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**Regulating the heat market to encourage
low-carbon technologies.
A comparison of the UK and Germany**

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Disclaimer

Except where otherwise stated and acknowledged I certify that
this dissertation is my sole and unaided work.

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Katharina Umpfenbach

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Abstract

Although accounting for more than half of end use energy demand, heat is a policy blindspot in the UK and Germany. Support measures have almost exclusively focused on the electricity and transport sectors.

On the basis of fifteen stakeholder interviews and the analysis of policy documents, this study examines how governments could encourage the uptake of renewable heat technologies and CHP. Germany and the United Kingdom serve as case studies, allowing to highlight common themes and differences in the respective policy frameworks. Based on an analysis of barriers to low-carbon heat, the effectiveness and acceptability of potential future policy options are evaluated.

A market transformation approach emerges as an appropriate framework for the short and medium term. Stable financial incentives for all sectors could be combined with minimum renewable heat requirements in the buildings sector. In the long-term, however, a system step change from stand-alone systems to community solutions will be required. Governments in both countries need to facilitate organisational changes alongside technological transformation by adapting the underlying legal and regulatory framework.

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List of Acronyms

BAFA	Bundesanstalt für Wirtschaft und Ausfuhrkontrolle (Federal Office of Economics and Export Control)
BMVBS	Bundesministerium für Verkehr, Bau and Stadtentwicklung (Federal Ministry of Transport, Building and Urban Affairs)
BMWi	Bundesministerium für Wirtschaft und Technologie (Federal Ministry for Economics and Technology)
BMU	Bundesministerium für Umweltschutz, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BRE	Building Research Establishment
CCL	Climate Change Levy
CERT	Carbon Emissions Reduction Target
DBERR	Department for Business, Enterprise and Regulatory Reform (until July 2007: DTI)
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DG TREN	Directorate General for Energy and Transport
DH	District Heating
DTI	Department of Trade and Industry (since July 2007: DBERR)
EC	European Commission
EEC	Energy Efficiency Commitment
EEG	Erneuerbare Energien Gesetz (Renewable Energy Act)
EnEV	Energieeinsparverordnung (Energy Conservation Act)
EP	European Parliament
ESCos	Energy Service Companies
EST	Energy Saving Trust
EU	European Union
ETS	Emissions Trading Scheme
GSHP	Ground-source heat pumps
Int.	Interview
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Loan Corporation)
LCBP	Low Carbon Buildings Programme
MAP	Marktanreizprogramm (Market Stimulation Programme)
MS	Member States of the EU
OFGEM	Office of Gas and Electricity Markets
PV	Photovoltaic
RHO	Renewable Heat Obligation
RO	Renewables Obligation
ROCs	Renewable Obligation Certificates

1 Introduction

If energy policy was a fairy tale, heat would be its Cinderella. For until recently, the attention of policy-makers who aim at cutting carbon emissions has almost exclusively focused on electricity and increasingly biofuels. In both sectors, targets and support mechanisms are in place whereas the production of heat has been neglected like the unloved step-sister. This is not justified by the numbers. Heating and hot water account for 49% and 58% of end use energy in the UK and Germany, respectively, and within the residential sector, its share rises to over 80% of the total energy consumption. Only a very limited part of this energy is generated from renewable sources: In 2005, renewables contributed approximately 6% to heat production in Germany and less than 1% in the UK, and the potential for cogeneration is likewise underdeveloped in both countries.

Just as the statistics call for more political attention on the carbon savings that could be achieved in the heat sector, a review of the technological options shows that the means for delivering those savings are available. Biomass boilers, solar thermal panels, heat pumps and deep geothermal systems and CHP are mature technologies which, many argue, can replace fossil fuel heating devices at comparably lower costs per displaced tonne of carbon than most low-carbon options in the transport and electricity sector (FES, 2005, Green Alliance, 2007). According to model calculations of the Environmental Change Institute's '40% House' report, low-and-zero carbon technologies could provide over 80% of UK heat demand by 2050 (Boardman et al., 2005).

However, if such ambitious targets are to be achieved, the policy blindspot has to give way to a supportive regulatory framework for low-carbon heat. This is why this study explores how effective policy could be conceived to promote low-carbon heating technologies. The research question will be broken down into the following sub questions:

- What are the barriers to low-carbon heat and do they justify policy intervention?
- What are the aims and characteristics of effective regulation to encourage low-carbon technologies in the heat markets?
- What is likely to be politically acceptable?

This analysis will compare the UK and Germany as two case studies. The two countries are comparable in size – representing the two largest economies in Europe – as well as in their ambition to slash CO₂ emissions. While the overall aim is the same, the point of departure differs substantially. Not only are the infrastructures currently in place dissimilar in terms of the fuels used and in regard to the building stock's structure, but, more importantly, the two countries have so far chosen different policy approaches to renewable energies and achieved different outcomes.

Therefore, as a first step in the search for an effective heat market policy, this paper will examine the strengths and weaknesses of the existing regulatory frameworks in Germany and the UK, respectively, with the aim of identifying which are the characteristics that render regulation effective. This provides the context for the following discussion of policy options for addressing the barriers to low-carbon heat. Finally, this paper will ask which could be the value added of new legislation at the EU level.

Within this framework, the main issues which need consideration include:

- objective and targets of heat market regulation;
- appropriate scope of regulation in terms of economic sectors and technologies covered;
- the role of district heating (DH);
- the debate about policy differentiation between technologies.

The study aims at covering all economic sectors, i.e. the use of heat in industrial processes and in buildings. Yet, the discussion of building-related issues takes up a larger share of the space for

three reasons: buildings represent two thirds of overall heat demand (Graph 6); they have traditionally been addressed with separate policy instruments; and lastly, the focus on buildings also results from the interviewees' perspective, a majority of which deals with residential buildings.

In the case of buildings, final heat demand is influenced by more than technology decisions. Insulation, the building fabric, ventilation systems as well as perceptions of what constitutes a comfortable indoor temperature have a significant impact on the overall energy consumption resulting from heating and cooling. Although this study focuses on renewable heat and CHP, interactions and, sometimes tensions, between policy instruments to increase energy efficiency on the one hand and encouragement of renewables on the other hand will be an integral part of the analysis.

The basis of the analysis are stakeholder interviews, policy documents and position papers since the perceptions of stakeholder are crucial when identifying current barriers to the uptake of low-carbon heat, and the level of acceptance of various policy options. The aim is to first map the stakeholders involved in order to subsequently examine how they conceive the problem and how their interest might shape future policy-making in the heat sector.

2 Methodology

2.1 Stakeholder Mapping

This study relies on qualitative key-informant interviews as its central source of primary data. The qualitative method allows capturing the multitudes of perspectives on the problem (Kvale, 1996) which precisely is the objective of a stakeholder analysis. The aim of sampling interviewees has been to represent the different stakeholder groups by at least one interviewee in both countries.

Graph 1: Stakeholder Mapping: UK and Germany

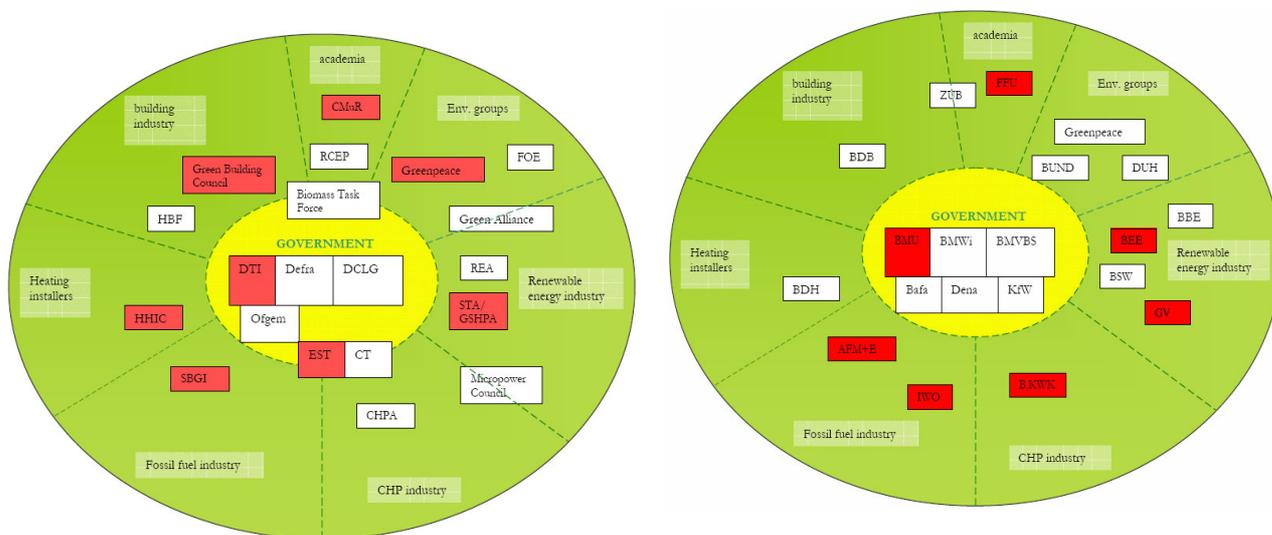


Table 1: List of interviewees

UK	
Gary Shanahan	Department for Business, Enterprise and Regulatory Reform (DBERR)
Dr Nick Eyre	Energy Saving Trust (EST)
Dr Brigdget Woodman	Centre for Management under Regulation (CMuR), University of Warwick
Robin Oakley	Greenpeace UK
David Matthews	Solar Thermal Association (STA)/ Ground Source Heat Pumps Association (GSHPA)
John Stiggers	Society of British Gas Industries (SBGI)
Roger Webb	Heating & Hotwater Industry Council (HICC)
Jules Saunderson	Green Building Council
Germany	
Dr Volker Oschmann	Bundesministerium für Umweltschutz, Naturschutz und Reaktorsicherheit (BMU) – Environment Ministry
PD Dr Lutz Mez	Forschungsstelle für Umweltpolitik (FFU) – Environmental Policy Research Centre, Free University
Norbert Kortlüke	Bundesverband Erneuerbare Energien (BEE) – Renewable Energy Association
Werner Bußmann	Geothermische Vereinigung (GV) – Geothermal Energy Union
Adi Golbach	Bundesverband KWK (B.KWK) – CHP Association
Dr Moritz Bellingen	Institut für wirtschaftliche Ölheizung (IWO) – Institute for Efficient Oil Heating
Bernd Schnittler	Außenhandelsverband für Mineralöl und Energie (Trade Association Petroleum and Energy Traders)

As Graphs 1 shows, this objective has been achieved in parts. Red indicates the organisations of which representatives have been interviewed and the stakeholder group they belong to. All but one of the seven stakeholder groups are represented in the UK sample, and the four main groups in the German sample. In total, fifteen interviews have been conducted (see list in Table 1) after 38 people had been contracted. Positions of central institutions that are not represented in the interviewee sample (indicated in white in Graph 1) have been analysed on the basis of documents and email contact.

2.2 Interview methodology

Most interviews were conducted in person and two by phone. The interviews followed a rough interview guide with an outlined set of questions (see Appendix 2). The interview guide ensures a certain degree of comparability as crucial discussion points will be touched upon in each interview. However, the interviews are only semi-structured with specifically open entry questions. This approach ensures that aspects the interviewees consider most relevant are covered – for in a cross-cutting and highly complex issue as the heat market, the definition of the problem shapes policy outcomes. Furthermore, semi-structured interviewing allows exploring unexpected directions which might develop into emerging themes and can themselves be integrated into a revised interview guide. In general, an iterative process of data collection, analysis and literature review is sought. Data have been selectively transcribed where needed and paraphrased in its largest part since the overall goal is content analysis of the text. Thus, non-verbal information or the sequence of statements are not of interest unless they hint at how interviewees prioritize issues (Meuser & Nagel, 1991). Creating labelled thematic blocs and, in a second step, coding them into categories helped to interpret the data in relation to the question which low-carbon heat policies are necessary, feasible and acceptable.

In order to make sure that the data are reliable, statements have been checked for internal consistency, and as much as possible, meaning of ambiguous concepts has been clarified in the course of the interview (Kvale, 1996). Validating the interpretation is crucial, all the more as only one or two representatives from every stakeholder group could be interviewed in each country and the aim is nonetheless to explore the position of the interest group as a whole. Therefore, validation procedures include triangulation with policy documents and other interviewees' statements. Also, interpretations have been opened to comments from the interviewees, including the opportunity to object in cases of direct quotes. It is hoped that the cross-country comparison which will allow identifying common conflicts and themes for the UK and Germany increases generalizability of the results, at least in regard to other EU countries.

In the course of the study, several limitations of the methodology have become obvious. One problem is the limited interview sample, its bias towards the residential sector, and, in some cases, difficulties to differentiate between personal opinions and the organisation's position because the issues often develop faster than official lines can be agreed upon. The evolving interview guide, although highly desirable, has proven to be another challenge at the analysis stage since several issues had not been clearly identified in the early interviews (mostly those with German stakeholder), thus affecting comparability. However, follow-up questions and cross-checking with other sources have helped to ease these problems.

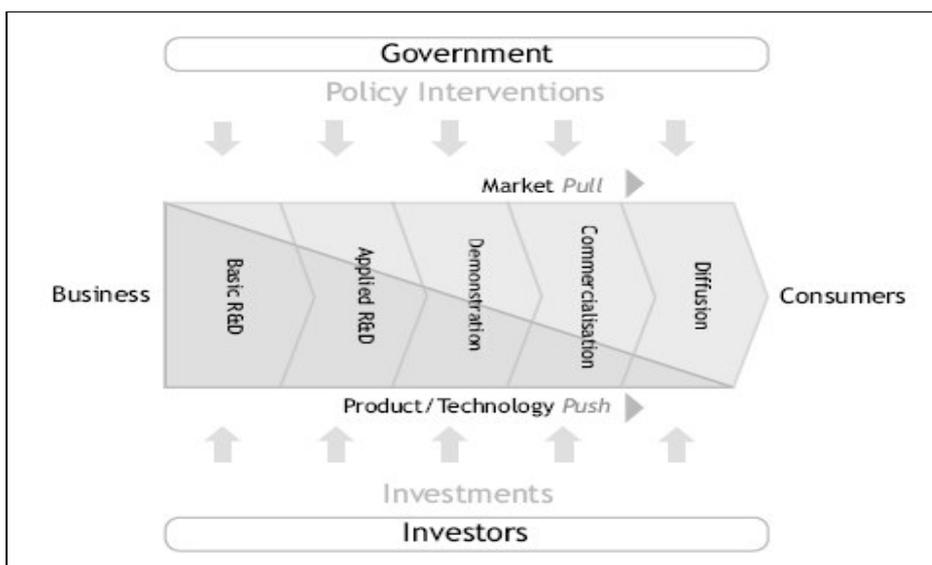
2.3 Theory

Although this study does not apply one particular theoretical lens, it is nonetheless informed by bodies of literature – the relevant theories include innovation theory, the concept of socio-technical systems as well as the market transformation framework to analyse policy. Part of the

analysis process is to examine to what extent elements of the interview responses and position statements in documents can be tied back to theoretical concepts.

The room is too limited to review the innovation literature in detail (see instead: Foxon, 2003; Grubb, 2004; Duke and Kammen, 1999), but, for the purpose of this study, it is important to stress the transition from linear models such as the ‘innovation chain model’ (Graph 2) to a stronger emphasis on *systems* of innovation which incorporate the side of users, and intermediary actors like retailers and installers as well as interaction between different manufacturers. Thereby, the focus has widened from purely economic aspects relating mostly to cost reductions to encompass interactive processes of knowledge creation and learning, and cultural and institutional change into the concept of innovation. In this perspective, technology emerges from being an interchangeable instrument which can be replaced once the parameters change and appears instead as a socio-technical system, i.e. as embedded in grown behavioural patterns with certain cultural meanings and underpinned by a highly adapted regulatory framework (Palmer et al., 2006; Geels 2004).

Graph 2: The innovation chain model

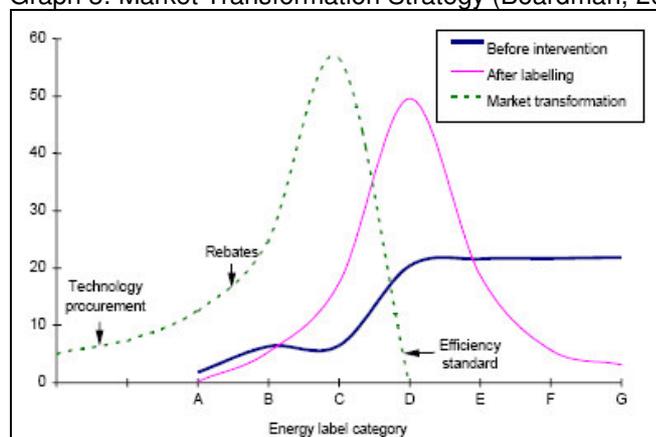


Source: Foxon, 2003, p. 18

Together with the growing pressure to abate climate change, this has led to a reassessment of the role of regulators and government. The model of ‘induced technological change’ is built on the observation that most technical change, even if carried out by the private sector, is responding to government policies and market conditions dominantly shaped by government. Therefore, development of technology costs cannot be considered entirely exogenous, rather government can induce and steer technological change (Edenhofer et al., 2006; Grubb et al., 2002).

The market transformation approach offers a framework for conceiving this type of policy. After the strong focus on users in the demand side management approaches in the 70s and 80s, market transformation directly targets manufacturers and retailers in order to change the products available to consumers (Blumstein et al., 2000). Ideally, market transformation strategies intelligently combine information on energy use of products (labels), incentives for high performing products (rebates, grants) and minimum standards (regulation) that force wasteful products out of the market, thereby gradually moving the whole stock towards higher efficiency as illustrated in Graph 3 (Boardman, 2004a, 2004b). Even though original developed for energy efficiency of white goods, the framework has already been applied to buildings (Boardman et al., 2004). It will be argued here that the toolkit is powerful in the case of renewable heat as well, but can only succeed when combined with additional elements.

Graph 3: Market Transformation Strategy (Boardman, 2004b, p. 169)



3 Where we are now: Existing policies in the UK and Germany

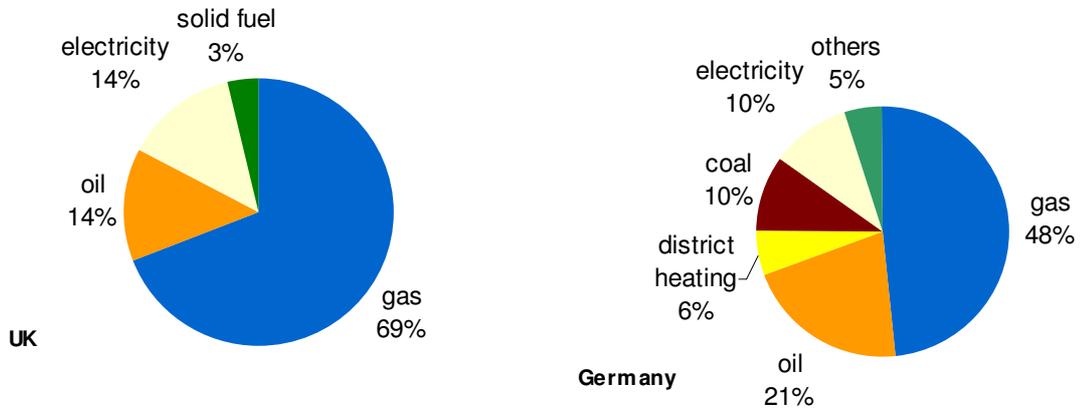
In the first section, an overview over the current energy mix in the heat market is presented, followed by a list of alternative low-carbon options.

In the following sections, the policy framework currently in place in both countries and at the European level is compared according to the types of instruments employed and the technologies covered, as well as in regard to the extent and time frame of the respective budgets. Where available, evaluations of the policies' achievement have been included (see Tables 3 and 4).

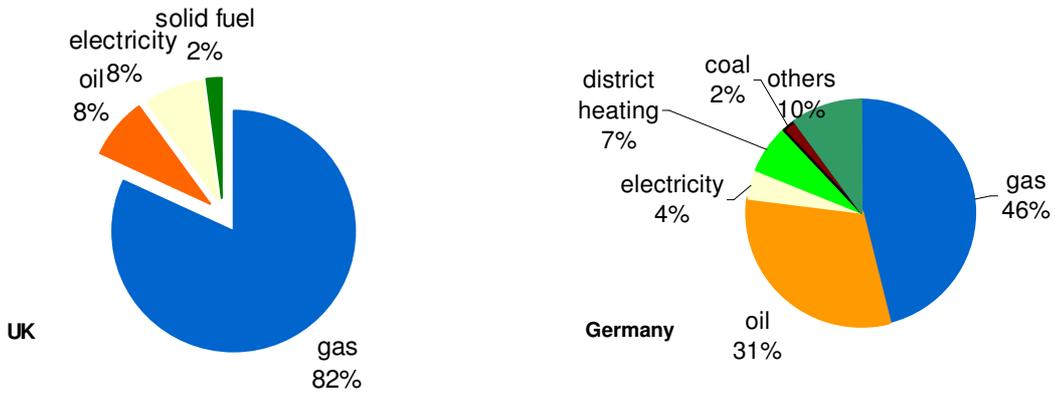
3.1 Technologies

As Graphs 4 and 5 illustrate, the heat market is currently dominated by gas in the UK and by gas and oil in Germany. Renewable heat represents only a share of 6% and less than 1% in Germany and the UK, respectively, mostly resulting from traditional biomass (Graph 8). This snapshot conceals the different dynamics in the two European markets. Whereas the German renewable heat market has grown steadily over the last decade, the total as well as the relative share of renewable heat production is falling in the UK due to tighter emission controls for old wood-fuel burning devices (DTI, 2007b). Another difference is the higher penetration of DH in Germany which has inherited a substantial infrastructure from the former GDR. By contrast, the demand side of the heat market is very similar in the UK and Germany (Graphs 6, 7). In both countries the residential sector consumes about half of the heat produced, and within that space heating largely dominates the demand. Industry with its needs for process heat is the second largest consumer of heat, followed by the commercial sector. Regarding the distribution of heat to households, a distinctive feature of the UK market is its 93% penetration rate of individual boilers (Int. N. Eyre).

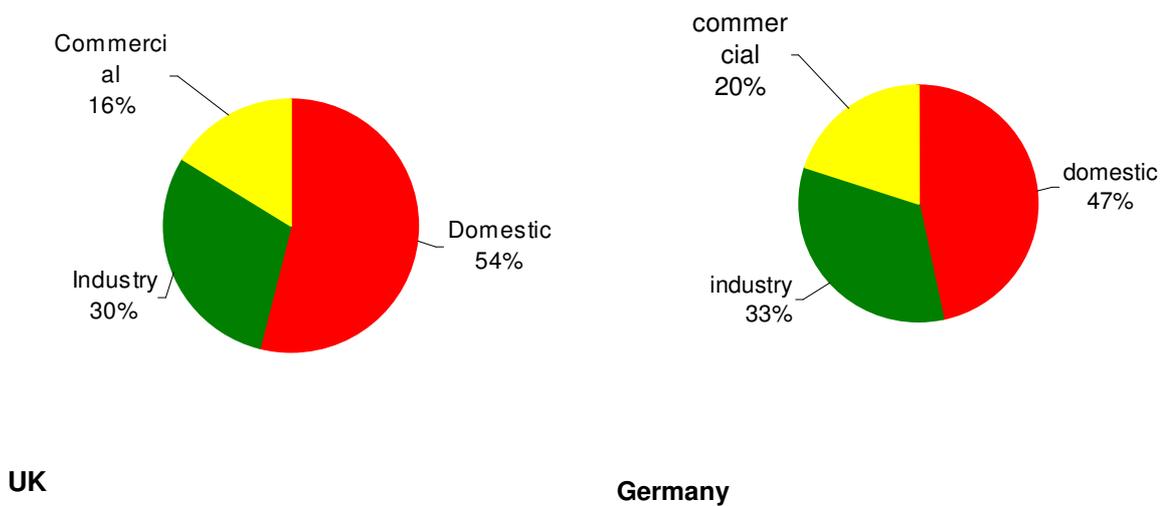
Graph 4: Share of heating fuels (2005)



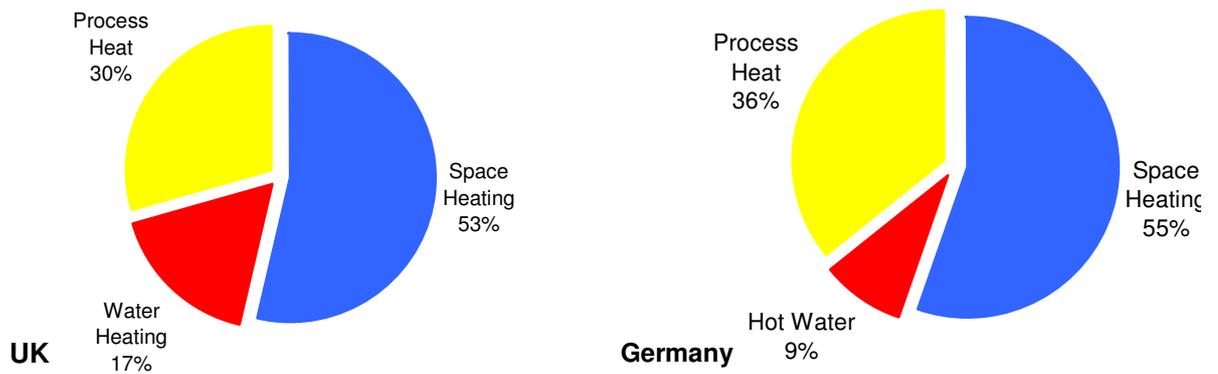
Graph 5: Residential sector heating fuels (2005)



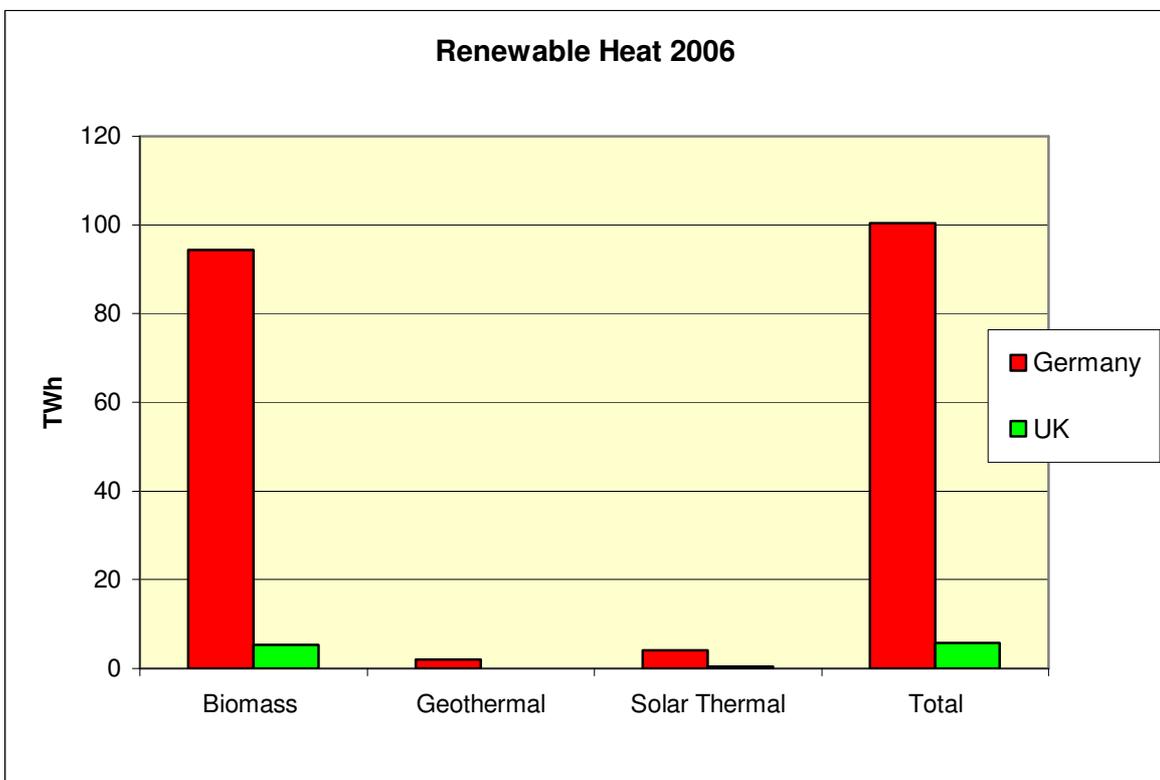
Graph 6: Heat Demand by Sector (2005)



Graph 7: Heat Demand by End Use (2005)



Graph 8: Renewable Heat Technologies



Source: Graphs 4–8 based on DTI, 2007b, BMWi, 2007, BEE, 2007.

Table 2 provides a list of low-and-zero carbon heat technologies which are described in more depth in Appendix 2. Estimates on the future potentials have to be regarded as indicative since assumptions in different studies vary greatly.

Table 2: Technologies

Energy source	Technology	Application	Development stage	TWh Output (2006)		Potential in TWh by 2020	
				GER	UK	GER	UK
solar energy	Solar thermal	hot water, heating support, cooling	mature, cooling: early adopter	4.1	0.4	14.6–30	5.8–17.1
geothermal energy				1.9	0.06	13.4–32	
	GSHP	heating, cooling	mature		0.03		7.6–20.1
	Deep geothermal	heating, cooling	mature		0.03		
bioenergy				94.4	5.32	105–118.3	13.5–34.3
	Wood-based biomass boilers	heating	mature				
	Biogas	heating	mature				
	Co-firing	process heat	mature				
	Blending biofuel into heating oil	heating	demonstration				
	Feeding biogas into gas grid	heating	demonstration				
CHP				130.6	59.3	166.6	112.9–242.3
	Biomass CHP	heating, electricity	mature				
	Stirling engine MicroCHP	heating, electricity	near market				
	Reciprocating engine MicroCHP	heating, electricity	near market				
	Fuel cell CHP	heating, electricity	development				
	Steam turbine CHP	heating, electricity	mature				
	Gas turbine CHP	heating, electricity	mature				
	Combined cycle CHP	heating, electricity	mature				

Sources: FES, 2005 (UK); Nitsch, 2007 (low estimate potential Germany), BEE, pers. comm. (high estimate)

3.2 EU Legislation

In order to achieve its goal of increasing the share of renewable energy in primary energy production to 20% in 2020 (EC, 2007), the EU has so far introduced frameworks for renewable electricity (2003/77/EC) and biofuels (2003/30/EC). Both sectors have been attributed 2010

targets of 21% for electricity and 5.75% for the biofuel share in petrol consumption, respectively. By contrast, the EU has not yet created specific legislation for renewable heating and cooling. However, two instruments – the cogeneration directive (2004/8/EC) and the directive on the energy performance of buildings (2002/91/EC) – already stimulate the low-carbon production of heat.

The cogeneration directive obliges member states (MS) to introduce support schemes for CHP based on the useful heat demand and primary energy savings. MS governments are asked to facilitate grid access and establish harmonized efficiency reference values. Furthermore, when complying with the directive, the EU members have to evaluate their national potential for cogeneration since the directive does neither contain national targets nor an EU-wide penetration target for CHP.

The core of the buildings directive is the introduction of energy certification for buildings but the directive also introduces an obligation to regularly inspect boilers. Moreover, the directive stipulates that developers of new buildings with over 1,000m² floor space have to assess the technical and economic feasibility of using renewable energy supply, CHP, DH or heat pumps. However, new-build only represents a small fraction of the entire EU building stock and even in those cases introduction of low-carbon heat is not mandatory.

In its 2005 Biomass Action Plan (COM 2005/628), the European Commission (EC) has recognized that existing regulation does not suffice to tap the potential of renewable heat. It has announced work towards heat market regulation – “the missing piece in the jigsaw” (EC, 2005, p. 7) – and was supported in this initiative by the European Parliament (EP) which has adopted a resolution in February 2006 encouraging the Commission to draft a renewable heating and cooling directive (EP, 2006). According to the Biomass Action Plan, the Commission also considers to amend the building directive in order to lower the threshold building size which

leads to mandatory assessment of alternative energy systems and to extend the obligation to major renovations. For biomass specifically, the Commission aims at developing a European spot market for pellets and chips and establishing standards for those products. MS are encouraged to produce national biomass action plans, with specific support for DH infrastructure as they represent an efficient way to distribute biomass produced heat.

The legislative process for the potential future renewable heating and cooling directive has stopped at the state of impact assessment. The EC has carried out a public consultation whose results have been published in November 2006 (DG TREN, 2006).

3.3 Existing Policy Instruments in Germany

As on the EU level, no specific legislation for promoting renewable heat has been enacted so far by the German Federal government. But like the EC, the German Environment Ministry has recognized the need for legislative action and announced to introduce a draft Renewable Heat Law into Parliament before the end of 2007 (Gabriel, 2007).

At present, targeted legislative efforts to increase the use of renewable energy are restricted to the electricity sector where the Renewable Energies Act guarantees feed-in tariffs for electricity from renewable sources and the biofuels sector which profits from tax exemptions. However, low-carbon heat is not entirely deprived of government support.

In terms of installed capacity of renewable heat, the market stimulation programme (Marktanreizprogramm – MAP) is the most important support mechanism in Germany. The programme' annual budget has steadily expanded since it started in 1999 and reached €213m (£142m) in 2007 compared to €81.4m (£54.3) in 2002. To date the MAP is financed in parts from the revenue of the ecotax. In the future, the government intends to also use the income from auctioning under the EU Emissions Trading Scheme (ETS) and increase the budget to up to

€350m (£233m) (Bundesregierung, 2007). The MAP supports solar thermal collectors, biomass boilers, heat generation from deep geothermal energy, and the construction of community heating networks. Heat pumps and CHP plants are not eligible for funding. On average, the grants cover about 12% of the devices' investment costs. Although the MAP is open to local communities as well as SMEs, it has been mostly used by private householders (Langniß et al. 2004, 2006). Having leveraged investment of almost €5bn (£3.3bn), the programme can be considered successful in increasing the market penetration of renewable heat in this sector (IEA, 2007).

Whereas the MAP provides financial support for changes of the existing building stock, the Energy Conservation Act (Energieeinsparverordnung – EnEV) determines minimum standards for new-build and extensively renovated houses. First introduced in 2002, amended in 2004 and again in 2007 in order to implement the EU Buildings Directive, the Energy Conservation Act limits the annual primary energy demand of new buildings for heat and hot water on a level 30% below the previous standards from 1995. The minimum standard for space heating demand varies between 40–70kWh/m²a, depending on the size of the building, and is set at 12.5kWh/m²a for hot water. Savings can be achieved by a combination of insulation and efficient or renewable heating devices. By formulating the standard on the basis of primary energy demand instead of energy end use, the EnEV favours renewable-fuelled heating devices which have lower or no energy losses through extraction, transport and distribution of the energy carrier (EnEV, 2004).

For new residential buildings which exceed the EnEV standards and achieve a minimum standard of 60 or even 40kWh primary energy demand per m², the state bank KfW offers low-interest loans via its Ecological Construction programme. Developers can use the loans to finance renewable heating devices, including in this case heat pumps, CHP or the connection to district and community heating (KfW Website, 2007). One interviewee expressed doubts if the environmental results of the programme are effectively monitored. Whereas the funding comes

from federal resources, the control of the final energy consumption of the supported buildings falls into the responsibility of local governments (Int. Mez).

The German Centre for Environmentally Conscious Architecture conducted a non-representative survey with 186 developers on their experiences with the implementation of the EnEV. The authors found that almost half of the developers installed condensing boilers to achieve the minimum standards, 13% of the developers used biomass boilers and 9% installed heat pumps. In one third of the sample's buildings, solar thermal collectors contributed to water heating (ZUB, 2006).

Although some developers use renewable options to fulfil stricter building regulations, the overall effect of the instrument on the penetration of low-carbon heat is limited by the low construction rate in Germany. It is currently around 1% relative to the building stock and shows a declining trend. As in the case of the KfW loan programme, uncertainty about the effective control of the new standards by the regional Länder governments is another problem (Nast et al., 2006).

Unlike renewable heat, CHP enjoys the support of a specific legislative instrument, the 2002 CHP law. It enacts an array of support mechanisms including investment support for modernising existing CHP infrastructure, a duty to connect new-build plants to the grid, and a bonus on exported electricity together with compensation for avoided distribution costs in the grid. MicroCHP receives a bonus of 5.11 €/kWh (3.4p) over ten years and bigger installation yearly decreasing bonuses of 1.65 €/kWh (1.1p) on average. The main caveat is the fact that the law only applies to existing CHP installations and new small-scale units with a capacity below 2MW_e. Therefore, it does not stimulate construction of new CHP plants beyond a capacity of 2MW_e. The government's original decision to establish a CHP quota system collapsed under the opposition of the big utilities and the Economics Minister of the time. Instead of a quota, the

utilities signed a voluntary agreement to lower emissions by 23mtCO₂/year by 2010 through use of CHP (Praetorius and Ziesing, 2001; Pehnt et al., 2004).

The voluntary agreement has proven a failure. With the introduction of new obligations under the EU ETS its targets have become obsolete. By contrast, the support mechanism for small-scale CHP has resulted in the installation of 7,119 new plants up to the end of 2005. A third of the newly installed small-scale capacity of 120 MW_e comes from MicroCHP. Together with the modernisation of existing plants, the law in its present form will result in annual CO₂-savings of approximately 14m tCO₂ until 2010. However, since the overall CO₂-reduction target has been missed, the CHP Law will be up for amendment in 2007 (BMW_i and BMU, 2006).

MicroCHP plants run on biomass or biogas receive an additional bonus of 2ct/kWh through the Renewable Energies Act (EEG) which promotes electricity from RES. The instrument has notably increased the number of biomass-run Stirling engines (Langniß et al., 2006).

3.4 Existing Policy Instruments in the UK

Support for renewable heat installations in the UK predominately comes in form of grant funding. Carbon pricing mechanisms and tax exempts provide additional incentives and biomass CHP plants profit, at least in theory, from the support of the renewable obligation (RO) for exported electricity. In the case of new-build houses, increasingly stringent building regulations are expected to lead to a zero-carbon standard by 2016, thereby fuelling the market penetration of low-carbon microgeneration devices, including renewable heat installations.

Financially the most important grant program is DTI's low carbon buildings programme (LCBP) which was launched in April 2006 in replacement of the previous Clear Skies and Solar PV programmes. Householders, public, not-for-profits and commercial organisations across the UK can apply for investment aid when installing solar thermal capacity, ground source heat

pumps (GSHPs), biomass boilers, renewable CHP or microCHP. Unlike its German counterpart, the LCBP also finances photovoltaics, wind turbines and small hydro (LCBP Homepage, 2007). The programme which was originally set up to run for three years has an overall budget of £86m up from a £53.5m budget for the previous microgeneration programmes (DTI, 2006a). However, the programme will now be closed in June 2008 without direct replacement. From 2008 to 2011, financial incentives for microgeneration are mostly expected to come from the energy suppliers' Carbon Emissions Reduction Targets (CERT), the third round of the Energy Efficiency Commitment (EEC). As currently proposed by Defra, a newly introduced 5% set-aside for innovation and demonstration activities is believed to generate up to £127m worth of activity over the three years. Eligible measures include microgeneration as well as behavioural measures. For these innovative approaches, the suppliers would be allowed to claim higher carbon savings than are delivered in order to make up for the higher costs (Defra, 2007). At this point, it is highly uncertain if, when and at which level renewable heat technologies would receive support through the scheme (Interview D. Matthews, N. Eyre).

First evaluation of the Clear Skies programme shows that 92% of projects funded are solar thermal, as the grants are not high enough to render more expensive technologies such as heat pumps or photovoltaics viable (Boardman et al., 2005).

When installing biomass boilers and biomass CHP, developers can furthermore apply for grants through the Bioenergy Capital Grants Scheme which is funded by Defra, and has a budget of £66m. A new 5-year-round is planned to start in 2007, with £10–15m available in the two first years (DTI and Defra, 2006). Additional funding sources include Defra's community energy scheme for CHP as well as the Scottish community and Household Renewables Initiative (DTI, 2006b).

Furthermore, financial support for low-carbon technologies also results from tax exemptions. Microgeneration technologies enjoy a reduced VAT level of 5%; CHP plants are exempt from business rate and the climate change levy (CCL). In the recent Energy White Paper, DTI (2007) also announced that all new homes meeting the zero carbon standard will pay no or a reduced stamp duty. In this way, the government gives incentives for early adopters to reach an efficiency standard which is planned to become binding on all new-build houses at a later stage.

Besides the financial incentives, the regulatory approach through tightening of building regulations is the second important policy instrument to promote low carbon technologies. The future policy framework is laid out in the 2006 Code for sustainable homes. It establishes a sustainability rating system based on nine different categories ranging from energy efficiency to waste, ecology and human well-being. The importance of the energy performance is reflected by minimum standards which have to be fulfilled in order to enter any of the rating levels. The standards are expressed in percentage improvement over target emission rate, an estimate of carbon dioxide emissions per m² of floor area, determined by the 2006 building regulations. Under the Code, ratings start at 10% improvement over 2006 and demand a zero carbon home to obtain the best rating. In a zero carbon home, heating, lighting, hot water and all other energy uses in the home produce no CO₂-emissions which implies that heating and electricity demand are covered by renewable devices (DCLG, 2006). To date, these principles only serve as a voluntary guide to developers but the UK government plans to gradually adapt the building regulation so as to make the zero carbon home the standard by 2016 (DTI, 2007c). The 20% tightening of energy efficiency requirements in 2006 represent a first step on this route.

On the local level, planning authorities can establish even stricter standards. The pioneer in this type of community initiative is the London Borough of Merton. It has introduced a requirement that all new non-residential developments have to reduce predicted carbon emissions

by 10% through on-site generation of renewable energy (DTI, 2006a). In its Planning Policy Statement 22, the central government explicitly encourages local authorities to follow the Merton example (DTI and Defra, 2006).

Two problems remain: the difficulties regarding enforcement and the fact that the regulations almost exclusively apply to new buildings even though, for the first time, the 2006 amendment also demands for upgrading of energy efficiency in existing houses when extensions or certain other works are carried out (Building regulations, 2006).

In addition to financial support and standard setting, the government has formulated a set of measures in its biomass strategy and the 2006 microgeneration strategy which aim at reducing the administrative and technological barriers facing small-scale renewable technologies. For example, the RO has been amended so as to make it easier for CHP-generators to claim ROCs. Also, the 2006 Climate Change and Sustainable Energy Act allows Defra to force energy suppliers to publish a tariff for electricity exported by their customers. Other provisions include stimulation of the technology development, information campaigns and demonstration schemes in schools (DTI, 2006a).

3.5 Comparison of UK and Germany's Policies

Instruments in the UK and Germany show substantial differences in approach (Tables 3 and 4). Firstly, the financial commitment to direct technology support is larger in Germany (programmes in darker grey shade). Annual per capita expenditures presented in the tables are approximations due to lack of reliable data for every programme. They nonetheless show a trend of per capita budgets being about five times higher in Germany. Furthermore, the lower budget in the UK spreads over a larger set of technologies. This is mainly due to the fact that the feed-in tariff

Table 3: Existing Policies Germany

Instrument type	Instrument name	Department	Technologies	Eligible Sectors	Level of support	Running Time	Budget	Avg. cap. budget pa	Achievements
Capital support	MAP	BMU, KfW, BAFA	Solar thermal, biomass boilers, deep geothermal, community heating networks	Residential, SMEs, local communities	~12% of devices' costs	1999-	€878.4m (£585.6m) till 2007	£0.97 2007: £2.58	triggered €5bn (£3.3bn) investment (end 2006)
	CO ₂ Building Restructuring Programme	BMU, KfW	Energy efficiency in buildings, renewable heat	Residential	Low-interest loans, recently grants	1996-	€3.8bn (£2.53bn) all KfW building efficiency programmes together 2006-09	£10.25	Loans worth €14.94bn (£9.96bn), of which ~13% renewable heat & CHP, 3mtCO ₂ /a saved (2004)
	Ecological Construction Programme	BMU, KfW	Energy efficient homes, including renewable heat	Residential new-build	Low-interest loans	2005-			Loans worth €3.63bn (£2.42bn)
	SME programme	BMU, KfW	Energy efficiency in buildings, renewable energies	SMEs, public buildings	Low-interest loans	2001-			Loans worth €3.04bn (£2.03bn)
Revenue Support	CHP Law	BMW _i , BAFA	CHP up to 2MW _e	All sectors	Feed-in bonus MicroCHP: 5.11€/kWh (3.4p) over 10 years, larger plants: ~1.65€/kWh (1.1p) for till 2010	2002-			€5.6bn (£3.7bn) till 2010
	Renewable Energy Act	BMU	Electricity element of biomass CHP up to 20MW _e	All sectors	Additional feed-in bonus of 2€/kWh (1.3p)	2004-			
Fiscal instruments	Eco-Tax on fossil fuels, electricity	BMW _i	renewable energies, CHP exempt	All sectors		1999-			
Regulation	EnEV		Limits primary energy demand per m ²	All buildings		2002, amended 2004, 2007			
	Renewable Heat Requirement (planned)	Law in Baden-Württemberg, planned on federal level	Obligation to provide share of heat from solar, geothermal, GSHP, biomass, CHP	All new-build (15%), existing stock (10%)		Baden-Württemberg from 2010 onwards			

Sources tables 3 and 4: IEA (2007), EnEV (2004), BMW_i und BMU (2006), Defra (2006), DTI (2006a), pers. comm. KfW, Ofgem, eaga, CT, interviews.

Table 4: Existing Policies UK

Type	Instrument name	Department	Technologies	Eligible Sectors	Level of support	Running Time	Budget	Avg. cap. budget pa	Achievements
Capital support	Clear Skies	DBERR	solar thermal, GSHP, biomass boilers, PV, wind, small hydro	Residential, not-for-profits	households: ~2% of costs; non-profits: ~25%	Jan 2003-April 2006	£10m	£0.05	
	Scott. Comm. & Household Renewables Initiative	Scott. Executive, EST	as Clear Skies	Residential, not-for-profits	as Clear Skies	2002	£15.75m (till 2008)	£0.62	>600 projects, majority heat-related
	Community Energy Scheme	Defra, EST, CT	heat networks, feasibility assessments	Local communities		Jan 2002-March 2007	£50m (£22.3 spent)	£0.07	19,481 tC/a saved, £50m investment leveraged
	LCBP	DBERR, EST, BRE	as Clear Skies plus renewable CHP, MicroCHP	Residential, not-for-profits, SMEs, public sector	up to 30% of costs	Phase 1: 2006- 2008, Phase 2: 2007-2009 (public sector only)	£86m (£50m public sector, £18m households, £18 others)	£0.48	Of £36m Phase 1 budget grants worth £16m committed, half of which heat-related
	Bio-Energy Capital Grants Scheme	DBERR	biomass in heat, CHP, power >50kW	Industrial, commercial, communities	£25,000-1m	2002-2007 (extension with heat focus planned)	£68m	£0.27	>100 biomass boilers installed, more expected (2006)
	Warm Front	Defra, EAGA	insulation, heating upgrade	Fuel poor residential	£300-4000 per household	2000-	£800m (2005-2008)	£1.66	>1.4m households assisted
	EEC	Defra, Ofgem	energy efficiency	Residential	varies	2002-2008	~£410m (2002-2005)	£2.27	192TWh saved, 2.9MtCO ₂ /a saved
	CERT (consultation stage)	Defra, Ofgem	energy efficiency, microgeneration, behavioural measures	Residential		2008-2011	~£2.5bn (£127m for innovation)	£13.84	4MtCO ₂ /a savings expected
Revenue Support	RO	DBERR, Ofgem	Electricity component of biomass CHP	All sectors	£32/MWh (buy-out price 2005/06)	2004-			
Fiscal instrument	VAT reduction	Treasury	Solar thermal, GSHP, biomass boilers, MicroCHP	Residential, Charities	reduced 5%VAT instead of 17.5%	2001-			
	Stamp duty reduction	Treasury	Zero-carbon homes	Residential new-build	up to £15,000	2007-2012			
	CCL Exemption	Treasury	Good-quality CHP	Industry	£0.43/kWh reduction	2001-			
	Enhanced Capital Allowance Scheme	Treasury, CT	Biomass boilers, biomass CHP	Business	100% corporation or income tax relief	2001-			
Regulation	Code for sustainable homes/ Building regulations	DCLG	Energy efficiency targets, renewable energy (Code level 3-6)	Residential new-build		Target: Zero-carbon homes by 2016			
	PPS 22, Merton Rule	Local authorities	Microgeneration Obligation	All new-build	% varies				established or planned in various communities

covers small-scale electricity generation in Germany, whereas the RO in practice does not provide financial support for technologies such as photovoltaics, small hydro or small-scale power generation from biomass. Hence, UK grant schemes such as the LCBP provide support to those technologies alongside financing renewable heat.

Secondly, Britain has had a higher number of subsequent programmes in place which have shorter time horizons and are more sector-specific than their German counterparts. Despite fluctuating budgets being a problem of the MAP, too, the occurrence of stop-and-go support is more striking in the UK, notably because changing institutional arrangements add to the problem of fluctuating funds. The recent example is the shift from grants through the LCBP to CERT, a utilities-managed programme based on reduction quotas. By contrast, the same two government bodies have administered Germany's three main instruments – grants, low-interest loans, and feed-in tariffs for CHP and renewable electricity – since the early 2000s.

For energy efficiency in buildings (light grey), on the other hand, both countries spend comparable sums and have achieved comparable CO₂ savings. The main difference here is the strong focus on fuel poverty in the UK which is absent from German policies. As a consequence, the UK mostly targets basic insulation in a large number of households whereas the KfW programmes also aim at incentivising a limited number of high-end efficiency examples. Thus, the resulting incentives for low-carbon heat are larger.

Thirdly, both countries use regulation, carbon pricing through the EU ETS which creates incentives in the industrial sector, and fiscal instruments – the UK uses a wider variety of the latter. Unfortunately, the resulting financial incentives are highly case-dependent and hard to quantify. In its approach to building regulations, the UK is substantially more ambitious than Germany where the Code's zero-carbon home objective has no equivalent. Together with the

recently introduced stamp duty waiver, the Code has the potential to create a similar dynamic towards best practice examples as the KfW programmes.

4 Current barriers or why we need a new policy framework

Both Germany and the UK have ambitious CO₂ reduction targets for the future: A cut by 60% in 2050 for Britain and by 40% until 2020 in Germany are the aims the respective governments have set (DTI, 2003; Gabriel, 2007). Hence, the thrust of any argument for changing the energy policy framework is rooted in the universally acknowledged need to reduce emissions. Similarly, there is widespread agreement that emissions from buildings represent a major share of overall emissions that can be reduced comparably easily and cheaply. There are, however, diverging opinions about how to achieve these emission cuts. Two of the interviewed stakeholders favoured a general carbon restriction for buildings or the residential sector as a whole, under the rationale that such an approach would leave developers the freedom to choose the appropriate mixture between energy efficiency measures and renewable energy (Int. J. Saunderson, M. Bellinghen). By contrast, the majority of the interviewees saw the need for specific action to increase the market penetration of low-carbon heat technologies *in addition to* energy efficiency measures. Arguments to justify intervention broadly fall into four categories relating to different barriers for low-carbon heat.

4.1 The infant industry argument

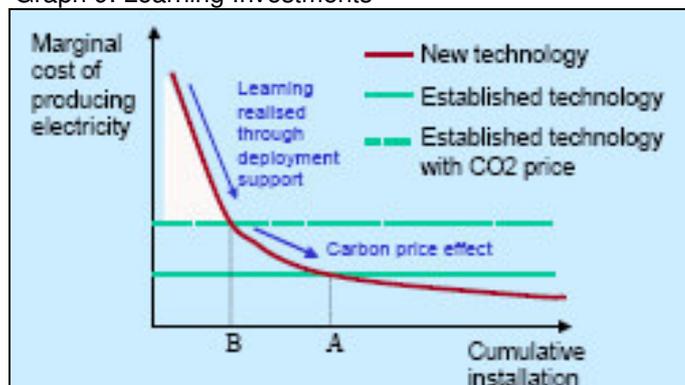
Most interviewees directly or indirectly mentioned a market failure which in the innovation literature is sometimes dubbed “the valley of death” between lab and mass market. It refers to the difficulties facing new technologies when they have achieved technological maturity but not yet conquered a substantial share in the market. In the early phase of deployment the costs of the new

technology tend to be high compared to the incumbent technologies which have profited from years of increasing returns and economies of scale. To achieve cost reductions, the market for the new product has to grow to a certain critical mass in order to allow investment in larger production facilities and stable supply chains. Since, however, a growing market relies on growing demand while demand presupposes cost reductions, new technologies can be trapped in a ‘chicken-and-egg’ problem of what comes first, demand or supply. In practice, this means that first market entrants face high risks and – as a consequence of these risks – often higher capital costs.

Furthermore, recent research on innovation in the energy sector has shown that first movers also suffer from a variation of the classical R&D market failure which stipulates that firms cannot appropriate all positive benefits of their R&D investment and, therefore, overall private investment is lower than the social optimum. There is evidence of an analogue problem in the phase of early market deployment when firms bear the costs of learning-by-doing and learning-by-using but cannot capture the full economic benefits since the produced knowledge is virtually cost-free for all competitors (Foxon, 2003). It is important to note that this market failure is additional to the carbon externality. In his Review, Stern concluded that even though internalising the social costs of CO₂ emissions into investment decisions is crucial, carbon pricing alone is not likely to stimulate the necessary level of low-carbon innovation (Stern, 2006).¹ The white area under the cost curve in Graph 9 illustrates this remaining learning investment which has to be made even in the presence of carbon pricing.

¹ For the moment, the effects of the established carbon pricing mechanisms are still small at any rate. In particular the residential sector is not directly affected by either the EU ETS or the CCL, and the German ecotax has reduced rates for heating fuels.

Graph 9: Learning Investments



Source: Stern, 2006, p.369

Several interviewees have supported this view by emphasizing that the problem of higher costs – although important – is not the only barrier. The “confidence barrier” (Int. J. Stiggers) was judged equally important. On the side of the suppliers, confidence in a growing demand is a prerequisite for investment (Int. D. Matthews), and on the side of the consumer confidence in supply chains and the quality of the technology influence the purchase decision (Int. N. Eyre). This is particularly obvious in the case of biomass heating. Even though biomass boilers can be cost-competitive in commercial or industrial settings, concerns about long-term fuel availability, wood prices and equipment quality seem to stop UK businesses from adopting biomass solutions (FES, 2005).

Moreover, the problem of costs is not necessarily that heat generation costs are higher over the life time of the equipment. Rather, investors can be deterred by high upfront costs with uncertain payback since economic viability depends on how the price of fossil fuel alternatives develops, and for CHP, future electricity prices are relevant as well. If combined with high expectations on capital returns, long pay back times can often tip the balance against CHP or community heating networks, for instance (Schulze, 2007). On the basis of these observations, most stakeholders as well as the interviewed government officials agreed that some form of support would be justified in order to encourage market penetration of renewable heat and CHP.

4.2 Existing schemes are insufficient and distorted towards electricity

In both countries, representatives of the renewable energy and CHP industry criticised existing support schemes, but on different levels. In Germany where most of the confidence issues described above are less of an obstacle due to a higher market share of low-carbon heat, critics mostly argue that the current support schemes will not allow to drive market growth as quickly as climate goals require (Int. Bußmann). Also, the volatility of the MAP is blamed for start-and-stop bounces in demand. Critics point out that no stable supply growth can unfold as long as the support scheme depends on highly uncertain annual budget negotiations (Int. N. Kortlüke). Nast et al. (2006) cite the funding interruptions in 2002 and 2006 as examples since they resulted in reduced installation rates, notably of solar thermal devices. As a result of bank and producers hesitating to invest, expected price reductions fail to materialize. Another point of criticism is that the MAP has to date not created sufficient incentives for large-scale installations due to limited funding for large projects (Nast et al., 2006). The CHP industry also criticizes limitations of the current CHP Law, demanding that support should be extended to large installations and include electricity which is consumed on-site instead of remunerating only exported kilowatt hours (Int. A. Golbach).

Nonetheless, with legislative action for both CHP and renewable heat in sight, policy critique by German stakeholder is less substantial than in the UK.

British stakeholders inside as well as outside the renewable industry agree that the microgeneration incentive schemes have not been very successful to date (Int. J. Stiggers, R. Webb), that efforts are disjointed, suffer from interruptions and lack long-term commitment (Int. B. Woodman; REA, 2007a; Green Alliance, 2007; Biomass Task Force, 2005; CHPA, 2006) while bureaucratic hurdles add to the problem. They include expensive product accreditation

under the planned microgeneration certification scheme, the high transaction costs for small CHP owners when aiming at ROCs or LECs, and the issues around planning permission which is a prerequisite for grant funding under the LCBP (Int. D. Matthews, B. Woodman, Micropower Council Website, 2007). More broadly, Greenpeace and the renewable industry's joint organisation, Green Alliance, blame the UK government for not including heat demand in its strategic energy policy (Int. R. Oakley, Green Alliance, 2007).

In addition, providing incentives for renewable electricity through the RO without offering an equivalent for heat, results in a the suboptimal outcome in the bioenergy sector (Biomass Task Force, 2005). The DTI (2007a) itself has established a hierarchy of biomass use options according to the respective carbon abatement costs which shows that almost all heat options are more favourable than power generation or biofuels. The electricity bias has a similar impact on CHP: a case study from Slough Heat & Power shows that due to ROCs income, it is considerably more attractive to produce only electricity from the wood-chip fired facility than running it in CHP mode and deliver steam to a DH grid (RPA, 2005). In Germany, a similar distortion results from the feed-in tariff for green electricity which equally has no counterpart in the heat sector, even though the extra bonus for biomass CHP gives some incentive for making efficient use of biomass resources.

For biomass and CHP, current renewable electricity policies are therefore not neutral but they penalise heat generation since extra revenue for electricity is foregone when heat is produced.

4.3 No level playing field with fossil fuels

Another line of argument to justify why government needs to intervene in favour of renewable energies and CHP is built on the idea that the current regulatory framework favours fossil fuels. The electricity network has been set up to accommodate centralised power plants with no regard

to the usefulness of the heat that is produced as a by-product of electricity generation. As a consequence, “there is nothing that focuses the people on CHP or heat” as a Greenpeace representative formulated it (Int. R. Oakley). This statement is echoed by both the UK industry association CHPA and its German counterpart B.KWK. Given the need to replace a large share of German power generation capacity over the next years, the B.KWK calls for “a clear political signal for CHP” which would also help to reduce resistance at the local level (Int. A. Golbach). Furthermore, research about the barriers to CHP extension in Germany has shown that the major utilities are not only disregarding the CHP option but, in many cases, actively hinder its development by using their market power. When industrial users or other actors plan cogeneration plants, the utilities can offer cheap electricity contracts as an alternative and thus “buy-out” CHP plants which cease to be economically viable under the new parameters. What is more, through shareholder linkages with the gas distribution network the utilities can even extend their price policy to the fuel supply side as well as prevent partly owned municipal utilities from considering CHP (Schulze, 2007; Mez et al., 1999). As a countermeasure, the industry calls for effective competition oversight, including strict unbundling of the utilities’ generation, transmission and distribution sections.

Equally, the CHPA (2006) addresses its criticism to the governmental regulator of the UK’s gas and electricity networks, Ofgem. The CHPA urges the government to reflect its CHP, renewable energy and energy efficiency targets in the regulator’s primary duties. As a result, Ofgem would have to “give greater regard to efficient use of heat” (CHPA, 2006, p. 4) and create long-term investment incentives for the growth of heat networks. To date, however, Ofgem’s remit does not extend to the heat market as a whole. The REA (2007a) argues in a response to a government consultation on distributed energy, that the fact of being regulated by Ofgem gives gas suppliers a competitive advantage over alternative, unregulated heat providers such as DH

operators. For Ofgem's performance standards signal reliability to customers, liability risks are reduced and hence capital costs lower. This is not only relevant for cogeneration but also for renewable heat since biomass and solar combined with storage can be used more efficiently and more economically in heat networks.

Yet, others challenge the claim that Ofgem's statute should be extended to the heat market. N. Eyre from the EST refers to the regulator's original task, the protection of consumer interests against the market power of network-bound natural monopolies, arguing that a heat market does not actually exist but rather a gas network aside of other heating fuels which consumers are free to choose. Promotion of environmentally-friendly outcomes should not be the task of the regulator but that of elected politicians (Int. N. Eyre). Similarly, G. Shanahan of DBERR agreed that defining a heat market is difficult. However, Ofgem might play a role in decarbonising the gas supply through biogas inputs.

In the light of innovation theory, the described issues can be considered as an additional element of the embryonic industry problem. The set-up of the grid system and the underpinning rules can be interpreted as a form of increasing returns to the incumbent technology. The problem is slightly more acute, but by no means restricted to the UK since the domination of the gas grid and individual boilers is stronger than in Germany. As a consequence, renewable heat and grid solutions are often only considered for off-gas locations. This approach limits, however, what can be achieved in the long term. In both countries, levelling the playing field for heat grid and CHP operators in all sectors needs to be a priority if ambitious targets are to be achieved in the long run.

4.4 Lack of awareness and prejudices

Finally, various UK actors cite ignorance of low-carbon heat options (Int. G. Shanahan, Biomass Task Force, 2005) and prejudices against heating networks as barriers to wider penetration of these alternatives. They identified the British attitude of “my home is my castle” as a cultural barrier to the communal approach of sharing services in a heat network (Int. R. Webb). One observer blamed the building industry for amplifying those prejudices when focusing only on delivering individual homes instead of sustainable communities under the veil of responding to customers’ preferences (Int. B. Woodman).

Even though DH is more wide-spread in Germany, with communities like Schwäbisch-Hall effectively marketing themselves as success stories, academic observers nonetheless diagnose a similar DH image problem at the level of decision-makers in municipal utilities and industry (Schulze, 2007). The reasons are manifold, but according to Schulze often based on perceptions instead of objective calculations. Low electricity prices after market liberalisation and shrinking heat loads due to higher insulation levels appear as threats to overall economic performance of DH or industrial CHP even before calculations are run.

The review has shown that the main justification for government intervention is the set of difficulties new technologies face when attempting to capture a critical market share. Although desirable for their climate benefits, a combination of high costs, asymmetries in the regulatory framework, lack of information and cultural barriers prevents low-carbon heat technologies from entering the market place (UK) and scaling up to their full potential fast enough (Germany). Before discussing the policy options available to address those barriers, a catalogue of evaluation criteria will be established.

5 Discussion of policy options

5.1 To choose or not to choose – Evaluation criteria

Although environmental effectiveness probably is the most obvious criterion for judging on the value of any policy instrument, it is by no means trivial to define what it means. In their extensive study on policy options for the German heat market, Nast et al. (2006) interpret it as a measure of how securely the policy will achieve its overall target, in this case a certain share of renewable-fuelled heating by 2020. Furthermore, the authors require an effective policy instrument to induce structural changes and innovative solutions essential for the long-term such as local heat grids and heat storage technologies. From this interpretation of effectiveness the authors conclude that the ideal policy instrument would allow differentiating between technologies. It would allow promoting each at the level required to increase its contribution, and adjusting support when needed.

This view is in direct opposition to the Anglo-Saxon model with its strong emphasis on competition and the conviction that markets are better placed than government to “pick winners” (Mitchell and Woodman, forthcoming). According to this approach, effectiveness does not imply achieving a preconceived technology mix. Instead, a suitable instrument should aim for cost-effective achievement of the set target and hence it should be technology-blind with support directly linked to carbon savings. Both, the RO and EEC match these criteria whereas the German Renewable Energy Act illustrates the approach propagated by Nast et al.

The stakeholder interviews showed that technology-blindness was defended by those organisations which argue that energy efficiency and renewable energies in buildings should be addressed with one single instrument: an overall limit on carbon emissions of buildings. Both J. Saunderson of the UK Green Building Council and M. Bellinghen of the German Institute for an

Economic Oil Heating claimed that excluding technology options might stifle innovation. By contrast, several actors in the UK expressed doubts on the ability of the market to deliver an effective technology choice. For example, J. Stiggers of SBGI questioned the utilities' willingness to show leadership and choose viable technologies to support within the planned innovation set-aside of CERT. As a result, too many systems might compete and receive some support but none will reach a critical market share (Int. J. Stiggers, R. Webb).

The renewable energy industry representatives in both countries stressed another point when describing the ideal policy framework: Support should be stable and offer the long-term perspective of a steadily growing market (Int. D. Matthews; N. Kortlüke; Green Alliance, 2007). In addition, it should include quality control measures (Int. D. Matthews). It is clear that stable growth for *all* renewable heat technologies will only result from a framework that in some form or the other allocates incentives according to the price level and the specific needs of each technology (for example the need to expand heat networks) rather than in proportion to carbon savings alone. By consequence, if one agrees that renewable heat systems and CHP need government support beyond carbon pricing or quantitative carbon restrictions, based on the grounds that they are market entrants, then measures must be tailored to respond to the needs of each specific technology.

That said such an approach clearly puts more responsibility on government to evaluate programmes so as to ensure that money is not wasted on technologies that do not progress towards cost-effectiveness (Duke and Kammen, 1999). The task becomes more difficult by the fact that renewable heat technologies do not only compete against fossil fuel-based solutions but with each other as well. More precisely, there is a rivalry between systems for individual houses (pellets, solar thermal, GSHPs), grid solutions (CHP, large biomass, solar with storage, geothermal) and blending renewables into fossil heating fuels (biogas, biofuels). Albeit not

always mutually exclusive, stand-alone solutions can locally prevent heat grids from reaching economic viability (Int. A. Golbach). Ideally, policy instruments should be conceived in a way to reflect these issues and approach them strategically.

Finally, the measures are expected to fulfil an array of requirements common to all proposed legislation. The administrative costs as well as the transaction costs for all affected parties should be minimised; windfall profits should be avoided as much as possible and the instrument should be acceptable for the industry and the wider public as well as being compatible with EU law (Nast et al., 2006). Two interviewees representing the German oil industry specifically called for simplicity and clarity of any rules and caution in regard to overlap with existing regulation (Int. B. Schnittler, M. Bellingen). This stands in contrast to voices from the renewable energy industry, environmental groups and academic observers who claim that only a strategic, well-coordinated mix of different instruments will lead to a fast uptake of low-carbon technologies in the heat market and an increase of buildings' energy efficiency at the same time (Green Alliance, 2007; Biomass Task Force, 2005; Int. R. Oakley; L. Mez).

For the purpose of this study, each policy option will be measured against the following criteria:

- probability of increasing rate of technology uptake (effectiveness)
- sectors addressed
- new-build vs. refurbishment
- barriers addressed
- flexibility to differentiate between technologies
- administrative and transaction costs
- acceptability
- interaction with other instruments.

5.2 Scope of regulation

Which sectors should be covered by different instruments obviously depends on the type of instrument. However, in regard to revenue support schemes, interviews in Germany and the UK showed a different perception. While all actors in the UK agreed that it would prove difficult to find one ‘fits-all’ instrument to work on all scales, stakeholders in Germany did not make such a clear distinction between the industrial, residential and commercial sector. According to the plans of the BMU, the proposed obligation to use a minimum share of renewable heat would apply to all building types and process heat (Int. V. Oschmann). Similarly, the CHP industry calls for extending the CHP bonus to new installations larger than 2MW_e as well as the biomass CHP tariff within the Renewable Energies Act to installations over 20MW_e (Int. A. Golbach). Hence, the demand on government is to scale up one instrument to deliver incentives for the industrial sector as well. However, these proposals are likely to face two main objections, particularly from the Ministry of Economics. Firstly, costs for the consumers and resulting impacts on competitiveness could be regarded as too high since increased revenue support translates into higher electricity costs. Secondly, the EU ETS covers installations over 20MW_e and one can argue that additional encouragement for CHP and biomass in the industrial sector undermines the rationale of the EU ETS which is to let industry choose the most cost-effective abatement option. All depends again on the prioritization of objectives.

Even though not shared by all actors (Int. M. Bellinghen), the view that developing markets for low-carbon heat justifies additional funding is far more common in Germany than in the UK where, by contrast, cost-effectiveness of carbon savings is a more important argument in the debate. The Future Energy Solutions study commissioned by DTI and Defra, for instance, estimated the costs of increasing low-carbon technologies by sector. The results indicated that

achieving substantial savings in the residential sector is 10-100 times more expensive per tCO₂ saved than changing process heat generation in the industrial and commercial sector. FES (2005) consequently recommends addressing these sectors first.² There might be advantages in tackling the industrial sector first to drive the demand for the technologies and increase supply chain security without facing the difficulties of heat grids and too many small-scale actors which characterise the residential market (Int. R. Oakley, B. Woodman). But the largest share of heat demand is in the residential sector, and drastic emissions reductions will not be achieved without it (Palmer et al., 2006). Also, technologies such as waste incineration and biomass co-firing are not relevant for the residential market. For all its specific barriers that often have a lot in common with barriers to energy efficiency measures and are in addition to the cost problem, addressing the residential sector separately might indeed be necessary (Int. N. Eyre).

But the perceptions on possible heat market regulation in both countries also owe much to the respective experiences in the electricity sector, at least when it comes to financial support schemes. Based on the principle of cost-effective savings, the RO has proven more successful in inducing large projects than small-scale generation and a similar outcome in the heat area would mean that no incentives would result for the residential sector. In turn, Germany's feed-in tariff has spurred uptake of a variety of technologies on all scales up to 20MW_e, but at higher costs per tonne of carbon saved.³

² In contrast to the German debate on renewable heat, this study includes energy from waste incineration. As waste is a relatively cheap source of heat and assumed to be relevant only for industrial sites, it significantly influences the study's outcomes.

³ It is important to note that this is not because feed-in tariffs do not drive down costs. On the contrary, Butler and Neuhoff (2005) have found that, once adjusted for the difference in average wind speeds, the price paid by society to onshore wind generation is lower in Germany than in the UK. However, in 2005 only 54% of the EEG-contribution was spent on wind. 18% went to the more expensive biomass and 15% to the extremely expensive PV technology (VDN, 2007).

5.3 The question of targets

All interviewees agreed that targets represent a useful long-term orientation. But differences emerged as to what would be the most appropriate basis for a target. A carbon restriction either for each building type (Int. L. Mez, J. Saunderson) or per m² (Int. M. Bellingen) was preferred by interviewees representing building as well as the non-renewable heating industry, while the renewable industry argued for ambitious targets based on the percentage delivered from renewable sources.

For Germany, targets proposals for 2020 vary between 14% proposed by the BMU (Gabriel, 2007), 20% by the Renewable Energy Association BEE and 40% believed to be possible by the Geothermal Energy Association (Int. W. Bußmann).

In the UK, the government hopes that the domestic sector will achieve 4.2 MtC savings by 2010 and aims at increasing CHP capacity to 10 GW_e in the same period (DTI, 2003), but no renewable heat target has been proposed yet. FES' analysis of the probable contributions suggests that an additional 4.7% could be delivered from renewable sources by 2020 (FES, 2005) while others assume that a 7% share is possible by 2015 already (Biomass Task Force, 2005). For 2050, Palmer et al. (2006) estimated that the penetration of low-and-zero-carbon technologies could lie between 29-85%, depending on the policy mix.

In the near future, the EU-level target of 20% renewable energy in overall primary energy consumption by 2020 is likely to represent the most ambitious goal for both countries. The target which was agreed upon at this year's Spring Council is binding on all MS, but the countries still have to decide on the arithmetic of burden sharing and, consequently, break the obligation down on sectors. Therefore, despite the ambition of the Council's decision, concrete policy measures will not result from it before the directive is finalised in 2008 (Int. G. Shanahan).

5.4 Regulatory Options

5.4.1 Capital Support

Grants, and in Germany also low-interest loans, have been the main support mechanism so far, but none of the actors regards them as a long-term strategy for sustainable growth of the industry. Criticisms in Germany mostly relate to the unsteadiness of grants (Int. N. Kortlüke) and to the complexity of the allocation process (Int. B. Schnittler). In the UK, the dislike of grants is far more general. In astonishing unity, stakeholders in the affected industries as well as government officials have expressed concerns about a “grant culture” which stops people from making investments without subsidies even where they are cost-effective (Int. R. Webb, G. Shanahan, N. Eyre).

This does not imply that grants have no role to play at all. The advantages include easing the barrier of high upfront costs – this is how the Biomass Task Force (2005) justifies its call for a stream-lined capital grant scheme – and the fact that grants allow technology differentiation and hence the possibility to support technologies according to their level of development. The drawbacks are high costs to the tax payer and the lack of long-term perspective for the industry’s planning purposes both of which limit the overall effectiveness of the instrument. Grants and low-interest loans could be envisioned to accompany a command-and-control approach which prescribes a minimum use of renewable heat, as well as creating early deployment opportunities for innovations.

5.4.2 Revenue Schemes

Output-based incentives for every kWh of renewable heat produced have been proposed in both countries. Given that the overemphasis on electricity has been identified as one barrier to the uptake of biomass heat in particular, the introduction of an equivalent to the German feed-in tariff

and the RO in Britain promises to increase the consistency of renewable energy policies. Albeit highly attractive from a theoretical point of view, the stakeholder interviews have shown that a revenue scheme is not likely to be introduced in either of the surveyed countries in the near future due to a range of perceived problems.

In the UK, a renewable heat obligation (RHO) was first proposed by the Royal Commission on Environmental Pollution (2004) and described in more detail by the Renewable Power Association (2005). As with the RO, suppliers of fossil fuel heating fuels, i.e. gas, oil and coal suppliers would be required to deliver an increasing percentage share of their sales volume from renewable sources. Renewable heat generators, on the other hand, would obtain heat obligation certificates (HOCs) proportional to their metered output and sell them to the fossil fuel suppliers. A buy-out price would limit the overall costs to consumers.

If implemented with the clear prospect of a gradually increasing obligation, the main advantage of the RHO would be the creation of a long-term investment incentive for renewable heat. Incentives would be directly linked to the heat output and, therefore, indirectly to carbon savings.⁴ Furthermore, the system would not burden the tax payer but the consumers of fossil heating fuels. As such, it would spread costs according to the polluter-pays principle. Proponents also claim that the RHO would cover all sectors and, by its technology-neutral approach, favour the most cost-effective solutions (RPA, 2005). It can, however, be expected that a RHO system would share the problems of the RO with regard to the limited incentives for small-scale installations. Similarly, the technological-neutral approach would imply that a very limited number of technologies profit in practice, probably mostly commercial and industrial biomass applications whereas little support would result for grid-bound solutions, solar thermal or heat pumps.

⁴ The precise amount of carbon saved will depend on the fossil fuel that is displaced.

In the interviews, high administrative costs emerged as the main concern. The metering of all heat flows and the difficulties for small-scale, residential generators of renewable heat to obtain certificates were cited as major barriers (Int. N. Eyre, B. Woodman). Complexity of the system was also the main reason for the Biomass Task Force (2005) to discourage the UK government from further investigating a RHO scheme. In addition, the Task Force argued that heating fuel suppliers have no control over the investment decisions of so many heat producers in contrast to the situation in the electricity market where utilities actually do control their generation facilities. Finally, the need for primary legislation is seen as a problem since it would delay the onset of incentives compared to a solution based on existing instruments (Int. G. Shanahan).

In Germany, the proposal to introduce a feed-in tariff for renewable heat has failed to forge consensus for similar reasons. First promoted by the BEE, and found the most effective instrument in a study for the BMU (Nast et al., 2006), the system would guarantee a fixed bonus per kWh of generated renewable heat. The obligation to hand out bonuses would fall on those companies which import fossil heating fuels into the country – according to Nast et al. a group of approximately 100 traders. Metering requirements could be reduced for small-scale, residential generators so as to simplify the procedure. Bonuses would vary depending on the technology used and decrease over time in order to spur and reflect cost reductions. The system has the same advantages as the RHO but, in addition, also allows promoting more expensive or less mature technologies through higher bonuses. In particular, community heating networks with large-scale biomass, geothermal or solar heating schemes could receive targeted support. Industry calculations showed that the ‘bonus model’ would result in slowly increasing growth for all renewable heat technologies, enabling the industry to expand capacity accordingly. These are the main reasons why the German renewable energy industry preferred it to the regulatory approach now propagated by the federal government (Int. W. Bußmann, N. Kortlüke).

Resistance within government (Int. V. Oschmann), probably from the BMWi, stopped the proposal from reaching cabinet level discussions. As for the RHO, interviews showed that the perceived complexity of the system is one main objection (Int. B. Schnittler). The general objection against measures that specifically reward renewables rather than emissions reductions overall is another counterargument (Int. M. Bellingen).

In both countries, a government regulator would have to be assigned for implementation. In analogy to the RO, Ofgem seems the obvious candidate in the UK, with the consequence that its statute would have to be extended beyond gas to the whole heat market. However, the debate in Germany shows no similar concerns. Ofgem's homologue, the Netzagentur, is considered as one possible regulator among others, but proponents of the model favour the BAFA, the institution running the MAP grant programme since it is also responsible for import and export and the obligation would fall on importers of fossil heating fuels (Nast et al., 2006). In other words, any agency with full information on heating fuel sales could in theory implement a market-based instrument for renewable heat. Yet, the involvement of Ofgem might be favourable for reasons of consistency and as a means to ensure the level entry conditions for all heat market participants.

It remains debatable if administrative costs for a RHO would in actuality be as much higher as for alternative instruments that implement the same target. For the UK, a comprehensive RHO appraisal has still to be carried out as called for by the House of Commons (2006). For Germany, the direct comparison with an administrative ordinance on building owners to use a certain share of renewable heat shows that the feed-in option is likely to induce lower transaction costs, mainly because costs resulting from compliance control in case of standards (Nast et al., 2006). The issues around metering, for instance, could be solved by introducing lump-sum remuneration for households and apply precise metering only for larger installation. In any case, only the

renewable heat flows would have to be measured since the calculations of the fossil fuel heat to determine the obligation level would be based on fuel sales and not on metering.

In sum, revenue support instruments suffer from a low level of acceptance due to their relative complexity. If founded or not, this perception shapes the political debate and has prevented the introduction of a renewable heat feed-in tariff in Germany. However, the review shows that revenue support – if implemented at the necessary level and with the appropriate long-term commitment – could help to tackle the embryonic industry problem by providing a stable and increasing demand. It could provide incentives for the existing buildings stock and for new-build, as well as across all sectors and thus ensure effectiveness. The feed-in tariff has two additional advantages: The flexibility to tailor support to the need of each technology can incentivise innovation and increase the technological options available for building long-term change, while enabling policy-makers at the same time to adapt the incentives to the each installation's scale. Therefore, if the RHO is reconsidered in the UK, it would be worthwhile to think about introducing a banded system analogue to the RO amendment planned for 2009.

5.4.3 Regulation

In the face of the perceived difficulties with market-based instruments in an arena as fragmented as the heat market, governments in both countries so far show an inclination to use more traditional regulatory instruments. One form has been the tightening of building regulations which, however, mostly drive energy efficiency measures at the moment. The more recent element is a requirement to use a minimum share of renewable energies. Both the local Merton rules in the UK and the proposed legislation for a renewable heat requirement in Germany are still in a fluid state of negotiation and any evaluation of their effectiveness will depend on the concrete rules implemented. So far, the difference that emerges is one of scope. Local

prescriptions based on the London Merton rule will apply only to new-build developments as will the Code for sustainable homes which, in addition, is restricted to residential buildings. Both will include small-scale renewable electricity alongside renewable heat (DTI 2006a). Yet, at the end stands the ambitious goal of delivering zero-carbon homes. By contrast, the proposed German renewable heat law will, if implemented according to the BMU proposal, set minimum standards specifically for the use of renewable heat, and it will apply to new buildings of all sectors as well as to the existing stock in case of boiler exchange. The last point is likely to be a major point in the parliamentary debate and could still be sacrificed to cost concerns (Int. V. Oschmann).

The stakeholder interviews revealed mixed attitudes towards minimum renewables standards. Strong opposition comes from the UK building industry for two reasons: Planning decisions by each local authority hold the threat of wide heterogeneity across the country (Int. N. Eyre) which is one reason why the chairman of the House Builders Federation, Stewart Basely, dismissed the approach as “soviet-style planning” (The Guardian, 21/08/2007). Instead, the developers prefer the national framework of the Code which – and that is the second objection to Merton-type rules – is not technology-prescriptive but performance-based (Int. J. Saunderson). Concerns with the obligation for on-site generation include high costs, limited technological options at some sites, particularly in central London, and the worry that technology accreditation schemes might stifle innovation (Int. J. Saunderson). By contrast, the renewable energy industry opposes the Code in its current form, precisely because it does not require renewable on-site or community generation for its first three levels (Int. D. Matthews; REA, 2007b, Micropower Council Website).

In Germany, the conflict lines are very similar. The building industry’s main concern is related to rising costs which are feared to further reduce the rate of new-build in the country (Email H. Barton, BDB). In the discussed proposal, government has accounted for these concerns by only demanding the fulfilment of the renewable heat obligation if the investment pays back in

its lifetime. Moreover, exceptions are planned for buildings that exceed the EnEV energy efficiency standards (Bundesregierung, 2007).

The renewables industry, on the other hand, argues for an unambiguous obligation to use renewable heat and opposes planned exceptions (Int. N. Kortlüke). It also criticises that not all renewable options will profit under the current proposal. The BEE expects a requirement to use 10% renewable heat to result in a choice for solar thermal in 75% of all cases and for biomass in the remaining 25%. 100%-systems and grid-bound solution such as geothermal heating will therefore receive little support from the heat law even though they count as fulfilment of the obligation (Int. W. Bußmann).

One way to solve both of these issues would be to integrate a buy-out option into the regulation. Developers would be able to choose between either installing a minimum share of renewables or contributing to a local fund dedicated to the increase of heat grids and, possibly, to innovative demonstration projects such as seasonal storage (Int. J. Saunderson). This could be combined with making community heating networks compulsory for new developments through planning regulations, a means which several interviewees saw as the only option to effectively introduce heat networks in Britain (Int. R. Webb; J. Stiggers; B. Woodman). Based on a thorough analysis of heat loads density, local authorities could strategically designate which areas are favourable for grids and, thus, ease potential problems of rivalry between stand-alone and community-based heat systems which were described earlier.

Independent of the detailed set-up, overall effectiveness of a regulatory regime will depend on its impact on the existing building stock and on how thoroughly the legislation is enforced. Government officials from both countries recognized control of building regulations as a problem since it needs technical expertise and is not always the highest priority for local officers (Int. N. Eyre; V. Oschmann). Compliance control furthermore increases the administrative costs of the

approach, particularly if the legislation includes options for exceptional waivers (Nast et al., 2006). Nonetheless, previous experience with the 2005 compulsory introduction of condensing boilers in the UK has shown that what seemed to be a “bold decision” (Int. R. Webb) at the time induced a successful market transformation process, with condensing boilers now making up over 90% of gas boiler sales. The initiative has been followed with interest in Germany (Int. M. Bellinghen) where various actors call for a speed up of heating modernisation (Int. B. Schnittler; BDH, 2007). Hence, an acceptable and effective way to tackle the existing stocks might be to not only apply minimum standards to new heating devices but at the same time set a maximum age limit for old boilers to increase the turnover speed.

To sum up, a regulatory approach with a combination of minimum renewable standards and a planning-based initiative to expand heat grids appears to be acceptable, provided that some flexibility is built into the system which allows developers to alternatively invest into a community fund or substantially increase energy efficiency if on-site renewable heat is unfeasible. To be effective the obligation needs to apply to new-build as well as to existing houses with end-of-lifetime boilers. Regulation leaves less room for technology-specific support than a feed-in tariff or a banded RHO. A supporting instrument for innovation might therefore be needed. If built on changes of the Code, the long process of passing primary legislation could be avoided. However, heat use in commercial and industrial buildings would have to be either integrated into the Code or covered by a separate instrument.

5.4.4 Enabling energy service companies (ESCos)

For the longer term, an overarching government task will be the enabling of ESCos or contracting as the outsourcing of energy management is known Germany. Mentioned by two interviewees (Int.B. Schnittler, J. Stiggers), the question of how business models could become viable that are

built on reducing rather than increasing customers' energy use is still an emerging issue. The advantages go far beyond the heat market. If professionals take over energy management for large estates, new developments, business or industrial facilities, the information barrier will no longer restrict cost-effective investments. ESCos could implement and manage community solutions, thereby taking the pressure off from developers to build under zero carbon standards. Level 6 of the Code demands that all consumed electricity is generated on-site. Once it becomes law energy management will become a necessity in the UK since community-based biomass CHP is likely to be the only cost-effective solution (Palmer et al., 2006). In Germany, local utilities owned by the municipality often run DH schemes, with the advantage of guaranteeing a certain level of democratic control over prices (Int. W. Bußmann). Yet, the level of expertise and capital expenditure needed in the future might favour ESCo-type approaches.

What is more, if contracts create the necessary incentives, ESCos have the potential to increase energy conservation alongside energy efficiency and investment in renewables – the element of the energy policy triad which most instruments so far neglect (Int. L. Mez). Finally, all sectors could be addressed.

To date, the barriers are predominantly legal issues. Long-term contracts have to be enabled, questions around liability and ownership of energy saving equipment have to be solved, and in Germany the landlord-tenant law has proven an obstacle as well (Breiboldt, 2007; Hinkel, 2007). In the UK, the rule enabling customers to switch energy suppliers within 28 days is hindering the development of ESCos (Int. J. Stiggers).

5.4.5 Supporting measures

In the interviews as well as in the surveyed policy documents, a range of supporting measures was described that could increase the acceptability and effectiveness of the above described policies:

- R&D for renewable heating and cooling
- Awareness raising campaigns
- Advice centres
- Development of skilled workforce through training
- Mapping of heat loads
- Public procurement

As Table 4 shows, less than a third of total renewable energy R&D funding in Germany and less than 20% in the UK is currently spent on technologies that can also generate heat.⁵ A specific programme on renewable heating, cooling and possibly innovative energy efficiency measures would help to ensure that ever tighter standards rely on a growing technology portfolio (Int. B. Schnittler, N. Eyre).

Table 5: Energy R&D Spending in USD (2005)

Technology	Germany	Per capita	UK	Per capita
Solar thermal (heating and cooling)	15.246		11.158	
Bioenergy (heat and electricity)	5.328		0	
Geothermal	15.180		0.144	
Total renewable heat related	35.754	0.43	11.302	0.19
Total renewables	123.512	1.50	66.489	1.10
Total Energy R&D	462.223	5.62	129.905	2.16

Source: IEA Website (2007)

⁵ Note, however, that the only category entirely related to heat is solar thermal. Hence, the absolute amount spent directly on heat generation technologies is probably smaller than indicated here.

Initiatives for raising awareness and delivering comprehensive advice concerning technologies, costs, fuel prices and grants are cited as a possible way to address the lack of information (Int. G. Shanahan Biomass Task Force, 2005). Research on regional strategies to expand cogeneration has shown that lack of information on costs and benefits of CHP are a problem in Germany as well. Independent regional or local agencies which act as one-stop shop for different target groups – from industrial actors over the building industry to home owners – are therefore a crucial element of a coordinated strategy to increase low-carbon heat (Steuer and Reiche, 2006). Training programs for builders and installers could be part of the task of advice agencies although it can be hoped that a strong ‘demand pull’ would lead the concerned industries to train employees themselves.

Comprehensive assessment of heat loads and densities are another piece of crucial information that could be provided either locally or nationally. Mapping could help grid developers to identify economically attractive areas as well as support local authorities in their strategic planning process. In the long term, they might allow to better match electricity with heat loads, since the mismatch is one of the obstacles for cogeneration (Int. R. Oakley, G. Shanahan, Nast, 2004).

Since the UK public authorities are responsible for 30% of total spending on new-build, green procurement appears as a promising leverage for driving investment in low-carbon heat technology (Int. B. Woodman; Biomass Task Force, 2005, DTI and Defra, 2006). However, in both countries a number of sustainable procurement measures is already in place. The German government announced in its recent energy strategy that it will invest €120m (£80m) annually into modernisation of public buildings over the next three years, including a 15% set-aside for innovative technologies (Bundesregierung, 2007). In the UK, primary energy reduction targets for the government as well as the NHS estate are expected to drive down emissions. In addition,

the Carbon Trust's local authority management programme advises communities on suitable reduction measures (Defra, 2006). There might be some scope to increase the emphasis on heat in these measures and a specific budget allocation to the issue might be helpful, but budget pressures and trade-offs with other spending demands are likely to limit the overall impact of green procurement on low-carbon heat markets. Due to their size, government estates can however serve as useful pilot studies for ESCo contracts.

5.5 EU Legislation

The overwhelming majority of the stakeholders viewed the role of the EU as positive in giving impulses to MS energy policies through past directives, but none of the interviewees saw the strong need for an additional directive on heating and cooling. This is mostly because the 20% target from March 2007 is seen as a sufficient driver for the uptake of renewable heat. This result stands in opposition to the outcome of the EC's consultation which stated "a large consensus that an initiative on renewable heating and cooling should be under taken at the EU level" (DG TREN, 2006, p. 7). The fact that the consultation was run in summer 2006, thus before the 20% target was agreed, might in part explain this discrepancy. Moreover, the stakeholders did not oppose EU action on renewable heat. Rather, the additional impulse that could arise from a new directive was not seen as very strong given that the Council decision already delivers a target for heat – even if so far only indirectly – and specifications on support schemes are expected to be fairly general in any case. One interviewee emphasised that more than an impulse from Brussels towards the MS, the EC conversely awaited exemplary initiatives on heat from the MS (Int. V. Oschmann).

The concerns of the interviewees were instead focussed on issues around implementation of and compliance with EU legislation. Two UK commentators expressed regret that the buildings

directive had not been implemented so as to act more effectively as a driver for energy efficiency and renewable energies in buildings (Int. J. Saunderson; B. Woodman). More importantly, all UK interviewees acknowledged that the 20% target was very challenging for Britain and some formulated doubts if the government would take the necessary action for achieving it (Int. R. Oakley; D. Matthews; B. Woodman). The DBERR representative, however, reassured that the UK government is indeed committed to the target but concrete action, including a break-down on sectors, would only be discussed once the burden sharing had been agreed upon (Int. G. Shanahan). Concerns about lack of government commitment are less acute in Germany given that government activity to implement the EU target is underway (Bundesregierung, 2007), but concerns about the stringency of the announced measures remain (DUH 2007).

Overall, the analysis demonstrates that the most promising impulse from the EU would result from a swift agreement on how much each MS has to contribute to the target. As one interviewee remarked, the EU can also serve as a forum for an exchange of best practices (Int. R. Webb). Rather than adding another directive, the EC might be able to proactively distribute MS experiences with heat market policy within the EU and thereby increase the likelihood of the 20% target to be achieved.

6 Conclusions

On the basis of fifteen key-informant interviews and the analysis of policy documents and position papers, this study has attempted to tackle the question how governments in the UK and Germany could encourage heat from renewable sources.

Although not entirely unchallenged, the majority of the interviewees agreed that a government intervention was justified by a number of barriers facing alternative heat technologies. They include problems associated with embryonic industries, distortions towards

fossil fuels in the existing regulatory framework, and asymmetries resulting from an overemphasis on electricity in current support schemes for renewable energy.

No policy instrument is likely to be welcomed by all stakeholders. Cost concerns mainly from the building industry, and concerns about public spending and industrial competitiveness will be a challenge for any proposal. Yet, in the short and medium term, an instrument set based on the market transformation approach appears appropriate *and* acceptable provided that implementation leaves some room for flexibility. Thereby, information to customers is likely to come in a different form than traditional labelling despite the Home Information Packs representing a move into this direction. People do not choose a house for its heating while in case of industrial applications solutions vary too greatly to be grouped under any one label. But local or regional advice centres for all interested parties and heat load maps have an important role to play in easing information barriers.

Financial incentives are the second important element. If in form of grants, soft loans, or tax breaks, the German experience demonstrates that continuity and a sizable financial commitment can increase uptake of the supported technologies. Revenue support through a RHO or a guaranteed kwh price seem evens more promising as it provides long-term, budget-independent planning security but suffers from the perception of high complexity. While unlikely in Germany at that point, a RHO could still be a viable option in the UK. To be effective in inducing long-term change, it should be banded to reflect different technologies' learning curves and different cost levels at different installation scales. A RHO for the industrial and commercial sector only represents a possibility to tap these sectors' large potentials without having to face the residential sector's problem of too many small-scale actors.

Regulation is the third element of a comprehensive market transformation, and it has been developed furthest in the building sector. However, to increase the use of low-carbon heat in the

entire stock, instruments such as the Code, the Merton rule and the planned Renewable Heat Law in Germany that specifically drive renewables have to be gradually expanded to the existing stock. The BMU proposal that boiler exchange triggers an obligation to introduce renewables is one step into this direction, limiting the lifetime of boilers might be another option to increase turnover speed. On the other hand, it is crucial that no single technological solution is prescribed – a danger that lies in prescribing minimum renewable requirements in percentages. For the challenge – and possibly the limitation of the market transformation approach in the case of heat – is the system step change from stand-alone systems to community solutions that will be required in the long-term.

In this process, the social-technical system of heat delivery will have to evolve from an individually controlled unit to a community-based service. The change requires institutional learning on the side of the regulator and the overcoming of cultural barriers and prejudices on the side of the users. In other words, it will require organisational changes alongside technological transformation in all sectors. In order to facilitate this change, the underlying legal framework has to be adapted. Planning might be used to encourage if not impose heat grids in new development sites and, thereby, create niches which allow to test the new organisational model.

Finally, most stakeholders emphasised the need for a coordinated and strategic policy approach to heat. Therefore, the above mentioned elements should form a comprehensive strategy with clear targets. Once broken down to MS and sectors, the EU 20% target will provide an ambitious framework for this.

Appendix 1: Technologies

In order to give an overview of the existing technologies which policy can be built upon, this Appendix briefly describes low-carbon alternatives for heat production, evaluates how mature the technologies are and quantifies their current contribution. Estimates of future potential are presented although comparison is extremely difficult. Assumptions on future prices, technological advancement and the development of the policy framework significantly influence the outcome of different studies and the values should therefore be regarded as merely indicative.

Energy from waste incineration has not been included in the review. This is mainly because it is more driven by waste policies than by developments on the energy side and thus outside the scope of this study (FES, 2005).

Solar thermal energy

In the UK, solar thermal energy is so far mainly used to heat up water, but it can also provide a share of the space heat demand. With an installation of 1–1.5m² per person, up to 15% of the overall heat demand can be provided by solar thermal devices (Heideman et al., 2005). Solar energy can also be used for cooling by absorption refrigeration. Solar cooling offers the advantage that load times coincide with availability of solar radiation. However, the technologies are still at the stage of demonstration and do not yet pay back the investment in their lifetime when compared to a conventional air conditioning system. Furthermore, retrofitting existing buildings is disruptive since solar cooling is currently not available for single rooms like electrical air conditioning but only for entire buildings (Henning, 2005). Theoretically, the overall potential of solar thermal for heating and cooling is very large. According to industry estimates, collectors could provide up to 200 TWh in Germany by 2050, compared to 4.1 TWh today (pers.

comm. BEE, 2007). In the long run, the dominant constraints might be the availability of roof top space and new heat storage technologies such as phase change.

Heat pumps

Ground source and air-to-air heat pumps convert geothermal energy into space heat on the level of an individual dwelling or for a heat network. In order to move the heat from the ground or the outside air into the house, heat pumps consume electricity or, more rarely, thermal energy. Thus, they represent a low-carbon rather than a zero-carbon technology, with air source heat pumps being less efficient than ground source ones but easier to install. Heat pumps are a proven and reliable technology. They are in widespread use in Scandinavia and the US, but currently only procure a few thousand homes in the UK and about 120,000 in Germany, with sales rising at over 100% (Ondreka et al., 2007, Interview W. Bußmann). The potential of GSHPs is restricted to houses with sufficient garden sizes and the highest efficiencies can be obtained in new-build with underfloor heating systems since they require lower temperatures. One UK industry representative expects that by 2020 GSHPs will become more common than gas boilers in new-build (Interview D. Matthews). Like solar thermal devices, heat pumps can also provide cooling (Boardman et al., 2005).

Deep Geothermal

Deep geothermal which extract heat from the earth at depths of 1,000–5,000m is a large-scale technology, and therefore requires heat distribution networks with a sufficient heat demand to pay-back the high up-front drilling costs. In 2005, twenty-four installations were in use in Germany, totalling 1GW_{th}. According to the German Renewable Energy Association, this only represents a fraction of the future potential since they estimate that about 15% of the nation's heat

demand could be delivered by the earth' crust (BEE Website, 2007). However, the boom in the geothermal industry, with a minimum of 70–80 additional plants at the planning stage, almost exclusively takes place in the electricity sector where the feed-in tariffs create a stable investment framework. In the heat sector, the uncertainty of heat sales remains a constraint in the face of extremely high up-front costs (Langniß et al. 2006). This is even more true in the UK where low costs and high availability of native oil and gas resources have undermined the development of geothermal energy. Estimates that geothermal energy could deliver 10% of the UK's energy needs contrast with the reality of only one large-scale plant supplying heat to a network in Southampton (Manning et al., 2007; Pierce, 2003).

Bioenergy

Bioenergy is the most diverse of all renewable energy sources, in terms of the technology variety as well as in regard to its possible applications. There are three different types of sources: crops, industrial and agricultural by-products and municipal waste as well as an array of conversion options including combustion, pyrolysis and anaerobic digestion. In 2006, biomass and biogas delivered 94.4 and 5.3 TWh of heat in Germany and Britain, respectively. Because of the diverse use options, it is very complex to determine future trends and potentials. Outcomes will depend on the interplay of policy instruments in all three energy end use sectors, heat, electricity and transport, as well as on technology advances. In the heat sector, wood-based biomass boilers are likely to remain the dominant solution for individual homes. The technology is mature and can directly replace gas or oil boilers provided that storing room for wood is available. Assessment of cost-effectiveness is more complicated than in the case of solar thermal or heat pumps because life-time costs do not only depend on installation costs, which are around twice as high as those of conventional boilers, but also on the price of the energy carrier. While the earth' heat and solar

radiation is essentially free, prices for pellets in Germany have increased over 30% in the last year, and, for the first time, have exceeded the price of heating oil in January 2007 (Brennstoffspiegel Homepage, 2007). Thus, both the overall technical potential for biomass boilers and its economic performance will depend on the market availability of fuel wood. Estimates on the technically available fuel wood range from 60 to 85PJ for the UK, and 260–420PJ for Germany (McKay, 2006; EEA, 2006; Thrän et al., 2005). In regard to future prices the structure of the market is important as well: Will there be widespread trading of fuel wood or will markets and prices rather remain regional as a result of high transport costs? Were continental or global market prices to develop, it will also be decisive whether or not their long-term trend is influenced by fossil fuel prices.

In larger installations with connection to a community heating scheme, a wider set of feedstocks and conversion technologies is available, including fermentation and gasification of agricultural products and farm or food wastes. In addition, installations can be run as CHP plants in order to maximise overall efficiency (Boardman et al., 2005). In this case, the remuneration of exported electricity will influence the overall economic performance. Finally, bioenergy could also be used in conventional heating devices if blending biofuels into heating oil or feeding biogas into the gas network becomes feasible on a large scale. Research and demonstration efforts are currently undertaken in Germany (Interview Bellingen, B. Schnittler).

CHP

CHP plants on fossil fuel or bioenergy basis are another low-carbon heating technology. Germany operates 44GW_e in total (BMWi and BMU, 2006) compared to 5.8GW_e in the UK (DTI Homepage, 2007). As microCHP with an electrical capacity below 50kW_e CHP can replace individual boilers, and on a larger scale, CHP can provide heat for community or DH networks.

Three major microCHP technologies exist, of which the Stirling and the reciprocating engine have already reached market availability whereas the fuel cell is still in the development phase and has to achieve further cost reductions. To reach cost-effectiveness, MicroCHP units have to run a certain number of hours a year, hence the dwelling's heat demand has to be appropriate. As heat needs are expected to decrease dramatically in new-build houses while electricity demand is bound to rise, the fuel cell technology with its higher power-to-heat-ratio will gain in importance (FaberMaunsell et al., 2002). The penetration of larger CHP plants is hitherto constrained by the fact that DH networks are not expanding accordingly. Therefore, although the technical potential for CHP is enormous – the German CHP industry association believes that 57% of electricity could be generated in CHP mode (Interview A. Golbach) – actual penetration will depend on the framework conditions for heating networks as well as on conditions for electricity buy-back, gas to electricity price ratios and the development of installation costs (Hawkes and Leach, 2005).

Appendix 2: Interview Guide

- In your view, is there a need for new policy instruments to encourage renewable heat and CHP beyond the existing legislation in the heat market?
- If so, why do you think new regulation is needed? What are the main barriers to an increase of low-carbon heat in the current institutional set-up?
- UK: What is your view on the proposal of the Renewable Energy Association and others to introduce a Renewable Heat Obligation?
- GER: What is your view on the Environment Ministry's proposal to introduce a renewable heat law which would prescribe a requirement to use a minimum share of renewable heat in new-build and refurbished buildings?
- What is your view on the appropriate scope of support schemes or legislation on low-carbon heat? Would it be desirable to have one framework for all sectors, including the residential sector, commercial and public sector buildings and industrial use of heat?
- Which technologies should be included when defining renewable heat? – Should heat pumps be included? Should heat from waste incineration be included and supported as well?
- Should the Government formulate numerical targets for renewable energies in the heat sector and how should they be formulated?
- GER: Do you think the target formulated by Mr Gabriel to increase the share of renewable heat to 14% by 2020 is appropriate?
- From your organisation's point of view, where are the biggest points of conflict when proposing, thinking about legislation to encourage low-carbon heat production?
- What are the main problems with government programmes currently in place?

- UK: Will the Code for sustainable homes bring about major incentives?
- Do you think that there is a need for a specific support strategy which targets DH and community heating networks?
- What is your assessment of the chance or need for competition within DH networks?
- Is the paradigm of competitive energy markets in conflict with the encouragement of renewable energies or can competitiveness enhance the market deployment of renewable energy?
- Ofgem regulates the electricity sector and the gas market, but not the heat market as a whole. Do you think that extending Ofgem's authority to other heating providers (bioenergy, DH) would help to increase the uptake of low-carbon heat technologies? What in detail would such a new regulation cover?
- Do you see a need for an EU directive on renewable heating and cooling? If so, which would be the most important elements of such a directive?

Appendix 3: List of Interview Partners

UK	
Gary Shanahan	Department for Business, Enterprise and Regulatory Reform (DBERR) Assistant Director, Emerging Energy Technologies Meeting: 18 August 2007, 1 hour, London
Dr Nick Eyre	Energy Saving Trust (EST) Director of Strategy Meeting: 3 August 2007, 1 hour, London
Dr Bridgdet Woodman	Centre for Management under Regulation (CMuR), University of Warwick Research Fellow Meeting: 16 July 2007, 90 min., London
Robin Oakley	Greenpeace UK Senior Climate Change and Energy Campaigner Meeting: 3 August 2007, 90 min., London
David Matthews	Solar Thermal Association (STA)/ Ground Source Heat Pumps Association (GSHPA) Executive Director Meeting: 27 July 2007, 90 min., Milton Keynes
John Stiggers	Society of British Gas Industries (SBGI) Chief Executive Meeting: 26 July 2007, 90 min., Leamington Spa
Roger Webb	Heating & Hotwater Industry Council (HICC) Director Meeting: 26 July 2007, 90 min., Leamington Spa
Jules Saunderson	Green Building Council Technical Co-ordinator Meeting: 23 July, 90 min., London
Germany	
Dr Volker Oschmann	Bundesministerium für Umweltschutz, Naturschutz und Reaktorsicherheit (BMU) – Environment Ministry Deputy Head of the Renewable Energies Law Division Phone Interview: 23 July 2007, 45 min
PD Dr Lutz Mez	Forschungsstelle für Umweltpolitik (FFU) – Environmental Policy Research Centre, Free University Berlin

	Deputy Director Meeting: 18 June, 1 hour, Berlin
Norbert Kortlüke	Bundesverband Erneuerbare Energien (BEE) – Renewable Energy Association Consultant Renewable Heat Law Meeting 21 June, 1 hour, Paderborn
Werner Bußmann	Geothermische Vereinigung (GV) – Geothermal Energy Union Managing Director Phone Interview: 26 July 2007, 45 min
Adi Golbach	Bundesverband KWK (B.KWK) – CHP Association Managing Director Meeting: 18 June 2007, 1 hour, Berlin
Dr Moritz Bellinggen	Institut für wirtschaftliche Ölheizung (IWO) – Institute for Efficient Oil Heating Responsible for Questions of Principle Meeting: 20 June 2007, 90 min, Hamburg
Bernd Schnittler	Außenhandelsverband für Mineralöl und Energie (Trade Association Petroleum and Energy Traders) Managing Director Meeting: 20 June 2007, 1 hour, Hamburg

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