District Heating - Heat Metering Cost Benefit Analysis

Prepared for: Aaron Gould
Heat Strategy & Policy
Department of Energy and Climate Change

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Prepared by

Name Keith Routledge & Jonathan Williams

Position Senior Consultant, Associate Director

Signature

Approved on behalf of BRE

Name Richard Hartless

Position Associate Director

Date 2 May 2012

Signature

BRE
Garston
WD25 9XX
T + 44 (0) 1923 664000
F + 44 (0) 1923 664010
E enquiries@bre.co.uk
www.bre.co.uk

Executive Summary

DECC has commissioned Databuild and BRE to undertake a project to: (a) compile a database of heat networks and consumers in the UK, and (b) to gather evidence to assess the costs and benefits of retrofitting heat meters to domestic and non domestic buildings connected to heat networks. This report describes the cost benefit analysis carried out by BRE to re-examine the current position of the UK in relation to compliance with the specific requirements of Article 13 of the Energy Services Directive which requires all consumers to be have heat meters and to be billed on consumption.

The agreed methodology recognises the reality of the district heating market in the UK as follows:

- non-domestic market (comprising commercial and public buildings) has a high penetration of heat metering as these buildings are normally supplied by commercial energy services companies (ESCOs) that rely on heat sales and these are not considered in the cost benefit analysis;
- the domestic or dwellings market has a low penetration of district heating (still estimated at around 1%) of total and an even lower percentage of heat metering (most households/consumers are billed on an apportionment basis).

Of the various types of housing stock identified in statistics by Department of Communities and Local Government (DCLG), three were considered as being relevant to the UK district heating market, i.e. purpose built flats, terraced housing (mid and end terrace).

In accordance with the requirements of the project the cost benefit analysis (CBA) takes two different perspectives. First, the study looks at the investment from the perspective of an individual consumer in various permutations, i.e. eight different ages of the building fabric of the dwelling, three different dwelling types and three different savings ranges. Second, the cost benefit analysis from the UK Government perspective, i.e. the ‘grossed up’ effect of implementing Article 13 of the ESD (without allowed exceptions) to the most common type of dwelling type, i.e. flats.

For this first perspective, called the Micro CBA, it was important to get accuracy for both sides of the equation. In order to determine accurate costs for heat metering in 2012, four different suppliers in the UK market were approached to submit costs against a hypothetical site. On the benefit side of the analysis, the various savings studies undertaken were reviewed. Based upon the evidence and the literature reviews undertaken the range of savings was covered by three values (10%, 15% and 20%). Some of the higher values of 30% saving quoted in Danish studies from 2006 were considered outliers and unlikely to be reproduced in dwellings in the UK. All relevant cash flows were analysed using a market based discount rate over a period of 15 years (deemed to be the useful life of the meter) with a twelve month delay following installation before ‘claiming’ energy savings. The results are detailed in the main report; however, in summary, heat metering in existing dwellings was found not to be cost effective except for older houses at higher savings levels (DECC Central and High gas price scenarios).

The second perspective (defined as the Social CBA) involved using the guidelines on cost effectiveness published by DECC for the valuation of energy use and greenhouse gas emissions[1]. The procedure set out in this document was used to review the cost effectiveness of installing heat meters in purpose built flats which make up the majority of the dwellings served by district heating. Heat metering was determined to be cost effective in flats at the 20% saving level. The improvement in the cost-effectiveness relative to the

[1] Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal and Evaluation

Micro CBA is primarily due to the effect of a lower discount rate and the inclusion of the value of carbon savings.

Contents

1 Introduction

1.1 Project

This report describes the project undertaken by BRE in partnership with Databuild for the Department of Energy and Climate Change (DECC) Reference No: 286/11/2011 District Heating: Evidence gathering and heat metering.

BRE was tasked with carrying out the second part of the two distinct parts of DECC's Technical Specification, i.e. cost benefit analysis (CBA) to understand the economic impact of retrofitting existing district heating networks with heat meters.

1.2 Context

There is a need to ensure that the UK remains compliant with the Energy Services Directive (Article 13) which requires all consumers to have heat meters and be billed on consumption unless the exemption criteria are met. At present the UK has not implemented this requirement for heat metering on the basis of an assessment made in 2007 that it would not be cost effective to mandate the retrofitting of all individual consumers. This work constitutes a test of the validity of that assessment in today's context of higher fuel prices and possible reduction in the cost of installing heat meters.

Article 13 (1) of Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services (hence referred to as the Energy Services Directive or ESD) requires that final customers are provided with metering for energy use including heat provided by district heating schemes. The actual text is as follows:

"Member States shall ensure that in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use.

"When an existing meter is replaced, such competitively priced individual meters shall always be provided, unless this is technically impossible or not cost effective in relation to the estimated potential savings in the long term. When a connection is made in a new building or a building undergoes major renovations, as set out in Directive 2002/91/EC, such competitively priced individual meters shall always be provided."

In implementing the ESD the UK Government (Department for Environment, Food and Rural Affairs) undertook a review and consultation which found that it was not cost effective to mandate the retrofitting of heat meters to individual consumers in the UK. This position has recently been challenged.

This work is important for a number of reasons but in particular fulfils a commitment made in response to questions raised about the UK position on Article 13 of the Energy Services Directive. Article 13 requires that all consumers have a meter and are billed on consumption; however, there are exemptions to this in terms of cost effectiveness, physical practicality and technical feasibility.

It will include a full account of the criteria for exemption. These exemptions are important as, for example, Member States may exclude small distributors, small distribution system operators and small retail energy sales companies from the requirements of Article 13 of the Directive and up to 45%[2] of the dwellings served by district heating in the UK may be supplied by these types of organisation.

This work will also inform future negotiations undertaken by DECC in relation to the Energy Efficiency Directive (EED) which will replace the ESD in which Article 8 addresses 'metering and informative billing'.

This report details a desk based exercise to determine whether the basis upon which the UK justified not implementing the heat metering requirements of the Directive are still valid.

1.3 The requirements of the Energy Efficiency Directive (EED)

At the time of writing the latest version of this Directive was dated 22 June 2011 and available on the Europa website http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0370:FIN:EN:PDF.

Article 8 *Metering and informative billing* sets out the proposed position of the European Commission on heat metering as follows:

"any building served by a district heating network shall have a heat meter installed at the building entry. In buildings that have multiple dwellings (blocks of flats) the Directive requires that individual meters should be installed to measure heat supplied for each dwelling."

There are three currently drafted major changes between the ESD and the EED in the articles relating to heat metering:

There is no reference in Article 8 (1) to '*financially reasonable*' or '*cost-effective'* in the EED being an acceptable criterion for exemption from the requirements for individual heat meters. However, there is reference to a situation where installation of heat consumption meters is not technically feasible so that individual heat cost allocators (radiator mounted) are used instead.

Although the 'small energy distributors and small retail energy sales companies are recognised in the EED (as in the ESD and with identical criteria) they are not exempt from the requirements of Article 8. Therefore, for the purposes of the analysis in this report this means that the societal cost benefit analysis takes account of the full population of dwellings (without heat meters) served by district heating.

There is a requirement for EU Member States to introduce rules on cost allocation of heat consumption in multi-apartment buildings supplied with district heating. The ESD states that these rules "…*shall include guidelines on correction factors to reflect building characteristics such as heat transfers between apartments"*.

[2] Desk study on heat metering – EC Directive on Energy End Use Efficiency and Energy, Defra, 2007

1.4 What is meant by cost effective?

This study looks at two perspectives and these are:

An individual consumer

The UK Government

For the individual consumer it is proposed that a cost benefit analysis resulting in a positive net present value (NPV) at a typical market based discount rate over the heat meter's economic lifetime is cost effective.

For the UK Government the Interdepartmental Analysts Group guidelines published by HM Treasury and DECC[3] are used. These rely on assessing the value of GHG emissions and include a definition of cost effectiveness which is adopted here.

1.5 Output

This report and the work associated with it is presented in such a way as to answer the question 'how cost effective would mandatory heat metering be?'

The analysis is presented in such a way that:

- Allows it to be published for consultation
- Allows DECC to formulate a view of cost effectiveness of retrofitting heat meters in existing networks based on the analysis
- Allows DECC to formulate a view on the relative cost effectiveness of including heat meters during the original development as opposed to retrofitting
- Evaluates the findings to provide a considered view as to the question of relative cost effectiveness
- Provides a full account of any assumptions and sensitivities

Information has also been gathered through researching the maturity of the heat metering market in the UK and on the continent, engaging with industry on the costs and, in line with existing metering knowledge such as from RHI analysis or from smart metering policy, developing a methodology to quantify the benefits. This includes consideration of the type of information that is required/helpful for consumers to see on their meters and bills. The work separately considers the benefits of retrofitting heat meters to domestic consumers (from an individual consumers and UK perspective), as well as the benefits of heat metering for domestic users.

[3] HM Treasury, Department of Energy and Climate Change, Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal and Evaluation – October 2011

2 Description of UK district heat metering market

2.1 District heating in the United Kingdom

District heating currently provides roughly 1-2% of the UK's heat demand[4]. Analysis shows that in the right conditions, district heating could supply up to 14% of the UK heat demand, and be a cost-effective and viable alternative to individual renewable technologies, at the same time as reducing bills for consumers.

The UK makes limited use of district heating. A study undertaken for Defra in 2007[5] indicated that about 4% of the total building floor area is served by district heating schemes.

This analysis showed a wide variation in the adoption of district heating between building sectors. In the non-dwellings sector the sectors where district heating has been adopted are hospitals, higher and further education establishments and industry. These schemes are generally supplying to buildings within an area of common ownership such as a university campus or a hospital site.

Also, largely serving the non-dwellings sector, there are larger multi-user schemes serving a number of buildings within a city. For example, Sheffield has one of the UK's largest district heating schemes which consists of 44 km of pipework serving 140 buildings across the city including two universities and various municipal buildings. Other similar schemes have been developed in Nottingham and Southampton.

Within the dwellings sector there is a lower occurrence of district heating with around 1-2% of all UK housing served. However, there is marked variation between the two major tenure sub-sectors and social housing has a far higher proportion of district heating than private housing. Due to the economics of district heating, there is a higher proportion of district heating in higher density dwellings (purpose built flats and some terraces) than in detached and semi-detached houses. Major players in the social housing market are the arms length management organisation (ALMOs) owned by the local authority and the registered social landlord (RSLs) such as housing associations, trusts and co-operatives providing affordable homes. These players operate and/or manage both directly with dwellings based schemes but will sometimes purchase heat from city schemes. For example, Sheffield Homes (the UK's largest ALMO) manages 42,000 homes of which 2,800 (7%) are connected to the city scheme operated by Veolia.

2.2 How many buildings are served by heat metering?

A review of the market was undertaken by contacting leading players in providing district heating in the UK. This revealed that, for a mixed end-user city type scheme operated by a private company, all of the non-dwelling nodes, i.e. the large loads, have revenue standard heat metering installed and any nodes supplying dwellings will have at least one heat meter at development level. This results from the commercial need to recover investment, fuel and operating costs from the sale of heat. As agreed with DECC, this has led to this study being focussed on the dwellings (residential) sector as the non-dwellings sector appears to be reasonably well served by heat metering due to the nature of the market. The 2007 report drew upon a study carried out in 2000 for Great Britain (excluding Northern Ireland) which identified

[4] Davies, G.& Woods, P. 'The Potential and Costs of District Heating Networks', A report to DECC, Poyry Energy Consulting and Faber Maunsell AECOM, 2009

[5] Desk study on heat metering – EC Directive on Energy End Use Efficiency and Energy, Defra, 2007

approximately 149,000 dwellings as being served by district heating schemes. However, this is an underestimate because some of the larger schemes operated by ALMOs/HA were not recorded. The current work carried out by Databuild suggests that around 200,000 dwellings in the UK are currently (2012) served by district heating.

2.3 How many dwellings are served by heat meters?

At this stage it is difficult to say how many dwellings are served by heat meters. Recent statistics from the Department of Communities and Local Government (DCLG) indicate that there are 27.1 million dwellings in total in the United Kingdom. Of this total 4.9 million (18%) are social housing (the RSL, local authority and ALMO sub-sectors) and the remainder in the private sector (owner-occupier and privately rented sub-sectors).

Responses from the survey work carried out by Databuild indicate that approximately 25% of existing residential led district heating schemes have heat meters installed. The charging mechanisms for the remaining 75% are based upon apportionment or a points based system. However, discussions with suppliers who contributed to this study and a review of recent case studies suggests that heat metering is being installed in new developments particularly in the social housing sector. The 2007 study indicated that 77% of dwellings in the social housing sector connected to a heat network did not have heat meters.

2.4 How many non-dwellings are served by heat meters?

As set out this sector is already well served by heat meters as non-dwellings (non-domestic users) are primarily served by commercial energy companies and the revenue from metered heat forms a major contribution towards recovery of investment and operating costs of the scheme. Other charges are often fixed to specifically cover maintenance and operation of the infrastructure. It was agreed with DECC in the methodology that the non-domestic sector will not be subject to cost benefit analysis in this study. However, very small non-domestic users (e.g. retail or community premises serving dwellings within the same building) may not have heat meters and this potential is noted.

2.5 How many schemes are exempt from the Energy Services Directive?

A key issue in relation to any decision on retro-fitting heat metering in compliance with the ESD is the potential exemption of district heating schemes from the requirements of Article 13 (as well as Article 6) allowed to energy companies.

Specifically, Article 3 (r) defines:

> "*small distributor, small distribution system operator and small retail energy sales company: a natural or legal person that distributes or sells less than the equivalent of 75 GWh energy per year or employs fewer than 10 persons or whose annual turnover and/or annual balance sheet total does not exceed EUR 2m (£1.7m)*"

The 2007 study used a survey of local authorities and larger housing associations with district heating schemes that was undertaken in 2000 and identified 1,606 schemes. Using energy data this suggests that the average annual consumption per scheme is 1 GWh per year and that the average number of schemes managed by local authorities and housing associations is less than 10 which, based on the average energy use per scheme figure, suggests that these schemes would be exempt from the heat metering requirement of Article 13 of the ESD. However, there are a small number of local authorities and housing associations who operate more than 100 schemes and therefore would not be exempt. Of the total number of dwellings it is estimated that on the energy criterion just under 40% of the total would be ‘captured’ by the ESD, i.e. not in district heating schemes operated by a *small distributor, small distribution system operator and small retail energy sales company.* This equates to approximately 79,000 of the approximately 200,000 dwellings.

As set out in section 1.3 there is no exemption criterion from the requirements to install heat meters in the proposed EED and this means that there are an estimated 154,800 dwellings in the UK which are connected to district heating networks and this figure will be used when assessing cost effectiveness at a social level.

In summary, the Table 1 sets out the position:

Table 1. District heating - dwellings served

	Not captured by ESD	Captured by ESD	**Totals**
No heat metering at dwelling level	97,200	57,600	**154,800**
Heat metering at dwelling level	23,600	21,400	**45,000**
TOTAL	**120,800**	**79,000**	**199,800**

3 Project methodology

3.1 Overview

This part of the work is split into examining the two sides of the equation, i.e. cost and benefit.

The potential benefit of the retrofitting of heat meters is to improve energy efficiency throughout Member States of the European Union, and this is the aim of the Energy End-Use Efficiency and Energy Services Directive (2006/32/EC) (ESD). Energy efficiency is achieved when the end user uses less energy to achieve the same outcome. Improved energy efficiency is seen as bringing a number of benefits to the Member States of the EU including:

- Improved security of supply
- Reduction in primary energy consumption and associated greenhouse gas (GHG) emissions
- Reduction of dependence on energy imports
- Improvement of the EU's competitiveness

In this specific case the outcome is the adequate provision of space heating and/or hot water for domestic and non-domestic use. The key point here is whether the provision of feedback on energy use will affect long-term changes in behaviour that reduce energy use (improve energy efficiency) that translate into reduced CO_2 emissions associated with existing district (community) heating schemes.

For a cost benefit analysis it is important to quantify this and an initial review revealed sources for this estimate.

There are a number of studies already carried out that address whether feedback to customers can cause permanent changes in behaviour (e.g. Darby 2006 for Defra). In addition, practical case studies in Denmark (the Member State with arguably the most experience of district heating) have also examined this issue.

3.2 The agreed methodology

Our research indicates that each Member State defines its own response to the requirements of the ESD in keeping with the principle of subsidiarity, i.e. energy policy does not fall under the exclusive competence of the European Union[6].

Following discussions with DECC it was decided that there are two 'viewpoints' of cost effectiveness as follows:

[6] European Commission – COM(2011) 370 – 2011/0172 (COD) Explanatory Memorandum, Section 3.3

- The viewpoint of an 'end user' as to whether the installation of a heat meter in a property served by district heating will give a positive net present value (NPV) using market rate discount factor over the economic lifetime of the meter. This is referred to as the 'Micro CBA'.
- The viewpoint of the UK Government (for the UK as a Member State) as to whether the mandatory retrofit of heat meters to existing district heating schemes is cost effective as a policy using the methods as set out in *Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal and Evaluation*. This is referred to as the 'Social CBA'.

3.3 Calculating net present value

A standard approach to calculating net present value has been used and this is can be described as follows:

For this analysis the formula uses an initial investment in period 0 (2012) and takes an account of future discounted cash flows:

NPV returns the net value of the future cash flows over the 15 years of the cost benefit analysis — represented in today's money. Because of the time value of money, receiving a pound today is worth more than receiving a pound tomorrow. NPV calculates that present value for each of the series of cash flows and adds them together to get the net present value. The Microsoft Excel 2007 NPV function is used for all calculations and this uses a standard formula as set out below:

$$NPV = \sum_{i=0}^{n} \left(\text{values}\right)_i / (1 + r)^i$$

Where n is the number of annual values, and r is the interest or discount rate

The initial investment value made in year zero is inserted into the function as a negative value (in keeping with the convention of the function).

3.4 Cost benefit analysis – determining investment costs

The first cost that needs to be determined is the capital investment cost required to install heat meters in existing dwellings – this consist of three elements: (a) capital cost of meter, (b) data collection technology cost and (c) installation cost.

In order to obtain current costs for heat meters, four of the 'major players' who supply heat meters to the UK market were contacted. These were: EnerG Switch 2, Evinox, SAV Systems and Vital Energi.

The second cost that needs to be determined is the cost of the technology used to gather data from the meter to provide billing. Research and discussions with the four suppliers listed revealed that there are various technologies used to read heat meters that are applicable to large numbers of dwellings.

A description of the four methods together with their advantages and disadvantages is given in Table 2 in Section 4 of this report. Discussions with the suppliers revealed the data collection technology costs relevant to their preferred method.

The third cost that needs to be determined is the installation cost. This cost is obviously location specific but discussions indicated that it could be estimated for an analysis of this type.

3.5 Cost benefit analysis – determining running costs

The annual running costs are the most critical for the CBA as it will be necessary for these to be exceeded by the estimated benefit of the annual heat savings to obtain a positive cash flow which, when discounted to present value and summated across the evaluation period, will exceed the initial capital cost (negative) to generate a positive net present value (NPV) in the Micro CBA. In the instance that the monetary value of savings in heat consumption are exceeded by the running costs then the cash flow is negative. By applying the formula in section 3.3 then if all future cash flows are negative then the NPV can never be positive.

The Social CBA uses the Interdepartmental Analysts' Group (IAG) guidelines and in particular the document on valuing energy use and greenhouse gas emissions for appraisals[7]. In particular, it takes account of the benefit of reducing GHG emissions by allocating a price of carbon (£/tCO_2e) to savings in CO_2e emissions whereas the Micro CBA does not. The other key difference is the use of the discount factor set out in the HM Treasury Green Book which is 3.5%. This means that future cash flows are 'worth more' than the Micro CBA which uses a more typical 'market-based' value of 9.0%.

The running costs for heat meters are data gathering, billing and revenue collection. A review of the UK market indicates that there are two approaches to this. The first is that a company will provide an all encompassing service, i.e. providing the technology and then the ongoing data collection, billing and revenue collection for the managing agent or landlord. The second is that the first company will provide the technology and then work in partnership with another company to provide the ongoing service.

Of the four suppliers contacted, two stated that they would definitely 'outsource' the gathering, billing and revenue collection.

Maintenance and operational cost were also considered but these were related to the projected lifetime of the heat meters and only considered if suppliers indicated this was necessary.

3.6 Cost benefit analysis – determining cost savings

The key point here is whether the provision of feedback on energy use will affect long-term changes in behaviour that reduce energy use (improve energy efficiency) that translate into reduced CO_2 emissions associated with existing district (community) heating schemes. The relevant equation used is:

Cost savings = Heating and hot water consumption of building type x savings (%) x unit cost of heat (p/kWh)

Both CBAs assume that any savings are applied to the variable part of the costs, i.e. that part related to heat consumption and excluding any other charges. The savings are not applied to that element of the costs relating to operation and maintenance.

[7] HM Treasury, Department of Energy and Climate Change, Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal and Evaluation – October 2011

The projected savings are determined from data for three dwelling types relevant to district heating in the UK (end terrace, mid terrace and purpose built flat) and these are modelled separately. In addition, these are modelled across an age profile using intervals starting with pre 1917 through to post 2000.

Studies on the benefits from heat metering have been reviewed. Three key sources of data have been identified. Two of these (one of which was itself a literature review) were used to inform the 2007 study but the third is the Energy Demand Research Project (EDRP) – 2007 and 2010 which was commissioned to inform the UK Smart Metering Programme.

These studies indicate a range of savings which are dependent upon the capacity of the metering to provide useful information to the end user.

The future cost of heat over the period 2012 – 2030 is estimated using DECC future gas price projections from October 2011. Each scenario - Low, Central and High is accommodated in the model as these have a direct bearing on the outcome of the NPV.

3.7 Assumptions

In order to carry out the CBA some further assumptions have been be made:

Assumption 1 – The analysis is applied to the domestic (dwellings) sector

The work carried out in 2007 for the Defra 'Desk study on heat metering' was re-visited by contacting suppliers of heat metering technology and providers of heat metering services. In addition, two of the leading providers of district heating in the UK have been contacted to ascertain the potential effect of any legislation on the non-domestic market. One of the early findings was that almost all non domestic customers served by district heating have heat meters fitted. Therefore, it has been assumed that any requirement for heat meters to be installed retrospectively would apply mainly to the domestic or residential market and only very small non-domestic customers.

Assumption 2 – The analysis is limited to three dwelling types in the domestic sector

In evaluating which types of dwelling might have district heating systems, the categories in the English Housing Survey (EHS) 2007 were used. From the eight different types it was assumed that district heating is only supplied to three of these types – end terrace, mid terrace and purpose built flat.

This assumption has been checked against the data gathering exercise performed by Databuild as part of the other element of the project, i.e. cataloguing existing district heating infrastructure and consumers. It been borne out as the study indicates that 98% of dwellings served by district heating in the UK fall into one of these three types. The Databuild study concluded that out of those dwellings determined as being connected to a district heating network only around 2,000 (of those categorised) fall into the category of semi-detached or detached properties.

The proportion of dwelling types in the UK has been determined from surveys such as the English Housing Survey and similar surveys for the Devolved Administrations. However, the Micro CBA does not aggregate these types but calculates an NPV for each type for different levels of savings.

3.8 Summary

The various cost elements including investment costs, ongoing costs and cost savings are used in the Micro and Social CBAs and subject to the relevant sensitivity analysis/scenario techniques as agreed with DECC.

4 Building the CBA models

4.1 Capital cost – heat meters

One of the key questions relating to this project was to determine an economic life for the meters and the associated systems. Responses indicate that the meters will last up to 20 years. However, for meters that rely on battery power an extended battery life is required. Research indicates that extended battery life is approximately 16 years so therefore at least one intervention is required for battery replacement for the meter to reach the economic life of 20 years. For the cost benefit analysis the estimated meter life has determined the length of the period over which the analysis is made and this has been set at 15 years for both the Micro and Social CBA.

With regards to accuracy, heat meters are usually supplied complete with calibration certificates which are valid for a set time period as stated by the competent authority, i.e. the test laboratory. After this time, the heat meter would normally be replaced or recalibrated. Some suppliers propose a sampling approach to checking and replacing a fraction of meters on a particular district heating network, say after 10 years and others adopt a 'fit and forget' approach. In order to obtain 2012 costs, the four suppliers were presented with a request to price a heat metering system to fit a hypothetical site as follows:

> *Provide pricing for the following hypothetical project to retrofit heat metering to an existing development of 250 dwellings of various sizes (one, two and three bedroom apartments) served by a district heating scheme. Each apartment will have an existing heat interface unit (HIU) but no heat meter. Residents are currently invoiced for heat on a floor area basis.*

The responses showed that the cost of a heat meter (supply only) ranged from £178 to £230 per year. At a mean value of £212 this represents an increase of 57% on the figure of £135 used for a domestic meter in the 2007 study.

4.2 Capital cost – Installation of heat meters

Obtaining typical installation costs (particularly for retrofit) is difficult as suppliers usually carry out a site survey before submitting any prices. The hypothetical site was intended to assist suppliers to give budget costs. One supplier provided an estimate based upon a programme of replacement over a short period to the 250 flats in the hypothetical site. It is envisaged that the work involved would be programming the work, gaining access to the dwellings and arranging to isolate an existing heat interface unit (HIU) to install the meter and re-connecting to the HIU.

On the basis of this single response the installation cost at the hypothetical site is £20,000 or approximately £80 per flat. This cost has therefore been incorporated into the cost benefit analysis.

4.3 Capital cost – Data gathering system

Once installed, a meter must be read so that the heat supplied over a given period can be determined and the user billed. There is a range of data collection technology available each with its associated advantages and disadvantages: This is summarised in Table 2.

This report refers to data gathering system rather than the more commonly used term of AMR (automatic meter reading) because the emphasis here is on the technology choice rather than the process.

Each supplier was asked to nominate the type of technology that they would choose for the hypothetical installation and the cost presented. Suppliers indicated flexibility in the choice of data gathering technology. Three suppliers indicated that they preferred a hard wired (M-BUS) system with individual cable connections to each dwelling. Their stated reason was that the Radio/General Packet Radio Service (GPRS) technology was not totally reliable although the cost of a radio system was significantly higher than the hard wired solution. However, one of the suppliers chose radio/GPRS as their solution as they regarded the existence of long cable lengths as being prone to damage, particularly in a new build situation.

Table 2 Data collection technologies

Method	Description	Advantages	Disadvantages
Visual direct reading of meter	Meter reader gains access to each dwelling and visually inspects meter.	No additional infrastructure required hence no additional capital investment.	Labour intensive and hence costly. Access not always available which necessitates estimation of reading.
Radio – General Packet Radio Service (GPRS)	Meter is fitted with a radio module and the data is collected by either a meter reader on a ‘walk by’ the dwellings or relayed to aerials on site for re-transmission	Does not require access. Meter can be read on an external walk by with a hand held data collection device.	Less labour intensive than visual direct reading but still requires labour and hence is costly. Can be issues regarding communication software between data collection device and meter.
M-BUS	Meter is fitted with an M-BUS module and is cabled to a data collection point forming a local area network.	Does not require access. Direct wired connection with each meter.	Requires capital investment in data cabling to each dwelling. Risk of cabling damage during construction or during any building work on property.
Radio/M-BUS Hybrid	Meter is fitted with a radio module and transmits data to a fixed M-BUS node (in a plant room or building core) which is then collected.	Does not require access. No cable required to each dwelling – reduced capital cost	Requires capital investment in M-BUS nodes and cabling to central data collection.

Table 2 shows that the choice of the data gathering technology will affect the capital cost of the project. This was borne out in the response of the four suppliers where three chose the M-BUS and the fourth the Radio-GRPS technology. It was evident that different suppliers applied different weighting factors to the advantages and disadvantages.

4.4 Running costs

The ongoing costs associated with heat metering have been identified as follows:

- Maintenance – Modern heat meters are designed to be maintenance free over their life time.
- Collection of data – depends upon the technology chosen
- Generating and sending out bills to individual end users
- Collection of money from individual end users

In responding to the request for costs associated with the hypothetical site, each supplier was asked to provide the costs associated with delivering the above services. The results are shown in Appendix A and gave a mean value of £81 per year per meter.

Discount rates

The discount rate is used to convert all costs and benefits to 'present values', so that they can be compared. The Micro CBA model uses a 'market based' discount rate of 9% and the Social CBA uses the discount rate of 3.5% as set out in the UK Treasury Green Book. Calculating the present value of the differences between the streams of costs and benefits provides the net present value (NPV) of an option. The NPV is the primary criterion for deciding whether action can be justified.

4.5 Determining the projected savings

Predicting the space heating and hot water load – dwelling type

To predict the space heating and hot water load the BREDEM (BRE Domestic Energy Model) output was used. This study looked at three dwelling types over an eight age range categories. Table 3 shows that the age of the dwelling determines the energy demand and that legislation leading to change in construction methods has resulted in a steady reduction in domestic heating and hot water demand over the 20th century. (It is clear that flats converted from existing buildings are excluded as they are a separate output category in BREDEM.) The demand for the category 'Terraced' in BREDEM was equated to mid-terrace in EHS and the demand for the category 'Semi-detached' to end terrace. This represents a logical and rational use of the data. Therefore, the annual heat consumption for heating and hot water set out in BREDEM for the three categories will form the baseline of the calculations on which savings are calculated in terms of cost and carbon.

The analysis also utilises the time dimension ('younger' dwellings have lower demand) as this can inform any policy decisions with regards to age of dwellings that are suitable for retrofitting. Therefore, the analysis uses an 8 x 3 matrix as shown in Table 3.

Table 3 BREDEM heating and hot water heat consumption (kWh/year)

	Semi-detached	Terraced	Flat
Pre 1918	20,476	16,042	10,581
1918 - 1938	18,652	14,640	9,755
1939 - 1959	16,688	13,182	8,994
1960 - 1975	16,065	12,710	8,653
1976 - 1982	14,749	11,740	8,101
1983 - 1989	15,072	11,989	8,331
1990 - 1999	11,728	9,479	6,828
Post 2000	10,306	8,371	6,218

4.6 Determining the cost of heat to be applied to the projected savings

The research undertaken to determine this key variable indicated that the domestic market is split into two distinct sectors with regard to the cost of heat to the end user. To investigate this two models of heat costing have been proposed:

4.7 The 'commercial' heat cost model

In this model a supplier (a commercial energy services company, ESCo) operates a district heating scheme on a tariff system and the price of the heat to the consumer is related to the alternative provision of heat and hot water from a stand-alone boiler in the dwelling. For example, the unit price of gas supplied to UK households was on average 4.15p per kWh[8]. If it is assumed that gas in a conventional system is burned to provide space heating and hot water in a boiler of SEDBUK D rating (78-82%) then an estimate of the average cost of conventionally supplied heat to a household in the UK during 2011 was 4.15/0.8 = 5.19p per kWh during 2011. Note: it is understood that maintenance costs are not usually included here but are recovered from consumers via a separate standing charge.

An interview with one of the larger energy services companies (supplying dwellings and non-domestic buildings) indicated that heat for households (where it is metered and charged) is typically priced at 10-15% below the equivalent, i.e. the 5.19p per kWh.

Therefore, the estimated price of heat to domestic consumers would typically be between 4.41 and 4.67p/kWh. Responses from the data gathering on district heating tariffs indicate that the price for heat is usually included in an apportionment based charge.

As the rationale produces an estimate of 4.41 to 4.67p/kWh and the actual 2011 price (4.64p/kWh) lies within that range then there is confidence in this approach being used where a commercial company owns and/or operates district heating schemes.

The price of heat used in the calculation of the Micro CBA were calculated using the DECC Assumed Gas Prices, 2011. In this case, the assumed DECC gas price (Figure 17)[9] for 2011 was 63p/therm (i.e. 2.15p/kWh). Using the average unit price of natural gas supplied to households (4.15p/kWh) a 'scaling factor' was determined, i.e. (4.15/2.15 = 1.93). This scaling factor was then used in conjunction with the DECC gas price projections to estimate the retail price of gas to a household under each of the three

[8] Quarterly Energy Prices – National Statistics Office for DECC – December 2011
[9] DECC Gas Price Projections – October 2011

scenarios: High, Central and Low. From this estimated retail gas price a price for heat was determined by dividing by 0.8 (to allow for conversion from gas to heat) and multiplying by 0.9 to allow for the 10% discount that is usually applied in this commercial ESCo model.

This methodology of determining future heat price has been applied to the spreadsheets used for the NPV calculations in both the Micro and Social CBA.

4.8 The 'social' heat cost model

In this case the supplier, a local authority, arms length management organisation (ALMO) or equivalent is assumed to be operating district heating schemes. This supplier is assumed to purchase gas to serve the boilers in district heating systems through a collaborative procurement group or to use a private sector energy procurement broker/consultancy. This enables the price of natural gas to be negotiated to a competitive level. The cost benefit of this negotiation is passed through to the consumer in social housing.

An example of such a consortium is Laser Energy Buying Group representing 106 Local Authorities and other publicly funded bodies throughout the south of England which currently purchases 3.7 TWh of natural gas on behalf of 26 London Boroughs, ten county councils and various other city and unitary authorities, district and borough councils, etc. in the south of England.

In the absence of heat metering, many local authorities, ALMOs, etc. charge users in social housing on a relative basis, e.g. London Borough of Lambeth currently uses a points system. The points reflect the number of rooms that have direct heating and those that do not have direct heating but which benefit from the heating from other rooms. Hot water is charged in a similar way. A cost is allocated to each point and the points added up to obtain a total heat price to the dwelling.

In this type of arrangement the benefits of collaborative procurement are passed on to the consumer and the resulting 'effective price of heat' can be significantly lower than the commercial model detailed above as the local authority or ALMO does not seek to make a profit from operating the district heating schemes.

In this model, collaborative procurement should allow gas to be purchased at a price equivalent to that paid by industrial users. Discussions with one of the larger London ALMOs indicate that in late 2011/early 2012 this price was around 2.7p/kWh delivered to the boiler house. After allowing for the efficiency of boiler plant and losses from the distribution pipework, the cost of heat to consumers is around 3.4p/kWh. This would exclude maintenance costs as these are consolidated and divided by heat supplied and added in to the unit heat charge.

4.9 Estimating the savings – the research

Investigations here revealed that there is limited further validation of energy savings attributable to metering that has been documented since the two sources quoted in the 2007 study. The major studies have covered electricity or gas metering. In 2006 *Darby* carried out an extensive literature survey of primary sources, together with a few review papers, from the USA, Canada, Scandinavia, the Netherlands and the UK. Darby divided feedback into two categories: direct (immediate, from a meter or associated display monitor) or indirect (feedback that has been processed in some way before reaching the end user, normally via billing). The findings of this study was that the level of savings was dependent upon technology but were generally in the region of 5 – 15% and 0 – 10% for direct and indirect feedback respectively.

A more relevant study was reported in the Danish Board of District Heating[10] periodical in 2006. This concerned the retrofitting of heat meters to three dwelling types in Denmark that had previously used apportioning of heat charges from a building heat meter. See Table 4 below for level of savings.

However, one substantial piece of work which has been used to inform this analysis is the large scale trials of consumption feedback that have been undertaken to inform the UK Smart Metering Programme. The Energy Demand Research Project (EDRP) was a major project in GB to test consumers' responses to different forms of information about their energy use. Four energy suppliers each conducted trials of the impacts of various interventions (individually or in combination) between 2007 and 2010. The interventions used were primarily directed at reducing domestic energy consumption. The project involved over 60,000 households, with over 25% using smart meters.

This report uses a simple theoretical framework based on the *means*, *motive* and *opportunity* for householders to change their behaviour (i.e. for householders to reduce energy demand, they must know what to do, have a reason for doing it and have the resources to do it). The wide range of behaviours that affect domestic energy demand may be characterised in terms of "*opportunity*" – the time required and the cost associated with them, and sometimes also the required space in the home. The final analysis of this three-year project was presented in a report commissioned by Ofgem on behalf of DECC and published in 2011. The headline findings were:

- With two exceptions, there was no significant reduction in energy consumption when the intervention did not include a smart meter.
- The combination of smart meters and real time displays (RTDs) consistently resulted in energy savings of around 3% but with some higher and lower savings, depending on fuel, customer group and period.
- The positive savings from smart meters depended on providing consumers with appropriate additional interventions, as discussed above.
- The provision of an RTD was particularly important in achieving savings in electricity consumption. Gas savings could be achieved through installation of a smart meter without further intervention, although evidence of persistence was not as strong as for electricity savings with RTDs.

However, it is important to remember that the EDRP represents a refinement of existing feedback, i.e. all consumers already have a meter that measures actual consumption whereas this study is focussing specifically on installing meters to consumers where no measurement takes place except at bulk (building or development) level.

4.10 Projecting savings

The 2007 study used three levels of savings (15%, 20% and 30%) as an input into the cost benefit analysis and this range varied depending upon the type of consumer (building type). For this study it is proposed that three savings levels are again used but as the analysis will cover dwellings, these three levels will be fixed and a scenario produced for each.

[10] Gullev, L. & Poulsen, M. "The installation of meters leads to permanent changes in consumer behaviour". News from DBDH. Journal 3/2006 pp. 20-24

Table 4 Summary of savings estimates

	Literature review – Darby 2006	EDRP – 2007 to 2010	Danish study
Study	Gas and electricity	Gas and electricity	Actual results from Danish district heating schemes
Scope	Direct feedback Indirect feedback	60,000 households in UK	
Savings range	5 – 15%	0 -11%	15 – 17% (Typical) (Up to 30%)

It was decided that the range of savings be limited to three values of 10, 15 and 20%. The rationale used here is that the EDRP is probably not representative of the householders considered in this assessment as it concerned consumers who had meters, but that the very high values of the Danish study (up to 30%) were probably supported by other measures such as improved insulation and an information campaign to consumers. Therefore, the higher values of saving (30% in dwellings) projected in the 2007 study have been revised down to a maximum of 20%. The three values are not specified with any particular rationale but these 'levels' could be assumed to correspond to the degree of sophistication of the feedback (as suggested by the EDRP) but it should be noted that all meters reviewed have a similar capability for 'smart' reporting.

4.11 General

Two cost benefit analyses have been undertaken as required by the DECC Technical Specification for this work:

> *The work will separately consider the benefits of retrofitting heat meters to domestic customers (from an individual consumer and UK perspective).*

The cost benefit analysis (CBA) from an individual consumer perspective is referred to as the Micro CBA and the one from UK perspective as the Social CBA.

4.12 The Micro CBA - methodology

This model consists of a standard investment discounted cash flow (DCF) appraisal covering investment costs for the retrofitting of heat metering to consumers supplied by existing district heating systems where heat supply is charged on an apportionment basis. Using discounted future cash flows the model is run over 15 years for intervals of one year. The factor used to discount future cash flows is based upon a market rate typical of that required by private investors. The CBA then calculates the net present value (NPV).

Relevant investment costs are:

- Capital costs – heat meters, data gathering system, installation and commissioning

Relevant running costs are:

- Data gathering, invoicing of consumers and collection of monies

Therefore, the fixed parameters of the Micro CBA are set out in Table 5:

Table 5 Costs of heat metering

Cost description	Cost per dwelling
Capital cost of heat meter:	£212
Capital cost of installation of heat meters	£80
Capital cost of data gathering system	£62
Capital cost of installation of data gathering system	£93
Running costs	£81 per year

Therefore the total cost (£447 per dwelling) for an individual dwelling could theoretically be paid by the consumer or the ESCo (who may choose to pass it on to the consumer).

These costs are used in each of the Micro CBAs.

The Micro CBA calculates the NPV for three dwelling types (end terrace, mid terrace and purpose built flat) for each of eight dwelling age bands, for three savings levels and for three heat prices derived using the commercial model from DECC's Low, Central and High gas pricing scenarios.

4.13 The Social CBA - background

The Social CBA uses the Guidelines set out in the DECC document published on the Interdepartmental Analysts Group (IAG) webpage. The overall objective is to utilise the data on dwellings served by district heating in the UK to determine an estimate of greenhouse gas savings and incorporate those into a cost benefit analysis using a lower discount factor, i.e. 3.5% as required by HM Treasury Green Book for analyses of this type relating to policy.

4.14 The Social CBA - methodology

Step 1 - Quantifying greenhouse gas emissions (GHG) savings

Projected savings in heat consumption were converted to gas consumed by the district heating boiler plant by dividing by 0.80 to allow for energy conversion and distribution losses.

Age of dwelling: Uses the BREDEM age profile applied (on a weighted basis)

Dwelling type used: Purpose built flat

Number of flats: 154,800 i.e. the estimate of all flats on district heating schemes – this is the Energy Efficiency Directive scenario with no exemptions

Savings achieved: The savings in natural gas consumption were calculated for the three levels of savings used for the Micro CBA (10%, 15% and 20%).

The resulting estimated gas consumption for each level of savings was then multiplied by the Marginal Emissions factor for the fuel as published by DECC (Gas: 183.2tCO_2e/GWh) to determine the GHG savings.

Step 2 – Valuing the reduction in GHG savings

The projected savings in GHG emissions were then valued as follows:

Although the majority of district heating schemes in the UK are served by gas from heat generation plant well below the EU ETS threshold of 20 $MW_{th,}$ there are a small number of schemes on the UK National Allocation Plan so in reality the supply of gas is from the Traded and Non-Traded Sectors.

However, for the purpose of this analysis, all GHG emissions are attributed to the Non Traded Sector and therefore the Non Traded Price of Carbon (NTPC) is used to determine the future value of GHG emissions. For the period included in the CBA year 0 to 15 (2012 – 2027) the NTPC increases from £56/tCO_2e to £70tCO_2e.

Step 3 - Determining the grossed up costs

For the Social CBA the capital cost (£447) and running cost (£81 per year) per dwelling was multiplied by 154,800 giving a total capital investment of £59.4 million and annual running costs of £10.8 million.

The current draft of the EED indicates states that meters should be installed at no extra cost to the consumer. The modelling in this report assumes that there is a capital cost which must be borne by the consumer or the heat supplier who can then choose whether to pass on this cost. The final agreed text of the Directive will have a substantial effect on both CBAs.

5 Findings

5.1 Micro CBA

The Micro CBA was run for the three dwelling types (end terrace, mid terrace and purpose built flat) for each of eight dwelling age bands, for three savings levels and for three heat prices derived using the commercial model from DECC's Low, Central and High gas pricing scenarios.

The NPV calculation utilises a 15 year project life with a one year delay from investment to savings started and a market based discount rate of 9%.

NPV compares the value of a pound (£) today to the value of that same pound in the future. If the NPV of a prospective project is positive, it should be accepted. However, if NPV is negative, the investment should probably be rejected because cash flows will also be negative.

Therefore, in simple terms if an NPV is negative for any of the 216 calculations made for the Micro CBA then investing in a heat meter in 2012 for that particular scenario is deemed not to be cost effective.

The following charts illustrate the results of the Micro CBA at a savings level of 15% for each of the three dwelling types. The vertical spread of the bars illustrate the change in NPV across the three DECC price scenarios with the top of each bar being the NPV at the High gas price scenario. The full results with the numerical output are presented in Appendix C to E inclusive.

Figure 1 - NPV for purpose built flats

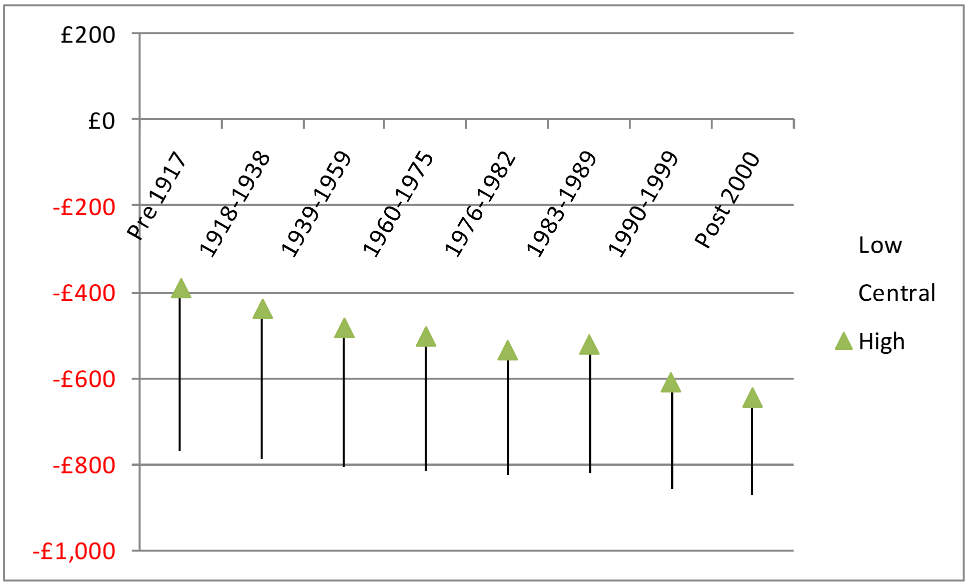


Figure 2 NPV for mid terrace houses

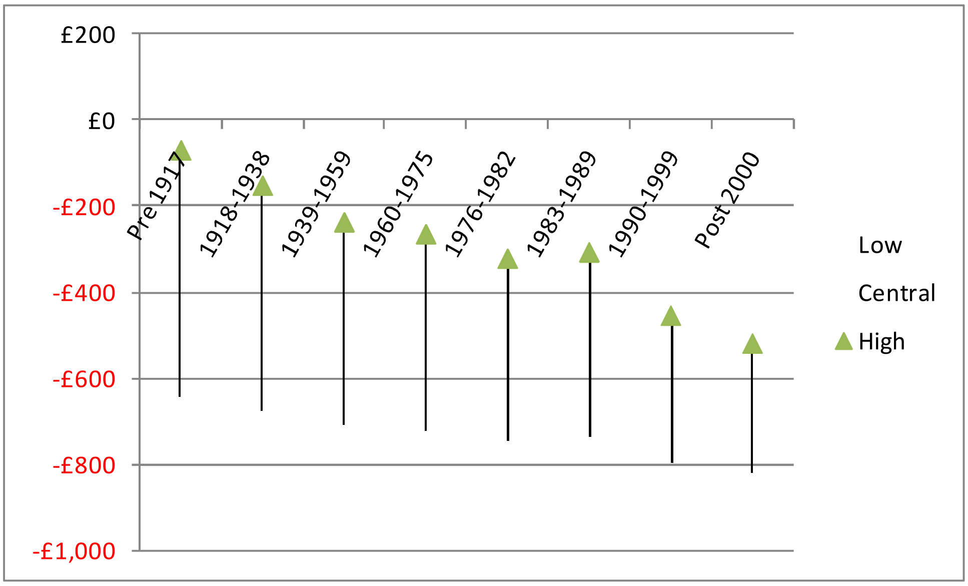
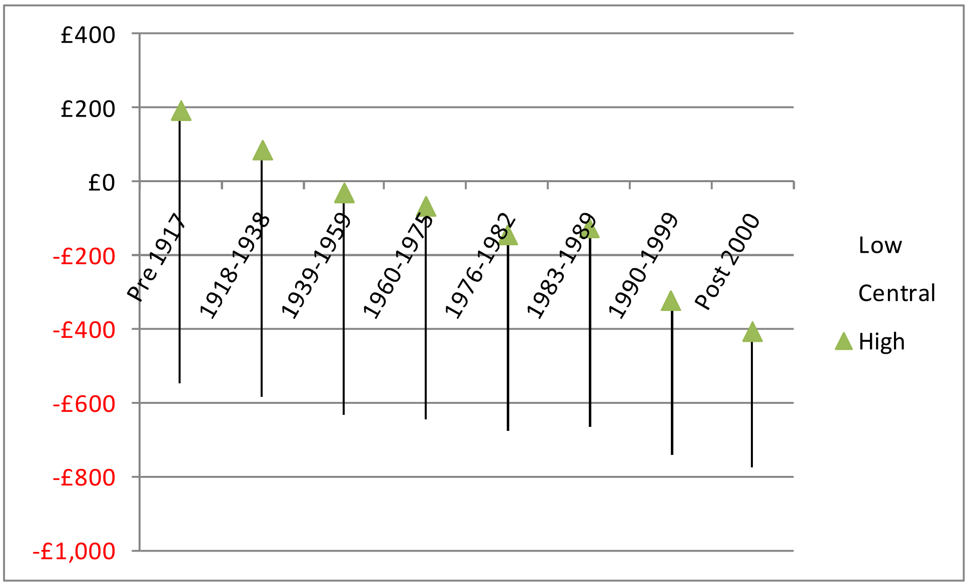


Figure 3 NPV for end terrace houses



The output from the Micro CBA indicates that there are only two dwelling types houses (end terrace and mid terrace) that display positive NPV. Positive NPVs are only indicated for end terrace houses more than 30 years old at the Central and High DECC gas price projections. In addition, older mid terrace houses (more than 50 years old) exhibit positive NPV under the same gas price scenarios.

The introduction of individual heat metering will affect different users within blocks in different ways. Within purpose built flats, by far the most common type of dwelling served by heat networks, heat demands vary depending on a range of factors including whether the flat is on the ground, mid or top floor and the number of external walls. For example, a top floor apartment with three external walls may have a space heating demand 40% higher than the equivalent mid floor apartment with two external walls. In addition, the behaviour of the occupant(s) also has a substantial effect upon heat consumption. If an example is taken of a flat which has heat consumption 50% above the average then the cost of heat provision would increase. A calculation using the Micro CBA indicates positive NPV for savings of 20% on predicted annual heat consumption at the DECC Central and High gas price scenarios – see Appendix F for detailed results. In the opposite situation where the heat consumption is 50% below the average and the cost of heat provision has decreased, no scenarios show a positive NPV. Therefore, there is a disparity of impact upon different dwellings. This is further considered for a hypothetical block in Appendix B.

5.2 Social CBA

The Social CBA was run as a standard NPV using the grossed up total for the number of dwellings in the UK without heat meters (154,800) – the EED compliance case.

The analysis was run using the most predominant type of dwelling served by district heating, i.e. the purpose built flat. Although not all dwellings served by district heating in the UK are flats, the data collected by project partners Databuild indicated that flats were around 90% of the total. Therefore, it was decided that for the Social CBA the report would only examine this type of dwelling. Therefore, only purpose built flats would be included in the ‘grossed up’ dwelling population. Savings were estimated for the grossed up total applied to the consumption profile of flats as determined by BREDEM.

The Social CBA was run for the DECC Central gas price scenario at the three projected savings levels resulting from installing heat metering into existing dwellings served by district heating. To determine the value of greenhouse gas emissions the Non Traded Price of Carbon (NTPC) was used. It was viewed that, whilst there are a small number of larger heat generation facilities that are registered under the UK National Allocation Plan which would use a Traded Carbon Price (TPC), the vast majority are smaller than the threshold, hence the decision.

The findings are summarised below:

Table 6 Social CBA (DECC Central scenario) - Results

	Saving level		
	10%	15%	20%
Total energy savings (GWh/year)	163	245	326
Total GHG emissions savings (tCO_2e/year)	29,871	44,806	59,742
Investment (£ million)	£69.3m	£69.3m	£69.3m
Annual running costs (£ million)	£12.5m	£12.5m	£12.5m
Undiscounted value of gas savings over	£132m	£198m	£263m

appraisal period (£ million)			
Undiscounted value of GHG emissions savings at NTPC price over appraisal period (£ million)	£28.2m	£42.3m	£56.4m
NPV (including valuation of GHG savings) (£ million)	-£98.7m	-£41.1m	+£16.5m
Present value of GHG emissions (£ million)	£26.1m	£39.1m	£52.2m
Total GHG emissions saved (million tCO_2e)	0.42	0.63	0.84
Cost Effectiveness Indicator (£/tCO_2e)	298	127	42

The cost effectiveness of the Social CBA was determined using the expression below – as set out in the HM Treasury/DECC guidance – Chapter 4 Cost Effectiveness. It should be noted that the convention is that a negative value of the Cost Effectiveness Indicator (CEI) is a net benefit per tonne of CO_2e and a positive value is a net cost.

$$\text{Cost Effectiveness Indicator } (£/tCO_2e) = \frac{\text{NPV - PV (Carbon in Non Traded Sector)}}{\text{- (Total carbon saved in Non Traded Sector)}}$$

As demonstrated the values of the CEI are positive at each saving level, i.e. they all present a net cost.

6 Conclusions

The conclusions drawn from the findings of this study are:

- Non-domestic buildings supplied by district heating schemes are already well served by heat meters so mandating the installation of heat meters will have little effect.
- The Micro CBA which looks at heat metering from the individual consumer's point of view indicates that the installation of heat metering in existing dwellings is not cost-effective except for older houses at the high savings levels (15 and 20%) for the DECC Central and High gas price scenarios used to estimate future heat prices under the commercial heat pricing model set out in the report.
- The Micro CBA predicts positive NPV (per dwelling) for older purpose built flats at 20% saving when the annual heat consumption is 50% above values projected by BREDEM. All other scenarios give a negative NPV.
- If there is no behaviour change following the introduction of heat metering, in any one multi-storey block of flats there will be consumers whose heat bills increase and those that decrease. However, the net effect over the block will be zero if a 'standard' fixed and variable element tariff is introduced. This statement assumes that occupants take no measures to manage space heating demand or domestic hot water use.
- The Social CBA includes the value of greenhouse gas (GHG) savings (using the DECC Non-Traded Price of Carbon) determines the NPV for installing heat meters in flats (estimated as 90% of dwellings in UK connected to district heating). Heat metering was determined to be cost effective at the 20% saving level indicated by a positive NPV.
- The Cost Effectiveness Indicator (CEI) was determined for the Social CBA in accordance with IAG guidelines and was found to be positive at all three levels of saving indicating the net costs per tonne of CO_2e of the investment.
- The Social CBA NPV and CEI were determined using the commercial heat price model using DECCs Central gas price scenario. This scenario was chosen as the reference and effectively means that the Low gas price scenario is ruled out, i.e. will not indicate cost-effectiveness at any of the levels of saving. The values of NPV and CEI will change under the High gas price scenario.
- Over the period considered (15 years) a decision to make the installation of heat meters mandatory for existing heat consumers would save between 0.42 and 0.84 million tonnes CO_2e depending on the savings level achieved.
- In summary, the position has changed little since the 2007 study and with minor exceptions (a small proportion of older housing) the installation of heat metering is not cost-effective from the perspective of an individual consumer. However, it must be remembered that the Micro CBA uses a discount rate of 9% compared to the 3.5% used in the 2007 study. The Social CBA in this study indicates a positive NPV for the highest saving level at a 3.5% discount rate.

Appendix A – Costs used in CBA

A.1 Investment costs

Four suppliers were approached to obtain real costs for heat metering for the UK market. Their responses with costing have been made anonymous to protect their commercial confidentiality and to allow the report to be published.

At an early stage it was decided that, in order to obtain meaningful information, a hypothetical case was presented and the four organisations asked to provide their response. In addition to costs, a telephone discussion was undertaken to determine the key features of their offering such as:

- Meter features (use of real time displays, etc.)
- Expected meter lifetime – maintenance and calibration programmes
- Data collection technology used – remote metering techniques
- Heat invoicing and collection

The hypothetical site was presented to the four suppliers as follows:

> *Provide pricing for the following hypothetical project to retrofit heat metering to an existing development of 250 dwellings of various sizes (one, two and three bedroom apartments) served by a district heating scheme. Each apartment will have an existing heat interface unit (HIU) but no heat meter. Residents are currently invoiced for heat on a floor area basis.*

A.2 Overview of responses

All four suppliers responded within the set time. The main features of the overall response were:

- All suppliers supplied information on the make and model of heat meter proposed
- All suppliers emphasised the difficulty of providing costs (albeit not quotations) for the installation of heat meters and only one chose to estimate this cost based on assumptions made about access to existing dwellings
- The choice of data gathering technology affected the capital cost of this element. Three suppliers chose a hard-wired system, the other, a wireless radio system.
- Only one of the suppliers indicated that ongoing costs would include a maintenance element although others did indicate that some sample calibration would be required.

Table A1 - Heat metering costs (per dwelling)

	Supplier A	**Supplier B**	**Supplier C**	**Supplier D**
Data gathering technology	Radio	MBUS	MBUS	MBUS
Capital cost				
Heat meter	Sharky 775	Sonometer	2WR6 K20 (PTB)	ModuSat
Capital cost - meter	224	230	178	215
Capital cost – installation of meters	80	80	80	80
Capital cost data gathering system	208	11	10	21
Capital cost – installation of data gathering system		130	100	142
Total capital cost	**512**	**451**	**368**	**458**
Running cost (per year)				
Meter servicing and metering	60	70	35	Not stated
Data service and credit billing			55	105
Total running cost (per year)	**60**	**70**	**90**	**105**

For each of the cost benefit analyses the following values have been used which are the mean value of the costs provided by the four suppliers:

Capital cost – meter: £212

Capital cost – installation of meters: £80

Capital cost – data gathering system: £62

Capital cost – installation of data gathering system: £93

Running cost: £81 per year

Appendix B – Heat charging pre and post heat metering – hypothetical case

In order to examine the effect of installing heat meters in dwellings where the charging system is based upon a flat charge the following methodology was used.

Stage 1 – Hypothetical case - flat and block configuration

The flats are assumed to be identical in size (61m^2) and layout (except that some have three external walls and some two). Layout is two bedroom, living room, kitchen, bathroom and hall. The flats are assumed to be located in a ten storey block (ground floor, eight mid floors and one top floor) with 20 flats on each floor – total 200 flats.

Stage 2 – Predicting dwelling heat consumption

Work done by BRE for OFGEM in 2007 used the BRE Domestic Energy Model (BREDEM)[11] and indicates that the predicted space heating consumption of a flat varies substantially according to its position in the block. This varies from 7,000 to 12,000 kWh for a mid floor flat with two external walls and a ground floor flat with three external walls. This work used the Standard Dwellings for Energy Modelling study produced for the Department of the Environment, Transport and the Regions by BRE in 1999[12] as a source for the typical flat within the UK dwelling stock.

By applying the results of this modelling (plus an estimate of 2,000 kWh per year for domestic hot water) the annual heat consumption of this block of 200 flats can be predicted.

Stage 3 – Determining the heat required from the district heating network (DHN)

Once the total heat consumption is determined, the fuel demand of the boiler house serving the block is determined. This uses an estimate of boiler efficiency of 90% (useful heat onto the network as hot water divided by heat content of fuel) and an allowance of 10% for distribution heat losses in the network.

Stage 4 – Determining the fuel, operating and maintenance costs of the DHN

In order to determine the costs of providing the heat to the dwellings the following:

- Determine fuel cost in the DH boiler house – using a typical value for natural gas bought as part of a collaborative purchasing initiative. Typically, this would be £0.0275 per kWh for 2011.

[11] BRE, Energy Efficiency Commitment 2005-2008 and BREDEM Calculation of Energy Savings, Client Report 237027 to Ofgem, 2007

[12] BRE, Standard Dwellings for Energy Modelling, A report to the Department of the Environment, Transport and the Regions (DETR), January 1999

- Determine the operating and maintenance costs - By using Table 19 of the Pöyry/ Faber Maunsell report[13] the cost of operating and maintaining a district heating network is estimated as £0.03 per kWh_t per year.

Stage 5 - Cost to consumers before heat metering installation

By using the values in (a) and (b) above the total cost of providing a quantity of heat can be determined. If this is then divided by the number of flats (200 in the hypothetical case) then the total flat charge is determined, i.e. total cost divided by number of flats (as flats are of an equal size).

This amount represents the charge to consumers in a non heat-metered dwelling.

Stage 6 – Costs to consumers post dwelling heat metering installation

In order to get a true representation of the total cost of supplying heat after meter installation then it is important that the 'tariff' is structured to give each consumer a 'fair share' of the operating and maintenance costs. A multi-part tariff is normally used but for the purpose of this analysis only two parts are proposed as follows:

- a variable charge based upon metered heat consumption using a calculated heat price based upon total cost of fuel to DHN boilers divided by total heat metered output from boilers (£/kWht);
- a standing charge based upon total operating and maintenance costs for boilers, pumps and DHN divided by the number of dwellings (200 flats in this case).

Stage 7 – Compare 'before and after'

Table B1 below apportions the costs associated with heat supply to flats of similar size but differing location. It can be seen that whilst a large number of individual flats would show a small saving on fixed basis charge this would be negated over the block by the increases on other flats (of identical size but different location) with a net zero sum. Although flats exhibit a location based effect this could be allowed for in the tariff. This would leave the variable heat metered charge within the control of the consumer without being unfair.

[13] Davies, G.& Woods, P. 'The Potential and Costs of District Heating Networks', A report to DECC, Pöyry Energy Consulting and Faber Maunsell AECOM, 2009

Table B1 – Heat charging comparison for different dwelling locations

Flat location	**No. of flats of type**	**Pre-metering Fixed (£/year)**	**Post metering Two part tariff**		**Difference (£/year)**	**Total across flat type (£/year)**
			Fixed charge (£/year)	**Heat charge (£/year)**		
Two ext walls – mid floor	144	605	284	306	- 15	-2,723
Two ext walls – top floor	18	605	284	340	+ 19	+327
Two ext walls – ground floor	18	605	284	356	+ 35	+633
Three ext walls – mid floor	16	605	284	373	+52	+834
Three ext walls - top floor	2	605	284	407	+86	+172
Three ext walls -ground floor	2	605	284	475	+154	+308
					Total change	0

Appendix C – Micro CBA: End terrace

Scenario Summary	Pre-1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year	20,476	18,652	16,688	16,065	14,749	15,072	11,728	10,306
Estimated savings	10%	10%	10%	10%	10%	10%	10%	10%
Result Cells:								
NPV Low Scenario	-£700	-£728	-£758	-£767	-£787	-£782	-£833	-£855
NPV Central Scenario	-£274	-£340	-£410	-£433	-£480	-£468	-£589	-£640
NPV High Scenario	-£210	-£281	-£358	-£383	-£434	-£421	-£552	-£608

Scenario Summary	Pre-1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year	20,476	18,652	16,688	16,065	14,749	15,072	11,728	10,306
Estimated savings	15%	15%	15%	15%	15%	15%	15%	15%
Result Cells:								
NPV Low Scenario	-£545	-£586	-£631	-£645	-£675	-£668	-£744	-£776
NPV Central Scenario	£95	-£4	-£110	-£143	-£215	-£197	-£378	-£455
NPV High Scenario	£191	£84	-£32	-£68	-£145	-£126	-£323	-£406

Scenario Summary	Pre-1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year	20,476	18,652	16,688	16,065	14,749	15,072	11,728	10,306
Estimated savings	20%	20%	20%	20%	20%	20%	20%	20%
Result Cells:								
NPV Low Scenario	-£389	-£445	-£504	-£523	-£563	-£553	-£655	-£698
NPV Central Scenario	£463	£332	£191	£146	£51	£74	-£167	-£269
NPV High Scenario	£591	£449	£295	£246	£143	£168	-£93	-£205

Appendix D – Micro CBA: Mid terrace

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1932	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	16,042	14,640	13,182	12,710	11,740	11,989	9,479	8,371
Estimated savings	10%	10%	10%	10%	10%	10%	10%	10%
Result Cells:								
NPV Low Scenario	-£768	-£789	-£811	-£818	-£833	-£829	-£867	-£884
NPV Central Scenario	-£434	-£484	-£537	-£554	-£588	-£579	-£670	-£710
NPV High Scenario	-£383	-£438	-£495	-£514	-£552	-£542	-£640	-£684

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1932	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	16,042	14,640	13,182	12,710	11,740	11,989	9,479	8,371
Estimated savings	15%	15%	15%	15%	15%	15%	15%	15%
Result Cells:								
NPV Low Scenario	-£646	-£678	-£711	-£722	-£744	-£738	-£795	-£820
NPV Central Scenario	-£145	-£220	-£299	-£325	-£377	-£364	-£499	-£559
NPV High Scenario	-£70	-£152	-£237	-£265	-£322	-£307	-£455	-£520

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1932	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	16,042	14,640	13,182	12,710	11,740	11,989	9,479	8,371
Estimated savings	20%	20%	20%	20%	20%	20%	20%	20%
Result Cells:								
NPV Low Scenario	-£524	-£566	-£611	-£625	-£655	-£647	-£723	-£757
NPV Central Scenario	£144	£43	-£62	-£96	-£166	-£148	-£329	-£408
NPV High Scenario	£244	£135	£21	-£16	-£92	-£73	-£269	-£356

Appendix E – Micro CBA: Purpose built flats

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (Heat_demand_PBFlat	10,581	9,755	8,994	8,653	8,101	8,331	6,828	6,218
Estimated savings	10%	10%	10%	10%	10%	10%	10%	10%
Result Cells:								
NPV Low Scenario	-£850	-£863	-£875	-£880	-£888	-£885	-£908	-£917
NPV Central Scenario	-£630	-£660	-£687	-£700	-£719	-£711	-£765	-£787
NPV High Scenario	-£597	-£629	-£659	-£673	-£694	-£685	-£744	-£768

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	10,581	9,755	8,994	8,653	8,101	8,331	6,828	6,218
Estimated savings	15%	15%	15%	15%	15%	15%	15%	15%
Result Cells:								
NPV Low Scenario	-£770	-£789	-£806	-£814	-£827	-£821	-£856	-£870
NPV Central Scenario	-£440	-£484	-£525	-£544	-£574	-£561	-£642	-£675
NPV High Scenario	-£390	-£439	-£483	-£503	-£536	-£522	-£610	-£646

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	10,581	9,755	8,994	8,653	8,101	8,331	6,828	6,218
Estimated savings	20%	20%	20%	20%	20%	20%	20%	20%
Result Cells:								
NPV Low Scenario	-£690	-£715	-£738	-£748	-£765	-£758	-£804	-£822
NPV Central Scenario	-£249	-£309	-£363	-£388	-£428	-£411	-£519	-£563
NPV High Scenario	-£183	-£248	-£307	-£334	-£377	-£359	-£477	-£525

Appendix F – Micro CBA: Purpose built flats @ 50% consumption increase

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	15,871	14,633	13,492	12,979	12,152	12,497	10,242	9,326
Estimated savings	10%	10%	10%	10%	10%	10%	10%	10%
Result Cells:								
NPV DECC Low Gas Price Scenario	-£770.15	-£788.96	-£806.29	-£814.08	-£826.64	-£821.40	-£855.65	-£869.56
NPV DECC Central Gas Price Scenario	-£439.71	-£484.29	-£525.37	-£543.85	-£573.63	-£561.20	-£642.40	-£675.39
NPV DECC High Gas Price Scenario	-£390.10	-£438.55	-£483.20	-£503.27	-£535.64	-£522.14	-£610.39	-£646.24

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	15,871	14,633	13,492	12,979	12,152	12,497	10,242	9,326
Estimated savings	15%	15%	15%	15%	15%	15%	15%	15%
Result Cells:								
NPV DECC Low Gas Price Scenario	-£649.62	-£677.83	-£703.82	-£715.51	-£734.35	-£726.49	-£777.87	-£798.74
NPV DECC Central Gas Price Scenario	-£153.96	-£220.83	-£282.46	-£310.17	-£354.84	-£336.20	-£458.00	-£507.48
NPV DECC High Gas Price Scenario	-£79.54	-£152.21	-£219.19	-£249.31	-£297.86	-£277.60	-£409.98	-£463.75

Scenario Summary	Pre 1917	1918-1938	1939-1959	1960-1975	1976-1982	1983-1989	1990-1999	Post 2000
Changing Cells:								
Heat consumption (kWh/year)	15,871	14,633	13,492	12,979	12,152	12,497	10,242	9,326
Estimated savings	20%	20%	20%	20%	20%	20%	20%	20%
Result Cells:								
NPV DECC Low Gas Price Scenario	-£529.10	-£566.70	-£601.36	-£616.95	-£642.07	-£631.59	-£700.09	-£727.91
NPV DECC Central Gas Price Scenario	£131.79	£42.63	-£39.54	-£76.49	-£136.05	-£111.20	-£273.60	-£339.57
NPV DECC High Gas Price Scenario	£231.02	£134.12	£44.81	£4.66	-£60.07	-£33.07	-£209.57	-£281.26