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BERR

BARRIERS TO RENEWABLE HEAT PART 2: DEMAND SIDE

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LIST OF ACRONYMS

ABPR	Animal By-Products Regulations
AD	Anaerobic Digestion
ASHP	Air source heat pump
CHP	Combined Heat and Power
DH	District Heating
GSHP	Ground source heat pump
LA	Local Authority
LFG	Landfill Gas

1. INTRODUCTION

The Department for Business, Enterprise and Regulatory Reform (BERR) commissioned Enviros Consulting and NERA Consulting to answer the question 'how much renewable heat could be delivered in 2010, 2015 and 2020 under different assumptions on barriers, and at what cost, assuming that financial subsidies are not a barrier?'

Part 1 of the project identified and quantified the barriers to the supply of renewable heat in the UK. This report presents our findings from Part 2 of the project which focuses on the demand-side barriers to renewable heat.

1.1 What is a demand side barrier?

For the purposes of this project, a demand side barrier is defined as something that puts a heat user off using renewable heat (either resulting in them using an alternative non-renewable fuel or in deciding not to replace their existing heating equipment).

We have only considered non-financial barriers; a working assumption for this project is that that sufficient financial support measures are in place to overcome the higher upfront capital costs associated with renewable heat systems.

Several of the barriers identified during Part 1 of this project were found to have an impact on both supply and demand. For example:

- difficulties in the planning process may slow or prevent a project once the developers have decided to proceed and would therefore pose a barrier on the supply side; and
- anticipation of difficulties with getting planning permission may also put off developers or end-consumers so that potential projects fail to reach even the design stage, creating a barrier to increasing demand.

Additional barriers that only affect demand were also identified, such as a lack of awareness of the technology and the increased 'hassle' factor created by the extra time and effort required to switch the system in a building or use non-conventional systems in a new build project.

1.2 Structure of this report

This document is structured as follows:

- Section 2 identifies the demand side barriers for each of the categories of renewable heat used for this research and prioritises them in terms of potential to deliver renewable heat between now and 2020[1].
- Section 3 presents our projections of renewable heat by end user group and discusses the assumptions made;

1 Consistent with the Part 1 analysis, we have considered heat generated from biomass, biogas, heat pumps and solar thermal. We note that while the last two of these are 'technologies', the first two are collective terms for a range of fuels which can be exploited for heat generation via various technologies. The potential for geothermal is considered small and was excluded from further analysis early in the project (where opportunities for geothermal do exist, we would expect them to be treated consistently with other renewables under any kind of financial incentive).

- Section 4 quantifies the costs to overcome the barriers identified for each scenario.

- Section 5 summarises our conclusions from this analysis.

In the appendices of this document we:

- present the demand side barriers that we have identified for each renewable heat category (Appendix 1);

- describe the approach used to the telephone interviews conducted as part of this project (Appendix 2 and Appendix 3);

- present the background data used to quantify the demand segments (Appendix 4) and the outputs from that analysis (Appendix 5); and

- list the references used for the literature review (Appendix 6).

The research that we conducted around biogas is provided in a separate document to this report.

2. DEMAND SIDE BARRIERS TO THE UPTAKE OF RENEWABLE HEAT

This section discusses the demand side barriers to the uptake of renewable heat in the UK. These were identified by Enviros through a literature review (the references consulted are listed in Appendix 6). In order to supplement the published information and to corroborate the barriers identified, we also conducted a short telephone survey[2]. This provided qualitative evidence to complement the literature and Enviros' own experience of developing renewable heat projects. The findings from it were qualitative; the sample size and survey methodology (see Appendix 1 and 3) were not intended to provide quantitative results. For domestic users, we drew on the barriers identified by Element Energy in their review of the domestic sector (TNS UK, 2007) as well as on the other literature reviewed.

2.1 Barriers identified

We have identified the key demand side barriers to the range of renewable heat categories in the UK and ranked them against the criteria established in Part 1 of this project. In many cases the same barriers apply to a number of different renewable heat categories. The details of this analysis are provided in Appendix 1 (page 40) and our approach to assessing the impact of the barriers is explained below. In all cases, the characterisation of a particular barrier has used the information collated via the literature review (including the Element Energy work on the domestic sector) and the telephone survey.

- Ranking: overall importance of this barrier in terms of the extent to which it reduces uptake. This ranking as been developed in order to prioritise the barriers addressed in the scenarios that follow.
  - We have developed it by ranking as 'high' those barriers that are common (i.e. that would affect a large number of users of a wide range of heat technologies) and/ or those that must be overcome for renewable heat to be considered at all.
  - In contrast, barriers ranked as 'low' are those that affect a smaller number of users/ technologies or those that would still allow the uptake of renewable heat at the uptake levels required for the heat output scenarios considered.
- Industrial/ commercial/ domestic/ public: this shows which end users the barriers typically impact on.
- Prevents: notes where the barrier prevents the uptake of renewable heat (rather than delaying it, see heading below).
- Delays: barrier delays the uptake of renewable heat but does not necessarily prevent it completely.
- Reduced capacity: the barrier affects the installed capacity (as well as or rather than the capacity factor, see heading below).

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2 In total 19 respondents were interviewed, including users from the commercial, industrial and public sectors. We attempted to contact organisations from the following groups: property developers; food and drink industry; retail sector; heavy industry sites; trade associations of renewable heat technologies; Local Government Association (for public sector portfolio holders); and English Partnerships. We also contacted representatives of different Government initiatives such as the Bio-energy Infrastructure Scheme, the Capital Grant Scheme for renewables and the CLA.

- Capacity factor: barrier leads to a sub-optimal capacity factor e.g. due to fuel constraint or technical problems.

- Impact on other barriers: describes whether overcoming this barrier could have a magnified impact by reducing the impact of other demand side barriers too.

2.2 Overview of barriers identified

There are some common themes across technologies amongst the barriers identified e.g. a lack of awareness of the potential for renewable heat generation and of its potential benefits. There are also some barriers that are specific to fuels or technologies and to whether it is necessary to retrofit or not. We have noted (see table below) those that it is most important to overcome, since even if other barriers were addressed not overcoming (at least some of) these barriers would prevent the increased uptake of renewable heat.

Table 1 Overview of barriers identified ranked as high for one or more renewable heat categories

	Biomass	Biogas	Solar thermal	GSHP	ASHP
Inertia	**High**	**High**	**High**	**High**	**High**
Awareness of renewable heat	**High**	**High**	**High**	**High**	**High**
Difficulty of retrofit	**High**	**High**	Medium/ Low	**High**	**High**
Hassle factor	**High**	**High**	Medium	**High**	Low
Consumer confidence (technology)	**High**	**High**	Low	Medium	Medium
Lack of skilled personnel	**High**	Medium	**High**	Medium	Medium
Resource constraints (fuel supply/ appropriate sites)	**High**	Medium (AD)	Low	Medium	Medium
Planning	**High**	Medium (AD & LFG)	Low	Low	Medium

The table lists these barriers in order of the magnitude of the impact that they are expected to have. When we come to prioritise which of these barriers to address (section below), it is worth noting that some of these barriers will be partly addressed by overcoming supply-side barriers. The lack of skilled personnel is an example; ensuring that there is sufficient qualified capacity to implement renewable heat projects is a fundamental step to overcoming demand-side concerns that there is insufficient capacity. Combining this with raising awareness around the potential for renewable heat and the routes to implement it will further overcome this barrier by ensuring that end-users are aware of that capacity. Others may not have a strong impact for lower levels of penetration (e.g. difficulty of retrofit is avoided in new properties and moderated somewhat where heating systems are already being refurbished/ replaced).

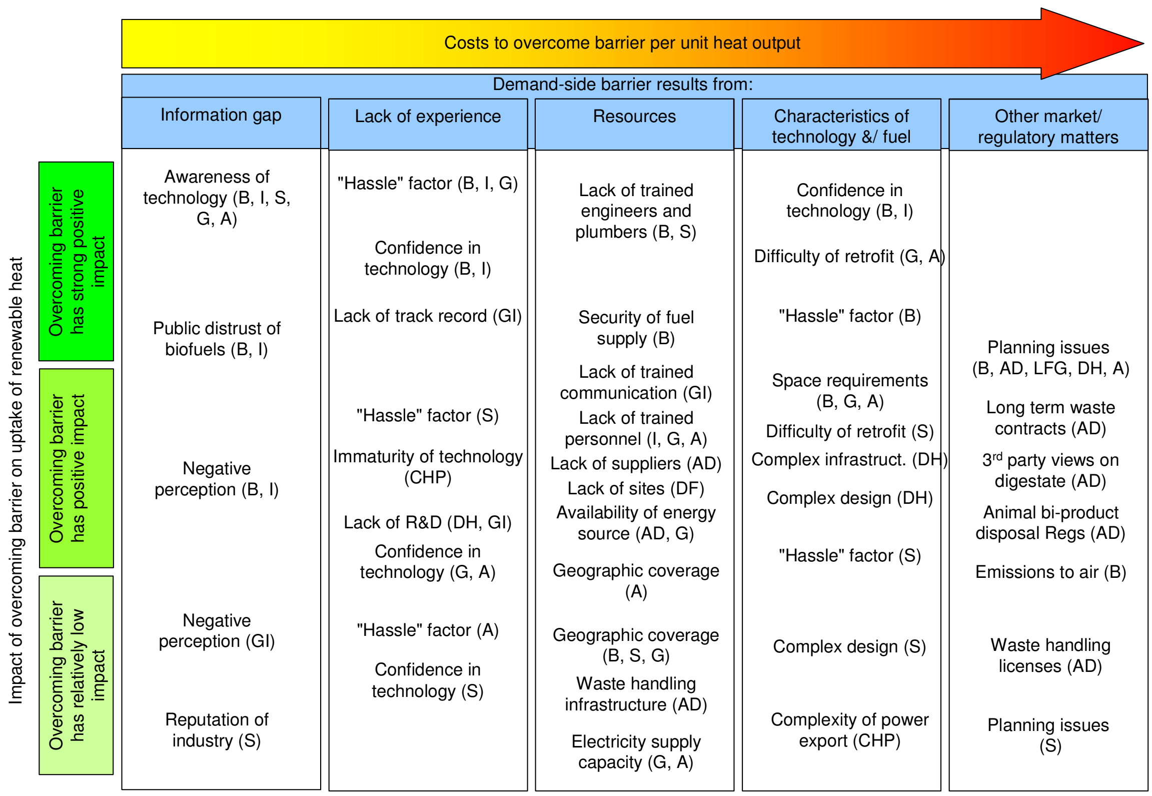
We also note that ‘lack of interest’ (one of the barriers identified by Element Energy) is not included in the table above; although an important barrier in the domestic sector, there is considerable untapped interest in the non-domestic sector and amongst some domestic users. The main barrier to interested parties implementing renewable heat is that projects are often not cost effective. Although a lack of interest is one of the factors that could slow down, or even prevent, higher levels of renewable penetration, it is not considered one of the priority barriers to target directly first. This is particularly true given that the increased uptake of renewables will in itself improve understanding and awareness of the options and at the same time interest in them.

2.3 Prioritising barriers to address

In addition to considering the magnitude of the impact that each of the barriers has, when deciding which to address first it is also necessary to consider how straightforward they are to overcome, since this will affect both how quickly increased uptake can be achieved and also how costly it will be.

Based on the findings of the literature review and the stakeholder feedback, the figure below illustrates the order in which barriers should be addressed and the relative impact on renewable heat that we would expect each to have. Behavioural barriers (i.e. inertia and a lack of interest) constitute a sixth group that serves to exacerbate the impact of the first two columns listed below in particular. The treatment of these is discussed in the bullets below.

Figure 1 Prioritising demand-side barriers to overcome



Notes: B: Biomass, I: Biogas, G: GSHP, A: ASHP, S: Solar Thermal, DH: district heating, AD: Anaerobic Digestion, LFG: Landfill gas, GI: Grid Injection, DF: Direct firing

In assessing which types of barrier should be overcome first, we have grouped them as follows:

- **Behaviour**: in its research Element Energy separately identified 'inertia' and 'lack of awareness' as barriers to the uptake of renewable heat in the domestic sector. These also impact on decision making amongst other users but to varying degrees. The magnitude of the barriers that individuals' behaviour creates increases the greater the penetration of renewable heat required. Three key factors that will help to overcome behavioural barriers are[3]: (i) that the project is cost effective; (ii) that the end-user has a propensity to explore it as an option; and (iii) that the end user has confidence in its assessment of the option (i.e. confidence in the view that, all things considered, the benefits of change will outweigh the costs). We assume for this project that renewable heat is cost effective. Focussing first on those projects where the site/ energy use is well-matched to the technology also helps to address (i). Targeting end users that are either aware of the environment or that have some other incentive to consider renewable heat (e.g. ready access to a fuel source) helps deliver (ii). Addressing the other barriers listed below will help to address (iii).

- **Information gap**: this is predominantly where there is a lack of awareness over the potential for renewable heat or where end users' perceptions differ from actuality. It is often not that the information does not exist but rather than end users are not aware that it applies to them or that it can be time consuming to search out the information that is most relevant. Ensuring ready access to and awareness of existing information is one of the most straightforward ways to increase the uptake of renewable heat in the short term. In addition, there is a need to ensure that information is tailored to the target group of end users (both so that they can readily see that it applies to them, but also in order to provide confidence that other similar users have used renewable heat successfully in the past).

- **Lack of experience**: by this we mean that, given the low penetration rates of renewable heat at the moment, many end users do not have experience of using it first-hand. This can result in a disconnect between the actual potential for renewable heat and end users' perception of it. In addition, it can mean that end users are not confident that there is sufficient capacity amongst experts to help them (e.g. to help avoid system design pitfalls) when and where required. As the uptake of renewable heat increases, this barrier will gradually be overcome. But a catalyst is necessary in order to build confidence in the short-term. A common method for achieving this is the use of case study projects that provide real examples for end-users and developers, as well as providing practical experience to inform other projects.

- **Resources**: the next group of barrier identified is one where there is not ready access to the resources required to implement renewable heat as cost effectively as would ideally be possible e.g. a lack of skilled operatives or the need to retrofit. This type of issues has been identified as a barrier on both the supply and demand side. Addressing supply-side capacity issues (e.g. through training) will ameliorate some of these barriers, although it will still be necessary to ensure that end users have a thorough understand of the situation i.e. that they are aware that there is sufficient capacity to help. In other cases where overcoming the resource constraint would take longer or be very difficult to overcome (e.g. absence of fuel), those projects where the barriers are lowest should be tackled first.

- **Characteristics of renewable heat technologies and fuels**: some of the barriers, like the need to store fuel for biomass or the difficulty of retrofitting, are

3 These are not the only factors; they are the key factors that are not captured under the other types of barrier listed.

the direct result of using (a particular kind of) renewable fuel or technology. These are the factors that may well result in end users needing to modify their behaviour in some way, even once any barrier caused by a gap between perception and actuality (reflected under information gap and lack of experience above) is addressed. It is important to note that the extent to which these types of barrier bite varies from project to project; the technical difficulties caused by retrofitting do not exist in new buildings, larger sites have more space for storing biomass fuel. As a result, these types of barrier can partially be overcome by targeting those users for which, despite these considerations, the renewable heat technology remains cost effective. However, once greater degrees of penetration are required, additional financial support may be required to make projects where these barriers bite be cost effective.

- **Other market/ regulatory barriers**: the final group of barrier identified is where other standards e.g. planning requirements or noise controls would make it more time consuming to introduce renewable heat, or may prevent its introduction completely. In some cases there are good reasons for this and it may not be in the wider interest for the barrier to be overcome. However in other cases, particularly where the barrier delays rather than prevents the uptake of renewables, there is scope to raise awareness of the barrier and to seek routes to overcome it. For instance, planning was considered a key barrier on the supply-side; methods to overcome it include training for planners to increase the understanding of the impact of renewable heat and avoid unnecessary delays. Equally providing developers/ end users with support to navigate the planning process can help to overcome this barrier.

3. PROJECTING THE UPTAKE OF RENEWABLE HEAT

For this project we have projected three different scenarios for the uptake of renewable heat, starting with a business as usual scenario and the working assumption that renewable heat is cost effective. We have then constructed three scenarios of actions to tackle the barriers. The level of effort to overcome the barriers differs between the three scenarios, and so the extent to which the barriers are addressed, and renewable heat employed, also varies. We have quantified how much it could cost to undertake the actions described for each scenario.

3.1 Measures to overcome the barriers identified

The section above highlights a range of ways to overcome barriers to renewable heat to deliver the types of uptake rate required under the renewable heat scenarios explored in Part 1 of this project. In summary, they are:

- addressing behavioural barriers by ensuring cost effectiveness, **targeting users with a propensity to switch to renewable heat** and helping ensure that end-users have confidence in their decision;
- addressing the information gap by ensuring ready access to existing information and that information is tailored to the target group of end users;
- addressing the lack of experience both by ensuring that experience from existing projects is shared (under information gap above) and supporting pilot or case study projects to help boost experience of particular options in the UK;
- overcoming specific difficulties or complexities posed by particular types of fuel or technologies by **targeting those end users that are best matched to particular fuels or technologies**;
- **ensuring the full utilisation of resources that are available to deliver renewable heat**, *providing additional resources to deliver addition capacity (e.g. expertise) where feasible* and making end-users aware of that additional capacity (see information gap above).

The list above includes, shown in bold, where a barrier can at first be overcome by ensuring that particular heat users or resources are targeted first[4]. Although if we were to look for 100% uptake of renewable heat it would be necessary to move to other less compatible types of heat users, at lower levels of penetration, the impact of these barriers can be minimised. In order to construct the scenarios for heat output, we have assessed which end-users/ resources it is best to target first and how much heat demand would be available.

3.2 Establishing which end users to target

The nature of heat demand varies considerably between end-users for a wide range of reasons. In addition, as noted above, different end users have different levels of willingness to switch i.e. they are affected by a lack of interest and inertia to differing degrees. This will affect the feasibility of using renewables rather than fossil fuels. It will also affect the type and magnitude of demand-side barriers facing users.

4 Measures shown in plain text are those which we have quantified as barrier costs where they need to be overcome to deliver a particular scenario. The last group (shown in italics) are those that would be addressed by overcoming supply-side barriers. These are discussed later in this report.

Heat demand characteristics considered

In order to be able to take these different drivers into account, we have divided heat demand into a number of different segments, reflecting consideration of the following drivers:

- Heat use: the nature of heat demand varies considerably from sector to sector (e.g. industrial, commercial, domestic, public). This will affect the temperature, volume, intermittency and profile of heat required and so the most appropriate fuel and technology.
- Building size: given that space heating is one of the key heat uses, the heat load will be affected by the size of the building.
- Building type: for instance, standalone buildings may have more space to install renewables that require fuel storage than apartments.
- Building age: this may affect the energy efficiency of the building and so the level of energy use and scope for energy savings (although this link is broken once a property is refurbished/ improved).
- Age of boiler/ existing heat supply system: it will often be more cost-effective for users to invest in biomass heating when the existing system is coming to the end of its life.
- Whether site is on or off the gas grid: this will affect the counter-factual costs of investing in renewables (which is the focus of a different study) but also potentially the magnitude of some demand side barriers[5].
- Ownership: the barriers to the uptake of renewables may be lower in occupier-owned buildings than in tenanted properties. In addition, social housing can be influenced centrally by Government and encouraging (or even mandating) the uptake of renewables may also provide an opportunity to address fuel poverty concerns.
- Attitude towards the environment: people with a highly positive attitude towards the environment who prioritise environmental concerns over other considerations may be more likely to switch to renewable heat than those that do not.

Resulting segmentation

In order to prioritise the end users to target, we have constructed different segments of demand that together combine to make total heat demand. Each segment characterises a tranche of heat use for which the impact of demand-side barriers would be different. The table below lists these and shows our rationale for identifying which types of heat use it would be 'best' to target (by 'best' we mean those where the barriers would be most straightforward, quickest or lowest cost to overcome). The number of segments presented here aims to strike a balance between the detail possible in this study and the level of granularity necessary to quantify the barriers.

5 For instance, if someone is already used to making space for an oil tank and to managing ordering oil supplies, they may find dealing with a renewable like biomass less of a step change than users used to a gas boiler.

Table 2 Sector heat demand segmentation and rationale

Sector	Segment	Rationale	Source
Domestic	New build	Installing renewable heat in new buildings is more straightforward than retrofit in existing buildings	Green Building Council (2008)
	Replacement of boilers	Replacement of boilers provides a good opportunity for considering renewable energy alternatives which can be a single or a combination of renewable technologies.	Friends of the Earth (2006) Environmental Change Institute (2005)
	Social housing	Social housing segment includes local authority and other publicly owned housing plus registered social landlord (RSL) dwellings. Demand for renewable heat in this segment can be directly targeted through government initiatives. In addition such initiatives can help to meet objectives around fuel poverty.	BRE (2006). Office of National Statistics (2008)
	Owner occupied/ off grid/ Detached & Semi Detached/ Environmentally aware	Owners are more likely to invest in renewables than where incentives are split between landlord and tenants, particularly where tenancies are short term.	Element Energy (2008)
		Detached and semi detached houses are have greater heat demand than other domestic dwellings and also typically have more space (roof or ground).	Department for Communities and Local Government (2007), Friends of the Earth (2006)
		Buildings not connected to the gas grid are more likely to consider renewable sources due to reliability problems and high costs of oil or electric heat supply	AEAT (2005), Element Energy (internal communication)
		Environmentally aware individuals are more likely to be prepared to overcome the barriers to renewable heat than those that do not consider these issues.	Rainy & Ashton (2007), DEFRA (2008)
	Owner occupied/ off grid/ Detached & Semi Detached/ not environmentally aware	Although, the starting point is that renewable heat technologies will not be a priority on environmental grounds, in terms of all the other factors these end users are good candidates for renewable heat. Awareness can be addressed through targeted Government intervention.	Enviros

Sector	Segment	Rationale	Source
	Owner occupied/ on grid	Households on the gas grid may be considered less likely to switch to renewables that require fuel storage and fuel deliveries. The cost of the counterfactual fuel (i.e. gas rather than electricity or oil) may be lower and so create less of an incentive to switch	Enviros
	Owner occupied: terraced, purpose built, other/ off gas grid	Flats and other (relatively) small properties are less likely to have sufficient space for technologies like biomass. Equally individual owners may not be able to choose technologies that have an impact on neighbours. Although this may be one of the key target groups for district heating, in our view DH is more likely to be readily accepted in a new build development or where there are a smaller number of building owners.	Enviros
	Rented buildings	Experience on the energy efficiency side has shown that it can be difficult to incentivise landlords to upgrade the building fabric since they are not affected by the operational costs or comfort of the building directly. Equally tenants are reluctant to invest in properties in which they hold no equity and where the equipment cannot cost effectively be taken with them when they change location.	Enviros
Industrial	New build	As for other sectors, installing renewables in new buildings is more straightforward than retrofit in existing buildings.	Enviros
	Replacement	As for other sectors, the replacement of an existing heating system provides a good opportunity to introduce renewable heat	Enviros
	Warehouse	Assumed the potential for renewable heat demand is for space heating only. This segment includes mainly warehouses that need to maintain a temperature which is higher than the ambient temperature.	Enviros, DTI (2007)

Sector	Segment	Rationale	Source
	Other buildings	Assumed the potential for renewable heat demand is for space heating only. The potential for renewable heat in this segment is fairly small given the diverse types of buildings included in this segment and the different heat requirements.	Enviros, DTI (2007)
	Process heat	We would expect that some (but not all) process heat can be substituted with renewable heat (e.g. CHP schemes). However, in some cases the temperature, reliability and volume of heat required mean renewables are not an attractive option for these uses	Enviros, DTI (2007)
Commercial	New build	As for other sectors, installing renewables is more straightforward in new buildings than retrofitting in existing buildings	Enviros
	Replacement	As for other sectors, the replacement of an existing heating system provides a good opportunity to introduce renewable heat	Enviros
	Offices	Offices are considered relatively straightforward targets for raising demand for renewable heat since their typical heat demand profile is large enough for various renewable technologies. Availability of space and Corporate Social Responsibility considerations can also catalyze demand for renewable heat	Enviros, DTI (2007)
	Hotels, Catering	Much of the demand for space and water heating in hotels and catering can be met by renewable sources. However, heat for cooking in hotels and catering is less likely to be replaced by renewable sources.	Enviros, DTI (2007)
	Sport and leisure	Privately owned sport and leisure centres have a relatively high heat demand profile (especially when needed for heating swimming pools). As in hotels the demand for space and water heating can also be met by renewables.	Enviros, DTI (2007)

Sector	Segment	Rationale	Source
	Retail	The primary heat demand for retail is space heating needs. However, depending on store size and the building in which it is housed, it may not be straightforward to meet the heat demand from renewables without e.g. the cooperation of a number of different organisations.	Enviros, DTI (2007)
Public	New build	As for other sectors, installing renewable heat source in new buildings is more straightforward than retrofit in existing buildings	Enviros
	Replacement	As for other sectors, the replacement of an existing heating system provides a good opportunity to introduce renewable heat	Enviros
	Local Government; Hospital; Government Estate	Demand for renewable heat in buildings directly used by government (central and local) can (and arguably has been) created by Government policies. Pressure on the public sector to lead by example is leading to increasingly stringent carbon and energy targets for the public sector and so additional incentives to install renewable heat.	Enviros, DTI (2007)
	Education	Schools and universities have largely space heating requirements which can be met by a range of renewable sources.	Enviros, DTI (2007)
	LA Sports Centres	Local Authorities (LAs) may be able to stimulate renewable heat demand in Sports Centres that they own or part own. Many will have fairly large, constant space and water heating requirements that may be suitable for many renewable heat technologies.	Enviros, DTI (2007)

While some segments combine a number of different characteristics, others are more discrete.

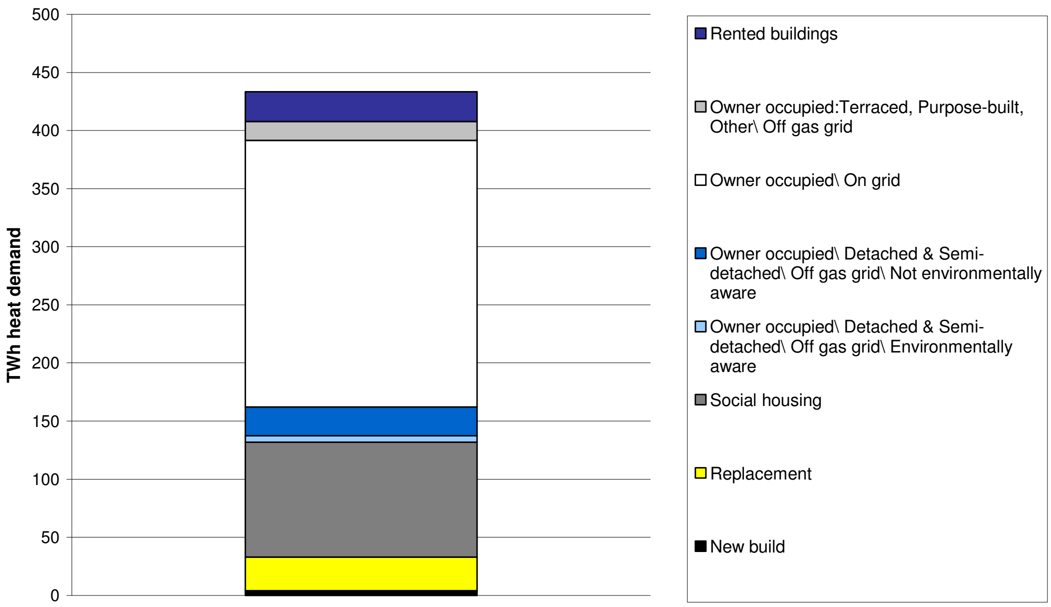
- For example, new buildings are one of the best sectors to target, regardless of their end use, on the basis that retrofitting is typically (considerably) more expensive.
- On the other hand, we have grouped owner-occupied buildings that are not connected to the gas grid as being more straightforward to influence than owner occupied buildings that are connected to the gas grid.

3.3 Quantifying the heat demand from different segments

There is no single data source that splits total heat demand by all of these factors in combination, but there are data to split certain sectors. For example, the building stock can be split based on various characteristics e.g. by size, age or ownership. In order that we can combine the different considerations we have first taken into account the volume of new build and replacement that we might expect for each sector. We have then assumed that the different characteristics apply pro rata[6] across the residual heat demand once we have taken replacement and new build into account. This creates a series of 'segments' of heat demand with different characteristics. The heat demand calculated for each segment was sense checked against published information in order to ensure that the heat demand figures and the relative contribution of each group to the overall sector heat demand profile were within the range of other information sources. Further information and the underlying assumptions used for this quantification are provided in Appendix 4.

The following figures illustrate how much heat is available from the different segments using this approach for each type of end user.

Figure 2 Segmentation of total domestic heat demand (2005)



Note: includes domestic heat that may be serviced by district heating. This heat is included as 'public' sector in the supply side work and when we consider the measures necessary to encourage the uptake of DH later in this document. It is estimated that DH currently constitutes less than 1% of total UK heat demand.

6 Based on total building stock (i.e. number of dwellings) in the domestic sector, or total built floor area of each of the other sectors. This difference is based on the assumption that each building in the non-domestic sectors varies in purpose and heat demand by a greater degree than those in the domestic sector.

Figure 3 **Segmentation of total commercial heat demand (2005)**

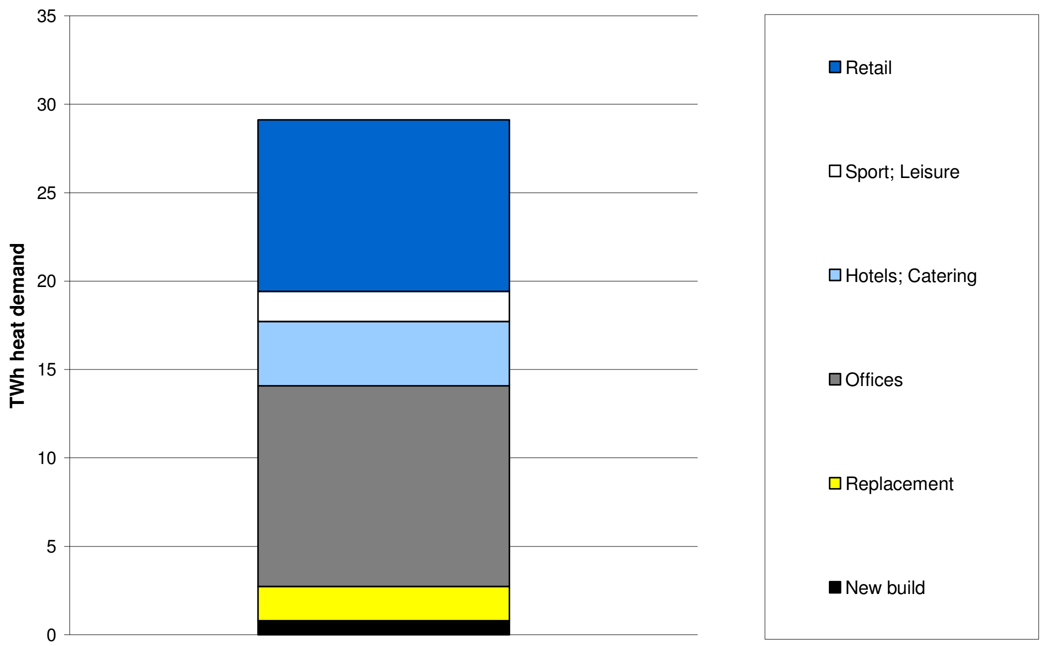


Figure 4 **Segmentation of total industrial heat demand (2005)**

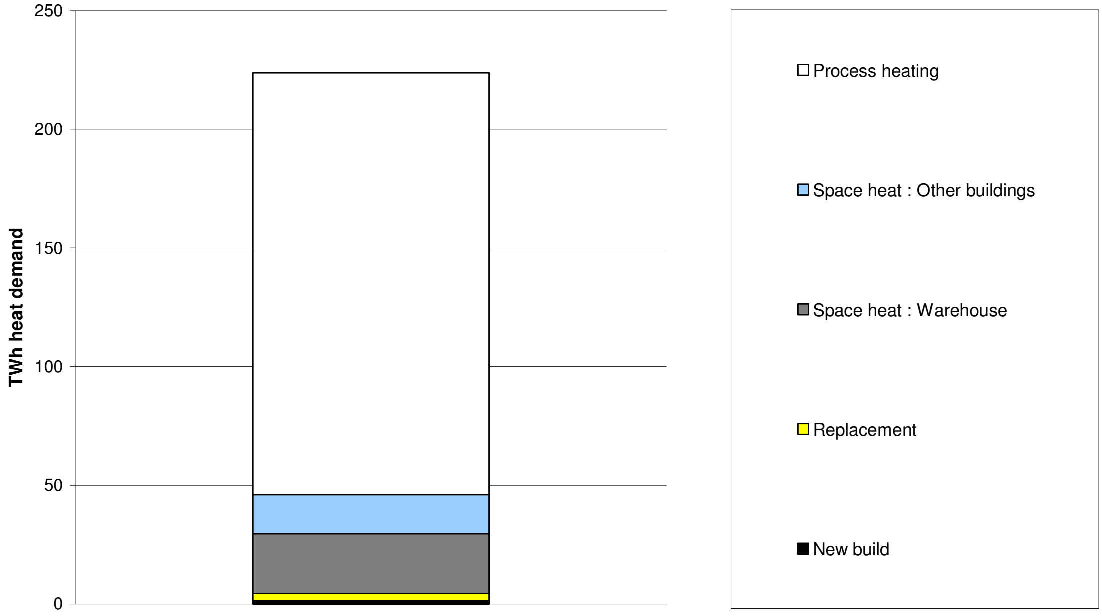
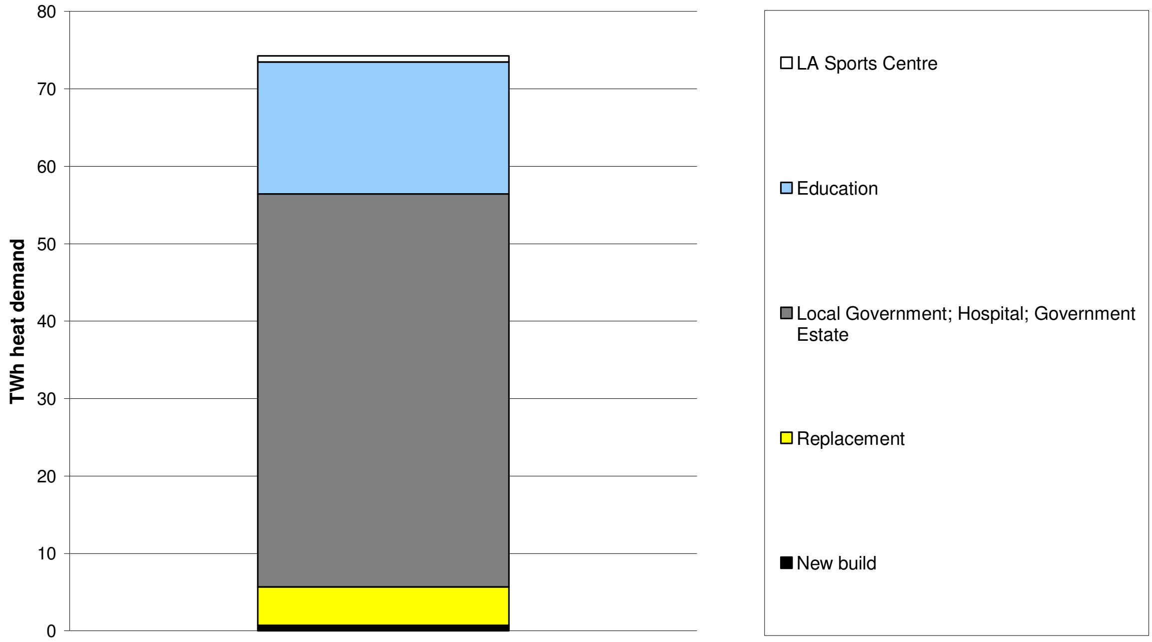


Figure 5 Segmentation of total public heat demand (2005)



Note: for the projections, this segment is also assumed to include District Heating in order to be consistent with the supply side categorisation.

Source: Enviros calculations based on data from BERR, BRE, AEAT, and DCLG.

3.4 Matching demand to technologies

We have then established which types of renewable heat these different types of end-user could utilise. For some, in principle, any one of the fuels or modes could be used. However, for others, use is limited to specific fuels or technologies (e.g. where the volume or quality of heat required or the space available in some cases). Equally, in some cases, total heat demand may be met through a combination of different renewable heat technologies and fuels (e.g. one to provide baseload and another for peak demand/ as back-up)[7].

3.5 Quantifying heat demand scenarios

In the first part of this project we developed three scenarios for the uptake of renewable heat to deliver three target levels in 2020[8]. In order to produce scenarios consistent with that analysis, we have taken the following approach:

- Assumed total heat demand in line with the assumptions described in Appendix 5, which shows total heat demand falling over time[9].

7 Table 20 in Appendix 4 shows where two technologies could in principle be used together.
8 We also projected a fourth scenario. A comparable scenario for the demand side is discussed in Section 3.5.2 (on page 27).
9 This means that average heat demand per household/ site is assumed to fall gradually over time. In addition, using published data, we assume that the number of buildings increases gradually over time, which

- Ranked the different types or segments of demand, with 'most straightforward to affect' first; 'straightforward' includes new build and replacement in particular (as described in Table 2).

- Considered each of the different barriers in the different sectors and constructed three scenarios for the uptake of renewable heat, assuming that it is best to target a mix of segments rather than trying to encourage all of one to switch to renewables. This is on the basis that it is unlikely that all of a segment would switch, even where the data appears to show that switching to renewable heating would typically be cost-effective for that type of end-user.

- Taken the levels of renewable heat uptake by sector from our supply side analysis and identified the actions required to achieve those levels of uptake. This involved establishing a package of measures that could overcome the barriers to the extent necessary to deliver that level of heat output required. We have then calculated the cost of delivering of the actions identified[10].

Replacement and new build

Our starting point was that the most straightforward segments to target would be new build and replacement. The table below takes the levels of renewable heat uptake for each end user group and each scenario that we developed in the supply side analysis. It shows the proportion of each user group that would need to install renewables to meet the incremental year on year growth projected in each scenario (i.e. excluding demand already assumed to exist in the baseline heat projection).

Figure 6 Total renewable heat demand in particular scenario as proportion of heat available from new build/ replacement in any one year

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Scenario 1	Domestic	2%	2%	3%	3%	4%	6%	7%	9%	11%	14%
	Industrial	5%	7%	8%	10%	12%	19%	24%	30%	39%	49%
	Commercial	1%	1%	1%	2%	4%	2%	3%	4%	5%	6%
	Public	9%	11%	13%	17%	21%	31%	39%	49%	63%	80%
Scenario 2	Domestic	2%	3%	4%	5%	7%	9%	12%	16%	22%	30%
	Industrial	7%	9%	12%	15%	20%	29%	39%	52%	70%	94%
	Commercial	1%	1%	3%	5%	9%	8%	12%	17%	24%	34%
	Public	11%	14%	18%	23%	31%	43%	56%	74%	99%	131%
Scenario 3	Domestic	3%	3%	5%	6%	9%	12%	16%	23%	34%	49%
	Industrial	8%	11%	14%	20%	27%	36%	50%	70%	99%	140%
	Commercial	1%	2%	4%	8%	16%	15%	22%	32%	48%	71%
	Public	12%	16%	21%	29%	40%	50%	67%	92%	126%	175%

Key: Darker colours show where a larger proportion of new build + replacement would be required to meet the additional heat demand in that year. Note: new build for industrial sector excludes any process heat, the largest heat demand in the industrial sector. Consistent with supply-side analysis, 2010 assumed same as baseline and therefore not shown.

One of the factors that we would highlight is that the sooner the accelerated uptake of renewables is encouraged, the greater the contribution of new build/ replacement can be by 2020 (see Appendix 4 for further comment).

results in a slightly larger reduction in energy use per building than if we were to assume that building numbers stayed constant.

10 These cost quantifications have been one of the inputs used by NERA Consulting in its analysis of financial incentives to overcome supply and demand side barriers. In this analysis NERA modelled four different scenarios; the fourth scenarios assumes the same types of measures are necessary to overcome demand side barriers as in Scenario 3, but that the level of effort (and so cost) associated with the fourth Scenario would be greater in order to achieve the higher levels of heat uptake.

2010 to 2015 The table above shows that in the early years, less than a third of demand from new build/ replacement in all of the sectors would need to be renewable and that this alone could deliver the target levels. From a demand-side perspective, we consider this achievable over five years, if steps are taken to overcome some of the most common demand side barriers (see next section of this report). In practice it may not be that all of the heat delivered comes from new build/ replacement; other users may choose to install renewable heat for a range of other reasons even if they are replacing existing heating equipment before the end of its lifetime or they need to retrofit. However, the analysis above supports the assumption that in the early years the majority of heat demand will come from these two user groups.

Beyond 2015 The story is rather different after 2015 and varies by user group. In the domestic sector, Scenario 3 would require that (only) 50% of new build and replacement in that year installs renewables. In contrast even if all new build/ replacement in the industrial and commercial sectors were to install renewables (and note that we view 100% achievement in any sector unlikely) the scenarios could still not be delivered from new build/ replacement alone. This highlights that it is necessary to look outside these two groups to deliver the target levels of heat from 2015 onwards in particular. This implies that some equipment will need to be replaced before the end of its lifetime i.e. it implies the accelerated depreciation of some assets.

3.5.1 Contribution of other segments

We have projected the contribution of the other segments in each scenario on the basis of the assumptions below. These take into account how 'tight' each scenario is compared to new build/ replacement (see Figure 6 above) and the 'best' sectors to target for additional renewable heat required (see Table 2). They assume that given the relatively high uptake rates the supply-side scenarios require for some sectors (the public sector in particular), the key target group should be new build/ replacement in all cases; the more ambitious the scenario, the greater the proportion of these segments that should be targeted.

Table 3 Scenario assumptions for segment contribution in each scenario

Scenario	Assumption
Scenario 1 (6.5% of final energy demand for heat from renewables)	Additional demand over baseline met by replacement/ new build for domestic and commercial sectors (resulting in 14% and 6% uptake levels for these segments respectively). In the industry and public sectors, uptake of these segments combined is capped at a maximum of 50% in 2020. The shortfall is assumed to be made up by process heat (1% of total segment) for industry. It is made up by non-replacement/ new build from government i.e. local government, hospitals, central government estate (50% of total segment) for public[11].

11 We consider this uptake rate for the non-replacement/ new build in the public sector high, see discussion beneath charts below.

Scenario	Assumption
Scenario 2 (10.5% of final energy demand for heat from renewables)	Additional demand over baseline continues to be met by replacement/ new build for domestic and commercial sectors (resulting in 30% and 34% uptake levels for these segments respectively. In the industry and public sectors, uptake of these segments combined is capped at a maximum of 60% in 2020. The shortfall is assumed to be made up by process heat (3% of total segment) for industry. It is made up partly by district heating (consistent with the supply side projection) and also by non-replacement/ new build from government i.e. local government, hospitals, central government estate (75% of total segment) for public.
Scenario 3 (14.1% of final energy demand for heat from renewables)	Additional demand over baseline continues to be met by replacement/ new build for domestic and commercial sectors (resulting in 49% and 71% uptake levels for these segments respectively. In the industry and public sectors, uptake of these segments combined is capped at a maximum of 75% in 2020. The shortfall is assumed to be made up by process heat (4% of total segment) for industry. It is made up partly by district heating (consistent with the supply side projection) and also by non-replacement/ new build from government i.e. local government, hospitals, central government estate (50% of total segment due to a larger assumed uptake of DH than in Scenario 2) for public[12].

The resulting heat output in each of 2010, 2015 and 2020 that these assumptions result in for each end user segment in each scenario is illustrated overleaf. Comparison of the charts show how each scenario builds on the one before i.e. Scenario 2 comprises the output assumed in Scenario 1 plus additional output from the new build/ replacement and a small number of other users. The figures behind these charts are provided in Appendix 5.

Consistent with the supply-side analysis, heat output in 2010 is assumed to be constant across the three scenarios (on the basis that the scope for a step change in output between the present day and 2010 is limited). However, in Section 4, where we quantify the costs of overcoming barriers in each scenario, the costs do vary by scenario in 2010. This is because some actions, like setting up a website or helpline, will need to be implemented in advance of the renewable heat projects being implemented and so the short term costs vary to deliver differing levels of uptake in the long term.

12 Note that the total contribution from the public sector is assumed to increase between Scenarios 2 and 3, but the types of technology used are assumed to vary.

Figure 7 Segment contribution to Scenario 1

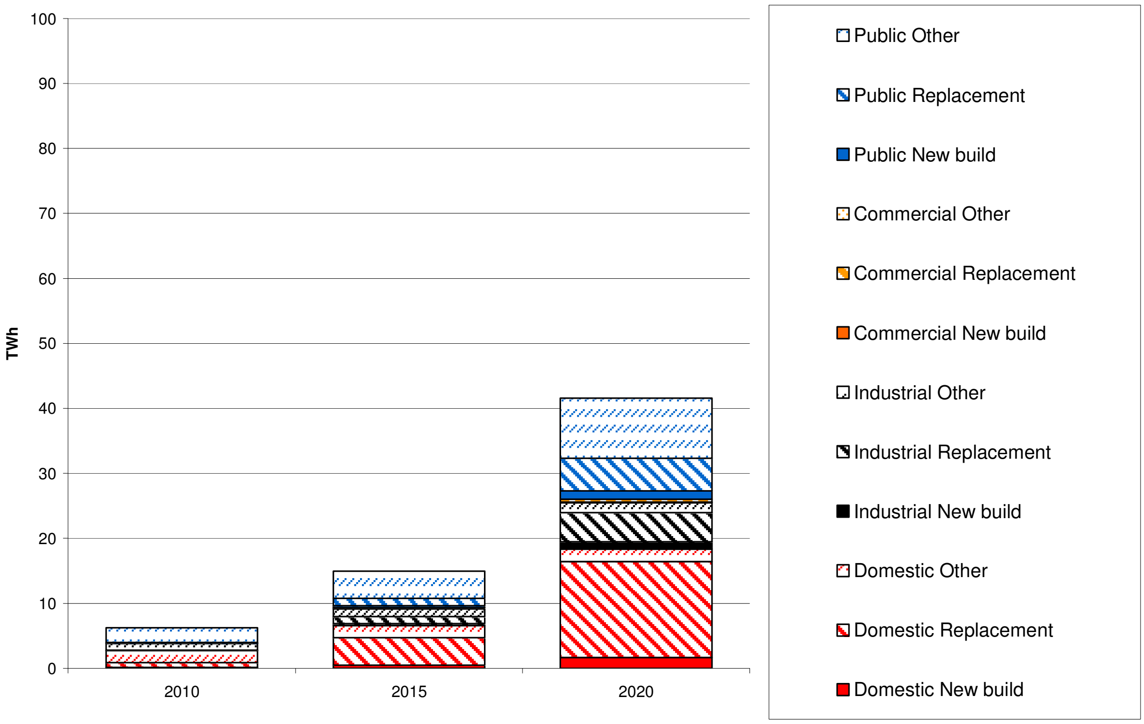


Figure 8 Segment contribution to Scenario 2

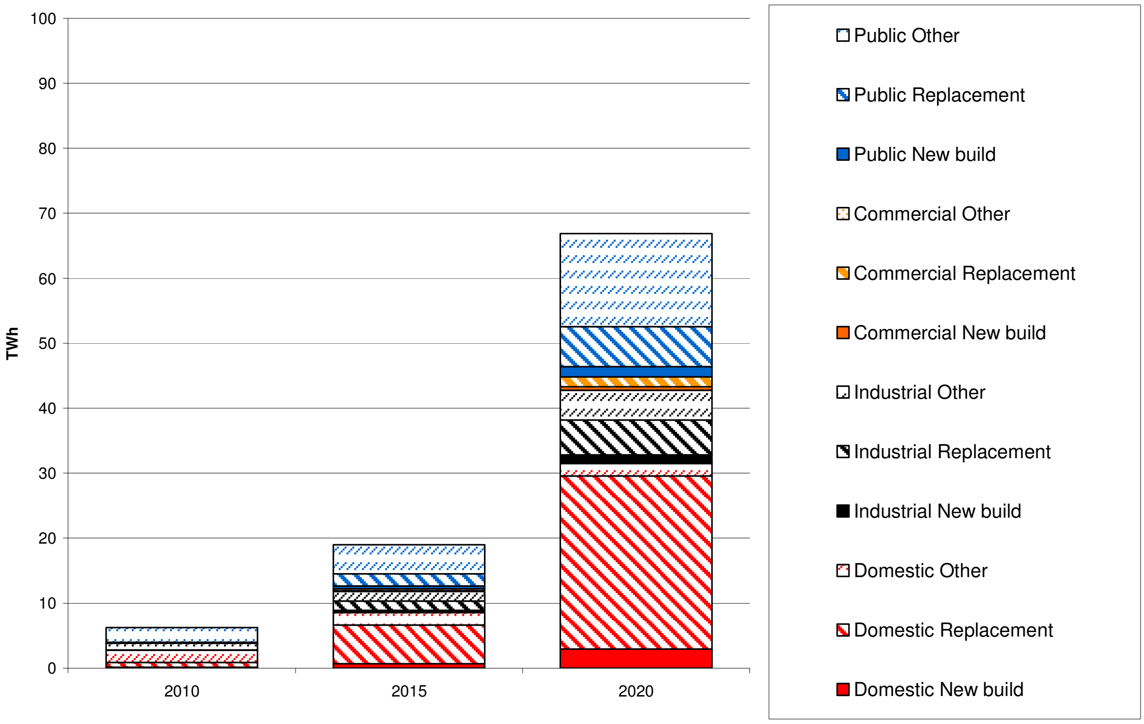
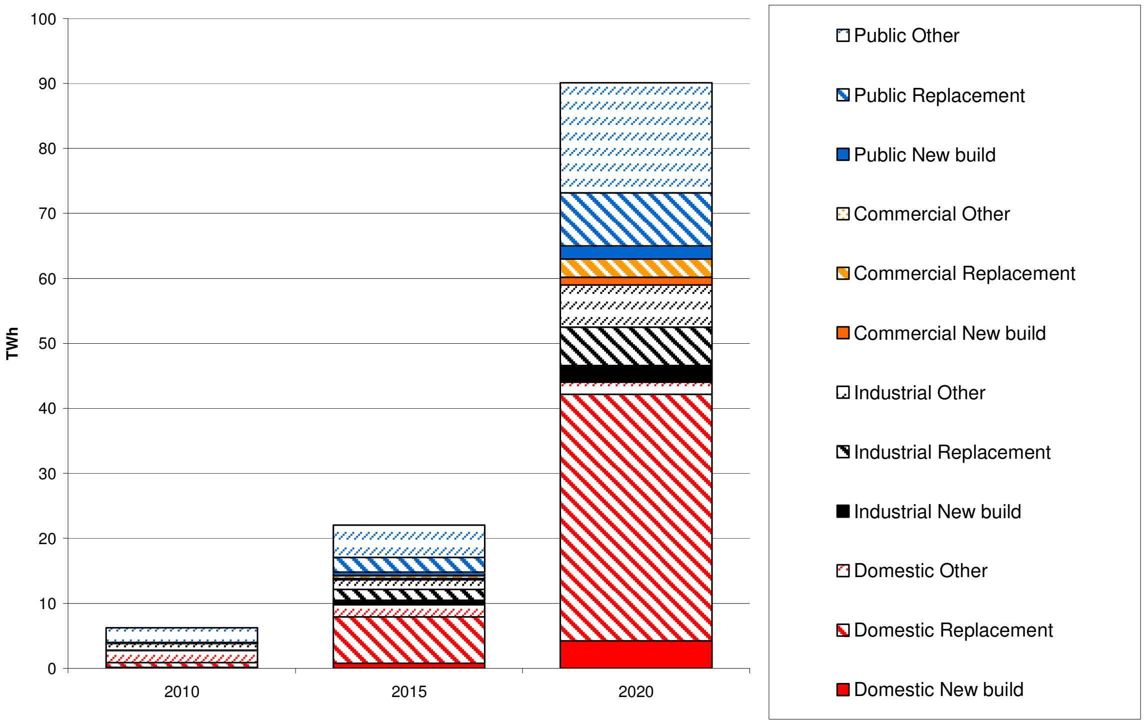


Figure 9 Segment contribution to Scenario 3



Consideration of relatively high uptake rates assumed for replacement/ new build in 2020

It is worth noting that the proportions quoted in Table 3 above relate to the level of uptake in 2020 (i.e. in the high scenario 75% of new build/ replacement in 2020 is assumed to be from renewables). This is a relatively high level of uptake, considerably higher than we see in new build/ replacement installations today. It is worth bearing in mind that this assumption reflects a gradual increase in the proportion of new build/ replacement from renewables year on year, rather than a step change[13]. In our view this gradual rate of increase could be achievable over ten years; however, a step change from current levels over a shorter time frame may not be possible (or at least, may be more costly). Again, this highlights the benefits of accelerating the uptake of renewables relatively quickly if heat targets are to be met.

Consideration of relatively high uptake rates assumed for the public sector

The table below shows why the scenarios are 'tighter' in terms of new build/ replacement for the public sector in particular. They require a larger proportion of heat demand to be serviced by renewables than is the case for the other sectors[14].

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13 Calculations have been based on the profile of heat demand for each snapshot year shown in the charts above. Heat demand is assumed to grow at a constant rate (i.e. gradually increasing volume year on year) between those milestone years.

14 If process heat were excluded from the total heat demand figures for the industrial sector, then the projections would look tighter for residual demand here too (however, as noted above, we consider it feasible that a proportion of process heat be served by renewables and so have not excluded it from the table)

Table 4 Renewable heat demand (as proportion of total demand for all years and in TWh for 2020 only as illustration)

		2010 %	2015 %	2020 %	2020 TWh
Scenario 1	Domestic	1%	2%	5%	18.3
	Industrial	1%	1%	4%	7.1
	Commercial	0%	1%	2%	0.6
	Public	3%	9%	25%	15.5
Scenario 2	Domestic	1%	2%	9%	31.5
	Industrial	1%	2%	6%	11.3
	Commercial	0%	2%	9%	2.1
	Public	3%	10%	35%	22.1
Scenario 3	Domestic	1%	3%	12%	44.0
	Industrial	1%	2%	8%	15.0
	Commercial	0%	3%	16%	4.0
	Public	3%	12%	44%	27.1

Note: domestic excludes District Heating which is included under Public.

We can see arguments for why the public sector could be assumed to deliver relatively high penetration levels of renewable heat (in order to play an exemplary role, for instance). It is also worth bearing in mind that for the purposes of this modelling exercise, this sector includes District Heating, which as the supply side scenarios set out, is one of the areas where growth could help meet the challenging targets for 2020.

However, based on our analysis of the different renewable segments in this second part of the work a stronger argument might be that (some of) this demand might come from a different source. Other sources could be:

- (1) social housing (part of 'domestic' rather than 'public' in the demand data). The scenarios currently assume no growth in renewable heat demand from this sector beyond that from replacement/ new build. It may be considered more appropriate to target this non-new build/ replacement in this sector than to achieve the high levels of penetration in the Government sector described above. As noted above, we consider public housing one of the more straightforward to target. Retrofit of any kind would require an assumption of accelerated depreciation. In terms of the supply side barrier quantification, the nature of the barriers would be similar to that originally assumed, but, depending on the technologies this affects, the number of units may be somewhat larger (and so the costs somewhat higher).

- (2) district heating (DH) (over and above that which we have assumed for Scenario 3 on the supply side). This would also help to target the domestic sector, for which the scenario projections are relatively low compared to the other sectors (Table 4). The supply side work highlighted that increased penetration of DH could be costly. Given that the supply side barriers to renewable heat are considerable, this would result in some additional supply side costs in Scenario 3 over and above those that we originally assumed.

3.5.2 Fourth scenario

When looking at the supply side we also calculated a fourth scenario which reflected our judgement of the maximum achievable potential by 2020 and was higher than the third scenario. We have considered how such a scenario may look from a demand perspective given the barriers identified.

In our view, a high demand scenario could be considerably higher than the supply scenario constructed. This is because many of the barriers like awareness, confidence, planning can in principle be overcome completely and we would argue this could be achieved over the ten year time horizon in question.

In the extreme, the most important demand-side barriers to the uptake of renewable heat could be overcome by mandating organisations and individuals to install renewables. Assuming that all financial barriers are overcome (as we have done throughout this project), that supply side constraints e.g. fuel availability are lifted (note to a greater extent than even Scenario 4 in the supply side work) and that such a mandate was accommodated in the planning process, it would theoretically be possible to effectively force demand for additional renewable heat. As an indication, over 71% of total UK heat demand is from space and water heating, much of which could, in such a scenario, be supplied by renewables.

However, some of the uses where we consider switching even under such an aggressive scenario would not be achieved are:

- some industrial process uses where the temperature and quality of heat required may not be achievable from renewable technologies currently available;
- uses like cooking where arguably the use of renewables is not currently a viable option;
- some specific cases where wastes or bi-products from other activities are currently used as a fuel and it would not be sensible to substitute them for renewables; and
- in the domestic sector, for some users an unwillingness to change or to consider the environment (either as a result of inertia and/ or a lack of interest) may prevent uptake unless it is required[15].

Given the penetration levels already assumed in Scenario 3, in our view the main scope for additional uptake is the domestic sector. As mentioned above, the scenarios do not currently assume that non-replacement/ new build in social housing is targeted and this could be an area in which to further encourage uptake. As an indication, by 2020, this constitutes around 4% of domestic demand. Even in the domestic sector there will be some users for whom a lack of interest and/or inertia is a barrier that may never be overcome.

The other area that may have additional potential is process heat in the industrial sector (at 178TWh this is one of the largest segments, exceeded only by owner-occupied premises on the gas grid). Beyond quality and reliability issues here, there can also be an information gap where an organisation may not be able to make a project feasible on its own, but if e.g. a neighbour were able to take steam as well the project could be viable. There is therefore arguably some potential for

15 For instance, Defra's analysis of environmental behaviours identifies 18% of individuals as being 'honestly disengaged', showing a lack of interest in the environment and the lowest levels of pro environmental behaviour.

additional uptake here although the scope will depend on the extent to which different organisations coordinate with, and are prepared to rely on, each other; regional or local schemes to match up energy users may be most effective.

4. SCENARIO COST QUANTIFICATION

This section presents our quantification of the costs to overcome demand-side barriers to an extent that would result in the achievement of the demand scenarios described in Section 3. To do this we have drawn on the hierarchy of barriers established (illustrated in Figure 1 on page 9) to prioritise the barriers to address first. We have then considered the extent to which these barriers could be addressed by targeting those end-users where the barriers are lower (see section 3.2) and where some form of additional support could result in the increased uptake of renewable heat by 2020. We have then quantified the costs of delivering these support measures.

Quantifying the barriers on the demand side is slightly different than on the supply side. In the case of the former, the barriers are typically capacity related (e.g. they relate to fuel handling or the number of installers). On the demand side, the question is how to make renewable heat a suitably attractive proposition that end-users invest in it despite the barriers identified.

4.1 Actions to overcome the barriers

The actions identified to address the barriers and to achieve the level of renewable heat uptake required is summarised in the bullets below. It is important to note that the scenarios assume that these activities are undertaken in conjunction with each other and with the actions identified to overcome supply side barriers. They have been chosen with the levels of uptake required for a specific scenario in mind. As noted above and for the reasons highlighted later in this chapter, there is no guarantee that these actions alone will deliver the levels of heat uptake required. In particular, they rely on the assumption that renewable heat is cost effective (a working assumption throughout this project). We would also emphasise that the sooner that they are undertaken, the greater the likelihood that the challenging 2020 targets for renewable heat will be met.

In summary, the actions to overcome the barriers are:

- A marketing campaign to raise awareness of, and increase confidence in, renewable heat options for the domestic sector.
- A marketing campaign with similar aims targeted at the non-domestic sector (i.e. industry, commercial, public sectors): to raise awareness of, and increase confidence in, renewable heat
- For all types of user, additional resources (time or money) to compensate for the added 'hassle' of fitting renewables (for search, options appraisal, installation and operation) as compared to the fossil fuel alternative.
- For the domestic sector, help with the planning process e.g. through the provision and dissemination of exemplar planning guidance documentation and a telephone helpline to help achieve successful applications.
- For the non-domestic sector, planning assistance in the form of expert support to bring experience of similar projects and a thorough understanding of the process to bear.
- For the domestic sector, examples of different types of renewable heat in practice e.g. by setting up exemplar households that can be visited, to demonstrate renewables in practice in the domestic sector.

- Awareness raising around the potential for district heating e.g. a website and public sector training for its application.

All scenarios assume that these actions are undertaken in combination, early on (i.e. as soon as is practicable given the supply side constraints identified) and that renewables are made cost effective.

4.2 Barrier costs under three scenarios

Our assumptions for each scenario are set out below. As on the supply side, the highest costs are for Scenario 3 where the levels of penetration, and so the extent to which uptake needs to be accelerated, are highest. The costs should be summed across columns to give the total cost by 2020, that is, costs reported for 2015 include costs incurred from 2011 to 2015, while costs for 2020 include those incurred from 2016 to 2020. They are all discounted back to 2008 money (using a discount rate of 3.5%). 'Non-domestic' in the tables below refers to all energy users other than householders i.e. commercial, industrial and public.

Table 5 Breakdown of costs for Scenario 1

End user	Barrier addressed			Cost (£m)
		2010	2015	2020
Domestic	Awareness & confidence: marketing campaign to raise awareness of renewable technology options and accelerate uptake so that confidence in technology increases as penetration levels increase. Assume upfront cost of £8.5m for marketing campaign to domestic sector (similar level to other schemes e.g. UK Climate Change Fund). Assume that runs annually for four years (to 2013)	£8m	£22m	£0m
Domestic	Awareness & confidence: demonstration installations to provide potential users with hands-on experience of how different renewable technologies work in practice. Not included for scenario 1 (awareness campaign assumed sufficient to deliver target demand for this sector in this scenario)	£0m	£0m	£0m
Non domestic	Awareness & confidence: marketing campaign for the non-domestic sector specifically. This will be able to build on different existing programs, like Partnership for Renewables run by the Carbon Trust to promote the uptake of renewables in the non-domestic sector. Assume that budget of £4m for each of first four years (to 2013) (based on CT budget for awareness raising as published by the NAO)	£4m	£10m	£0m
Total cost: Awareness & confidence Scenario 1		**£12m**	**£32m**	**£0m**

End user	Barrier addressed	Cost (£m)		
		2010	2015	2020
Domestic	Planning: helpline to provide guidance to the domestic sector to help reduce the time spent dealing with planning issues and to provide confidence that others have been able to successfully implement the technology chosen. £200k set up costs[16] (based on Enviros experience of similar projects) and £460k ongoing operation costs to 2013 (4 consultants at £500 per day full time).	£0m	£1m	£0m
Domestic	Planning: guidance: example planning applications to help show how projects have been successfully implemented in the past and avoid delays/ increased hassle that may result from first-time applications from householders.	£0m	£0m	£0m
Non domestic	Planning: expert support for non-domestic sector. Assume that same level of help required on demand side as on supply side (i.e. 25% of sites need support at cost of £3,000 (3 days at £1,000 per day)[17].	£4m	£41m	£60m
Total cost: Planning total Scenario 1		**£4m**	**£43m**	**£60m**
Domestic	Hassle factor[18]: time cost for search and options appraisal (all technologies). Assumed that finding out about renewable technologies takes longer than their conventional equivalent. Assuming that awareness campaign above is implemented, set at 3 days for domestic sector[19] i.e. assuming that people need to be compensated for 3 days of their time to overcome the hassle factor.	£0m	£83m	£189m
Domestic	Hassle factor: time cost for installation (biomass): assumed that extra time to install biomass over and above conventional technologies of 3 days.	£0m	£11m	£30m
Domestic	Hassle factor: time cost for installation (HP, Solar, Biogas): assumed that extra time to install biomass over and above conventional technologies of 2 days[20].	£0m	£48m	£106m
Domestic	Hassle factor: time cost for operation (biomass) on the basis that fuel deliveries etc. will take up additional time than e.g. use of gas and that there may be additional teething problems. Given that the majority of demand required can be met by off-grid users in Scenario 1, this cost is not included in this scenario.	£0m	£0m	£0m

16 This is over and above the advice recommended to overcome supply side barriers. Set up costs higher than those assumed for the supply side on the basis that this effort would be targeted at householders rather than supply side organisations and hence at a larger number of individuals.

17 Note that cost is over and above those assumed on the supply side.

18 Note that all hassle factor costs represent the *additional* time required to choose, install and operate renewables rather than an alternative heating technology.

19 All domestic sector hassle factor costs are calculated based on £14/ hour based on 7.5 hour days, costs we understand we used for EEIR

20 There are arguments that the installation of ground source heat pumps make take longer; however average time for both GSHP and air source heat pumps here (and we might expect ASHP to take less extra time than the other technologies listed).

End user	Barrier addressed			Cost (£m)
		2010	2015	2020
Domestic	Hassle factor: time cost for operation (HP, Solar, Biogas). We have assumed that once operational, these technologies need not systematically require any additional effort than the other technologies that they replaced. Hence cost of zero in Scenario 1.	£0m	£0m	£0m
Non-domestic	Hassle factor: time cost for search and options appraisal (all technologies)[21]: Rationale as for domestic, assumes 5 days' time for non-domestic sectors.	£0m	£117m	£231m
Non-domestic	Hassle factor: time cost for installation (biomass) as for domestic.	£0m	£0m	£1m
Non-domestic	Hassle factor: time cost for installation (HP, Solar, Biogas) as for domestic.	£0m	£47m	£92m
Non-domestic	Hassle factor: time cost for operation (biomass) as for domestic.	£0m	£0m	£0m
Non-domestic	Hassle factor: time cost for operation (HP, Solar, Biogas) as for domestic	£0m	£0m	£0m
Total cost: Hassle factor total Scenario 1		**£0m**	**£306m**	**£649m**
Public	District heating: website and public sector training once DH over and above current systems is required. Assumed not to bite in Scenario 1.	£0m	£0m	£0m
Total cost: District heating total Scenario 1		**£0m**	**£0m**	**£0m**
Total cost: Scenario 1		**£16m**	**£381m**	**£709m**

Table 6 Breakdown of costs for Scenario 2

End user	Barrier addressed			Cost (£m)
		2010	2015	2020
Domestic	Awareness & confidence: marketing campaign. As for scenario 1 but campaign continues (at same level) for an additional 3 years (i.e. until and including 2016).	£8m	£36m	£6m
Domestic	Awareness & confidence: exemplar installations. Assume one project per RDA and region (i.e.12 in total); material additional costs over and above equipment costs are manning it by one person full time (£500 per day) and local marketing (£50k per year).	£2m	£5m	£0m
Non domestic	Awareness & confidence: marketing campaign. As for scenario 1 but campaign continues (at same level) for an additional 3 years (i.e. until and including 2016).	£4m	£16m	£3m

21 We have not assumed that the time cost necessarily varies by size of technology (i.e. by sector) on the basis that the installation and operation resource requirements for these technologies will already vary. There is not necessarily a reason to assume that the challenges facing the adoption of renewables increase by size of technology. For instance, public sector organisations may be able to take advantage of multiple installations and so the hassle cost per installation would be lower. Equally, companies may have more ready access to information about renewables and be better set up to manage the installation of the technology and its subsequent operation as compared to, say, a household.

End user	Barrier addressed	Cost (£m)		
		2010	2015	2020
Total: Awareness & confidence total Scenario 2		**£13m**	**£57m**	**£9m**
Domestic	Planning: helpline to provide guidance As for scenario 1 but campaign continues (at same level) for an additional 3 years (i.e. until and including 2016).	£0m	£2m	£0m
Domestic	Planning: guidance (example planning applications) Upfront costs to design and disseminate case studies £200k (based on other similar projects) plus £50k ongoing costs to keep material up to date.	£0m	£0m	£0m
Non domestic	Planning: expert support As for scenario 1 but assumed 50% rather than 25% of sites require support.	£11m	£208m	£576m
Total: Planning total Scenario 2		**£12m**	**£209m**	**£577m**
Domestic	Hassle factor: time cost for search (all technologies) As scenario 1	£0m	£172m	£770m
Domestic	Hassle factor: time cost for installation (biomass) As scenario 1	£0m	£13m	£35m
Domestic	Hassle factor: time cost for installation (HP, Solar, Biogas) As scenario 1	£0m	£106m	£490m
Domestic	Hassle factor: time cost for operation (biomass) assumed to be 1.5 days per site to take account of fuel delivery impact as penetration levels increase	£0m	£37m	£252m
Domestic	Hassle factor: time cost for operation (HP, Solar, Biogas) As Scenario 1	£0m	£0m	£0m
Non-domestic	Hassle factor: time cost for search (all technologies) As Scenario 1	£0m	£258m	£1,067m
Non-domestic	Hassle factor: time cost for installation (biomass) As Scenario 1	£0m	£0m	£1m
Non-domestic	Hassle factor: time cost for installation (HP, Solar, Biogas) As Scenario 1	£0m	£103m	£426m
Non-domestic	Hassle factor: time cost for operation (biomass) as for domestic sector	£0m	£1m	£7m
Non-domestic	Hassle factor: time cost for operation (HP, Solar, Biogas) As Scenario 1	£0m	£0m	£0m
Total cost: Hassle factor total Scenario 2		**£0m**	**£691m**	**£3,047m**
Public	District heating: website and public sector training. Assumed does not bite Scenario 2	£0m	£0m	£0m
Total cost: District heating total Scenario 2		**£0m**	**£0m**	**£0m**
Total cost: Scenario 2		**£25m**	**£959m**	**£3,633m**
Change on Scenario 1		**£9m**	**£577m**	**£2,925m**

Table 7 Breakdown of costs for Scenario 3

End user	Barrier addressed	Cost (£m)		
		2010	2015	2020

End user	Barrier addressed			Cost (£m)
		2010	2015	2020
Domestic	Awareness & confidence: marketing campaign. As for Scenario 2 but campaign continues (at same level) for an additional 2 years (i.e. until and including 2018).	£8m	£36m	£19m
Domestic	Awareness & confidence: exemplar installations Assume as Scenario 2 but two (rather than one) projects per RDA and region (i.e.24 in total).	£4m	£17m	£3m
Non domestic	Awareness & confidence: marketing campaign. As for Scenario 2 but campaign continues (at same level) for an additional 2 years (i.e. until and including 2018).	£4m	£16m	£8m
Total: Awareness & confidence total Scenario 3		**£15m**	**£69m**	**£30m**
Domestic	Planning: helpline to provide guidance. As for Scenario 2 but campaign continues (at same level) for an additional 2 years (i.e. until and including 2018).	£0m	£2m	£1m
Domestic	Planning: guidance (example planning applications). As for Scenario 2 but campaign continues (at same level) for an additional 2 years (i.e. until and including 2018).	£0m	£0m	£0m
Non domestic	Planning: expert support As for Scenario 2 but assumes all additional sites require support.	£26m	£625m	£2,319m
Total: Planning total Scenario 3		**£26m**	**£627m**	**£2,320m**
Domestic	Hassle factor: time cost for search (all technologies) As Scenario 2	£0m	£208m	£1,479m
Domestic	Hassle factor: time cost for installation (biomass) As Scenario 2	£0m	£15m	£33m
Domestic	Hassle factor: time cost for installation (HP, Solar, Biogas) As Scenario 2	£0m	£128m	£964m
Domestic	Hassle factor: time cost for operation (biomass) 3 rather than 1.5 days in Scenario 2	£0m	£85m	£546m
Domestic	Hassle factor: time cost for operation (HP, Solar, Biogas) As Scenario 2	£0m	£0m	£0m
Non-domestic	Hassle factor: time cost for search (all technologies) As Scenario 2	£0m	£363m	£2,109m
Non-domestic	Hassle factor: time cost for installation (biomass) As Scenario 2	£0m	£0m	£1m
Non-domestic	Hassle factor: time cost for installation (HP, Solar, Biogas) As Scenario 2	£0m	£145m	£843m
Non-domestic	Hassle factor: time cost for operation (biomass) 3 rather than 1.5 days in Scenario 2	£0m	£2m	£15m
Non-domestic	Hassle factor: time cost for operation (HP, Solar, Biogas) As Scenario 2	£0m	£0m	£0m

End user	Barrier addressed			Cost (£m)
		2010	2015	2020
Total: Hassle factor total Scenario 3		**£0m**	**£948m**	**£5,988m**
Public	District heating: website and public sector training assumes £50k to produce guidance plus provision of one full day training course in each RDA/ region, repeated four times a year (cost of £96k) until 2015.	£0m	£0m	£0m
Total: District heating total Scenario 3		**£0m**	**£0m**	**£0m**
Total: Scenario 3		**£42m**	**£1,644m**	**£8,339m**
Change on Scenario 2		**£17m**	**£686m**	**£4,705m**

4.3 Comment on costs: uncertainty around the scenarios

As is the case on the supply side, these cost estimates depend on the assumptions made, both in terms of the number of units/ capacity installed and in terms of the costs of delivering that change. We have built on published data where possible but in many instances it has been necessary to make an estimate based on market intelligence and our experience.

We have not undertaken any statistical analysis to establish where within the range of possible outcomes these cost estimates fall. However, in our view, they are likely to be on the low side. For instance, in each scenario, we have assumed that it is not necessary for awareness raising to continue right up until 2020, on the basis that once uptake has begun to accelerate, this increased rate of change can be expected to increase and grow as renewables become more common. In addition, it assumes that from this point onwards, organisations and individuals will be able to take advantage of a range of other information sources that also exist e.g. provided by regional development agencies (RDAs), local authorities, organisations like the Energy Savings Trust and Carbon Trust.

In addition, we have not explicitly quantified costs to overcome ‘behavioural’ barriers (e.g. inertia or a lack of interest) that could leave end users reluctant to invest in renewable heat even if it is the more cost effective option. This is because we have assumed that this barrier is addressed in these scenarios by targeting the ‘best’ end-users[22] first and by ensuring that renewables are cost effective[23]. This approach means that the scenarios avoid those end users that may never choose to use renewables (we discuss some of the potential reasons for this in Section 3.5.2). In practice, it may not be possible to identify and so to accurately target the preferred group and as a result the costs of increasing uptake may be higher[24].

This is not to understate the importance of behaviour on the uptake of renewable heat. It may be that even in the face of more complete information, a cost effective project and other non-financial benefits that accrue to using renewable heat[25] an

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22 i.e. those with the greatest propensity to start to use renewable heat and those whose demand needs are best met by renewable heat

23 This is a strong assumption which underpins the analysis of this project.

24 e.g. environmentally aware householders would to some extent identify themselves by proactively seeking to consider renewable heat in the first place.

25 e.g. for organisations there are potentially benefits in terms of corporate social responsibility (CSR) benefits, carbon footprint reductions (which can help regulatory compliance e.g. with emissions trading schemes) and stakeholder engagement (i.e. with consumers, customers, staff and investors).

end user still chooses not to invest in renewables. This type of behaviour has been witnessed around the uptake of energy efficiency measures, for instance. The potential for this impact has been taken into account to some extent in the analysis by assuming that even in the 'best' sectors 100% penetration would not be achieved. However, one of the uncertainties around this analysis is the extent to which end-users can be relied on to make the decision an appraisal of the costs and benefits considered for this project leads us to expect. With this in mind, different uptake rates have been applied to different demand segments.

It is also important to note the inherent uncertainty in assessing the impact that any policy could have. An additional risk to the delivery of the types of support described here is that the environment in which heat users are making decisions changes over time. These changes could affect the nature and cost of the renewable heat options available, the characteristics of an end-user's heat demand and so the impact that different barriers have on uptake. In some instances these factors may work together to make renewable heat a more attractive option, but in others the impact may be to slow or even prevent uptake.

5. CONCLUSIONS

Following our research into the demand and supply side barriers detailed in this and the Part 1 and biogas reports which accompany it, we highlight the following conclusions. These are based on the literature review and quantitative analysis undertaken for this project, supported by stakeholder feedback (gathered through our own telephone interviews and research on the domestic sector by Element Energy).

- Both the literature and end users identify a wide range of barriers to renewable heat that currently bite on both the supply and demand sides.
  - The result is a shortfall in the capacity of suppliers and fuel handling and reluctance to invest in renewable heat. This causes business-as-usual levels of heat uptake to be considerably lower than required even to meet the lower of the three scenarios that we have modelled.
- Although the extent and nature of these barriers varies between end users and technologies, a lack of awareness and confidence in the technologies is commonly cited as a barrier on both the demand and supply sides.
  - Planning has also been raised as a key issue on both the supply and demand side; it can delay projects (increasing the hassle factor expected by end users) and prevent them going ahead altogether.
- We are of the view that the target levels of output could be delivered by 2020 if the key demand and supply side barriers are addressed.
  - However, it is worth noting that we do not consider the challenging renewable heat targets specified are achievable *unless* targeted steps are taken both to support the development of a supplier base and to increase end user interest in and investment in the technologies.
- There is a wide range of ways that the targets could be met; this project has quantified one set of scenarios.
  - After reviewing information on both the demand and supply side, we consider the levels of output projected one plausible future outcome. However, as noted above, after analysing the demand side, the scenarios appear fairly heavily weighted towards the public sector. An alternative approach may have been either to assume that non-new build/ replacement social housing is targeted more strongly or that district heating is used to a greater extent.
- The lack of comprehensive and detailed information on heat use in the UK has meant that these projections rely on assumptions to a considerable extent.
  - If progress towards the targets (or the impact of different initiatives to deliver them) is to be measured, the data available will need to be improved.
  - The ideal starting point for the development of scenarios for this project would have been a time series data set showing annual heat use by end user segment, sector, technology and fuel from.
  - Such data could be used both to understand the characteristics of end users currently using fossil fuels and/ or electricity for heating and to establish the current uptake of renewable heat with greater certainty.

APPENDICES

1. BARRIERS TO RENEWABLE HEAT BY CATEGORY

Table 8 Demand side barriers for biomass

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia (all modes)	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Public distrust of biofuels (all modes)	Recent publicity has heightened concern over the negative impacts on wider environmental issues e.g. rape seed oil and social issue in competition with food production. There is a risk that all biomass is associated with biofuels and so this distrust feeds through to other fuels where these concerns may not actually be applicable.	High	√	√	√	√	√	X	√	X	√	If people are better educated about the impact of different types of biomass they may be more aware of benefits and opportunities of different renewable heat technologies.
Awareness of technology (all modes)	Lack of awareness of technology and potential benefits by end-users (in a wide range of sectors), policy makers and installers. If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	High	√	√	√	√	√	X	√	X	X	n/a
Confidence in technology - high perceived risk (all modes)	Lack of confidence in technology and commercial infrastructure due to small number of successful projects operating in UK. Particular problem in cases where disruption would have severe impacts such as loss of production, loss of customers and market share.	High	√	√	√	√	√	X	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research /information.

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
"Hassle" factor (all modes)	Extra time and effort required to use a non-conventional system or to switch systems. Research, feasibility study, planning permission, finding an installer, installation of equipment, setting up delivery of fuel etc. can all create an additional time cost both upfront and once the project is up and running.	High	√	√	√	√	√	√	√	X	√	"Hassle" factor decreases confidence in technology and commercial infrastructure.
Planning issues (all modes)	In England, changes to permitted development rights for renewable technologies have lifted the need to get planning permission for most micro biomass plants. (Wales, Scotland and Northern Ireland yet to relax rules). Public opposition to large biomass plants can, however, slow or stop the planning process, particularly difficult for plants using waste. There is also no standard planning template for large biomass projects and requirements can vary between areas. The additional effort and elapsed time necessary to overcome these issues, and even for projects where it might not exist, the perception that there could be these issues, may put an end-user off even attempting to install renewable heat.	High	√	√	√	√	√	√	√	X	√	Increases "hassle" factor and perceived project risk.
Lack of trained engineers and plumbers (all modes)	Fear that if equipment fails to work repairs will be delayed which might put end users off, particularly if they have no past experience of the technology.	High	√	√	√	√	√	√	√	√	√	n/a

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Concerns around security of fuel supply (all modes)	Fuel supply can be perceived as unreliable (i.e. that fuel of the necessary type and quality may not be available in a particular location at a particular time). This could put end users off, particularly when comparing it against natural gas. These concerns could relate to general supply chain issues or be more specific. Although not expected to be as widely used as e.g. waste wood or forest derived materials, there may also be concerns that energy crop prices are linked to food prices which could mean higher fuel prices[26].	High	√	√	√	√	√	√	√	√	√	A more reliable supply would increase confidence in the technology.
Lack of interest (all modes)	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.
Concern over emissions to air (all modes)	Perception that burning biomass may lead to air quality issues. Particular issue in areas which already have problems with air quality. May be more of an issue in areas that typically use natural gas rather than fuel oil or solid fuels.	Medium	√	√	√	√	√	X	√	X	√	Yes may prevent/slow planning process.

26 Arguably this barrier is compounded by a lack of understanding about and priority being given to energy recovery from waste by key stakeholders. Local Authorities have in many cases chosen composting as their management solution to landfill diversion. The long-term nature of waste management contracts (up to 25 years) means that many local authorities are 'locked-in' and cannot modify their contract targets when new technology becomes available. An association of biomass heating with waste can also cause negative perceptions of the technology. It also has planning implications. Changing the definition of waste in favour of biomass could affect the available resource base and the fuel supply.

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
High space requirements (all modes)	Larger equipment in comparison to conventional heating systems might discourage customers. Arguably this barrier is less likely to bite where end users are already more used to storing heating fuel e.g. where they are off the gas grid.	Medium	X	√	√	√	√	X	√	X	X	n/a
Transportation (all modes)	Concern over fuel transportation requirements may restrict the levels of deployment in densely populated areas where congestion is already an issue. e.g. domestic customers may not consider biomass a viable option particularly if they have previously used gas. Restrictions of vehicle movements set out in planning permission for some sites might prevent projects from proceeding. Some sites might also have problems in terms of accessibility by lorries.	Low	X	√	√	√	√	X	√	√	√	May have an impact on planning permission.
Geographic coverage - travel requirements (all modes)	Customers prefer local suppliers which are accessible.	Low	√	√	√	√	X	√	√	X	√	Delivery networks and the availability of skilled personnel would follow the geographical patterns of biomass heat supply.
Difficulties with installing infrastructure (Approaches requiring DH)	Particularly in Cities most of the space is already used by other pipes and cables. It is difficult to retrofit DH network to cities. It is also challenging to interlink different DH systems which would make it more efficient to operate. These factors could put off project developers from installing district heating (over and above the barriers of awareness and hassle that face other biomass heat technologies).	High	√	√	√	√	√	√	√	X	√	Planning permission is less likely to be gained if the DH network is difficult to fit into the existing infrastructure.

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Planning permission (Approaches requiring DH)	Extensive permitting and consenting is required to install heat transmission infrastructure underneath existing public highways. Even if the technical issues identified above could be overcome, this barrier may serve to prevent some projects moving forward to the timescales necessary to make the project viable (or even altogether).	Medium	√	√	√	√	√	√	√	X	X	n/a
System design problems (Approaches requiring DH)	Current buildings poorly designed to exploit DH effectively - leads to overheating of buildings which results in higher air conditioning use. There is also the potential for heat loss which can result in higher prices for end users. If end users are not certain that they will be able to have the level of heat they want, when they want it, they will be less likely to install DH.	Medium	√	√	√	√	√	X	√	X	√	Negative perception of DH increases if overheating or extra cost is experienced.
Negative perception of district heating (Approaches requiring DH)	Lack of familiarity with technology and contractual arrangement. Concerns about level of heat service (comfort levels, reliability, and maintenance). This may prevent project developers from taking forward a scheme, both as a result of negative perceptions on their side but also of negative perceptions on the side of eventual end users to whom they must market the idea.	Medium	√	√	√	√	√	X	√	X	X	n/a
Relative immaturity of technology (compared to fossil fuel alternatives) (CHP)	Biomass CHP technology seen as higher risk than other CHP options, especially gasification. This may act as a disincentive for users to switch to renewables.	Medium	√	√	√	√	√	X	√	X	√	Lack of confidence due to relative immaturity of technology increases 'hassle' factor due to need for additional research/information.

Biomass

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Exporting electricity to grid (CHP)	Selling electricity back to grid is both complex and financially unattractive as generators receive a low rate. There is a need for users to understand the economic impacts and practical requirements of selling electricity to the grid for a project to be considered financially viable. e.g. determining ROC allocation complicated if user is not familiar with the scheme and given a market price, can be uncertain.	Low[27]	√	√	√	√	√	X	√	X	√	Increases "hassle" factor and financial viability of project.

27 Ranked as 'low' given that, in our experience, if a project has overcome all the other barriers listed above the developer will take the time to understand these issues and support/ information exists to do that. In addition, for this project the working assumption is that financial barriers are overcome; ranking this barrier as low show not be interpreted to mean that projects whose financial viability cannot be proven with some certainty would go ahead.

Table 9 Demand side barriers biogas

Biogas

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia (all modes)	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Awareness of technology (all modes)	For all modes of biogas utilisation, a lack of awareness of technology and potential benefits by end-users, policy makers and installers (plumbers, builders, architects etc). If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	High	√	√	√	√	√	X	√	X	X	n/a
Confidence in technology - high perceived risk (all modes)	For all modes of biogas utilisation, a lack of confidence in technology and commercial infrastructure due to small number of successful projects operating in UK. Particular problem in cases where disruption would have severe impacts such as loss of production, loss of customers and market share.	High	√	√	√	√	√	X	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research/information.
"Hassle" factor (all modes)	For the on-site installer of a biogas plant: Extra time and effort required to switch from conventional fossil fuel technologies. This requires research, feasibility study, planning permission, finding an installer, installation of equipment and fuel storage etc. For end-user of district heat: disruptions caused by installation of DH infrastructure and contractual/maintenance changes.	High	√	√	√	√	√	√	√	X	√	"Hassle" factor decreases confidence in technology and commercial infrastructure.

Biogas

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Lack of interest (all modes)	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.
Lack of skilled technicians/operatives (all modes)	For all modes of biogas utilisation, as with biomass heat, there is a need for suitably trained engineers and technicians (installers and maintenance engineers) plus skilled chemical engineers and micro-biologists to maximise stable gas yields. Fear that in case the equipment fails to work repairing will be delayed might put end users off.	Medium	√	√	√	√	√	√	√	X	√	More skilled engineers would also enable companies to grow faster and cover a larger geographical area.
Long-term waste contracts (AD)	Long-term nature of waste management contracts (up to 25 years) means that many local authorities are 'locked-in' and cannot modify their contract targets when new technology becomes available.	Medium	√	X	X	√	X	√	√	X	X	n/a
3rd party views on digestate (AD)	Supermarkets are reticent to accept food grown on land where digestate has been spread before. Supermarkets are reticent and Soil Association will not confirm organic status on land spread with digestate. These concerns reduce the options available to AD developers and so the extent to which they are prepared to invest in the technology.	Medium	√	√	√	√	√	√	√	√	√	n/a
Presence of lower cost composting as a waste management solution for Local Authorities (AD)	Local Authorities have in many cases chosen composting as their management solution to landfill diversion. This constrains the feedstock available for AD projects and so affects whether a project is viable. End users that are aware of this may be concerned about the feasibility of a project and also about the uncertainty that the different waste management solutions could create for the availability of feedstock in future.	Medium	√	√	√	√	√	√	√	X	X	n/a

Biogas

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Lack of technology suppliers (AD)	There is a lack of active players in the UK, including a lack of supportive capacity e.g. of labs for digestate and biogas analysis. As a result, individuals may not be able to obtain the support that they need and may remain uncertain around the viability of a particular project. This will also act as a barrier by limiting customer confidence in the potential for renewable heat and their awareness of the different options.	Medium	√	√	√	√	√	√	√	X	√	The creation of new companies would entail more trained personnel.
Animal bi-products disposal regulations (AD)	Bio-security - Handling ABPR wastes on mixed farms requires strict animal hygiene regulations to be applied. This reduces the numbers of farms interested in receiving food waste in digesters.	Medium	√	√	X	√	√	√	√	√	√	It will impact on all digestate disposal related barriers by improving information flow and engagement.
Waste handling licences, if importing 3rd party waste (AD)	For AD systems a waste handling licence is needed which adds a bureaucratic barrier. The need to get a licence might put people off.	Low	√	√	X	√	√	X	√	X	X	n/a
Waste handling infrastructure (AD)	There is a lack of a proper waste handling infrastructure for AD in the UK. Complexity of waste collection may deter local authorities.	Low	√	√	√	√	√	√	√	X	X	n/a
Planning permission (AD and LFG)	The current planning system retards the development of community scaled schemes due to waste logistics and odour. This is mainly due to a lack of understanding from planners, other regulators. Long lead times deter market development.	Medium	√	√	X	√	√	√	√	X	X	n/a

Biogas

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Lack of R&D on collection of landfill gas for distribution in heating systems/ gas injection (LFG using heating system/ gas injection)	There is currently a lack of understanding around the collection of landfill gas distribution in heating systems. In the absence of readily available information on the opportunities, individuals on the demand side are not in a position to judge whether a project is feasible. This also reduces customer awareness of the options and their confidence in this type of project.	Medium	√	√	√	√	√	√	√	X	X	If there was a greater match of the supply of geothermal energy to the demand then the resource potential would be greater and more efficient to utilise.
Difficulties with installing network (systems using hot-water heat transfer)	For systems utilising hot water heat transfer, particularly in Cities most of the space is already used by other pipes and cables. It is difficult to retrofit DH network to cities. It is also challenging to interlink different DH systems which would make it more efficient to operate. These factors could put off project developers from installing district heating (over and above the barriers of awareness and hassle that face other biomass heat technologies).	High	√	√	√	√	√	√	√	X	X	n/a
Planning permission (systems using hot-water heat transfer)	Extensive permitting and consenting is required to install heat transmission infrastructure underneath existing public highways. Even if the technical issues identified above could be overcome, this barrier may serve to prevent some projects moving forward to the timescales necessary to make the project viable (or even altogether).	Medium	√	√	√	√	√	√	√	X	X	n/a
System design problems (Approaches requiring DH)	Current buildings poorly designed to exploit DH effectively - leads to overheating of buildings which results in higher air conditioning use. There is also the potential for heat loss which can result in higher prices for end users. If end users are not certain that they will be able to have the level of heat they want, when they want it, they will be less likely to install DH.	Medium	√	√	√	√	√	X	√	X	√	Negative perception of DH increases if overheating or extra cost is experienced.

Biogas

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Negative perception of district heating (Approaches requiring DH)	Lack of familiarity with technology and contractual arrangement. Concerns about level of heat service (comfort levels, reliability, and maintenance). This may prevent project developers from taking forward a scheme, both as a result of negative perceptions on their side but also of negative perceptions on the side of eventual end users to whom they must market the idea.	Medium	√	√	√	√	√	X	√	X	X	n/a
Consumer confidence due to lack of track record (bio-methane gas injection)	The absence of any track record in the UK that gas injection can be made to work in the context of UK gas quality standards would be overcome with a suitable demonstration project	High	√	√	√	√	√	√	√	X	√	A demonstrator site would, through demonstrating successful utilisation, accelerate the alleviation of other awareness and performance related barriers
Lack of communication (bio-methane gas injection)	Lack of concerted business to business communication between landfill, sewage and waste AD facilities and gas grid networks to identify suitable injection opportunities which will capitalise on the current legislation (Gas Act 1986)	Medium	√	√	X	X	√	X	√	X	X	n/a
Public perception (bio-methane gas injection)	Public perception of waste-derived biogas being used in the natural gas grid, particularly with respect to cooking food	Low	X	X	√	X	X	√	√	X	X	n/a
Lack of suitable sites (direct firing)	Limited number of industrial sites that offer co-location opportunity (i.e. space and waste resource) with demand for the gas that is matched in scale	Medium	√	√	X	X	√	X	√	X	X	n/a

Table 10 Demand side barriers solar thermal

Solar Thermal

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Awareness of technology	Lack of awareness of technology and potential benefits by end-users, policy makers and installers (plumbers, builders, architects etc). If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	High	√	√	√	√	√	X	√	X	X	n/a
Lack of trained engineers and plumbers	Fear that if equipment fails to work repairs will be delayed which might put end users off, particularly if they have no past experience of the technology.	High	√	√	√	√	X	√	√	√	√	More skilled engineers would also enable companies to grow faster and cover a larger geographical area.
Lack of interest	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.

Solar Thermal

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
"Hassle" factor	Extra time and effort required to use non-conventional system. Research, feasibility study, planning permission (for all systems outside England and all large systems), finding an installer, installation of equipment etc	Medium	√	√	√	√	√	√	√	X	√	"Hassle" factor decreases confidence in technology and commercial infrastructure.
Difficulty fitting solar to existing roofs	Range of roof types, collector fittings and health and safety requirements create problems for quick (and cost effective) installation. Increased time requirement (and costs) might put off consumers.	Medium	√	√	√	√	√	√	√	X	√	Increases "hassle" factor.
Difficulty fitting solar to existing heating systems	Retro fitting to existing heating systems can be complex, so time consuming (and costly). Increased costs might put off consumers. Some combi boilers are compatible with solar while others are not. Confusion may prevent installations which could have gone ahead.	Low	√	√	√	√	√	√	√	X	√	Increases "hassle" factor.
Confidence in technology - high perceived risk	Lack of confidence in technology and commercial infrastructure. In our view, the impact of this barrier is lower for solar than it might be for some other renewable technologies; even though uptake rates are not that high in the UK compared to some other countries, experience from overseas can help to reassure customers.	Low	√	√	√	√	√	X	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research/information.
Concern about whether industry is ‘reputable’	Complaints about hard selling techniques by sales people visiting homes leads to perception that there are ‘cowboys’ in the industry. There is also an issue of deliberate mis-selling i.e. overstating the benefits/ cost savings or failing to point out additional costs/ barriers.	Low	√	√	√	√	√	X	√	X	√	Decreases confidence in technology and installers

Solar Thermal

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Geographic coverage - travel requirements	Existing companies do not cover the whole of the UK which poses difficulties in terms of travel requirements. Customers may prefer local suppliers which are easily accessible.	Low	√	√	√	√	X	√	√	X	√	n/a
Planning permission	History of failed and delayed retrofit applications. However in England changes to permitted development rights for microgeneration technologies introduced on 6th April 2008 have lifted the requirements for planning permission for most solar water heating installations. Roof mounted and stand-alone systems can now be installed in most dwellings as long as they respect certain size criteria. Exceptions apply for Listed Buildings, buildings in Conservation Areas and World Heritage Sites. In Wales, Scotland and Northern Ireland, the devolved governments are currently all considering changes to their legislation on permitted developments to facilitate installations of microgeneration technologies including solar water heating.	Low	√	√	√	√	√	√	√	X	√	Increases "hassle" factor and perceived project risk.

Table 11 Demand side barriers Ground Source Heat Pumps (GSHP)

GSHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Awareness of technology	Lack of awareness of technology and potential benefits by end-users, policy makers and installers (plumbers, builders, architects etc). If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	High	√	√	√	√	√	X	√	X	X	n/a
"Hassle" factor	Extra time and effort required to use non-conventional system or switch system. Research, feasibility study, planning permission, finding an installer, digging of boreholes, installation of equipment etc.	High	√	√	√	√	√	√	√	X	√	"Hassle" factor decreases confidence in technology and commercial infrastructure.
Difficulty of retrofitting to existing buildings	The technology requires low temperature heat distribution system for optimal performance (which is likely to deliver heat via an under-floor system). This creates extra hassle (and cost) which may put consumers off.	High	√	√	√	√	X	√	√	√	X	n/a

GSHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Lack of interest	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.
Confidence in technology - high perceived risk	Lack of confidence in technology and commercial infrastructure due to relatively small number of successful projects operating in UK.	Medium	√	√	√	√	√	√	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research/information.
Lack of trained engineers and plumbers	Fear that if equipment fails to work repairs will be delayed which might put end users off, particularly if they have no past experience of the technology.	Medium	√	√	√	√	X	√	√	√	√	Local arability of supply and installation skills will help reduce costs of installation.
Lack of space to install collectors	Some buildings will not have access to sufficient space for horizontal or even vertical collectors. Limits number of projects that are feasible (and may increase costs) hence putting end users off.	Medium	√	√	√	√	√	√	√	√	n/a	More skilled engineers would also enable companies to grow faster and cover a larger geographical area.
Availability of aquifers for ground water heat pumps	Not all areas have suitable aquifers; effort to find out whether suitable aquifer and then efforts to use an energy source that is not optimally located may increase a project's complexity (i.e. time requirement) and capital costs.	Medium	√	√	X	√	√	√	√	√	n/a	n/a

GSHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Permission to use aquifers	Short licensing period creates uncertainties which affect end users' confidence in using a new energy source.	Medium	√	√	X	√	√	√	√	X	X	n/a
Geographic coverage - travel requirements	Customers prefer local suppliers which are accessible.	Low	√	√	√	√	X	√	√	X	√	Local availability of supply and installation skills will help reduce costs of installation.
Electricity supply capacity	The lack of three phase electricity supply limits the capacity of domestic installations. Overall capacity of local networks may also become an issue for other sectors. Both factors may increase costs.	Low	X	X	√	X	√	√	√	√	X	n/a

Table 12 Demand side barriers Air Source Heat Pumps (ASHP)

ASHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Awareness of technology	Lack of awareness of technology and potential benefits by end-users, policy makers and installers (plumbers, builders, architects etc). If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	High	√	√	√	√	√	X	√	X	X	n/a
Difficulty of retrofitting to existing buildings	The technology requires low temperature heat distribution system for optimal performance (which is likely to deliver heat via an under-floor system). This creates extra hassle (and cost) which may put consumers off.	High	√	√	√	√	X	√	√	√	X	n/a
Lack of interest	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.

ASHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Confidence in technology - high perceived risk	Lack of confidence in technology and commercial infrastructure due to small number of successful projects operating in UK.	Medium	√	√	√	√	√	√	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research/information.
Lack of trained engineers and plumbers	Fear that if equipment fails to work repairs will be delayed which might put end users off, particularly if they have no past experience of the technology.	Medium	√	√	√	√	X	√	√	√	√	More skilled engineers would also enable companies to grow faster and cover a larger geographical area.
Lack of space to install collectors	Some buildings will not have access to sufficient space for horizontal or even vertical collectors. Limits number of projects that are feasible (and may increase costs) hence putting end users off.	Medium	√	√	√	√	√	√	√	√	X	n/a
Geographic coverage - travel requirements	Customers prefer local suppliers which are accessible.	Medium	√	√	√	√	X	√	√	X	√	Local availability of supply and installation skills will help reduce costs of installation.
Noise and planning	Fan noise may lead to planning rejection; it may also affect the amenity value of this technology compare with non-renewable options, particularly in built up areas.	Medium	√	√	√	√	√	√	√	X	X	n/a

ASHP

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
"Hassle" factor	Extra time and effort required to use non-conventional system or switch system. Research, planning permission, finding an installer, installation of equipment etc	Low	√	√	√	√	√	√	√	X	√	"Hassle" factor decreases confidence in technology and commercial infrastructure.
Electricity supply capacity	The lack of three phase electricity supply limits the capacity of domestic installations. Overall capacity of local networks may also become an issue for other sectors. May increase costs.	Low	X	X	√	X	√	√	√	√	X	n/a

Table 13 Demand side barriers geothermal

Geothermal

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Inertia	End users are often reluctant to move from a method of heating that they are familiar with. This can be due to concerns around whether the quality of heat supplied will be maintained or due to uncertainty around the costs & practicalities of the alternative options.	High	√	√	√	√	√	√	√	X	√	Inertia exacerbates the impact of the other behavioural type barriers (e.g. distrust).
Mismatch of geothermal resource to population centres	Demand likely to be close to energy resource for a project to be feasible. In the UK the lack of a widespread energy resource often restricts the potential for a feasible project and so end users' interest in the technology.	High	X	X	√	√	√	√	√	√	X	n/a
Lack of interest	Some end users are simply unwilling to explore the options or whether renewable heat is relevant to them. This is different from 'hassle' in that even if it was just as easy to install renewable heat as other alternatives, some users would simply not want to.	Medium	√	√	√	√	√	X	√	X	√	A lack of interest exacerbates some of the other barriers identified e.g. it may seem like more hassle to invest in renewables if the end user is not interested in doing so.
Awareness of technology	Lack of awareness of technology and potential benefits by end-users, policy makers and installers (plumbers, builders, architects etc). If end users are not aware that a technology exists, or that that technology could service their needs, they will not consider installing it.	Low	X	X	X	√	√	X	√	X	X	n/a

Geothermal

Barrier name	Description of barrier	Rank	Industrial	Commercial	Domestic	Public	Prevents	Delays	Capacity	Capacity factor	Impact on other barriers	Impact on other barriers: What and how?
Confidence in technology - high perceived risk	Lack of confidence in technology and commercial infrastructure due to small number of successful projects operating in UK. Particular problem in cases where disruption would have severe impacts such as loss of production, loss of customers and market share.	Low	X	X	X	√	√	X	√	X	√	Lack of confidence in technology increases 'hassle' factor due to need for additional research/information.
Lack of local council backing	Council support would encourage the development and management of geothermal projects.	Low	X	√	√	√	√	√	√	X	X	n/a

2. APPROACH TO MARKET RESEARCH INTO CONSUMER BARRIERS

Aim of the research

We have used a targeted piece of telephone market research to provide evidence on the demand-side barriers identified in the literature review[28]. The aim of this research was to back up our findings and to identify any additional barriers not already distinguished. We have also used the market research to inform our ranking of the importance of the different barriers. The findings were qualitative; the sample size and survey methodology are not intended to provide quantitative results (i.e. it would not be appropriate to use statements like 'X% of respondents said…').

Survey methodology

In discussion with BERR we designed a questionnaire which we ran through over the phone with each contact. Interviewees were asked about the barriers that they had faced and the measures that they though could help overcome them. A copy of the questionnaire can be found in Appendix 1. On the whole individuals were happy to help and to provide input.

Individuals interviewed

We interviewed individuals from a cross section of organisations[29]. Interviewees included representatives that have already deployed renewable heat technologies as well as organisations without prior experience, in order to get a broader perspective of the perceived barriers. In total 19 respondents were interviewed, from a range of different sectors, summarised in the table below.

Table 14 Summary of organisations interviewed

Organisation	Sector	Experience of renewable heat
Fairview New Homes	Property Developer	Yes
Anonymous	Property Developer	Yes
Anonymous	Property Developer	No
Anonymous	Property Developer	Yes
Anonymous	Heavy Industry	No
Anonymous	Food Manufacturer	No
Barnsley Metropolitan Council	Local Government	Yes
Sheffield Council	Local Government	Yes
Anonymous	District Heating Supplier	Yes
Renewable Energy Association	Trade Association	Yes

28 The focus has been on the non-domestic sector since BERR had also commissioned Element Energy to undertake a detailed piece of research for the domestic sector.

29 Including users from the commercial, industrial and public sectors. We attempted to contact organisations from the following groups: property developers; food and drink industry; retail sector; heavy industry sites; trade associations of renewable heat technologies; Local Government Association (for public sector portfolio holders); and English Partnerships. We also contacted representatives of different Government initiatives such as the Bio-energy Infrastructure Scheme, the Capital Grant Scheme for renewables and the CLA.

Organisation	Sector	Experience of renewable heat
Solar Trade Association	Trade Association	Yes
GSHP Association	Trade Association	Yes
Local Government Association	Association	Yes
Anonymous	DIY Retailer	No
English Partnerships	Regeneration Agency	Yes
Bio-energy Infrastructure Scheme (Defra)	Central Government	Yes
Capital Grant Scheme (AEAT)	Central Government	Yes
Country Land and Business Association	Association	Yes

Coverage

The scope of this research limited the number of organisations that we contacted. The cross section chosen aimed to ensure that the full range of barriers was considered and discussed; it should not be taken to be statistically representative of renewable heat users in the UK.

The table below shows that we covered users of the majority of the technologies assessed in this study (with the exception of geothermal heat). Most of the respondents had considered or deployed biomass, solar thermal and heat pumps while biogas had been considered by only a few interviewees. Organisations like trade associations (who may not use the renewables themselves, even if their members do) were asked for their comments on those technologies they were confident to comment on. Some respondents were not able to comment on individual technologies in much detail but instead provided a high level response.

Table 15 Technologies commented on by respondents

Organisations that use renewables themselves		
Interviewee's sector (number of interviewees)	**Technology deployed**	**Technology considered**
Property developer (4)	Biomass Solar Thermal GSHP	Biomass ASHP
Food manufacturer (1)		Biomass Solar Thermal Biogas
Local Government (3)	Biomass (DH) GSHP	
Retailer (1)	Solar Thermal GSHP	

Heavy industry (1)	AD (for electricity only)	Biogas, Biomass
District Heating Supplier (1)	Mainly Biomass (DH)	All District Heating Technologies
Organisations that do not use renewables themselves		
Interviewee's sector (number of interviewees)	**Technology commented on**	
English Partnerships (1)	Biomass Biogas	
Bio-energy Infrastructure Scheme (1)	Biomass	
Capital Grant Scheme (1)	Biomass	
Country Land and Business Association (1)	Biomass, GSHP	
LGA (1)	All (high level)	
Solar Trade Association (1)	Solar Thermal	
GSHP Association (1)	GSHP	
Renewable Energy Association (1)		

Findings from the market research

In summary[30]:

- Many of the barriers identified in the literature review were confirmed by the interviewees.
- Some respondents reported insurmountable barriers to renewable heat. For instance, heavy industry responded that process heat would be difficult or impossible to generate from renewables due to the high temperatures and the large volume of heat required[31].
- The importance of different barriers varied widely across the different interviewees. In the extreme, one respondent gave high importance to a particular barrier while others did not consider it to be a barrier at all.

  For instance, one property developer stated significant problems with the planning process for biomass technologies. In contrast, another property developer took the view that planning barriers were not an issue at all

30 The detailed feedback from the market research was presented to BERR as a spreadsheet an attached spreadsheet (at the request of some respondents, the individuals' names and organisations were deleted from it).

31 Note, in the analysis that follows and based on our research and discussion with BERR, this has not been interpreted to mean that all process heat would be impossible to source from renewables.

As we expected, the majority of the information collected was qualitative rather than quantitative. These findings have been incorporated into the barriers identified in this report.

Detailed findings from the market research

The detailed findings from this survey have been provided to BERR as a separate spreadsheet [SurveyResults_v1_0.xls].

Information from Element Energy

As noted above, Element Energy is conducting research in the domestic sector alongside this project. Their findings have now been published (TNS UK, 2007) and have been incorporated into the barriers identified in the next section.

Their research identified the following demand side barriers:

- lack of interest;
- lack of knowledge of renewable heat technologies and their benefits;
- hassle;
- inertia; and
- For tenants, a lack of influence on decision making.

Based on their research, Element Energy labelled environmental factors as 'unessential' for households when making their decisions. The main factors that do influence householders' investment decisions cited by Element are cost, reliability and meeting heat demand. Based on their research, there appears to be a lack of interest in alternative heat technologies as long as the existing heating system works and is affordable. These findings have been incorporated into our identification of demand side barriers to renewable heat.

3. MARKET RESEARCH QUESTIONNAIRE

Introduction

Hello, my name is XXX from Enviros Consulting in the Climate Change and Renewables Team. One of my colleagues, XXX, has given me your contact details.

Enviros is working on a project dealing with barriers to renewable heat on behalf of the Government (BERR). We are looking at the demand side barriers. We are looking for the non-financial barriers only. We are approaching selected organisations from various sectors in order to identify the main barriers and the key actions which could help to overcome those.

I would appreciate your views on this issue. Would you be willing to answer a couple of questions on the phone? Is now a good time for you to talk?

Your answers and contact data will remain confidential.

Before we start, could you tell me about your company's / organisation's main business activities?

1) Can you tell me briefly if you have considered renewable heat technologies in the context of your business and if so, which technologies?

IF NOT: Why not?

2) Now (for each technology you have considered) I will read out a couple of barriers based on our research. I would like you to comment on each barrier and answer some questions.

The next questions are asked for <u>each</u> of the barriers identified by the interviewee.

Barrier 1

3) Can you describe how this barrier has affected your companies approach to renewable heat technologies?

4) How important is this barrier for your company (high, medium, low)?

5) Does this barrier affect you already now or will it become important in the future?

6) Which actions/measures could be introduced to overcome the barrier?

7) Do you think this will be expensive or relatively cheap?

After running through all the barriers:

8) Are there any other barriers I have not mentioned you could think of?

If yes, repeat questions 5 to 9.

9) Do you have any other comments you would like to make?

4. QUANTITATIVE ANALYSIS OF HEAT DEMAND

Our assessment of the information available about renewable heat demand in the UK is presented below.

Total UK heat demand

In order to assess the potential for renewable heat, we have used BERR's estimates of total UK final heat demand in 2010, 2015, and 2020 as a starting point (shown in the table below as provided for this project). These include heat demand from all users (classified for this study as domestic, industrial[32], commercial and public). In addition, it is assumed that, over time, some heat previously supplied by electricity (and therefore classified as electricity rather than heat use in current data) will switch to supply by renewables (also shown in the table below).

Table 16 . BERR assumptions for 2010, 2015 and 2020 (TWh)

	Final heat demand (TWh)			
Year	Heat demand pre 2020 target (excludes electricity)	Switch from electricity to renewable heat	Heat demand post 2020 (excludes electricity)	% change of total year on year
2005	761	0	761	
2010	695	0	695	-1.8%
2015	665	4	669	-0.8%
2020	625	12	637	-1.0%

Source: *BERR. Net calorific values; for consistency with other data in our analysis we have converted all gross values to net using a conversion factor for tonnes of oil equivalent (toe) of 95% (DUKES 2006).

Assuming a constant rate of change year on year over each five year period, the projections show a reduction in heat demand of between 1.8% and 0.8% once fuel switching from electricity is taken into account. We understand that this reflects an assumption of improving energy efficiency over time.

Heat demand by end user

Heat demand by sector

For the purposes of this study, it is necessary to consider how this demand is split across different users of heat. To do this, we have taken heat data from a different BERR source (Energy Trends) which relate to 2005 and have assumed that the proportionate contribution of each sector remains constant over time[33]. These proportions are shown in the table below.

32 Including process heat

33 This is a simplification; the extent to which energy efficiency improves in any sector and will offset any growth in demand/ be magnified by any underlying drop in demand will vary. It will be influenced by (amongst other things) the nature and scope of additional efficiency savings available, energy prices and end-users' propensity to make these changed. Detailed modelling of this sort was not the focus of this project and hence in the absence of more detailed information that is consistent with the total demand projections above we have used this pro rata approach.

Table 17 Share of heat demand by sector and end use in 2005 (TWh)

Sector	End use	% of sector demand	% of total UK demand
Domestic	Space heating	69.9%	
	Water heating	27.0%	
	Cooking	3.1%	
	Other	0.0%	
	Sum Domestic	*100%*	*57%*
Industrial	Space heating	15%	
	Other: process heating*	85%	
	Sum Industrial	*100%*	*29%*
Commercial	Space heating	71.1%	
	Water heating	13.4%	
	Cooking	15.4%	
	Other	0.0%	
	Sum Industrial	*100%*	*4%*
Public	Space heating	71%	
	Water heating	13%	
	Cooking	15%	
	Other	0%	
	Sum Public	*100%*	*10%*
All	**Total**		**100%**

Source: DTI (2007) *In the industrial sector the group "Other" includes heat used for drying/separation and process heat. Water heating and cooking are also included in this group but are considered negligible by DTI.

Assumptions for new build

It may be more straightforward to encourage the use of renewable heat in new buildings than in existing premises (due, for instance, to the increased complexity and cost of retrofit for some technologies). The table below sets out the assumptions that we have used to calculate the volume of heat demand that new build allows us to target each year.

In the absence of detailed data that is consistent with the high level total heat demand information, we have assumed that:

- the number of new houses (in the domestic sector) and the new floor area (in the other sectors) are built at a constant rate;
- that the total housing stock/ floor area remains constant (i.e. new build is offset by buildings demolished/ left unused)[34]; and

34 This means that changes to the average level of heat demand per dwelling or unit floor area are driven by the assumed reduction in total heat output (see section 4.1) rather than assumptions about growing or falling numbers of users.

- new buildings have the same average heat demand as all other premises in that sector in a particular year (hence total heat demand declines gradually over time) [35].

Table 18 Assumptions for new build in each sector

Sector	Year	Annual new build in a particular year	Units	Annual heat demand from new build in particular year(TWh)	% of total sector heat demand
Domestic	2010	240,000	Number of dwellings	3.5	1%
	2015	240,000		3.2	1%
	2020	240,000		2.9	1%
Industrial	2010	6,130,000	m2	1.1	1%
	2015	6,130,000		0.9	0%
	2020	6,130,000		0.8	0%
Commercial	2010	6,838,350	m2	0.7	2%
	2015	6,838,350		0.6	2%
	2020	6,838,350		0.5	2%
Public	2010	4,543,650	m2	0.6	1%
	2015	4,543,650		0.6	1%
	2020	4,543,650		0.5	1%

Source: Enviros calculations based on heat projections from BERR and building characteristics from DCLG (2007).

Assumptions for replacement

We have assumed that, of the heating systems that remain once new build is taken into account, each is replaced once every 15 years (Friends of the Earth, 2006) (we have made the same assumption for all sectors).

- In practice, some heating systems may be kept for longer than this, particularly if they are only infrequently used or installed for back-up purposes for non-essential operations.
- Equally others may be replaced more quickly e.g. due to changes in the use of the building, major refurbishment or technical problems.

The purpose of this assumption is to indicate that, on average, 1 in 15 heating systems will be replaced in any particular year. The volume of heat that this implies is shown in the table below. As for new build we have assumed that each replacement heating system results in the same heat demand as the average system,

35 It could be argued that, on average, the heat demand from new properties will be lower than the average of the existing stock, due to improvements in energy efficiency and building design. However, we might also expect the energy efficiency of the existing stock to improve over time due in part to government policies to achieve this. As can be seen from Table 18, new buildings represent only a small proportion of total heat demand in any one year and so in the absence of further detailed research we consider this simple assumption appropriate in this instance.

which for the purposes of this project we consider reasonable, but the same caveats apply.

Table 19 Assumptions for replacement in each sector

Sector	Year	Replacement annual heat demand (TWh)	% of sector heat demand in any one year
Domestic	2010	26.2	7%
	2015	24.1	6%
	2020	21.8	6%
Industrial	2010	2.7	6%
	2015	2.3	6%
	2020	1.9	5%
Commercial	2010	1.7	7%
	2015	1.5	6%
	2020	1.2	5%
Public	2010	4.4	6%
	2015	3.7	6%
	2020	3.1	5%

Source: Enviros

Compatibility of different renewable heat categories to operate together

Table 20 Technology pairings at the same site

	Biomass	Biogas	Solar thermal	ASHP	GSHP
Biomass		X	✓	✓	✓
Biogas	X		X	X	X
Solar thermal	✓	X		✓	✓
ASHP	✓	X	✓		X
GSHP	✓	X	✓	X	

Source: Enviros

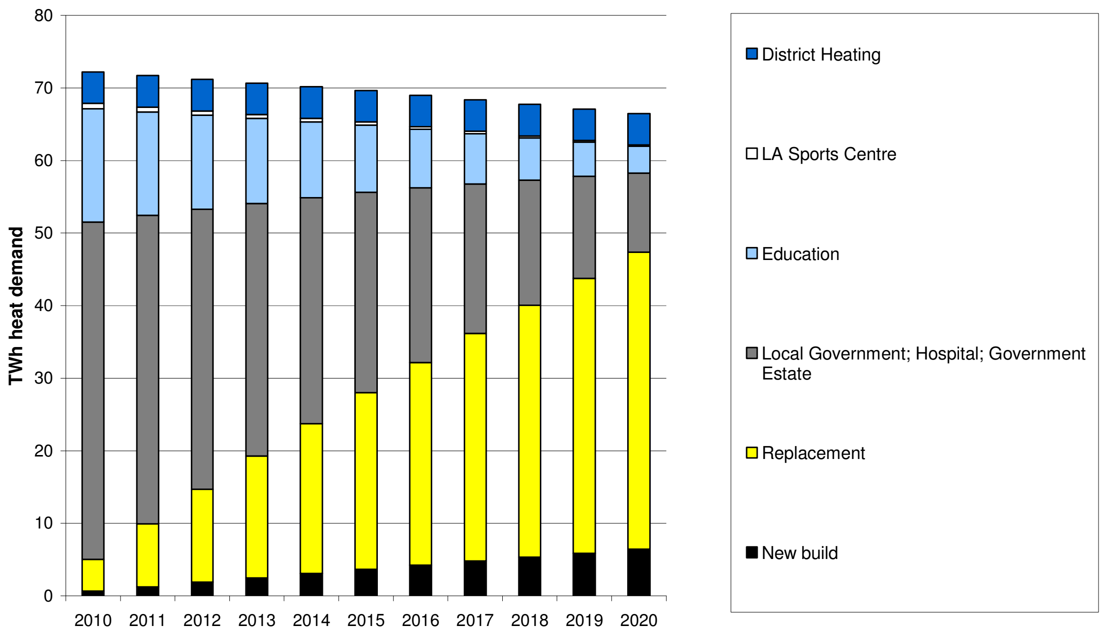
It is worth noting that practically any combination of renewable heat technologies could be feasibility used within the same buildings however certain combinations are rare.

Discussion around treatment of replacement

In our scenarios we have assumed that if replacement heat is not converted to (or new build does not comprise) renewables in the year in which it is replaced (or is built) then it is no longer available to be targeted by renewables in the time frame modelled. As a result there is a shortfall from these segments for the public and industrial sectors in the later years (shown by the darker colours in Figure 6).

One of the factors that we would highlight is that the sooner the accelerated uptake of renewables is encouraged, the greater the contribution of new build/ replacement can be by 2020. The diagram below (Figure 10) takes the public sector as an example. It illustrates that by 2020, based on the assumptions we have made, around 65% of heating equipment could have been replaced. This represents around 41TWh of heat in 2020, around 150% of the Scenario 3 projection for this sector i.e. all of that demand could theoretically come from units that had been replaced or built over the preceding 10 years, but only if sufficient installs renewables prior to 2020.

Figure 10 Public sector segment profiles over time treating replacement cumulatively



Source: Enviros

5. DEMAND BREAKDOWN BY SEGMENT

The breakdown of demand by segment is illustrated in Figure 7 to Figure 9 on page 24. The detailed data behind these figures is provided in the tables below.

Table 21 Scenario 1: demand breakdown by segment

		2010	2015	2020
Domestic	New build	105,101	491,715	1,666,311
Domestic	Replacement	746,783	4,226,307	14,797,673
Domestic	Social housing	0	0	0
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Environmentally aware	73,928	73,928	73,928
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Not environmentally aware	336,781	336,781	336,781
Domestic	Owner occupied\ On grid	1,375,689	1,375,689	1,375,689
Domestic	Owner occupied:Terraced, Purpose-built, Other\ Off gas grid	97,758	97,758	97,758
Domestic	Rented buildings	0	0	0
Industrial	New build	22,237	274,501	1,126,636
Industrial	Replacement	54,653	1,063,709	4,472,251
Industrial	Space heat : Warehouse	0	0	0
Industrial	Space heat : Other buildings	0	0	0
Industrial	Process heating	1,022,746	1,225,900	1,530,534
Commercial	New build	3,288	47,677	136,837
Commercial	Replacement	2,597	135,764	403,242
Commercial	Offices	0	0	0
Commercial	Hotels; Catering	12,433	12,433	12,433
Commercial	Sport; Leisure	4,682	4,682	4,682
Commercial	Retail	0	0	0
Public	New build	12,704	269,422	1,247,679
Public	Replacement	88,201	1,115,075	5,028,100
Public	Local Government; Hospital; Government Estate	1,650,362	2,889,277	5,153,186
Public	Education	408,377	408,377	408,377
Public	LA Sports Centre	14,585	14,585	14,585
Public	District Heating	216,716	893,679	3,685,297

Table 22 Scenario 2: demand breakdown by segment

		2010	2015	2020
Domestic	New build	105,101	683,671	2,978,271
Domestic	Replacement	746,783	5,953,911	26,605,317
Domestic	Social housing	0	0	0
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Environmentally aware	73,928	73,928	73,928
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Not environmentally aware	336,781	336,781	336,781
Domestic	Owner occupied\ On grid	1,375,689	1,375,689	1,375,689
Domestic	Owner occupied:Terraced, Purpose-built, Other\ Off gas grid	97,758	97,758	97,758
Domestic	Rented buildings	0	0	0
Industrial	New build	22,237	369,809	1,349,256
Industrial	Replacement	54,653	1,444,943	5,362,729
Industrial	Space heat : Warehouse	0	0	0
Industrial	Space heat : Other buildings	0	0	0
Industrial	Process heating	1,022,746	1,457,211	4,588,229
Commercial	New build	3,288	101,964	518,952
Commercial	Replacement	2,597	298,625	1,549,588
Commercial	Offices	0	0	0
Commercial	Hotels; Catering	12,433	12,433	12,433
Commercial	Sport; Leisure	4,682	4,682	4,682
Commercial	Retail	0	0	0
Public	New build	12,704	449,437	1,537,106
Public	Replacement	88,201	1,835,131	6,185,808
Public	Local Government; Hospital; Government Estate	1,650,362	2,949,330	8,235,472
Public	Education	408,377	408,377	408,377
Public	LA Sports Centre	14,585	14,585	14,585
Public	District Heating	216,716	1,108,624	5,671,242

Table 23 Scenario 3: demand breakdown by segment

		2010	2015	2020
Domestic	New build	105,101	811,298	4,236,404
Domestic	Replacement	746,783	7,102,561	37,928,512
Domestic	Social housing	0	0	0
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Environmentally aware	73,928	73,928	73,928
Domestic	Owner occupied\ Detached & Semi-detached\ Off gas grid\ Not environmentally aware	336,781	336,781	336,781
Domestic	Owner occupied\ On grid	1,375,689	1,375,689	1,375,689
Domestic	Owner occupied:Terraced, Purpose-built, Other\ Off gas grid	97,758	97,758	97,758
Domestic	Rented buildings	0	0	0
Industrial	New build	22,237	706,918	2,535,261
Industrial	Replacement	54,653	1,652,243	5,918,377
Industrial	Space heat : Warehouse	0	0	0
Industrial	Space heat : Other buildings	0	0	0
Industrial	Process heating	1,022,746	1,457,211	6,498,927
Commercial	New build	3,288	194,675	1,194,131
Commercial	Replacement	2,597	449,166	2,781,231
Commercial	Offices	0	0	0
Commercial	Hotels; Catering	12,433	12,433	12,433
Commercial	Sport; Leisure	4,682	4,682	4,682
Commercial	Retail	0	0	0
Public	New build	12,704	549,447	2,028,427
Public	Replacement	88,201	2,235,171	8,151,094
Public	Local Government; Hospital; Government Estate	1,650,362	2,994,046	5,478,972
Public	Education	408,377	408,377	408,377
Public	LA Sports Centre	14,585	14,585	14,585
Public	District Heating	216,716	1,545,226	11,017,764

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