services the Council already undertakes. A summary of the different roles required to operate a district heating network, are detailed in **Table 5** along with the Council's potentially similar experience.

Operational function	Council potentially relevant experience
Energy Centre O+M	Not significantly different to operating a leisure centre energy centre
Customer service – managing call from customers	Not dissimilar to handling tenant maintenance issues
Billing and payment collection	Not dissimilar to collecting rent
Meter reading	Off the shelf metering reading systems can be purchased and staff trained in their use
HIU maintenance	Plumbers who currently maintain domestic gas boilers can be trained up – HIUs maintenance is actually simpler than for gas boiler
Gas procurement	Councils through organisations such as LASER are already good at procuring gas
CHP electricity sales	Not difficult. A real Council advantage could be the Council's scope to find and connect non domestic loads to the CHP generation which would greatly increase the value of the CHP electricity generated
Technical performance	Diligent monitoring and analysis of the district heating performance can lead to significant potential to improve economic performance and use existing plant to supply extra heat loads. This is achievable with the correct in house technical skills and prioritisation of this task.
CHP O+M	Best left to the specialist, but to get the best CHP and CHP O+M contractor performance the contactor needs to be well managed

Table 5: district heating system roles and comment on potential suitability for Council to undertake

The economic feasibility of providing a service to read heat meters, bill customers, respond to HIU faults etc. are very sensitive to scale. For example a billing system has a number of quite large fixed setup costs for software and set up and staff training. These costs are fairly independent of the number heat meters billed – therefore as the number of customers increases these fixed costs are shared over a larger number of customers.

To provide a 7 day a week 24 hour a day cover for HIU and energy centre faults requires a minimum of about 5 people. A sufficient volume of work is therefore needed to employ number of people. But such staff could undertake a range of roles e.g. maintaining, servicing and repairing energy centre plant and HIUs. They could also undertake other maintenance work for the Council such as gas boilers and plumbing in Council flats etc.

Due to these scale issues we would probably not recommend the Council consider undertaking these services for just the Grange Farm development but once other heat networks are developed by the Council over the next few years the case to consider undertaking some of these functions in-house becomes much stronger. Working with other neighbouring boroughs to share these resources should further improve their cost effectiveness.

5. Local Dimensions

Objectives Heat networks are a technological system capable of providing a range of benefits. However, some of the benefits will need active management in order to be achieved. Furthermore, the rate return required on capital invested in the technology will impact on the ability to secure those benefits. As discussed previously both of these two factors will impact upon the configuration of the business model and will have implication on the allocation of risk. Here we discuss the benefits that are typically derived from heat network projects.

5.1 Carbon Savings

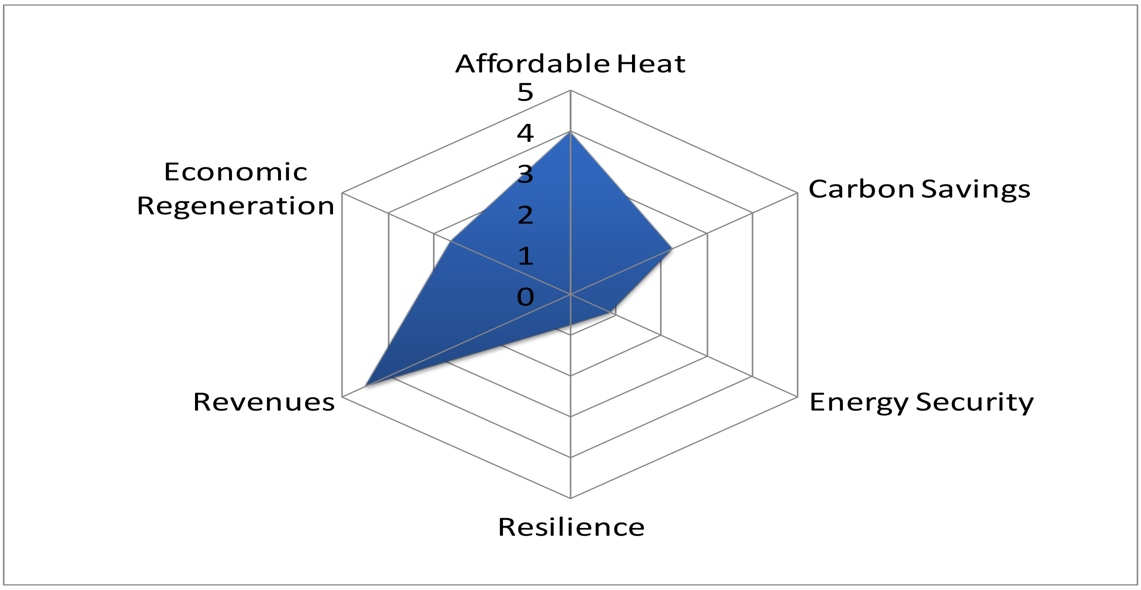
As discussed above heat networks are inherently more efficient than the counterfactual, which are individual gas boilers in each building. This is because they are able to aggregate a range of differing user demand profiles leading to the optimisation of the central plant and consequently reduce the amount of primary fuel required to meet overall demand. However, the heat losses from the distribution system will counter the benefits of the optimisation of the central plant depending on the length of the system. Careful design is required to ensure a positive result. On the other hand, the scale of demand achieved through aggregation allows the deployment of high efficiency generation technologies such as CHP and large scale renewable heat sources such as geothermal energy as well as waste heat from power generation including Energy-from-Waste plants. All of these are opportunities to achieve ***carbon savings*** on heat supply to buildings.

5.2 Energy Security and Resilience

Heat networks are agnostic as to the sources of heat. The diversity and multiplicity of heat sources that can connect to a heat network improves the ***energy security*** of the buildings supplied. They also allow multiple buildings or whole areas to convert easily to new low and zero technologies or energy sources. Furthermore, such diversity means that should one source of heat fail for any reason than there is ***energy resilience*** to recover rapidly from any systemic shocks.

5.3 Affordability

Many of the heat sources that can potentially connect to a heat network can provide heat at a lower cost than traditional fossil fuels. Additionally, the high efficiency means that less primary fuel is needed to provide a given level of heat demand.



Consequently, heat networks can deliver ***affordable heat.*** However, their ability to do so will crucially be affected by the rate of return required on the capital funded invested in them. Lower cost heat will reduce levels of fuel poverty amongst residential customers and reduce energy costs for local businesses.

5.4 Economic Regeneration

Money saved on lower energy costs will be retained within the local economy acting as a stimulus. Furthermore, the financial resilience of existing businesses will be boosted and other businesses may be attracted by the availability of low cost and low carbon energy. These factors contribute to ***economic regeneration.***

5.5 Revenues

Lastly, a viable local energy project such as a heat network will provide a business opportunity in itself. Viability will be determined by whether a potential heat network developer is able to obtain capital at a lower rate than the technical project can deliver. The gap between the two will be available to the developer as ***revenues.***

5.6 Objective setting workshop

In order to determine the benefits considered most important for Harrow Council an objective setting exercise was held at the Civic Centre on 2nd June involving representatives of housing, planning, energy and finance stakeholders. The results are shown above.

This determined that the priorities for Harrow Council are as follows:

1. Revenues (Score 4.5 out of 5)
2. Affordable Heat (Score 4.0 out of 5)
3. Carbon Savings (Score 2.0 out of 5)

5.7 Financial parameters

As with many other local authorities Harrow Council is suffering an ongoing pressure on its budget and needs to find savings of £50m over the next few years. Although it does not have much available cash, there is access to capital through the Public Works Loan Board. This can provide funds at a rate of 3.5%. Furthermore, the Director of Finance has confirmed that the Council are willing to borrow capital for projects judged to be a 'good business case'. The criteria for such a judgement are as follows:

- Return on capital. The Council has adopted an internal hurdle rate of 7%.
- Payback. The Council does not wish to see capital tied up for a long period of time. Consequently it expects projects to begin to pay back with 8 years.
- A project does not add to total debt beyond the Council's capacity to service that debt out of total revenues up to the point where the project reaches payback.
- There is a capacity constraint on the number of major projects the Council can handle at one time. Whilst the prioritisation of projects will be a political decision for members the Council can manage approximately 5 major projects at a time.

The Council is awaiting a central government decision on what proportion of business rates may be retained by local authorities. This is due within the next 18 months and the impact on the Council's finances will become clear.

5.8 Risk

All human activities have risk attached to them. This is not a negative thing as it flags up issues that require attention and helps prioritise action to manage them and reduce the risk. The key issue is to identify risks and understand them, as unmanaged risks can be potentially dangerous. Once identified and understood they should be allocated to the party best able to manage them. However, passing them to another party to manage will increase costs, as they will price the risk into their charges. Wherever possible, therefore, project developers should endeavour to manage any risks internally as far they can.

As discussed above the key risks of developing, owning and operating a heat network are:

- Design risk. This includes the selection of appropriate technologies. The key issue is if the project fails to meet performance or cost expectations
- Construction risk. Particularly budget or time overruns. A frequent cause in London is encountering unforeseen subterranean obstructions
- Demand risk. If customers fail to connect, pay or consume the predicted amounts of energy. For new build developments this risk can arise if proposed dwellings or buildings fail to be built due to a downturn in the property market. Demand risk is substantially reduced is the project developer owns, controls or has major influence over the buildings to be connected.
- Operational risk. Ensuring that the system was operating efficiently before it was accepted as complete from the contractor and is then maintained sufficiently to operate to the standard to which it was designed. A key feature is having sufficient resilience to cope with unexpected outages.
- Commercial risk. To keep fuel prices and customer payments balanced whilst allowing sufficient margin to provide a surplus.

Methodologies for analysing and managing risk are standard management tools in many organisations including local authorities. Indeed Harrow Council has a standardised risk matrix tool and has experience of managing risk on other projects. Nevertheless, it is recommended that the Council commence by hosting a risk workshop with the involvement of persons experienced in the development and operation of heat network projects, as there will be risks that are particular to them.

5.9 Skills

A key element to managing risk is to have the relevant skills to do so. As a first step a skills register should be developed to identify what skills are present or absent within the Council. Skills that are absent can be contracted out, as there is an active market in personnel and companies that are able to provide them. However, activities any contracted out will still need to be managed internally. If the skills register does not identify a suitably qualified and experienced project manager then it is recommended that such a person be recruited. Thereafter a core team can be developed around this person as the project advances and contracted activities are brought in-house, if desired.

5.10 Procurement

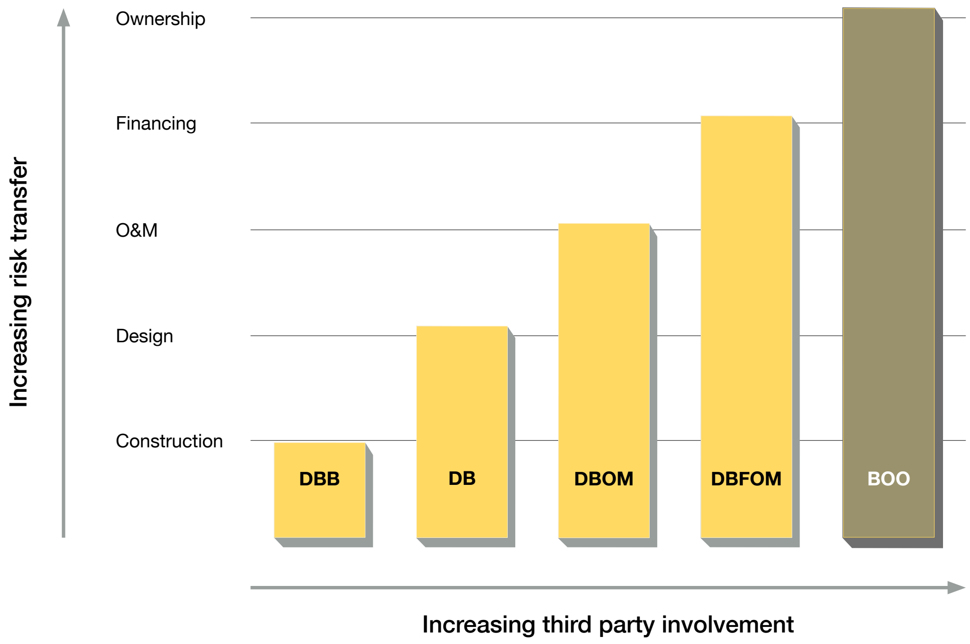
Public authorities purchasing goods, works and services must comply with the EU Public Contracts Directive. This obliges them to follow OJEU procedures, including procurement routes, which are detailed in UK Regulations. Whilst there are a number of procurement routes other local authorities have found the most appropriate routes to be ‘restricted tender’ for simpler contract structures such as design, build, operate (DBO) and ‘competitive dialogue’ for more complex contract structures such as design, build, finance, operate & maintain (DBFOM).

The activities involved in the development, construction and operation and maintenance of heat networks are typically packaged into a range of contract structures or approaches. Each approach will vary in the transfer of risk to a third party but at the same time increase the involvement of that third party in the project with a commensurate loss of control over the project. This is summarised in the table on the next page.

The different contract structures are:

- Design, bid & build (DBB). This involves procuring a design specification and separately procuring a contractor to build that network according to that design.

PROCUREMENT OPTIONS - Mechanisms and risk



- Design & build (DB). This is combining design and construction into a single contract. Operation & maintenance can then be procured as a separate contract.
- Design, build, operate & maintain. All four activities are combined into a single contract
- Design, build, finance, operate & maintain. This involves the contractor providing third party finance and is the common approach adopted by commercial ESCO's.
- Build, own, operate (BOO) is not really a contract as this is represents a private development without any involvement of the local authority.

6. Potential Structures for Harrow

Reviewing the Energy Masterplan for Harrow & Wealdstone Opportunity Area identifies certain features for the area.

- The North Cluster will only achieve a 6.3% rate of return over 40 years. This is below the Council's hurdle rate of 7%. However, within the cluster a network serving the Civic Centre and Harrow View East sites could deliver a 7.7% rate of return over 25 years, which is above the Council's hurdle rate. This cluster is the most easily delivered, particularly south of the railway, as the Council controls the likely demand through significant ownership of land and buildings and the proposed development. Furthermore, the development timescales allow sufficient time to develop a project and the obligation within the local area action plan to connect to a heat network will reduce risk.
- The South Cluster is the most attractive financially achieving a rate of return of 7.3% over 25 years, above the Council's hurdle rate, and the University within it achieving 19% over the same period. Connecting the university and hospital was identified as a priority.
- Connecting the North and South Clusters into a larger network will improve the rate of return on the lower performing North Cluster as typically larger networks will deliver higher returns than smaller ones.
- Grange Farm provides a poor rate of return. But because of the size of the project a heat network is obligatory under the London Plan. An approach to procurement for this project is considered below.
- It should be noted that the Masterplan undertaken by Arup is approximate and necessarily conservative. Further work to refine the technical details may improve the rates of return delivered.

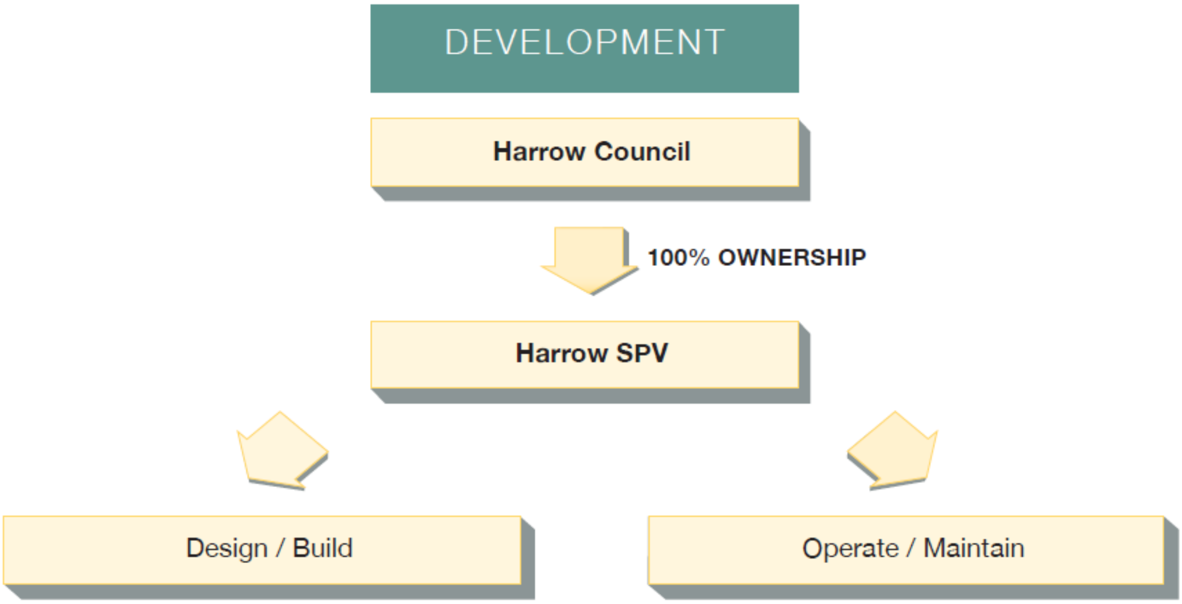
6.1 Consideration of the different delivery models for Harrow & Wealdstone
The North and South Clusters will build-up slowly at an incremental pace as the boilers expire in existing buildings that then connect to the heat network. Typical ESCO contracts are fixed to deliver heat to a specific set of building over a term. They do not have the contractual flexibility to adjust to odd connections. Consequently, the private ESCO approach is not well suited the evolving nature of the North and South Clusters.

Furthermore, the Council has indicated that its primary objective is the generation of revenues from a potential project. Consequently it must maintain ownership or a major share of it. If other parties hold an ownership stake, then any potential revenues will need to be shared with them. This requirement further rules out the private ESCO approach as well as a joint venture and a community-owned approach. It should be noted that the secondary objective for the Council is affordability. This conflicts with the desire to generate revenues. Consequently, the sharing of the benefit the company may generate between shareholders and customers will need to be determined in the construction of the charging and tariff structure.

The Council has a track record of establishing new enterprises externally in order to provide a focussed management with a separate business plan and to minimize risk. It recognises that a focussed management is necessary to target management resources and avoid mission creep whilst a separate budget allows prudent investment that meets the needs of the business instead of the Council. Lastly, a project delivery by an external organisation isolates it from the risk of policy change by central government forcing the Council to privatize its operations. These concerns rule out the internal department approach.

The remaining option is therefore a wholly-owned external special purpose vehicle (SPV) which provides the focussed management and separate business plan and budget whilst allowing the

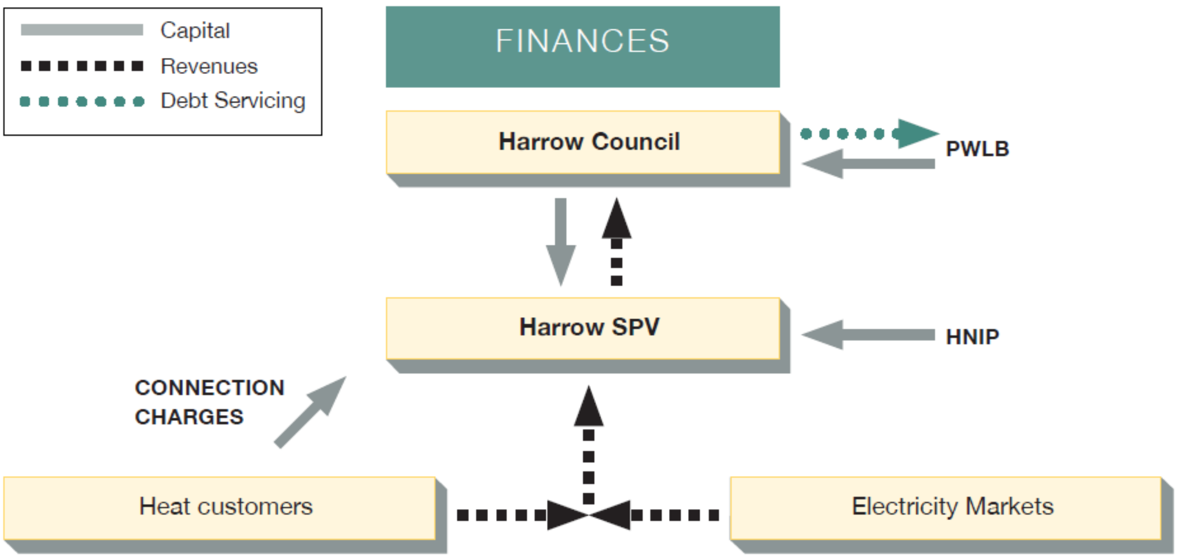
Council access to the revenues through dividends paid to it as a shareholder whilst maintaining sufficient control to determine that the charging and tariff structure shares the benefits with customers as affordable heat. This structure is shown below.



The special purpose vehicle can be established as a limited company based on shares. This will leave open to option to transfer to a joint venture, potentially with a neighbouring borough, through the sale of a proportion of the shares reflecting the equity or level of business they could bring to the company.

The company would contract out design and construction for the installation of the network and contract out operation and maintenance until it was able to bring certain activities in-house.

The company could be funded as illustrated below.



Capital will come from:

- PWLB to the Council which could then lend it on to the SPV
- SPV will seek grants/soft loans from the Heat Network Investment Fund (HNIP)
- Connection charges for building developers who will be obliged to contribute to the development of the network under the requirements of the Area Action Plan
- It is also noted that Harrow's Core Strategy makes allowance for the development of a Tax Incremental Funding approach. Additionally it has recently identified district heating as a type of infrastructure that could potentially be funded through its Community Infrastructure Levy.

Revenues could be derived from:

- Heat sales from the buildings connected
- Electricity sales to the market

This arrangement is an outline and will need further refinement through the development of a detailed financial plan. This recommended as a next step in the development of business case for consideration once clarity is achieved on the likely retention of business rates next year.

6.2 Grange Farm

The Housing Dept wishes to procure a commercial ESCO to deliver the heat network on the Grange Farm development, as required by planning policy, through a *design, build, finance and operate* (DBFO) contract. The principal motivations are the speed of delivery possible with the relevant skills and experience immediately available and the need to gain external gap funding investment into the overall project. The procurement process at Grange Farm is running ahead of the time line for the North and South Clusters, which are only at feasibility study stage and therefore not ready for procurement.

Therefore, in order to meet the Housing Dept's need for speedy delivery it is recommended that the Grange Farm procurement proceed as a *design build finance & operate* (DBFO) contract. In parallel a second procurement should be undertaken for *design and construction* (DB) contract for the installation of the network together with a limited *operation and maintenance* (O&M) contract of about 5 or 10 years. Islington Council used this approach on its Bunhill project. After the expiry of the O&M contract term on the latter option the Grange Farm heat network can then be integrated into the municipal SPV. As this approach excludes the funding element of a DBFO contract the Council will need to provide the funding. However, this can be obtained at lower cost through public debt such as the PWLB and/or the HNIP.

Through this parallel procurement of both options a much more robust assessment of the financial and commercial aspects of each option can be developed as it will bring forth what size of contribution a commercial ESCO is willing to make under the DBFO approach. Furthermore a benefit of this parallel procurement approach is that if the DBFO with a commercial ESCO is the chosen option the negotiations may take longer than expected and the lack of a signed ESCO contract could potentially hold up the wider Grange Farm development. In this case the Housing Dept could switch to the other option.

6.3 Optimising commercial ESCO procurement
To compare proposals from commercial ESCO providers it is recommended that a shadow model be established for a municipally operated district heating network. This will help to understand the cash flows of costs and revenues for such a project and will quantify the benefits of a wholly-owned external SPV approach

Nevertheless the Council is currently proceeding with a procurement exercise for a commercial ESCO for the Grange Farm development. It should be noted that with the low rate of return available for the Grange Farm development a commercial ESCO approach will not fully fund the cost of the heat network project through a DBFO contract. Consequently the Council's corporate budget or the capital cost budget for the Grange Farm development would need to bear the remaining cost. As previously suggested, this could be delivered as a DB + separate O&M contract with the Council providing the necessary gap funding by using public debt and/or the HNIP. However, if it were to proceed as a DBFO contract there are a number of considerations to potentially improve the complex process of identifying the best ESCO partner and scope.

Firstly to procure the most beneficial commercial ESCO there are two slightly conflicting challenges. To be able to compare the offers from different ESCO the specification needs to be tight enough to allow a common benchmark against which the proposals offered by each ESCO can be compared. But part of the value in an ESCO is that they have each developed a range of cost effective approaches to all the likely required services. These may be different to the specification but nevertheless deliver the customers' requirements. Consequently each ESCO may seek to make alternative proposals - technically, commercially and contractually – to provide best value for the Council as well as giving them the best return in balancing capital and operational costs. The challenge is then to be able to compare them.

For example, different ESCOs will potentially have different views on the technical approach such as the optimum size of boilers required, the HIU design and heat metering systems – all of which can affect both capital and operational costs. A key area where such difference of views may occur will be on the size of CHP. The balance between the size of the CHP unit and the thermal store affects the economic optimisation of the project (investing in a larger CHP normally maximises the carbon savings too). However, as the life of a CHP unit at approximately 15 years is shorter than the typical ESCO contract term of 25 – 30 years the decision on CHP size will be a matter for the ESCO rather than the Council. In contrast the thermal store has a very long life extending beyond the ESCO term and is very difficult to retrofit. Therefore the Council could require a minimum thermal store size to futureproof the energy centre for the installation of a larger CHP at a later date.

Secondly to remove one area of variation between ESCO bids the Council might consider setting the heat charging structure and tariffs for the compliant bid tender return. The heat price is an issue that will need Council agreement before an ESCO contract could be signed. Consequently, work on the billing structure will need to be done at some stage and tested in the shadow model (as recommended above). This will allow a comparison against the shadow cost of heat. However, once selected as the preferred partner the ESCO may ultimately require a slightly different billing structure to that specified by the Council to fit with the systems they already have in place on other networks operated by them.

Thirdly, it may be helpful to request that each ESCO provider states their total financial investment into the project. It can be difficult to value one ESCO offering a capital contribution of £xx million and another offering to install the HIUs and the energy centre at zero cost. Essentially the operation of the heat network over the ESCO term must provide a positive net revenue that allows the ESCO to invest a sum of money – what they actually offer to buy with this money can be a bit of a distraction from what is the total is amount. The exception would be if the ESCO could purchase and install some of the plant at significantly lower costs than another competitively tendered contractor. Having the ESCO install some of the plant reduces risk they are not happy with the plant.

A significant factor in the amount an ESCO will invest into the project is the time at which the investment is paid. The later the ESCO funding is required the greater the sum available will be. For example an increase of year between the time between the time of the investment and the commencement of revenues from the heat customers will result in the ESCO investment falling by approximately 13%. The maximum scheme profitability will be when the scheme is fully built out and all the customers buying heat – so a site with slow build out times will be offered lower levels of ESCO capital funding.

7. Client considerations for heat network developments

There is a range of commercial and technical issues that there is benefit in the Council developing a view on. Having an understanding and agreed Council position in these areas should benefit all the DH development and ownership options. These are discussed below. These will apply to both a private ESCO and wholly-owned SPV approach.

7.1 Heat Tariffs

Heat tariffs need to be developed and cover both the unit charges and the fixed costs. The charge structure will need to be different for private properties where the district heating is removing the owner's cost of maintenance and periodic replacement of the gas boiler. For Council owned properties the tenant would not usually directly pay for the costs of boiler ownership so the district heating costs that the tenant pays should be lower than for a private residence.

There may be motivations to vary the balance between the fixed and consumption based charges, for a range of reasons such as fuel poverty concerns (seeking to lower consumption charges) and those seeking to motivate and reward reduced energy use (seeking higher p/kWh heat). In general the commercial ESCOs like the fixed charges that cover their fixed costs as it slightly de-risks incorrectly estimating the heat consumption unit charge. A high unit rate for heat, and low fixed charge, would make the scheme profitability more sensitive to financial loss if the heat consumption of the flats was underestimated.

The tariff structure needs a methodology for increasing prices over time, a suitable benchmark is required to base future price rises on. For example the unit charge for heat can be linked to domestic gas prices and the fixed charges increased in line with RPI.

Should tariffs be specific to each site or should the tariff be the same for all sites where the Council can influence such decisions? There is a range of equity issues to be considered here, larger schemes should potentially offer lower heating costs, but should such variations in costs be shared across the Borough? Administratively a Council wide tariff would be easier and cheap to administer.

In new build flats relatively high heat charges are less likely to cause fuel poverty issues due to the much lower space heating requirements in new flats, but a high unit rate for heat would be more likely to cause fuel poverty issues in older stock with much poorer levels of insulation and consequent higher space heating loads. If all the proposed district heating is to be for new developments then this isn't an issue. It is also less of an issue where district heating is replacing electric heating as if the district heating benchmark is gas heating which is significantly cheaper than electric heating.

7.2 Prepayment

Prepayment is an option for heat customers which works in similar ways to the prepayment systems for gas and electricity with which people are familiar. Some residents may request it as a budgetary aid; some organisations view it as self-disconnection and don't agree with it. It is a good tool to prevent bad debt, but it does increase capital costs. It is an option that needs some consideration by the Council before an approach is agreed. Different commercial ESCOs will have different views as to the costs and desire for prepayment systems.

7.3 Sinking fund for future plant replacement

As plant reaches the end of it's life it will need to be replaced and money needs to be set aside to fund these works assuming that it is unacceptable to bill such costs to resident as and when they occur. A common approach is to estimate the cost of future plant replacement and when it will need to be replaced. Then a monthly payment is calculated to cover these costs. The fund would be reviewed periodically to check it was sufficient but not excessive to meet the anticipated replacement requirement. For council owned flats the funding could be arranged differently. The most robust approach for a commercial ESCO and wholly-owned SPV is to require the money is put in an independent account from which the operator is paid when plant replacement has been agreed. In this way the money is safe from risks of the ESCO failing or going out of business. At the end of the ESCO term, if that approach is adopted, the plant condition can be balanced off against the value of the funds in the sinking fund.

Keeping the sinking fund monies in a safe and secure deposit account can be viewed as a waste of valuable capital. The district heating customers are effectively financing a loan from the ESCO for part of the district heating construction at 12-15% interest rate and at the same time building up capital funds for plant replacement that are earning low deposit account rates. For a commercial ESCO there seems to be little option but to take this approach, but for a Council owned district heating system the capital replacement fund could be used to fund investments in say other district heating schemes avoiding the Council borrowing more capital with the future plant replacement paid for by the profits from the new district heating networks. The risk to the heat customers are low as the Council cannot cease to deliver the services it has committed to do. It must be said that this is how district heating networks in the 1960s and 1970s worked and in constrained financial times the Councils failed to invest in the upkeep of district heating networks and the resulting poor reliability tarnished the image and appeal of district heating. A more ring fenced and separate budget, as suggested above, is recommended to demonstrate to the customers contributing to the fund that it is well run.

7.4 Managing technical and operational risk of district heating operation

A key recommendation is for all parties involved in the district heating project to follow the CIBSE Heat Networks Code of Practice. This includes requirements for the client and the client needs to be checking the Code is followed by the other entities that have responsibilities under the Code. The requirements need to be thoroughly considered and not just treated as ‘tick box’ exercise.

7.5 District heating acceptance performance standards / tests

To date the district heating industry and clients have been poor at making measured efficient district heating operation part of the system acceptance criteria. It is suggested that performance targets are developed which can be theoretically tested during design and then measured during commissioning as part of the client requirements for acceptance of the completed district heating system. The key system variable is return temperature[4] – which needs to be low at all times including the times when there is little load on the system. If the return temperature is low then the system is set up well. Additionally checks will be required on the return temperatures from HIUs when the space heating is operating. Each HIU will need to demonstrate and record the performance as part of the HIU commissioning process. This is because the radiator circuits in each flat need to be setup well to deliver the low return temperatures the design is based on. The system performance tests could have financial penalties for failure as part of the contract. The penalties being based on the costs of extra heat losses due to poor system efficiency.

It is suggested that the HIU needs to achieve a maximum Volume Weighed Average Return Temperature (VWART) as part of the selection process and that the selected HIU is retested at the chosen operating temperature if these are different from the temperatures used for the standard HIU test. Detail of a recommended HIU test can be found at www.fairheat.com The HIU testing should help ensure the constructed system operates efficiently and help build contractor

[4] Technically the benefits of low return temperatures are lower heat losses from the DH pipe work and improved boiler efficiency. Lower return temperatures result in a wider temperature difference between the water leaving the energy centre and that returning and this means less water needs to be pumped for each unit of heat delivered which means all the pipework and pumps can be smaller. The larger the temperature difference the smaller a thermal store can be whist storing the same amount of heat. Economically a low return temperature lowers both the capital and operating cost and will increase the CO_2 savings.

confidence that taking on an element of performance risk is not too onerous. But there are few newly built district heating schemes that are working as efficiently as they should be. It is recommended that part of the designer / contractor selection process should be to establish the performance of other schemes they have designed and built. Once the contractor has demonstrated a good track record it needs to be ensured that it would not be a totally different design and construction team on the new work. Ideally good system performance arises from well considered and well executed design, construction and commissioning. If the system fails to achieve the performance requirements at commissioning it can be hard to recover the situation if the design and construction has been poor.

Maximising the proportion of heat supplied by the CHP, and ensuring the CHP operates at the times when the electricity prices are highest is key to the CHP delivering maximum economic returns. The CHP should be used in conjunction with a thermal store. The thermal store means that when the CHP runs it runs at its most efficient output (full power). When the heat demand is low most of the CHP heat goes into the store, which then supplies the heat when the CHP is off. The store also allow heat demands greater than the CHP heat output to be delivered by using both the CHP heat output and drawing from the store. The store allows the CHP to operate at times of maximum electricity value and the heat in the store to supply the site at times when the electricity price is low e.g. overnight. In the summer the CHP may only run a few hours each day and yet still provide all the site’s heat demands. The sizing of the CHP and thermal store should be an economic evaluation of a range of CHP and thermal store sizes. The analysis needs to include not only the CHP size but also its heat and electrical efficiencies, the CHP maintenance cost and the capital costs. A more expensive CHP may be more efficient and have lower maintenance costs and hence the additional capital cost a good investment.

All of these issues require knowledge within the recommended wholly-owned SPV, potentially with external support, but giving Council staff time and continuity with the developing district heating projects will help build the knowledge required to ensure best district heating operational performance and to better inform the considerations of bringing more of the district heating operations functions in house.

Once the system is in operation and heat demands and customer feedback start to be understood there are range of small tweaks and adjustments that can be made over time to reduce the system operating costs without sacrificing the service to the customers. The initial system setup is bound to err on the conservative side, but once it is known this setup easily achieves the requirements on the coldest days/ times of highest demand there is scope to gradually reduce system temperature – which reduces heat losses and to reduce pumping power to save electricity. Much of this can be gradually programmed in to the control systems such that the temperatures and pump pressures at any time better reflect the actual requirement on the system at that time. Such setup is very difficult to achieve at the time of construction, but as long as the control system and design allows for this to implemented at a later date there are routes to improve system performance / reduce operating costs over time. This is a neglected area for many smaller district heating schemes, but good potential upside of having in-house staff within the wholly-owned SPV with skills and knowledge. External contractors will have less motivation and scope to be continually seeking small performance improvement opportunities.

7.6 Managing district heating capital costs

District heating is expensive to install and part of this is due to excessive design conservatism and a lack of analysis of operating schemes. The designer will need to consider oversizing certain elements in order to futureproof the system to allow for expansion. But the typical result is that everything is too big, the boilers, the pumps, all the pipework etc. This adds to the capital costs and space requirements but also it has a significant impact on the efficiency in operation, the larger pipes lose more heat, the big boilers cannot efficiently deliver the actual low heat loads required by the operating system. This tends to start with specifying heating infrastructure commonly to deliver 55kW of domestic hot water in each flat when most households can be adequately served by with a gas combi boiler which only delivers 30-35kW of hot water. The Heat Networks Code of Practice raises these issues but it is still left to designer's judgement as to what is required. A Client, such as the Council, questioning the designer to justify their decisions may lead to less conservatively designed district heating system that is cheaper to construct and operate. These discussions with the designer and contractor are also very useful for the Council in gaining system knowledge and helping the Council understand what to be looking for during commissioning and plant acceptance.

7.7 The Impact of flow and return temperatures on capital and operating costs

Heat is delivered over a district heating network by the customer taking some hot water and cooling it down To deliver the same amount of heat the customer can take a large amount of water and cool it a little or take a small amount of water and cool it a lot. For the district heating to be efficient and low capital cost the latter approach is needed. The smaller the volume of water the customer needs the smaller all the pipework and pumps can be. The more the water is cooled the lower the temperature going back the energy centre, which means the pipe is cooler, so it loses less heat, and the condensing boiler, heat pump, CHP (if well specified) can all be more efficient.

To get the lowest return temperature from a flat the HIU may cost a little more and radiators will need to be a bit larger but these 'extra' costs need to be set against the cost savings arising from smaller pipework, smaller pumps and lower operating costs. To get the lowest capital and operating costs may involve spending a little more in some areas to enable savings to be made in other areas. To get the best value system it is key the Council-owned SPV has sufficient knowledge to test these design decisions and to check the contractor's installation will meet and deliver the design intent.

District heating is fundamentally pretty simple – just pumping hot water around. But to achieve the best operating efficiency requires good attention to detail and persistence in pushing for the best solution at every level however small. The overall efficiency of district heating is determined by the sum of a multitude of many small design decisions.

7.8 Expanding district heating

As noted earlier the economics of district heating are very sensitive to scale and as such larger schemes will tend to be more economic and will deliver greater CO_2 savings. The GLA planning requirements for district heating have been in place for over a decade and as such are likely to continue. These factors mean the technical design and the contractual structures used to own and operate the district heating want to promote and facilitate heat network expansion and interconnection. Over the life time of a typical project term of 25 – 30 years it is highly likely local opportunities for expansion will arise - be it the odd extra building or a whole new development. Consequently some oversizing is needed to allow for future growth of the heat network. But careful economic analysis needed to maximise the potential benefit for the extra capital spent up front and the higher operating costs arising. For example extra boilers are probably a false economy over leaving vacant space within the energy centre. Should the heat demand grows an extra 3MW of heat may be need. However, if a 2MW boiler occupies this space then there is no room to install another 1MW boiler. On the other hand if the space had been left vacant a 3MW boiler is not much larger than a 2MW boiler. Underground DH pipe is very expensive to install and larger pipe sizes only carry a relatively small cost premium – so this is an area where oversizing should be considered. Conversely pipe work within blocks should be of the minimum size as it is highly unlikely to ever serve extra load, as the building itself will not expand.

As mentioned above a commercial ESCO contract can act as a barrier to district heating expansion. When adding an extra building there is a potentially complicated calculation on how the benefits are shared between the ESCO, the newly connected building and the existing district heating customers. If the capital cost of the connection is funded by the ESCO the IRR will be high. If extra plant is needed within the energy centre – which is in the ownership of the ESCO for the ESCO contract duration -questions will arise as to who funds it. Changing the ESCO contract to accommodate a new heat customer is complex as are the process to demonstrate connection and heat charges are fair to new customer – all these things mitigate against it being worth the effort on the ESCO's part. As the ESCO contract nears its end such things become more difficult as there is less time left for the ESCO to make it required economic return. These factors suggest that a commercial ESCO contract is not the best approach to the slowly evolving heat network likely for the North and South Clusters.

Expanding district heating not only spreads the fixed costs over a wider customer base it can also make better use of the already installed plant. District heating central plant serving new developments is always oversized as it's impossible to predict the heat loads accurately – no designer or contractor will risk a scheme not the meeting the peak demands. Over time as the actual loads are established the level of surplus capacity can be established. Then new customers can be connected without any additional central plant cost – which should reduce the costs of the connection or allow a profit to be made on the connection charge that could be used to lower customer bills or invest in system efficiency projects.

On district heating projects with CHP a significant expansion opportunity is to find a customer for the CHP power generation. Typically the power the CHP generates will be sold to the grid and will receive 3.5-5.5p/kWh. If the power could be sent directly to a site and reduce that sites' import of electricity that costs them, say, 9p/kWh then there is great scope to sell the CHP power for a higher price and to offer a generous discount to the power customer. This is called 'private wire' supply. The Regulator (Ofgem) is not keen on private wire supplies to domestic customers – as this would remove their ability to switch electricity suppliers. For larger non-domestic customers private wire supply is not a problem – such customers should have sufficient knowledge of the electricity market to understand what is being offered and it should be easy to develop a price benchmark that always ensures both parties are benefiting from the private wire supply set up. There are supposed to be mechanisms within the electricity market structure to enable small generators to sell their power across the 'public' electricity distribution network but to date there has only been limited success in such options resulting in higher electricity sales value from CHP plant. This area has become active again with the GLA developing 'Electricity Licence Lite' through which London Transport will buy power from small generators for a higher price than they could obtain otherwise. Additionally a number of Councils (Bristol and Nottingham) are establishing licensed electricity supply businesses where part of the aim is to increase the value of locally generated electricity.

8. Conclusion and Next Steps

8.1 The Energy Master Plan

The Energy Master Plan completed in January 2016 Harrow Council concluded that there is potential for the development of technically feasible heat networks within the Borough. A high level assessment of their viability found that they would not achieve sufficient returns on capital to attract commercial investment but could provide an opportunity for municipal investment.

Based on this understanding the Council commissioned the present study to consider the range of business models and contractual approaches that could be used for the development of these opportunities. Engaging with key stakeholders both directly and in a workshop to explore the stakeholders' attitude to risk, desire for control and undertook an exercise to determine the overall Council objectives for the heat network projects.

The primary objective is to secure revenues for the Council with secondary objectives of delivering affordable heat and carbon saving respectively. In order to achieve these objectives the Council will need to maintain maximum ownership of a possible delivery vehicle, in particular over the design of its charging and tariff structure. It was found that the Council has a track record of establishing arm's length external ventures to provide focussed management of services with ring fenced budgets that isolate the Council from risk. Furthermore, engagement with the Director of Finance revealed that the Council is able to invest in projects if they are determined to be a 'good business case'. Lastly, the nature of the priority cluster areas identified in the Energy Master Plan consisting predominantly of existing buildings suggests that a commercial energy services approach is contractually inflexible and will have difficulty coping with the likely incremental development pattern of heat networks in these areas.

Consequently, a wholly municipally owned special purpose vehicle was recommended. Funding could be provided from municipal debt through the Public Works Loan Board, connection charges reflecting to avoided capital and operating costs of alternative heating systems, Harrow's Community Infrastructure Levy and the Government's impending Heat Network Investment Project.

The separate heat network project at Grange Farm provides a poor investment opportunity. However, it is obligated to include a heat network to serve the proposed development under the London Plan. In order to meet the Housing Department's advanced time line it is proposed that this project is delivered by a commercial ESCO although it is considered unlikely that it will provide the capital contribution to the overall project that the Housing Department desires. Instead it is consider more likely that Council funding will be required to deliver the heat network through a '*design & build*' and '*operate & maintain*' set of contracts. The latter should be kept short and on its expiry the assets and operation transferred to the Council-owned special purpose vehicle.

A key milestone for any Council investment is the Government's determination on the possible retention of business rates by local authorities. This is likely to happen in 18 months and will clarify what funding the Council will have at its disposal. Therefore it is appropriate to adopt this target date in determining a programme of actions to build the required 'good business case'.

8.2 Recommended actions

1	Establish a project board incorporating the key cabinet members and senior officers to provide corporate governance and oversee the strategic development of heat network projects within the Borough
2	Project board to provide clarity of vision and objectives
3	Project board to work to secure political support
4	Project board to secure development funding
5	Appoint a project manager responsible for the programme of actions. (It is understood that a specification for this role is currently underway.)
6	Develop schedule of tasks to undertake
7	Develop a forward programme over 18 months with resource implications
8	Undertake an audit of relevant skills and capability available within the Council
9	Project manager to build a project delivery team drawing on staff with relevant skills and involving key departments – planning & regeneration, finance, legal, housing and estates, procurement etc
10	Consider what additional skills and services are required from external sources to augment skills available internally and where these might be sourced – consultants, short term contracts, specialist service providers for (a) project development (b) project delivery (c) project operation
11	Consider sources of revenue: develop a charging and tariff structure; electricity sales approach including Licence Lite and private wire
12	Consider operational costs: fuel purchasing; O&M; staffing; billing & revenue collection including consideration of bad debt and approach to pre-payment; and other opex costs
13	Consider contractual structure (heat contracts etc)
14	Refine and optimise technical design to develop robust financial costings through detailed techno-economic modelling
15	Liaise with planning and highways over outline technical design (energy centre location and pipe network routes)

16	Quantify capital costs
17	Build shadow financial model to develop and understanding the cash flows of costs and revenues and provide a benchmark for comparing proposals from commercial ESCOs
18	Develop risk register and strategy for management of them
19	Develop procurement strategy and contractual structure. Define specification and develop evaluation criteria
20	Develop comms strategy to engage with key stakeholders, particularly anchor loads
21	Develop the business case for the North & South Clusters with costs and benefits for the Council in order to secure capital funding
22	**Move to delivery……….**