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Heat Network Detailed Project Development Resource:

Guidance on Economic and Financial Case – Development of the Financial Model, Heat Pricing and Maximising Opportunities

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Introduction

Introduction

This document provides guidance to support the development of the economic and financial elements of a Heat Network project Outline Business Case (OBC).

The guidance is from a financial perspective therefore the aim is to produce a document that enables Local Authorities to take the project from the Feasibility Stage through to delivery of the OBC. It draws heavily from the HMT Green Book Five Case model to ensure that best practice is applied to the development of the OBC.

The guidance specifically follows the Five Case Model and the derived BEIS Business Case Template but will also be applicable in other instances. The Five Case Model (and the BEIS Business Case Template) consider the viability of the project from five perspectives:

- Strategic
- Economic
- Commercial
- Financial
- Management

Although all five elements are relevant, this guidance focuses on the Economic and Financial Case. Separate guidance has been commissioned by BEIS for the Heat Network Detailed Project Development Resource, namely:

- Guidance on Strategic and Commercial Case; and
- Guidance on Powers, Public Procurement and State Aid.

A significant focus of this guidance relates to the development of the Financial Model and how the commercial structures that this represents can be optimised. The Financial Model is used in a number of sections of the Economic and Financial Case and we summarise this below.

Economic Case Guidance

The Five Case Model Guidance explains at Chapter 2:

"The main purpose of the Economic Case is to demonstrate that the spending proposal optimises public value (to the UK as a whole).

"It explains how this is achieved and by, identifying and appraising a wide range of realistic and achievable options, known as the "long list", in terms of how well they meet the spending objectives and critical success factors agreed for the scheme; and subjecting a reduced number of options, known as the "the shortlist" to cost benefit analysis.

…

"The "preferred option" is subjected to sensitivity analysis in order to test its robustness. The output of the economic case should never be a one number answer, rather it consists of an appraisal summary table which includes the preferred option net present value, risk analysis and sensitivity figures with switching values, a distributional analysis (where relevant), information on qualitative costs and benefits which may be decisive and information on other viable alternative options."

The guidance supports completion of the Economic Case by describing the development of the Techno-Economic Model from the Feasibility Study into the Financial Model. It sets out how the key inputs can be challenged and refined and then describes how the Financial Model will be structured. The Financial Model will be one of the key tools in generating the value for money appraisal.

Financial Case Guidance

The Five Case Model guidance explains at Section 2:

"*The Financial Case demonstrates that the 'preferred option' will result in a fundable and affordable deal.*

"This section of the business case requires the spending authority to set out the capital requirement for the spending proposal over the expected life span of the service, together with an assessment of how the Deal will impact upon the balance sheet, income and expenditure account pricing (if applicable) of the public sector organisation.

"Any requirement for external funding must be supported by clear evidence of Commissioners' support for the scheme, together with any funding gaps".

The guidance supports completion of the Financial Case by identifying where the information required is contained within the Financial Model. It also sets out approaches to determining the Financing Mechanisms and the potential sources of finance. It also considers how the commercial viability of the scheme can be improved to reduce any affordability gap.

Structure of guidance

This document is structured in three parts:

Part 1: Development of the Techno-Economic Model into the Financial Model

This section describes the development of the Techno-Economic Model used at the Feasibility Stage into the Financial Model, which underpins the decision making through the OBC. It seeks to provide Local Authorities and developers with the means to understand the range of Optimism Bias, Sensitivities and Risks that would impact on the Economic Case and the Financial Case and manage those risks.

It explains the approach to developing the Financial Model through the options appraisal process and identifies the impact of different financing approaches.

Part 2: Heat Pricing

This section identifies the charging options and emerging consensus on billing for heat supplies and highlights the benefits and risks of different approaches. It focusses on the financial elements of the pricing and provides a link back to the Financial Model development as to how this should be treated. Different customer types are explored which may lead to different pricing approaches for each.

It also recognises the importance of customer protection in relation to the setting of the heat price and sets out some of the measures that are being put in place to ensure this.

Part 3: Revenue Stream and Avoided Costs – Maximising Opportunities

In this section, there is an explanation of the types of revenues that are, or could be included in Heat Network projects, including reference to optimising heat revenues. This will contribute to the commercial reality and expansion of Heat Network projects. It also considers funding streams and a holistic view of avoided costs.

Again, it considers these issues from a financial perspective and looks at how they impact on the Financial Model.

How to use the guidance

This guidance aims to take the reader through the journey of developing a Financial Model, which underpins the commercial reality of the OBC.

At Figure 1, there is a detailed flowchart and summary guide which sets out how the Financial Model is used as the OBC develops. It also cross refers to the ‘BEIS Heat Networks Outline Business Case Template’ and the ‘Guidance on Strategic and Commercial Case’. We recommend that the reader prints out this flowchart (it is set to print at an A3 size in colour) and uses this to follow the process described in the text.

This should allow the reader to understand the additional information that is required to develop the Financial Model from the Techno-Economic Model at the Feasibility Stage. It should also allow the reader to critically appraise the information that may be coming from its specialist advisors.

Parts 2 and 3 of the guidance should allow a Heat Network Project Team to consider areas where they can improve commercial viability of their project and offer customer protection to the end user. If a Local Authority is still at the Feasibility Stage then this guidance can also be used to further inform detailed project development.

Glossary

BAU	Business As Usual
BEIS	The Department of Business, Energy & Industrial Strategy
Blended Equity IRR	This represents the return to investors after taking account of Senior Debt service. For tax and accounting reasons investors typically provide a mixture of share capital (equity) and Junior Debt. In which case the IRR calculation takes into account all payments received on both equity and Junior Debt
Capex	Capital Expenditure – funds used by a company to acquire or upgrade physical assets such as land, buildings or equipment
CCHP	Combined Cooling Heat and Power
CCL	Climate Change Levy
CHP	Combined Heat and Power
CIBSE	Chartered Institution of Building Services Engineers
CP1: 2015	Heat networks: Code of Practice for the UK, Raising standards for heat supply, 2015
Community Company	A community backed/owned co-operative or company that has a leading role in the business supplying heat.
Concept Diagram	A diagram which sets out –in headline terms – the components of the key revenue and expenditure items, such as revenue and cost drivers, operating cost profiles and heat demand assumptions to ensure there is a common understanding of the calculations. This is used to support the development of the Financial Model.
Connection Charge	A one off charge for connection to a HN
Consumer Comparator	Cost of the Alternative heat supply if not supplied by a HN
Cost Of Carbon	It is possible to consider the CO2 performance of the Heat network as compared to the counter factual. Typical units are £/tonne CO_2 pa
Cover Ratios	The Cover Ratios are a measure of a company's ability to meet its financial obligations
D&B Contractor	Design and Build contractor
Debt Service Cover Ratio	Debt-Service Cover Ratio (DSCR) is a measure of the cash flow available to pay current debt obligations. The ratio states net operating income as a multiple of debt obligations due within one year, including interest, principal, sinking-fund and lease payments.
Debt Service Reserve Account	The Debt Service Reserve Account (DSRA) works as an additional security measure for lenders. It is generally a deposit which is equal to a given number of months projected debt service obligations (ie repayments of principal and interest)
Delivery Vehicle	Structure of the entity developing and delivering the Heat Network. The four Delivery Vehicles in the guidance notes are (see Guidance on Strategic and Commercial Case): • Private sector led • Public private shared leadership • Public sector led • Community Company

DNO	Distribution Network Operator for the local electricity network and the interface between building electricity connections and the National Grid. (refers to the gas distributed network operator)
DNUoS	Distribution Network Use of System - charges that are levied by the UK's regional Distribution Network Operators that go towards the operation, maintenance and development of the UK's electricity distribution networks. http://www.pcmg.co.uk/services/energy/duos-distribution-use-of-system/
DSR	Demand Side Response, 'actions taken by consumers to change the amount of electricity they take off the grid at particular times in response to a signal' *Ofgem*
EED	Energy Efficiency Directive
EfW	Energy from Waste
Energy Centre	The main heating plant for the Heat Network
ERF	Energy Recovery Facility
Energy Demand/ Consumption	The Heat / Cooling / Electricity required by customers
ESCo	Energy Service Company
FAST	The FAST (Flexible, Adaptable, Structured and Transparent) Modelling Standard is a set of rules providing guidance on the structure and design of efficient spreadsheets for Financial Models. http://www.fast-standard.org/about-fast/
FBC	Full Business Case
FiT	Feed in Tariff
Fixed Charge	An annual fee for availability of the system which is payable irrespective of use
Flat Charge	An all-inclusive fixed payment for use of the system, irrespective of use
FM	Financial Model – A mathematical model, typically an excel workbook, designed to represent a simplified version of the performance of the financial aspects of a project. The Financial Model is developed to include the commercial structure and financing solution, and to reflect the technical design and Business Case as these aspects of the project progress
FMCIRD	Financial Model Cost Input Reference Document – a resource available in this guidance to underpin the review that the LA can undertake on the TEM
GVA	Gross Value Added
HIU	Heat Interface Unit
HMT	Her Majesties Treasury
HMT Green Book	HM Treasury guidance for public sector bodies on how to appraise proposals before committing funds to a policy, programme or project
HN(s)	Heat Network(s)
HNDU	Heat Network Delivery Unit
Hurdle Rate	The minimum rate of return on a project or investment required by a manager or investor. In order to compensate for risk, the riskier the project, the higher the hurdle rate
IRR	Internal Rate of Return
kW	Kilowatt, measurement of energy - KWe is electrical, KWth thermal
LA(ies)	Local Authorities

Loan Life Cover Ratio	The loan life coverage ratio (LLCR) is a financial ratio used to estimate the ability of the borrowing company to repay an outstanding loan. The Loan Life Coverage Ratio (LLCR) is calculated by dividing the net present value (NPV) of the money available for debt repayment by the amount of senior debt owed by the company
Modified IRR	Assumes positive cash flows are reinvested at the organisation's financing or cost of capital rate. With Project IRR it automatically assumes the cash flows from a project are reinvested at the project's calculated IRR
MW	Megawatt, measurement of discrete provision of Energy (in technical terminology called Power and is typically used to determine system capacities and peak demands). MWe, refers to a megawatt electrical or MWth, Megawatt thermal.
MWh	MWh is the provision of Energy and is the equivalent of 1MW per 1 hour typically used to describe provision or usage of energy over a period of time.
Nominal Prices	The value of an item expressed in money terms at a specific point in time. This value therefore takes into account the impact of underlying inflation on the money value. This compares to Real Prices which removes the inflationary impact.
NPC	Net Present Cost. In public sector investment appraisal, this would use the HMT discount rate (which starts at 3.5% for the first 30 years and then reduces from this point). NPC tends to be used in projects which have a net financial cost to the public sector ie the project costs are more than the project revenues
NPV	Net Present Value. The calculation is the same as for NPC. NPV tends to be used in projects which have a net financial value to the public sector
O&M Operator	Operation and Maintenance operator
OB	Optimism Bias - The demonstrated and systematic tendency for project appraisers to be overly optimistic
OBC	Outline Business Case
OJEU	Official Journal of the European Union
ONS	Office of National Statistics
Opex	Operating Expenditure – On-going costs of running a business or system
Private Wire	These are electricity networks owned and operated outside of the transmission or distribution system. This might be a wire system from a CHP generator to buildings to supply electricity.
Project Comparator	The comparator against which to compare the Preferred Options. This could be the 'Business as Usual' of 'Do Nothing' case. It will be costed up over the project life and presented in NPV terms.
P&L	Profit and Loss (Account)
PPA	Power Purchase Agreement – It is the principle agreement that defines the revenue and quality of a generating project, PPA can be adjusted to suit the needs of the buyer, seller and financing parties
Project IRR	Project IRR represents the weighted average cost of capital for a project. It is usually calculated from all of the non-financing project cash flows, including capital costs, operating and maintenance costs, revenues and working capital adjustments
Property Developer Comparator	Cost which would otherwise be incurred (avoided cost) by the developer if it did not connect to the HN
PSC	Public Sector Comparator
PWLB	Public Works Loan Board
Risk Register	A risk register is a risk management tool in which the risks of the project will be identified and allocated to project team members for monitoring and management
Real Prices	The Nominal Price adjusted to account for price inflation over time
RHI	Renewable Heat Incentive

RIBA 2, 3 & 4 Standard	Royal Institute of British Architects Standard - the stages 2,3&4 refer to: concept design, developed design and technical design respectively
Sensitivity Testing / Analysis	These are different scenarios run on a Financial Model (or Techno-Economic Model) to see what impact the scenario would have on the project
SOC	Strategic Outline Case
Social NPV	Social Net Present Value – this looks at the value of a project to society as a whole. It takes into account the full range of costs and benefits, both private and social, associated with a project.
SPV	Special Purpose Vehicle
Strategic Case	The Strategic Case demonstrates that the spending proposal provides synergy with the organisational strategic fit and is predicated upon a robust and evidence based case for change
STOR	Short Term Operating Reserve where signed up generators or consumers of electricity will be asked to increase capacity or reduce load within ten minutes and sustain this for up to two hours
TEM	Techno Economic Model – A design tool in the Feasibility Stage of a Heat Network project, enabling the analysis of various technical configurations and the associated cash flow implications. This informs the basis for the final Technical Design and is then developed into the Financial Model
TNUoS	Transmission Network Use of System – charges levied by the UK's electricity transmission network operators for the operation, maintenance and development of the UK's national transmission networks. http://www.pcmg.co.uk/services/energy/tnuos-transmission-network-use-of-system-charges-and-triads/
TRIAD	System used by the National Grid to apply charges for the use of the transmission system. More detail provided in Part 3
Unbundled Model	An "Unbundled Model" sees separate entities undertaking key and distinct roles for different parts of the network. For instance in this model there might be a separate asset owner owning pipework, a separate generator producing heat and a separate supplier purchasing the heat and using the pipework to supply customers. The lack of an overarching or integrated Delivery Vehicle is key
UoS	Use of System charges, which may be for use of the electricity transmission network (TNUoS) or electricity distribution network (DNUoS)
Variable Charge	A price payable per unit used
VFM	Value for Money: In this case applying HM Treasury Green Book Principals and the 5 Case Model to arrive at a view
WACC	Weighted Average Cost of Capital

Part 1: Development of the Techno-Economic Model into the Financial Model

1 Introduction and linkage to the 5 Case Model

1.a Introduction

Before arriving at the Outline Business Case (OBC) stage of development of a heat network (HN) project, it is assumed that the Local Authority (LA) will already have made some fundamental decisions regarding alternative strategic approaches as part of the detailed techno-economic Feasibility Study. It will therefore have considered:

- Energy Demand and Supply Assessments
- Heat Network Options
- Energy Distribution Systems
- Business as Usual (BAU), as a minimum
- Alternative projects (e.g. energy efficiency measures, rooftop solar etc.)

This guidance aims to link this initial work into the detailed development of the OBC. In HN projects supported by the HNDU, the stages link across to the 5 Case Model as follows:

- Masterplanning and the Feasibility and Techno-Economic Modelling would be viewed as the development of the Strategic Outline Case
- This guidance sets out the Outline Business Case (specifically in relation to the Financial Modelling) which includes the commercialisation phase
- A Full Business Case may be required if the project is particularly complex and / or is receiving significant central government funding support

Chapter 6 of the 'Green Book Supplementary Guidance on "Delivering Public Value from Spending Proposals"' sets out a headline methodology for planning a scheme and preparing the OBC. The overarching purpose of the OBC is to:

- Identify the spending option which optimises value for money (VFM)
- Prepare the scheme for procurement
- Put in place the necessary funding and management arrangements for the successful delivery of the scheme – in particular the affordability of the scheme and the budgets which would need to be made available by the LA(s).

This briefing note does not seek to reproduce the detailed guidance in the BEIS Business Case guidance (BEIS Business Case Template v1.1), its purpose is to set out how the Techno-Economic Model (TEM) from the Feasibility Stage will be developed into the Financial Model to support the key elements of the OBC. It therefore supports the OBC development in relation to Step 4 'Determining Potential VFM' and Step 6 'Ascertaining Affordability and Funding Requirements', with reference to the Green Book Supplementary Guidance as noted above.

The purpose of the Financial Model is to assist the LA in making major decisions around their preferred approach to developing HNs. As the project will be moving from the detailed techno-economic Feasibility Study to an OBC phase, these models are likely to be complex. This means that errors can occur if effective risk management around the model development is not applied. Errors may arise from the following areas:

- Not understanding the purpose of the model
- Incorrect inputs and assumptions
- Insufficient risk assessment of the inputs and outputs through sensitivity analysis and Optimism Bias (OB) assessment
- Construction errors occurring during the model build process

The OBC will need to be based on a number of assumptions around the technical, financial and commercial characteristics of the scheme. The final decision making that the Financial Model underpins will therefore only be as good as the quality of the inputs and the structuring of the analysis that follows. The LA needs to be comfortable with the parameters around the inputs and the accuracy of the outputs this engenders at an OBC stage.

This section should be read alongside the detailed flowchart (as set out in Figure 1) and description of the 'Approach to Model Development'. This details the key stages that need to be undertaken in developing the Financial Model to support the options appraisal process to robustly develop the Preferred Option through the Economic and Financial Case. It also provides the link to the Guidance on Strategic and Commercial Case and the CP1:2015 stages. This is set to print out in A3 format so that it can be considered alongside the drafting in this note.

This note is set out in the following sections:

- Section 2 (along with the Financial Model Cost Input Reference Document 'FMCIRD' – 'Inputs' and 'Risk Register') describes the development of the Financial Model, including the structuring, sourcing of inputs and key output measures
- Section 3 considers the non-financial benefits and impacts and how they are worked into the options appraisal process
- Section 4 looks at OB, Sensitivity Analysis and Risk. It sets out a methodology for calculating Optimism Bias and an approach to undertaking sensitivity analysis on the shortlisted options to understand the changes to the variables which may change the Preferred Option decision (along with the 'FMCIRD – Risk Register')
- Section 5 discusses how the Commercial Structure and Financing Mechanisms can be factored into the Financial Model
- Section 6 describes the Preferred Option and how the information contained within the Financial Model should be presented in the Financial Case section of the OBC
- At Appendix A, a detailed 'FMCIRD' is provided, which is a resource to underpin the review that the LA can undertake on the TEM as it is developed into the Financial Model. It is structured as follows:
  - 'Inputs' – to provide information on the approach that should be followed to develop the key inputs into a HN Techno-Economic and Financial Model
  - 'Risk Register' – which considers the risk of variability of the 'Inputs' and a mitigation approach to try and minimise this. Where available it also sets out a range of the potential variability to help inform the sensitivity analysis

– 'Comparator' which provides guidance on developing the 'Project Comparator', 'Property Developer Comparator' and the 'Consumer Comparator'.

This guidance assumes that an initial Feasibility Study has been undertaken, the LA already has determined the broad parameters / options of a HN scheme and that an initial TEM has been developed.

1.b Linkage to the Outline Business Case within the HMT 5 Case Model

Table 1 summarises Green Book guidance as to the role of the Financial Model in the development of the OBC. Please note that this is not an exhaustive list of Green Book activities, it simply summarises those identified for the OBC stage.

Table 1: Role of the Financial Model in the Economic and Financial Case

Development Process	Deliverable in relation to 5 Case Model	Commentary on use of the Financial Model	Stages / Steps / Actions as set out in Green Book Supplementary Guidance
Stage 2 - Planning the scheme and preparing the OBC			
Determining potential VfM	**Economic case – part 2**		**Step 4**
Revisit Strategic Outline Case (SOC) / Feasibility Study and determine short list, including the Reference Project (Outline Public Sector Comparator)		The options will help determine the structure of the model. The full Financial Model will not be fully utilised here.	Action 9
Prepare the economic appraisals for the short-listed options		The Financial Model will be utilised to generate NPVs to allow comparison between options	Action 10
Undertake benefits appraisal		Not part of the Financial Model although some of the key elements may be used to generate benefit measures e.g. Gross Value Added (GVA)	Action 11
Undertake risk assessment / appraisal		Key input variables to the Financial Model will be considered, a range of likely cost identified and a risk allocation and mitigation strategy identified.	Action 12
Select preferred option and undertake sensitivity analysis		The degree of sensitivity analysis on the Financial Model will depend on the degree of sophistication of the initial Feasibility Study. If an overarching commercial structure has not been explored / agreed at the earlier stages	Action 13

Development Process	Deliverable in relation to 5 Case Model	Commentary on use of the Financial Model	Stages / Steps / Actions as set out in Green Book Supplementary Guidance
		then sensitivity analysis will need to be run on the different commercial models.	
Ascertaining affordability and funding requirement	**Financial Case**		**Step 6**
Prepare financial model and financial appraisals		Financial Model will be a key data source for all elements of the Financial Case. Care must be taken at the design stage of the model to ensure that it can be disaggregated enough to provide the relevant information.	Action 19

Step 4 ('Determining potential VFM', HMT Green Book) is the spending (or 'options') appraisal phase of the project, where the potential VFM of the scheme is determined in relation to the various options for delivery. This is the Economic Case. Whilst bringing together a variety of information on costs, benefits and risks means options appraisal aids decision making, it should not be seen as unequivocally providing the right answer. The goal is 'optimal' – in other words, the option looked for is the one which best balances the costs in relation to the benefits and risks.

Further details around all the steps required to complete the Economic Case are set out in Section 3 of the BEIS Business Case Template. This provides details around the:

- Development of Critical Success Factors
- Long-listing of options from the Strategic Outline Case
- Short-Listing of Options – this is where the guidance in this note should be considered
- Procurement Options – where reference needs to be made to the separate 'Guidance on Powers, Public Procurement and State Aid'

The purpose of Step 6 ('ascertaining affordability and funding requirements', HMT Green Book) is to ascertain the affordability and funding requirements of the preferred option, in relation to the other short-listed options; and to demonstrate that the recommended deal is affordable. This is the Financial Case.

Whilst there tends to be a significant cross-over between the two steps, 5 Case guidance specifies the key differences between the Economic and Financial analysis. An initial Economic Appraisal will have been undertaken at the Feasibility Stage and will form the initial basis of the analysis – this will have been undertaken on a cashflow model which will not have included taxation or financing assumptions as set out in the Green Book and reproduced in Table 2 below.

Table 2: Economic versus Financial Appraisal

	Economic Appraisals	Financial Appraisals
Focus:	• VFM – net present value (NPV)	• Affordability – cash flow
Coverage:	• Wide coverage – Government and society ('UK plc')	• Relevant organisation(s)
Relevant standards:	• HM Treasury Green Book Rules • Discount rate (3.5% real) applies (Note this rate applies for first 30 years of the appraisal period. For the years 31 – 75, a real rate of 3.0% should be applied)	• Organisational accounting rules and standing orders
Analysis:	• Constant (real) prices • Includes opportunity costs • Includes indirect and attributable costs - costs of others • Includes all quantifiable costs, benefits and risks • Excludes all Exchequer 'transfer' payments – for example, VAT • Excludes general inflation • Excludes sunk costs • Excludes depreciation and capital charges	• Current (nominal) prices • Benefits – cash releasing only • Includes transfer payments (e.g. VAT) • Includes inflation • Includes depreciation and capital charges

If HMT sign-off is not required for any elements of the funding that the project is looking to source then there may be some flexibility in the application of Green Book guidance to the Economic Appraisal. For example, it may be possible to compare the options at the LA level taking into account the interests of local residents rather than the 'UK plc' level as part of the Economic Appraisal.

It is recognised that there will be a number of financial drivers for a LA and that the Financial Model will need to be able to assess these. For example, the LA may be concerned about the viability (whether revenues exceed costs over the life of the project), upfront costs including development costs and start-up losses, operating costs and cost of heat, and financial risks for the council.

Many LAs will also want to understand the impact of the Financing Mechanism within the Economic Appraisal and therefore require this analysis to be brought into an earlier stage of the process than envisaged within the Green Book. We have therefore not replicated the approach suggested in the Green Book around undertaking the value for money analysis on a cashflow model without taxation and financing assumptions. This is because by the time of the OBC, we will be comparing the costs of the HN to the Project Comparator (see section 1.c). These are both real options for delivery which therefore need to consider the impact of financing the scheme and therefore a taxation assumption. This differs from the Public Sector Comparator as described in Green Book and the value for money analysis needs to take into account two deliverable options rather than making a decision around a public versus a private sector procurement route.

1.b.i Financial Model Development Process

The flowchart set out in Figure 1 (overleaf) and Table 3 set out the process which should be followed to develop the TEM from the detailed Feasibility Study stage through to the Financial Model as part of the Commercial and Financial Cases. It sets out the following:

- Activity undertaken and its purpose
- What the model will look like at that stage
- Key outputs of the model / stage
- Who would build / use the model
- Which members of the project team would be involved in the process
- Cross reference to the more detailed guidance in this note, 'FMCIRD' and 'BEIS OBC Template'

It should be noted that the flowchart has been set up to print A3 to allow the reader to review it more easily.

To assist in the presentation, Figure 1 sets out the Financial Model development process only. At Appendix B, this development process is linked to the stages in the CIBSE Code of Practice and the key activities in the Guidance on Strategic and Commercial Case.

The heading references in Table 3 are also identified on the flowcharts to assist in working through the model development process.

Figure 1: Financial Model Development Process

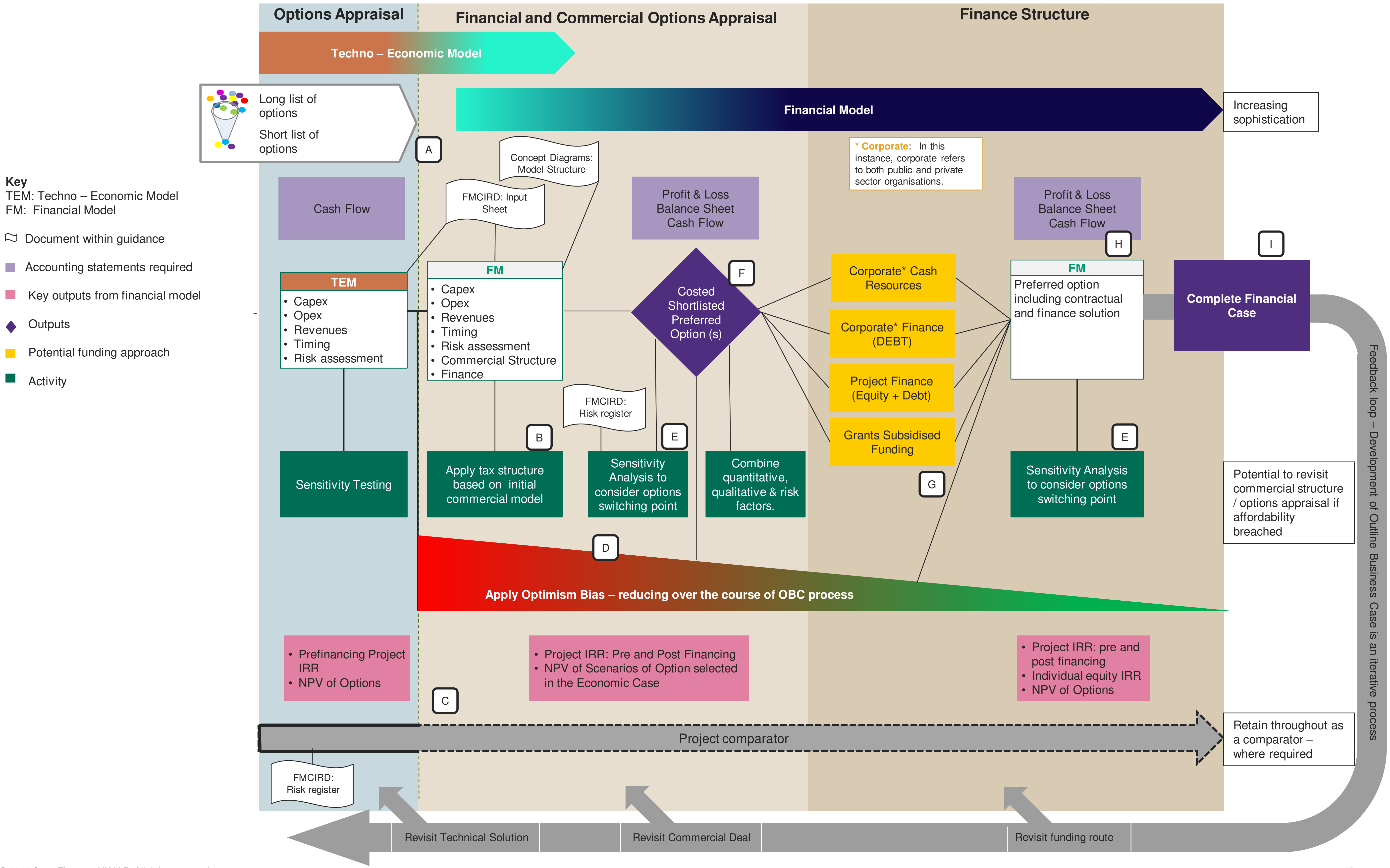


Table 3: Approach to Model Development and Explanatory Guide to the Flowchart

NB For the purposes of this example it has been assumed that it is the LA which is leading the HN development.

During Stages 1 & 2 an interim decision may be required to revisit the whole project if the more detailed analysis indicates that the decision in the Feasibility stage was not correct

Activity and purpose	What will the model look like	Key outputs of model / stage	Who would build / use the model	Who else would be involved in the process	Cross reference
A Review the output of the Feasibility Study and TEM The first stage will be to understand the characteristics of the shortlisted options and their likely ability to be delivered on a commercial basis. This should allow the determination of the number of options to take into the Economic Case – ideally only one alongside the Project Comparator. However, a couple of technical options may continue to be examined, depending on the nature of the HN.	Cashflow model developed in accordance with CP1:2015 Objective 2.9 This will have considered key technical inputs and scheduled these cashflows out over 25 and 40 year periods.	NPV of all options Pre-Financing Project IRR of all options	External Technical Advisory (TA) / Council team will develop cashflow model. Although if it is a complex scheme then a Financial Advisor may be required	TA support to develop key inputs On-going review from LA team	Section 2c of this guidance note FMCIRD 'Inputs' & 'Risk Register' section at Appendix A OBC Template 3.3 & 3.4
B Apply an initial Financing assumption and Taxation treatment This should be applied to one (or a limited number of) shortlisted option. It may that the financing assumption will have been agreed at the Feasibility Stage. The financing assumption should be simple in the first instance e.g. a fully debt financed solution provided by Prudential Borrowing. This can be flexed later in the process. This process will allow the development of a Financial Model which can generate NPVs and upon which Sensitivity Analysis can be undertaken. If there is still more than one technical option being considered, this will support the Preferred Option decision.	It is likely that this will be a full Financial Model with a full set of financial statements i.e. Profit and Loss Account, Balance Sheet, Cashflow. It will also include the tax structure (Corporation Tax, Capital Allowances, VAT). However, dependent on the complexity of the HN being proposed and the number of options being taken forward it may be that a slightly more sophisticated cashflow model than at the TEM can be used to reduce the shortlist. This will need to be determined on a project specific basis.	NPV of all shortlisted options Pre- and Post-Financing Project IRR of shortlisted options Potentially a 'Financing IRR' to reflect the return to each of the individual financiers if different sources of finance are used.	If financing structure then it is likely that an external financial adviser would be required unless the Council has the capacity in house. If still a cashflow model then this could potentially still be done in-house	TA support to challenge key inputs from initial TEM On-going review from LA team	Section 2c of this guidance note Concept Diagram – Appendix C OBC Template 3.4
C Develop the Project Comparator and Consumer Comparator This is a comparator option against which you would compare the Preferred Option. It should generate the same outputs as the Preferred Option but without delivery of the HN e.g. if the HN project was only concerned with the delivery of heat then the Project Comparator would only be modelled for the same heat	The model will cover the same appraisal period as the model underpinning the Preferred Option. If a full Financial Model is being developed to reflect the Preferred Option then the Project Comparator will need to reflect a financing solution. A simplifying assumption should be made	NPV of Project Comparator Levelised cost of heat to act as a Consumer comparator for HN	Although the financing structure is likely to be straightforward, it may be that an external financial adviser would be required unless the Council has the capacity in house.	TA support to develop the Project Comparator inputs. On-going review from LA team	Section 1c of this guidance note FMCIRD 'Project ComparatorTab' & 'Risk Register' OBC Template 3.3 & 3.4

Activity and purpose	What will the model look like	Key outputs of model / stage	Who would build / use the model	Who else would be involved in the process	Cross reference
demand. The LA will need to determine the degree of development and on-going use of the Project Comparator. It may be that for smaller and more straightforward schemes, the Project Comparator is only used to quickly confirm the Preferred Option.	in this regard. If the NPV assessment is still being made on a cashflow basis then the approach to financing should not be considered in the Project Comparator.		If still a cashflow model then this could potentially still be done in-house		
D Risk Assessment - Undertake Optimism Bias assessment OB is a process that starts at the options appraisal stage of the Economic Case and is continued near to financial close – its use is dependent on the scale of the opportunity. It would be expected that large scale and / or multiple options would use it more heavily and in an iterative way. It should be undertaken alongside the Sensitivity Analysis described in '5' below. One or more optimism bias workshops may need to be carried out dependent on the project at various stages of the FM development. Key points in the process where OB could be considered are: • Initial Feasibility • Final Shortlisting • Final Decision This generates a quantified assessment of the 'optimism' that has been applied to the model developed in '2'.	It is likely that the calculation of OB will be undertaken outside of the Financial Model. However, it will be the key inputs into the Financial Model that will need to be assessed to understand the degree of 'optimism' that has been applied to them. This will need to be considered in NPV terms.	Quantified assessment of optimism bias in NPV terms to allow assessment of the VFM position.	This process would need full input from the Project Team with a focus from the Technical and the Financial Advisors.	This process would need full input from the Project Team with a focus from the Technical and the Financial Advisors.	Section 4a of this guidance note OBC Template 3.4.1
E Risk Assessment - Run sensitivity analysis The purpose of the sensitivity testing is to assess the impact of changes to the key input variables to the key outputs of the Financial Model e.g. Project IRR, NPV, Heat Price (if this is generated by the Financial Model). The sensitivity analysis should be undertaken alongside the Optimism Bias assessment set out in 4.	The sensitivity analysis will be run by applying changes to the input variables in the Financial Model developed in 2.	Impact of changes to input variables on output of the Financial Model.	If including a financing structure then it is likely that an external financial adviser would be required unless the Council has the capacity in house. If still a cashflow model then this could potentially still be done in-house	TA support to challenge key inputs from initial TEM On-going review from LA team	Section 4b of this guidance note FMCIRD 'Risk Register' sets out ranges of variability where they are available OBC Template 3.4.4

Activity and purpose	What will the model look like	Key outputs of model / stage	Who would build / use the model	Who else would be involved in the process	Cross reference
F Combine Qualitative and Quantitative Factors to determine Preferred Option (Cost Benefit Analysis) This activity will be undertaken through a workshop and its objective is to identify the likely Preferred Option before the detailed work on the Financing Mechanisms is undertaken. It would be expected that an assessment of the qualitative scores of the different options would have been undertaken. This will have been alongside the review of the Social NPV and any other approaches that the LA will have used to consider the non-financial elements of the projects. The LA should then combine the risk adjusted Financial NPV (i.e. NPV of the option generated by the Financial Model plus the NPV of the Optimism Bias adjustment) with the qualitative analysis to determine the Preferred Option. This is the Cost Benefit Analysis. In making this decision the LA will also need to consider the: • acceptability of the IRR generated, • the Heat Price that needs to be charged to ensure the viability of the scheme • analysis which flows out of the Social NPV calculation although care needs to be taken that the quantifiable costs aren't double counted The Sensitivity Analysis undertaken in '5' should be reviewed in the context of the Preferred Option decision.	The NPVs of the project option(s) will be taken from previously developed Financial Model. The NPV of the Project Comparator will also need to be identified. These will be combined with the risk adjustment identified through the Optimism Bias adjustment and the Sensitivity Analysis to generate a risk adjusted NPV for each option. The Sensitivity Analysis should be reviewed to understand the switching points as to the change in key input which generates a change in the Preferred Option decision. It will need to answer: By how much can operating costs increase if the proposal is to remain worthwhile? How likely is this? By how much can revenues fall, if the proposal is to remain worthwhile? How likely is this?	See Table 10 in Section 4 demonstrating Preferred Option NPV of all options Pre- and Post-Financing Project IRR of all options Potentially a 'Financing IRR' If private ESCo structure then 'Blended Equity IRR' from the ESCo's perspective. Levelised cost of heat to act as comparator for HN Switching points as to when Preferred Option decision may change	Full Project Team	Full Project Team	Section 4c of this guidance note OBC Template 3.4.4
G Apply different finance, commercial and delivery structures to the Financial Model At this point, the number of options to be considered should have been reduced to a Preferred Option and potentially one other. The Project Comparator could also be maintained. The work that has been undertaken in the Strategic and Commercial Case will have identified the likely	The Financial Model developed in '2' will be a starting point for the analysis. Additional functionality may be required to meet the requirements of different funders e.g. if bank finance is introduced then Debt Services Reserve Accounts and Cover Ratios would need to be applied.	NPV of Preferred Option(s) Pre- and Post-Financing Project IRR of all options Potentially a 'Financing IRR'	External Financial Advisor	Full Project Team	Guidance on Strategic and Commercial Case Section 5 of this guidance note OBC Template 3.4 & 3.5

Activity and purpose	What will the model look like	Key outputs of model / stage	Who would build / use the model	Who else would be involved in the process	Cross reference
Roles of the different Parties and the impact that this will have on the Delivery Structure. Based on the output of this work it will be possible to run the Financial Model with the different financing solutions that are available under the proposed Delivery Structure(s). This process is likely to be iterative as there will be an interplay between a key input variable, the Delivery Structure and the Financing Mechanism e.g. if external bank finance is being proposed they may require a more prudent assumption around the embedded benefits in electricity sales.	As these Financial Models are likely to be more complex, the project needs to be progressed to a point that the models are being developed on a limited (ideally one) number of options.	If private ESCo structure then 'Blended Equity IRR' from the ESCo's perspective. Levelised cost of heat to act as comparator for HN Total Revenues generated Total Capex and Funding Requirement			
H Confirm Preferred Option including Contractual and Financing Solution Once the analysis in '7' has been completed, it should be possible to identify the preferred contracting and finance solution. And procurement The analysis undertaken in 6 should then be repeated to confirm the Preferred Option. A further headline consideration of Optimism Bias and Sensitivity Testing should be undertaken at this point setting out the scenarios at which there would be a change to the Preferred Option. The Economic Case should now be complete.	The Financial Model will be fully developed as set out in '7'.	See Table 12 in Section 5 demonstrating Preferred Option Switching points as to when Preferred Option decision may change Procurement routes Heads of Terms Key stakeholders and anchor load customers	Full Project Team	Full Project Team	Section 5e of this guidance note OBC Template 3.4.4 Procurement & State Aid Guidance Guidance on Strategic and Commercial Case
I Complete Financial Case The majority of the information required for the Financial Case should be generated from the Financial Model. The LA will need to ensure that the project is affordable from their perspective and this will require them to identify the budgets that are available – both revenue and capital. To further assess this additional sensitivity analysis should be undertaken to understand at which point the Preferred Option becomes unaffordable.	The Financial Model should have been developed to allow separate identification of the LA cashflows. This is determined depending on the role of the LA. The LA will need to identify the budgets that it has available to support the scheme	Completed financial statements including Cash Flow, Balance Sheet and Income statement clearly outlining liabilities and assets that will end up on the LA's balance sheet Completion of the BEIS OBC template – section 5.1	LA in-house finance team to understand budgetary position. External Financial Advisor to extract financial information in the Financial Model	Full project team	Section 6 of this guidance note FMCIRD 'Risk Register' OBC Template Section 5

1.b.ii Developing the functionality of the Financial Model

As the Financial Model is developed, it will need to have the functionality to consider the overall economics of the HN and the role that the LA (or other Developer) wants to play. As an example, the Economic Appraisal of a HN project would look at the whole system and determine whether it was economically viable. The measures that would determine this would be a mixture of quantitative and qualitative factors – see Sections 3 and 4. The Financial Appraisal would look at the cash flows etc. associated with the particular position taken by the LA (e.g. does the particular position taken make a sensible business opportunity?).

This guidance describes the use of Concept Diagrams at section 2b. The use of these is good practice and should ensure that the Financial Model is developed so that key project cashflows can be extracted.

The Guidance on Strategic and Commercial Case sets out a range of organisational structures for delivering the project or operating the scheme. These are:

1. Private sector led
2. Public-private shared leadership
3. Public Sector led
4. Community Company

1.b.iii Use of the Financial Model after the OBC has been approved

Once the OBC has been approved, the use of the Financial Model developed within the OBC will change dependent on the structuring of the deal as follows:

- Key elements from the Financial Model will be used to determine parameters of the procurement process, for example:
  - Affordability envelope – this sets out the range of budget support that the LA and others would be prepared to provide to support the scheme before having to revisit the scope
  - NPV competitive benchmark to feed into the bid assessment, although it is noted that Bidders will be assessed on their whole life cost
  - Initial guidance to bidders on financing options
  - Heat Tariff / Consumer Comparator (see section 1(c)) eg a LA may reasonably assume that a bidder will reveal a pricing methodology that has been used on other projects or a justification why a new heat pricing methodology may be required. This may give the LA confidence to the LA that end customers will not be overcharged
- If the LA decides to finance the scheme itself, then the Financial Model may be used to determine the level of Prudential Borrowing or internal cash reserves that the LA would require to develop the project
- If there is a competitive process to choose a delivery partner (this is likely to be in the Private Sector Led approach with the LA procuring the delivery partner) then the Financial Model should not be shared with the bidders. It would be expected that guidance would be provided to bidders to confirm the requirements that the LA would want to see in the bid Financial Model. The delivery partner would then use the models they have developed to work with its potential funders of the project.

1.c Project Comparator

In the context of a HN, it may not be possible to develop a Public Sector Comparator (PSC) in the way that is specified in the Green Book. This is because it is likely that the development will involve a combination of public and private sector interests which wouldn't directly compare to a purely public sector approach.

Consequently, to comply with HMT 5 case guidance, a Project Comparator Option will need to be developed for comparison to the Preferred Option. The Project Comparator should be developed over the same appraisal period as the other options and should be:

- Assessed over the full project life and presented in NPV terms
- Maintained through the final options appraisal process to demonstrate the value for money of the Preferred Option
- Utilised throughout the procurement process to act as a benchmark and maintain competition.

This will need to be considered carefully. Whilst the Project Comparator may be apparent, the methods used to model and evaluate the difference between the Preferred Option and the Project Comparator may not be immediately obvious and will vary depending on a number of factors such as the degree of new developments which may immediately or ultimately connected to the HN.

There could be a number of potential options developed as the 'Project Comparator'. A detailed description of different potential Project Comparators is set out in the 'Comparator' section of the 'FMCIRD' at Appendix A. The project team will need to carefully consider the most appropriate Project Comparator but key examples are set out below:

1. Business As Usual (BAU) Model - if the HN is being developed to heat existing public buildings, the comparator may simply be the business as usual model. This would consider the current costs of heating the existing buildings (with an appropriate level of capital and maintenance spend over the appraisal period). Where the HN is being expanded to provide heat to end consumers (potentially both social and private residential housing and non-residential) then the comparator could be the on-going costs of providing that heat through gas fired boilers with a phased approach to the boiler replacement.
2. In cases where the development of a HN will be to meet the aspirational requirements of the LA, be that for new public developments or for connection to commercial buildings, the Project Comparator will be more complex. One way of developing this could be to look at the cost of bringing the proposed assets up to current building regulation standards, but without introducing the HN. More guidance around this is set out in the 'Project Comparator' section of the 'FMCIRD' at Appendix A.

It is important to note the role that scale, location, development type (e.g. residential, commercial offices etc.) and whether the scheme is new-build or a retrofit / refurbishment project, plays on determining appropriate Project Comparator scenarios. There is a detailed analysis as to the elements to consider in the 'Comparator' section of the 'FMCIRD' at Appendix A.

Including the Cost of Carbon – A London example

As part of this assessment, it may be possible to consider the CO_2 performance of the HN as compared to the Project Comparator. This may not be relevant in some schemes but it is an approach that is used in London, for example planning guidance [1] suggests that £1,800 / tonne should be applied to schemes to 'offset' CO_2 underperformance (to be charged once – as capital expenditure – often as a condition of planning consent). Whilst this methodology is intended to ensure developers contribute to emissions reductions outside the scheme, the same approach could be used in establishing the capital cost associated with the Project Comparator.

The Project Comparator will serve a specific purpose in the assessment of options. It will therefore need to be considered separately from the other comparators which may be developed in the OBC, i.e.:

- Property Developer Comparator – this is the cost which would be incurred if the user didn't connect to the scheme (which may give rise to a Capital Contribution / Connection Charge)
- Consumer Comparator – this is the Heat Price Cost of the Alternative – see Part 2 Section 4.

[1] Para 2.5.13, Sustainable Design and Construction, Supplementary Planning Guidance, Mayor of London, April 2014

2 Use of the Financial Model

The evolution of the TEM into the Financial Model will be pivotal to the development of the OBC. As part of the Feasibility Study, it would be expected that an initial TEM would have been developed. In accordance with CP1:2015 Objective 2.9 'to conduct a consistent financial analysis and options appraisal', as a minimum it is likely that it would have been developed on a cashflow basis, considering key technical inputs and generating a pre-financing pre-tax Project Internal Rate of Return (IRR). Dependent on the degree to which the HN is developed, it may be that an initial post-financing Project IRR may have been determined. This will have required an assumption to be made around the financing of the scheme.

As the project moves into the OBC stage, the TEM will be developed into the Financial Model to allow analysis of the following:

1. Different potential technical solutions – although these should be limited in number eg HN with a Combined Heat and Power Plant v HN with Energy from Waste facility
2. Project Comparator
3. Commercial Structure
4. Funding Mechanism
5. Sensitivity of Outputs to varying ranges of key Inputs

The Financial Model will also be used for Sensitivity Analysis and elements within it extracted to allow the calculation of OB.

The Financial Model must be developed with the specific project requirements at the heart of the design, taking robust inputs, through logical calculations to generate outputs which enable informed decision making. As part of the development of the Financial Model, an approach to managing the risks around the cost inputs will need to be developed. The 'FMCIRD' provides a detailed 'Risk Register' which provides a methodology to managing the risk of errors in the inputs – it is worth noting that these are pre-finance components of the FM.

This section sets out:

1. Model build using Best Practice
2. Model Structure
3. Concept Diagrams
4. Sourcing Inputs
5. Calculations within the Financial Model
6. Outputs

2.a Model build using Best Practice

Best practice modelling now often refers to the FAST (Flexible, Adaptable, Structured and Transparent) standard.[2] Whilst the full requirements of FAST may not be required, dependent on the complexity of the model structure, the following best practice should be retained as the model is developed.

Key principles in the model development should be:

- Clear separation between inputs, workings and outputs. All assumptions are clearly defined
- Formulae are consistent across each row and timelines are treated consistently
- Data flows from inputs through working to outputs
- Linearity with no circularity
- Appropriate model integrity and commercial check are included
- There are no hidden rows, columns or worksheets
- Sign convention is consistent
- Transparency and simplicity of macros within the Financial Model. Their use should be minimised

2.b Concept Diagrams

As part of transitioning the TEM from the Feasibility Stage model into the Financial Model at the OBC stage, it will be important to set out the components of key revenue and expenditure items, such as revenue and cost drivers, operating costs profiles and heat demand assumptions to ensure there is a common understanding of the calculations.

This process will also help to identify the assumptions which will need to be obtained in order to complete the model.

An example of concept diagrams is set out at Appendix C of this note. This is an indicative example only (based on a Gas CHP HN) which sets out a best practice approach to determine the key drivers and calculations of the costs before developing the Financial Model. This sets out the key calculations that the Project Team need to be comfortable with before embarking on the detailed financial modelling process. This will also allow the Financial Model to be checked and refined as it increases in sophistication.

The structure of the Financial Model should be based on the following worksheet types:

- Inputs
- Calculations
- Outputs

Appendix C shows the core calculations that generate the outputs from an initial set of inputs. This means the Project Team can understand how the key categories of Income, Operating and Lifecycle Costs, Capital Expenditure (and potentially Capital Income) and Financing Costs are generated.

[2] http://www.fast-standard.org/

2.c Sourcing Inputs

As the TEM is developed into the Financial Model, the key model assumptions will be developed and expanded to cover the categories as set out in Table 4.

It should be noted that currently HNDU expect that energy prices are based on real, local figures where possible or modelled from local information. This is before national estimates are used, as they do not accurately reflect current energy prices.

It would be expected that an early task in the development of the TEM into the Financial Model would be to apply an initial financing assumption to allow a full suite of project returns to be considered. The financing assumptions should be simple in the first instance, e.g. a fully debt financed solution provided by Prudential Borrowing. More detailed analysis will be applied around the Financing Mechanisms in Section 5.

Table 4: Category of Input assumptions and source

Key category	Source
General Macro-Economic Factors • Indexation Rates	Will be specific to Input Category, e.g. General Inflation - Office of National Statistics[3] – factor used to be agreed by Project Team
• Electricity Prices	Key variable – see 'FMCIRD – Input' and also DECC 'Updated Energy and Emissions Projections – Annex M' [4]
• Heat and Coolth Prices	Key variable – see 'FMCIRD – Input'. Note this can be an input to and an output of the Financial Model.
Project • Commencement • Duration • Phasing • Expansion • Configuration • Load Input	This information will be project specific and should be worked through in detail by the project team based on initial findings from feasibility. It is likely that these would be developed in conjunction with the Technical Advisors to the project (this could be an in-house technical team or external advisors)
Capex	See separate 'FMCIRD' 'Inputs'
Opex	See separate 'FMCIRD' 'Inputs'
Energy Demands	See separate 'FMCIRD' 'Inputs' – in particular the section on Consumption
Heat Sources	See separate 'FMCIRD' 'Inputs'
Customer Types	To be developed through the project design phase. Will flow from the Techno-Economic Modelling at the Feasibility Stage.
Revenue	See separate 'FMCIRD' 'Inputs'
Funding	See Section 5 (this will include details on the cost of capital, financing terms etc)
Taxation	See 'Tax Guidance' in Guidance on Strategic and Commercial Case. Given the complex nature of taxation required for a HN it is likely that there will need to be external Financial Advisor support

[3] Office of National Statistics 'Inflation and Price Indices' - https://www.ons.gov.uk/economy/inflationandpriceindices
[4] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015

Key category	Source
Project Comparator	See discussion on Project Comparator in Part 1.c. The Project Comparator is likely to be developed in the same workbook as the Financial Model behind the HN Project. However, it will not necessarily need all the functionality detailed above.

Further detail on the sub-categories and the approach to costing items are set out in the attached 'FMCIRD' – both in the 'Inputs' and 'Risk Register' sections. There is a separate guidance note on the use of the 'FMCIRD' but as previously discussed, it is important that the LA challenges the inputs that have been used in the Feasibility Stage and understands the degree of accuracy that may be assigned to them. This is the purpose of the 'Inputs' section of the 'FMCIRD' at Appendix A in that it allows the LA to consider whether their costings have been developed appropriately. Dependant on the skills within the project team there may be a need to seek technical advisory support in this regard. Within the 'Inputs' section of the FMCIRD at Appendix A there is a cross reference to a 'Risk Register' which identifies how the risk of wide cost variations in outturn expenditure can be mitigated and potential ranges for Sensitivity Analysis.

The 'Cost Input' information should be reviewed by the Project Team and an appropriate level of contingency assigned based on the perceived risk of the project. This analysis should be considered alongside the Optimism Bias calculations set out in Section 4 of this report.

The phasing of the scheme development will be demonstrated through the cash flows in the Financial Modelling. The distribution design drawings will provide a basis for the analysis. Major plant items, distribution networks and all final valve sets and hydraulic interface sets will be identified and scheduled.

2.d Calculations within the Financial Model

As an example from a HN Financial Model, the worksheets set out below will be developed from the Concept Diagrams as detailed at Appendix C and generate the calculations to assess the options.

Table 5: Worksheets

Worksheet	Description
Inputs	
Input Constants	non-time dependent inputs and scenarios
Input Series	inputs based on annual timeline
Calculations	
Time	model timeline, project flags and phasing
Index	indexation and discount factor calculations
Income	Heat, Coolth and Electricity income calculations for plant
Operating Costs	Operating cost calculations for plant (including fuel costs)
Capex	Capital Expenditure cost calculations for plant and pipe network over the chosen appraisal period
Financial Costs	Financing and investor return calculations

Worksheet	Description
Heat Price	**NB** Heat Price can be input to and an output of the Financial Model. • Scenarios for calculation of heat price (see further guidance in Part 2), depending on whether a cost based approach or pricing with respect to the alternative is used
Electricity revenues	Options for calculation of electricity revenue, which will be based in the output of the plant multiplied by the price determined as follows: • Base on floor price in Power Purchase Agreement – although noted that this may be a variable pricing structure • BEIS/ Pöyry profiles • Private Wire, Licence Lite or other electricity sale options • Equity risk appetite if Special Purpose Vehicle (SPV) structure
Cashflow Considerations and Bad Debt Provision	This is discussed in more detail in Part Section 6(d), however the Financial Model should include appropriate provisions for delayed payments of bills and an assumption around bad debts.
Dashboard Workings	Supporting workings for Dashboard presentation (see below)
Outputs	
Financial Statements	Profit and Loss Account, Balance Sheet, Cashflow Statement These should include the impact of sensitivities, phasing and timeline variations
Economic Outputs	Economics of HN scheme - including project returns (e.g. Pre- and Post - Financing Project IRR, individual financing return to each investor)
CHECKS	Model integrity check sheet
Dashboard	Summary and graphical presentation of scheme, highlighting outputs for key decision making metrics, such as NPV and IRR. This will need to be tailored for the LA's requirements. Within this summary, dependent on the functionality of the FM, it may be possible to record the impact of sensitivities such as phasing and timeline variations. This will allow comparison of the sensitivity findings to determine the robustness of the HN project.
Other	
Map	Contents sheet
Concept Diagrams	Summary of key calculations within Financial Model

When developing the Financial Model the implications for the financial statements of the parties should be considered. This is expected to include:

- Potential treatment as a Service Concession
- Treatment of construction costs and extent to which they are eligible to be capitalised,
- Treatment of any financing costs
- Revenue recognition depending upon the contractual and tariff structure and extent to which payments are guaranteed or usage dependent
- Approach to valuing heat network assets in balance sheet"

Professional advice should be sought as to the accounting treatment that is applied to ensure that the above items are dealt with correctly. This will need to determine whether UK Generally Accepted Accounting Principles (GAAP) are applied or whether the Financial Model is developed under International Financial Reporting Standards (IFRS).

2.e Outputs of the Financial Model

For each technical option that has been shortlisted through the Feasibility Stage, the Financial Model will need to assess the full whole life costs of the project under a range of scenarios over an agreed appraisal period (e.g. 25, 30 and 40 year periods – dependent on the scheme it may not be necessary to model all these appraisal periods and it may be that longer appraisal periods may need to be considered). The appraisal period should be appropriate for a project and the potential financing arrangements. The Financial Model will need to present this in terms of a Balance Sheet, Income Statement and Cashflow Statement.

The same analysis will need to be undertaken on the Project Comparator – this will need to be considered on a whole life cost basis.

This sub-section briefly describes:

- The IRR and the NPV
- Other likely key outputs from the Financial Model

2.e.i Internal Rate of Return (IRR) and Net Present Value (NPV)

The IRR and NPV are key outputs from the Financial Model. The 'London Heat Network Manual' [5] sets out at a headline level description of these two measures. Table 6 describes the measure and details variants on them which may be used.

[5] 'London Heat Network Manual', April 2014, Mayor of London and Arup

Table 6: Description of Net Present Value and Internal Rate of Return

Key Measures	Description	Output from Financial Model
Net Present Value	NPV is frequently used for long term projects to calculate the prospective value of a project over its life, allowing for the time when the investment is made and cash flows are received. The NPV calculation discounts the projected cash flows to allow for the time delay in receiving them, at the required rate of return on the investment (see Table 1 in Section 1). This is normally used in the investment appraisal decision.	Pre-finance and Post-finance NPVs - To understand the impact of financing approach on the total cost of the project
Internal Rate of Return	IRR is used to measure the return that can be made from alternative investments. The higher a project's IRR, the greater the return or profit the project may offer. A project may be considered an acceptable investment if its IRR is greater than an established minimum acceptable rate set by the institution making it.	At a headline level, the difference between the Project IRR and an Equity IRR relates to the return measure being calculated pre- and post- capital structuring. The Financial Model should be able to produce both and do so on a pre- and post- corporation tax basis and in real and nominal terms. There are three commonly used IRR measures in assessing projects: [6] • **Project IRR** - represents the weighted average cost of capital for a project. It is usually calculated from all of the non-financing project cash flows, including capital costs, operating and maintenance costs, revenues and working capital adjustments • **Modified IRR** – this is calculated in the same way as the Project IRR but assumes that positive cash flows are reinvested at the investing organizations cost of capital and the initial outlays are financed at the organisations financing cost. This compares to the Project IRR which assumes the cash flows from a project are reinvested at the one calculated IRR • **Individual Investor IRR** – represents the return on the individual investors investment based on the cash inflows and outflows over the time the investment is held in the project. A commonly used return measure is the **Blended Equity IRR** if an SPV structure used - represents the return to investors after taking account of Senior Debt service. For tax and accounting reasons investors typically provide a mixture of share capital (equity) and Junior Debt [7]: in which case the IRR calculation takes into account all payments received on both equity and Junior Debt,

At this point, there will need to be a detailed workshop to discuss the outputs of the Financial Model to ascertain and understand the key metrics that will be monitored as this will depend on the Contractual and Financing Structure chosen. This will need to be tested through the Sensitivity Analysis. It may be that a number of iterations of the model will be required to reach the Preferred Option.

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225363/02_pfi_internalratesguidance1_210307.pdf
[7] Junior Debt is defined as debt that has is assigned a lower priority than Senior Debt in a liquidation or administration scenario. In SPV structures, it is often used as quasi-equity reflecting the fact that it requires a higher rate of return due to the higher level of risk being taken. It is also tax efficient.

Given that the development of the HN pipeline in England and Wales is in its early stages, there is limited precedent on HN IRR values. However, DECC have identified[8] that initial HN projects are a 'diverse range of potential schemes ranging from £3 to £4 million up to projects in excess of £40m. The IRR on these projects vary between 0% and 15%, but with the majority sitting between 5% and 9%'. As schemes often have a social objective then it may be that a lower IRR is acceptable to a LA.

The LA will need to carefully consider the IRR (range) that it believes is acceptable in a development. The Financial Model should be optimised using the best available figures and that will generate the IRR. That IRR will dictate the business models which are available to the LA and therefore the role that it wants or needs to play (based on the above ranges and the 'Role Descriptions' in Section 3 of Guidance on Strategic and Commercial Case) in order to deliver the strategic benefits of the project. This will need to be set against the wider objectives of the scheme, e.g. reducing fuel poverty, and key assumptions made – in particular heat and electricity price assumptions (see 'Risk and Sensitivity Analysis' in Section 4).

The IRR is unlikely to be the only measure scrutinised in these projects; the NPV should also be considered. These metrics should also be compared against the corresponding outputs of the Project Comparator. See Table 11 which summarises the key metrics used to determine the Preferred Option. Underneath this table, the use of the different outputs in making the Preferred Option decision is discussed.

2.e.ii Other key outputs from the Financial Model

The Financial Model should include an 'Outputs tab' or 'Project dashboard' to effectively present the outputs to the LA which are important in their decision making. This information can then feed through into the Business Cases and for translation into reports for members. Alongside the key return metrics set out above, this is likely to include items such as:

- Integrated financial statements (P&L, BS and cash flow implications)
- Capital structuring
- Levelised Heat, Electricity and Coolth Prices – see Part 2
- Discounted payback period
- Undiscounted payback period
- Key Dates for the Project
- Total Capital Expenditure – split out by Capex type and fully detailed
- Sources and Uses of Funds during construction and operations
- Plant output capacity – in terms of both heat and electrical output and detailing losses allowed for
- Electrical kWh sold split into on-site sales and export to the local distribution network
- Fuel usages in main plant and back-up boilers

If a project finance structure is being proposed with external debt the following key ratios should be presented:

- Debt Service Cover Ratio (average, minimum and any year within which the target is breached)
- Loan Life Cover Ratio (average, minimum and any year within which the target is breached)

[8] DECC 'Investing in the UK's heat infrastructure: Heat Networks."

3 Consideration of non-financial benefits / impacts

Below is set out – at a headline level – an approach which tailors the guidance in the Green Book to quantify the non-financial benefits of a HN. This demonstrates the flow of the options appraisal process and how this generates the decision around the Preferred Option.

BEIS has also produced a document for LAs considering Social NPV[9]. This document defines Social Net Present Value (Social NPV) before providing a methodology that could be used to measure the Social NPV of a HN project. It also considers further impacts which should be considered locally in the Social NPV calculation (e.g. reputational benefits (industry wide), air quality improvements) but which will none the less be of interest to LAs when making their investment decisions. This approach is particularly applicable for projects seeking to deliver specific social objectives.

For projects where the key driver relates more to Economic Development / Regeneration, some LAs have also commissioned work to look at quantifying the Gross Value Add (GVA) to their local area through undertaking a HN scheme. This approach generates a further quantification of factors which are not directly related to the underlying cost or revenue base of the scheme. In simple terms, GVA is the value of goods and services produced in an area, industry or sector of an economy. In the case of HN, it is the goods and services created/supported through investment in the HN.

3.a Undertake benefits appraisal as part of the Economic Appraisal

The benefits that can be quantified financially (i.e. in £s) should be included in the economic appraisals and subject to the cost benefits analysis. However, a HN project is likely to deliver a number of wider benefits to LAs which cannot necessarily be quantified financially. An example is shown below of a set of criteria that could be used to generate the qualitative assessment in accordance with section 3.4.2 of the BEIS HN OBC Guidance. Dependant on the approach that the LA was taking to their project, these can be supplemented by the key drivers set out at Appendix A of the Guidance on Strategic and Commercial Case.

- Economic benefits of having the HN business in the region and the money spent on energy bills staying in the region. The development of a HN could be a unique selling point for a region to attract new business and help support existing business and organisations through lower development costs and lower cost low carbon energy
- Direct and indirect jobs created to run and maintain local energy schemes
- Skills increased through participation
- Recycling of energy cost savings to the consumer back into the economy

[9] Heat Network Investment Decisions – Social NPV

- Potential health and economic benefits through alleviation of fuel poverty (although this may already have been covered in the Social NPV calculation)
- Environmental benefits of reducing carbon emissions
- Air quality improvement
- Reputational benefits

A common method within option appraisals is to weight and score the non-financial benefits for each option. This allows the LA to compare and rank different options in relation to their associated non-financial benefits. It should be undertaken as follows:

1. Exclude all financial benefits, whether cash-releasing or non-cash releasing
2. Group the quantifiable (non-financial) and qualitative benefits according to their relevant spending objective, and / or other benefit criterion for the scheme as a whole
3. Select an expert and representative team to weight and score the benefits for each of the shortlisted options
4. Give a weight (0% to 100%) to each of the spending objectives and / or benefit criteria
5. Give a score (1 to 10) to each option for how well it delivers the benefits associated with each spending objective or benefit criterion
6. Multiply the weights and scores to provide a total weighted score for each option
7. Rank the options in terms of benefit delivery and identify the preferred option on the basis of the highest score

3.b Recording the results

The process and the reasoning behind the scores and weightings should be documented clearly to demonstrate that a robust analysis has been carried out. As the assigned weights and scores given to options are value judgements, then the option appraisal process will require negotiation and compromise. The composition of the assessment team and their involvement in the process will lend credibility to these value judgements. Typically, the composition of the appraisal team would be the key project team and or the project board as supplemented by specialist advisors to cover specific issues that may have been identified as key objectives of the scheme, e.g. skills increased through participation.

A summary of the approach required in 3.4.2 of the BEIS HN OBC Guidance is set out in Table 7.

Table 7: Quantified Benefit Criteria – Example

		Project Comparator		A – HN with CHP		B – HN linking into Energy from Waste facility	
Benefit Criteria	Weight	Score	Weight x Score	Score	Weight x Score	Score	Weight x Score
Economic benefits of having the HN business in the region and the money spent on energy bills staying in the region	X	X	X	X	X	X	X
Impact on fuel poverty	X	X	X	X	X	X	X
Direct and indirect jobs created to run and maintain local energy schemes	X	X	X	X	X	X	X
Skills increased through participation	X	X	X	X	X	X	X
Recycling of energy cost savings to the consumer back into the economy	X	X	X	X	X	X	X
Potential health and economic benefits through alleviation of fuel poverty	X	X	X	X	X	X	X
Environmental benefits of reducing carbon emissions	X	X	X	X	X	X	X
Air quality improvement	X	X	X	X	X	X	X
Reputational benefits	X	X	X	X	X	X	X
Total	**100%**	**X**	**X**	**X**	**X**	**X**	**X**

Note: Options are indicative and not meant to give any specific guidance as to the preference of one option over another. Only three options are included here – it may be that there are more options to consider. The options have been deliberately not weighted or scored, as this will be for the project team on the specific project to work through.

The presentation of the above analysis should be considered alongside the calculation of the Social NPV.

The Preferred Option will be made based on a judgement made against the following:

- Pure financial (to include NPV and IRR)
- Qualitative and other Social NPV (although care needs to be taken when using this analysis that there isn't a double count of the quantifiable costs)
- Risk factors (eg technical / commercial, environmental, reputational)
- Deliverability of the HN and timeframe

4 Risk Assessment – Optimism Bias and Sensitivity Analysis

HMT Green Book and Departmental Manuals have always required public sector organisations to undertake a risk assessment of the short-listed options. Risk Management is not just important from compliance perspective but it is a fundamental part of project management which should lead to lower costs and better performance. HNs are complex infrastructure projects and there needs to be adequate risk transfer arrangements – there are particular issues around interface risk in HNs given that there are generation, transmission and billing operations contained within the same project.

Action 12 in the 'Green Book Supplementary Guidance' sets out a detailed approach to dealing with the risk assessment and appraisal. In relation to HN projects, the accuracy of the TEM should increase as it develops into a more detailed Financial Model. However, it is important that Sensitivity Analysis is applied to the key variables in the model to check the Preferred Option decision and to understand the impact of changes in variables on the affordability of the scheme and how it impacts the strategic and economic case.

This section deals with Risk Assessment in relation to the costings that are included in the Financial Model. It does not deal with the wider project management risks that sit around a project.

The key areas to test in relation to the Cost Inputs are set out in the 'Risk Register' section of the FMCIRD. These should be considered alongside the factors set out in Table 10 below.

The Green Book also introduces the concept of Optimism Bias (OB). This is defined as 'the demonstrated and systematic tendency for project appraisers to be overly optimistic'. This is a worldwide phenomenon whereby appraisers tend to overstate benefits and understate timings and cost, both capital and operational. To redress this tendency, project teams are required to make explicit adjustments for the bias.

This section considers the approach to managing the risks of underestimating the costs or using incorrect assumptions in the Financial Model. This analysis will form a key part of the overarching approach to risk management in relation to the HN development. It is likely that the following assessments will be delivered through a series of workshops. The development of the risk analysis will require full involvement from the wider project team and potentially require specialist advice. Whilst the process has been presented sequentially below, it is likely that it will be iterative.

In relation to developing the Economic Assessment within the OBC:

- Strictly in accordance with Green Book guidance, it would be assumed that an allowance for OB would have been applied at the detailed Master Planning stage (in effect the Strategic Outline Case in Green Book terminology). However, it is recognised that this may not have happened explicitly in some Feasibility Studies (although contingency factors may have been applied – the link between identification of optimism bias and the level of contingency will need careful consideration by technical work stream in the project team. It is likely that professional technical advisory support will be required – including quantity surveying skills – as there can be a trade-off between the contingency included in the underlying capex and the level of optimism bias that is then applied), therefore this should be revisited at the start of the OBC development process

- A full risk analysis including OB assessment and sensitivity analysis should be undertaken to feed into both on the Shortlisted Options and the Preferred Option decision within the options appraisal process. See Risk Register section of the FMCIRD at Appendix A.
- A further risk analysis should be undertaken to confirm the final decision when the detailed structuring and funding approach has been worked through

The remainder of this section is set out under the following headings:

1. Optimism Bias
2. Sensitivity Testing
3. Conclusion on Shortlisted Options

4.a Optimism Bias

The main objectives of the OB calculations are to:

- Provide a better estimate of the likely capital costs and works' duration.
- Make adjustments to the estimates of capital and operating costs, benefits values and time profiles

It is recognised that there has been no specific approach to OB developed for HNs. LAs are therefore going to need to draw on the experience of their project team on a project specific basis and take a considered view as to the level of OB to apply to their scheme. Dependant on the size of the project team it may be that technical and financial advisory support may be required to assist in the calculation.

This section is structured under the following headings:

i. Capital Expenditure Optimism Bias
ii. Operating Expenditure and Revenues Optimism Bias
iii. Confirmation of the Preferred Solution decision

4.a.i Capital Expenditure Optimism Bias

In relation to Capital Expenditure OB, an approach to calculating this based on the Green Book Generic Guidance, as developed by Mott MacDonald, is set out below. However it should be noted that, given the specific characteristics of a HN, it is not possible to use the Mott MacDonald guidance 'off the shelf'. Whilst their analysis provides a useful starting point, the adjustment factors and approach will need tailoring for individual heat network schemes.

Making adjustments as per Green Book – Capital Expenditure

Table 8 sets out the adjustment percentages for generic project categories as developed by Mott MacDonald based on the results of a study which looked at the sizes and causes of costs and time overruns in past project. This has been presented here purely to link back to Green Book guidance and indicate a starting point for HN schemes.

Table 8: Green Book Recommended Adjustment Ranges

	Optimism Bias (%)			
	Works Duration		Capital Expenditure	
Project Type [10]	Upper	Lower	Upper	Lower
Standard Buildings	4	1	24	2
Non-standard Buildings	39	2	51	4
Standard Civil Engineering	20	1	44	3
Non-standard Civil Engineering	25	3	66	6
Equipment / Development	54	10	200	10
Outsourcing	n/a	n/a	41[11]	0

In order to utilise the methodology set out in the Green Book, the project team should consider the ranges above alongside CP1:2015 categories i.e.:

- Energy Centre (plant and thermal store)
- HN (variable speed pumps, surveillance system)
- Building Connections (heat exchanger, heat meter, two port control valve)
- Building heating systems (heat emitters, two-port control valves)
- Gas Mains extension
- HV DNO connection

In undertaking the OB adjustment under Green Book, the project team should identify the upper bound percentages relating to the average historic optimism bias found at the OBC stage for a traditionally procured project (i.e. a design & build project, funded and project managed by the public sector). Each scheme will need to assess and agree project

[10] As defined in HMT Green Book guidance p.60.
[11] The OB for outsourcing projects is measured for operating expenditure.

specific values, but Table 8 provides an upper starting point. Once specific percentages are determined for the HN project then these should be used for determining the OB adjustment.

The following approach can then be undertaken to calculate the optimism bias for the specific HN proposals. The same methodology should be applied for both the Capital Expenditure and Works Duration risk elements for the scheme.

A worked example of applying this to a HN project is set out below – this is purely illustrative to allow a LA to develop an approach to calculating OB and is developed from previous work undertaken in the waste PPP sector. The process which should be followed is:

1. *Consider each element of the HN project in turn*

For example, the first asset to be considered could be the Energy Centre. It could be assumed that this has an estimated Capital Expenditure of £5m.

2. *Use the appropriate upper bound value adjustment as the starting value for calculating the Capital Expenditure and Works Duration OB*

For example, the Energy Centre OB could have an upper bound adjustment value of 24% (this is an illustrative example assuming that an Energy Centre could be considered as a standard building in Green Book guidance. It is recognised that this upper bound will need refining.) The value that is chosen will also depend on the stage of the business case at which the assessment is being undertaken ie it is likely to be higher at the feasibility stage as compared to a more developed business case.

3. *Consider whether the optimism bias factor can be reduced*

The Project Team should review the asset category and ascertain whether the upper bound percentage is valid and applied correctly. The focus of this is mainly from a technical perspective to inform the costing itself. The level of contingency already contained in the capital cost will also need to be considered as part of this technical assessment – it is likely that this will have moved on significantly from the Feasibility Stage, given the greater technical understanding of the scheme(s) and the iterative nature of the process.

In relation to financial and delivery issues, the HMT Green Book Guidance identifies a framework for mitigating down against the categories. This should be undertaken using the following methodology – this will need to be tailored to the specific scheme.

For each OB category – for both the 'Capital Expenditure' and 'Works Duration' categories, the upper bound value should be the starting point. Contributory Factors to that OB percentage should be identified and weighted. By considering the stage of the OBC development, the risk mitigation plan should enable the OB to be scaled down over time as the risks are addressed. This should be considered on a percentage basis – see Table 9 below.

The Project Team should consider the specific contributory factors that generate the initial upper bound percentage. These can then be weighted by the Project Team's considered view as to how well developed the project is – so in this example the most important item contributing to the optimism bias is the 'Degree of Innovation' weighted at 10.

There will need to be a process of discussion and negotiation as to the overarching view of the relative weightings between the Contributory Factors.

The Project Team should then work through each item to understand the degree of mitigation that is in place at this stage of the project. The example overleaf crudely uses the following mitigation approach:

Mitigation Percentage (%)	Description
0	Not mitigated
25	Partially mitigated
50	Understood factor and mitigation in hand
75	Well understood factor
100	Fully mitigated

Table 9: Example of Mitigation of Non-Standard Buildings Upper Bound Capital Expenditure Optimism Bias (anonymised version of a Waste PPP project)

			Standard Buildings		
	Upper Bound		24%		
Contributory factors to Upper Bound Optimism Bias (%)		INTERNAL NOTES ON MITIGATION & COSTS	CE (upper bound %)	Mitigation (%)	CE (project %)
Procurement	Complexity of Contract Structure	Initial Scheme so will be complex	1	25%	0.75
	Late Contractor Involvement in Design	Early Bidders day / contractor involvement	2	50%	1.00
	Poor Contractor Capabilities	Prequalification to select suitable contractors	5	25%	3.75
	Government Guidelines	Strong guidance	1	75%	
	Preparation of Tender Documents	Potential to use Public Procurement or new Utilities Regulations - currently unclear	7	0%	7.00
	Information Management			0%	
	Other			0%	
Project Specific	Design Complexity	Likley to be well understood technology (EFW or equivalent)	5	50%	2.50
	Degree of Innovation	Likley to be well understood technology (EFW or equivalent)	10	50%	5.00
	Environmental Impact			0%	
	Other	Early work on developing the project specific items	5	50%	2.50
Client Specific	Inadequacy of the Business Case	Early development of OBC by specialist advisers, with external review from HNDU	8	60%	3.20
	Large number of Stakeholders	Likely to be long time to get contract signed with investment partners	8	25%	6.00
	Funding Availability			0%	
	Project management Team	Strong resources team	2	0%	2.00
	Poor Project Intelligence	Informed client & Market	6	50%	3.00
	Other		2	0%	2.00
Environment	Public Relations	Public relations work established at outset		50%	0.00
	Site Characteristics	Network to be developed early	1	25%	0.75
	Permits/Consents / Approvals	Approval of Planning Permission is likely to happen but will be time consuming	6	25%	4.50
	Other		3	25%	2.25
External Influences	Political	Subject to change in policy	5	25%	3.75
	Economic	Some current uncertainty	8	25%	6.00
	Legislation / Regulations	High risk of new legilslation	8	25%	6.00
	Technology	Known technology	5	50%	2.50
	Other		2	0%	2.00
			100%		66.45

For each Contributory Item, a calculation can then be performed which indicates the degree of mitigation that has taken place. These can then be summed to give a total percentage mitigation. So in this example, through the Project

Team's understanding of the stage of development of the project, 66.45% of this upper bound OB (24%) needs to be applied i.e. 15.9%.

4. *Apply the optimism bias factor. The present value of the capital costs should be multiplied by the optimism bias factor. The result can then be added to the total net present cost (or net present value) of the whole life project costs to provide the Base Case*

In the worked example above this would mean applying an optimism bias of 15.9% to the Energy Centre element of the capital expenditure (£5m) giving an OB of £814k (if it is assumed all of the Energy Centre Capital Expenditure takes place in the first year of construction. If the construction is phased over a number of periods then the capital expenditure will need to be discounted back to an NPV).

5. *Review the optimism bias adjustment*

The above exercise will need to be completed for each element of the HN project and for both the Capital Expenditure and Works Duration Categories. The total OB to be applied to each option should then be compared to understand whether the approach is reasonable.

It should be noted that this exercise needs to be undertaken for both the Preferred Option and the Project Comparator. It is likely that one or more OB workshops may need to be carried out dependent on the project at various stage of FM development. Key points in the project are likely to be:

- Initial Feasibility
- Final Shortlisting
- Final Decision

As previously discussed, it is likely that there will be some overlap between the contingencies included in the underlying capital expenditure estimates and the optimism bias percentage. This will need careful consideration by the financial and technical workstreams within the project team.

4.a.ii Operating Expenditure Optimism Bias

In their analysis, Mott MacDonald were unable to recommend sound upper and lower bound optimism bias levels for operating expenditure and /or revenue items. However, the guidance is clear that optimism bias should still be considered for these parameters. If there is no other evidence to support adjustments to operating costs or revenues, appraisers should use sensitivity analysis to check tolerances and / or 'switching values', i.e. asking the following questions:

- By how much can operating costs increase, if the proposal is to remain worthwhile? How likely is this?
- By how much can revenues fall, if the proposal is to remain worthwhile? How likely is this?

It would be expected that the majority of this sensitivity testing will be undertaken as set out in section 4b below.

4.b Sensitivity Testing

As per the Code of Practice section 3.12.4, the Techno-Economic Modelling should – as a minimum - have considered the following sensitivities

- heat sales volume
- delays in the connection of buildings to the network
- downtime of primary heat source, e.g. CHP unit
- variations in future fuel and electricity prices
- out-turn construction cost
- construction programme over-run
- non-fuel operating and maintenance costs and management costs.

As the project moves into the sensitivity testing on the Financial Model to support the Economic Case, the key areas to test in relation to the Cost Inputs are set out in the 'Risk Register' section of the FMCIRD at Appendix A. The impact of these changes on the IRR and NPV of the remaining shortlisted options will need to be considered.

As the OBC moves towards identifying the Preferred Option, it would be anticipated that the focus of the sensitivity testing on the model will consider the key revenue drivers as discussed in Table 10 below. The LA will need to consider the degree to which they apply these sensitivities. It would be expected that each sensitivity will be run individually and then a combination of these will also be run e.g. combined sensitivities on future electricity and heat prices.

The analysis should consider the potential maximum upside and downside exposure to demonstrate the ranges that may be delivered by the project and this should be fed into the risk assessment. However, care should be taken to ensure that the number of sensitivities considered is contained to a manageable level.

Table 10: Areas to test for Sensitivity Analysis

Main Sensitivity Category	Sensitivity to run	Discussion
Capital Expenditure	Will be project specific and depend on technology choice	See guidance in the Risk Register section of the FMCIRD at Appendix A. There will be a number of impacts which will determine the sensitivity band to apply e.g. accuracy of sizing requirements, number of connections to be made, technology risk etc.
Fuel Price	Will be project specific	See guidance in the Risk Register section of the FMCIRD at Appendix A. Will depend on technology chosen.
Level of Demand Risk	Will be project specific	See guidance in the Risk Register section of the FMCIRD at Appendix A and Part 2 3(e) Will depend on the 'Density of the Load, the 'Heat Loss percentage' and 'Occupancy and Diversity'. The demand risk associated with retrofitting projects over a locality should be considered. In particular, this will need to pick up where there is a risk attached to the rate and the number of connections made and the longevity of the heat supply arrangements which can be entered into.

Main Sensitivity Category	Sensitivity to run	Discussion
Heat Price charged to end user	Model at current price paid for heat for retrofit and new build (Consumer Comparator)	Understand return generated by putting customer in a 'no better, no worse position'.
	Maximise / Minimise IRR	"Stress test" the model to understand the maximum and minimum pricing. This would give a range of the likely heat price to allow checking against market prices. The maximum IRR is likely to be generated by using the highest Heat Price that could be charged. In understanding the impact of the minimum IRR, this would potentially be agreed upfront and would give rise to the minimum heat price. This range would be of particular interest in a project finance style contracting structure – see Section 5 – as it would set out the potential returns to equity investors.
	Different pricing models i.e. Fixed and Variable Charging	Part 2of this guidance sets out the key considerations when developing a tariff structure. Each section within Part 2 describes how the issues considered in that section should be reflected in the Financial Modelling. Once the base sensitivities have been considered then the specific scenarios set out in this note should be considered.
	Different indexation profiles e.g. fuel indexation, RPI, CPI	To assess the impact a differential indexation rate for revenues as compared to the indexation rate inherent in the model.
Differing technical performance of the plant leading to heat loss	Run above sensitivities against different technical performance of plant and consequent heat revenue.	The heat loss percentages and technical tolerances specified on the plant itself will need to be reviewed.
Price of electricity sold for CHP. This will need to consider electricity sold to the grid and private wire, as well as embedded benefits See discussion in Part 3 Section 3 of this guidance	Wholesale electricity price	Sets the base position to compare against
	Percentage of electrical output which can be sold through private wire	As this will have a different pricing point to the wholesale electricity price – see Part 3 Section b3
	Floor price in Power Purchase Agreements (PPA)	PPA contracts differ, The PPA structure will also need to be considered in terms of the variable time of day, season and long and short term contracts and resulting prices
	DECC Electricity Profiles	DECC (now part of BEIS) produce price curves for wholesale electricity prices dependant on different economic growth assumptions [12]. The different scenarios in these could be modelled, as could an average of the profiles.
Electricity Volumes	Equity Appetite	In an SPV structure, the equity investor may be prepared to take a view on the electricity sale price they are prepared to assume in the Financial Model. This could be higher than the wholesale price – more in the region of the retail price, although soft market testing should be undertaken on this item.

4.c Conclusion on Shortlisted Options prior to testing the Financing Mechanisms

Once the OB and Sensitivity Analysis on the different Shortlisted Options has been undertaken (including the Project Comparator) it should be possible to provide the base information as set out in Table 11 below. If the required

[12] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015

analyses have been undertaken rigorously, then selecting the preferred option should be reasonably straightforward. The detail on the Commercial Structure and Funding Options can then be considered.

Table 11: Summary analysis of shortlisted options – Illustrative Example

	Project Comparator NPV (£'m)	Option A – HN with CHP NPV (£'m)	Option B - HN with EfW NPV (£'m)
Capital Costs	X	X	X
Operating Costs	X	X	X
Revenue	X	X	X
Sub total	X	X	X
NPV	X	X	X
Optimism Bias	X	X	X
Cash Releasing Benefit	X	X	X
NPV	X	X	X

	Agreed Measure	Agreed Measure	Agreed Measure
Benefits Score / Social NPV / Other non - quantifiable benefits (from Section 3)	X	X	X
Risk (non-financial) score / assessment of option	H / M / L	H / M / L	H / M / L

The sensitivity analysis undertaken in section 4b above should then consider at what point a change in the input variables would change the decision set out in Table 11. As set out in Figure 1 then this may indicate that the some of the key project parameters will need revisiting.

In making its Preferred Option decision, the LA will therefore need to consider the analysis above with the Project IRR that the project is generating. If the different financing approaches available do not generate the value for money position of the Preferred Option and /or an acceptable IRR to the project developer then the scheme may not be viable.

The Heat Price can be both an input and an output of the model (See discussion in Part 2 Section 4(e) of this guidance). There needs to be an initial Heat Price input into the Financial Model to identify a starting position and this can then be adjusted to optimise the key outputs – to the extent that the LA may have control over it within the commercial structure. The Financial Model needs to be flexible enough to deal with these different analyses.

A key option, that may mitigate fuel poverty, would be to have, for example, a 10% saving against the heat price cost of the alternative (Consumer Comparator). However, this would need to be considered on a project specific basis.

5 Commercial Structure and Financing Mechanism

Once a limited number of potential options that meet the Technical and the Economic Assessment ('Costed Shortlisted Preferred Option' as set out in Figure 1) have been identified, the impact of different potential delivery vehicles and financing mechanisms needs to be applied through the Financial Model. In reality, the final decision around the preferred technical solution and the different Delivery Vehicles and funding structures is likely to be developed in an iterative way.

This section does not seek to prescribe commercial structuring solutions for HNs. It recognises that commercial solutions are currently being developed and that greater clarity around approaches will occur when more projects come to market. It is also recognised that some initial consideration of the structures and funding sources will have been identified at the Masterplanning and Feasibility Stages.

Within England and Wales, there are a large number of existing networks, but with limited exceptions, they are small and mostly confined to single housing developments (see 'London Heat Network Manual'[13]). It is recognised that the development of new business models could support increased roll-out of heat networks.

Part 7 of the Guidance on Strategic and Commercial Case sets out four delivery vehicles that can be used to develop a HN. It also describes the Unbundled Model.

Dependant on the nature of the HN, there may be a need to set up a Special Purpose Vehicle (SPV) to determine the contract structures and the associated commercial relationships. However, this will depend on the strategic benefits that the LA wants to undertake and the financial performance of the project. As the Financial Model is developed alongside the Strategic and Commercial Case, the LA will need to:

i. Determine and review its objectives in relation to the scheme
ii. Determine its risk appetite for the scheme – both in terms of the roles that it wants to play and the financial resources it makes available – p88 of the Guidance on Strategic and Commercial Case summarises the Delivery Vehicles alongside the Roles
iii. From (i) & (ii) above the contractual relationships should become clear – this may create the need for an SPV or a number of different Delivery Vehicles

Ultimately, the OBC should result in a recommended governance structure and funding route.

[13] 'London Heat Network Manual, April 2014, Mayor of London, Arup

This section considers how these issues should be reflected in the Financial Model under the following headings

1. When is an SPV and contract delivery structure needed?
2. Structure of the SPV
3. Financing Mechanisms and Funding Sources
4. The 'unbundling of networks'
5. Confirmation of the Preferred Option Decision

5.a When is an SPV and contract delivery structure needed?

In their simplest form HN developments do not require a specialised Delivery Vehicle e.g. a HN installed in a social housing development by a LA that owns it – the 'Public Sector Led' delivery structure (the LA would need to determine if the development of the infrastructure was covered by its general powers or whether it would require the development of a limited company under the Localism Act).

For larger HN schemes to develop that are not owned, financed and managed by the same party then the scheme needs to be commercialised i.e. contractual relationships have to be put in place to:

- Introduce investors and financiers to the project
- Enable the installation work to be instructed
- Allocate the risks between the differing parties to the project

A LA which owns and finances a HN but sub-contracts the Operations and Maintenance and Lifecycle Management roles may still want to set up an SPV to ring-fence the operations of the network. This would make any future sale of the HN and / or refinancing of public sector and any commercial debt easier to achieve.

These arrangements may not be fully settled at the OBC stage eg if it is agreed that a HN partner is to be procured then only a headline structures may be identified with the LA proposing to use the procurement process to determine the best approach. However in a fully LA owned scheme then this would be worked up in more detail with approach to financing being determined through the interplay of state aid and risk. The OBC should clearly document the proposed approach.

5.b Structure of the SPV / Delivery Vehicle

In developing the appropriate structures for the delivery vehicle and contract mechanisms, the first step is to identify the factors which will be the main consideration in their design. In relation to the creation of an SPV / Delivery Vehicle, this requires understanding the balance of interests of the parties participating. There will be a trade-off between the commercial interests of the parties developing, delivering and operating the scheme and the most appropriate risk allocation between them.

The Guidance on Strategic and Commercial Case sets out four main categories of delivery vehicles:

1. Private Sector Led
2. Public-Private shared leadership

3. Public Sector
4. Community Company

Section 5.4 of the Guidance on Strategic and Commercial Case ('Choosing the Appropriate Delivery Vehicle') cross refers the different Roles in the heat supply system to the different Delivery Vehicles. **The Financial Model will need to have the functionality to able to deal with potential changes in consideration of the roles of the different Parties as the OBC is developed.** This may change the risk allocation in the commercial and legal structure and potentially flow through to the funding source affecting the cost of finance.

For example, the Financial Model could be set up so that the cashflows relevant to each of the physical components of the network (see Section 1.4 Physical components of a Heat Network within Guidance on Strategic and Commercial Case) can be analysed discretely, i.e.

- Heat Generation Plant
- Energy Centre
- Primary Network
- Secondary Network
- Tertiary Network
- Fuel (input)
- Electricity (output)

These cashflows would need to be aggregated to consider the overall economics of the project and to allow the application of Financing Mechanisms.

The Financial Model would then need to be able to consider the different commercial structures that are determined through the Commercial Case, e.g. an SPV may be set up to manage the purchase and sale of heat from the Energy Centre to the end users whilst the Primary Network could be owned and financed by the public sector. The SPV could utilise one of the three of the Delivery Structures identified (which may have different return requirements), i.e.

- Private Sector Led
- Public-Private Shared Leadership
- Public Sector Led

The Financial Model would need to include the functionality to assess the impact of these different Delivery Structures on the overall project economics. These conclusions would also need to be subject to Sensitivity Analysis set out in Section 4(b) above.

Change in commercial structure and its impact on the funding source – an example to demonstrate required functionality in the Financial Model

An initial assumption may have been that a private sector Developer would fund the pipe network and therefore the finance was being sourced from the private sector. If the Financial Modelling demonstrates that this does not generate a suitable IRR for the scheme overall, then this may be a role that the LA steps into and uses Prudential Borrowing and / or seeks other funding (eg BEIS HNIP) to help finance this element of the scheme.

The Financial Model would need the flexibility to apply different funding terms to the different elements of the scheme.

5.c Financing Mechanisms

The Financial Model is the key tool used to assess the different potential Financing Mechanisms which could be used to fund the HN scheme. It will need to be developed to reflect the commercial structure of the HN and it should have the functionality to allow the financial position of the different commercial stakeholders to be extracted.

In particular, the Financial Model will need to be able to deal with potential different Financing Mechanisms and be able to compare between them – in terms of the key metrics for the LA (e.g. IRR, NPV, heat price etc.). As previously discussed, this will depend on the complexity of a scheme – the Finance Mechanism appraisal for a small heat off-take scheme will look very different to a full SPV structure.

The Financial Model is likely to need to include functionality to accommodate the requirements of external finance (e.g. Debt Service Reserve Accounts, Cover Ratios) and also of private sector developers of the network (e.g. identifying connection charges to end customers). As the size and complexity of HN developments increase, the sums of capital investment required are likely to go beyond that which the promoters or developers (including the LA) are willing or able to accept on their balance sheets. That means providers of finance will need to be able to see a structure for a delivery vehicle capable of securing the cashflows of the scheme to finance their loans. The Financial Model is the starting point for assessing the relationship between the key project variables and the impact that they have on the cashflows available to service the financing of the project. It will also calculate the different returns for the different investors

Commercial Funders and the Green Investment Bank [14] have identified and are prepared to support a range of investment structures and Financing Mechanisms for HN projects. As part of the OBC development and the Financial Modelling, project teams will need to appraise the projects from an investor's perspective, whether public or private. The following analysis considers two Financing Mechanisms although structures can vary significantly on a wide spectrum.

Projects could be structured to sit on the scheme owner's balance sheet (this could be on a LA or private sector balance sheet), financed through **corporate finance** loans (this could be internal finance available to the corporate entity or access to Prudential Borrowing by the LA) or reserves. A separate fully owned entity could be established to separate the HN business unit – the scheme owner is in essence providing 100% project 'equity' with risk transfer being achieved through the contractual structure. Linking this back to the Guidance on Strategic and Commercial Case this would be either the:

A - Private Sector Led Model; or
C - Public Sector Led Model.

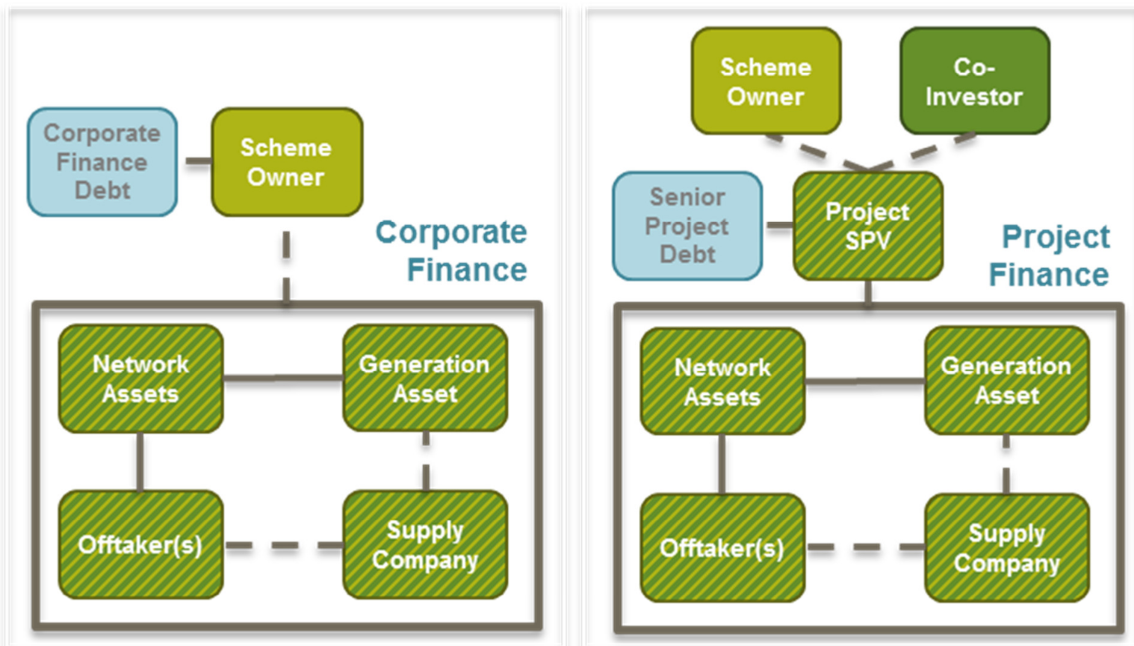
In a **project finance** structure, the scheme owner would invest through a separate entity (this would be a SPV set up specifically for the delivery of the HN project). If the IRR and the Economic Case indicated that the HN was viewed as 'Commercial' then this structure could attract other equity co-investors and project senior debt. These investors would have limited recourse to the scheme owner's own balance sheet; as such risk transfer is achieved through the contractual and Financing Mechanism. This structure could be either of the following Delivery Structures set out in the Guidance on Strategic and Commercial Case:

[14] Green Investment Bank – 'District Heating Finance' – link to website to be added when know

A – Private Sector
B - Public-Private Sector Shared Leadership'

A simplified representation of Corporate and Project Finance is set out in Figure 2:

Figure 2: Contract Structure applied to Financing Mechanisms



5.c.i Types of Financing Mechanism

Table 12 below sets out potential Financing Mechanism and Project Characteristics together with where a LA may look to source funding / provide guarantees. The purpose of this table is to group the broad categories of Financing Mechanism to the different characteristics of a project to allow the different funding sources to be reflected in the Financial Model. A more detailed description of the different potentially available funding sources is set out in Section 3, sub-section 2 of this guidance note.

This table should not be viewed as definitive guidance as to when a particular funding source should be used. Its purpose is to help a LA work through the potential Financing Mechanisms which could be applied.

The choice of funding will depend on the Delivery Structure for the different Roles within the HN and a number or all of the 'Types of Financing Mechanism' presented in Table 12 could be used. Therefore, for any given HN project the Financial Model will need to have the functionality to deal with the combination(s) of 'Types of Financing Mechanism' that are being evaluated through the business case.

It should be noted that BEIS are currently consulting on how the Heat Network Investment Project (HNIP) funding may be allocated to projects. This funding is not included in the table below but will be an important source for projects in the future.

Table 12: Linkage of Types of Financing Mechanism to Project Characteristics and where the LA may provide funding

Types of Financing Mechanism	Project Characteristics	LA funding sources

Corporate Cash Reserves:
• Cash resources used for projects with short paybacks, newer technologies, or where external funding not available or expensive
• Should consider alternative uses and long term nature of assets
	• Given the likely availability of cash reserves that a LA may wish to invest in a HN project, then if it was the sole funding source then this would likely be for a smaller scale project
	• As the LA / Developer would be putting its cash immediately at risk then it is likely that the project would have:
	  • No/Low build out risk/ limited build out potential
	  • No/Low demand risk
	• This could be a project that a LA is keen to take forward for non-financial reasons therefore it may have low returns. However, it is recognised that ideally all projects a LA invests in could generate a commercial return
	• Alternatively, this funding could be a useful source of finance to try and de-risk the early phases of a larger project to attract future private finance
		• Retained reserves
		• Prudential Borrowing

Corporate Finance (debt)
• On-balance sheet, against the scheme owner's (borrower) credit rating
• Fully owned arm's length entity to separate business unit can be established
• Public Sector use of Debt Management Office (DMO) finance eg Public Works Loans Board debt
• Banks can make term loan to private or public sector clients
• If private sector led then all debt would sit on balance sheet of the Developer – however the LA will need to carefully consider the accounting treatment in the context of the ownership structure
	• As the debt is being secured on the credit quality of the LA rather than the specific project economics then it is likely that the LA would only support small – medium size schemes as its liability could cover full repayment of the debt. As above these schemes are more likely to have:
	  • Lower build out risk/ limited build out potential
	  • Lower demand risk
	• It is noted that this may not be the case for all LAs and that they may have a higher risk appetite
	• As above, this could be a project that a LA is keen to take forward for non-financial reasons therefore it may have low – medium returns (but sufficiently above internal cost of capital)
	• However, this funding could be a useful source of finance to try and de-risk the early phases of a larger project to attract future private finance
		• Retained reserves
		• Prudential Borrowing
		• Specific energy efficiency funds e.g. London Energy Efficiency Fund
		• Direct Borrowing from Banks Eg project lending from a major infrastructure bank or GIB's Green Loan [15]

[15] GIB's Green Loan - offers the public sector a low, fixed-rate loan for periods of up to 30 years. It has been specifically designed to provide a flexible financing mechanism able to facilitate "spend to save" low carbon projects with repayments profiled to forecast project economics.

<table>
<tr><th>Types of Financing Mechanism</th><th>Project Characteristics</th><th>LA funding sources</th></tr>
<tr><td>Project Finance (equity and debt)
• Special purpose vehicle set up to identify the contractual arrangements to deliver the Financing Mechanism
• Long term service provision with project risk transferred
• In a traditional PPP structure, this has referred to off-balance sheet, limited recourse finance. However the risk / reward position will be need to be considered to assess the accounting treatment
• Some risk underwriting by the scheme owner could reduce cost of capital
• Equity required and debt finance possible for large projects
• The majority of the SPV finance is likely to come from a mixture of equity and debt finance.</td><td>• Medium – Large size. Larger lenders may have higher ticket requirements (perhaps £50-100m). Smaller lenders may be interested in providing funding < £20m (perhaps £5-10m), which could be accompanied by higher pricing and shorter tenors.
• Medium build out risk/ visible build out potential
• Some future demand risk
• Could be 100% Private or Public sector owned or a shared undertaking in a Public Private Joint Venture
• Risk adjusted commercial returns</td><td>• Dependant on specific SPV structure, the LA could provide an element Prudential Borrowing into the scheme. Potentially this may be at a premium therefore providing additional revenues to the LA. The potential implications of State Aid will require careful consideration
• Specific energy efficiency funds e.g. London Energy Efficiency Fund</td></tr>
<tr><td>Grants/ Subsidised Funding:
• Support for demonstrators and new technologies, where external funding not available or expensive
• Central Government/ European Funding</td><td>• These funding sources are likely to be contributory sources and be provided to the HN along with the sources above
• Small – Large size
• High build out risk/ visible and speculative build out potential
• High demand risk
• Public / Private sector owned
• Low – medium Return (sub-market given project risk)</td><td>• City Deal Financing
• European Structural Funds[16] (includes ERDF and specific innovation criteria)</td></tr>
</table>

This demonstrates that the Financial Model will need to be developed such that a range of funding sources can be considered with different tenors of debt with different returns. This is one of the key differences between the Financial Model and the Techno-Economic Model in that it allows the ownership and financing structures to be modelled to demonstrate debt and equity returns.

5.c.ii Financial Modelling of the Financing Mechanisms

The LA should work through different project characteristics set out above and determine which of the above financing structures would be applicable to the project. Once these have been narrowed down, then this can be modelled financially and the different returns assessed against the differential risk profile.

A Financial Model which is designed to satisfy the requirements of external financiers in a Project Finance structure is likely to require more functionality than a fully Corporate Financed or Grant Funded approach. This is due to the need to maintain cash reserves to cover future debt and interest payments and the need to 'optimise' the Financial Model to the different return requirements of investors.

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224755/13-1049-development-and-delivery-european-and-investment-fund-strategies-guidance-for-leps.pdf https://www.gov.uk/european-structural-investment-funds

Project Finance Structure – an example to demonstrate the impact this may have on the heat price to be charged to the user

A project finance structure would require a higher return delivered to the private sector to cater for the risk transfer that is inherent under a debt / equity structure. Dependant on the project economics it could mean that a more aggressive assumption would be required on any heat price charged to end users. Hence, a privately financed HN may require access to a higher heat density than a public sector financed HN to achieve the same end tariff to customers.

It is likely that this process will be iterative and that once the different financing and contractual structures are applied to the preferred option(s) then the scope of the project may need to be revisited. It may be that some of the funding sources which have specifically been developed to promote the development of HN will allow flexibility around some of the funding terms eg deferral of repayment until construction is completed, reduced repayments in the early years of the schemes.

5.d The unbundling of networks

As set out in the 'London Heat Network Manual', the role of a SPV in the development of a HN at scale is particularly focussed at the establishment and construction management of networks. An important consideration in the structuring and strategy of SPVs and the consequent Financial Modelling is the potential unbundling of networks and possible exit strategies.

There are examples of project structures which as the project expands, unbundle into their constituent businesses e.g. a heat generation company or companies, possibly in different ownership from the network itself – as per networks served by energy from waste, possibly a different ownership from the network, e.g. a separately owned and operated EFW plant serving a network.. The businesses and risks associated with heat transmission or distribution may be separated from that of heat generation. The result is the need for a structure of control which recognises the role of these parties as contractors, but at the same time accommodates their common reliance on the network's operation and economics.

Again, the Financial Model should retain the flexibility to deal with these sorts of changes at a later stage of the project e.g. if the CHP units are likely to be replaced by a different technology / commercial approach at the end of their life / change in strategy of the project.

5.e Confirmation of the Preferred Solution Decision

The application of the Contractual Structures and the Financing Mechanism may have changed some of the outputs from the Financial Model since the analysis in Section 4 summarised in Table 10. This analysis should be revisited and the OB assessment updated. Given the detailed analysis that will have been undertaken in the earlier assessment it would be expected that this could be undertaken quite quickly.

The analysis should be represented as in Table 13 below.

Table 13: Summary analysis of Project Comparator and Preferred Option including Capital Expenditure Optimism Bias – Illustrative Example

	Project Comparator NPV (£'m)	Preferred Option - HN with EfW NPV (£'m)
Capital Costs	X	X
Operating Costs	X	X
Revenue	X	X
Sub total	X	X
NPV	X	X
Cash Releasing Benefit	X	X
NPV	X	X
Optimism Bias – CAPEX	X	X
NPV	X	X
	Agreed Measure	**Agreed Measure**
Benefits Score / Social NPV / Other Qualitative (from Section 3)	X	X
Risk (non-financial) score / assessment of option	H / M / L	H / M / L

Again, the LA may wish to run some sensitivities on key input variables to understand at which point there may be a switch between the Preferred Option decision and Project Comparator.

6 Conclusion on Preferred Option(s) and Completion of Financial Case

Once the Preferred Option is known and the commercial and financial structures have been applied then it should be possible to complete the Financial Case. It is preferable to only consider one Preferred Option at this point although it may be that another option is considered.

The majority of the information in the Financial Case should be generated from the Financial Model.

BEIS's OBC template (Section 5) sets out the key elements that should be contained within the analysis. The key purpose of this section is to determine that the Preferred Option is affordable from the LA perspective and to understand the level of funding required.

At this point, the satisfaction of the value for money goal of the Economic Case and the affordability goal of the Financial Case should largely be established. However, both these positions will need to be monitored throughout the next phases of the project – which will require a number of procurement activities. These positions will be finalised in the Final Business Case.

The information for the Financial Case should be developed from the perspective of the LA as set out in Table 14 below and provided for each year of the appraisal period.

Table 14: Sources of information for Financial Case

Cost Category as per BEIS OBC Financial Case Guidance	Source of information	Comment
Capital Resources		
Preferred Option: Capital Resources required	Financial Model tabs: • 'Capital Expenditure' • 'Outputs dashboard'	LA may not directly be providing capital funding into the project. Financial Model should be developed with functionality to identify all Funding Sources.

Cost Category as per BEIS OBC Financial Case Guidance	Source of information	Comment
Funded by:	Financial Model tab 'Funding Sources' will break out the funding along the lines of: • Grant Funding • Internal Resources • Additional Prudential Borrowing from Public Works Loans Board If a Project Finance Structure is being considered then this will need to identify debt and equity sources also.	Funding sources may be wider than this. In a SPV structure, the funding sources may come from a mix of debt and equity and not impact on the LA in terms of capital budgets. Also it may be that some categories of finance are to be sourced through the procurement process.
Revenue Resources		
Programme	Financial Model tabs: • 'Profit and Loss Account' • 'Cashflow'	This will depend on the specific nature of the scheme and the commercial structures chosen. There will be a P&L for the scheme which will have been used to assess the viability of the overall development. The P&L in the Financial Model will need to be interrogated to draw out the element of costs that are being passed onto the LA. It may be that this could be a net income to the LA. In HN schemes where the LA is taking an equity stake in the delivery vehicle then the dividend flow to the LA will need to be considered. Also if the LA is lending Prudential Borrowing into a delivery vehicle but charging a 'premium' on the underlying rate then this should also be recognised in the affordability assessment.
Admin	Costs of administering the HN scheme	These should be developed by the LA or the Developer / SPV / ESCO developing and delivering the network. Care should be taken to ensure there is no double-count with costs included in the Programme Costs line. This may arise in LA led schemes where the LA plays a key role in the delivery vehicle.
Funded by: • Existing Budgets • Additional Sources	There may be some budgets already in existence to fund the operations of the HN. These should be compared to the proposed costs and a commitment made to find the difference.	An important part of the OBC approval will be the degree to which there is LA elected member approval of the scheme and commitment to meet any revenue shortfall which needs to be found for the project.

6.a Financial Risk

The impact on the sensitivity testing undertaken in Section 4 should now be considered on the financial position of the LA. This should specifically determine the impact on the affordability of the scheme. As part of this, an assessment should be made as to what movement in the key variables could cause the LA to reconsider its commitment.

If this affordability commitment cannot be met then the decision around the Preferred Option will need to be reconsidered. It is likely that the process will be iterative.

6.b Next Steps

Once the OBC has been approved, the use of the Financial Model developed within the OBC will change dependent on the structuring of the deal. The commercial characteristics of the deal and the roles performed by the different parties will need to be considered to determine which elements of the Financial Model are utilised by the LA and where the private sector may be involved.

It would be expected that the model would be used as follows:

- Key elements from the Financial Model will be used to determine parameters of the procurement process, for example:
  - Affordability envelope – this sets out the range of budget support that the LA and others would be prepared to provide to support the scheme before having to revisit the scope
  - NPV competitive benchmark to feed into the bid assessment, although it is noted that Bidders will be assessed on their whole life cost
  - Initial guidance to bidders on financing options
  - Heat Tariff / Consumer Comparator (see section 1(c)) eg a LA may reasonably assume that a bidder will reveal a pricing methodology that has been used on other projects or a justification why a new heat pricing methodology may be required. This may give the LA confidence to the LA that end customers will not be overcharged
- If the LA decides to finance the scheme itself, then the Financial Model may be used to determine the level of Prudential Borrowing or internal cash reserves that the LA would require to develop the project
- If there is a competitive process to choose a delivery partner (this is likely to be in the Private Sector Led approach with the LA procuring the delivery partner) then the Financial Model should not be shared with the bidders. It would be expected that guidance would be provided to bidders to confirm the requirements that the LA would want to see in the bid Financial Model. The delivery partner would then use the models they have developed to work with its potential funders of the project
- As at the OBC stage, the Financial Model will be the key source of information to allow completion of the Final Business Case

Part 2: Heat pricing

1 Introduction

Consideration of the pricing approach for a HN will be key to understanding the revenues available and overall viability of the project. As discussed further in Part 1 Section 4(b), the price and pricing structure will be pivotal to testing the robustness of the project, in particular sensitivity testing relating to consumption. Not only will there be a high level of consumer interest in the pricing and charging structure (including attracting customers to connect in the first place), but it is also likely to have an impact on the type and origin of funding which might be available to the project.

This Part of the guidance firstly sets out the context in which this document is operating, noting the largely unregulated market in which the supply of heat is currently made. A summary is given of the emerging guidance in the market aimed at consumer protection and setting best practice standards such as Heat Network (Metering and Billing) Regulations, the Heat Trust and CP1:2015.

Secondly, the principles which should be borne in mind when setting the pricing strategy and structure for the scheme is described, including the types of pricing structures currently in the market and which elements of cost are most likely to be reclaimed through each element of the pricing structure, some of which may vary over time as the cost of delivering the service changes. The ways in which pricing levels can be set is discussed, commenting on the consumer expectation that prices might be equivalent to (or cheaper than) the common alternative (i.e. Consumer Comparator), and how to develop the cost of the alternative benchmark. It should be noted that this Consumer Comparator may play a role in the assessment of the Project Comparator – see Part 1 Section 1c Project Comparator. Different customer types are discussed and how the pricing structures might be different for these users depending on their consumption attributes and statutory requirements.

Thirdly, the options for revenue collection over varying periods are discussed, including the implications on cash flow and budgeting for both the heat provider and the heat user. Cash collection will also need to be considered as well as the approach to dealing with debt, especially in the case of vulnerable customers.

Finally, the link back to the Strategic Case is made, identifying examples of strategic objectives which may be conflicting when it comes to setting the pricing strategy.

2 Context

The context in which HNs are operating should be considered when setting heat prices. Key areas of emerging guidance are summarised below. Clearly implementing an efficient and well-designed HN will be a first step in supplying heat to consumers at a 'reasonable' price and therefore protecting consumers, which is dealt with in more detail in Part 3 Section 4c.

2.a Legislative framework

There is currently no regulator for the supply of heat via a HN, unlike for electricity and gas (Ofgem) and water and sewerage (Ofwat). HNs are sometimes perceived to be a natural monopoly as there can be very little market choice and consumers are often tied to one supplier for a long period of time. As such, the onus for customer protection, in particular with respect to operating an efficient HN and setting pricing levels, lies with the supplier.

Consumer issues in the industry have been highlighted by research reports by the consumer group Which?, Changeworks[17], and the statutory consumer representative Citizens Advice. The Which? report highlighted that "a significant number of consumers were dissatisfied with their district heating scheme, with cost a widely held concern" and states the "Government must consider measures to regulate the market and to introduce fair pricing". In particular, consumers had concerns that they may have been mis-sold district heating, there was confusion about what was included in their bills and consumers dissatisfied by poor customer service and complaints handling procedures. Which? collected data for 40 metered schemes and estimated that the average cost was equivalent to 11.04 p/kWh, but ranged from 5.51-14.94 p/kWh. This range is significant and highlights the disparity in costs for users.

Ofgem's Insights paper on households with electric and other non-gas heating[18] shows increasing interest in protection for HN customers and notes that the paper hopes to inform any future decision regarding the regulatory framework of this market. However, Ofgem currently has no powers with regards to heat networks and consumer issues.

2.b Metering and Billing Regulations

Heat Network (Metering and Billing) Regulations[19] implement the requirements in the EU Energy Efficiency Directive (EED) with respect to the supply of distributed heat, cooling, and hot water. It should be considered whether the HN in question falls under this regulation using the Scope Guidance[20], noting that the regulations do

[17] Section 4.4 Approaches to billing, Identifying the fair share – Billing for District Heating, Changeworks, 2015
[18] Insights paper on households with electric and other non-gas heating, Ofgem, 2015 (https://www.ofgem.gov.uk/sites/default/files/docs/insights_paper_on_households_with_electric_and_other_non-gas_heating_1.pdf)
[19] Heat Network (Metering and Billing) Regulations 2014 and the Heat Network (Metering and Billing) (Amendment) Regulations 2015, SI 2014 No.3120 (HM Government, 2014)
[20] Heat Network (Metering and Billing) Regulations 2014, Scope Guidance

cover most district HNs and communal heating in England, Scotland, Wales and Northern Ireland, and includes residential, commercial, industrial, public sector and other networks.

The Heat Network (Metering and Billing) Regulations cover: duty of heat suppliers to notify the Secretary of State (and thereafter every four years) of heat supplies which fall within scope; metering requirements; and billing requirements. The below summary is not intended as a substitute for reading the full Regulations.

- Where technically possible and economically justified to do so (i.e. less than £70 each year per bill paying customer[21]), billing information must be accurate and based on actual consumption
- Specific charges for the provision of the required bill or billing information is not permitted (with some exceptions)
- Explanation of the information contained in a bill, including how the bill was calculated and specifying fixed and variable charges must be provided
- At the request of the customer:
  - Electronic billing information must be available
  - Billing information must be provided to an energy services provider (a person who supplies energy efficiency services)
  - Estimates of energy costs must be provided in a format which enables customers to compare the charges of different energy suppliers
- At least once a year a bill must be issued to the final customer. Where the final customer has opted to receive electronic billing or where requested by the final customer, billing information must be issued by the heat supplier at least quarterly, otherwise this should be issued at least twice a year.

What constitutes 'Billing Information'

- current energy prices charged
- energy consumption data
- where available, comparisons of current energy consumption with the previous year (preferably in graphical form)
- contact information for organisations from which information may be obtained on available energy efficiency improvement measures and technical specifications for products which use energy

2.c Heat Trust

The Heat Trust[22] is a GB-wide customer protection scheme for residential and micro-business customers served by communal and district heating networks, launched in November 2015. The industry-led Scheme is a voluntary self-regulation initiative aiming to recognise best practice, in the absence of a statutory regulator. It sets out customer service standards and customer protection requirements. Once a supplier becomes a member, it will be able to use the Scheme Certification Mark. Members must agree to the terms of the scheme and pay a joining fee, as well as a fee per connection.

HEAT TRUST
HEAT SUPPLY YOU CAN TRUST
Registered Participant
2015-16

[21] Paragraph 6, Schedule 2, Heat Network (Metering and Billing) Regulations 2014
[22] http://heattrust.org/index.php

It should be noted that the Heat Trust 'Rules' are publicly available and therefore even if a decision is taken not to become accredited, the Heat Trust's best practice can still be adhered to.

Key sections of the 'Rules' are noted below:

Section 8 Joining and Leaving Procedures describes the information to be provided and processes which should be undertaken for those joining and leaving a scheme. In particular, it states that a scheme information sheet should set out the principles and benefits of district heating, including the key differences between district heating and the regulated utilities and a link to the Heat Cost Calculator. See Section 4b for further detail on the Heat Cost Calculator.

Section 14 Vulnerable Heat Customers details how to identify and support Vulnerable Heat Customers with access to additional and impartial information or assistance, e.g. bill payment; energy consumption; and debt management.

Section 15 Heat Bill and Heat Charge Calculations sets out requirements for calculating and billing heat users. This section references the Metering and Billing Regulations, and supplements this on specific requirements for participation in the Heat Trust Scheme in relation to current and future heat charges, notable areas of which are detailed below. The below summary is not intended to substitute reading the full Rules.

- Bills must be provided in the customer's preferred format (paper or electronic)
- Bills must be issued promptly following the end of each agreed period and 31 days' notice should be provided of any changes to planned billing dates
- Payment dates must be a minimum of 14 days from the date of the bill and this payment date must be set out clearly on the bill
- An annual account statement/bill must set out in a clear and transparent format:
  - Tariffs associated with each element of the pricing structure (see below), including VAT
  - Volume of heat consumed (for metered properties)
  - Total charge over the period
  - Explanation of how the total charge has been derived (for unmetered properties)
  - Billing Information (as above)
- A charges schedule must be available setting out a list of the cost components that make up the pricing structure elements
- Any external datasets used for calculating elements of the charge should be referenced and accessible
- Fixed charges must be consistent across the site, regardless of metering type
- Billing Information must be issued at least twice a year and with every bill issued (when billed based on actual consumption) and at least quarterly (when billing electronically)
- Initial bills and billing information must be issued free of charge
- The basis and triggers for future change to charges must be set out, must not occur more than once every 6 months, and customers must be notified 31 days in advance of any change to charges

Section 16 Paying the Heat Bill and Payment Difficulties details requirements for communication, payment methods and working closely with those having difficulty making payments.

2.d Heat Network Code of Practice (CP1:2015)

Section 7.1 of CP1:2015 describes minimum standards for meeting the objective *'To provide reports on energy supply and use and bills that are clear and informative'* (referencing The Metering and Billing Regulations and the Heat Trust).

A requirement is set out to issue the heat customer with an annual statement:

- comparing the heating charges for the HN supply with the equivalent charges for the most common form of alternative means of heat supply for this building and its location, taking account of maintenance and capital replacements costs;
- detailing the amount of heat energy supplied to the network from each energy source;
- of the heat losses on the network based on meter readings where available;
- of the parasitic electricity used to deliver the heat (pumping energy and other energy centre electricity use); and
- of the CO_2 content of the heat delivered to the customer (taking account of heat losses and pumping energy) and a comparison with the emissions from other standardised energy supply systems such as: individual gas-fired boilers, direct electric heating or heat pumps.

It also supplements this with propositions for Best Practice, which could involve the following in relation to pricing:

- Providing bills at more frequent intervals, using actual meter data not estimates, and installing smart heat meters so users can see in real time via energy display devices their heating use and the heating cost
- A discount on the bill if the return temperature achieved is consistently lower than a specified threshold (most likely to be suitable in contracts with non-domestic customers).

Offering a discount where the return temperature achieved is consistently lower than a specified threshold, is not currently common in the UK but can be seen elsewhere in Europe. In order to arrive at an appropriate discount rate, technical advice should be sought on the operating cost savings available when return temperature are below a given level (with reference to CP1:2015), and then pass a proportion of this back to the customer. In order to realistically influence customer behaviour, this discount will need to be at a level which is appealing to the customer. The operating and capital cost implications of this will also need to be considered (e.g. of installation and monitoring of an advanced metering and information storage system) and weighed up against the operating cost savings available.

2.e Wider Regulatory Context

As well as the context specific to HNs, projects will need to consider the wider regulatory context within which the project will operate, in particular seeking legal advice where necessary. For example, 'The Consumer Contracts (Information, Cancellation and Additional Charges) Regulations 2013' which covers pre-contract information and complaints procedures, 'The Consumer Protection from Unfair Trading Regulations 2008' which protects against unfair commercial practices, and 'The Consumer Rights Act 2015' which covers issues such as unfair contract terms. Where supplies are being made to leasehold and rental properties, familiarity with the 'Landlord and Tenant Act', will be required as well as the role of the Housing Ombudsmen and Leasehold Valuation Tribunal, who support in the resolution of complaints under the Act.

2.f Impact on the Financial Modelling

Although there is no statutory regulator, following the key guidance emerging in the sector represents an administrative cost to the supply of heat. This cost will be in the form of customer care, the cost of heating controls, administering comprehensive billing information and the initial and continued cost of metering and billing based upon actual consumption. Depending on the approach taken, the costs will need to be factored into the Financial Modelling.

In particular, impacts on the Financial Modelling as described in the table below can be expected.

Item	Impact
Revenue	Due to a focus on billing based on actual consumption, seasonal variations in revenues would be expected which will impact cash flow. If heat tariffs are to be capped at the cost of the alternative (see Section 4b), this will act as a ceiling on potential revenues. The billing mechanism will impact the cash flows and may impact the level of debt risk.
Opex	Customer care and administrative cost would be expected to increase in line with the frequency of billing, the number of tariff options and the detail of billing information provided.
Capex	As well as the on-going cost of maintaining metering equipment, there will be an initial capital outlay.

3 Pricing Structures

In this section, detail is given of the most common elements of pricing structures for HNs. Typically, the following system is implemented:

- Flat Charge, or
- Fixed Charge plus Variable Charge.

In addition, a Connection Charge may be required.

The Heat Network (Metering and Billing) Regulations require bills to be based on actual consumption unless it is not technically possible and economically justified to implement metering (see Section 2b). This means that Flat Charges (which are not based on actual consumption) would need to be justified. Retrofit schemes, new schemes and existing schemes are all subject to these Regulations.

When it comes to pricing a HN, the "customer" can come in several forms and there may be multiple customers applicable under any one bulk heat supply. See further details on roles within (see Role Profile 'Customer' within the Guidance on Strategic and Commercial Case). For example, a private developer or LA may pay a connection charge (a type of capital contribution) for connection to the scheme. During operations, the landlord might be responsible for the maintenance costs of the scheme, and the tenant responsible for the remaining fixed and variable charges for heat consumed – see further detail on the requirements of landlords, social housing and mixed tenure at Section 5f. Alternatively, if a private owner is the energy consumer, they will be responsible for the maintenance costs, as well as the fixed and variable charges.

The table below identifies some typical elements of pricing structures, but please note that there are different pricing structures available to suppliers, and these may be tailored to the specifics of the scheme and the customer types involved – see also Customer Types at Section 5.

Table 12: Elements of Pricing Structures

	Connection Charge	Fixed Charge	Variable Charge	Flat Charge
Description	A one off charge for connection to the scheme	An annual fee for availability of the system which is payable irrespective of use	A price payable per unit used	Fixed payment for use of the system, irrespective of consumption
Regulations	Allowed	Allowed	Allowed	By exception only
Pricing Principle	To cover (a proportion of) the upfront / capital cost required to connect a new customer to the scheme or capture developer contributions	To cover (a proportion of) fixed operating costs and funding costs of the scheme	To cover the marginal costs of supplying each unit of heat	Cover all costs (with potential exceptions for lifecycle replacement and maintenance of tertiary network)

	Connection Charge	Fixed Charge	Variable Charge	Flat Charge
Profits	It would be expected that an element of profit would be included in each of the above pricing / revenue streams for the scheme, unless a not-for-profit scheme.			
Pros (customer perspective)	Upfront payment may reduce subsequent charges	For a high volume user, cost does not reflect usage	For a low volume user, cost reflects usage	Can allow customers to budget more easily Does not restrict usage
Cons (customer perspective)	May deter new customers from connecting	For a low volume user, cost does not reflect usage	For a high volume user, cost reflects usage	Not reflective of usage Perception of subsidising other users

Identifying the fair share[23], gives further detail on the pros and cons of the various pricing methods for customers. This report summarises research exploring experiences of social landlords and residents with district heating, particularly around metering and billing. The report highlights that an effective way of setting tariffs for customer satisfaction is through engaging with customers and/or offering tariff options, albeit the cost implications of this will need to be considered.

3.a Connection Charge

A connection charge is a capital contribution towards the capital cost of initiating a connection to the HN. Depending on whether considering a new build or a retrofit scheme, connection charges could be paid by either the property developer, by the heat user if a private owner, or by the landlord. A connection charge may be payable by both public and/or private sector parties to the scheme.

If in relation to a new scheme, the connection charge is likely to be passed through to the first owner of the dwelling via the initial purchase price. If in relation to a retrofit scheme, the connection charge is likely to be passed through to property owners via a major works charge. A landlord would need to consider how to recharge this, for example, it could be in lieu of a major works bill for replacing a boiler.

The connection charge could be designed to cover:

- The capital outlay required for connection to the scheme
- An amount not more than the avoided cost (e.g. the cost of connection to/installation of an alternative heat source, the cost of operation and lifecycle replacement of an existing heating system, or the avoided cost of carbon contribution). To aid a calculation of this avoided cost, see 'Project Comparator' and 'Property Developer Comparator' within the FMCIRD at Appendix A
- Planning Authority requirements (e.g. s106 Agreement or CIL – see Part 3 Section 2d)

In any case where a connection charge is being agreed, there is often a negotiation to be had and will be governed by the amount which the entity that will incur the charge is willing to pay. Where this does not satisfy the capital costs required for connection to the scheme, these costs will need to be recovered in on-going fixed and/or variable charges.

[23] Section 4.4 Approaches to billing, Identifying the fair share – Billing for District Heating, Changeworks, 2015

3.b Fixed Charge

Fixed Charges are often set to cover the fixed costs or minimum running costs of the scheme. This gives comfort to the operator (and funder) of the financial viability of the scheme. A common complaint made by customers is that Fixed Charges are high, and therefore a commercial decision should be taken as to whether the full extent of fixed costs should be included in the Fixed Charge. A balance may need to be drawn here between customer satisfaction and comfort over revenue streams for the operator (and funder); it should be borne in mind that the lower the Fixed Charge, the higher the demand risk.

Broadly, these fixed costs are commonly made up of:

- Operation & Maintenance
- Lifecycle Replacement (i.e. cost of overhauls and replacement of capital items over the life of the project)
- Debt repayment
- Metering and Billing[24]
- Cost of heating controls
- Other Overheads (e.g. Insurance, Customer Service)
- Cost of heating communal areas (if applicable)

For transparency, suppliers may look to split Fixed Charges by category. In particular, this would help where different entities are required to pay for separate elements of the Fixed Charge. For example, under the Landlord and Tenant Act[25], the cost of maintenance and replacement must be charged to the landlord and not directly to the customer (albeit will likely be recharged to the customer via their rent).

There are a number of factors to consider regarding variance in fixed charges amongst users which are noted below. In all cases, the costs of administering multiple Fixed Charges should be considered.

- Estimated Consumption – larger properties are likely to have higher consumption and fixed charges could be set to reflect this, based on floor space or number of bedrooms. See Figure 3 at Section 4b for heat usage estimates by property size.
- Consumer Choice - tariff options could be offered as a choice to the consumer, similar to mobile phone packages. Low volume heat users would likely choose a low fixed charge and higher variable rate and high volume heat users would likely choose a higher fixed charge and lower variable rate.
- Property Efficiency – In order to spread total costs more evenly amongst consumers, efficient properties may be allocated a higher Fixed Charge. This could be influenced by the location of a flat within a block, e.g. a cold top floor flat or a central one insulated by its neighbours.

[24] Specific charges for the provision of bills or billing information is not permitted under Heat Network (Metering and Billing) Regulations 2014, however, as an overhead, this cost will likely be wrapped up into the Fixed Charge.

[25] Landlord and Tenant Act 1985, 11,c, “there is implied a covenant by the lessor to keep in repair and proper working order the installations in the dwelling-house for space heating and heating water”

3.c Variable Charge

The Variable Charge is often set to cover the marginal costs of supplying heat to the customer, which are commonly made up of:

- Input fuel
- Losses due to efficiency of the plant / transmission
- Other variable charges (e.g. DNUoS, variable maintenance)
- Revenue gained from power export (to offset other costs)

Variable Charges can be set in bands such that a certain price per kWh is paid up to a set level of consumption and a different rate per kWh is paid beyond this level of consumption. However, a single unit rate is favoured by the Gas and Electricity Markets Authority when it comes to electricity supply[26] (unless multiple tariffs are determined by time of use) so multiple unit rates may not represent best practice, albeit this may change with the increase in smart metering.

3.d Flat Charge

Notwithstanding the requirements to bill based on actual consumption where technically possible and economically justified, DECC estimated in 2014 that three quarters of existing residential networks do not have heat meters[27]. In many cases, heating bills are paid as Flat Charges alongside rent payments. Heat with rent can cause complications when benefits are involved, as benefits are only applicable to rent, not heat. Flat Charges vary in makeup; some based on occupancy, number of rooms, floor area, or simply divided amongst the number of dwellings in the block.

3.e Additional Payments/Costs

There may be some costs which are excluded when developing the pricing structure described above, the most common examples of which are noted below. The arrangements in relation to additional payments should always be made clear to the customer from the outset. Where additional payments are required and there is a sale of the property being supplied, then the buyer should be made aware of this prior to the sale

Lifecycle Replacement: Where revenues from the main pricing structure are not intended to be put aside for lifecycle replacement costs, i.e. as a sinking fund, additional payments may be required from the customer to cover these costs. Use of a sinking fund, however, allows customers to budget more easily.

Maintenance of Tertiary Network: Maintenance of the tertiary network (customer-side equipment) may not be included in the main pricing structure and it may be the responsibility of the customer to undertake/fund this.

When charging the costs of maintenance and lifecycle replacement to leaseholders/tenants, the Landlord and Tenant Act 1985 and the Housing Act 1996 (as discussed further in Section 5f) should be borne in mind.

[26] ELECTRICITY ACT 1989, Standard conditions of electricity supply licence, Gas and Electricity Markets Authority
[27] DECC, Implementing the Energy Efficiency Directive as it applies to the meeting and billing of heating and cooling, 2014

3.f Impact on the Financial Modelling

The main impact of the pricing structure on the Financial Model is in relation to demand risk. The higher the element of variable pricing, the higher the level of demand risk inherent in the business case. The Financial Model should undergo sensitivity testing under a number of plausible upside and downside demand scenarios in order to understand the robustness of the business case.

In particular, impacts on the Financial Modelling as described in the table below can be expected.

Item	Impact
Revenue	The Financial Model should be designed to accommodate any combination of the pricing structures described above (excl. Flat Charge unless otherwise determined as the only solution) so that a combination of scenarios can be tested. In undertaking the scenario testing it should be noted that the higher the proportion of variable charges, the more at risk revenues will be to variations in demand.
Opex	Heat revenues will be required to cover the cost of operating the scheme, unless other contributions or incomes are available. Note that the operational costs of running the scheme and exposure to variable costs (e.g. gas/electricity prices) are dependent on the technology.
Capex	Connection charges (or other capital contributions) can be used to offset capital expenditure amounts required for installation of the HN. Depending on the commercial agreement, connection charges may only be payable once assets are operational and therefore funding may still be required during the construction phase.

4 Pricing Levels

In this section ways in which the heat supplier might arrive at (quantify) the price chargeable to the consumer under the selected pricing structure - as described in Section 3 - is set out.

4.a Cost Based Pricing vs. Pricing with Respect to the Alternative

The costs of undertaking the project (e.g. capital expenditure, operating expenditure and the required rate of return for the project) can be fed into the Financial Model and used to generate a heat price for the consumer over the life of the project. This cost-based method of pricing makes for a *theoretically* financially viable project. However, a key question here is whether this price will be acceptable to the customer (now and in the long-term).

A common theme emerging within Section 2 is in relation to being able to compare the price of supplies under a HN with the common alternative in an unregulated market:

- Which? recommends that an independent, tailored and easy-to-use heat price comparator should be developed for all home owners and tenants connected to a HN;
- The Heat Network Metering and Billing Regulations require estimates of energy costs to be provided in a format which enables customers to compare the charges of different energy suppliers;
- the Heat Trust is in the process of developing the 'Heat Cost Calculator'; and
- CP1:2015 suggests an annual statement is issued to consumers comparing the heating charges for the HN supply with the equivalent charges for the most common form of alternative.

This move towards comparability of the cost of HNs with the common alternative builds a customer expectation that these prices should be equivalent, an expectation that does not seem unreasonable given that it is commonplace for other utilities. If heat prices charged are higher than the cost of the alternative, the operator is likely to be open to significant criticism from their customers and subject to scrutiny from the emerging 'regulatory' forces in the market. HN operators should look to ensure that the prices set for consumers are reasonable and affordable.

In order to be competitive in the market and meet customer expectations, one option would be to ensure that district heating pricing is equivalent to (or cheaper than) the alternative, e.g. gas boiler. In Norway for example, the price for district heating cannot exceed the cost of electrical heating in any given supply area[28]. In the UK, some suppliers are implementing a price promise that heat prices are capped at the cost of the alternative and some have set their heat prices to be equivalent to, or at a percentage discount against the cost of the alternative. Clearly where a cost saving to consumers can be demonstrated, customers are more likely to connect to the scheme.

The heat price then becomes an input to the Financial Model, with the rate of return becoming an output. Scheme operators will need to be comfortable that this (financial) rate of return (along with any other non-financial returns, if

[28] Norwegian Water Resources and Energy Directorate, Energy Act 1990

assessed) is satisfactory, and remains satisfactory under sensitivity testing. This balance between heat prices and rate of return during the Financial Modelling process is likely to be an iterative process.

4.b The Cost of the Alternative (Consumer Comparator)

To aid with the process setting heat prices, a determination of the cost of the alternative (i.e. the Consumer Comparator) will be required. This will also be useful throughout the operational phase of the HN for disclosure on billing information. Please also see the 'Consumer Comparator' within FMCIRD at Appendix A for further support in developing this comparator.

Depending on the alternative technology that would be used to heat (e.g. gas boiler, electrical heater), it is likely that a number of elements of cost should be taken into account:

- Utility standing charge
- Input fuel costs
- Maintenance costs
- Replacement costs
- Health & Safety compliance

The comparator is unlikely to be a 'one size fits all'. For example, the specification, usage intensity and age of the identified alternative technology will impact the efficiency and maintenance requirements of the system. The audience for the comparator will also be a consideration, as for example, a tenant would expect to pay for costs associated with boiler maintenance through their rent, not through their heating bill. At the time of writing, the Heat Trust is in the process of developing a "Heat Cost Calculator" to enable comparison of the cost of HN supplies compared to the gas central heating alternative. This proposed heat price comparator takes into account the estimated full costs associated with an alternative heating system (i.e. system purchase price, installation, maintenance and running costs).

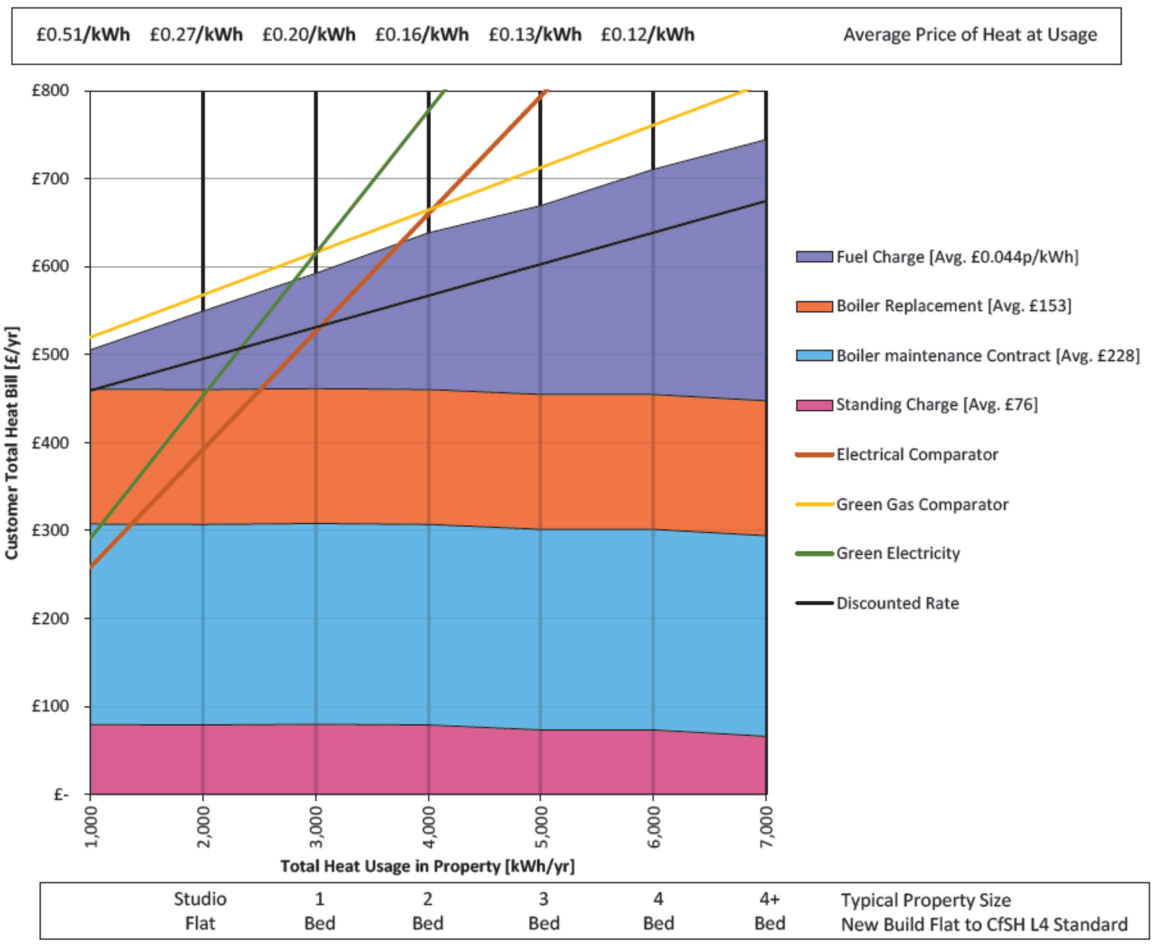
The Heat Trust: 'Heat Cost Calculator'

"means a publicly available facility (as amended, supplemented or replaced from time to time) developed and maintained by the Scheme Administrator which allows Heat Customers to compare the cost of his or her Heat Energy Supply against the costs of an alternative form of supply of Heat Energy"

Guidance existing in the market[29] suggests comparators for various residential dwelling sizes using a typical gas boiler heating system. The 'Average Price of Heat at Usage' shown at the top of the Figure below includes standing charges, variable fuel costs, boiler replacement costs and maintenance contract costs.

[29] The Price of Heat and The Regulation of the UK's Heat Market, CIBSE Technical Symposium, London, UK 16-17 April 2015, Thomas Briault and Stuart Allison (Arup)

Figure 3: Average Price of Heat at Usage



Source: The Price of Heat and The Regulation of the UK's Heat Market, CIBSE Technical Symposium, London, UK 16-17 April 2015, Thomas Briault and Stuart Allison (Arup)

4.c Price Reviews & Indexation

As well as identifying the initial heat price which will be charged to customers, consideration will need to be given to how that heat price may be reviewed or indexed over time. This is particularly important given the long term nature of HNs. There are two main reference trajectories which will need to be borne in mind:

- The cost of supplying heat (i.e. the cost base)
- The cost of the alternative (i.e. the Consumer Comparator)

In many cases, these will vary over time on a similar trajectory, e.g. gas-fired CHP and individual gas boilers will both be highly influenced by the cost of gas. However, in some cases, the trajectory may separate, e.g. the cost of input fuel for a biomass-fired CHP may not always reliably track the cost of gas or electric-fuelled heating.

An inflationary impact upon the cost base is a risk difficult for any operator to manage. The extent to which this risk can be passed onto the customer (via price reviews and indexation), the lower the perceived project risk (which may lead to lower project return requirements, and therefore lower heat prices). However, the consumer will expect that their heating costs under a HN will not be higher than the cost of the alternative and therefore it is preferable to cap the outturn heat price (following price reviews and indexation) at the cost of the alternative to ensure that the supply is affordable.

The cost base of a HN will be project-specific but a combination of the following indices (i.e. a basket of indices) are likely to come into play. In the interests of transparency, auditable market data should be used wherever possible.

Table 13: Indices applicable to HNs

Cost Item	Applicable Index
Input Fuel	Gas / Electricity prices (DECC/BEIS published prices) – depending on the source of the input fuel, wholesale or retail gas price indices may be relevant
Wages & Salaries	Average Weekly Earnings (AWE)
Other	Retail Price Index (RPI) / Consumer Price Index (CPI)

Below is an example of a heat price formula which could be used to generate the fixed charge and variable charge for heat supply in year N. *Please note that the proportions given here are for demonstration purposes only and will vary from project to project.*

Example Heat Price Formula

For demonstration purposes, it is assumed that:

- The variable cost base of the system is determined to consist ¾ of costs tracking gas prices (CHP input fuel) and ¼ of costs tracking RPI (variable maintenance); and
- The fixed cost base of the system is determined to consist ½ of costs tracking RPI (fixed maintenance, replacement) and ½ of costs tracking AWE (labour costs, customer service).

Variable Charge

$$VC_n = VC_0\left(\frac{3}{4}\left(\frac{GP_n}{GP_0}\right)+\frac{1}{4}\left(\frac{RPI_n}{RPI_0}\right)\right)$$

where:

- VC_n Variable Charge in Year n
- VC_0 Variable Charge in Year 0
- GP_n Gas Price Year n
- GP_0 Gas Price Year 0
- RPI_n Retail Price Index Year n
- RPI_0 Retail Price Index Year 0

Example Heat Price Formula

Fixed Charge

$$FC_n = FC_0\left(\frac{1}{2}\left(\frac{RPI_n}{RPI_0}\right) + \frac{1}{2}\left(\frac{AWE_n}{AWE_0}\right)\right)$$

where:

- FC_n Fixed Charge in Year n
- FC_0 Fixed Charge in Year 0
- RPI_n Retail Price Index Year n
- RPI_0 Retail Price Index Year 0
- AWE_n Average Weekly Earnings Year n
- AWE_0 Average Weekly Earnings Year 0

Application of Example Heat Price Formula

Below is a worked example of how to calculate the heat prices as described by the above formulae for the Fixed Charge and Variable Charge in year 3 (i.e. where n = 3).

For demonstration purposes only, we make the following assumptions:

•	VC_0	Variable Charge in Year 0	£0.15/kWh
•	FC_0	Fixed Charge in Year 0	£200 per annum
•	GP_3	Gas Price Year 3	£0.05/kWh
•	GP_0	Gas Price Year 0	£0.04/kWh
•	RPI_3	Retail Price Index Year 3	270
•	RPI_0	Retail Price Index Year 0	250
•	AWE_3	Average Weekly Earnings Year 3	£500
•	AWE_0	Average Weekly Earnings Year 0	£480

Variable Charge

$$VC_3 = VC_0\left(\frac{3}{4}\left(\frac{GP_3}{GP_0}\right) + \frac{1}{4}\left(\frac{RPI_3}{RPI_0}\right)\right) = 0.15\left(\frac{3}{4}\left(\frac{0.05}{0.04}\right) + \frac{1}{4}\left(\frac{270}{250}\right)\right) = £0.18 / kWh$$

Fixed Charge

$$FC_3 = FC_0\left(\frac{1}{2}\left(\frac{RPI_3}{RPI_0}\right) + \frac{1}{2}\left(\frac{AWE_3}{AWE_0}\right)\right) = 200\left(\frac{1}{2}\left(\frac{270}{250}\right) + \frac{1}{2}\left(\frac{500}{480}\right)\right) = £212 \; p.a.$$

To avoid 'price shocks' to customers during the winter months, suppliers should consider applying annual price reviews during the spring/summer months or applying indexation more frequently.

Where heat prices are to be capped at the cost of the alternative, consideration should be given to how this Consumer Comparator might vary over time. It may be that a domestic gas boiler is the alternative now, but it is difficult to predict what would be the norm 40 years into the future (e.g. green electricity-fired heaters? solar-thermal?). Scheme operators should perform sensitivity testing on the trajectory of heat prices available to become comfortable about the robustness of the financial viability of the project. Consideration should be given to contractual options to amend and agree indexation over time. Please also see 'Regulation Role' within Guidance on Strategic and Commercial Case.

4.d Treatment of Surpluses

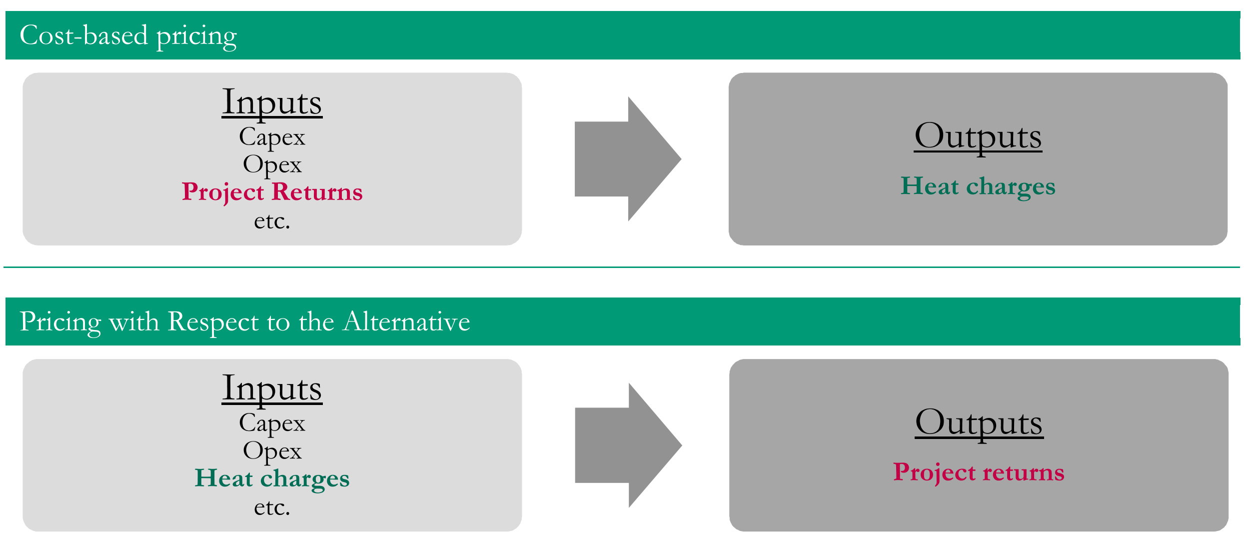
Depending on how the actual revenues compare to the cost base, surpluses may be generated. A governance consideration will be how these surpluses should be used. The following options may be considered:

- Accumulate in order to cover future capital expenditure
- Repay any external loans
- Rebates against customer heat bills
- Dividends to investors

4.e Impact on the Financial Modelling

Whether cost-based pricing or pricing with respect to the alternative is determined to be the preferred method will have an impact on the way that the Financial Model is used. For cost-based pricing, the heat price is an output of the Financial Model. For pricing with respect to the alternative, the heat price is an input and the rate of return is likely to be an output of the Financial Model. This is shown in the Figure below. Ideally both project returns and desired heat prices are satisfied as a balance between the two is drawn, which may be through several iterations of the Financial Model optimisation process. Providing reasonable and affordable heat prices to consumers should be at the forefront of this heat price development process.

Figure 4: Financial Model using cost-based pricing vs. pricing with respect to the alternative



In all cases, thorough sensitivity analysis is required upon revenues in the Business Case, including scenarios covering variations in initial prices, indexation and consumption. In particular, it will be important

to understand the reduction in revenues that the project could sustain before it becomes un-investible (based on the investors criteria for investing). This is sometimes referred to as the 'break-even point'.

Understanding the Break-Even Point

In order to identify the break-even point, the Financial Model should be interrogated to understand: 'By how much would projected revenues (as linked to the cost of the alternative) need to reduce to render the project un-investable?'. The second question to ask would be a qualitative question: 'How likely is it that projected revenues would reduce by this much?'

5 Customer Types

It may be that a single HN supplies various heat users, in which case, it should be considered whether a separate pricing strategy should be implemented for each customer type. In this section, some of the considerations which may come into play when supplying heat to different types of customers are discussed.

5.a Volume of Consumption

The higher the volume of annual consumption of gas and electricity, the lower per unit rate that consumers are likely to pay within the wider gas and electricity market. For example in the non-domestic gas market, high volume gas consumers can pay 50-60% less per unit when compared to low volume gas consumers. Similarly in the non-domestic electricity market, high volume electricity consumers can pay 30-40% less per unit when compared to low volume electricity consumers.

Therefore when negotiating heat prices, it is likely that higher volume heat users will require lower heat prices in order to make it commercially preferable to connect to the network. Understanding the consumer's current/alternative cost of heat is key to this. High volume heat users offer potential anchor heat loads into the project, which may also influence price of heat negotiations.

5.b Stability of Consumption

Consumers with a stable, constant and predictable level of year-round heat consumption (e.g. swimming pools) allow efficient use of base-load plant and lower requirement for peaking plant. Highly stable heat users offer potential anchor heat loads into the project, which may also influence price of heat negotiations.

5.c Social Objectives

Tariffs may be set at below market rates (either with respect to the Cost of the Alternative, or with respect to the tariffs charged to other users) in order to address social objectives such as fuel poverty. LAs may consider subsidising or accepting the cost of some elements of the pricing structure, e.g. the Fixed Charge. LAs may also choose to recognise the non-financial benefits of a HN as reasons for investment. See also Part 1 Section 3.

Where heat sales are being considered at below market rates, please refer to section 'Downstream aid to third parties' within the Guidance on Powers, Public Procurement and State Aid, which discusses the potential State Aid implications of this approach. Although supplies of heat at below market prices to a private individual would not be considered to breach State Aid, an intermediary purchasing heat for onward sale (obtaining a commercial benefit) may indeed be considered to be benefitting from state resources.

5.d Complementary Consumption Profiles

Customers should be sought for the scheme so as to achieve a consumption profile which is as flat as possible (therefore optimising usage of base plant and reducing the requirement for peaking plant). Customers with a flat consumption profile are clearly most advantageous in this respect but complementary demand profiles can also be obtained. For example, residential customers tend to have higher heat demands in the early morning and evening. This might complement well with an office block requiring demand during the day and an industrial process requiring heating overnight. The flattening of seasonal variances will also need to be considered, including identifying opportunities to increase summer demand and potentially cooling opportunities – see Part 3 Section 3c Cooling.

Typically, consumers are likely to be a combination of the following (which may be public or privately owned):

Table 14: Typical consumption profile by consumer

Consumer	Typical consumption profile
Offices	Daytime on week days, seasonal variance likely
Industrial	Dependent on industrial process
Leisure	May be low but constant demand, e.g. swimming pool
Residential	Mornings and evenings during the week and all day on weekends, seasonal variance likely
Prison / Care Home / Hospital	Likely to be constant, seasonal variance likely
Commercial	Dependent on opening hours, seasonal variance likely

Furthermore, commercial or industrial heat load customers can help to ensure the return temperature of water to a CHP (if applicable) unit is low and this improves efficiency.

In this way, a project may be willing to offer lower heat prices to customers with certain consumption profiles to gain their custom given the positive impacts (and financial consequences) they may have on the project should the consumption profile be complementary to the scheme.

It should be noted that as well as complementary consumption profiles within the scheme, flattening demand from plant can also be achieved by e.g. heat storage – see further detail on this in Part 3 Section 4d Heat Storage.

5.e Density of Demand

The higher the density of demand, the more efficient the scheme. This is due to reduced pipework distances required, lower thermal losses on transmission and therefore lower plant capacity and input fuel requirements. For this reason, location of consumers can significantly impact the cost of a HN. Therefore, a project may be willing to offer lower heat prices to customers at certain locations to gain their custom given the positive impacts (and financial consequences) they may have on the project.

5.f Social Housing and Mixed Tenure

Careful consideration should be shown where heat supplies are being made to a building which includes tenants (social and private) and/or leaseholders; different pricing structures may be required for these groups where there is mixed tenure. An example of this would be social housing which may include both (long) leaseholder and (short lease) tenants.

(Short Lease) Tenant: Under the Landlord and Tenant Act 1985[30], landlords must bear the cost of maintenance and replacement of a HN, as it relates to keeping "in repair and proper working order the installations in the dwelling-house for space heating and heating water". This landlord overhead is typically wrapped up into the rent charge, but it must not be charged over and above the rental amount.

(Long) Leaseholder: The cost of maintenance and replacement of a HN would need to be reclaimed (in all or part) via a service charge, which must reasonably reflect actual cost incurred under the Housing Act 1996[31]. Furthermore, leaseholders have a legal right to be consulted prior to certain types of service charge expenditure, such as major works (over £250 per leaseholder) and long term agreements (contracts for more than 12 months and £100 per annum per leaseholder)[32].

Case Study: Camden Gospel Oak

Almost 1,500 residents in six neighbouring social housing blocks benefit from this tripartite scheme, which harnesses surplus heat from the CHP at The Royal Free Hampstead NHS Trust hospital and pumps it to local Camden council homes. It is anticipated that the scheme will save in excess of £1m on fuel costs by 2026 and 2,500 tonnes of CO_2 annually. The Council pays an access fee to the hospital annually and O&M costs to the term contractors.

5.g Impact on the Financial Modelling

The types of customer and the pricing structure identified for each customer type will need to be built into the Financial Model. In order to set prices at suitable price levels, a clear understanding of the potential customer Cost of the Alternative (i.e. Consumer Comparator) should be developed and an initial/in principle agreement sought giving additional robustness to the Business Case.

In the context of the Business Case, it can be considered that there is a degree of feedback between the level at which prices are set and the level of demand, as the cost of heat is likely to either attract or deter certain customers. In some cases, and particularly for non-residential customers, varied tariffs for time of day use can be implemented in order to drive consumption habits and favour network load balancing.

[30] Landlord and Tenant Act 1985, 11,c, "there is implied a covenant by the lessor to keep in repair and proper working order the installations in the dwelling-house for space heating and heating water"
[31] Housing Act 1996, Part III Landlord and Tenant, 83, the tenant has a right to "determination of reasonableness of service charges" and can dispute whether the costs were reasonably incurred via the Leasehold Valuation Tribunal
[32] https://www.gov.uk/leasehold-property/service-charges-and-other-expenses

6 Revenue Collection

Once the pricing structure and levels have been set for the various customer types, the way in which this revenue is collected from the customer will need to be considered. There will need to be consideration of the frequency of billing, managing debt and performing the billing function itself.

6.a Cash Flow

Elements of the pricing structure may be billed on a weekly, monthly, quarterly or annual basis. Payments may be required in advance, in arrears or on a pre-payment basis (if the HIU has been engineered to accommodate this payment structure). As impacted by consumption during the period, the method of collecting Variable Charges will need to be considered. Methods include:

- (most common) charge in advance and reconcile with meter readings at the end of the period;
- charge in arrears once meter readings are available for the period; or
- operate a pre-payment system.

When setting billing/discount frequency, the cash flow and budgeting implications of both the customer and the energy provider will need to be considered. It is likely that the heat provider will favour advance or regular payments, whereas the heat user may favour fewer payments in arrears. The frequency of payments may also have an impact on the ability for the heat user to keep up with payments and therefore a strategy for dealing with debt will be required. It is likely that the more frequent the billing, the lower the risk of debt, albeit the cost implications of frequent billing should be considered.

Subject to the approach taken on billing frequency, it is advisable to make the customer aware of the time window within which meter readings can be reported to be taken into account in the billing period in question. This will avoid confusion and unnecessary communication when the customer sees an estimated bill.

6.b Debt Strategy

It will be important to set a strategy in terms of debt management. Although more expensive to install, it has been noted that prepayment meters often lead to lower debt collection issues, as compared to direct debit or credit billing. Prepayment meters, however, can lead to residents self-disconnecting or under-heating.

Common approaches include sending out reminder letters, eventually leading to disconnection (where technically possible). However, in the case of social landlords and vulnerable customers this process must be considered carefully with reference to *Section 14 Vulnerable Heat Customers* and *Section 16 Paying the Heat Bill and Payment Difficulties* of the Heat Trust standards.

6.c Billing Management Function

It should be considered whether billing will be performed in-house or outsourced to a third party. Depending on the billing frequency, payment methods and debt strategy, billing management can be a resource-intensive function. Outsourcing this function leads to lower levels of control, but may allow for access to expertise/resource which may not exist in-house. On the other hand, social landlords have "felt that the potential to disconnect people from their energy supply would conflict with their role as a social landlord"[33]. In any case, the meter reading and communication system implemented will need to be robust in order to effectively perform the billing management function. In particular, where guarantees have been given to consumers regarding savings against the Consumer Comparator, robust management processes will need to be in place to ensure that such guarantees are respected.

Clearly, collection of heat consumption data will be required in order to bill based on actual consumption. Such data could be collected by the scheme operator or a third party, received as a submission by the consumer, or collected electronically under a 'smart meter' approach, if processes are developed to enable this. As well as being necessary for the billing process (under a metered scheme), consumption data also aids a greater understanding of usage profiles and therefore may allow for further optimisation of the scheme.

6.d Impact on the Financial Modelling

The charging methodology will be key to understanding revenue cash flows within the Financial Model. Infrequent and in arrears cash collection may cause difficulties for the delivery body in servicing its own operating expenditure, which will have an impact on the solvency of the delivery body. The working capital implications of the mechanism will need to be factored in to cover estimated levels of debtor days. Within the Financial Modelling, it will be important to make an assumption in relation to bad debts, which will have an impact on profitability and cash flow. Where bad debts are considered to be a significant cost to the scheme, sensitivity testing should be performed.

Finally, the cost of the billing management function must be factored into the Financial Model, be they performed in house or outsourced.

[33] Section 6.5 Variable rate billing, Identifying the fair share – Billing for District Heating, Changeworks, 2015

7 Tensions of Strategic Objectives

When setting the pricing strategy, it will be important to link back to the overall strategic objectives of the project. For further guidance on strategic objectives, see Guidance on Strategic and Commercial Case.

The diagrams below give some examples of objectives / requirements which may be in consideration for a HN project. You will see from the commentary that some of these objectives may be conflicting when it comes to setting the pricing strategy.

Figure 5: Tensions of Strategic Objectives

Alleviating fuel poverty	Heat Prices?	Generating income/profits
The lower the heat prices, the more the schemes is likely to be able to tackle issues of fuel poverty		The higher the heat prices the more income/profit generating ability the scheme will have
Cost linked to usage	Proportion of Fixed Charge?	Give comfort to funders
The lower the fixed charge, the more heat costs to the consumer are linked to heat consumption		The higher the fixed charge, the more comfort over income the funder will have
Meet consumer expectations	Track Cost of the Alternative?	Cover running costs
Consumers are more likely to be satisfied if prices are set to be equivalent to (or cheaper than) the cost of the alternative (e.g. gas boiler and gas prices)		Revenues must cover the actual costs of the scheme in order to be financially viable (unless other contributions are available)
Alleviating fuel poverty	Prepayment meters?	Avoid debt collection issues
Residents are less likely to self-disconnect from their heating or under-heat their homes under a billed schemes		Prepayment metering avoids heat users falling into debt and the need for resources spent on debt collection

Given the potential conflicts noted above, prioritisation and balancing of strategic objectives will be required when setting the pricing strategy.

In order to manage the tension between potentially conflicting objectives, it is important that good governance and proper regulation are implemented. For more detail on the governance and regulation roles, see Guidance on Strategic and Commercial Case.

8 Pricing Examples

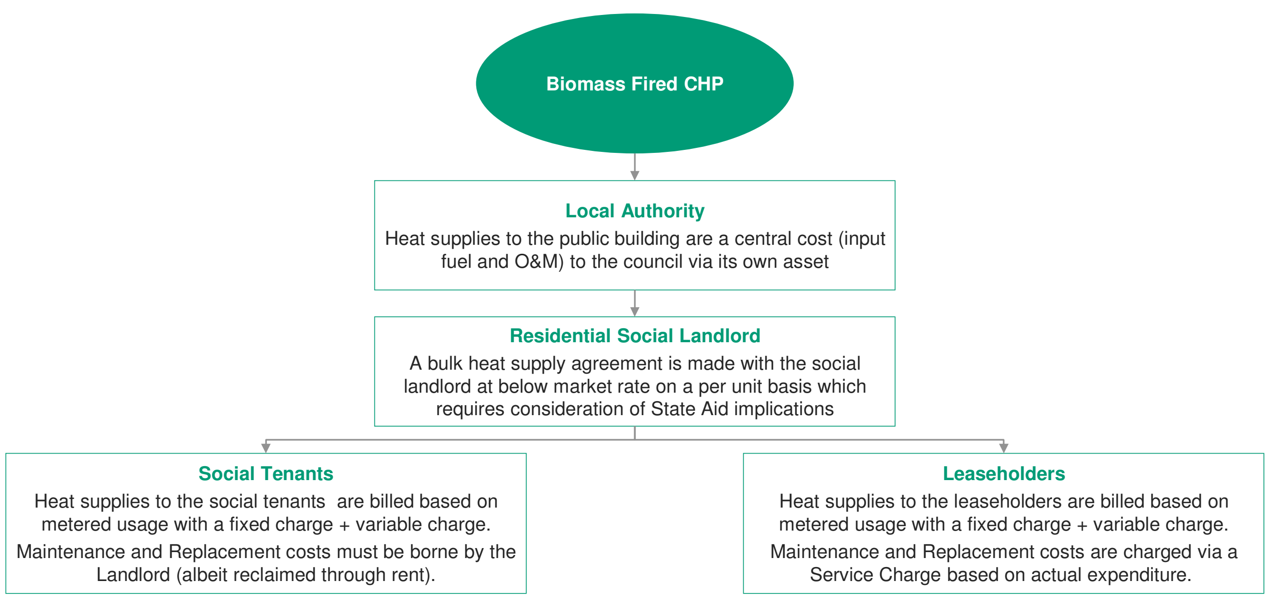
A number of theoretical examples of ways in which pricing structures may be developed when taking into account the specifics of the scheme opportunity (such as the heat source, the customer types and the delivery structure) are given below.

8.a Example 1: Bulk Supply to Social Landlord

In this example, the LA is requiring investment in its ageing heating stock for a public building and this is also the case for a nearby mixed-tenure social housing block. A small district heating network using biomass-fired CHP has been identified as a viable option for combined delivery. The LA will finance and own the HN assets. Direct supplies of heat to the council buildings will be on a cost-basis but the social housing block will be served via a bulk supply agreement with the social landlord, who will sell the heat onwards to the residents.

The LA has agreed to set the price of heat sales to the social landlord at x% below the cost of the alternative (the gas boilers) with indexation tracking the cost of gas, on the agreement that this benefit is passed onto the residents.

The cost of input fuel (biomass) is lower than had been expected due to a surfeit of high quality wood pellets in the market. The trajectory of this commodity reduces below that of gas. For this reason, a surplus is generated. The LA decides to put this surplus towards capital expenditure required to expand the network.



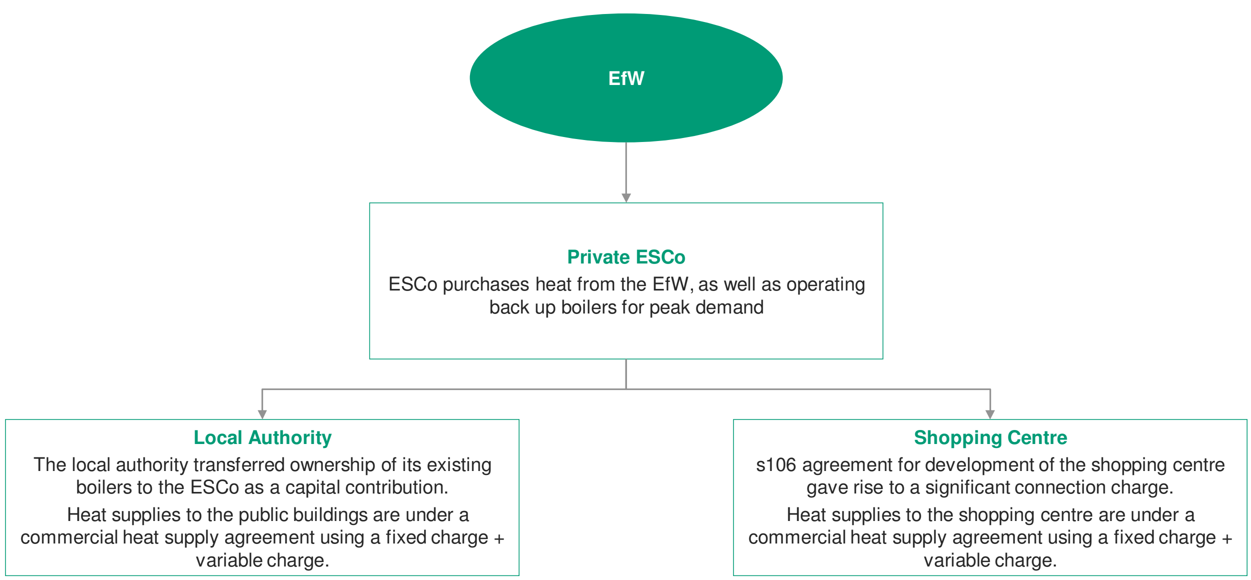
8.b Example 2: Connection Charges

In this example, the LA is looking to meet carbon reduction targets. A set of council buildings has been identified as heat load potential for a nearby operational energy from waste (EfW) facility which has surplus heat.

A shopping centre requests planning permission in the vicinity for which permission is granted on the condition of a s106 agreement for connection to the potential HN. This increased heat demand and connection charge renders the scheme economically viable to a private sector investor (ESCo).

Due to the significant s106-driven connection charge and the capital contribution (in asset form) of the council's boilers, limited capital expenditure was required by the private sector ESCo. The limited capital cost led to low funding costs which (coupled with the low perceived demand risk of the customers) meant that the LA and the Shopping Centre were able to benefit from low fixed charge elements for on-going heat supplies (as agreed within the heat supply agreements from the onset).

The LA objective for connection to the scheme was in relation to the carbon savings offered and therefore was satisfied to pay the cost this low carbon heat. Similarly, the shopping centre was content to promote its green credentials. A negotiated and agreed cost based pricing approach (including costs, overheads and profit for the ESCO) was therefore taken and agreed over the long term with inflation to be reflective of the heat purchase agreement with the EfW.



Part 3: Revenue Streams & Avoided Costs – Maximising Opportunities

1 Introduction

A HN tends to be specifically designed for the context in which it operates. Some schemes are large, connecting hundreds of users and others are small, linking in only two or three buildings. Heat sources and users will also vary from scheme to scheme. In many cases, they have grown organically over time, as funding or planning has allowed, and as need or technology has developed.

The result of this is that whilst there are some commonalities between HNs, each one is unique and has its own developmental ancestry. This is a mixed benefit. The benefit is the wealth of varied approaches from which to draw lessons learned and successes. The flip side is that there is no 'one size fits all'.

In order to develop and deliver a cost effective scheme, the organisation undertaking the Promotion role - see Guidance on Strategic and Commercial Case - must understand the context and environment (social/geographical/political/economic/technical) in which the scheme is being developed, draw from historic schemes and be innovative. This guidance note seeks to highlight areas for consideration when designing a scheme in this way.

Main reference documents used for this guidance note include:

- Towards a Smart Energy System, DECC, December 2015;
- District Energy in Cities, Unlocking the Potential of Energy Efficiency and Renewable Energy, United Nations Environment Programme, 2015; and
- CP1:2015

Firstly, areas where the approach to funding can reduce costs to a project are identified, for example through reducing the perceived risk to the funder, availability of internal funds and/or funds to which interest and repayments are not applicable (grants, s106). Types of funders which may be available to the project are noted and consideration is given to the implications of refinancing. This section should be read alongside Part 1 Section 5 'Commercial Structure and Financing Mechanism'.

Secondly, heat revenues and additional revenue streams which may supplement the supply of pure heat are considered. These could include revenues relating to sales of electricity, cooling, as well as supplies of other utilities such as water. Consideration of government subsidies is also made.

Finally, avoided costs are considered, from both a LA and developer perspective. System design for efficiency is discussed with reference to CP1:2015 and consideration is given to exploring demand side response and heat storage. The benefits of an informed customer should not be forgotten and educational programmes to incentivise efficient energy usage can also offer opportunities for reduced costs. The guidance notes certain areas where costs can be reduced through access to surplus / naturally occurring heat sources and through exploring opportunities for collaboration and running an efficient procurement process.

2 Funding

The approach to developing the Financing Mechanisms for the HN project and how it links to the specific project characteristics is set out in Part 1 Section 5. Once the Financing Mechanism has been determined then it should be possible to consider the specific sources of funding. As a general principle, the lower the risk perceived by the funder, the lower the cost of finance is likely to be. Therefore, parent company guarantees and guarantees of demand are likely to reduce the risk and therefore the cost of finance of the scheme.

Due to their high frontloaded capex and long return periods, HN projects may not be attractive to some types of funders, who are looking for a higher return over a short period. However, the secure and long-term income opportunity will be attractive to certain institutional lenders, particularly if there is an ability to refinance during the operational phase.

In any case, the ability of funders to lend for the required period of time will need to be understood when the viability of the project is tested through the Financial Model. As the Economic and Financial Case is developed, the source and type of funding will influence and be influenced by the delivery vehicle for the project. This will therefore need to be reflected back through the Commercial Case - see Guidance on Strategic and Commercial Case.

2.a Types of Funding – overview

There are many sources of funding which could be used to fund a HN project, broad categories of which are set out below:

- Retained Reserves – funds already existing within the public or private sector, which can be invested in a HN project (either directly spent on the project, lent as debt or as equity into an SPV)
- External Debt Providers:
  - Prudential Borrowing – Public Works Loans Board (PWLB)
  - Bank funding
  - Pension funds
  - Bond holders
  - Construction period lenders/mezzanine debt
  - Asset backed finance/lease
  - Working capital facilities
- External Equity Providers – would be Private Equity where not publicly traded on a stock exchange
- Subsidised Funding – debt with a social or environmental purpose which may be on preferable terms
- Grants – interest free and non-repayable, grants with a social or environmental purpose may be available

There are a number of considerations when deciding on the funder for a HN project, as described in the paragraphs below.

2.a.i Speed and availability of funding

In order to be able to mobilise a project quickly, readily accessible sources of funding (e.g. retained reserves, PWLB) may be considered preferable to more conditional sources of funding (e.g. grants and bank funding), even if more expensive. The conditions may be in terms of lengthy due diligence processes or grant conditions.

2.a.ii Sector seeking funding

Certain funds may only be available to public sector (e.g. PWLB and certain grants/subsidised funding) whereas other sources of funding may be available to both (e.g. asset backed finance) and therefore consideration should be given to the body which will be receiving the funding.

2.a.iii Pre or post-construction

The construction period is generally considered to be the highest risk phase of the project and due to risk appetites, different funders may be more suited for either pre or post construction financing. For example, pension funds and bond issues are unlikely to be appropriate for investment pre-construction, whereas construction lenders provide funding specifically available during the construction phases. Some funders, however, will be able to fund throughout the project (e.g. GIB and retained reserves). Note that the cost of finance will likely increase in line with the level of risk being taken by the funder and therefore construction period lending is often a higher cost form of finance.

2.a.iv Size of funding required

As the typical capex for a heat network is in the region of £4-40m, sourcing external debt finance may be challenging. In particular, bond issues and pension funds are unlikely to be appropriate for individual or small heat networks; the minimum bond size is likely to be in the region of £150m. There may therefore be the need to aggregate projects to make the investment more attractive to large lenders e.g. infrastructure banks.

2.a.v Project specific or general

Certain sources of funding may be non-project specific (e.g. PWLB or working capital facilities), whereas other funding may be in relation to the specific project (e.g. Salix, HNIP).

2.a.vi Cost of finance

Certain sources of funding will be more expensive than others. This will be partly due to the specific risk perception of the project by the funder, however, certain types of funding are inherently more costly. For example, equity funders are likely to expect a higher return than debt funders, as they have last call on a company's assets and only receive dividends after debt payments are made. Similarly, short term loans are likely to be lower cost than long term loans due to the risk taken by the lender.

2.a.vii Terms and conditions

Funding providers will attach terms and conditions to the funding. When seeking funding, these terms and conditions should be considered, as they may be cumbersome. For example, grant providers will likely specify the ways in which the funding can be used and may require reporting in order to satisfy grant conditions and therefore avoid claw backs. Banks will likely prescribe covenants (minimum standards which must be maintained or else funding can be withdrawn), which may be operational or financial in nature.LA Funding

LAs should consider if they have funding available for the project, either through retained reserves or through additional borrowing. A LA's cost of borrowing is generally lower than the private sector through access to low-interest sources of finance (e.g. PWLB, grants and subsidised funding).

However, the issue is whether a HN scheme can fully benefit from this low cost of finance. Depending on the delivery vehicle, State Aid implications (see Guidance on Powers, Public Procurement and State Aid) will need to be considered, which may put a floor on the level of interest chargeable by the LA into a delivery vehicle[34]. LA funding could be considered for the construction phase of the project (as noted above as generally considered to be the most risky phase of the project), at which point private sector refinancing could be explored and could allow LA capital to be recycled for future development phases. Alternatively, existing HNs could be used as collateral for asset backed finance to fund new HNs.

2.b Specific Funding Sources

Below some examples are set out of specific sources of funds which may be available to a HN project, within the categories of public and private sector recipients and whether or not they are project-specific sources of funds. This listing is not intended to be exhaustive and the organisation undertaking the Promotion role should consider what funding sources may be available at the time.

When approaching funders, one should be aware that commercial funders are likely to look more favourably at projects which are more advanced in development (i.e. are actually at a point where finance is required). When deciding on the duration of funding, the interest rate chargeable and the amount of funding that will be extended, funders will pay particular attention to how much security can be taken against assets and the level of guarantees that will be in place. In particular for heat networks, the following would be considered to give comfort to funders:

- Guaranteed consumption/demand from a creditworthy entity
- Power Purchase Agreements in place with a creditworthy entity
- Financial Model not overly reliant on variable prices, which are susceptible to demand risk
- Offering charges over assets, such as the plant and network

[34] The second iteration of General Block Exemption Regulation (GBER), adopted in July 2014, added a new exemption expressly permitting investment aid for energy efficient district heating and cooling systems

2.b.i Non Project Specific – Public Sector

Below is an example of funding which may be available to the public sector and is non-project specific.

Name	Prudential Borrowing - Public Works Loan Board (PWLB)
Description	The Public Works Loan Board (PWLB) is a statutory body operating within the United Kingdom Debt Management Office, an Executive Agency of HM Treasury. PWLB's function is to lend money from the National Loans Fund to LAs, and to collect the repayments. PWLB is non-project specific borrowing.
Value	PWLB fixed interest rates are based on gilt yields and as such are lower than commercial risk related lending rates. The LAs borrowing limits will govern the maximum loan available.
Risk	As a loan these funds are repayable and will count against the LA's borrowing limits.
Further Information	http://www.dmo.gov.uk/index.aspx?page=PWLB/Introduction
Recipient	LA

2.b.ii Non Project Specific – Public or Private Sector

There are many sources of non-project specific funding which may be available to the public or private sector, such as commercial banks – Lender Option Borrower Option (LOBOs) in the case of LAs, so they are not listed here.

2.b.iii Project Specific – Public Sector

Below are some examples of funding which may be available to the public sector and are project specific.

Name	Salix interest free loan
Description	Salix Finance Ltd. offers interest-free capital, under a number of interest-free loan programmes across the UK. The loans are for public sector organisations to improve their energy efficiency and reduce their carbon emissions. Eligible technologies include CHP (gas and biomass) and a number of heating technologies, including "connect to existing district heating".
Value	Loans extended average £300k per project. For example, The University of Liverpool has interest free funding from Salix Finance to install two new 2MW CHP engines in their old boiler house. The total project cost was £7.3m, with £6.1m of funding coming from Salix and £1.2m from other funding sources. The university is saving £1.5m and 5,730 tonnes of carbon each year. The payback period of the loan is 4.1 years.[35]
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement.
Further Information	http://salixfinance.co.uk/
Recipient	Public sector

Name	Tax Increment Financing (TIF)
Description	Under the Local Government Finance Act 2012, Tax increment financing (TIF) works by allowing LAs to borrow money for infrastructure against the anticipated increase in business rates income expected as a result of those projects - creating funding for local public projects that may otherwise be unaffordable.
Value	The value of loans would vary depending on the increase in business rates income expected as a result of the

[35] http://salixfinance.co.uk/system/files/documents/liverpool_uni_web.pdf

Name	Tax Increment Financing (TIF)
	project.
Risk	There is the risk that expected revenues from business rates do not materialize within the timescale envisaged, and so there is insufficient money to service the debt.
Further Information	http://www.lgiu.org.uk/wp-content/uploads/2013/04/LGIU-Guide-to-the-Local-Government-Finance-Act-2012.pdf
Recipient	LA

Name	Carbon & Energy Fund (CEF)
Description	Launched in 2011, the Carbon and Energy Fund (CEF) was created to fund, facilitate and project manage complex energy infrastructure upgrades for the NHS and wider Public Sector. The CEF can support Public Sector organisations through a variety of methods, including providing a source of funding.
Value	The CEF typically has up to £300m of capital available for projects via a panel of funders. It is endorsed by the Green Investment Bank and has sources of capital available from Banks and Pension Funds for terms from 7 to 30 years. The CEF is estimated to provide c.90% of this type of finance to the NHS.
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement.
Further Information	www.carbonandenergyfund.net
Recipient	Organisations wishing to work with the CEF must seek membership. Recipients of the benefits provided are the NHS and the wider Public Sector.

2.b.iv Project Specific – Public or Private Sector

Below are some examples of funding which may be available to the public or private sector and are project specific.

Name	Heat Network Investment Project (HNIP)
Description	The Heat Network Investment Project (HNIP) is intended to facilitate the expansion of the UK Heat Network sector. BEIS are keen to start making awards on this project in 2016, although the format is in development at the time of writing. Whilst it is possible the funding may be in the form of grant funding, it is also possible that it will be in the form of loans or other financial structures.
Value	BEIS have set aside £320m of capital funding to award to the delivery of heat networks in England over 2016-2021. This is considered to be seed funding, with total combined public and private funding expected to be in the region of £2bn.
Risk	To be confirmed when the structure of the HNIP funding has been agreed.
Further Information	https://www.gov.uk/government/consultations/consultation-on-the-heat-networks-investment-project-hnip
Recipient	May be available to both public and private sector

Name	UK Green Investment Bank (GIB)
Description	UK Green Investment Bank is a “for profit” bank, whose mission is to accelerate the UK’s transition to a greener economy, and to create an enduring institution, operating independently of Government. They can support public sector organisations by engaging early on projects and have the flexibility to provide a full range of structured

Name	UK Green Investment Bank (GIB)
	financing options for energy efficiency and district heating projects. They aim to help progress challenging projects and to find innovative solutions to make sure good projects can be financed.
Value	£3.8bn of UK Government funding has been committed to green projects via GIB. As an example, in 2016 GIB committed to support the acquisition and expansion of the Wick renewable energy plant and district heating network. The Equitix-managed fund Energy Savings Investments (ESI), in which GIB is a cornerstone investor, has committed £4.9m to the project. An additional £5.1m of private capital has been mobilised from the Equitix Energy Efficiency Fund (EEEF).
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement, including the GIB's 'green' objectives.
Further Information	http://www.greeninvestmentbank.com/
Recipient	GIB is flexible in its lending structure, which could be directly to a LA or into a special purpose delivery vehicle.

Name	Scottish Partnership for Regeneration in Urban Centres (SPRUCE)
Description	The Scottish Partnership for Regeneration in Urban Centres (SPRUCE) Fund is a JESSICA (Joint European Support for Sustainable Investment in City Areas) UDF (Urban Development Fund) that is a source of funding for regeneration and energy efficiency projects within targeted areas of Scotland. The fund was established with funding from the Scottish Government and the European Regional Development Fund.
Value	£50m of funding is available, offering loans and equity investments to revenue generating infrastructure and energy efficiency projects to support regeneration in 13 eligible local authority areas in Scotland.
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement, repaid within an agreed timescale.
Further Information	http://www.gov.scot/Topics/Built-Environment/regeneration/investment/spruce
Recipient	Eligible projects must be located within the 13 local authority areas in the Lowlands and the Uplands of Scotland as determined by the Scottish Index of Multiple Deprivation. Projects may come from a variety of sources, and may be sponsored by public, private, or third sector bodies. Borrowers may include Local Authorities, Urban Regeneration Companies, private sector developers, national and local regeneration bodies, Registered Social Landlords, joint ventures and the voluntary sector.

Name	European Investment Bank (EIB)
Description	European Investment Bank provides finance and expertise for sound and sustainable investment projects which contribute to furthering EU policy objectives. EIB provides lending, blending (unlocking financing from other sources, particularly from the EU budget) and advisory services. One of their focus sectors is Energy. Projects typically include retrofitting and expansion of existing social and urban infrastructure and services and specifies "district heating".
Value	Funding value varies depending on the project. In 2015, the Ukraine was allocated €400m (£284m) for 25 – 40 individual projects, including district heating.
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement.
Further Information	http://www.eib.org/projects/sectors/energy/index.htm
Recipient	Their project funding is to provide benefit to municipal projects, but would be provided to the SPV or similar who required financing as part of a financing consortium. They would normally participate in a procurement on the basis that they did not align to a particular bidder but that their financing was available to all bidders to use.

Name	Pension Infrastructure Platform (PIP)
Description	The government has developed a Pension Infrastructure Platform (PIP) to facilitate long term investment into UK infrastructure by pension schemes. Pension funds require steady, low risk and long term incomes to cover their long-term obligations. As such, pension funds could offer an opportunity for long term, low cost funding.
Value	Pension fund return requirements are likely to be lower than other commercial lenders (albeit the risk inherent will need to be commensurately low and therefore more likely to be an opportunity for re-financing) post-construction phase, particularly if projects are aggregated.
Risk	Pension Funds have historically not taken construction period risk, albeit that position is changing and would need to be assessed by the entity sourcing such financing.
Further Information	http://www.pipfunds.co.uk/about-us/
Recipient	Likely to be private sector

Name	Local Enterprise Partnership (LEP)
Description	A Local Enterprise Partnership (LEP) is a voluntary partnership between local authorities and business set up in 2011 by the Department for Business, Innovation and Skills to help determine economic priorities and lead economic growth and job creation within the local area. To date there are 39 local enterprise partnerships in operation. The creation of LEPs signified the move to devolution of power to the regions, but with the private sector driving decision making, working closely with its public sector partners. LEPs attract certain types of funding such as City Deal and Growing Places. The heat network developer should liaise with their LEP to identify any funding opportunities.
Value	A total of over £15bn has been investment in LEP projects and programmes, including £5bn of private sector leverage secured to date. Funding is obtained through a wide variety of sources, through the negotiations and efforts of the Local Enterprise Partnerships.
Risk	Variable – as the sources and variety of the funding is not fixed from project to project, the risk profile and any associated repayment parameters can vary.
Further Information	https://www.gov.uk/government/policies/local-enterprise-partnerships-leps-and-enterprise-zones
Recipient	Public or private sector

Name	Green Growth Wales (under development)
Description	The Welsh Government is developing a fund to support investment in green energy projects in Wales through equity or debt commitments. The fund would work to investment criteria set by the Welsh Government, which would cover such matters as the nature of the investments (including technology and geography), acceptable returns, carbon savings and other factors to be confirmed.
Value	£25m with the aim of attracting private sector investors to take the funding pot to around £100m
Risk	The fund would look for those receiving finance to invest themselves, therefore putting own funds at risk.
Further Information	http://gov.wales/consultations/environmentandcountryside/green-growth-wales-options-for-investment-support/?lang=en
Recipient	Public or private sector

Name	London Energy Efficiency Fund (LEEF)
Description	LEEF has £100m from the European Regional Development Fund and London Green Fund to be lent to public or private sector borrowers on projects that promote energy efficiency. LEEF can also support larger projects such as Combined Heat and Power, District Heating and Renewable Energy Generation.
Value	Loans must be £1m to £20m in value, with tenors of up to 10 years and interest rates from 1.65% per annum.

Name	London Energy Efficiency Fund (LEEF)
	For example, London Borough of Enfield borrowed £6m from LEEF for the Lee Valley Heat Network.
Risk	As a loan these funds are repayable and recipients will need to adhere to the terms of the loan agreement.
Further Information	http://www.leef.co.uk/
Recipient	Public or private sector

2.c Grants and Development Costs Support

Availability of funding into the project through grant funding which does not attract interest or repayment can have a significant impact on the overall cost of capital for a project. Grant funders inevitably change as funding pots are exhausted and as new initiatives are brought into play. LAs should research available grants at the time, which may be location or sector-specific. BEIS is likely to be a good source of current grant funds relevant to HNs. Grant providers, however, may impose restrictions on how the funds are to be used or reporting requirements, which should be considered as an administrative cost to the scheme. Some examples (non-exhaustive) of potential grant and development cost support providers are noted in the tables below.

Name	Heat Network Delivery Unit (HNDU)
Description	Recognising the capacity and capability challenges which LAs identified as barriers to HN deployment in the UK, the Heat Network Delivery Unit (HNDU) was established by the Department of Energy and Climate Change to provide grant funding and guidance to LAs in England and Wales. This programme will be continued by the Department of Busiess, Energy & Industrial Strategy. The HNDU support LAs through heat mapping, feasibility studies, detailed project development, and project specific investigation.
Value	Grant funding of no more than 67% of eligible costs is provided to successful LAs.
Risk	The remaining funding must be provided by the LA and supporting partners. Restrictions on how funds are used and reporting requirements may be onerous.
Further Information	https://www.gov.uk/guidance/heat-networks-delivery-support
Recipient	LA

Name	Energy Company Obligation (ECO)
Description	The Energy Companies Obligation (ECO) is a domestic energy efficiency programme which works alongside the Green Deal to provide added support for packages of energy efficiency measures. These measures are implemented through legal obligations based on energy suppliers to improve the energy efficiency of households. Support includes insulation and heating packages to low income and vulnerable households and insulation measures to low income communities. HN projects may qualify for the purposes of ECO and therefore certain energy efficiency measures would be funded by energy suppliers.
Value	Suppliers are allocated a proportion of the overall ECO targets, depending on their relative share of the domestic gas and electricity market therefore the value of measures varies.
Risk	A HN project would need to align with the requirements of ECO
Further Information	https://www.ofgem.gov.uk/environmental-programmes/energy-company-obligation-eco

Name	Energy Company Obligation (ECO)
Recipient	Likely to be a refurbishment development by public or private sector

Name	European Structural and Investment Funds (ESIF)
Description	The European Structural and Investment Funds (ESIF) programme provides funds to help local areas grow. The funds support investment in innovation, businesses, skills and employment and create jobs. Running from 2014 to 2020, there are three types of funds involved in the programme: European Social Fund (ESF), European Regional Development Fund (ERDF), and European Agricultural Fund for Rural Development (EAFRD).
Value	The ESIF funding is allocated on the basis of national 'calls' for proposals. England's 2014-2020 ESIF allocation totals €6,937.2 million, which is allocated amongst the 39 Local Enterprise Partnerships (LEP) areas. Grant amounts will vary depending on the 'call' and region.
Risk	Restrictions on how funds are used and reporting requirements may be onerous.
Further Information	https://www.gov.uk/european-structural-investment-funds
Recipient	Public or private sector

Name	European Local Energy Assistance (ELENA)
Description	ELENA support helps to put solid business and technical plans in place, which will help to attract funding from private banks and other sources, including the EIB. Examples of eligible projects include retrofitting of public and private buildings, sustainable building and energy-efficient district heating and cooling networks.
Value	ELENA covers up to 90% of the technical support cost needed to prepare, implement and finance the investment programme. This could include feasibility and market studies, programme structuring, energy audits and tendering procedure preparation. As an example, Bristol City Council received €2.6m in 2012 towards the costs of preparation and implementation of an investment programme, which included a district heating project.
Risk	Restrictions on how funds are used and reporting requirements may be onerous.
Further Information	http://www.eib.org/products/advising/elena/index.htm
Recipient	LA

2.d Development and Planning Obligations

As well as being able to use planning policy to encourage uptake and development of HN projects, financial requirements can also be put in place to require developers to fund specific or general infrastructure improvements, which can be used to support HN projects.

Below are set out the main mechanisms for receiving financial contributions from developers under development and planning obligations.

Name	Community Infrastructure Levy (CIL)
Description	The Community Infrastructure Levy is a planning charge, introduced by the Planning Act 2008 as a tool for LAs in England and Wales to help deliver infrastructure to support the development of their area. It came into force on 6 April 2010 through the Community Infrastructure Levy Regulations 2010. Unlike Section 106 (see below), the funds raised can be invested in a wide range of infrastructure and is not site-specific.
Value	Whether or not this is chargeable will depend on whether the local planning authority has chosen to set a charge in its area based on a needs and viability assessment. Most new developments which create a net additional floor space of 100 square metres or more, or creates a new dwelling, is potentially liable for the levy. As an example, 2016 rates for City of Westminster are up to £550/m^2 for residential developments, whereas Shropshire Council charges £40/m^2.
Risk	There is the risk that imposing high CIL rates may deter development investment in a region. In this way, charging authorities, 'must aim to strike what appears to the charging authority to be an appropriate balance between' the desirability of funding infrastructure from the levy and 'the potential effects (taken as a whole) of the imposition of CIL on the economic viability of development across its area'[36].
Further Information	http://www.legislation.gov.uk/ukdsi/2010/9780111492390/contents
Recipient	LA

Name	Section 106 (of the Town and Country Planning Act 1990)
Description	Planning obligations under Section 106 of the Town and Country Planning Act 1990 (as amended), commonly known as s106 agreements, are a mechanism which make a development proposal acceptable in planning terms, that would not otherwise be acceptable. They are focused on site specific mitigation of the impact of development.
Value	The value is negotiable with the developer but agreements can be up to several million pounds in value. For example, 20 years after the EfW facility was originally commissioned, 2013 saw the development of a district heating network to harness the heat from South East London Combined Heat and Power (SELCHP). This heat element finally came to fruition through a Section 106 agreement under Southwark Council's planning policies relating to Veolia's Old Kent Road SRF facility.
Risk	Negotiating s106 agreements can be a lengthy and costly process and could deter development investment in the region. They are linked to planning applications and so the knowledge of what would be available for a particular project would depend on progress of planning applications at the time of the OBC development.
Further Information	http://www.legislation.gov.uk/ukpga/1990/8/section/106
Recipient	LA

2.e Impact on the Financial Modelling

The cost of financing the capital development is likely to be a significant element of cost in the Financial Model, as the interest and repayment cashflows are payable over the life of the project. Any low cost funding or indeed zero cost grant funding/capital contributions (e.g. connection charges – see Part 2 Section 3a) can significantly improve the viability of the project and therefore opportunities to offer heat users reduced prices.

The proposed Delivery Structure and the Financing Mechanism – see also Part 1 Section 5(c) - will therefore need to be carefully considered as the likely source of funding is being determined. As with other areas in the project development, this will be an iterative process and will need a degree of soft market testing with potential funders.

[36] The Community Infrastructure Levy Regulations 2010, Section 14

3 Revenue Streams

There are a number of ways in which revenue streams for HNs can be optimised and supplemented through accessing additional revenues such as in relation to electricity, government operating subsidies, and through exploring parallel supplies.

3.a Heat Revenues

Setting heat prices and pricing structures is discussed in detail in Section 3 and 4 of Part 2, which will clearly have a direct impact on the heat revenues available to the project. Although higher heat prices might lead to higher heat revenues, providing affordable heat prices and meeting consumer expectations that the price of heat should be equivalent to (or less than) the price of the common alternative will be key to attracting and retaining customers.

Section 5 of Part 2 discusses Customer Types which can be identified and combined to optimise revenue streams for the project, for example by considering the customer location, density of demand, consumption profiles and that certain consumption profiles may be complementary. An optimised set of customers will need to be attracted to the scheme, and the level at which heat prices are set will have an impact on the desirability of the scheme to these customers.

Once customers have been attracted to the scheme, ensuring a high quality customer service with appropriate billing information and performance guarantees will help to retain customers. Although there is currently no regulator for the supply of heat, guidance is emerging in the market for the protection of customers, which is discussed in Section 2 of Part 2. Managing the collection of these revenues, including debt management strategy is dealt with in Section 6 of Part 2, and is important for maximising cash receipt of revenues.

Ensuring an efficient and well-designed scheme from the outset will maximise the cost to revenues ratio and therefore the reader should refer to Section 4c of Part 3 where reference is made to CP1:2015. It is anticipated that the initial design and route of the network will have been developed via thorough heat mapping, masterplanning and feasibility study and therefore optimisation of the route will have been performed from both a technical and financial point of view, however, project sponsors should keep abreast of developments within the scheme boundaries to ensure that new information is factored in as appropriate.

3.b Electricity Revenues

HNs often use combined heat and power (CHP) technology to generate heat. The electricity generated can be either:

- Consumed on site or via a private wire; or
- Exported off-site via the local Distribution Network Operator (DNO).

There are complex legal implications of the generation, distribution and supply of electricity and legal advice should be sought in all cases to navigate this and understand the options available to the project.

Any sales to a third party will likely involve a Power Purchase Agreement (PPA). A PPA is a contract between a generator of electricity and a purchaser of electricity. It sets out the commercial terms, such as payment terms, including penalties for non-delivery, commencement and termination conditions. A PPA may agree the sale of electricity at a rate which fluctuates in line with wholesale/retail electricity prices or may be fixed over a period. The receipt of lower but certain revenues over the long-term may be considered preferable in some cases. Time of day and seasonal variations to prices may also be agreed within a PPA.

The third party purchasing the electricity will have an impact on the revenues available, as the price offered will need to compete with, or more likely undercut, the price which it would otherwise pay for electricity. Notably, wholesale electricity prices (i.e. the price paid by commercial energy suppliers) are usually 40-50% of retail electricity prices (i.e. the price paid by retail consumers). This difference is due to TNUoS and DNUoS charges, environmental & social obligation costs recharged to suppliers by government, supplier overheads (e.g. customer service, sales, metering and billing), which are passed onto the consumer through the retail price, as well as the retailer profit margin and VAT. If selling via private wire (see Section 3bi), much of this expenditure can be avoided. Note that non-domestic consumers (e.g. industrial and commercial) can often negotiate rates based on their consumption levels and therefore size will influence the price which they pay.

Case Study: Portsmouth City Council

In 2002 Portsmouth City Council upgraded the heating system in the City's Charles Dickens Estate. It connects to 538 dwellings in the residential blocks as well as two schools, an arts and sports centre. A high-efficiency CHP unit was used, which supplies 500kWe of heat, hot water and electricity. Electricity generated is supplied to other Council facilities through a type of 'sleeving' arrangement with SSE. The heating system was pre-insulated to minimise heat losses and is electronically monitored. The project was facilitated by a grant of £435k from the Community Energy Programme.

Source: http://projects.bre.co.uk/partL_study/pdf/Portsmouth.pdf

Where schemes are considering electricity sales, consideration should be given to the Spark Spread (i.e. the difference between the value of the electricity generated and the cost of the fuel used to generate it). If gas costs for a CHP increased but electricity prices reduced (e.g. due to high levels of renewable sources) the Spark Spread may reduce to the extent that it is no longer economic to generate and sell the electricity.

3.b.i On-site and Private Wire

On-site sales are classed as being either to the same premises, premises immediately adjoining, or premises separated from each other only by a road, railway, watercourse or by premises occupied by a group company.

Private wire is a privately owned electricity distribution network operated outside of the public network. Private wire can involve additional upfront capital expenditure to implement but the revenues (sometimes nearing retail levels) may justify this spend.

Sales of electricity on-site and via private wire may be an option due to the Electricity (Class Exemptions from the Requirement for a Licence) Order 2001. This rules that operators need to determine if they qualify for an automatic licence exemption for generation, distribution and supply under the Electricity Act 1989, on the basis that the type of supply being made falls within one of the types made exempt from the requirement for a licence by the Order. A brief summary of the exemptions are below, which are not intended to substitute reading the full Order and seeking legal advice on the matter:

- **Generation** Exemptions: Small generators (<10MW or <50MW depending on the circumstances) and on-site supplies
- **Distribution** Exemptions: Small distributors (<2.5MW) and on-site distribution (<1MW) to domestic customers and distribution to non-domestic customers
- **Supply** Exemptions: Small suppliers (<2.5MW to domestic, <5MW to non-domestic), on-site and private wire supplies, but limited to 1MW to domestic consumers and re-sale of supplies purchased from a licensed electricity supplier

Where licensing exemptions are applicable, operations do not need to be licensed and are not bound by industry codes. Such supplies also avoid the UoS (Use of System) charges levied by distribution and transmission network operators for use of the public network.

Due to concerns regarding the monopoly implications of private wire agreements and the Citiworks ruling, there is a requirement to allow third party access to a private wire in circumstances where a customer has expressed an interest in being supplied by an alternative supplier or has signed a contract with a third party supplier. Further information on this is available in a DECC guidance paper on the subject[37]. However, even if third party access is requested, a use of system charge can be levied upon the third party, and alternative electricity exports can be negotiated.

Case Study: Cardiff County Council & Vale of Glamorgan Council

Kelda Organic Energy Ltd was contracted by the councils over a 15 year period to provide food and green waste treatment services. The 35ktpa anaerobic digestion plant is to be located on Welsh Water's land with the benefit of sales of electricity generated by the AD plant directly to Welsh Water's waste water treatment works via a private wire. The revenues from the sale of electricity help to reduce the cost of waste treatment to the Councils.

Source: https://www.cardiff.gov.uk/ENG/Your-Council/Strategies-plans-and-policies/Cardiff-Organic-Waste-Treatment-Project/Pages/default.aspx

3.b.ii Exports via Distribution Network Operator

Exports of electricity via the local Distribution Network Operator (DNO) will usually be contracted via a PPA with:

- a mainstream licensed electricity supplier (potentially via an aggregator);
- an alternative licensed electricity supplier, e.g. Nottingham City Council
- a Licence Lite supplier, e.g. Greater London Authority – see Section 3(b)iii below
- a consumer via some form of 'sleeving' – see Section 3(b)v below

The revenues available will be dependent on the customer type, for example sales to a mainstream licensed supplier will be at wholesale rates whereas an alternative licensed supplier may have a business model which is sympathetic to heat networks and therefore may offer a higher price per unit.

[37] GUIDANCE: PROVISION OF THIRD PARTY ACCESS TO LICENCE EXEMPT ELECTRICITY AND GAS NETWORKS, February 2012, DECC

When exporting via the DNO, there are a number of opportunities to access embedded benefits, exploit peak demand periods and gain access to availability payments for generation capacity being available.

'Embedded benefits' are a cost advantage available to those who are supplying energy within the local distribution network, rather than entering the national transmission network. Purchasing energy for distribution within the same supply region reduces the supplier's requirement to draw down energy from the transmission network and therefore avoids related charges and costs. Although much of the benefits are initially captured by (usually) the supplier, these benefits may be shared with the generator or consumer.

Embedded benefits arise from avoided:

- TNUoS (Transmission Network Use of System) charges – costs of using the transmission network, which vary significantly across the country and can increase significantly during TRIAD periods – see below;
- BSUoS (Balancing Services Use of System) charges – charged for balancing services by National Grid and is set at a universal rate;
- transmission losses costs – losses of 1-2% which occur through the transmission network;
- BSC (Balancing and Settlement Code) trading charges – charges for supplies and imbalances under the code; and
- the Assistance for Areas with High Distribution Cost (AAHDC) subsidy – charges used to subsidise distribution in the North of Scotland supply region.

Please note that these embedded benefits undergo frequent review and can vary by location so should be reviewed for relevance and applicability to the HN project in question.

Generators may choose to export into the public network only at peak demand periods in order to access the sometimes high revenues available at these times, or to have their capacity available in order to achieve availability payments. Some of the key arrangements in this regard are detailed below. Note that in cases where there is a minimum capacity required to access these revenues, 'aggregators' often operate to bring together multiple generator sites, taking a percentage fee for their services.

Name	TRIADS
Description	The Triad refers to the three half-hour settlement periods with highest system demand between November and February, separated by at least ten clear days. National Grid uses the Triad to determine Transmission Network Use of System (TNUoS) charges payable by each electricity supplier for the supply made to its customers with half hourly metering. Each licensed supplier will have to pay fees to National Grid for demand on the transmission system during these periods. If the project can generate and export during these periods, the electricity supplier who purchases the export will be relieved of transmission charges in respect of the exported volume and will recompense the cost that the supplier has avoided. This is a type of 'embedded benefit'.
Value	Any contribution an embedded small scale generator can make during the Triad periods reduces the supplier's requirement for electricity sourced through the transmission network and therefore its liability for TNUoS charges. The amount saved and payable as an embedded benefit to the generator varies regionally and depends upon the particular deal made with the supplier to whom the generator sold its exported power; but it can be worth in the region of £25,000 - £30,000 each year per megawatt of electricity generation capacity.
Risk	The triad periods are determined in retrospect so it is not possible to know for certain when these periods will occur although they are usually on a Monday to Thursday, during periods of particularly cold weather, at around 5-7pm. Therefore it is difficult to be certain that TRIAD benefit will be receivable, albeit operators can sign up to Triad warning notification systems.
Further Information	http://www2.nationalgrid.com/UK/Industry-information/System-charges/Electricity-transmission/Transmission-Network-Use-of-System-Charges/Transmission-Charges-Triad-Data/
Recipient	Energy generator

Case Study: Islington London Borough Council

Bunhill 1, Islington London Borough Council's heat network, is supplied by a 1.98MWe gas CHP engine. As well as heat sales, the Council exports energy all year round to the DNO. The electricity is sold via Power Purchase Agreements with aggregators. During TRIAD periods, the Council is able to access this embedded benefit. The Council continues to explore additional opportunities for maximising revenue streams and avoiding costs. For example, using its 115m3 thermal store for demand side response services. Bunhill 2 (the second phase of the heat network) will seek to optimise net electricity revenues by switching on the CHP/off the heat pump when electricity prices are high and may also access Renewable Heat Incentive (RHI) income.

Name	Short Term Operating Reserve (STOR)
Description	At certain times of the day, National Grid needs reserve power in the form of either generation or demand reduction to be able to deal with actual demand being greater than forecast demand and/or plant unavailability. National Grid will procure part of this requirement ahead of time through STOR. A STOR provider must be able to: • Offer a minimum of 3MW or more of generation or steady demand reduction (this can be from more than one site); • Deliver full MW within 240 minutes or less from receiving instructions from National Grid; and • Provide full MW for at least 2 hours when instructed.
Value	There will be two revenue streams associated with STOR: • Availability Payments (£/MW/h): service providers are paid to make their unit/site available for the STOR service. This is currently in the region of 3-5p/MW/h. • Utilisation Payments (£/MWh): service providers are paid for the energy delivered as instructed by National Grid. This is currently in the region of 165-175p/MWh The amount of revenue available depends on the location of the capacity and the season during which it is available, however, such contracts can be worth in the region of £10,000 – £15,000 each year per megawatt of electricity generation capacity.
Risk	Penalties are payable and income will not be received if the capacity is not available during the required availability window. Scheme operators should carefully consider whether diverting capacity away from 'normal' operations would

Name	Short Term Operating Reserve (STOR)
	jeopardise the scheme.
Further Information	http://www2.nationalgrid.com/uk/services/balancing-services/reserve-services/short-term-operating-reserve/
Recipient	Energy generator

Name	Capacity Market (CM)
Description	The Capacity Market is part of the government's Electricity Market Reform package and guarantees generators who are successful in the CM auctions a steady, predictable revenue stream (capacity payment) for availability of their generating capacity. This is to enable investment in new generation assets and to keep existing generation available on the system. Total available capacity must be greater than 2MW.
Risk	Revenues are driven through an auction which will take place annually, four years ahead of the relevant capacity delivery year. Therefore, revenue levels are market driven and difficult to predict prior to the conclusion of the auction.
Further Information	https://www.gov.uk/government/collections/electricity-market-reform-capacity-market
Recipient	Energy generator

3.b.iii Licence Lite

In 2009, Ofgem introduced 'Licence Lite' to give smaller electricity generators the potential to engage in the retail supply of electricity, without conforming directly to industry codes (i.e. effectively outsourcing compliance to another licensed supplier). This allows small players to enter the electricity supply market and supply their electricity retail to any premises connected to the public electricity distribution system. Greater London Authority (GLA) has applied for a Licence Lite licence and therefore this presents an opportunity for London-based HNs to access such revenues.

3.b.iv Full Licence

Becoming a fully licensed electricity supplier is an option that a number of LAs have considered and/or implemented. This option requires conforming to all industry codes, which can be a burden in resource terms and therefore is only likely to be viable where there is sufficiently large customer base. Unless covered under the Electricity (Class Exemptions from the Requirement for a Licence) Order 2001 – see 3bi above, an application will need to be filed with Ofgem's Industry Codes and Licensing Team. Before beginning the application process, it is recommended that independent legal advice on how best to comply with industry rules and regulations is sought.

3.b.v Sleeving

'Sleeving' is a direct agreement between an electricity consumer (importer) and a generator (exporter). This is also known as 'virtual network' or 'third party netting'. A contract between the two sets out that the importer will buy a fixed volume of electricity from the exporter over a set period of time, either at a fixed of floating purchase price.

Sales over the public network need to be administered by a licensed electricity supplier who can cover responsibilities such as Balancing and Settlement, metering and invoicing and TNUoS and DNUoS charges and is the supplier for regulatory purposes. This cost means that a virtual network is unlikely to be economic for low levels of supply.

Case Study: HSBC

Wind farms will provide 40% of HSBC's total energy requirements in the UK due to a 12 year power purchase agreement with Jack's Lane Wind Farm in North West Norfolk and Wryde Croft Wind Farm in Cambridgeshire. The wind farm will generate and export electricity directly to the national grid to offset HSBC's electricity consumption via a 'sleeving' agreement, supporting the bank's commitment to reducing its environmental footprint.

Source: HSBC Press Release, HSBC powers ahead with renewable electricity from new UK wind farms, 5 August 2015

3.b.vi White Label

White Labels are unlicensed companies that have a contractual agreement with a licensed supplier for the supplier to sell gas and/or electricity to consumers using the white label's brand. This approach is being used by LAs who can use their trusted brand to encourage residents to switch suppliers and access better tariffs. The licensed supplier normally provides the customer service and billing infrastructure because it is responsible to the regulator Ofgem for the supply under its licence, not the owner of the white label brand. Arrangements are often governed by KPIs such as in relation to customer services and the supplier's price position in the market. Although this does not represent an opportunity for HN projects to sell their own energy, it does offer the opportunity for broader service (electricity) offerings to customers served by the network. This model is usually only viable where there is a large customer base of electricity consumers.

3.c Cooling

Cooling, as well as heating, is a saleable product and there are a number of opportunities for introducing cooling systems within a district heating network. 'Trigeneration' or combined cooling, heat and power (CCHP), is the process by which some of the heat produced by a cogeneration plant is used to generate chilled water via an absorption chiller. This cooling power could equally be generated through 'free' sources such as lakes, rivers or seas.

Case Study: MediaCityUK

Cofely was commissioned to design, build and operate a natural gas CHP trigeneration solution. Heat from the CHP is circulated around the complex through a network of pipes and Surplus heat is also used to chill water, providing a cooling service to buildings.

Trigenration extends the environmental benefit of the scheme, displacing the need for separate air-conditioning, in turn reducing overall CO_2. The installation will result in a saving of £560,000 each year in energy costs. It also delivers a minimum 29% saving in CO_2 emissions when compared to supplying the power, heat and cooling through conventional separate sources.

Source: http://www.theade.co.uk/trigeneration_188.html

In the UK, heating rather than cooling is usually the requirement. A HN project should carefully consider whether the additional cost of enabling the scheme for trigeneration or a separate cooling network makes financial sense when compared to using alternative cooling methods. A building with a continuous cooling demand is likely to be more attractive for trigeneration rather than an intermittent requirement.

3.d Other Utilities

Making use of the billing and customer services infrastructure which will need to be present for the supply of heat, the project could consider providing additional utility services such as water/sewerage, telecoms and highways, or offering a duel fuel tariff. The relevance of water is particularly topical given that the Water Act 2014 means that from April

2017, business customers (businesses, charities or public sector) will be able to choose who supplies their water and wastewater retail services (i.e. water meter reading and customer services). Business customers will also be able to apply for a licence to supply themselves (self-supply) with retail services. This offers the opportunity for economies of scale for any 'retail services' capacity and capability developed as part of a HN.

3.e Asset Rental

A LA may own assets which may be useful to an operator of a HN, for example land, boiler house or plant and equipment. These assets can be rented to the HN operator to drive a revenue stream for the LA. Where rental/lease agreements are being set up, legal advice should be sought to ensure the protection of the LA.

3.f Government Operating Subsidies

Subsidies available to HNs will vary over time under political changes. It will be important to understand the subsidy opportunities available, which are likely to vary based on the technology and generating capacity of the plant involved. At the time of writing, Renewable Heat Incentive (RHI) is available to help businesses, public sector and non-profit organisations meet the cost of installing renewable heat technologies. Subsidies may also be available as attached to electricity generated from renewable and low-carbon technologies, such as Feed in Tariffs (FiTs).

Name	Non-Domestic Renewable Heat Incentive (RHI)
Description	The Non-Domestic Renewable Heat Incentive is a government financial incentive to increase the uptake of renewable heat. Eligible technologies are as follows: • solid biomass, including when contained in waste (including CHP) • ground and water source heat pumps • air to water heat pumps • geothermal (including CHP) • solar thermal (at capacities of less than 200 kWth) • biogas combustion (except from landfill gas but including CHP) • biomethane injection Note that gas-fired CHP is not eligible for RHI.
Value	Payments are made on a quarterly basis over a 20 year period to the owner of the RHI installation or the producer of biomethane. Payments are based on a p/kWth rate for which current rates are between 2 – 11p/kWth depending on the generating capacity, technology and accreditation date.
Risk	The rates applicable to RHI do reduce in line with uptake but once accredited the income is low risk. The recipient commits to providing annual declarations and provision of periodic data. RHI cannot be claimed if a grant from public funds has assisted in respect of any of the costs of purchasing or installing the generation equipment.
Further Information	https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi
Recipient	Energy generator

Name	Feed in Tariff (FiT)
Description	The Feed-in Tariffs (FiT) scheme is a government programme designed to promote the uptake of a range of small-scale renewable and low-carbon electricity generation technologies. It is available through licensed electricity suppliers. To be eligible for the FiT scheme, the total installed capacity of an installation must not exceed 5 MW (see Contracts for Difference for capacity over 5 MW). The limit is 2 kW for micro Combined Heat and Power (CHP). Eligible renewable and low carbon technologies are: • Solar Photovoltaic (PV) • Wind • Hydro • Anaerobic Digestion • Micro CHP
Value	FiTs payments are made at least quarterly by licensed electricity suppliers that participate in the scheme. Payments are over a 20 year period (10 years for micro CHP). Payments are based on a p/kWh rate for which current rates are between 2 – 16p/kWh (for non-photovoltaic installations) depending on the generating capacity, technology and accreditation date. For example, the rate for micro-CHP is currently listed as 13.61p/ kWh.
Risk	The rates applicable to FiTs do reduce in line with uptake but once accredited the income is low risk.
Further Information	https://www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme
Recipient	Energy generator

Name	Contract for Difference (CfD)
Description	Contracts for Difference (CfDs) are designed to give investors the confidence and certainty they need to invest in low carbon electricity generation. They do this by paying the generator the difference between a measure of the cost of investing in a particular low-carbon technology (the 'strike price') and a measure of the average market price for electricity (the 'reference price'). The generator participates in the electricity market, including selling its power, in the normal way. Low carbon technologies such as biomass CHP and anaerobic digestion are eligible, subject to generating capacity.
Value	The value of the contract is the value of the difference between the 'strike price' and the 'reference price', which may be positive or negative. An important value, however, is the stability in income which allows investment decisions to be made without exposure to a fluctuating electricity market.
Risk	Allocation is through an auction process. Upside risk as well as downside risk is foregone when entering a CfD.
Further Information	https://www.gov.uk/government/publications/electricity-market-reform-contracts-for-difference
Recipient	Energy generator

3.g Impact on the Financial Modelling

A prudent approach should be taken when considering the levels of revenue to recognise in the Financial Model. It will be important to run a range of sensitivities (see Part 1 Section 4) on the assumptions around additional revenue streams to understand if their absence or (at what point) their reduction would render the scheme unviable. In particular, TRIAD and STOR income is considered to be high risk and therefore it would be prudent not to include this income as part of the Financial Modelling.

4 Avoided Costs

Optimising the cost base for a project should be a key consideration through the development stage. As one of the most significant costs of the system, finding a cost-effective source of heat should be prioritised, as well as ensuring the system is designed for maximum efficiency. Consultation with technical experts will be required in this regard and also consideration of where collaboration and taking a holistic view of the wider benefits of HNs may make a project viable. With advancing (and often the decreasing cost of) technology around data management and communications, there are opportunities to be innovative and take a 'smart' approach to maximising opportunities of HNs.

4.a LA Budgets

Whether or not LAs have specific budgets in place for HNs, the impacts of their implementation are likely to be felt across the LA on a whole system cost basis. For example HNs may lead to avoided costs in areas such as:

- Energy purchase, where supplies are being made to council properties
- Capital spend, where ageing heating systems are in need of replacement – the timing of the heat network is critical for avoiding this spend
- Maintenance spend, where the cost of maintaining heating plant is avoided (or reduced)

4.b Developer avoided costs

Depending on local policy, developers may have standards to conform to in terms of carbon efficiency for developments. Connecting to a heat network may satisfy these requirements, therefore avoiding costs of alternative measures. For example and as discussed in Part 1 Section 1c, developers in London are required by planning guidance to pay £1,800 / tonne to 'offset' CO2 underperformance. Therefore, installation of a HN which reduces underperformance can be seen as an avoided cost.

Please see the Comparator section within the FMCIRD at Appendix A for guidance on calculating this Developer Comparator (i.e. the cost which would otherwise be incurred (avoided cost) by the developer if it did not connect to the HN), which may justify charging the developer a Connection Charge or negotiating a Developer Contribution – see Part 2 Section 3a.

4.c System Design for Efficiency

Historically HNs in the UK have suffered criticism for being inefficient and sometimes oversized. It is therefore imperative that the design of the network is optimal to ensure an efficient and cost-effective system. Technical expertise should be sought to optimise efficiency of the system, with reference to Section 3 Design of CP1:2015. As highlighted in CP1:2015, some of the 'Goals' for an optimised HN are set out in the table below.

Table 15: Financial Implication of CP1:2015 Goals

Goal as per CP1:2015	Description	Financial Implication
A. Correct sizing of plant and network	Plant and the network should be sized in line with accurate demand profiles, matching base load demand and peaking capacity to relevant generation assets. For example, a CHP plant would be typically sized to provide 60% to 80% of the total heat demand of a scheme with the balance (peaking plant) from gas-fired boilers. A heat store is particularly useful where heat generation and heat demand do not match up. Designers should also bear in mind the potential for expansion of the scheme when sizing e.g. primary network branches.	Conservative designs can be more costly and have lower performance, however, oversizing leads to unnecessary capex and opex.
B. Achieving low heat network heat losses	Heat losses can occur through poorly insulated pipework and designers need to consider ways to reduce the heat losses as far as practical through proper insulation and optimised flow temperatures.	The impact of losses will depend on the cost of the heat source, i.e. heat losses under a scheme using a low marginal cost heat source (e.g. geothermal) will have less financial impact than heat losses under a scheme using a higher marginal cost heat source (e.g. gas fired CHP).
C. Achieving consistently low return temperatures and keeping flow temperatures low	Where there is a high temperature difference between flow and return temperatures, a low design return temperature will reduce peak volume flow rates leading to smaller pipes. As noted in Part 2 Section 2d, heat consumers can be incentivised to achieve a consistently low return temperature through discounts on their heat bills. Networks operating at lower temperatures can make use of plastic pipes which are relatively cheap, flexible and quick to fit when compared to conventional steel pipes.	Reduction in capital and operating expenditure requirement.
D. Use of variable flow control principles	Using variable flow control systems will result in lower flow rates and lower return temperatures at part-load. Variable speed pumps are used and should be controlled to maintain a minimum pressure difference at the extremities of the network.	Reduction in heat losses and pumping energy therefore reducing costs.
E. Optimising the use of low carbon heat	Where a primary driver for the HNs is a reduction in carbon, low carbon heat capacity should be sized to deliver a high proportion of the annual heat demand.	Carbon benefit is the driver here but low carbon heat sources can be cost effective (often high capex and low opex).
F. Delivery of a safe, high quality scheme where risks are managed and environmental impacts controlled	A safe, high quality scheme where risks are managed and environmental impacts controlled is an objective which should be at the core of any scheme design.	Cost of 'quality' may be high but the risk of failure and the financial implications which come with this will be avoided.

Case Study: Knowsley Council

Knowsley Council are in the process of procuring a Strategic Energy Services Partner (SESP) to deliver the a HN in Knowsley Industrial and Business Park (KIBP). To maximise revenues, the design recommendation promoted both the sale of heat and power, with power sold directly to connected anchor loads through private wire. A phased approach will be taken to avoid front-loaded capital expenditure. HN routes were selected to utilise council land and sub-soil rights and thereby minimise costs associated with land and wayleave rights.

4.d Heat Storage

Storage of electricity via batteries has had its challenges, but heat lends itself to thermal storage in insulated water tanks, or more innovatively within the building fabric itself. As noted in CP1:2015[38], "incorporating thermal storage has a number of benefits:

- Smoothing of the daily variation in heat demand reducing the use of peak boilers – normally of a benefit in the spring and autumn months.
- Enabling a CHP plant to operate during times of higher electricity price (daytime) and shutting down at times of low electricity price (night-time)[39].
- Enabling extraction [i.e. decreased electrical output] from steam turbine and operation of heat pumps to be prioritised during times of low electricity price (night-time).
- Enabling biomass boilers to operate continuously.
- Enabling plant to operate at full output for fewer hours rather than at part-load where it would be less efficient.
- Reducing the number of starts of low carbon plant especially CHP units.
- Allowing the peak heat network capacity to be reduced and hence smaller pipes, by using local distributed stores."

Case Study: Bunhill Heat Network

Bunhill Heat and Power is a ground-breaking scheme retrofitting district heating to existing buildings in an inner-city environment. Completed in 2012, the first phase of the network serves over 850 homes, two leisure centres and a new housing development. It provides cheaper, greener heat to residents, helping to provide a buffer for residents against rising fuel prices and delivers CO2 savings of around 60% for the existing buildings compared to their previous heating systems. Islington Council is expanding the network to connect additional homes and capture low carbon and renewable heat from the London Underground network.

A 115m³ thermal store allows the CHP to efficiently operate during periods of high electrical demand (securing better prices) by storing the heat generated. Expansion to this is anticipated in the form of a further 70m³ store which will be charged via low carbon sources (such as a heat pump) during periods of low electricity prices.

Source: Delivering UK Energy Investment: Networks, January 2015, DECC and Towards a Smart Energy System, DECC, 17 December 2015

Heat storage can also be used to harness excess electricity from variable renewable generators such as wind and solar power. As the UK's renewable generation capacity increases, the supply to the grid becomes more variable. Heat storage can be used to smooth this supply variability through storage of excess energy (e.g. on windy and sunny days). Contrariwise, at times of low renewable output, CHPs can be switched on to meet shortfalls. Heat storage is also extremely helpful in "smoothing out" space heating demands throughout the day, particularly when utilised in HN schemes.

Depending on the level of insulation, heat storage periods can range from a few hours, up to a few seasons. Intra-seasonal transfer of energy can be supported through thermal storage to capture heat during warm summer months for releasing during the winter periods.

Case Study: Galliford Try: Grayling Park Chichester Linden Homes

Regeneration of a former Victorian hospital on an 85 acre site, the scheme is the first in the UK to utilise twin pipe insulation technology which dramatically reduces heat losses and also optimises the construction process by reducing the amount of trenching required. The system provides heat to 750 newly built homes, some of which are in the converted Victorian hospital. The design includes a 96,000 litre thermal store and is powered by a combination of 6 heat and electricity generators to ensure the system runs efficiently. The 8km

[38] CIBSE Heat Network Code of Practice Section 3.11, To optimise the use of thermal storage
[39] PPAs may govern electricity prices with variations during the day or between seasons.

network is electronically monitored and any anomaly in the operation of the system is immediately picked up. The development is scheduled to be complete for 2017. The system runs on natural gas and produces both heat and electricity. The electricity is supplied into the local grid.

Source: www.eneteq.co.uk/case-studies/graylingwell-park-chichester/

4.e Demand Side Response (DSR)

Demand Side Response is defined by Ofgem as 'actions taken by consumers to change the amount of electricity they take off the grid at particular times in response to a signal'. In the case of a HN the 'consumer' would usually be the network operator. There are two common forms of DSR activities:

1. reducing demand for a short period, or
2. using on-site generators to temporarily meet on-site requirements and/or export to the grid.

This may be relevant to HNs through:

- Switching on CHP during high demand periods to access peak tariffs from the grid, or to supply electricity to network users therefore reducing demand from the grid
- Switching off of a heat pump during high demand periods to reduce electrical demand
- Generating during TRIADs – see Section 3bii
- Implementing varied tariffs (by time of day) for heat users, to incentivise reduced heat usage during periods where electricity supply to the grid is achieving low tariffs.

4.f Heat Controls & Education

DECC's research[40] suggests many people find their heating controls confusing or difficult to use, which can lead to energy being wasted. Firstly, education programmes (including training and user-friendly manuals) can be implemented so as to ensure an informed user. Secondly, smart heating controls can be installed to offer various innovative functions to better align the timing and temperature of heating with when it is needed. These systems can also come equipped with automated DSR services.

4.g Procurement

Procurement following OJEU procedures can present an opportunity to drive efficiencies and innovation from the private sector under competitive pressures of quality and price. The more market interest there is in the competition, the more likely these efficiencies will be generated. For this reason, prior to going to OJEU, LAs should consider packaging the project in order to make the risk-reward opportunities to the private sector appealing, whilst protecting public interests.

To facilitate and support the procurement of products and services related to district energy, there is potential that a municipally owned procurement cooperative will be established, called District Energy Procurement Agency (DEPA).

[40] https://www.gov.uk/government/publications/2010-to-2015-government-policy-household-energy/2010-to-2015-government-policy-household-energy#appendix-2-smarter-heating-controls-research-programme

This would be an OJEU compliant procurement organisation mirroring the well-established Swedish model – Värmek. One of the objectives of DEPA would be to significantly reduce the capital costs of district energy projects and enhance their viability. The core service of the DEPA would be the procurement of district energy goods and services for LAs, undertaking two key activities:

- Procuring frameworks of relevant goods and services; and
- Undertaking procurement on behalf of members (UK LAs).

It is intended that revenue funding for DEPA would come from both subscriptions paid by the members and through a levy on successful project delivery contractors, suppliers and/or service providers.

4.h Secondary Heat Source

A significant area of cost to the scheme is likely to be fuel/heat generation – both from a capital investment and an operating expenditure point of view. Therefore the technology used to generate/capture the heat should be carefully considered in conjunction with the surrounding built and natural environment to identify opportunities. Most HNs in the UK are heated via natural gas or biomass-fuelled CHP/boilers, but the following should be considered for maximising opportunities to harness secondary heat sources, i.e. surplus heat arising as a by-product of industrial and commercial activities or heat that exists naturally within the environment (air, ground, water). Much of the information below is sourced from London's Zero Carbon Energy Resource[41].

A drawback of using secondary heat is that it may be low grade heat (usually 5 - 35ºC). As such it may need to be upgraded to the required temperature using a (single or two stage) heat pump, which will require capital investment and on-going opex, which will need to be taken into account when determining surplus heat as the preferred source.

4.h.i Surplus Heat

Where surplus heat can be harnessed, (e.g. heat arising as a by-product of industrial and commercial activities) this might be available to the scheme at a cost lower than that required to purpose-generate the heat from a fuel. In particular, generation plant and input fuel costs are likely to reduce. However, depending on the grade (i.e. temperature) of the heat, expenditure may be required to upgrade the heat to the required temperature using heat pumps.

Case Study: Sheffield Energy Recovery Facility (ERF)

Under a 35 year contract with Sheffield City Council, Veolia operates an ERF which treats 28 tonnes of the city's residual waste per hour. This waste generates up to 21MW of electricity for the grid each year and up to 45MW of heat is supplied to buildings connected to the city's HN.

Source: http://www.veolia.co.uk/sheffield/sites/g/files/dvc461/f/assets/documents/2014/11/Sheffield_ERF_Brochure_0.pdf

Numerous HNs in the UK are supplied via Energy from Waste (EfW) plants processing municipal solid waste. A heat off-take can be a welcome source of revenue for such a facility and therefore reasonable prices may be negotiated.

[41] LONDON'S ZERO CARBON ENERGY RESOURCE, Secondary Heat, Buro Happold, July 2013

Other waste management processes such as Anaerobic Digestion of organic waste and sewerage treatment works produce heat due to biological activity required as a by-product and therefore similar off-take contracts may be negotiated.

Power stations often have high levels of energy losses (sometimes operating with efficiencies of 30-50%) as heat is produced as a by-product of the combustion process of a fuel to generate electricity.

Cooling processes often reject heat as part of a chilling mechanism. Cooling will often be more in demand during the summer months so harnessing heat from cooling processes may only offer a seasonal source. However, data centres and supermarket fridges need cooling year-round and so may offer a reliable source of heart.

Industrial processes can lead to high levels of surplus heat, which can be up to 70ºC (depending on the process). Processes which are likely to generate waste heat include chemical and pharmaceutical, clinical waste incinerators and food producers. In some cases, water bodies located next to an industrial (e.g. a soap factory) can raise the temperature of the water, which can then be harnessed for a heat network.

There are also a number of infrastructure sources of surplus heat, which include underground and metros (generated though train breaking and lighting), electricity substations and sewers.

Planning conditions and/or planning opposition may mean that some of the technologies noted above are not permitted to be built close to population centres. This can be a lost opportunity to harness surplus heat as long distances and transportation of the heat can render its use infeasible. Where possible, the organisation undertaking the Promotion role should be in contact with planning authorities to ensure awareness of the wider considerations of certain planning consent decisions.

4.h.ii Naturally Occurring Heat

Although the upfront capital expenditure can be high, and indeed there is potential uncertainty of availability of heat until the wells are drilled, geothermal offers a reliable, long term solution with very low running costs and zero fuel costs. Deep geothermal is a relatively untested technology and therefore the costs associated with construction may be subject to high variation from initial estimates – see Inputs within FMCIRD at Appendix A.

Case Study: Southampton Geothermal

Southampton City Council created the UK's first geothermal power scheme in conjunction with Cofely via a 1,800m deep aquifer at a temperature of 76 ℃. The scheme heats a number of buildings in the city centre as part of an enlarged city centre district heating system that includes other cooling and power sources. Electricity generated from the scheme is sold via a private electrical connection to the Port of Southampton, with any surplus electricity sold back to the grid.

Ground, air or water source heat pumps can also be considered, albeit electricity is required to run heat pump systems, as they upgrade the naturally occurring heat (usually less than 20ºC) into higher grade heat. Ground source is a very stable source as it is not subject to significant seasonal variation, whereas air source will vary both on a seasonal and diurnal basis.

Another source of naturally occurring heat can be considered to be solar thermal, which collects solar energy as heat. Clearly, the level of heat collected will vary depending on cloud levels and seasons so this may not represent a stable heat source.

Case Study: Stoke on Trent Geothermal

The Stoke-on-Trent and Staffordshire City Deal is built around a flagship proposal for the UK's first at-scale, HN system that takes advantage of local deep geothermal energy. The proposal forms part of the City's Low Carbon Task Force that is driving the transition to increased energy self-sufficiency and sustainability.

With a total expected investment of £52.4 million, of which £20.2 million will be funded from Government through the City Deal, the project will supply 45 GWh per year to a range of consumers. The scheme is expected to lower heating costs by up to 10% and save around 10,000 tonnes of CO_2 per year when it is completed in 2019. Phase 2 of the scheme has wider ambitions for sustainable energy across Stoke-on-Trent including opportunities to use mine water and waste industrial heat.

Source: Delivering UK Energy Investment: Networks, January 2015, DECC

4.i Decarbonisation

District heating systems, through aggregation, scale and sometimes low grade heat requirements, can make the use of renewable energy sources economically viable, which may not otherwise be so at the household or building level. HNs are technology agnostic when it comes to heat source and so offer opportunities to increase use of / swap in renewable technologies as they become available, or as they become more cost competitive.

Case Study: Basildon Langdon Hills, Thames Energy

The district heat scheme serving 556 dwellings on the Langdon Hills Estate was first developed in the 1970s. Its original design standards coupled with old age had reduced its efficiency to only 55%. Thames Energy were appointed to carry out the upgrade. This included replacing the original boiler system with a gas fired CHP unit, replacement of the piping for new high thermal insulation piping and a replacement of the control systems. The revenue brought in from the sale of electricity into the grid helps to reduce bills for those on the HN, which have come down by 20% as well as reliability improved.

Gas CHP is a common source of heat for HNs and their long term carbon benefits of this technology have come under scrutiny. Current government guidance suggests "operators can save up to 30% on carbon emissions"[42] through use of CHP. It should be noted that that there are also expectations regarding decarbonisation of the grid and therefore the carbon differential in self-generation via gas fired CHP and using 'greener' electricity from the grid may be seen to close over time. In any case, CHP usually has a lifespan of approximately 15 years and therefore will need to be replaced or swapped out for an alternative technology after this period. Plant replacement strategy should plan for a lower carbon heat source based on information available at the time.

4.j Network Routing and Installation

HNs often require a significant civils cost for installation of pipework and therefore opportunities to reduce this cost through innovation and efficiencies can have a significant impact on the viability of the scheme.

There is a clear incentive to reduce the length of pipework required as this is typically a £ per meter cost, albeit physical constrains such as avoiding rivers and roads will be required. In addition to this, routes may be considered

[42] https://www.gov.uk/guidance/combined-heat-and-power

preferable where there are opportunities for shared utilities trenching and timing developments to share the cost of groundwork. Similarly, consideration should be given to selecting routes where the gas mains have been abandoned or have yet to be replaced, which may offer an opportunity to reduce future costs in the gas network. Horizontal directional (HD) drilling can be used may also avoid the requirements for open trenching, this is particularly cost-effective for ambient temperature networks supplied by heat pumps.

Case Study: Bunhill 1, Islington London Borough Council

Launched in 2012, Bunhill 1 is a district-wide heat network which is wholly owned and operated by Islington London Borough Council. The system consists of a 1.98MWe gas CHP engine and 115m^3 thermal store which serves heat to 6 local sites, including 850 homes and two leisure centres. The project avoided costs through sharing utilities trenching with Thames Water, during the Victorian mains replacement and the shared trench ran down approximately 200m of road. The first contractor opened the trench and laid their pipework and the second (Vital Energy) laid the heat network pipework within the same trench and undertook the backfilling and reinstatement works. The network is due to be extended in 2016 (Bunhill 2) to serve the King's Square housing estate. An additional energy centre will be developed to recover heat from the London Underground via a heat pump and supplied to the network.

4.k Collaboration

As the number of networks within any given conurbation might be anticipated to grow, there may be opportunities for collaboration in the form of interconnection with neighbouring district heating networks. This would enable excess energy that is produced to be traded under a commercial agreement, reducing demand volatility in the overall network and allowing access to increased economies of scale. Other opportunities for collaboration might be in terms of bulk procurement/transportation of fuel sources and economies of scale gained on specialist operation and maintenance.

4.l Impact on the Financial Modelling

Taking a holistic view of avoided costs could make or break the viability of a scheme being tested through Financial Modelling. Where possible, wider avoided costs should be captured in the modelling process and/or under the Project Comparator – see Part 1 Section 1(c) and Inputs within the FMCIRD at Appendix A. System efficiencies, capital expenditure and cost of fuel should be a key area of sensitivity testing where variability might be perceived.

Smart systems may offer opportunities for efficient energy use but this 'intelligence' comes at a price. In all cases, a cost-benefit analysis should be performed as part of the Financial Modelling exercise. Due to their nature, revenues generated based on variability in demand from the grid will be mixed and therefore caution should be applied when assuming such revenues, with sensitivity testing performed.

Appendix A – Financial Model Cost Input Reference Document

The Financial Model Cost Input Reference Document (FMCIRD) has been developed to enable an interested party to review the financial implications of a proposed heat network and should be used in reference with the Guidance on Economic and Financial Case in addition to the Guidance on Strategic and Commercial Case as well as other relevant publications, such as the Heat Networks Code of Practice.

The accuracy and robustness of the Feasibility stage Techno Economic Model (TEM) will be based upon the level of technical and commercial knowledge held at the time of assessment. This reference document should be used to assist in identifying that key financial items have been accounted for, if not directly identified. The information should be further used to validate assumptions and considerations made within the TEM.

The assessment should be carried out in three stages, in order to develop reflective costs and support the development of the TEM into the Financial Model (FM) in the Outline Business Case (OBC).

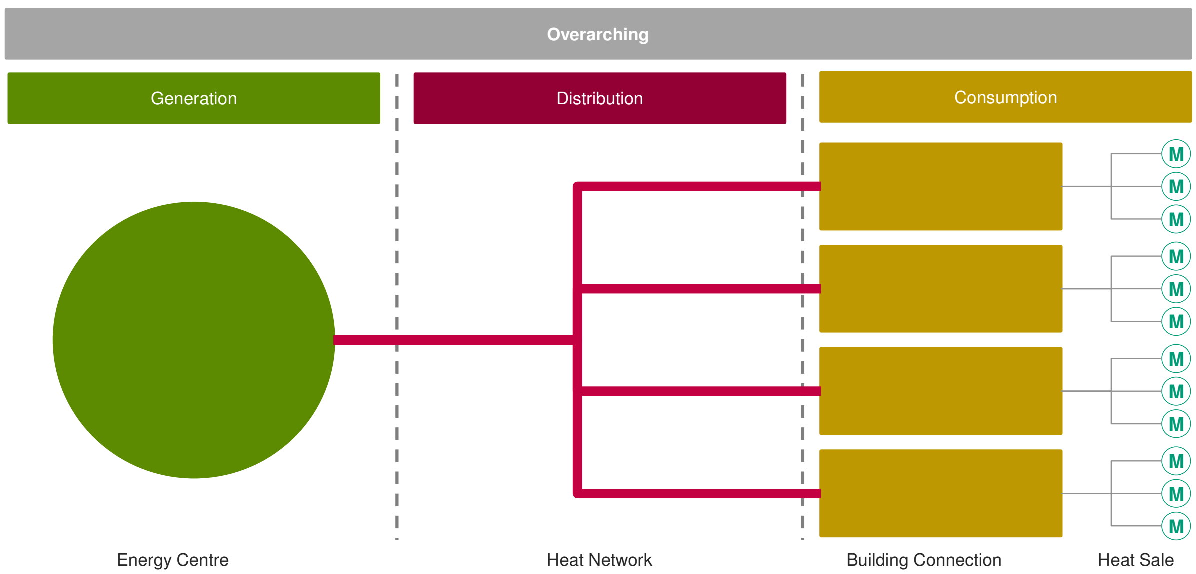
The three stages, for each option, are as follows:-

1. Input Data
2. Risk Assessment
3. Project Comparator

The Input Data has been further sub-divided into four areas of a heat network, as defined below;

1. Overarching; costs relating the overall heat network
2. Generation; all costs associated with thermal energy generation including plant, buildings and connection to the distribution system
3. Distribution; all cost associated with distributing heat from the thermal energy generation plant boundary, to the first point of building thermal connection
4. Consumption; all costs associated with delivering heat from first point of building thermal connection, to the internal heat customer. Captures thermal energy sales.

The figure below visually presents the boundaries of these groups and has been colour coded for ease of use; Overarching (Orange), Generation (Green), Distribution (Blue) and Consumption (Red).



Inputs – General notes

The data contained within the FMCIRD has been developed as a guide for LAs to assess and review the level of detail within the Techno-Economic Model (TEM) developed at the Feasibility stage of a project.

The information contained within the Input section, is intended to allow the LA to review their current TEM and identify whether key items have been considered. The Input section of the FMCIRD has been developed into four categories, each representing a physical element of a heat network;

- Overarching:- Costs associated with the overall scheme that may not be suitable to attribute to a specific cost type (defined below) on most projects
- Generation: - Costs associated with the generation of thermal energy. Demarcation set from the primary energy import (gas, electricity etc) through to the thermal energy export (Generation - GC/31 Network Distribution Pumps)
- Distribution: - Cost associated with thermal energy distribution from point of generation (Generation - GC/31 Network Distribution Pumps) to the customer (Distribution - DC/06 Thermal Sub-Station).
- Consumption: - Cost associated with thermal energy consumption from the heat network (Distribution - DC/06 Thermal Sub-Station). Costs dependant on extent of the network but should include all items up each point of sale.

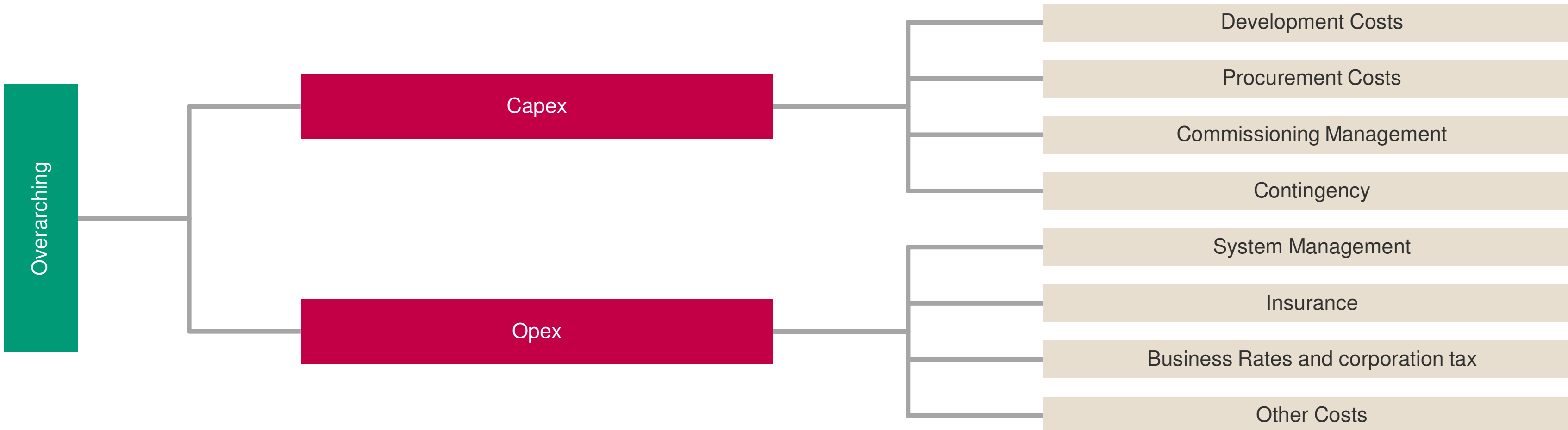
Not all projects will be split into these categories nor will all items be required for all projects. Additionally, it is not necessary to have each item identified within the TEM but there should be consideration to identify with sufficient allowances have been made. The information is not intended to comment on the accuracy of the prices developed within the project TEM. The reader may refer to published data, such as SPONs, but it is recommended to seek manufacturer/installer/operator cost input to validate financial assumptions. To date, the limited published financial information on heat networks is unspecific and can be inappropriate for use in alternative projects.

The cost areas are further categorised into three cost types; Capex, Opex and Revenue. Cost line items are identified by these categorisations and information provided to assist in their testing and development. The information provided is as follows;

- Item – Items that should be considered within the TEM
- Including – summary of what the item includes
- Influenced by – summary of what can influence the price of the item
- Guidance – information on how to develop the cost with considerations required to improve accuracy

All information provided is for high level guidance only and cannot cover every eventuality within its scope. The output of this process will allow the LA to review the TEM, developed at the Feasibility stage. This will then be developed into a Financial Model. Awareness is required as to the timing and impact of when capital cost occurs in addition to operational costs and projected revenue.

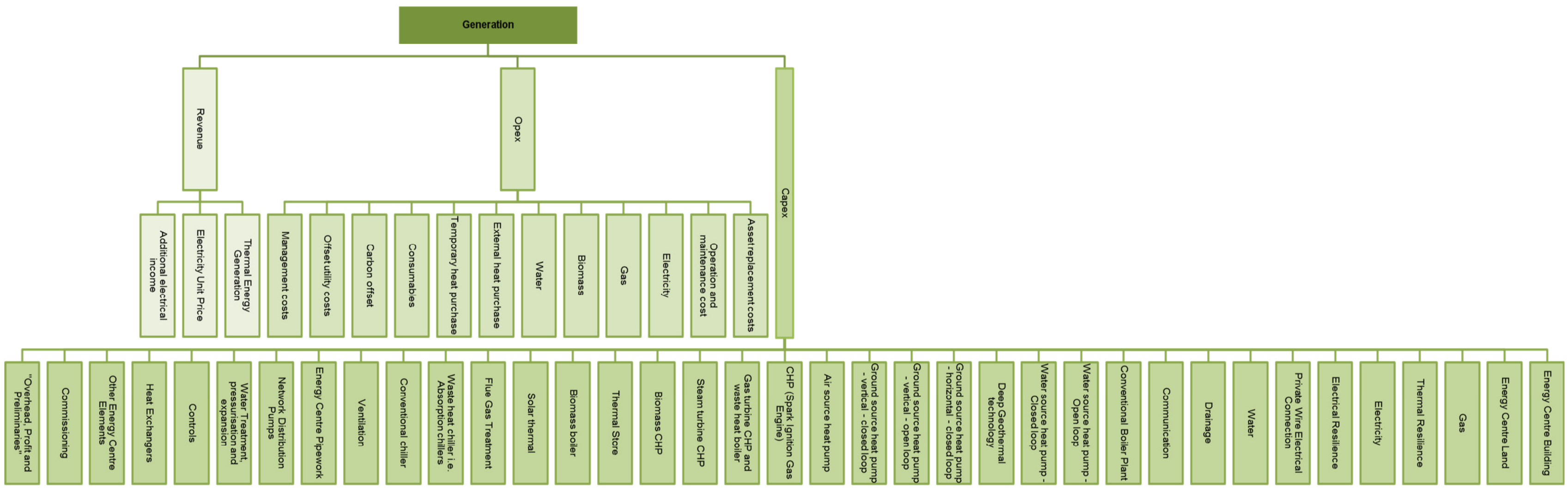
Input – Overarching



Cost type	Item	Including	Influenced by	Guidance on developing cost
Capex	Development Costs	• Stakeholder costs • Design/Professional costs • Planning costs (building, above ground pipework etc.)	• Complexity • Professional skills required • Duration • Scope change	Prior to materials being installed on-site, the project will incur costs associated with the design, development and procurement of a proposed heat network. These costs will be impacted by the complexity of the project, the team required to deliver the project as well as the length of time taken to deliver the project. Further costs may be incurred on on-going management of the delivery process until the scheme is deemed to be operating successfully. Costs beyond this point are considered to be covered under Opex.
Capex	Procurement Costs	• Assessment of procurement routes • Financial appraisal • Procurement of installation • Procurement of operation	• Operational complexity • Procurement complexity • Professional skills required • Duration • Phasing	Whilst identified above in Development Costs, procurement costs can be considerable and depends on the procurement proposed. The procurement route is to be based on the guidance identified within the Guidance on Strategic and Commercial Case. Items to consider include procurement route, development of the commercial procurement details including duration of procurement, phased of procurement, stages of procurement (multiple tender stages) and the team required to deliver the appropriate procurement strategy. This process may continue for significant lengths of time post tender, up to installation once a contract is agreed/signed.

Cost type	Item	Including	Influenced by	Guidance on developing cost
Capex	Commissioning Management	• Commissioning Management • Soft Landings	• Complexity • Professional skills required (manager and agents) • Duration • Project phasing • Seasonal commissioning	Review the commissioning requirements for the project including BREEAM drivers and soft landings. At an early stage of project design, Commissioning Management is to be considered with a team member appointed to review commissioning strategy and delivery of the project. If the project is de-coupled and/or phased, additional complexity may be present. The Commissioning Manager should review the full system from primary fuel purchase, through to final point of sale on the network. Seasonal commissioning may also need to considered and managed.
Capex	Contingency	• Residual Risk Cost	• Project assessment • Selection of contingency level	Following a review of the project risk profile, a contingency sum may be generated to cover the level of residual risk that is assessed to be held within the project. Poor project assessment may lead to incorrect selection of contingency level
Opex	System Management	• Overarching network management • Governance • Reporting	• Commercial structure	Additional costs covering the cost of the overarching heat network management, governance, reporting etc. Some costs may already be covered under Generation, Distribution or Consumption management. The scale of complexity of these additional costs will be affected by how the heat network is commercially structured i.e. Decoupled Model. Please refer to the Guidance on Strategic and Commercial Case.
Opex	Insurance	• Project specific cost	• Dependent on provider or self-cover	Project specific cost to be included. Please refer to Guidance on Strategic and Commercial Case.
Opex	Business rates & corporation tax	• Project specific cost	• Dependent on operator	Project specific cost to be included. Further guidance is provided in the Guidance on Strategic and Commercial Case.
Opex	Other costs	• Heat network management • Governance • Reporting	• Contractual structure	Additional costs would also cover the cost of heat network management, governance, reporting etc.

Input – Generation



Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
GC/01	Generation	Capex	Energy Centre Building	• Building frame/structure • Façades and roof • Ground works/landscaping	• Footprint, area, volume and finish • Building geometry • Requirement for additional plant • Planning	The energy centre cost is affected by footprint, area, volume and finish. Building geometry will be a result of the building's location and plant requirements. Finish can be driven by Planning restrictions, acoustic requirements and client drivers. Multiple energy centres may require an increase in area/volume due to additional plant. Containerised solutions and using existing building areas can reduce cost, if appropriate. Guidance around the Useful Economic Life of Assets can be found at 'CIBSE Guide M - Economic Life Factors Section 12.'
GC/02	Generation	Capex	Energy Centre Land	• Land value • Requirements for demolishing existing infrastructure/buildings Landscaping requirements Removal or relocation of	• Size required • Access restrictions • Utilities locations • Parking requirements • Delivery frequency	Energy centre location(s) to be considered in the context of land value and existing uses. Energy Centre may also require permanent access, external utility locations, parking and future plant movement requirements, all of which may increase required land area. Consideration to be given to the access due to regular maintenance visits, future plant movement and

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				flora/fauna	• External utility buildings (Gas and Electricity) • Future plant movement requirements	deliveries (fuel, spare parts, plant)
GC/03	Generation	Capex	Gas	• Gas network upgrades for provision of gas to combustion plant • Meter stations • Boosters • Network re-enforcement • If medium pressure required: • Pressure reducing valves • Building/kiosk for gas meters, if required	• Pressure requirements • Peak capacity • Annual consumption • Requirement for medium pressure	Gas is to be provided to combustion plant. Cost of gas will be based on the pressure requirements, peak capacity and annual consumption. Costs may increase if medium pressure is required along with pressure reducing valves, meter stations, boosters and possible network re-enforcement. PRVs and gas meter room may require separate buildings/kiosk to be constructed
GC/04	Generation	Capex	Thermal Resilience	• Gas resilience plant • Any further infrastructure/utilities works to support resilience	• Availability/type of chosen alternative fuel supply	Method of gas resilience is to be considered and costed if required. Methods can include alternative fuel provision such as diesel or a connection point for temporary boilers
GC/05	Generation	Capex	Electricity	• Electrical network upgrades to support additional load • Ring Main Units and Transformers	• Import and export capacity of connection • Voltage and transformation requirements • Requirements for area separation of electricity plant	Electricity is to be provided to each energy centre. Consideration is required for the import and export capacity of the connection as well as the voltage and transformation requirements. Separate areas, and possibly buildings may be required for Ring Main Units and Transformers. Separate costs should be identified for any potential private wire connections to allow specific cost benefit analysis.
GC/06	Generation	Capex	Electrical Resilience	• Back up generation plant • Controls infrastructure to support back up generation • Any utilities/infrastructure upgrades required to support back up plant	• Voltage and transformation requirements • Type of back up generation chosen • Back up capacity requirements	Method of electrical resilience is to be considered and costed if required. Methods can include separate electrical supply, UPS or back up generation
GC/07	Generation	Capex	Private Wire Electrical Connection	• Wiring from generators to point of sale • Private transformers, if required	• Voltage and transformation requirements • Capacity of system	Costs associated with the installation of a private wire system. Consideration required for peak provision, voltage requirements and distance.

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				• Electrical metering		
GC/08	Generation	Capex	Water	• Utilities infrastructure costs for provision of raw water to energy centre • Initial network filling	• Peak capacity under normal operation • System volume • Network filling plan • Distance of energy centre from existing water mains	Raw water to be provided to the combustion plant and network filling point. Peak capacity can be minimised to meet normal operational capacity of the system i.e. leaks and boiler re-filling. Initial network filling to be considered
GC/09	Generation	Capex	Drainage	• Drainage system costs • Separate discharge facility if required for Boiler blow down water	• Type and volume of effluent	Drainage will be required in each energy centre. Consideration to be given as to any limitations as to the type and volume of effluent that may be discharged. Boiler blow down water may require a separate discharge strategy
GC/10	Generation	Capex	Communication	• Connection to external communication systems • Cable and system costs • Set up of web based facilities such as system viewing platforms	• Type of communications system in place • Method of communication • Network coverage in the area, eg 3G	Energy centre will require connection to external communication systems
GC/11	Generation	Capex	Conventional Boiler Plant	• Boiler Plant Costs • Installation Cost • Boiler ancillaries costs	• Thermal peak capacity • Type of the Plant • Quantity • Resilience strategy • Phasing	Consideration is to be given to the type, quantity and resilience strategy in order to meet the identified thermal peak capacity of the system. Phased developments may require differing boiler technology types or sacrificial plant
GC/12	Generation	Capex	Water source heat pump - Open loop	• Plant and pipework costs • Installation Cost • Consideration of system's impact on the water source by specialist. • Permission by appropriate authority (Environment Agency). • Plant requirements to service peak load	• Capacity of the system • Distance of energy centre from water source • Type of water source - stagnant or flowing • Quality/cleanliness of water source • Method of peak load provision	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Detailed consideration required for the possible impact to the water source. Permission may be required from appropriate authorities such as the Environment Agency. EA (or alternative) should be engaged to identify financial impact of requirements
GC/13	Generation	Capex	Water source heat pump - Closed loop	• Plant and pipework costs • Installation Cost • Consideration of system's	• Capacity of the system • Distance of energy centre from water source	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Detailed consideration required for the possible impact to the water source. Permission

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				impact on the water source by specialist. • Permission by appropriate authority (Environment Agency). • Plant requirements to service peak load	• Type of water source - stagnant or flowing • Quality/cleanliness of water source • Method of peak load provision	may be required from appropriate authorities such as the Environment Agency. EA (or alternative) should be engaged to identify financial impact of requirements
GC/14	Generation	Capex	Deep Geothermal technology	• Cost of deep geothermal plant, including drilling to necessary depth • Consideration of ground conditions by specialist • Alternative heat source to service peak load	• Capacity of the system • Distance of energy centre from borehole • Depth necessary for drilling • Prevailing subsurface temperatures	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Detailed consideration of ground conditions required and specialist pricing is necessary.
GC/15	Generation	Capex	Ground source heat pump - horizontal - closed loop	• Plant Cost including ground array • Installation Cost • Consideration of ground conditions by specialist • Alternative heat source to service peak load	• Heating and cooling capacity of the system • Prevailing ground conditions • Area available for ground works • Prevailing water table conditions • Resilience requirements	Capacity of the system may aligned with an identified base load with an alternative heat source required for peak load. Detailed review of ground conditions required prior to confirmation of costs
GC/16	Generation	Capex	Ground source heat pump - vertical - open loop	• Plant Cost including ground array • Installation Cost • Consideration of system's impact on the water source by specialist. • Permission by appropriate authority (Environment Agency). • Alternative heat source to service peak load	• Heating and cooling capacity of the system • Prevailing ground conditions • Area available for ground works • Prevailing water table conditions • Resilience requirements	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Detailed consideration required for the possible impact to the water source. Permission may be required from appropriate authorities such as the Environment Agency. EA (or alternative) should be engaged to identify financial impact of requirements
GC/17	Generation	Capex	Ground source heat pump - vertical - closed loop	• Plant Cost including ground array • Installation Cost • Consideration of ground	• Heating and cooling capacity of the system • Prevailing ground conditions	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Detailed review of ground conditions required prior to confirmation of costs

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				conditions by specialist • Alternative heat source to service peak load	• Area available for ground works • Prevailing water table conditions • Resilience requirements	
GC/18	Generation	Capex	Air source heat pump	• Air source heat pump to serve base load • Alternative heat source to service peak load	• System location • System capacity • Visual and acoustic considerations	Capacity of the system may be aligned with an identified base load with an alternative heat source required for peak load. Confirm capacity of the system and seek quotation. Location of the system may be required to be external with associated consideration of acoustic and visual impact
GC/19	Generation	Capex	CHP (Spark Ignition Gas Engine)	• Plant Cost • Installation Cost • Alternative heat source to service peak load • Dry air coolers and oil system if required	• Capacity of the system • Operational effectiveness of CHP • Phasing • Acoustic and vibration requirements • Flue requirements • Flue gas treatment (noise and emissions)	Consideration to be given to the operational effectiveness of the CHP installation. This consideration should consider the base load thermal profile and how it is met by the proposed CHP installation. CHP may be installed at a later stage if the base load is required to be demonstrated on phased developments. Acoustic and vibration requirements will impact associated cost of the CHP installation. The CHP cost should also include dry air coolers and oil system if required. Noise and emission constraints can impact cost of installation.
GC/20	Generation	Capex	Gas turbine CHP and waste heat boiler	• Plant Cost • Installation Cost • Alternative heat source to service peak load	• Capacity of the system • Operational effectiveness of CHP • Phasing • Acoustic and vibration requirements • Flue requirements • Flue gas treatment (noise and emissions)	Turbine systems normally suited to applications with high (>3 MWth) for long periods of time. As such, turbines are normally suited to very large heat networks. If turbine technology is being considered as part of an energy solution, quotations are to be sought and early manufacturing engagement is essential. Noise and emission constraints can impact cost of installation.
GC/21	Generation	Capex	Steam turbine CHP	• Plant Cost • Installation Cost • Alternative heat source to service peak load	• Capacity of the system • Operational effectiveness of CHP • Phasing • Acoustic and vibration requirements • Flue requirements	Turbine systems normally suited to applications with high (>3 MWth) for long periods of time. As such, turbines are normally suited to very large heat networks or heat generators i.e. Energy from Waste. If turbine technology is being considered as part of an energy solution, quotations are to be sought and early manufacturing engagement is essential
GC/22	Generation	Capex	Biomass CHP	• Plant Cost	• Capacity of the system	Fuel silo and flue design be areas of cost impact. Upon

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				• Installation Cost • Alternative heat source to service peak load	• Fuel silo • Delivery mechanism • Flue design • Flue gas treatment (noise and emissions)	selection, seek quotations. Noise and emission constraints can impact cost of installation.
GC/23	Generation	Capex	Thermal Store	• Plant Cost • Installation Cost	• Scale of thermal store required • Space capacity • Load capacity of structural base • Delivery routes • Visual impact (external)	Evaluate scale of thermal store required and ability to include the proposed thermal store. Upon completion of verification obtain quotations for accurate cost, inclusive of plant movement. Additional cost associated with the area to locate the thermal store and that the structural base is sufficient to accommodate the weight. If the stores are to be external consideration of visual impact will be required and detailed in a Planning application
GC/24	Generation	Capex	Biomass boiler	• Plant Cost • Installation Cost • Alternative heat source to service peak load	• Capacity of the system • Fuel silo • Delivery mechanism • Flue design • Flue gas treatment (noise and emissions)	Capacity of the system may aligned with an identified base load with an alternative heat source required for peak load. Fuel silo, delivery mechanism and flue design be areas of cost impact.
GC/25	Generation	Capex	Solar thermal	• Plant Cost • Installation Cost • Fluid costs	• Assess Space • Available roof area for installation • Performance • System volume	Purpose-designed ‘evacuated tube collectors’ have been developed to increase performance against the typical ‘flat plate collectors’. Assess space for installation and impact to system integration. System may not be suitable for heat network integration, dependant on design temperatures, and may have a negative impact on the performance of a heat network system
GC/26	Generation	Capex	Flue Gas Treatment	• Plant Cost • Installation Cost	• Permitted emission levels	Flue gas may require treatment in order to meet identified emission levels. These items have significant associated capital cost and should be captured, if required. Requirement may be driven through direct local air quality requirement or indirect environmental performance requirements such as BREEAM
GC/27	Generation	Capex	Waste heat chiller i.e. Absorption chillers	• Plant Cost • Installation Cost	• Capacity of system • Availability of waste heat (annual, peak) • Cost of waste heat • Carbon factor of waste heat	Assess required capacity of system to specify chiller. This will determine the space requirements and installation considerations. Careful consideration must be given to the method of waste heat collection, its effect on chiller efficiency and the controls strategy

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
					• Level of controllability	
GC/28	Generation	Capex	Conventional chiller	• Plant Cost • Installation Cost	• Capacity of system • Supply and ambient temperature requirements/conditions	Assess required capacity of system to specify chiller. This will determine the space requirements and installation considerations.
GC/29	Generation	Capex	Ventilation	• Plant costs • Heat gain control • Smoke ventilation	• Acoustic limitations on site • Ventilation method • Level of acoustic attenuation	The energy centre ventilation strategy is to be considered based on the acoustic limitations of the site. Combustion air, heat gain control and smoke ventilation to be considered. Cost will be affected by ventilation method, resilience and level of acoustic attenuation
GC/30	Generation	Capex	Energy Centre Pipework	• Pipework • Lagging • Valves • Small pumps (plant circulation) • Supports	• Length of pipework • Structural constraints • Spatial constraints • Pipework material and weight	Pipework, lagging, valves, small pumps and supports to be priced and included
GC/31	Generation	Capex	Network Distribution Pumps	• Plant Cost • Installation Cost • Sacrificial and resilience plant cost	• Peak flow requirements • Control method • Thermal strategy (delta T) • Phasing and future proofing • Minimal summer load conditions (diversified load)	The heat network distribution pumps are likely to have multiple pumps designed to meet peak flow requirements and resilience. Consideration required on control method, flow and return temperatures (deltaT), phased development of the network and minimal summer load conditions. Consideration of sacrificial plant may be required
GC/32	Generation	Capex	Water Treatment, pressurisation and expansion	• Plant Cost • Installation Cost	• Operational water quality requirements • Pressure requirements • System size/capacity/volume	Long term water quality within a heat network is essential in maintaining its value. Poor water quality can significantly shorten the life span of the network. Operational water quality and its management to be considered with an appropriate method to technically deliver and maintain those conditions. Pressurisation and expansion also to be considered as part of this
GC/33	Generation	Capex	Controls	• Cost of Controls • Interface to thermal sub-station control • Interface to fiscal energy meters (heating and	• User interface requirements • Reporting/alarm requirements • Limitations on control	Appropriate controls to be developed for the energy centre plant control as a minimum. Recommended to be designed to monitor and control all aspects of the heat network; generational (all plant within the energy centre), distribution (all items installed at point of demarcation from network to building i.e. thermal sub-

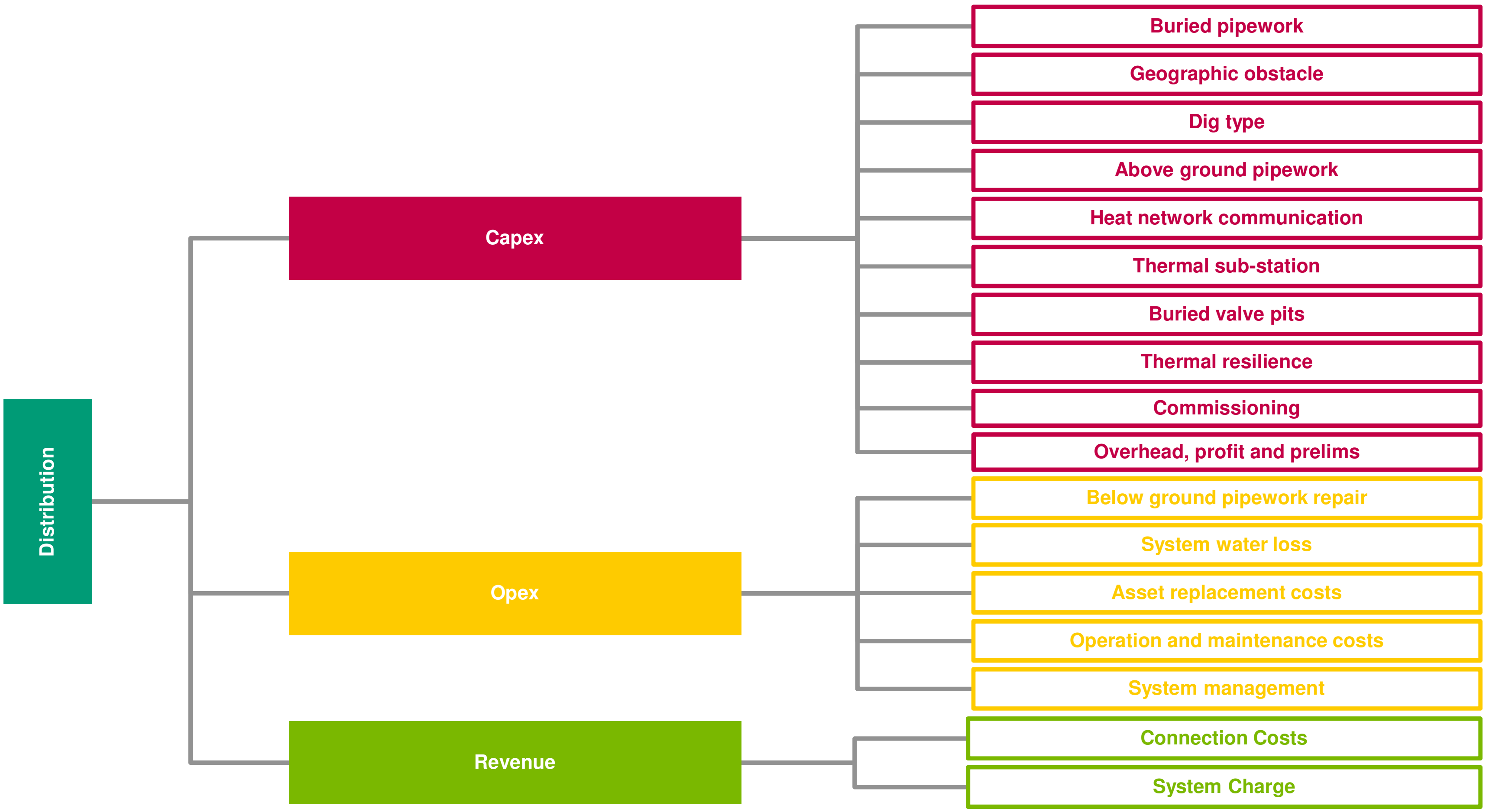
Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				cooling) • Network heat energy management • Field communication system • Hardware • Software	communications i.e. wireless may not be appropriate	station) and point of sale. All data from fiscal heat meters should be provided back to the control system to allow operator to optimise the system. Communication strategy to be identified and agreed in principle at an early stage. Wireless communication can be appropriate in some circumstances but signal interference needs to be considered in the context of the built environment.
GC/34	Generation	Capex	Heat Exchangers	• Plant Cost • Installation Cost	• Capacity • Flow rate • Pressure drop and resilience	Plate heat exchangers (PHEX) may be required if a dry air cooler is a sufficient height away, high temperature networks are being used to import heat or if the heat network is operating at lower temperature than the generation equipment. Cost of the PHEX is influenced by capacity, flow rate, pressure drop and resilience
GC/35	Generation	Capex	Other Energy Centre Elements	• Small power • Lighting • Fire systems • Security • Welfare	• System size/capacity • Prevailing regulatory requirements	In addition to the items identified above, cost consideration is required for the following items; small power, lighting, fire systems, security, welfare etc.
GC/36	Generation	Capex	Commissioning	• Commissioning planning • Factory Acceptance Testing • Installation commissioning • Seasonal commissioning • Knowledge transfer	• Commissioning management plan • System size/capacity • System complexity • Phased installation of equipment/plant • Development of the heat network (peak and annual load)	Based on the commissioning management plan, the installation commissioning processes should align and demonstrate installed plant performance. Once initial plant performance is proven and accepted, the system should continue to be monitored and may require additional work as the heat network evolves. The evolution of the heat network will be impacted by the installation of assets as well as growth in thermal energy consumption. Cost of commissioning is considered separately under Generation, Distribution and Consumption.
GC/37	Generation	Capex	Overhead, Profit and Preliminaries	• Contractor overheads • Contractor profit • Associated preliminary contract costs	• Procurement strategy	Developed costs need to ensure they account for contractor overheads, profit and any associated preliminary contract costs. OHP and Prelim costs considered separately for Generation, Distribution and Consumption.
GO/01	Generation	Opex	Asset replacement costs	• Installed asset replacement	• Asset capacity • Asset quality • Age of plant • Hours of operation • Operation and	Planned cost for replacement of capital plant. Whole life costs can be significantly affected by the level of the maintenance undertaken. The costs may be further influenced by the simplicity of replacement of the plant. All plant should be assessed as early as feasibility through to installation stages for future maintenance

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
					Maintenance regime • Resilient design • Ease of access	and replacement requirements.
GO/02	Generation	Opex	Operation and maintenance cost	• Operation of the associated assets for heat, cooling and electrical power • Planned maintenance of the associated assets for heat, cooling and electrical power • Unplanned maintenance of the associated assets for heat, cooling and electrical power • Spares • Staff costs (operator, management and maintenance)	• Manufacturer's maintenance requirements • Demarcation of the O&M • Specialist equipment • Requirement to hold spares in stock • Complexity of access to undertake maintenance • Requirements of the contract • Energy production/sales • Quality of O&M on other areas of the system • Control system data (detailed analysis of asset performance)	Cost associated with the operation and maintenance of the associated assets. Cost can be impacted by the demarcation of the O&M and requirements of the contract. O&M can be significantly impacted by the quality of the O&M in other areas of the heat network, if hydraulically linked. A comprehensive control and monitoring system should also enable detailed system performance reviews to be undertaken with potential for interventions to improve system performance.
GO/03	Generation	Opex	Electricity	• Prevailing electricity prices for purchase	• Time dependency of prices • Size and capacity of system	Consider cost of whole sale electricity and how it is to be procured. Any co-generation within an energy centre may be used to offset an element of this cost
GO/04	Generation	Opex	Gas	• Prevailing gas prices for purchase	• Time dependency of prices • Size and capacity of system	Consider cost of whole sale gas and how it is to be procured.
GO/05	Generation	Opex	Biomass	• Availability of fuel supply • Quality of fuel supply	• Time dependency of prices • Size and capacity of system • Consistent fuel source	Assess and identify source of biomass fuel as part of the design process. Specify and agree fuel supply contractor. Continuous monitoring of fuel quality (make-up, size, moisture etc) is necessary.
GO/07	Generation	Opex	Water	• Prevailing water prices for purchase	• Time dependency of prices • Size and capacity of system	Consider cost of water

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
GO/09	Generation	Opex	External heat purchase	• Fixed cost for annual external thermal energy provision (standing charge) • Variable cost for thermal energy consumed (unit rate)	• Total annual thermal energy consumed • Installed peak thermal energy requirement • Carbon factor of supplied thermal energy	The cost, operational quality and value of the external heat should be considered. Capacity of supply (diversified), annual consumption, availability, carbon factor and cost need to be considered.
GO/10	Generation	Opex	Temporary heat purchase	• Delivery of temporary system • Operation of temporary system • Fuel consumption for temporary system	• Points of connection (quantity) • Peak capacity of temporary system • Ease of connection including location of temporary system • Duration of use (time and fuel)	Having conducted a risk assessment upon failure of heat supply, temporary heating solutions may be utilised. Normally containerised boiler systems with integral fuel storage (diesel) may be brought onto site and operated.
GO/11	Generation	Opex	Consumables	• Oils/lubricants • Dosing chemicals • Flue gas treatment chemicals	• Operation and maintenance strategy • Control systems (stop/start operation) • Inability to match low load thermal energy demand within installed capacity • System leaks	The costs associated with consumables will be affected by the operation and maintenance strategy applied to the plant. This will be further impacted by the ability of the plant to efficiently meet the thermal energy requirements of the system especially at low load points. The ability to meet the variable demand is impacted by both plant selection and the control systems installed. Increased costs associated with issues, such as leaks, should be addressed through corrective measures.
GO/12	Generation	Opex	Carbon offset	• Avoided costs associated with carbon charges	• Prevailing carbon market charges	The proposed scheme may result in avoided costs associated with carbon charges i.e. Climate Change Levy (CCL). This avoided cost should be identified
GO/13	Generation	Opex	Offset utility costs	• Offset utilities costs due to a net reduction in energy purchased	• Prevailing utility market charges	On-site energy generation may be utilised to reduce operational utility costs (OG/13), with excess energy being sold to a DNO (GR/03) or private third party (CR/02 and CR/03). Each of these levels of use or sale may have different financial values, which should be identified and accounted for. May enable the reduction in traditional utility costs i.e. TNUoS and DNUoS.
GO/14	Generation	Opex	Management costs	• Cost of managing the generation assets	• Complexity of the system • Capacity of the system • Phased development of the system	Cost of the system management. The scale of complexity of these additional costs will be affected by how the heat network is commercially structured i.e. Decoupled Model. This cost will also be affected by the requirements of the Governance structure and

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
					• Contractual Structure of the Heat Network • Governance requirements • Regulatory requirements	Regulatory requirements imposed. System Management costs have been identified for each area of the heat network. These costs should be considered in coordination to ensure that costs/activities are not duplicated or overlooked. Duties should be defined within the Governance and Regulatory requirements for each cost area.
GR/01	Generation	Revenue	Thermal Energy Generation	• The annual quantity of energy produced in kWh or MWh, by the thermal generation system	• Capacity of the network • Quality of the installation • Operational parameters of the network	Thermal energy will be lost between the point of generation i.e. boilers, to the point of sale i.e. residential HIU. The losses are to be identified and minimised as these losses represent a cost that needs to be passed onto the customers. The ability to minimise loss, has a direct impact on the financial viability of the project. Below ground and above ground pipework losses should be separately identified and minimised in accordance with Heat Networks Code of Practice
GR/02	Generation	Revenue	Electricity Unit Price	• Annual electricity cost	• Prevailing cost of electricity	Electricity generated may be sold. The sale mechanism is to be identified and the appropriate wholesale value input within the model
GR/03	Generation	Revenue	Additional electrical income	• Prevailing energy revenue tariffs	• Generating capacity • External operational restrictions (noise, heat rejection) • Time dependent	The electrical generating capacity should be reviewed against the electrical capacity market and any additional potential income identified. The operational impact of signing up to an additional revenue scheme is to be assessed technically as it may impact environmental performance and require additional plant i.e. CHP rejecting heat to the environment in order to generate electricity

Input – Distribution



Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
GC/01	Generation	Capex	Energy Centre Building	• Building frame/structure • Façades and roof • Ground works/landscaping	• Footprint, area, volume and finish • Building geometry • Requirement for additional plant • Planning	The energy centre cost is affected by footprint, area, volume and finish. Building geometry will be a result of the building's location and plant requirements. Finish can be driven by Planning restrictions, acoustic requirements and client drivers. Multiple energy centres may require an increase in area/volume due to additional plant. Containerised solutions and using existing building areas can reduce cost, if appropriate
GC/02	Generation	Capex	Energy Centre Land	• Land value • Requirements for demolishing existing infrastructure/buildings Landscaping requirements Removal or relocation of flora/fauna	• Size required • Access restrictions • Utilities locations • Parking requirements • Delivery frequency • External utility buildings (Gas and Electricity) • Future plant movement requirements	Energy centre location(s) to be considered in the context of land value and existing uses. Energy Centre may also require permanent access, external utility locations, parking and future plant movement requirements, all of which may increase required land area. Consideration to be given to the access due to regular maintenance visits, future plant movement and deliveries (fuel, spare parts, plant)
DC/01	Distribution	Capex	Buried Pipework	• Material storage • Dig management • Utility coordination • Excavation • Drilling • Material movement and disposal • Installation • Inspection • Backfilling • Making good •Requirement for trenching the system	• Type of pipe • Size of pipework (peak thermal capacity) • Depth of pipework • Security of pipework • Location of pipework • Presence of other utilities • Road closure/traffic management/licensing costs • Road surface instatement (type of surface) • Valve locations and future access • Expansion systems and future access	The cost of pipework will be directly affected by the type of pipe, size, depth and location of the pipework. Type of pipe (including insulation) and size can be affected by the thermal strategy and will impact the cost of the materials and labour. Location and depth will affect the civil cost element of the installation and may impact the cost of materials based on route length. The technical requirements for both the pipework and civil costs are to be reviewed in detail and include pipework material storage, dig management, utility coordination, excavation, material movement, installation, inspection, backfilling, making good and commissioning. If the system is required to be trenched, this is to be considered separately. Costs can vary depending on whether the dig is soft, suburban hard dig, urban hard dig or central urban hard dig
DC/02	Distribution	Capex	Geographic obstacle	• Cost for overcoming Physical barriers such as: • Private land • Roads • Railways	• System location • Future expansion requirements • Legal considerations • Stakeholder engagement	Special cost consideration to be given to any significant physical barrier to the proposed heat network route. Physical obstacles can include, but are not limited to, private land, roads, railways, canals, rivers, major utility routes and areas with environmental or archaeological interest.

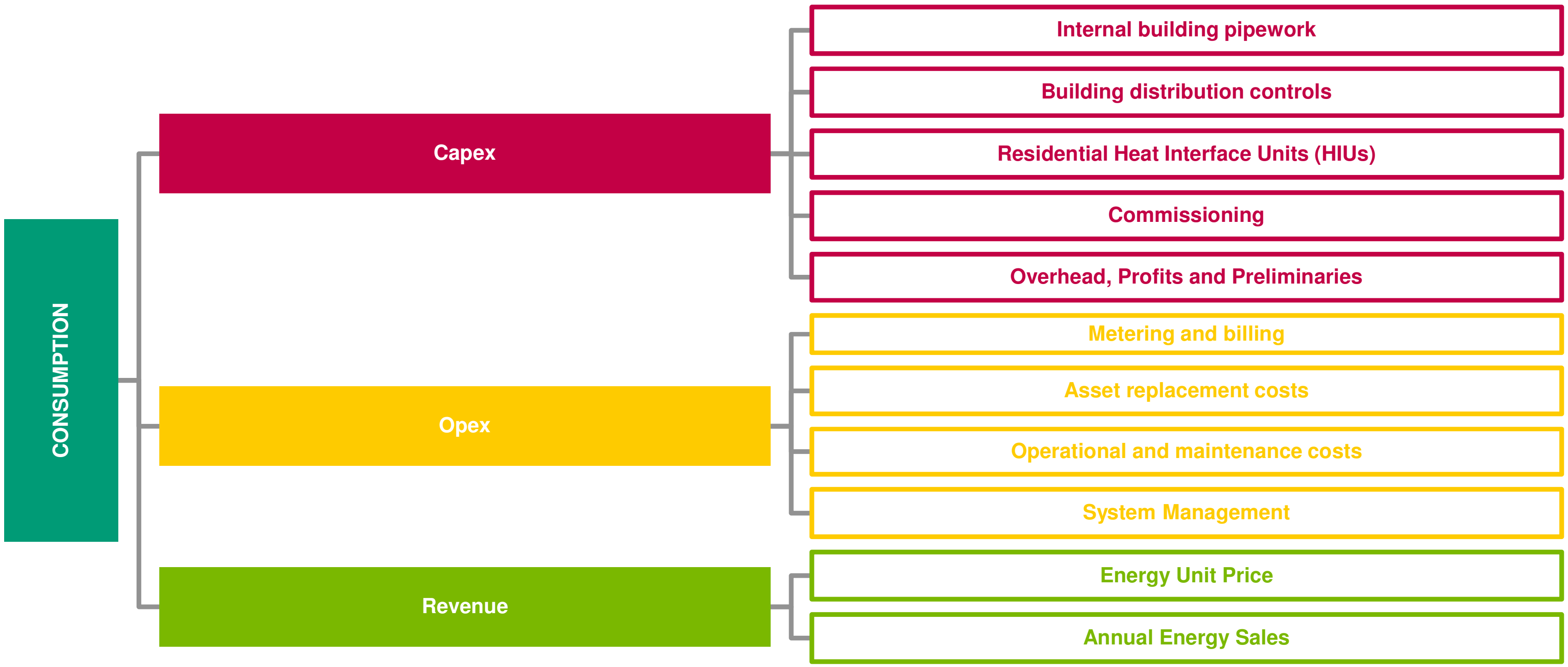
Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				• Canals and rivers • Major utility routes • Areas with environmental or archaeological interest		
DC/03	Distribution	Capex	Dig type	• Cost of materials • Cost of labour • Cost for burying pipework in major network routes	• Public impact by forming a trench	Dig type can be divided into the following categories; soft dig, suburban hard dig, urban hard dig and central urban hard dig. The associated costs of the civil component can significantly increase dependant on the public impact by forming a trench. Detailed consideration to any additional costs associated with burying pipework in major network routes is required.
DC/04	Distribution	Capex	Above Ground Pipework	• Cost of materials • Installation Cost • Pipework support	• •Type of pipe • Size of pipework • Location of pipework • Pipework support • Planning permission (if required)	The cost of pipework will be directly affected by the type of pipe, size and location of the pipework. Type of pipe (including insulation) and size can be affected by the thermal strategy and will impact the cost of the materials and labour. Location will also affect the installation cost based on complexity of access and physical protection. Pipework support to be considered as part of this cost
DC/05	Distribution	Capex	Heat network communication	• Communication ducts • Fibre optic cables • Connection costs • Data points	• Chosen communication strategy • Size of network and distance between communication points	The method in which data from the thermal sub-stations, fiscal heat meters (if required) and network monitoring is communicated back to the energy centre. System may include communication ducts and fibre optic cables independent of the other systems installed in the area, effectively forming a private communication system. Alternative solutions to be considered and selected as appropriate
DC/06	Distribution	Capex	Thermal sub-station / Bulk heat exchanger	• Isolation valves • Pressure/Flow Control • Heat metering • Network performance control and monitoring • Hydraulic separation (if required) • Area (GIA) taken	• Capacity of sub-station • Complexity of sub-station • Space available • Access (installation and maintenance) • Communication systems available to enable control from Generation control systems	A point where there is a physical and/or contractual break in the heat network. The thermal sub-station may serve a single or multiple buildings. The cost should cover from an identified point of isolation within the heat network, a form of heat metering, hydraulic separation (if required) and controls if not considered under GC/33. Cost for secondary side controls and building distribution are to be considered under CC/02 and CC/03 respectively. Cost will be impacted by the capacity and complexity of the thermal sub-station
DC/07	Distribution	Capex	Buried valve pits	• Cost of materials • Associated chambers	• Pit locations and associated required ground works/landscaping	The quantity of buried valves and their associated chambers are to be identified and costed. Locations of valves may include; road crossings, plot boundaries, positions to allow for future extension etc.

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
					• Access requirements • Thermal resilience strategy • Strategic network isolation requirements	
DC/08	Distribution	Capex	Thermal Resilience	• Isolation points on network to allow for the connection of temporary boilers	• Spatial impact of connection points • Peak capacity of the temporary solution allowed for • Impact on the area (road, parking, site operation) if the facility is used • Customer level thermal resilience	Having conducted a risk assessment upon failure of heat supply, temporary heating solutions may be utilised. Strategy to be developed and adopted. Points of connection may be installed on the network or at an individual building level. Capital costs may be reduced if customers have their own form of thermal energy resilience. operational costs considered under GO/10
DC/09	Distribution	Capex	Commissioning	• Commissioning planning • Installation commissioning • Seasonal commissioning • Knowledge transfer	• Commissioning management plan • System size/capacity • System complexity • Phased installation of equipment/plant • Development of the heat network (peak and annual load)	Based on the commissioning management plan, the installation commissioning processes should align and demonstrate installed plant performance. Once initial plant performance is proven and accepted, the system should continue to be monitored and may require additional work as the heat network evolves. The evolution of the heat network will be impacted by the installation of assets as well as growth in thermal energy consumption. Cost of commissioning considered separately under Generation, Distribution and Consumption.
DC/10	Distribution	Capex	Overhead, Profit and Preliminaries	• Contractor overheads • Contractor profit • Associated preliminary contract costs	• Procurement strategy	Developed costs need to ensure they account for contractor overheads, profit and any associated preliminary contract costs. OHP and Prelim costs considered separately for Generation, Distribution and Consumption.
DO/01	Distribution	Opex	Below ground pipework repair	• Buried pipework • Backfill and surface • Valves and chamber • Leak detection system • Expansion system	• Records of installation • Management of civil works in or around pipework • System water quality • Pipework material • Operating temperatures	The buried pipework element is most likely to experience issues if the system is poorly document and reported. Clear control measures are required to be in place to ensure that knowledge of the system is available and communicated throughout its life.
DO/02	Distribution	Opex	System water	• Cost of treated water to	• Leaks within the system	If the system is known to be losing water, and it is not located/identified in the above ground systems

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
			loss	keep the system filled		(Generation or Consumption side), the distribution system may have a leak. Treated water and heat costs may be incurred unless the leak is rectified. Installation of a leak detection system would clarify the situation. More advanced systems would allow for accurate identification of where the leak is occurring. Detailed and accurate drawings would further support in locating the leak.
DO/03	Distribution	Opex	Asset replacement costs	• Installed asset replacement	• Asset capacity • Asset quality • Age of plant • Hours of operation • Operation and Maintenance regime • Resilient design • Ease of access	Planned cost for replacement of capital plant. Whole life costs can be significantly affected by the level of the maintenance undertaken. The costs may be further influenced by the simplicity of replacement of the plant. All plant should be assessed as early as feasibility through to installation stages for future maintenance and replacement requirements.
DO/04	Distribution	Opex	Operation and maintenance cost	• Operation of the associated assets for heat, cooling and electrical power • Planned maintenance of the associated assets for heat, cooling and electrical power • Unplanned maintenance of the associated assets for heat, cooling and electrical power • Spares • Staff costs (operator, management and maintenance)	• Manufacturer's maintenance requirements • Regulatory maintenance requirements, eg F-Gas • Demarcation of the O&M • Specialist equipment • Requirement to hold spares in stock • Complexity of access to undertake maintenance • Requirements of the contract • Energy production/sales • Quality of O&M on other areas of the system • Control system data (detailed analysis of asset performance)	Cost associated with the operation and maintenance of the associated assets. Cost can be impacted by the demarcation of the O&M and requirements of the contract. O&M can be significantly impacted by the quality of the O&M in other areas of the heat network, if hydraulically linked. A comprehensive control and monitoring system should also enable detailed system performance reviews to be undertaken with potential for interventions to improve system performance.
DO/05	Distribution	Opex	System management	• Cost of managing the distribution assets	• Complexity of the system • Capacity of the system • Phased development of the system	Cost of the system management. The scale of complexity of these additional costs will be affected by how the heat network is commercially structured i.e. Decoupled Model. This cost will also be affected by the requirements of the Governance structure and

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
					• Contractual Structure of the Heat Network • Governance requirements • Regulatory requirements	Regulatory requirements imposed. System Management costs have been identified for each area of the heat network. These costs should be considered in coordination to ensure that costs/activities are not duplicated or overlooked. Duties should be defined within the Governance and Regulatory requirements for each cost area.
DR/01	Distribution	Revenue	Connection costs	• Cost paid by a third party to connect to the heat network	• Capacity of the connection • 3rd party thermal energy system design and operation • Capacity of the network to serve connection • Heat sale agreement • 3rd party counterfactual whole life costs • Cost of connection to distribution network	The cost of connection should be identified at an early stage of the project to enable the Promoter to engage with prospective customer connections. The capital cost of connection will be affected by the issues identified above (Distribution Capex items). The likelihood of earning revenue from a connection can be affected by the cost of the connection, terms of the heat sale agreement and the connecting customers' whole life counterfactual costs/business case.
DR/02	Distribution	Revenue	System Charge	• On-going costs paid by a third party to remain connected to the heat network	• Capacity of the connection • 3rd party thermal energy system design and operation • Capacity of the network to serve connection • Heat sale agreement • 3rd party counterfactual whole life costs • Cost of connection to distribution network	Charges made against a connected customer, independent of the amount of the thermal energy consumed. Charge not always associated with the heat network distribution as it is often covered within the consumer heat charges.

Input – Consumption



Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
CC/02	Consumption	Capex	Internal building pipework	• Pipework risers and laterals • Pressurisation, dosing and pumping (if hydraulically separated) • Insulation • Corridor overheating mitigation strategy	• Type of pipe • Size of pipework • Pipework routes • Future O&M access requirements	This item may be procured directly by a third party i.e. Developer. The Heat Network team should ensure that all items prior to the final point of thermal energy sale adheres to the same standards as the rest of the Heat Network. System to be installed in accordance with the Heat Networks performance requirements, or clear demonstration of Developer design performance in accordance with the Networks Code of Practice. The cost of pipework will be directly affected by the type of pipe, size and location of the pipework. Refer to Heat Network Code of Practice to promote best practice system. Type of pipe (including insulation) and size can be affected by the thermal strategy and will impact the cost of the materials and labour. Location will also affect the installation cost based on complexity of access and physical protection. Additional cost consideration to be given to the corridor overheating mitigation strategy. Corridor overheating should be minimised through reduced pipework temperatures, improved insulation and minimised length of installation (more verticals with a view of eliminating laterals). Need for heat dissipation methods should be designed out, as far as reasonably practical, as these have a direct impact on Opex and Revenue
CC/03	Consumption	Capex	Building distribution controls	• Cost of Controls • Interface to thermal sub-station control • Interface to building distribution energy meters (if installed) • Hardware • Software • Link to Heat Network controls	• User interface requirements • Reporting/alarm requirements • Limitations on control communications i.e. wireless may not be appropriate	This item may be procured directly by a third party i.e. Developer. The Heat Network team should ensure that all items prior to the final point of thermal energy sale adheres to the same standards as the rest of the Heat Network. System to be installed in accordance with the Heat Networks performance requirements, or clear demonstration of Developer design performance in accordance with the Networks Code of Practice. The building distribution controls enable to the building to deliver thermal energy from the thermal sub-station, to the final point of sale i.e. residential HIU, within the technical parameters set. Control will focus around pump control along with flow and return temperatures within the building distribution network. Failure to meet the agreed technical requirements can have an adverse effect on the performance of the heat network, by raising the return temperatures.
CC/04	Consumption	Capex	Residential Heat Interface Units (HIUs)	• Plant Costs • MID compliant heat metering	• Number of connections • Type of connections • Future access	This item may be procured directly by a third party i.e. Developer. The Heat Network team should ensure that all items prior to the final point of thermal energy sale adheres to the same standards as the rest of the Heat

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				• Pre-payment systems	arrangements	Network. System to be installed in accordance with the Heat Networks performance requirements, or clear demonstration of Developer design performance in accordance with the Networks Code of Practice. The cost of an individual HIU can be small but is impacted on the type and complexity of the system. In large quantities, the associated cost of the HIUs can form a significant element of the project. Cost will be impacted by the type and capacity of the HIU as well as whether it also includes MID compliant heat metering and pre-payment systems. Additional consideration to be given to future access and impact of future HIU operation/maintenance.
CC/06	Consumption	Capex	Commissioning	• Commissioning planning • Factory Acceptance Testing • Installation commissioning • Seasonal commissioning • Knowledge transfer	• Commissioning management plan • System size/capacity • System complexity • Phased installation of equipment/plant • Development of the heat network (peak and annual load)	Based on the commissioning management plan, the installation commissioning processes should align and demonstrate installed plant performance. Once initial plant performance is proven and accepted, the system should continue to be monitored and may require additional work as the heat network evolves. The evolution of the heat network will be impacted by the installation of assets as well as growth in thermal energy consumption. Cost of commissioning considered separately under Generation, Distribution and Consumption.
CC/05	Consumption	Capex	Overhead, Profit and Preliminaries	• Contractor overheads • Contractor profit • Associated preliminary contract costs	• Procurement strategy	Based on the commissioning management plan, the installation commissioning processes should align and demonstrate installed plant performance. Once initial plant performance is proven and accepted, the system should continue to be monitored and may require additional work as the heat network evolves. The evolution of the heat network will be impacted by the installation of assets as well as growth in thermal energy consumption. Cost of commissioning considered separately under Generation, Distribution and Consumption.
CO/01	Consumption	Opex	Metering and Billing	• Gathering meter informationCompiling the billsGathering revenueDebt managementCapital meter replacement	• Number of connectionsType of connectionsData gathering systemData gathering system	Cost associated with the management of gathering meter information, compiling the bills, gathering revenue and debt management. The cost of capital meter replacement to be clearly stated as whether it is to be included within this cost or elsewhere
CO/02	Consumption	Opex	Asset replacement	• Installed asset replacement	• Asset capacity • Asset quality	Planned cost for replacement of capital plant. Whole life costs can be significantly affected by the level of the

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
			costs		• Age of plant • Hours of operation • Operation and Maintenance regime • Resilient design • Ease of access	maintenance undertaken. The costs may be further influenced by the simplicity of replacement of the plant. All plant should be assessed as early as feasibility through to installation stages for future maintenance and replacement requirements.
CO/03	Consumption	Opex	Operation and maintenance cost	• Operation of the associated assets for heat, cooling and electrical power • Planned maintenance of the associated assets for heat, cooling and electrical power • Unplanned maintenance of the associated assets for heat, cooling and electrical power • Spares • Staff costs (operator, management and maintenance)	• Manufacturer's maintenance requirements • Demarcation of the O&M • Specialist equipment • Requirement to hold spares in stock • Complexity of access to undertake maintenance • Requirements of the contract • Energy production/sales • Quality of O&M on other areas of the system • Control system data (detailed analysis of asset performance)	Cost associated with the operation and maintenance of the associated assets. Cost can be impacted by the demarcation of the O&M and requirements of the contract. O&M can be significantly impacted by the quality of the O&M in other areas of the heat network, especially if hydraulically linked. A comprehensive control and monitoring system should also enable detailed system performance reviews to be undertaken with potential for interventions to improve system performance.
CO/04	Consumption	Opex	System Management	• Cost of managing the Consumption assets	• Complexity of the system • Capacity of the system • Phased development of the system • Contractual Structure of the Heat Network • Governance requirements • Regulatory requirements	Cost of the system management. The scale of complexity of these additional costs will be affected by how the heat network is commercially structured i.e. Decoupled Model. This cost will also be affected by the requirements of the Governance structure and Regulatory requirements imposed. System Management costs have been identified for each area of the heat network. These costs should be considered in parallel to ensure that costs/activities are not duplicated or overlooked. Duties should be defined within the Governance and Regulatory requirements for each cost area.
CR/01	Consumption	Revenue	Energy Unit Price	• Generated (Heat, cooling, electrical) energy fixed price • Generated (Heat, cooling, electrical) energy variable	• Heat network technical performance • Heat network financial performance • Utility costs	Heat cost to be evaluated and considered with clearly stated fixed and variable components. Project specific annual heat cost targets should be identified, evaluated and compared to show comparable end user costs have been reached.

Ref.	Cost Area	Cost Type	Item	Including	Influenced By	Guidance on developing cost
				price	• Debt risk • Project Counterfactual • Cost to customer limitations	See main report discussion Part 1, Section 4c and Part 2 'Heat Pricing'
CR/02	Consumption	Revenue	Annual Energy Sales	• The annual quantity of heating, cooling or and electrical energy sold in kWh or MWh	• Capacity of the network • Customers • Voids (customers connected but not consuming energy) • Debt risk	The amount of thermal energy that will be sold to customers. This value is to exclude all network losses. Appropriate annual thermal energy sales assessments to be identified for each customer type. Whilst metered data is preferable for existing or comparable buildings, benchmark assessments may be required for new buildings.

Risk Register

The Risk Register contains 49 general risk considerations that will have direct impact on the cost of a project. The heat network developer should review the risks identified and consider them in the context of their own project. Separate evaluations of the same risk item may be applicable if the scheme is to feature multiple stakeholders and customers who have different requirements and expectations e.g. leisure centre, hospital, prison, industrial, retail, housing etc.

Each line provides the following information:-

- Risk - Risk heading
- Affected Roles – The group that may be primarily associated with controlling the risk, as identified within the Guidance on Strategic and Commercial Case
- Commentary – description of the risk and impact that it may have
- Risk Probability – the chance that the risk will occur
- Risk Impact – the impact the risk would have should it occur
- Risk Severity – A function of Risk Probability against Risk Impact resulting in an overall Risk Severity
- Typical Risk Mitigation – proposed methods and actions to be considered to minimise either probability, severity or both occurring.
- HNCoP Ref - Supportive clause references to the Heat Network Code of Practice that provides further information on how to address the identified risk. The HNCoP.
- Sensitivity - Guidance on how sensitivity may be applied to the identified risk
- Mitigated Risk Probability, Impact and Severity – revised analysis of probability, impact and resulting severity having implemented a mitigation strategy

The risks below have been assessed in the context of a generic project. The reader should agree an assessment methodology and apply to the table below. A methodology is defined within the BEIS Business Case Template for quantifying measurable risks and scoring unquantifiable risks. Upon reviewing the risks, it is recommended that the assessor also identifies any additional project specific risks. The assessor should then evaluate the proposed mitigation strategies and re-score the risk profile in the blank boxes.

The output from the risk assessment should be two fold;

1. Following a risk review of the project the following capital cost considerations;
    a. The cost of risk mitigation should be identified and built within the relevant items identified within the Input Data
    b. Residual risk should be identified and converted into an appropriate contingency sum to be included within the capital cost assessment as shown within the Input Data.
2. A qualitative statement of the level of residual risk faced by the project that will be reported in the TEM.

The cost of the mitigation actions, post mitigation residual risk and contingency sum should be shown to be cost effective when measured against the un-mitigated risk. Risk transfer may also be considered as defined within the BEIS Business Case Template. The assessment will be project specific.

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
R/01	Customer satisfaction	Customer Sale of Heat Operation Governance	Customer satisfaction and retention will depend to a large degree on having fair and equitable contracts. It is important that the service level for the heat supplied is defined as ultimately this will determine the design and hence the costs of delivering the heat.	Low	High	Med.	1. Engage with customers were education is required to communicate what a Heat Network is and how it operates 2. Provide reports on energy supply and use and bills that are clear and informative; 3. Develop communications with customers that meet customer expectations; 4. State levels of service provision and response times to reported failures: 5. Customers to meet agreed obligations. 6. Consider adoption of a Code of Conduct scheme such as Heat Trust 7. Adoption of agreed performance guarantees to be monitored and reviewed	1.2, 1.3, 7.1, 7.2	Consider under R/04 Thermal Loads
R/02	Heat Tariff	Customer Sale of Heat Operation Governance Regulation	Heat tariff may require change due to external influences, in order to remain attractive or compliant with future guidance	Low	High	Med.	1. Establish proposed heat tariff (fixed and variable element) and demonstrate current cost effectiveness against identified counterfactual 2. Conduct sensitivity analysis on future heat tariff rates based on risk identified within this document 3. Consider within sensitivity testing that future heat rate tariffs may be capped against identified metrics	1.2, 1.3, 7.1, 7.2	Project heat tariff should be compared to conventional heat price and value demonstrated
R/03	Customer bad debt	Customer Sale of Heat Funding	The customer fails to pay on submitted bills and falls into Debt.	Med.	High	High	1. Establish whom holds debt risk within commercial structure 2. Identify possible level of debt risk 3. Conduct sensitivity analysis and establish level of debt that could be accommodated within the heat tariff 3. Develop revenue protection strategy that can be applied throughout the lifespan of the system 4. Establish suitable heat sale agreements.	1.2, 1.3, 7.1, 7.2	Conduct sensitivity analysis and establish level of debt that the business could accommodate against cost of operating pre-payment system

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
							5. Consider adoption of Heat Trust scheme.		
R/04	Assessment of thermal loads	Promoter Asset Owner Installation Funding Operation Revenue Customer	The peak heat demand drive capital costs as plant and network capacity increases. Oversized assets also lead to increased operational costs. The annual heat consumption determines the heat revenues to the scheme and, together with the daily and annual profiles of this consumption will determine the capacity of the low carbon plant which will supply the majority of the heat. Oversizing is more likely to occur than under sizing.	High	Med.	High	1. Establish peak and annual loads based on best available data as defined within HNCoP. If potential loads are unknown, document assessment basis. 2. Conduct sensitivity analysis on the projected loads based on the level of certainty of projected loads being present and connecting 3. Establish likelihood of load being connected by engaging with responsible representative 4. Confirm projected loads with responsible representative; occupation rates, periods of occupation etc.	2.1, 3.2	Conduct project specific sensitivity analysis on peak and annual thermal load. Identify impact on capex, opex and revenue.
R/05	Connection of thermal loads	Promoter Asset Owner Installation Funding Operation Revenue Customer	The projected peak and annual thermal loads do not occur due to; development not progressing or customers do not connect	Med.	Low	Med.	1. Engage with responsible representative/stakeholder/customer at an early stage of the project 2. Maintain dialogue until connection is made 3. Identify heat sale agreements with commercial information being made available 4. Ensure that the heat network offering is competitive with the counter factual	1.3, 2.10, 2.11, 2.12, 3.12, 3.13	Conduct project specific sensitivity analysis on peak and annual thermal load. Identify impact on capex, opex and revenue.

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
R/06	Realisation of thermal load	Promoter Asset Owner Installation Funding Operation Revenue Customer	The projected thermal loads of connected customers fail to be realised.	High	Med.	High	1. Establish peak and annual loads based on best available data as defined within HNCoP. If potential loads are unknown, document assessment basis. 2. Conduct sensitivity analysis on the projected loads based on the level of certainty of projected loads being present and connecting 3. Establish likelihood of load being connected by engaging with responsible representative 4. Confirm projected loads with responsible representative; occupation rates, periods of occupation etc. 5. Develop heat sales agreements with consideration of guaranteed annual thermal energy purchase with a minimum connection duration	2.13.2, 3.34.35.1, 5.2, 5.3, 5.56.5, 6.6	Conduct project specific sensitivity analysis on peak and annual thermal load. Identify impact on capex, opex and revenue.
R/07	Change of connected thermal loads	Promoter Asset Owner Installation Funding Operation Revenue Customer	Connected thermal loads change due to alteration of building usage, improvement in energy performance or connection termination	Low	High	Med.	1. Maintain dialogue with customer to identify potential for future change 2. Develop heat sales agreements with consideration of guaranteed annual thermal energy purchase with a minimum connection duration	3.7, 4.2, 7.2, 7.3	Conduct project specific sensitivity analysis on peak and annual thermal load. Identify impact on capex, opex and revenue.
R/08	Unsuitable operating temperatures	Operator Development of Property Customer Governance	Operating temperatures are a key aspect of heat network design and will determine both the capital cost of the network and the heat losses and pumping energy. Designing for	Med.	High		An optimisation study shall be carried out to determine the operating temperatures for peak design conditions and how they vary with any given scheme, as it will be impacted by the type of heat supply plant and the characteristics of the heat network. The designer has also to consider constraints such as the temperatures used for existing heating systems and the degree that these can be varied. Hence, the	2.4, 3.3, 3.4	None directly. May impact quantity of heat sold

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			lower operating temperatures will result in higher efficiencies with some types of heat sources, e.g. heat pumps and steam turbine extraction.				requirements given below may not be valid in all cases and may be over-ruled by the conclusions of a detailed study for an individual scheme.		
R/09	Heat losses	Operation Sale of Heat Customer	Losses (proportion of annual thermal energy lost in kWh or MWh) are often incorrect leading to inaccurate energy centre plant and financial planning. The HNCoP states a best practice of 10% annual thermal production is lost to below ground pipework (energy centre to building). The HNCoP states a best practice of 10% annual thermal loss of vertical and lateral pipework, up to and including the HIU.	Med.	Med.	Med.	Detailed assessment of below ground and above ground losses. Review of insulation applied, pipework diameter, length of pipe and operating temperatures.	2.1, 2.2, 2.4, 2.5, 2.7, 3.2, 3.3, 3.4, 3.5, 3.9, 4.2, 6.3,	Below ground pipework is -5%/+10%. Above ground pipework is -5%/+25%. Review impact to Opex and utilisation of CHP
R/10	Combustion plant size	Asset Ownership Installation Operation	It is common for combustion plant to be oversized to meet peak thermal demand, in order to be cautious. However, this may be further	Low	Med.	Med.	1. Identify and agree peak thermal loads assessment 2. Consider development of the peak thermal load if the system is to have phased completion 3. Identify thermal resilience strategy with specific consideration of boiler capacity and low carbon system capacity. Boilers at N+1 with	2.1, 3.2, 3.3, 4.3	Sensitivity may be -0%/+30% range. Impact to capex and opex of plant

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			compounded in combination with a plant resilience strategy and how the thermal capacity of any low carbon thermal plant is considered. The impact of this is increased plant costs, increased space requirements (cost and loss of development revenue), possible lower thermal efficiency and increased maintenance costs. Oversizing a CHP is normally driven by overestimating annual thermal consumption. Oversizing a CHP will result in increased plant costs, increased space requirements (cost and loss of development revenue), increased maintenance costs and lower operational performance due to lack of operation.				CHP as supplementary heat (not considered in peak capacity) is common. 4. Review impact of capex inclusive of material, labour, maintenance as well as spatial impact		
R/11	Heat controls	Customer	Heat controls result in poor operation of the	Med.	Low	Med.	Appropriate generation, distribution (primary and secondary) and customer side controls	3.114.35.1 , 5.3, 5.4,	Typically none. Consider impact

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Sale of heat Operation Governance	system at generation, distribution and customer level. Key issues are optimisation of the system's resultant heat carbon factor and maintenance of flow and return temperatures.				should be designed, installed, commissioned and monitored. Employ suitable designers and operators and review proposals with Commissioning Manager. Ensure the systems are put in place, commissioned and operate as intended	5.56.47.3	to overall system efficiency
R/12	Inefficient heat network routes, pipe sizes and reliability	Customer Sale of Heat Operation Governance	The capital cost of the heat network is likely to be a major component of the project cost. The routes for the network will define the length, installation difficulty and hence cost.	Med.	High	High	The quality of materials, design, construction and operation of the heat network are important in determining the reliability of the system. An optimisation study shall be carried out under high standards to achieve: 1. Energy efficient heat network; 2. Low cost network - optimisation of routes and pipe sizing for minimum lifecycle cost; 3. Reliable network with a long life and low maintenance requirements; 4. Efficient heat distribution system within a multi-residential building; 5. Other buried utility coordination; 6. Geographical obstacle review; 7. Land ownership	2.5, 3.6, 3.9, 4.2	Consider under R/09 Heat Losses
R/13	Inappropriate building interface connection	Promoter Asset Owner Installation Operation	A fundamental design choice is whether the buildings or dwellings are directly connected to the heat network (where the water in the network flows directly through the	Low	High	Med.	1. A study shall be carried out to assess the costs and benefits of each connection methods at a building level and at an individual dwelling level; 2. Where indirect connection is used the heat exchanger shall be sized with an approach temperature (primary return (outlet) temperature – secondary return (inlet) temperature) of less	2.6, 3.3, 4.3, 5.2	Consider impact to connection costs and possible reduction in connecting customers - R/04

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			heating circuits of the building) or indirectly where a heat exchanger is used to provide a physical barrier to the water. The choice has an impact on cost and operating temperatures and pressures.				than 5℃; 3. Where boilers are being retained within the building for use at times of high demand the connection design shall ensure that the heat network heat supply is prioritised and the boilers used only when required to supplement this; 4. Large bodied strainers with fine mesh shall be specified to reduce the risk of dirt accumulating on valves and heat exchangers; 5. Control valves shall be two-port so that a variable volume control principle is established; 6. The design of plant rooms for the heat network interface substations shall provide sufficient space for maintenance access and for future replacement of equipment. It shall provide suitable power supplies including for use when carrying out maintenance, lighting, ventilation, water supply and drainage facilities.		
R/14	Assessment of Environmental Impacts	Installation Asset Ownership Funding Regulation	The potential for negative environmental impacts that need to be considered, in particular there may be additional NOX and particulate emissions, increased noise and visual impact.	Med.	Med.	Med.	A more detailed evaluation of environmental impacts and benefits will be required at the design stage to support a planning application, to comply with legislation and to make the case for the project in terms of CO2 reductions.	2.11, 3.13, 4.4, 6.7	Conduct project specific sensitivity analysis based on measures required to address environmental impacts
R/15	Air quality requirements	Promoter Governance Regulation Asset	Optimism that emissions standards can be met with ease, without any flue scrubbing and	Low	Med.	Med.	1. Assess local planning requirements in addition to any environmental permitting 2. Analyse plant flue gas performance 3. Develop mitigation strategy as required i.e. change plant or install flue treatment systems	2.11,3.13, 4.4,6.7	Consider within R/14

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Ownership Installation Operation	emissions reduction technologies (which are costly)				4. Financially plan for proposed approach 5. Conduct appropriate flue gas/air quality assessment 6. Confirm final solution 7. Demonstrate operational performance when appropriate		
R/16	Health and safety issues in construction, operation and maintenance	Installation Asset Ownership Funding Regulation	Reducing health and safety risks is of primary importance in any project. The health and safety of the general public during construction must be considered particularly as heat networks are often installed through publicly accessible areas.	High	High	High	1. The client body shall recognise their role and obligations under the CDM Regulations and register the project as one governed by the CDM Regulations prior to the start of the design process. 2. The designer has a key role to carry out a designer's risk assessment and then to mitigate these risks by taking appropriate design decisions. The requirements of the COSHH and DSEAR Regulations shall be taken into account in developing the design. Consider undertaking a HAZOP assessment	2.10, 4.1, 6.1	Conduct project specific sensitivity analysis based on H&S requirements of the project
R/17	Poor performance of central plant	Operation Installation Governance	The principal rationale for any heat network is that heat can be produced at lower cost and with a lower carbon content at a central plant than at a building level. In particular, certain heat sources are only feasible at scale (e.g. deep geothermal, energy from waste). The economic case for the heat network	Med.	High	High	1. Designers will need to refer to detailed guidance on various aspects of central plant design as appropriate and identify a performance level 2. Monitor the operation of the central plant and to provide regular reports to the owner/developer so that a high standard of performance can be maintained. 3. Conduct sensitivity analysis based on the poor performance of the plant	2.3, 2.7, 3.5, 3.10, 4.2, 5.4, 6.4	Sensitivity may be -10%/+0% range based on operational efficiency

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			will depend on achieving the cost and environmental benefits at the central plant.						
R/18	Inadequate thermal energy supply	Customer Sale of Heat Funding	Failure to deliver the required amount of heat to each customer, critically at the times of peak demand.	Low	High	Med.	1. ensuring that each customer cannot take more than the design flow rate that has been set in the supply contract (typically defined as a kW supply rate at defined flow and return temperatures); 2. For residential properties, a hydraulic interface unit (HIU) is often used to provide a central control and metering point at each dwelling; 3. Commission cost effective, accurate and reliable heat meters in accordance with the Measuring Instruments Directive (MID) and shall be Class 2 accuracy; 4. Implement guaranteed performance standards within the contract	2.1, 3.2, 4.2, 6.1, 6.3	Conduct project specific sensitivity analysis based on failure to meet availability requirements
R/19	Thermal Connection Arrangements	Promoter Governance Installation Asset Ownership Operation Sale of Heat	Anchor load customers/developers can prove key to the financial success of a network. Failure to secure these connections can result in financial failure of the heat network	Med.	High	High	Discussions with key anchor load customers should be undertaken as early as possible in order to establish both the technical and the commercial viability of providing heat utilities to them. Time and resource should be itemised in the business plan to allow for these. Negotiations may be required in order to secure connections	1.2, 1.3	
R/20	Future fuel price variation	Operation Asset Ownership Funding	The price of heat would include fuel cost, standing charge, maintenance	High	High	High	Conduct sensitivity analysis on projections of future fuel and electricity prices such as those published by the Inter-departmental Analysts Group (IAG), HM Treasury. Operator can help	2.9, 2.10, 3.12	Conduct sensitivity analysis based on agreed projection

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Governance	cost, etc. These cost are significant parts of Opex, variation of which will impact the revenue.				mitigate risk through use of future heat sale prices and linking to identified and agreed indices.		guides
R/21	Change of regulation	Operation Asset Ownership Funding Governance Regulation	Financial incentives and various funding scheme have significant impact on the case financial model.	Med.	High	High	Financial analysis based on both current regulations and potential policies under consultation.	2.9, 2.10, 3.12	Conduct project specific sensitivity analysis based on certainty around any incentives being considered
R/22	Industry Regulation	Operation Asset Ownership Funding Governance Regulation	The heat industry is not regulated by an external third party. Formation of external regulatory body will incur additional management costs	Med.	High	High	Whilst the industry is currently unregulated, there have been a number of motions that have been applied by central Government, independent trade groups and professional bodies to improve the base level quality of the industry. Future external regulation may still occur given the current and predicted state of the market. Conduct sensitivity analysis on the potential for increased management/governance costs in the future. Sensitivity should be higher if not already assessing costs associated with current schemes i.e. CHPQA, Heat Trust, Heat Network Regulations	2.9, 2.10, 2.123.12	Conduct project specific sensitivity analysis based on level of governance and management will require beyond level already allowed for
R/23	Professional experience	Promotion Asset Ownership Installation Operation Governance	Without the correct set of skills or experience within the delivery team, a potential project may face increased costs at any stage of the project.	Med.	High	High	1. Promoter role can include the review of project requirement's and develop a delivery team that covers the identified roles with sufficient expertise; 2. Ensure companies and individuals have sufficient experience by reviewing CVs, case studies, references and training; 3. Consider specifying project to be delivered	1.1	May impact Development Costs, if additional time is required, or have long term effect on system performance if system is poorly

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
							under the requirements of a formal structure, such as the Heat Networks Code of Practice.		set-out
R/24	Fuel incomer requirement	Asset Ownership Installation Operation	Risk that gas main infrastructure near chosen scheme site is of sufficient pressures and kW capacity to service energy centre.	High	Med.	High	Energy centres often require significant gas main peak capacity and pressure which cannot always be readily provided locally from the existing in situ pipework. Early investigation of gas mains infrastructure recommended.	2.1, 3.2, 3.5, 4.2, 5.1, 5.4, 6.3, 6.4	
R/25	Fuel incomers costs	Asset Ownership Installation Operation	Assumed that connection of gas network to Energy Centre is straightforward when it can be onerous and costly	Med.	Low	Med.	Early investigation of gas mains infrastructure recommended.	2.1, 2.9, 2.10. 2,12, 3.2, 3.12	
R/26	Water quality	Asset Ownership Operation	Water treatment is sometimes not considered, impacting CAPEX and OPEX. Hard water means extensive water treatment is required to reduce mineral content of the water. Without water treatment, plant lifespans will be reduced which is unlikely to be considered in life-cycle costs.	Low	Med.	Med.	1. Level of water treatment required should be investigated early. 2. Water treatment plant to be identified along with capex and opex costs 3. Water quality to be maintained whilst the system is operational.	2.8, 2.9, 2.10. 2,12, 3.12	Conduct project specific sensitivity analysis based on water quality and proposed water treatment system.
R/27	DNO electrical connection	Promoter Customer	Electric DNO fee to connect and export to	High	High	High	Initial budget costs to be developed based on knowledge and experience of the local utilities.	2.1, 2.2, 2.9, 2.10.	Conduct project specific sensitivity

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Governance Regulation Funding Asset Ownership Development of Property Installation Sale of Heat	grid is underestimated/unknown at design stage (can often lead to huge one-off expense to connect for grid reinforcement works). Initial budget costs are often not tested soon enough within the project life cycle. Requirement to undertaken lengthy G59 application means it's often not done at early feasibility stages, which can lead to optimism on DNO connection cost/procedure. Occasionally, DNO infrastructure connection requirements/costs can halt a project completely.				Identify changes in the current connection; increased import capacity (Heat Pumps) or ability to export (CHP) and amend price accordingly Seek quotations as soon as practically possible Identify key technical requirements are addressed within and quotations; security of supply, faults, capacity. Ensure cost of connection is contained within the business case and verified. Continue to engage with the market to ensure prices remain accurate and fit-for-purpose	2,12, 3.2, 3.12	analysis based on level and quality of information available
R/28	Electric export market	Promoter Funding Regulation Operation Governance	Electrical energy generated on-site, not evaluated suitability based on the perceived inability to connect to suitable loads, resulting in 100% export	Med.	Low	Med.	Local grid constraints to be assessed at Feasibility Stage. Identify opportunities to sell electricity to higher value connections. Conduct sensitivity analysis based on assumed average unit price per kWhe. As the project progresses, further mitigate risk and sensitivity by proving viability of connections and entering commercial negotiations with potential customers	2.2, 2.9, 2.10, 2.12, 3.12	Test assumed average unit kWhe price against base unit kWhe price. Establish threshold limit.

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
R/29	Electrical load available for sleeving/privat e wire	Promoter Funding Regulation Operation Governance Customer Asset Ownership	Sleeving/private wire end customer might not have the electric load requirement it is assumed to have or be willing to enter contract due to pre-existing electrical supply arrangements	Low	High	Med.	Early engagement with potential customers is required to establish the real electrical load available. Discussion around potential costs and willingness to enter contractor to be commenced at an early stage to de-risk item.	2.2, 2.9, 2.10, 2.12, 3.12	
R/30	Sleeving/ Private wire arrangements	Promoter Funding Regulation Operation Governance Customer Asset Ownership	Assumption of sleeving to end customers is assumed to be technically easy, requiring little or no upgrade to electrical infrastructure. Cost can directly impact maximum sale price per MWh.	Low	High	Med.	Capital costs to be identified based on the level of design information available. Risk of price increased to be considered and appropriate contingency value put in place until risk designed out.	2.2, 2.9, 2.10, 2.12, 3.12	
R/31	Electrical export	Asset Ownership Operation	Parasitic loads, transmission losses and transformer inefficiency often under-estimated/ignored.	Med.	Med.	Med.	Assess potential parasitic loads and losses that could impact the quantity of electrical energy available for sale. Can reduce saleable electricity by up to 10%.	2.2, 2.9, 2.10, 2.12, 3.12	Sensitivity may be -10%/+0% range
R/32	Electric revenue	Funder Asset Ownership Operation	Achievable sale price of electric often assumed to be too high (retail/wholesale).	Med.	High	High	Consider value of electricity used to generate heat and evaluate cost benefit of making loads parasitic Identify suitable electrical customers. Assess mid-point sale price per kWh for each point of sale. Agree a lower price and a higher price to sensitivity analysis	2.2, 2.9, 2.10, 2.12, 3.12	Conduct project specific sensitivity

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
R/33	Heat meters	Customer Sale of heat Operation Governance	Heat meters either not present, not installed properly or unable to transmit recorded information	Low	Low	Low	Suitable heat meters are to be installed in accordance with the relevant regulations and Heat Networks Code of Practice. The heat meter should be appropriate to the system design and installed in accordance with the manufacturer's requirements. Installed meters are to be commissioned and proven to operate over a continuing period of time, including data transmission. Meters will require on-going maintenance and possible recalibration, as identified during the planned maintenance process.	3.8, 4.3, 5.3, 6.5, 6.6, 7.1, 7.2,	
R/34	Energy Centre size and cost metrics	Promoter Development of Property Asset Ownership Funding Installation	No industry standard benchmark on physical size requirements, so often energy centres can be under-estimated. When at design stage, these errors can impact construction costs, cause programme delay and land use/developer availability. Furthermore, no industry standard benchmarks are available for construction/ procurement costs (£/m2).	Med.	Med.	Med.	Limited information or specific published metrics available therefore assessment to consider plant size, movement and maintenance. Internal heights and location of heavy plant also to be considered.	2.1, 2.2, 2.3, 2.7, 2.8, 3.2, 3.10, 3.11	Sensitivity may be -0%/+30% range
R/35	Connection to external heat sources	Regulation Promoter	Potential current/future requirements to	Low	High	Med.	1. Assess potential for current/future connections to external heat sources and their technical compatibility	1.3, 2.2, 2.3, 2.4, 2.5, 2.9,	Conduct project specific sensitivity analysis based on

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Customer Sale of heat Operation Governance Funding Asset ownership Installation	connect to other external heat sources e.g. Energy from Waste plants. External heat sources will impact both peak and base load generation requirements for the heat network.				2. Identify drivers that would lead to connection and the cost impact of the connection 3. Establish possible timescale in which a connection would be made 4. Review impact on peak thermal generation plant (possible redundancy) 5. Review impact on LZC plant due to reduced run hours 6. Review impact on plant area required	2.10, 2.12, 3.5, 3.6, 3.7, 3.12, 6.3	placement and heat available from external sources
R/36	Connection to other DH networks	Regulation Promoter Customer Sale of heat Operation Governance Funding Asset ownership Installation	Potential current/future requirements to connect to other heat networks. External heat network will impact both peak and base load generation requirements for the heat network.	Med.	High	High	1. Assess potential for current/future connections to external heat networks and their technical compatibility2. Identify drivers that would lead to connection and the cost impact of the connection 3. Establish possible timescale in which a connection would be made4. Review impact on peak thermal generation plant (possible redundancy)5. Review impact on LZC plant due to reduced run hours6. Review impact on plant area required	1.32.2, 2.3, 2.4, 2.5, 2.9, 2.10, 2.123.5, 3.6, 3.7, 3.126.3	Conduct project specific sensitivity analysis based on placement and heat available from external heat networks
R/37	DH pipework design	Promoter Asset Ownership Operation Installation Governance Funding	Pipe lengths often assumed to be too short than is necessary Installation of pipework is assumed to be straightforward, without the need to coordinate with utilities/highways which is rarely the case	Med.	High	High	Principles of network design (pipe sizing, DeltaTs, velocities, stress) should be based on agreed standards i.e. HNCoP and manufacturers recommendations. Networks should be designed for identified connected loads and documented allowance for any future expansion (increase in diversified peak capacity). Routes of pipework are to be established at any early stage with an identified allowance for additional pipework that has yet to be accounted for i.e. inaccuracy in routing and expansion loops. As the design progresses, routes detailed and confirmed, the additional	2.1, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.2, 3.3, 3.5, 3.6, 3.7, 3.9, 4.2	Consider under R/09 Heat Losses

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			Pipework insulation performance overestimated, impacting energy losses and load on Energy Centre Inappropriate DeltaT can result in larger (increased capital and operational costs) Adverse design parameters can result in the shortening of the systems lifespan				allowance proportion should be reduced to zero.		
R/38	DH pipework costs	Promoter Asset Ownership Operation Installation Governance Funding	Pipework costs often underestimated at early stages of the project until installation. Additional costs arise from the location of the pipework; soft dig, sub-urban, urban or central urban hard dig.	Med.	High	High	Establish lengths, sizes and routes at Feasibility stage and apply appropriate metrics dependant on dig type, location and obstacles Engage with manufacturers and installers to review and improve pricing accuracy when detail is available. This should be conducted as early as possible and prior to completion of the outline business case.	2.1, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 3.2, 3.3, 3.5, 3.6, 3.7, 3.9, 4.2	Conduct project specific sensitivity analysis based on knowledge and quality of cost information available
R/39	DH pipework maintenance	Operation Customer Sale of heat Asset Ownership Funding Governance	Pipe failures are not accounted for. If they are accounted for, they are assumed to be easy to maintain. In reality, to fix a failed pipe is difficult, takes time and is costly - due to ground excavation works,	Low	Med.	Med.	OPEX cost estimates for pipework failure/servicing should be allowed for in the economic model. Consider use of leak detection, water quality monitoring and extended warrantees	2.1, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.2, 3.3, 3.5, 3.6, 3.7, 3.9, 4.2, 5.1, 5.2, 5.4, 5.5, 6.3	Sensitivity may be -5%/+5% range based on high quality installation

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			welding costs etc. Servicing of loads from DH network will be interrupted, requiring a short-term servicing strategy to be put in place and temporary plant to be brought onto site - this is often unaccounted for.						
R/40	Secondary/Tertiary system compatibility (existing buildings)	Promoter Customer Development of Property Asset ownership Installation Governance	Within existing buildings it can be assumed to be easy to convert/changeover secondary side systems to be compatible with network connection. Cost of ensuring technical compatibility to be considered In new build, how SH and DHW services are designed can have a significant impact on the capital costs and operating costs of the heat network. For example, achieving consistently low return temperatures will reduce capital costs for the network and thermal store, result in lower heat losses and	High	High	High	1. Identify existing buildings that may wish to connect to the heat network 2. Estimate initial cost of connection based on anticipated supply arrangement 3. Confirm and validate operational parameters of the existing system 4. Confirm age and condition of existing/retained assets 5. Develop costs to reflect works to be undertaken and risk levels present i.e. re-commissioning of customer system from 82°C/71°C to 80°C/60°C flow and return temperatures.	2.4, 2.5, 2.6, 2.7, 2.12, 3.3, 3.4, 3.9, 4.3, 5.1, 5.2, 5.3, 5.5, 6.3, 6.4, 6.5, 6.6, 7.3	Consider under R/04 and R/09

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
			pumping energy and in some cases reduce the cost of low carbon heat production.						
R/41	Secondary/ Tertiary system compatibility (new buildings)	Installation Asset Ownership Funding Operation	How SH and DHW services are designed can have a significant impact on the capital costs and operating costs of the heat network. For example, achieving consistently low return temperatures will reduce capital costs for the network and thermal store, result in lower heat losses and pumping energy and in some cases reduce the cost of low carbon heat production.	High	High	High	1. Conduct specific design study to review the various options available for space heating and DHWS in relation to supply from heat networks. 2. Implement agreed design, installation, commissioning standards and review their implementation 3. Operator and Land Developers, or persons responsible for customer heat systems, to coordinate and ensure compatibility.	2.4, 2.5, 2.6, 2.7, 2.12, 3.3, 3.4, 3.9, 4.3,5.1, 5.2, 5.3, 5.56.3, 6.4, 6.5, 6.6,7.3	Consider under R/04 and R/09
R/42	Secondary/ Tertiary systems operation	Customer Landlord Sale of heat Operation Asset ownership Governance	Poor secondary/tertiary side operation can result in high return temperatures, corridor overheating and poor system performance	Med.	Low	Med.	1. Develop and agree a heat network design manual that covers design, installation, commissioning and operation. 2. Consider making technically measurable items contractually binding i.e. return temperatures during summer and low loads 3. Review operational interface if customer plant is being retained. 4. Ensure that the heat taken from the network is maximised, measured and monitored. Emphasis to be placed on measuring return temperatures to the network.	2.4, 2.5, 2.6, 2.7, 2.12, 3.3, 3.4, 3.9, 4.3, 5.1, 5.2, 5.3, 5.5, 6.3, 6.4, 6.5, 6.6, 7.3	Consider under R/04 and R/09

Ref.	Risk	Affected Roles	Commentary	Risk Probability	Risk Impact	Risk Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
R/43	Secondary/ Tertiary systems commissionin g	Promoter Development of Property Asset ownership Operation Governance	Poor secondary/tertiary side commissioning can result in high return temperatures, corridor overheating and poor system performance	Med.	Med.	Med.	Potentially significant risk. Impact can be reduced by incentivising downstream system owners to optimise their systems, or by commissioning systems as part of the network (this would require associated costs to be included in the business case). Network operator may not wish to undertake downstream side systems.	2.4, 2.5, 2.6, 2.7, 2.12, 3.3, 3.4, 3.9, 4.3, 5.1, 5.2, 5.3, 5.5, 6.3, 6.4, 6.5, 6.6, 7.3	Consider under R/04 and R/09
R/44	Planning consent and Way leave agreements	Promoter Funding Asset Ownership Regulation	Planning process often not considered, or are assumed to be straightforward. Energy Centre building planning performance requirements often not considered. Assumption that wayleave consent for preferred pipework routing will be granted, meaning in reality the required pipework lengths may increase and/or target anchor heat loads may not be connectable.	Med.	High	High	Often overlooked. Early engagement with relevant bodies within local authority recommended (planning, highways etc.) to establish requirements for the energy centre, environmental performance and routing option viability. If above ground pipework (pipe bridges) are being considered, additional Planning engagement may be required. Way leaves agreement may take considerably longer than anticipated.	2.9, 2.10, 3.12	Conduct project specific sensitivity analysis based on planning risk with change in Development Costs. Risk to consider alternative design solutions
R/45	Carbon content of fuels	Governance Regulation Asset Ownership Installation	Future carbon content of electric offset is uncertain, potentially impacting future carbon tax abatement. Unknown carbon	Med.	Med.	Med.	Whilst utility carbon content is projected to reduce, the exact reductions are unknown. Use of BEIS projections is recommended for initial assessment and BEIS CHP bespoke carbon factors.	2.9, 2.10, 3.12	Use published BEIS data (IAG and bespoke CHP data) and measure against any agreed

Ref.	Risk	Affected Roles	Commentary	Risk: Probability	Risk: Impact	Risk: Severity	Typical Risk Mitigation	HNCoP Ref	Sensitivity
		Operation	content of future fuel used in the Energy Centre, impacts the carbon content of electrical/heat export.						alternative approaches. Sensitivity ranges may increase with time to reflect increasing uncertainty
R/46	Technology costs with maturity	Promoter Asset Ownership Governance Regulation Funding Operation	Expectations of significant reductions in technology costs, particularly for technologies that currently are only marginally viable that may not have much scope for quick price reductions (e.g. platinum content fuel cells). Impacts the technologies that are considered in current studies.	Med.	Med.	Med.	Significant unknowns. Conservative estimates recommended. Review opportunities to future proof the heat network both technically and commercially. Consider heat network suitability for current alternative technologies that are not yet commercially viable.	2.9, 2.10, 3.12	Conduct project specific sensitivity analysis based on considerations on future proofing
R/47	Technology availability	Promoter Asset Ownership Governance Regulation Funding Operation	Expectation that future technologies that replace CHP as the prime mover become available at scale, and are compatible with designed and installed network.	Med.	Low	Med.	Cost allowances should be made in the business case to allow technology changeover. Review opportunities to future proof the heat network both technically and commercially.	2.9, 2.10, 3.12	Conduct project specific sensitivity analysis based on considerations on future proofing

Comparator

This section contains technical themes that may be considered in forming an avoided financial cost or Business as Usual (BAU). The LA may wish to use this information to develop three Comparators for each building type on the network:-

Project Comparator

The LA should use the information below to evaluate the capital, operational and revenue costs that could be seen by a Project Promoter/Asset Owner, for the same level of thermal energy delivery, if they were not to connect to the heat network. This Business as Usual (BAU) cost should be used to assess the value of the proposed Heat Network.

The BAU could be designed to cover, for each proposed building type:

- The capital cost for installing the minimum compliance system for thermal generation and any mandatory carbon reduction systems
- The associated costs (capital and loss of revenue) of any space used including plant rooms and risers (pipework and flues)
- The operational costs for operating and maintaining the alternative system
- Any revenue earned through the operation of the alternative systems e.g. energy sold from PV

Property Developer Comparator

The LA should use the information below to evaluate the capital, operational and revenue costs that could be seen by an external Property Developer, for the same level of thermal energy delivery, if they were not to connect to the heat network. This cost may be used to assist in the evaluation and negotiation of any proposed Connection Charge. A connection charge is a capital contribution towards the capital cost of initiating a connection to the HN.

Depending on whether considering a new build or a retrofit scheme, connection charges could be paid by either the property developer, by the heat user if a private owner, or by the landlord. A connection charge may be payable by both public and/or private sector parties to the scheme.

The connection charge could be designed to cover:

- The capital outlay required for connection to the scheme
- An amount not more than the avoided cost (e.g. the cost of connection to/installation of an alternative heat source, the cost of operation and lifeycle replacement of an existing heating system, or the avoided cost of carbon contribution).
- Planning Authority requirements (e.g. s106 Agreement or CIL – see Part 3 Section 2d)

In any case where a connection charge is being agreed, there is often a negotiation to be had and will be governed by the amount which the entity that will incur the charge is willing to pay. Where this does not satisfy the capital costs required for connection to the scheme, these costs will need to be recovered in on-going fixed and/or variable charges.

Consumer Comparator

The LA should use the information below to aid a determination of the cost to the consumer of the thermal energy alternative (i.e. the Consumer Comparator), which will aid the process of setting heat prices and will also be required throughout the operational phase of the HN for disclosure on billing information – see Part 2. The information below will assist in identifying the alternative technical solution that the consumer will be presented with.

Depending on the alternative technology that would be used to heat (e.g. gas boiler, electrical heater), it is likely that a number of elements of cost should be taken into account:

- Utility standing charge
- Input fuel costs
- Maintenance costs
- Replacement costs
- Management costs

The comparator is unlikely to be a 'one size fits all'. For example, the specification, usage intensity and age of the identified alternative technology will impact the efficiency and maintenance requirements of the system. The audience for the comparator will also be a consideration, as for example, a tenant would expect to pay for costs associated with boiler maintenance through their rent, not through their heating bill.

Developing the BAU Case

Each comparator should be assessed for the duration of the project life and presented in NPV terms for each building type on the network. Each project will require a bespoke assessment to identify the specific cost items to be considered within the comparators. The table of information below identifies typical solutions and considerations. Each line provides the following information:-

- Development Type - buildings can be classified under each type, where buildings may be new builds, existing or existing refurbishments. Any difference in costs between new build, existing or existing refurbishments are highlighted
- CAPEX - the associated installation cost of the system being considered to achieve a minimum required technical level. Further installation costs identified if additional low carbon technology is required to achieve higher standards

- OPEX - the associated whole life maintenance and operation cost of the system being considered to achieve a minimum required technical level. Further whole life costs identified if additional low carbon technology is required to achieve higher standards.
- REVENUE - the associated revenue of the system being considered to achieve a minimum required technical level. Revenue may be adjusted based on the operation of any low zero carbon technology.

Upon review of these options, the LA should develop a separated techno-economic cash-flow for capital, operation and revenue as per the process identified above. If appropriate, the comparators may be developed into a financial model.

Development type	Cost	Project	Property developer	Consumer
Residential; individual heating	CAPEX	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on current requirements for operations i.e. increased controls or metering • Cost of utility connection to development • Cost of utility connection to each dwelling • Cost of thermal generation plant for each dwelling **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	**Minimum Compliance** • Cost of utility connection to development • Cost of utility connection to each dwelling • Cost of thermal generation plant for each dwelling **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure i.e. PV]	• None
	OPEX	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology
	REVENUE	• Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• Typically none	• Possible generation of income of applied low carbon solution if appropriate, to Asset Owner
Residential; communal heating	CAPEX	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards	**Minimum Compliance** • Cost of utility connection to development • Installation of communal plant (per block) • Installation of internal heat distribution	• None

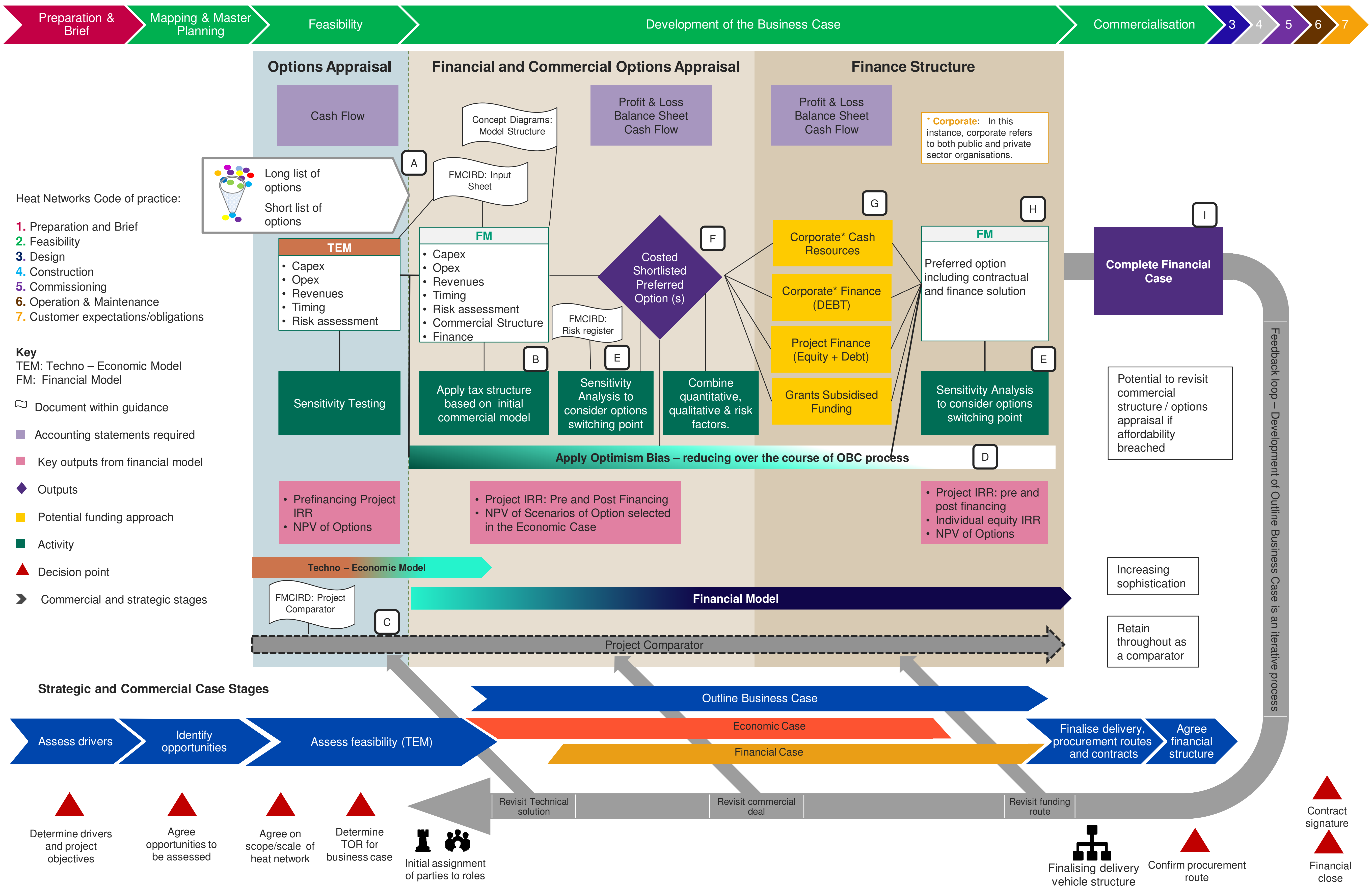
Development type	Cost	Project	Property developer	Consumer
		• Establish uplift costs based on current requirements for operations i.e. increased controls or metering • Cost of utility connection to the block • Installation of communal plant (per block) • Installation of internal heat distribution systems (per block) • Installation of heat metering (per customer) **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	systems (per block) • Installation of heat metering (per customer) **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure i.e. PV]	
	OPEX	• Asset owner whole life cost of maintenance of central thermal generation plant • Landlord annual cost of fuel to generate heat; standing charge and usage • Management cost of operating the communal heating system • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of central thermal generation plant • Landlord annual cost of fuel to generate heat; standing charge and usage • Management cost of operating the communal heating system • Asset owner whole life cost of maintenance of LZC technology	• Management cost of operating the communal heating system • Annual cost of fuel to generate heat; fixed charge and variable usage
	REVENUE	• Residential heat sale • Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• Residential heat sale • Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• None
Mixed Use	CAPEX	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on revised requirements for operations i.e. increased controls or metering • Cost of utility connection to the residential block or customer • Installation of communal plant (per block	**Minimum Compliance** • Cost of utility connection to the residential block or customer • Installation of communal plant (per block or customer) • Installation of internal heat distribution systems (per block or customer) • Installation of heat metering (per customer) **Additional CO_2 Reduction**	**Non-Residential Unit Occupier** • Installation of thermal energy plant specific to operational needs **Residential** • None

Development type	Cost	Project	Property developer	Consumer
		or customer) • Installation of internal heat distribution systems (per block or customer) • Installation of heat metering (per customer) **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	• Cost of low and zero carbon (LZC) solution and associated infrastructure i.e. PV]	
	OPEX	• Asset owner whole life cost of maintenance of central thermal generation plant • Landlord annual cost of fuel to generate heat; standing charge and usage • Management cost of operating the communal heating system • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of central thermal generation plant • Landlord annual cost of fuel to generate heat; standing charge and usage • Management cost of operating the communal heating system • Asset owner whole life cost of maintenance of LZC technology	**Non-Residential Unit Occupier** • Asset owner whole life cost of maintenance of central thermal generation plant • Non-residential annual cost of fuel to generate heat; standing charge and usage • Management cost of operating the non-residential heating system **Residential** • Management cost of operating the communal heating system • Annual cost of fuel to generate heat; fixed charge and variable usage
	REVENUE	• Residential heat sale • Commercial heat sale • Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc (if applicable) • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• Residential heat sale • Commercial heat sale • Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	**Non-Residential Unit Occupier** • None **Residential** • None
Commercial	CAPEX	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on revised requirements for operations i.e. increased controls or metering	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on revised requirements for operations i.e. increased controls or metering	• None

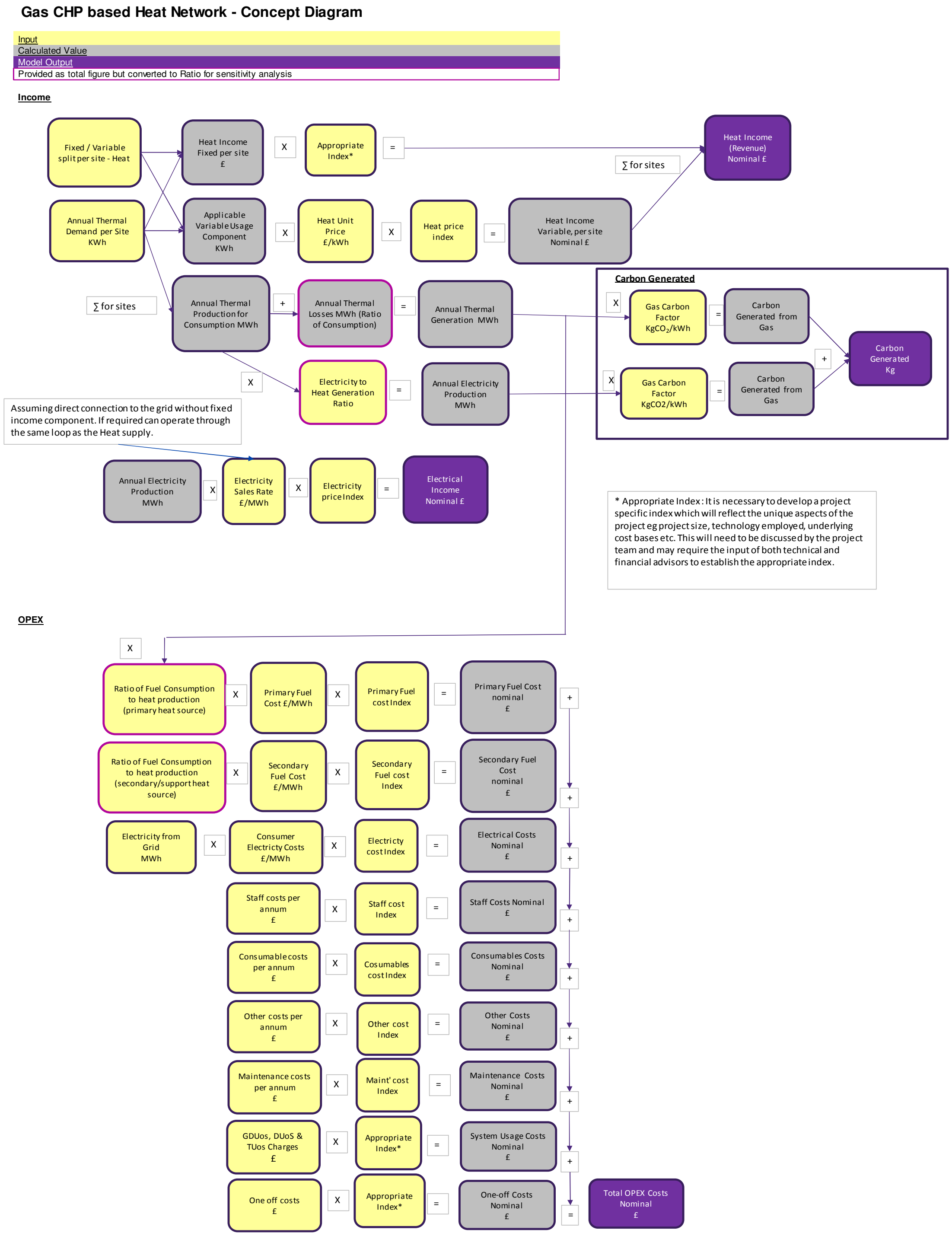
Development type	Cost	Project	Property developer	Consumer
		• Cost of utility connection to building • Cost of thermal generation plant **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	• Cost of utility connection to building • Cost of thermal generation plant **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	
	OPEX	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Management cost of operating the communal heating system • Annual cost of fuel to generate heat; fixed charge and variable usage
	REVENUE	• Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc (if applicable) • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc (if applicable)	• None
Industrial	CAPEX	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on revised requirements for operations i.e. increased controls or metering • Cost of utility connection to building • Cost of thermal generation plant **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	**Minimum Compliance** • Review residual life of current plant (if applicable) and develop cash flow based on plant permitted to be installed to meet minimum efficiency standards • Establish uplift costs based on revised requirements for operations i.e. increased controls or metering • Cost of utility connection to building • Cost of thermal generation plant **Additional CO_2 Reduction** • Cost of low and zero carbon (LZC) solution and associated infrastructure e.g. PV	• None
	OPEX	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Asset owner whole life cost of maintenance of thermal generation plant • Annual cost of fuel to generate heat; standing charge and usage • Asset owner whole life cost of maintenance of LZC technology	• Management cost of operating the communal heating system • Annual cost of fuel to generate heat; fixed charge and variable usage

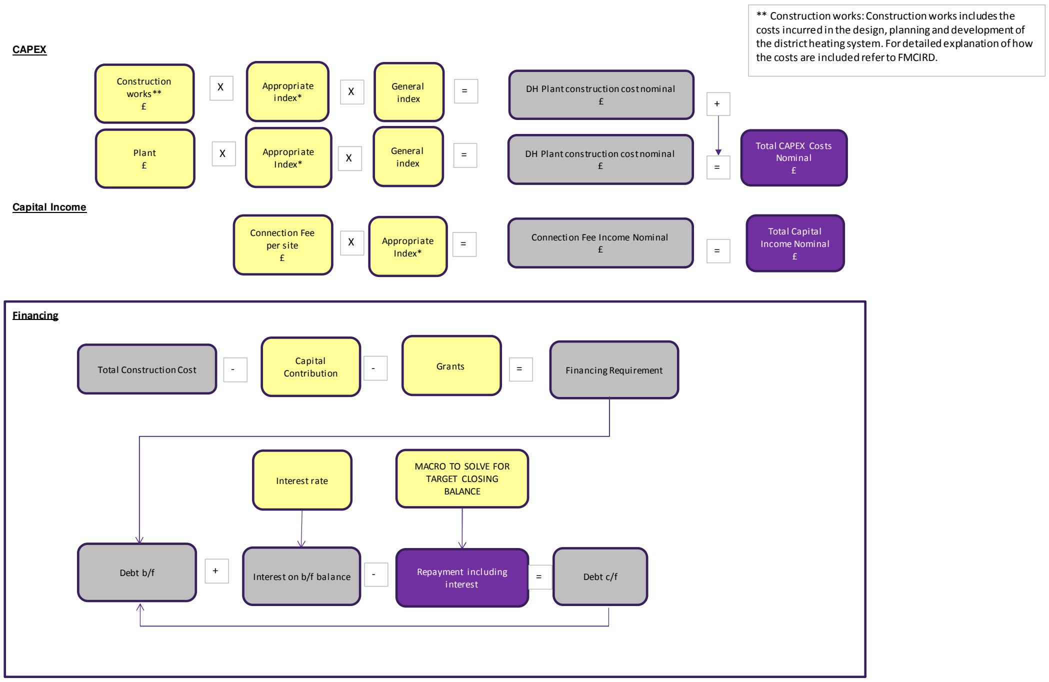
Development type	Cost	Project	Property developer	Consumer
	REVENUE	• Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc (if applicable) • Possible generation of income of applied low carbon solution if appropriate, to Asset Owner	• Loss of revenue from space occupied with thermal energy equipment; plant room, risers, flues etc (if applicable)	• None

Appendix B – Financial Model Development Process linked to Strategic and Commercial Case



Appendix C – Concept Diagram





GUIDANCE ON INDEXATION FACTORS TO BE USED

- Heat Price Index – see discussion in Part 2, Section 4c
- Electricity Price Index – a common start would be to use RPI or RPIx. However it may be that the electricity price is profiled over the life of the project with reference to other price curves eg DECC, https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015, Annex 4
- Primary Fuel Cost index – Variable as per DECC forecasts, as above
- Secondary Fuel Cost Index – Variable as per DECC forecasts, as above
- Electricity Cost Index – again a common start would be to use RPI or RPIx but then consideration made of DECC forecasts
- Staff Costs Index – will depend on the project view. CPI could be used for this index, however over a longer appraisal period, generally RPIx + 1% could be used
- Consumable Cost Index – a common start would to use RPI or RPIx
- Maintenance Cost Index – a common start would be RPI or RPIx
- Capital Expenditure – this would depend on the specific nature of the expenditure. It is likely that any civil engineering aspects of a HN could use an appropriate Building Cost Information Service (BCIS) from the Royal Institute of Chartered Surveyors (RICS). Where there is specialised equipment required within a scheme (for example turbines or connection infrastructure within in CHP system) then more specific indices may need to be sought. These may have to come from the likely supplier themselves or from specialist technical advisory support