Chapter 5: Reducing emissions in buildings and industry

Introduction and key messages

Our December 2008 report identified a major opportunity for reducing emissions in buildings and industry through energy efficiency improvement. The report noted barriers to uptake of measures, differentiating between technical emissions reduction potential (i.e. if there were no barriers to uptake) and realistically achievable emissions reductions given an assessment of barriers and the way that these are or could be addressed by policies in place or that could be introduced.

We also considered renewable heat in the context of the UK's commitment to a 15% renewable energy target for 2020 and discussed the contribution it could make to meeting longer term emissions reduction objectives.

We presented a high level assessment of the policy framework, and questioned whether this currently provides sufficiently strong incentives for uptake of measures in the residential sector and across non-capped sectors in commerce and industry. We noted the absence of and need to develop a new framework to support renewable heat deployment.

In this chapter, we do four things:

- We revisit our assessment of potential for residential energy efficiency improvement. We focus both on the pace at which emissions reductions can be realistically achieved, and the incentive framework that will unlock the emissions reduction potential, including a discussion of the Government's draft Heat and Energy Saving Strategy for residential buildings published in February 2009.
- We present new analysis of renewable heat which extends our previous work by considering a wider range of technologies and setting out new renewable heat scenarios.
- We present scenarios for non-residential buildings, and set out high level policy options that could unlock the significant potential in this area.
- We set out indicators against which we will make future assessments of progress in reducing emissions from buildings and industry (Box 5.1).

Box 5.1 Key Indicators

Residential sector:

- installations of loft and cavity wall insulation (10 million lofts and 7.5 million cavity walls insulated by 2015)
- solid wall insulation (2.3 million by 2022)
- replacement of old boilers (12 million non-condensing boilers replaced by 2022)
- increase in stock penetration of A+ rated wet (82% by 2022) and A++ cold appliances (45% by 2022).

Renewable heat: 12% penetration by 2020, resulting in emission reductions of 18 $MtCO_2$.

Non-residential buildings: minimum EPC rating of F or higher by 2020.

The main messages in the chapter are:

- A new framework for accelerating residential emissions reductions is required. This should include *whole house* and *neighbourhood* approaches, with strong leadership from central government and an important role for local government. Complementary financial incentives and regulatory measures are also likely to be required to overcome the significant barriers that exist despite the cost-effectiveness of most energy efficiency measures.
- Increased deployment of renewable heat should aim at meeting carbon budgets in the most cost-effective way and developing a portfolio of options for possible deployment in the 2020s on the way to meeting longer term emissions reduction goals. This should include biomass boilers and combined heat and power (CHP), air source and ground source heat pumps, and biogas. In our analysis, we have assumed the Government's suggested renewable heat share of 12% by 2020, but recognise that this could be very expensive at the margin.
- It is crucial that the public sector emissions reduction potential is unlocked, because this can make an important contribution to meeting carbon budgets; encourage behavioural change among users of public sector buildings; stimulate the low carbon supply chain; and underpin government credibility in leading a wider emissions reduction programme. By 2008, all cost-effective emissions reduction potential should be realised for buildings in the central government estate and for other public sector buildings covered by the Carbon Reduction Commitment.
- A new framework to incentivise emission reductions by SMEs should be introduced. Options to be considered might include an extension of the new residential sector delivery model and mandating certain measures to improve energy efficiency. In order to support any new policy, more widespread requirements for energy audit and certification of non-residential buildings should be introduced.

We set out the analysis that underpins these messages in five parts:

1. Emissions trends in buildings and industry
2. A framework for energy efficiency improvement in residential buildings
3. Scope for reducing emissions through the deployment of renewable heat
4. Emissions reductions in non-residential buildings and industry
5. Indicators for buildings and industry.

1. Emissions trends in buildings and industry

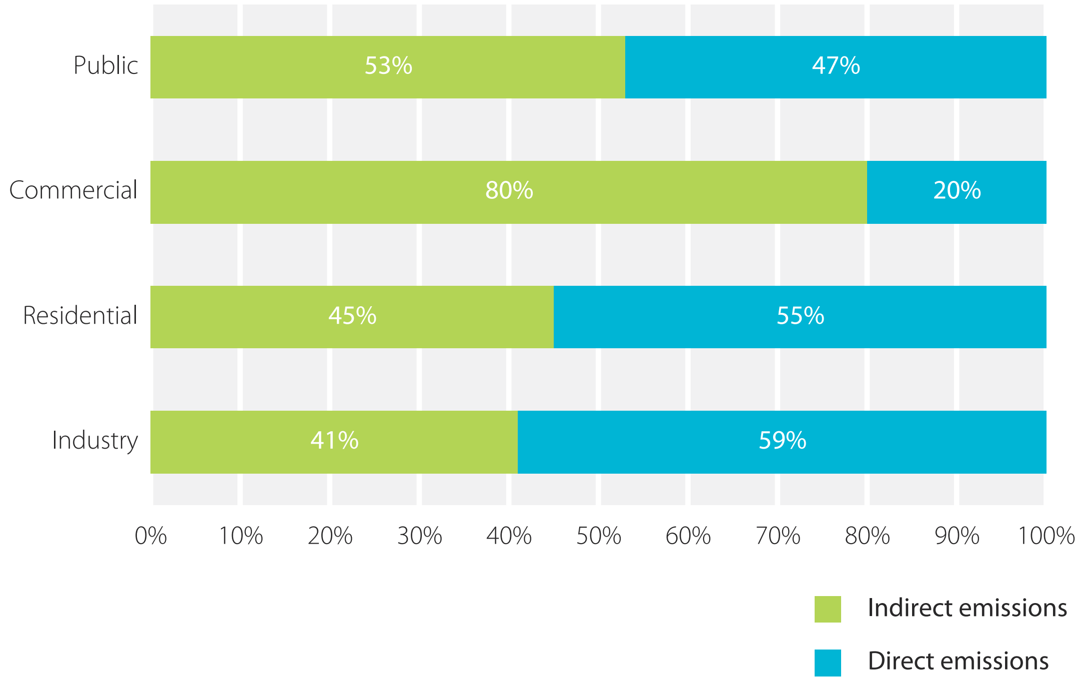
Total emissions in buildings and industry

Homes, non-residential buildings and industry are responsible for around two-thirds of total UK CO_2 emissions. Direct emissions (e.g. due to burning of fuel for heat) account for 51% of total buildings and industry emissions and indirect emissions (mainly electricity related) for 49%. The split between direct and indirect emissions varies between sectors, with the commercial sector having the highest proportion of indirect emissions, whilst in industry direct emissions dominate (see Figure 5.1).

Total emissions from buildings and industry have fallen significantly since 1990 (see Figure 5.2), although emission reductions have slowed more recently, particularly as regards indirect emissions:

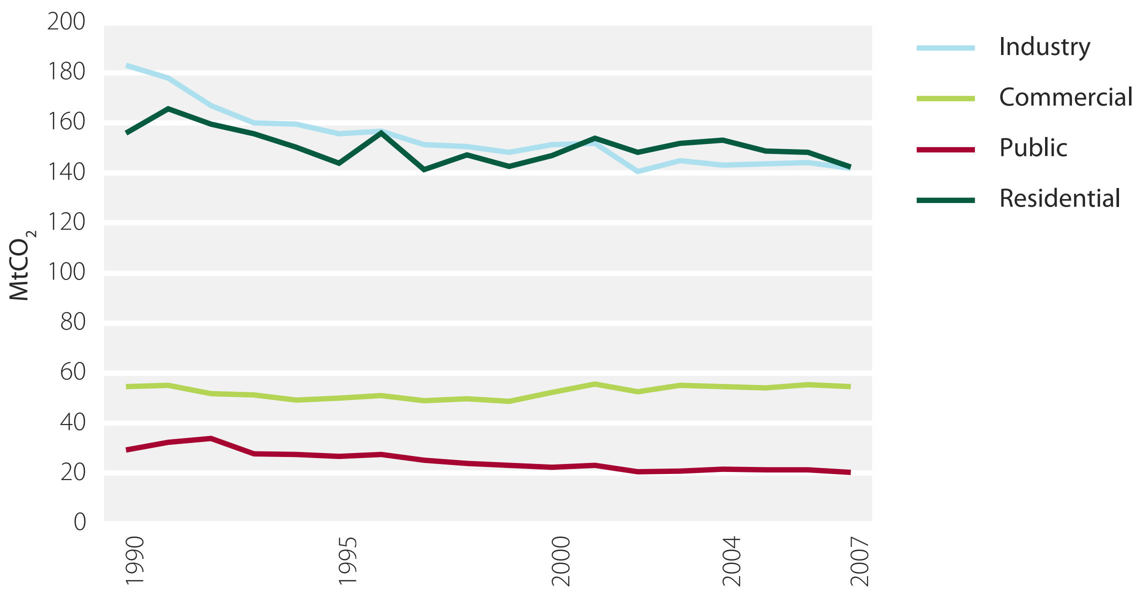
- Emissions in these sectors fell by 15% over the period 1990 to 2007, with direct emissions falling 14% and indirect emissions falling 16%.
- Between 2003 and 2007 emissions fell by 4%, driven by reduced direct emissions, while indirect emissions were broadly flat.
- Provisional estimates suggest that direct emissions from buildings and industry in 2008 were broadly the same as in 2007, as was electricity consumption.

Figure 5.1 Direct and indirect emissions from energy use by sector in 2007



Source: NAEI (2009).

Figure 5.2 Emissions from energy use in buildings and industry by sector 1990-2007



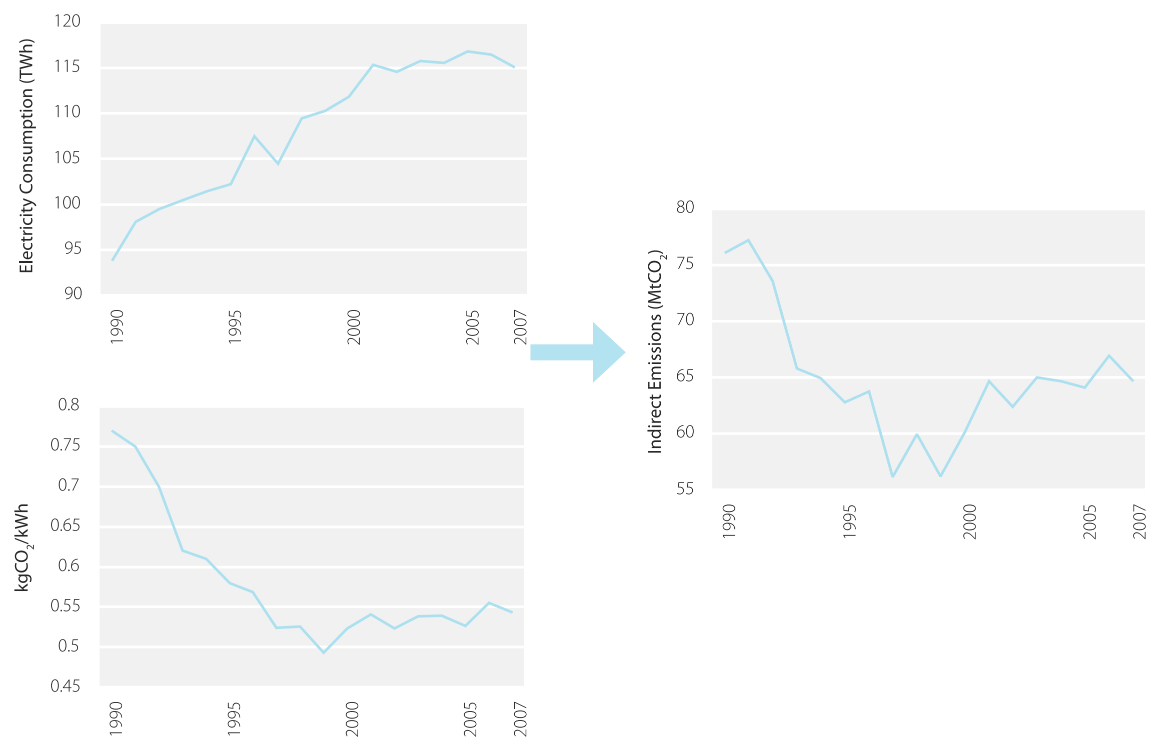
Source: NAEI (2009).

Residential emissions

Residential emissions have fallen since 1990. However, while there was a substantial drop in the first five years of the period, over the last 12 years, emissions have fluctuated.

- Overall, residential emissions fell by 9% between 1990 and 2007. This was driven mainly by falling indirect emissions in the 1990s as a result of the switch from coal to gas power generation (Figure 5.3).
- Between 2003 and 2007, residential emissions fell by 6%.
  - This was underpinned by an 11% reduction in direct emissions between 2003 and 2007, at least partially as a result of reduced demand due to increased energy prices.
  - Residential indirect emissions were broadly flat between 2003 and 2007.
- Provisional 2008 emission and energy consumption data shows:
  - Direct residential emissions increased by 5%, driven by a 3% increase in fuel consumption in the winter of 2007/08.
  - Electricity consumption increased by 2% over the same period.

Figure 5.3 Electricity consumption, carbon intensity and indirect emissions from residential buildings 1990-2007



Source: DECC (2009), *Energy consumption in the UK*; Defra (2009) *Guidelines to Defra's GHG conversion factors for company reporting and NAEI (2009).*

Public sector emissions

Public sector emissions reductions over the period since 1990 have resulted mainly from fuel switching rather than energy efficiency improvement or reduced energy consumption:

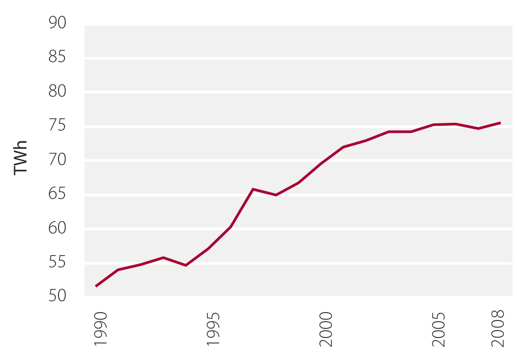
- Public sector emissions fell by 30% over the period 1990 to 2007 due to a greater use of lower carbon fuels with overall energy consumption remaining largely flat.
- In the period 2003 to 2007, emissions fell by 2% due to a 5% reduction in direct emissions. Indirect emissions over this period were broadly flat.
- Preliminary data suggests that the level of direct public sector emissions in 2008 was broadly similar to 2007.

Commercial emissions

Commercial emissions have not fallen since 1990, with the impact of falling carbon intensity in electricity generation offset by increased electricity consumption:

- Commercial emissions are around the same levels as in 1990 and stayed broadly constant between 2003 and 2007.
- Indirect emissions currently make up approximately 80% of commercial sector emission, having grown by 2% between 1990 to 2007 and by 2% between 2003 to 2007, with increased electricity demand more than offsetting falling carbon intensity of power generation over the period since 1990 (see Figure 5.4).
- Provisional data suggests that commercial sector direct emissions in 2008 remained around the level for 2007.
- The retail sector, hotel and catering and warehouses currently account for the largest proportion of energy consumption and emissions in non-residential buildings (see Figure 5.5).

Figure 5.4 Commercial sector electricity demand 1990 to 2008



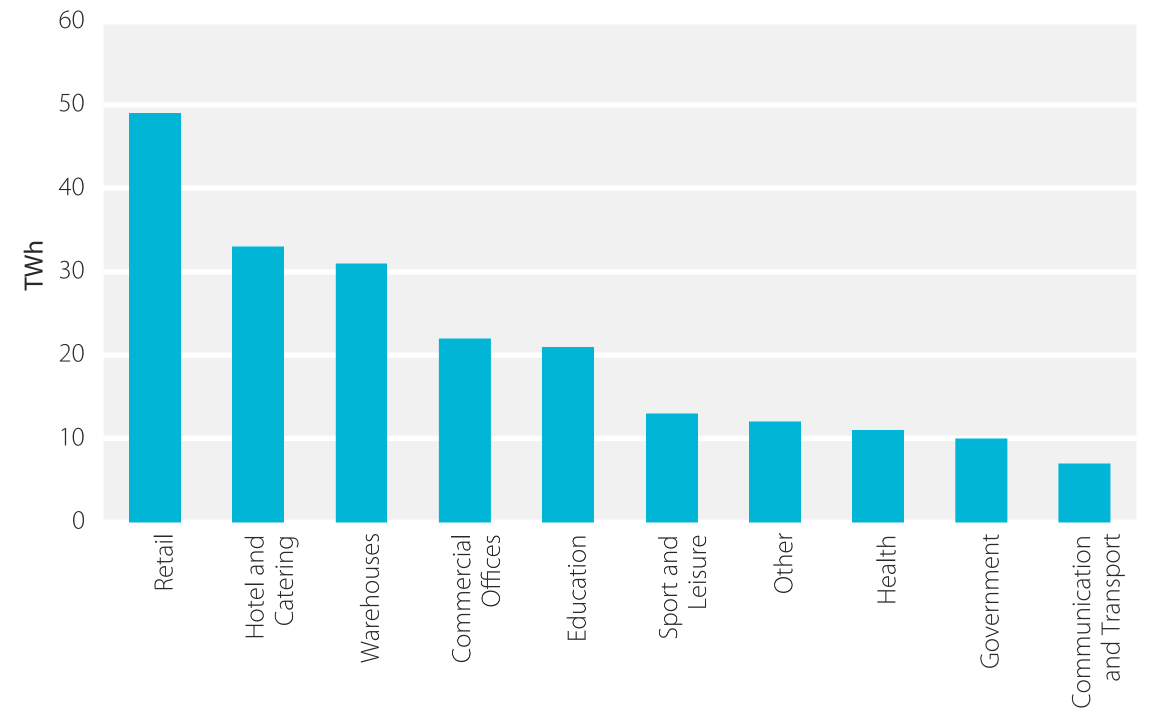
Source: DECC (2009), *Energy consumption in the UK*

Industrial emissions

Industrial emissions fell significantly in the period since 1990, although less so in recent years, due to fuel switching and industry restructuring:

- Industrial emissions fell by 22% between 1990 and 2007, due to direct emissions reductions from the decline of heavy industry and fuel switching. Indirect emissions fell slightly as a result of improved carbon intensity of power generation.
- More recently, emissions fell by only 2% in the period 2003 to 2007.
  - Direct emissions fell by 5% from 2003 to 2007, due to the changing structure of the UK industrial sector and the use of less carbon-intensive fuels in industrial production.
  - Indirect emissions increased by 3% over the same period, as electricity demand growth offset any energy efficiency improvement.
- Provisional 2008 data suggests that direct emissions fell by 4% relative to 2007, while electricity consumption fell by 3%, both of which reflect declining production due to the recession.

Figure 5.5 Public and commercial energy consumption by sub-sector in 2007



Source: DECC (2009); *Energy consumption in the UK*.

2. A framework for energy efficiency improvement in residential buildings

In our December 2008 report we set out a range of measures for improving energy efficiency and reducing emissions in 2020.

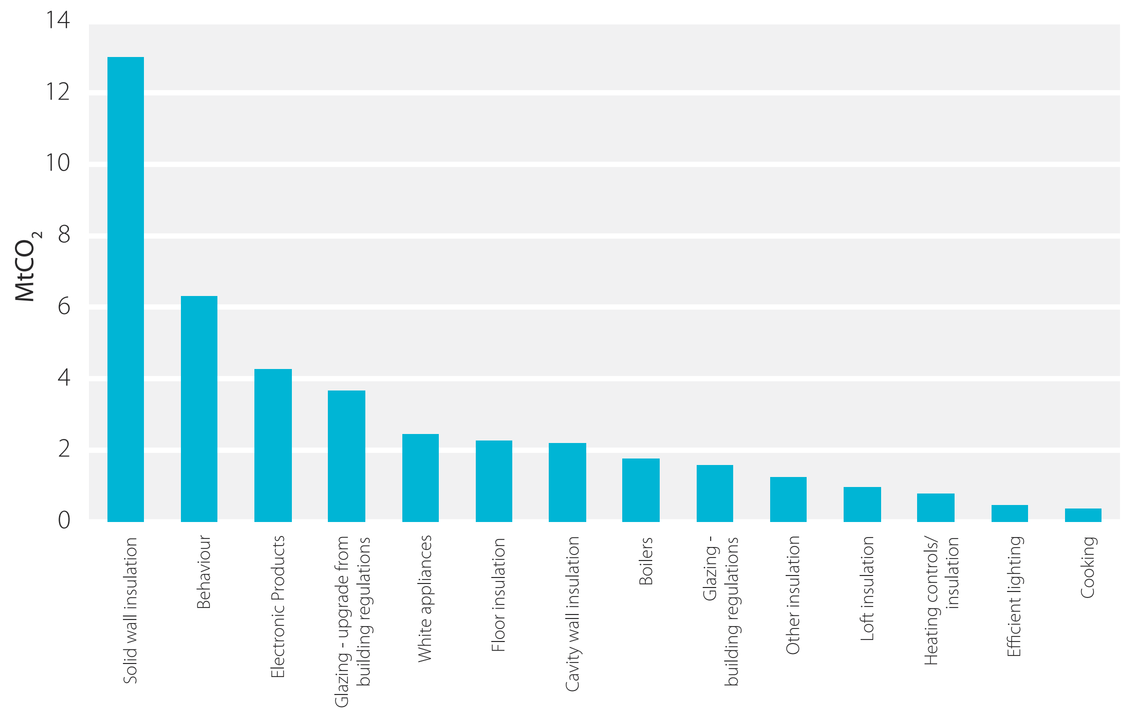
We started with a reference scenario that included emissions reductions expected to ensue from energy efficiency improvements under the Government's Climate Change Programme (CCP) 2006, including:

- 2 $MtCO_2$ from loft insulation.
- 3 $MtCO_2$ emissions reduction from cavity wall insulation.
- 7 $MtCO_2$ from replacement of old inefficient boilers with new efficient condensing boilers.

We then carried out a detailed assessment of remaining emissions reduction potential over and above what was expected from the CCP (Figure 5.6). We estimated potential for a further:

- 1 $MtCO_2$ from loft insulation.
- 2 $MtCO_2$ from cavity wall insulation.
- 17 $MtCO_2$ from more difficult measures including solid wall insulation, under-floor insulation and upgrade of glazing above building regulation levels.
- 2 $MtCO_2$ from early replacement of condensing boilers.
- 8 $MtCO_2$ from more efficient lights and appliances.
- 6 $MtCO_2$ from lifestyle change including turning the thermostat down by 1 degree C and using appliances on efficient cycles.

Figure 5.6 Technical potential from domestic energy efficiency measures in 2020



Source: CCC (2008).

We noted that emissions reductions were unlikely to be achieved under the existing policy framework, which – based on a preliminary assessment – the Committee viewed as providing insufficient incentives to address barriers to uptake of measures.

This chapter considers barriers to uptake and the way that these might be addressed in more detail, drawing on new analysis that we commissioned from Element Energy. We first focus on supply side barriers, which could constrain potential for uptake in the near term. We then move to an assessment of demand side barriers and the way that these are or could be addressed by the policy framework. Given an assessment of supply and demand side barriers, we set out indicators based on what the Committee believes is achievable, and against which future progress reducing emissions should be judged.

We therefore consider in turn:

(i) Supply side barriers to rolling out energy efficiency measures

(ii) The policy framework for energy efficiency improvement

(iii) Indicators and scenarios for residential emissions reductions.

(i) Supply side barriers to rolling out energy efficiency measures

In our December 2008 report, we made a general assumption that measures to improve energy efficiency could be rolled out on a straight line basis. In order to explore the validity of this assumption, we commissioned Element Energy to carry out detailed analysis of feasible implementation given supply and demand side barriers.

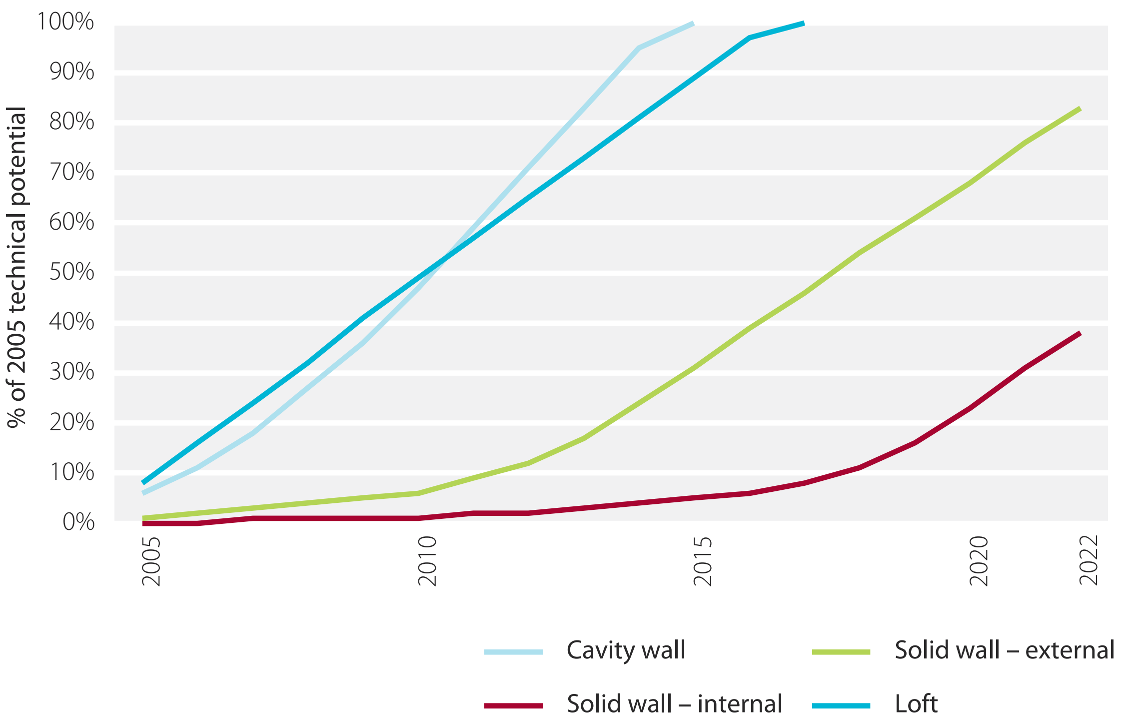
Element Energy's analysis and our consultation with key industry players suggest that there is currently adequate industry capacity to support very ambitious rolling out of loft and cavity wall insulation. For other measures where current capacity is lower (e.g. solid wall insulation) the lead time for industry expansion is relatively short (see Figure 5.6), although training and skills gaps need to be addressed, especially for more difficult measures such as external wall insulation.

The Committee therefore believes that the Government's targets for rolling out energy efficiency improvements as set out in the draft Heat and Energy Saving Strategy (HESS) are achievable based on a consideration of supply side constraints only. These targets include:

- All lofts and cavity walls will be insulated where practicable by 2015.
- By 2020, 7 million homes make more substantial changes such as solid wall insulation.
- All homes to have received by 2030 a 'whole house' package including all cost-effective energy saving measures, plus renewable heat and electricity measures as appropriate.

The Element Energy analysis suggests, however, that targets are highly unlikely to be met under current policies given demand side constraints on uptake of energy efficiency improvements.

Figure 5.7 Insulation measures – percentage of 2005 technical potential realised under supply only constraint



Source: Element Energy (2009).

(ii) The policy framework for energy efficiency improvement

The current policy framework

The main policy for delivering residential energy efficiency improvement is the Carbon Emissions Reduction Target (CERT). This was introduced in 2008 as the successor to the Energy Efficiency Commitment and will run until the end of 2012. CERT works by setting targets for energy supply companies to implement measures in homes that will reduce emissions, with failure to meet targets resulting in fines. Initially, a target of 154 $MtCO_2$ of lifetime savings was agreed but this was extended to 185 $MtCO_2$ in 2009.

Under CERT, energy companies offer measures to consumers free or at discounted rates, spreading associated costs across their customer base. Forty per cent of measures are targeted at a 'Priority Group' comprising people over age 70 and those on benefits.

In its first year of operation, CERT delivered half of the target for the period to 2012. A significant part of this reduction (31%) was achieved by sending customers free compact fluorescent light bulbs. There are no checks in place, however, to ensure that customers actually use these bulbs. Given the risk that bulbs are not used and therefore not actually reducing emissions, the government will not count mailing of bulbs to consumers against CERT targets after January 2010, although subsidising the sale of bulbs in shops will continue to be credited.

In our December 2008 report, we expressed our confidence that CERT will deliver on easy measures such as energy efficient light bulbs. However, we questioned whether it was appropriately designed for the much bigger challenges associated with full roll-out of measures around changing the fabric of buildings, particularly where these measures are potentially costly and disruptive (e.g. widespread solid wall and floor insulation). This is borne out by the data from CERT's first year of operation when only 8,600 solid wall insulation measures were delivered. Initially, the government suggested that the scheme might deliver 150,000 solid wall measures between 2008 and 2011.

CERT operates in England, Wales and Scotland. In addition, the Devolved Administrations have introduced their own energy efficiency policy levers, generally with a strong emphasis on combating fuel poverty (Box 5.2).

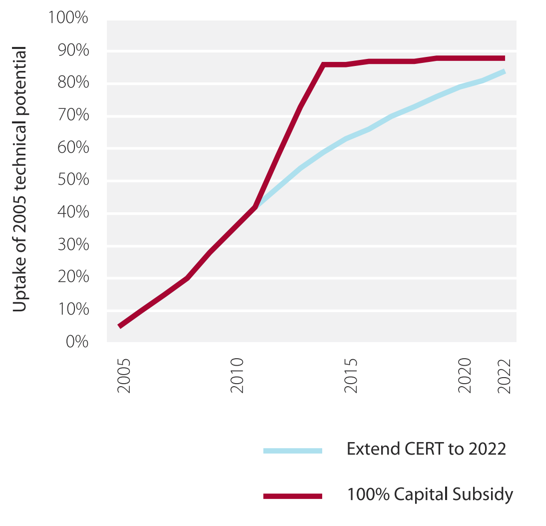
Likely uptake of measures under the current policy

The results of the analysis commissioned by the Committee reinforces our concerns about the effectiveness of CERT. The work is based around statistical analysis of survey data which is then used to simulate household response under various policy levers. The results suggest that even with full subsidisation of upfront cost, there might only be limited uptake of cost-effective energy efficiency improvement measures to 2020.

- Even with full capital grants, uptake rates for lofts are projected to be not more than 88% of total potential (Figure 5.8), and for cavity walls not more than 72% (Figure 5.9). This reflects the underlying survey data upon which the Element Energy simulations are based, and which suggest that up to 30% of the population are not currently interested in energy efficiency improvement even when this is free.
- Uptake of solid wall insulation is projected to be in the range of 7% of total potential under current CERT incentives, with full capital grants resulting in uptake of no more than 47%, reflecting a lack of willingness to take up this disruptive measure (Figure 5.10).

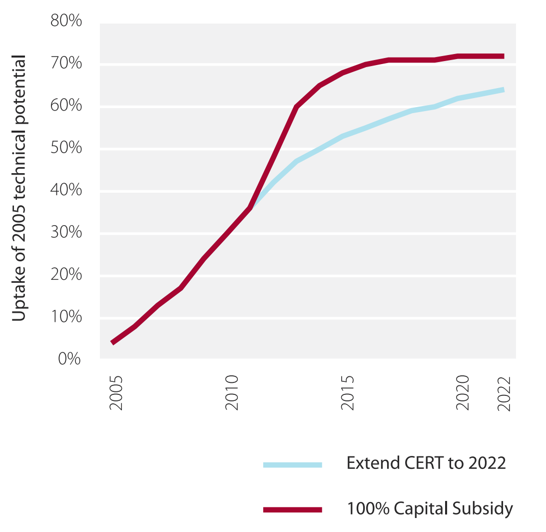
Across the full range of cost-effective measures, Element Energy's analysis suggests that less than half of emissions reduction potential through energy efficiency improvement would be achieved if there was a CERT extension to 2022. In broad terms, this bears out our previous assessment that the current policy is not well designed to address the range of barriers to energy efficiency improvement (lack of information, hassle factor, lack of willingness to implement measures, etc.). A new policy is therefore required.

Figure 5.8 Uptake for different measures under alternative scenarios – loft insulation



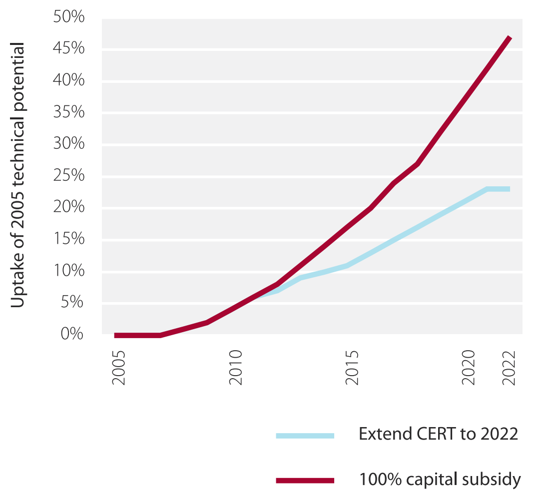
Source: Element Energy (2009).

Figure 5.9 Uptake for different measures under alternative scenarios – cavity wall insulation



Source: Element Energy (2009).

Figure 5.10 Uptake for different measures under alternative scenarios – solid wall insulation



Source: Element Energy (2009); CCC analysis.

Government proposals for a new policy framework

Recognising the importance of energy efficiency improvement in meeting carbon budgets, together with limitations of the current policy, the Government proposed a new approach in its draft Heat and Energy Saving Strategy published in February 2009 and to be finalised by December 2009.

This new policy framework is based on three pillars:

- **A whole house approach**, under which a comprehensive energy audit of each house is carried out, identifying the full range of measures for low-carbon refurbishment. These can then be delivered in 'one hit' or through incremental improvement. Ideally, the company performing the audit acts as a one-stop shop for the household, arranging financing and implementation of measures.
- **A neighbourhood approach**, under which whole house packages are rolled out on an area basis (i.e. street by street), and where there are examples of successful implementation (Box 5.3).

Box 5.2 Devolved Administrations energy efficiency programmes

Wales

The Home Energy Efficiency Scheme (HEES) is a Welsh Assembly Government funded initiative aimed at making homes in Wales warmer, healthier and more energy efficient. The HEES grant provides a package of heating and insulation improvements up to the value of £3600. The Welsh Assembly Government is planning to restructure HEES to target the most inefficient properties and those most in need of support as part of the Fuel Poverty Strategy consultation.

The Heads of the Valleys Low Carbon Zone is a new area-based scheme supported by the Welsh Assembly and local authorities. Over a 15 year period, the programme will install energy efficiency measures and microgeneration units into 40,000 socially owned homes, with an emissions reductions target of 140,000 tCO_2.

Scotland

The new Energy Assistance Package was launched in April 2009 and is supported by a budget of £60m in 2009/10. The package includes energy efficiency advice, income maximisation and energy tariff checks, and, for eligible households, help with standard and enhanced physical measures to improve energy efficiency of the home. Enhanced physical measures are targeted at those most likely to be fuel poor and can include newer technology such as air source heat pumps.

The Scottish Government has also introduced a new area-based 'Home Insulation Scheme' to increase the take up of energy advice and insulation measures in selected areas. It is managed by the Energy Saving Trust, and is supported by £15m of Scottish Government funding with additional funding being sought from other partners. The scheme will target almost 100,000 houses in 10 council areas in its first year and is focused on measures such as loft and cavity wall insulation.

Northern Ireland

Instead of CERT, Northern Ireland has been operating the Energy Efficiency Levy Programme (EELP) since 1997, run by the Utility Regulator. The EELP is not a legal obligation on suppliers; instead a levy is charged per customer and is available to all suppliers wishing to promote energy conservation projects. The EELP was introduced to implement energy efficiency schemes for domestic and non-domestic customers but since 2002, the majority of the funding (80%) has been targeted at alleviating fuel poverty. It has recently been rebranded as the Northern Ireland Sustainable Energy Programme (SEP).

Box 5.3 Area-based (neighbourhood) schemes: Kirklees

'Kirklees Warm Zone' is the largest free insulation scheme in operation in the UK. The three year scheme, which started in March 2007, aims to roll out free insulation to all 171,000 properties in the Council's area. The principal insulation measures are cavity wall insulation and loft insulation top-up to 300mm, resulting in an average SAP improvement of 6 points.

The scheme has a budget of £20 million over a three year period, funded by Kirklees Council, Scottish Power, National Grid and the Regional Housing Board. It systematically targets households, first by mail and then by up to three door knocks. Evidence suggests that word of mouth has been important in promoting take up.

By June 2009, over a third of households targeted had been insulated. The other two thirds of households either already had insulation or were not suitable (30%) or were not interested (6%) or contact had not yet been made (26%); these latter two categories will be targeted in a "mop up" phase. For those households which have been insulated, costs are around a third lower than if a street by street approach had not been used.

- **New financing mechanisms**, which involve consumers taking long-term loans to finance upfront costs of energy efficiency improvements, rather than these costs being spread across the customer base of energy companies. One proposal is to attach the loan to the property, so that both costs and benefits are passed on to the next owner.

The Committee has considered this proposed approach against five criteria set out in our December 2008 report which effective policies should meet: (i) provide information which increases awareness of potential, (ii) strongly encourage households to take action, (iii) reduce hidden costs associated with undertaking measures to improve energy efficiency, (iv) improve financial incentives for action through provision of implicit or explicit subsidies, (v) require action through direct regulation where this is the most appropriate policy lever.

Whole house approach

The whole house approach meets the first three of these criteria, providing information, encouraging households to take action and reducing hidden costs. The Committee therefore supports a whole house approach applied to the full range of cost-effective measures (i.e. that cost less per tonne of CO_2 saved than the projected carbon price) to improve energy efficiency (loft and cavity wall insulation, solid wall insulation, early scrapping of old inefficient boilers, etc.) together with measures to support lifestyle change including installation of heating controls (e.g. thermostatic valves on radiators) and smart meters (Box 5.4), and possibly investment in renewable heat.

Neighbourhood approach

In considering the neighbourhood approach, the Committee has noted three important findings from the social research evidence base put together by Defra, DECC and the Energy Saving Trust:

- **Community based approaches.** Defra survey evidence suggests that a majority of people are keen to act on climate change (either because they are concerned about this directly, or want to save money, avoid waste, etc.) subject to caveats that this should not significantly disrupt current lifestyle (e.g. through restricting mobility). People are concerned, however, that their individual impact will be limited. Community based action is therefore desirable so that people can see how their action together with that of others will make a difference. Beyond a critical mass, people will join community based action simply to conform to social norms even though they may not necessarily want to act on climate change.

- **Government leadership.** The majority of respondents in Defra surveys say that they are looking for the Government to provide a lead on tackling climate change, and that they would be prepared to act if the Government were to act first. The current situation is one where people do not generally perceive energy efficiency improvement in homes to be a top government priority, and so do not make it their own priority. A stronger signal from Government through actively leading and participating in taking forward implementation of measures to improve energy efficiency would therefore raise confidence that measures to improve energy efficiency will be successfully implemented.

Box 5.4 Heating controls

Turning down thermostats is probably the easiest and cheapest way to achieve substantial CO_2 reductions. In our December 2008 report, we estimated that turning down thermostats by 1°C could reduce emissions by 5.5 $MtCO_2$ annually.

Lack of effective heat controls is currently a barrier to unlocking this potential:

- Industry evidence suggests that around 10 million homes lack some or all standard heating controls (such as programmable timers, room thermostats and thermostatic radiator valves).
- Analysis for the Market Transformation Programme suggests that a substantial proportion of householders do not set and use their controls correctly.

Accelerated roll-out of heating controls as well as smart meters under a whole house approach would provide opportunities for households to save energy and reduce bills.

- **Role for energy companies.** Evidence from the Energy Saving Trust questions how trusting the population is of energy companies, suggesting that only 10% of those surveyed consider energy suppliers trustworthy and impartial when providing advice on how to save energy. Energy companies may not therefore be well placed to lead on what in many respects is a fundamental social transformation (e.g. to mobilise communities, change attitudes and behaviours) required to achieve widespread implementation of buildings fabric measures, and may be better placed to focus on delivery within a government led framework.

A neighbourhood approach *led by government*, aimed at transforming social attitudes, could therefore better meet the second criterion for effective policy than the current situation where the lead is with energy companies.

The Committee recommends that such a neighbourhood approach is adopted. At a high level this should involve central government providing leadership and strategic guidance, for example through a new office tasked with taking forward the new energy efficiency commitments (similar to the Office for Renewable Energy Deployment). Local government would have a key delivery role, building on the trust relationships that it has already established with households and taking advantage of its local housing stock knowledge. Implementation would be in partnership with energy companies and other appropriate commercial organisations, building on their delivery experience.

It is not for the Committee to comment on detailed design of an implementing framework for the neighbourhood approach. We note, however, that whilst 130 out of 150 local authorities have signed up to National Indicator 186 committing them to per capita CO_2 reductions, the majority have no experience of running major energy efficiency programmes. Given the radical change that would be required in order for local authorities to play a leading role in promoting energy efficiency improvement, strong levers including possible statutory instruments may be required in order to secure adequate political and financial commitment.

Complementary regulatory measures for the private rented sector need to be seriously considered as this sector is likely to be less responsive to the neighbourhood approach or pay-as-you save models, given split incentives for landlords and tenants.

More generally, to the extent that some owner occupied households may not respond to the neighbourhood approach, regulatory measures may also need to be considered (e.g. requiring a minimum energy efficiency rating as part of major renovation or upgrade or as a condition of sale, linking council tax or stamp duty to energy efficiency rating).

New financing mechanisms

Energy bills are currently around £35 more than they otherwise would be to reflect costs associated with CERT. Going forward, costs associated with the new delivery model will be substantially higher than those for CERT as more expensive measures are implemented:

- A recent study for Consumer Focus[1] suggested that a retrofit programme aiming to improve all properties in England to EPC bands B and C (currently only 6% of properties) would cost on average around £7,000 per house. It would also reduce annual fuel bills by an average of 46%.
- Evidence from a trial of the whole house approach by Drum Housing Association in Petersfield suggests that in the least efficient properties costs could be as high as £38,000 per house for a *full* range of measures (including solar water heating and PV).
- Estimates for annual investment needs for a ten year low-carbon refurbishment programme vary from £5 billion to £15 billion (UK Green Building Council: £5-15 billion, Climate Change Capital: £7.9 billion, Consumer Focus: £15 billion[2]).

1 Consumer Focus (2009) *Raising the SAP*. http://www.consumerfocus.org.uk/media/viewfile.aspx?filepath=1_20090513110418_e_@@_FuelpovertyproofingcostpubMay09final.pdf&filetype=4

2 UK Green Building Council (2009) *Pay as you save*. http://www.ukgbc.org/site/document/download/?document_id=670
Climate Change Capital (2009) *Delivering Energy Efficiency to the Residential Sector*. Briefing Note.

Box 5.5 Solid Wall Insulation

Solid wall insulation has the highest potential of any of the domestic energy efficiency measures. In our December 2008 report we calculated a reduction potential of 13 $MtCO_2$ in 2022 from 7 million houses at a cost of £5/tCO_2.

More recent work carried out by Element Energy for us suggests that we had previously underestimated the capital costs of solid wall insulation and that this increases the abatement costs to around £17/tCO_2. In other words, whilst solid wall insulation is still cost effective relative to our projected carbon price, it will take longer to pay for itself in energy savings.

Only around 17,000 retrofit solid wall installations are undertaken per year (mostly in the social sector) given limited incentives in the current framework. At this rate, only 15% of existing solid wall properties will be insulated by 2050. The Committee's view, however, is that this could be significantly accelerated if new incentives were to be introduced around a whole house/neighbourhood approach. The Government will propose a framework to support measures such as extensive solid wall insulation as part of its Heat and Energy Saving Strategy, to be published in late 2009. We will consider the effectiveness of the proposals in our 2010 progress report.

Current annual spending by government and energy suppliers on residential energy efficiency programmes is just over £2 billion, therefore implying a large funding gap.

Government proposals to move towards individual charging are partially motivated by concerns over distributional issues that would arise under continued socialisation of costs. For example, passing on costs of rolling out solid wall insulation (Box 5.5) for all seven to eight million houses with solid walls in the UK would have a significant impact across the whole population (i.e. 25 million households), most of which would have no offsetting energy bill reductions.

Evidence from Germany suggests that it is possible to generate high demand for energy efficiency improvement, the situation we would hope to create here through the whole house – neighbourhood approach. In Germany, significant uptake for more expensive and disruptive measures has been achieved through individual charging, while in the UK a new 'Pay-as-you-save' model is to be trialled (Box 5.6).

Box 5.6 Financing Whole House refurbishment

1. Germany's 'Energieeffizient sanieren' programme

Germany's 'Energy Roadmap 2020' has the aim of making Germany the most energy efficient country in the world. A major energy efficiency refurbishment programme is underway which covered 780,000 properties between 2006 and 2008. Its key features are:

- Implementation of measures is generally voluntary; the exception is loft insulation which has been made mandatory.
- Households are expected to make a financial contribution to the installation of measures.
- This is complemented by Government funding of €2.4 billion per year to support a range of measures but the programme has not subsidised CFLs.
- Households receive grants covering up to 17.5% of costs, or loans of up to €75,000 are provided at subsidised interest rates.
- Loans also include a cash-back scheme of up to 12.5% depending on the energy efficiency standard achieved.
- The most favourable terms are available when combinations of measures are implemented together (i.e. for a whole house approach).
- Separate grants and subsidised loans for renewable heat technologies, as well as a feed-in tariff for microgeneration and subsidies for CHP and district heating systems.

2. Pay-as-you save

This concept is based on spreading the cost of low-carbon refurbishment over a long period of time, across different owners. A UK Green Building Council Task Group[3] evaluated the concept in 2009 at the request of the Government and proposed the following model:

- An accredited low energy refurbishment provider develops a 'whole house' energy improvement plan.
- The provider uses finance from a third party to cover the upfront costs of the work.
- An obligation to repay is linked to the property over an extended period of time; this would require legislation to allow local authorities to create a PAYS Local Land Charge.
- Repayments are calculated to be less than the savings that will be made on the fuel bills.
- Billing could be through council tax or electricity bills.
- At change of tenure the benefit and the obligation to pay is transferred to the new householder.
- The whole scheme is underwritten by Government to reduce financing risk.

The proposal is to fund upfront costs of up to £10,000 which would provide annual savings of £50 to £200. To drive mass-scale take up beyond environmentally aware households, the proposal notes that strong incentives may be necessary such as stamp duty or council tax rebates, reduced VAT rates or cash-back.

3 http://www.ukgbc.org/site/document/download/?document_id=670

In moving towards individual charging, however, the Government's proposals do not meet the fourth criterion for effective policy, to strengthen financial incentives through providing implicit or explicit subsidies. This is problematic for a number of reasons:

- Some measures do not result in a net cost saving in the short to medium term even with low cost long-term finance. The best example of this is solid wall insulation, which is unlikely to be taken up without at least some subsidy.
- More generally, the Element Energy analysis suggests that there is likely to be a significant decline in uptake as individual charging is substituted for grant funding.
- Consumer research carried out by the Energy Saving Trust suggests many people are unwilling to take on long-term loans for energy efficiency even if these will result in a net cost saving.
- In the German example cited above, individual charging is on the basis of subsidised loans and complemented with grants and mandation.
- More than 40% of the fuel poor live in hard-to-treat homes where solid wall and other expensive measures are required (Figure 5.11). The fuel poor are less well placed to pay for energy efficiency improvements than the non-fuel poor.

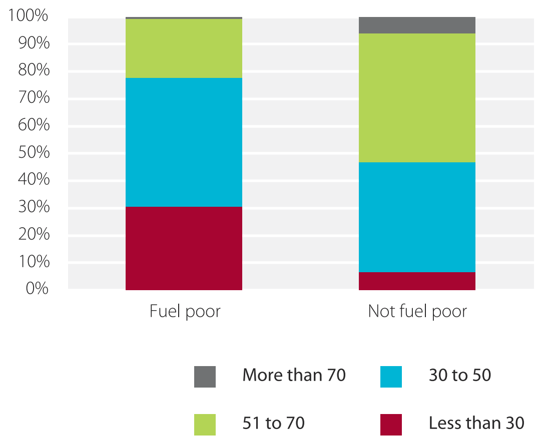
Therefore an element of financial support should be maintained under the new arrangements, both in general and targeted to the fuel poor, in order to provide sufficiently strong incentives for uptake. This would probably best be achieved through ongoing socialisation of some costs (i.e. a hybrid of the current system and the Government's proposals) to provide free measures for the fuel poor and subsidised measures for the population more generally.

(iii) Energy efficiency and fuel poverty

Financial support targeted at energy efficiency improvement for vulnerable households can help to reduce fuel poverty. It cannot, however, fully alleviate this problem, which will be exacerbated by higher energy prices due to increased levels of relatively costly renewable electricity and renewable heat.

In our December 2008 report, we argued that there may be scope to address fuel poverty through the introduction of rising block tariffs (RBTs) – where a subsidised price is charged for consumption to cover basic needs, and a higher price for any additional consumption – which may also incentivise energy efficiency. We commissioned the Building Research Establishment (BRE) to model the potential impact of RBTs using a model of the housing stock, household income and energy consumption.

Figure 5.11 SAP ratings of fuel poor versus non-fuel poor households



Source: BRE (2009), *An Investigation of the effect of rising block tariffs on fuel poverty.*
Note: SAP is the Government's Standard Assessment Procedure for energy rating of dwellings. The rating is on a scale from 1 to 120, with higher ratings denoting better energy efficiency.

The BRE analysis suggests that on average, the fuel poor require more energy to adequately heat their homes than those households not in fuel poverty. This is partly because the fuel poor live in relatively energy inefficient houses. It is also because the fuel poor – comprising around 50% pensioners – also spend a lot of time at home, and therefore require relatively high levels of heating (Figure 5.12).

Given that the fuel poor have relatively high energy requirements, the introduction of RBTs would increase average bills for the fuel poor whilst having a negligible overall impact on the number of households in fuel poverty.

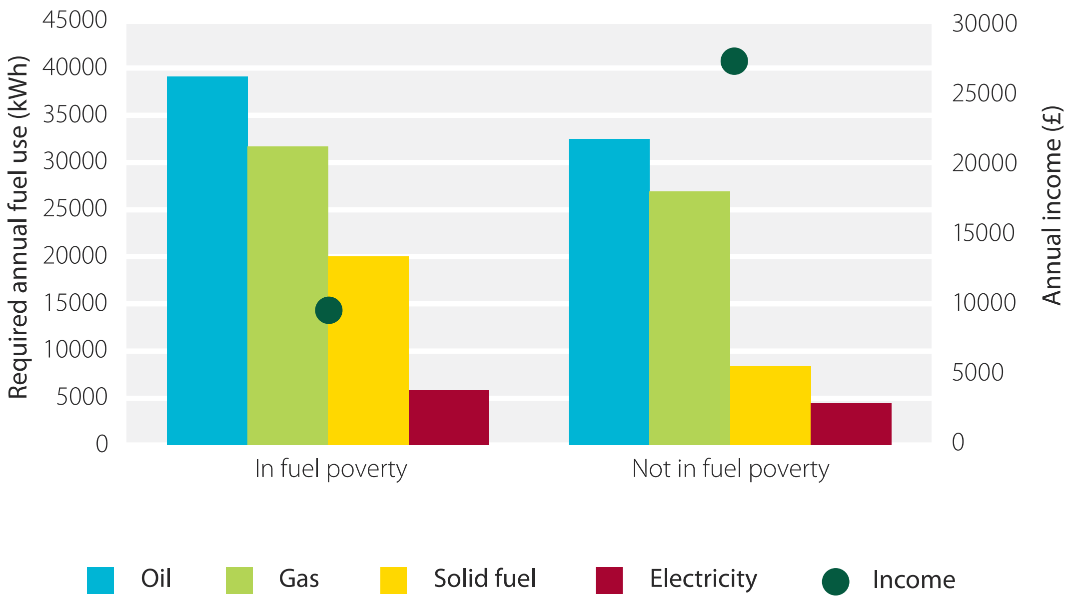
Therefore RBTs should not be introduced until fuel poverty has been addressed through targeted energy efficiency improvement and other fuel poverty policy measures.

(iv) Indicators and scenarios for residential emissions reductions

Our residential buildings indicators – against which we will judge future progress reducing emissions – focus on a number of key measures to improve energy efficiency (lofts, cavity walls, solid walls, boilers and appliances). The indicators are based on our Extended Ambition scenario. For some measures, we have also outlined a more ambitious 'Stretch' scenario which could provide additional emission reductions.

In setting out trajectories for these measures, we assume that a new policy with high powered incentives is introduced. This would require a high level decision in 2009 with detailed proposals and measures to be developed in 2010-2011 for implementation from 2012.

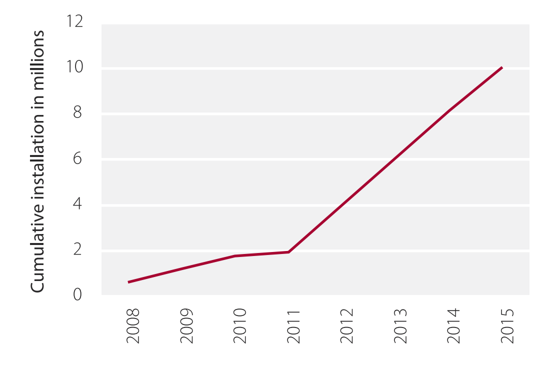
Figure 5.12 Average required use of each fuel (where used) in households in fuel poverty compared to households not in fuel poverty



Source: BRE (2009), *An investigation of the effect of using block tariffs on fuel poverty.*

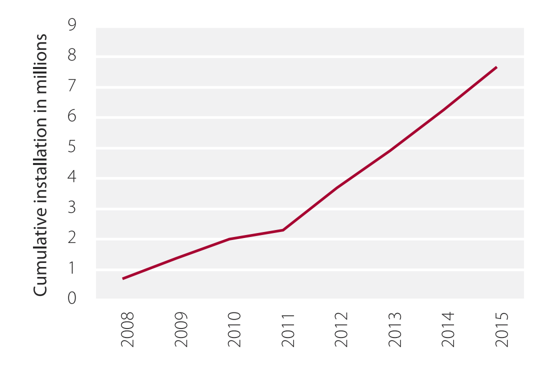
We assume that the new policy delivers the Government's ambition as set out in the draft Heat and Energy Saving Strategy to insulate all lofts and cavity walls by 2015 (where practicable). We assume this applies to 7.5 million unfilled cavity walls and 10 million under-insulated lofts by 2015 (Figure 5.13 and Figure 5.14[4]). To achieve the 2015 target will require a significant scaling up of installation numbers from what is currently being delivered under CERT.

Figure 5.13 Roll-out of loft insulation



Source: CCC analysis.

Figure 5.14 Roll-out of cavity wall insulation



Source: CCC analysis.

For solid walls, we assume implementation begins to accelerate significantly in 2012 from the current very low levels as a new policy is introduced. In our Extended Ambition scenario we assume that 2.3 million properties will have solid wall insulation installed by 2022; this is in line with the level of ambition set out in the draft Heat and Energy Saving Strategy. In our Stretch Ambition scenario, we assume that there are 3.3 million solid wall insulations by 2022 (i.e. around 40% of total technical potential).

We make the following assumptions on roll-out of other key measures to reduce residential emissions:

- By 2022, 12 million older boilers are replaced (either at the end of their lives, or through early replacement under a whole house approach) by new efficient condensing boilers or more efficient emerging technologies (such as fuel cell micro-CHP). In the Stretch scenario, we assume 16 million boilers will be replaced.
- By 2022, the proportion of A+ rated wet appliances increases from the current 15% of stock penetration to 82%, with the proportion of A++ cold appliances increasing from the current 0% to 45%, both in line with what is envisaged under the Government's Market Transformation Programme[5] and the EU Framework Directive for the Eco-design of Energy Using Products (EuP). This would require a move to a situation where almost all new appliances sold are the most efficient rating. New policies might therefore be required to support what is a step change relative to the current status (e.g. lower tax rates for more efficient appliances, as have recently been introduced in Italy).

4 This includes lofts which currently have insulation levels below 125 mm and will be topped up to 270 mm as specified in the building regulations. Top ups for the 7 million lofts that currently have 125 mm or more could provide a small additional saving (0.3 $MtCO_2$).
5 Market Transformation Programme 2009 figures are currently unpublished and subject to revision post-consultation.

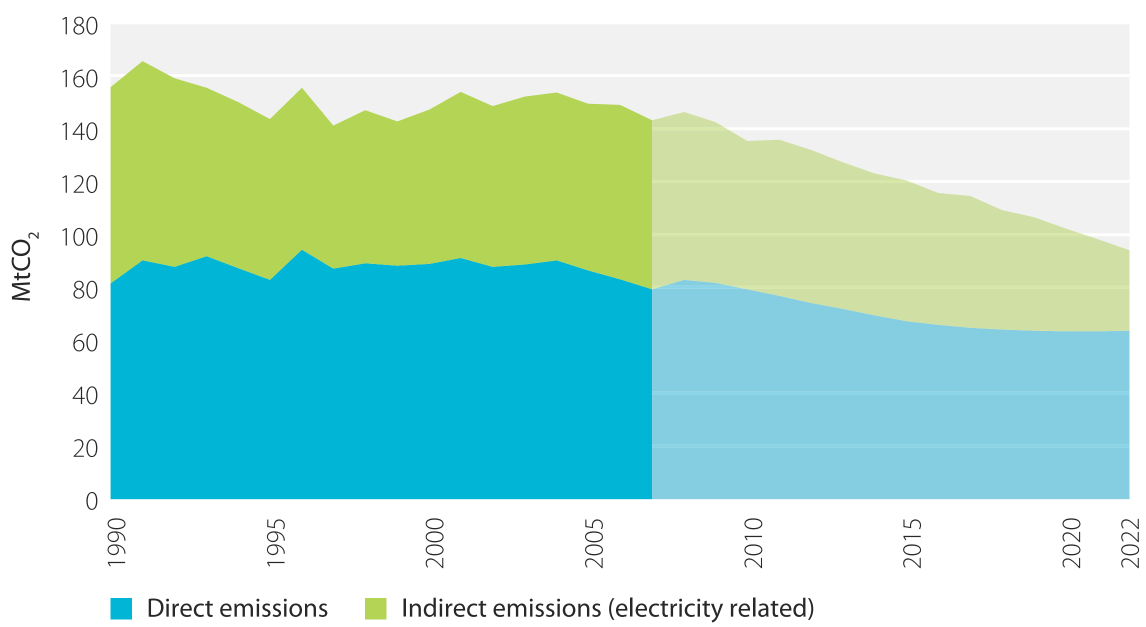
- We also estimate around 4 $MtCO_2$ savings from energy efficiency improvements to consumer electronic products (including reduced stand-by consumption). However, data on the energy performance of these products is currently inadequate and we have therefore not chosen any indicators for these products. We will return to this issue in future reports as data improves.
- In addition, we assume that every household will have been offered a whole house energy audit by the end of the second budget period, to facilitate take up of the 7 million whole house energy packages the government has committed to by the end of 2020.

Successful implementation of these measures would:

- Reduce residential sector emissions by 35% from 140 $MtCO_2$ in 2007 to 92 $MtCO_2$ in 2022, with direct emissions falling by 20% and indirect emissions falling by 53% (Figure 5.15).

We will collect data on these indicators from a range of sources, although we envisage that the bulk of data will come from CERT and the post-2012 delivery model, which should track implementation of specific measures. In our future reports to Parliament, we will then use this indicator framework to assess trends in residential emissions, the extent to which these are falling as required for meeting budgets and the extent to which underlying measures are being implemented both to meet budgets and to be on the path to meeting longer term targets (see Table 5.1).

Figure 5.15 Residential emissions trajectory under the extended ambition scenario 1990-2022



Source: CCC analysis.

3. Scope for reducing emissions through deployment of renewable heat

Currently heat accounts for nearly 50% of final energy consumed in the UK and almost 50% of CO_2 emissions. Residential buildings account for 54% of heat consumption, commercial and public buildings for 16% and industry for 30%. However, industry is responsible for around 50% of heat related CO_2 emissions. This is due to greater use of carbon-intensive fuels such as oil in order to generate the high temperatures required for process heat.

There is a need to increase renewable heat in the UK from the current level of less than 1% of total heat demand (equivalent to 7.7 TWh), in order to both reduce emissions and meet the EU 15% renewable energy target by 2020.

In our December 2008 report, we set out an Extended Ambition scenario resulting in emission reductions from renewable heat of around 12 $MtCO_2$ in 2020. The scenario was characterised by increased use of biomass with some solar thermal water heating. We did not consider air source heat pumps or biogas in detail.

This section sets out our new analysis which considers a wider range of technologies (e.g. air source heat pumps). It also sets out a high level overview of what a framework to support uptake of renewable heat might include, and presents renewable heat scenarios which will provide a benchmark for assessment in our future progress report.

This section therefore considers:

(i) Analysis of renewable heat technologies

(ii) Overview of the policy framework for renewable heat deployment

(iii) Renewable heat scenarios.

(i) Analysis of renewable heat technologies

In order to better understand technical and economic aspects of renewable technologies, we commissioned NERA to analyse where specific technologies are best applied, their cost effectiveness, and any barriers to uptake. The NERA analysis is focused on biomass (boilers and district heating), heat pumps, biogas, and solar thermal heating (Box 5.7). It does not include assessment of biomass CHP; the Committee recognises that there may be significant potential for carbon saving from this technology (e.g. based on preliminary results from a new AEA technology study for DECC) and will consider this further as part of its work programme for 2010.

Biomass boilers. Biomass can be used in both residential and non-residential sectors, with a technical potential (i.e. if there were no barriers to uptake) to abate 42 $MtCO_2$ by 2022. Costs range from £20-£80/tCO_2 for industrial boilers and £60-200/tCO_2 for residential boilers. The range of costs reflects different applications, types of boilers and heat load sizes, as well as the type of fuel replaced, and is based on an assumption that feedstock prices remain at current levels.

- Biomass boilers have become more common in new developments as they often provide the cheapest option to meet renewable energy targets.
- Biomass boilers and CHP plants could potentially substitute for some of the use of oil in industry to produce steam and process heat.
- In the residential sector, biomass boilers are more suitable in non-urban areas, both because they can substitute for more carbon intense fuels in off-gas grid homes, and there are fewer space constraints and air quality considerations compared to some urban areas. There are currently around 4.3m homes without connection to the gas grid.

Box 5.7 Description of renewable heat technologies

Biomass: refers to any organic matter derived from plants or animals, which is then combusted. Currently, biomass is mainly used in power generation (especially co-firing) due to incentives under the Renewables Obligation. However, in recent years smaller scale boiler systems and combined heat and power (CHP) plants have become more common. Biomass boilers usually operate on wood chip or pellets, while the often larger CHP plants burn virgin or waste wood.

Biogas: organic material is fermented to be broken down into methane and CO_2. This biogas can then be burned in a generator or a CHP plant, or upgraded to biomethane for injection into the gas grid. Sources of biogas include landfills, sewage treatment processes and purpose built anaerobic digesters (AD).

Air source heat pump (ASHP): extracts heat from the outside air in the same way that a fridge extracts heat from the inside. There are two types of ASHPs: an air to water heat pump heats water through under floor heating and radiators and an air to air heat pump delivers warm air.

Heat pumps need electricity to operate the compressor. The Coefficient of Performance (COP) measures how much electricity is needed per unit of heat produced.

Ground source heat pump (GSHP): extracts heat from the outside ground to heat water and air. As the temperature found in the ground is relatively stable throughout the year, a GSHP is more efficient than an air source heat pump.

Solar thermal: harnesses the heat from the sun to produce hot water via a solar collector. Although the solar thermal system performs better under direct sunlight it can also produce energy on a cloudy day.

- Analysis commissioned by DECC from E4Tech[6] indicated that there is enough sustainable biomass to support 7% penetration relative to total heat demand in 2020. The EU has consulted on a sustainability scheme for biomass feedstocks under the European Renewable Energy Directive which has received widespread support.
- The upfront cost of a commercial biomass boiler ranges from £37,000 for a 110kW size boiler to £678,000 for a 1,600kW size boiler.
- In the residential sector, upfront boiler costs are around £4,000–£11,000 for a boiler ranging in size from 12kW to 18kW. Cost savings could reach over £400 per year where biomass replaces electric heating.
- Biomass CHP plants can provide both heat and electricity. Analysis by Pöyry for DECC[7] suggests that the CO_2 saving per unit could be a third higher for CHP units than for individual or community biomass boilers.

Air source heat pumps (ASHPs). ASHPs may be used in buildings with vent or wet (i.e. with radiators) heating systems. There is technical potential for air source heat pumps to save 16 $MtCO_2$ by 2022 costing from less than zero (£-40) to £55/tCO_2 in the non-residential sector and over £300/tCO_2 in the residential sector. The range of costs reflects which type of fuel is displaced, energy efficiency of the building, and size of application.

- ASHPs work well in vent heating systems, and their flexibility to be used in reverse for air conditioning in summer has produced high penetration rates in the commercial sector. The upfront cost of a commercial air source heat pump is around £30,000 for a 55kW unit and £183,000 for a larger 300kW unit.
- In the residential sector, ASHPs are most suitable for under floor heating systems in highly efficient new houses.

6 E4Tech (2009) *Biomass supply curves for the UK.* http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx
7 Pöyry (2009) *The potential and costs of district heating networks.* http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/distributed_en_heat/district_heat/district_heat.aspx

- For existing houses, ASHPs will often require larger radiators and upgraded insulation to operate effectively, thus substantially increasing the cost.
- The upfront cost of a residential heat pump is £4,000-£23,000. Current cost savings per year vary from £50 (when replacing gas heating) to £700 (when replacing electric heating).

Ground source heat pumps (GSHPs). These are most suitable for the residential sector, with scope for technical abatement potential of 6 $MtCO_2$ and costing £5-200/tCO_2. The range of costs reflects different ground conditions and installation costs. Bore holes are usually more expensive than horizontal trench installation.

- As with ASHPs, GSHPs are most cost-effective in well insulated new homes.
- They tend to be more suited to non-urban areas, where space is less of a constraint for installing the ground loops. In some urban areas, more expensive bore hole applications are an option.
- The Energy Saving Trust estimates that upfront costs of a residential GSHP system range between £7,000-£13,000, with annual cost savings between £160 (if replacing an oil-fired heating system) and £840 (for electric heating).
- Both ASHPs and GSHPs have seen rapid penetration in a number of countries in recent years (Box 5.8)

Box 5.8 Countries with high heat pump penetration

Rising fossil fuel prices combined with government financial support have facilitated rapid market growth of both ASHPs and GSHPs in many EU countries. In 2008, sales in the eight European countries with the highest heat pump penetration (Austria, Finland, France, Germany, Italy, Norway, Sweden and Switzerland) increased by 46% to 576,000. Sales were highest in France, almost doubling to 130,000.

- France introduced income tax rebates for heat pumps in 2005 which offer 50% subsidy of the capital cost of the equipment.
- In Sweden, grants are available up to a maximum of €3,300 for installation of various renewable technologies including heat pumps. Rapid growth in heat pumps has driven the reduction in use of heating oil by more than 50% in the last 15 years. Strong market competition has lead to considerable price reduction and almost half of all single family houses now have a heat pump installed.
- In Switzerland, heat pumps accounted for 78% of heating systems in new homes in 2008. A range of subsidies are available from energy suppliers and some local authorities. By 2020, the Swiss government expects the number of heat pumps to triple and deliver a 8% reduction in CO_2 emissions.
- Germany has implemented the largest GSHP project in Europe with 21 boreholes serving 383 new houses and flats in a development near Cologne.

Biogas. This is produced by the anaerobic digestion (AD) of agricultural and food wastes. Biogas is best used either directly in CHP plants or, once upgraded to biomethane, injected into the gas grid.

- Estimates for the abatement potential from biogas vary considerably:
  - Work by NERA for the CCC indicates that by 2022 annual emissions reductions potential from biogas is just over 1 $MtCO_2$ (5.7 TWh).
  - The NERA estimate of potential is close to the estimates in our December report based on analysis of agriculture and waste commissioned from the Scottish Agricultural College and Eunomia respectively.
  - DECC's Renewable Energy Strategy suggests that there is technical potential for biogas production of around 10-20 TWh per year (saving around 2-4 $MtCO_2$ per year).
  - Estimates by E4tech for DECC and by Ernst and Young for National Grid[8] suggest that there is a much higher technical potential, with scope for annual emissions reductions of 8-22 $MtCO_2$ by 2030.
- The Committee accepts that there may be more potential available than suggested by the NERA analysis and will consider this as part of further work on heat decarbonisation in the context of developing advice on the fourth budget (2023-27), in which we will also draw out any implications for the first three budget periods.
- NERA estimate that biogas costs around £12/tCO_2 saved, largely driven by capital costs for AD and the cost of upgrading biogas for grid injection.
- Current penetration of biogas is very low in the UK, reflecting the absence of a support mechanism for burning of biogas in CHP or grid injection. This contrasts to Germany, where a comprehensive support mechanism for biogas currently results in emissions reductions of 8 $MtCO_2$ annually (mainly through biogas CHP), and a target for grid injection for 2020 that would result in emissions cuts of a further 9 $MtCO_2$.

Solar thermal. This has technical potential for use in residential water heating and supplementing central heating, where it could result in emissions reductions of 6 $MtCO_2$ in 2022 at a cost ranging from £670-£1,350 /tCO_2 in the residential sector. This range for costs, driven by size of system and location, makes solar thermal the least cost-effective renewable heat technology.

- Solar thermal has the potential to supply on average up to a third of household hot water demand and a smaller proportion of household heat demand. In the summer, up to two-thirds of hot water needs can be met by a solar thermal system.
- It is more cost effective in better insulated and more water efficient new homes.
- According to the Energy Saving Trust, upfront costs for a solar water heating system are £3,000-5,000.
- Annual cost savings for solar thermal are £65 if displacing gas and £95 if displacing electricity.[9] Low annual cost savings mean that the shortest payback period is over 30 years.
- Solar thermal penetration in the UK is around 50,000 units. This contrasts to Germany, where significant financial support has resulted in installation of 1.25 million units.

8 National Grid (2009) *Potential for renewable gas in the UK.*
http://www.nationalgrid.com/NR/rdonlyres/E65C1B78-000B-4DD4-A9C8-205180633303/31665/renewablegasfinal.pdf
http://www.nationalgrid.com/NR/rdonlyres/9122AEBA-5E50-43CA-81E5-8FD98C2CA4EC/32182/renewablegasWPfinal1.pdf
9 Based on displacing gas in a three bedroom semi-detached house.

Summary of technical potential for renewable heat

In summary, the NERA analysis suggests that there may be scope to reduce emissions by up to 85 $MtCO_2$ in 2022 through increased penetration of renewable heat (Figure 5.16).

Most potential comes from the use of biomass in industry, although there is scope for application of all technologies considered in residential and commercial buildings. From an economic perspective, each of biomass, air source heat pumps and biogas has applications that are cost effective when considered against a £40/tCO_2 benchmark, with savings from ASHPs available for less than zero cost in some applications.

It is, however, very important to differentiate between technical potential and what is realistically achievable. The gap between technical and realistic potential will be driven by the policy framework and the way that this addresses the range of barriers to uptake.

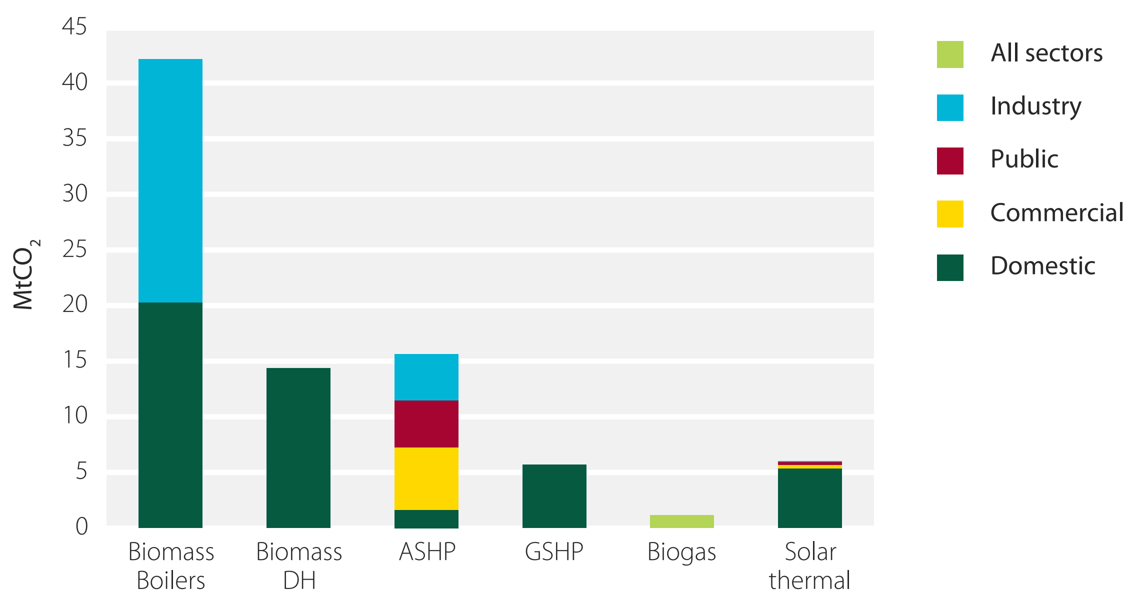
(ii) Overview of the policy framework for renewable heat deployment

Principles for a renewable heat support framework

NERA's analysis of costs suggests that financial support for renewable heat will be required, with the level of support varying according to technology:

- There is currently no carbon price in the heat sector except for the 10% of households and the large proportion of non-residential buildings using electric heating. The financial support provided for renewable electricity by the EU ETS price is absent where gas is the heating fuel.
- If households and businesses are to invest in renewable heat, they will have to be given financial incentives. Preliminary estimates for DECC suggests that financial support required to meet its 12% renewable heat target is in the range £2.7 billion to £4 billion per annum in 2020.

Figure 5.16 Renewable heat market potential by technology, by sector in 2022



Source: NERA (2009).

- The level of the financial incentive should be a function of cost effectiveness. The range of cost effectiveness from £12/tCO_2 for biogas to £20/tCO_2 for some biomass up to £1,350/tCO_2 for solar thermal suggests that different levels of support are required for different renewable heat technologies.
- Financial incentives should allow flexibility over the mix of renewable heat technologies (e.g. to allow more biogas than suggested by the NERA analysis and to allow for CHP).
- Financial incentives should encourage efficient resource allocation (e.g. use of biogas in CHP or grid injection rather than use in inefficient gas turbines, energy efficiency measures rather than over-sizing heat pumps).

Consumer attitudes to renewable heat will also have to change if there is to be significant growth in penetration in the residential sector. This will require strong encouragement from Government, provision of information, and measures to reduce transaction costs (e.g. hassle costs). Sustainability and other environmental concerns (e.g. air quality) also need to be addressed.

Given that the barriers to uptake of renewable heat are similar to those for energy efficiency, renewable heat might usefully be included as part of the whole house/neighbourhood approach discussed above. There may be particular scope to appeal to that part of the population (i.e. up to around 20%) identified as being 'positive greens' in Defra's segmentation model, and those households currently not connected to the gas grid. There is therefore a potentially significant opportunity for uptake of renewable heat in the residential sector if the right incentives are put in place.

In the commercial and industrial sectors, financial incentives will be crucial in determining the level of uptake. There may be scope here to leverage any incentives provided through a tailored mechanism by including renewable heat in any future revisions to existing schemes to improve commercial and industrial energy efficiency improvement (e.g. Climate Change Agreements, the Carbon Reduction Commitment).

Government proposals

The Government's proposed framework for renewable heat is set out in the UK Renewable Energy Strategy 2009. This includes a Renewable Heat Incentive (RHI) which will provide guaranteed payments to householders and businesses using renewable heat, to be implemented from April 2011. Government will consult on the design of the RHI towards the end of 2009.

(iii) Renewable heat scenarios

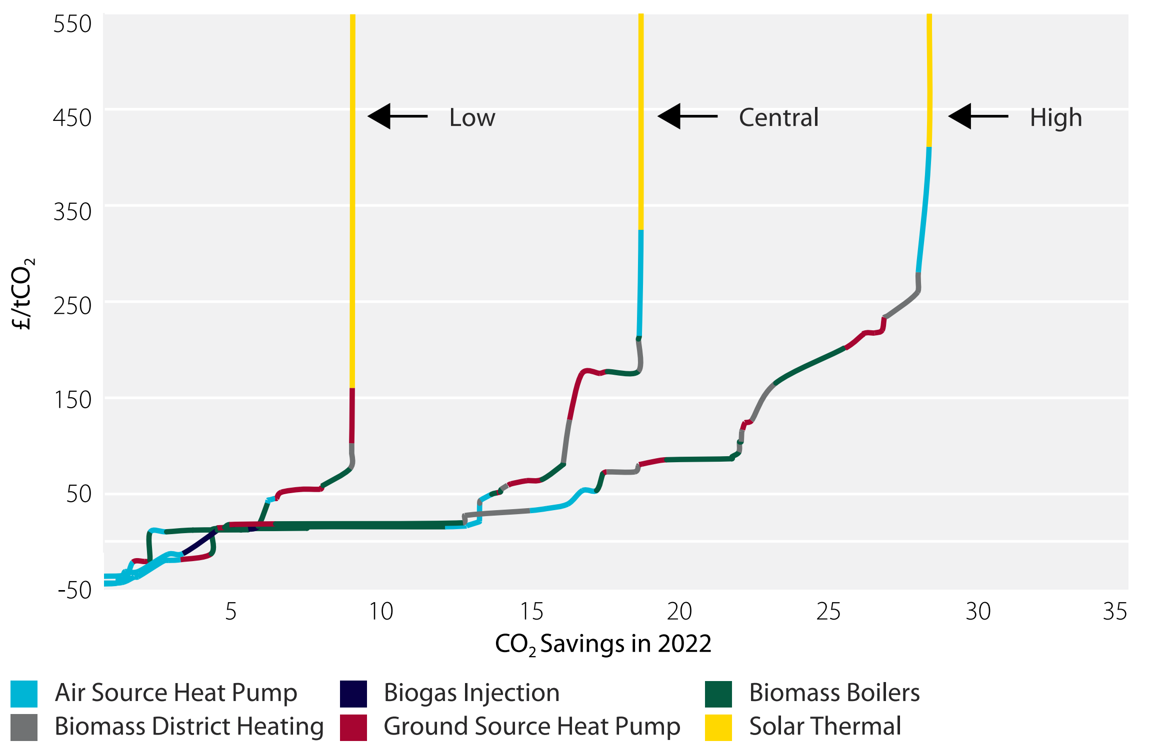
We asked NERA to develop a range of scenarios for uptake of renewable heat to reflect various levels of policy ambition in terms of both financial support and effort to change attitudes, together with supply chain response. Their low, central and high scenarios model emissions reductions in 2022 of 10 MtCO_2, 20 MtCO_2 and 31 MtCO_2 (Figure 5.17).

The central scenario is close to the DECC renewable heat scenario of 24MtCO_2 that we included in the December 2008 report. It differs in composition, however, substituting some industrial biomass, air source heat pumps and biogas for residential biomass. Figure 5.17 shows the emissions reductions by 2022 under the central scenario for each technology with biomass boilers projected to contribute around a third of total abatement (i.e. 7 MtCO_2).

Nearly all the abatement potential available under £100/tCO_2 involves the displacement of electric, oil or solid fuel heating. It is less attractive to displace natural gas with renewable technologies given its relative cheapness. With gas accounting for 80% of residential heat supply this explains why abatement potential in the residential sector below £100/tCO_2 is less than half of that available in industry.

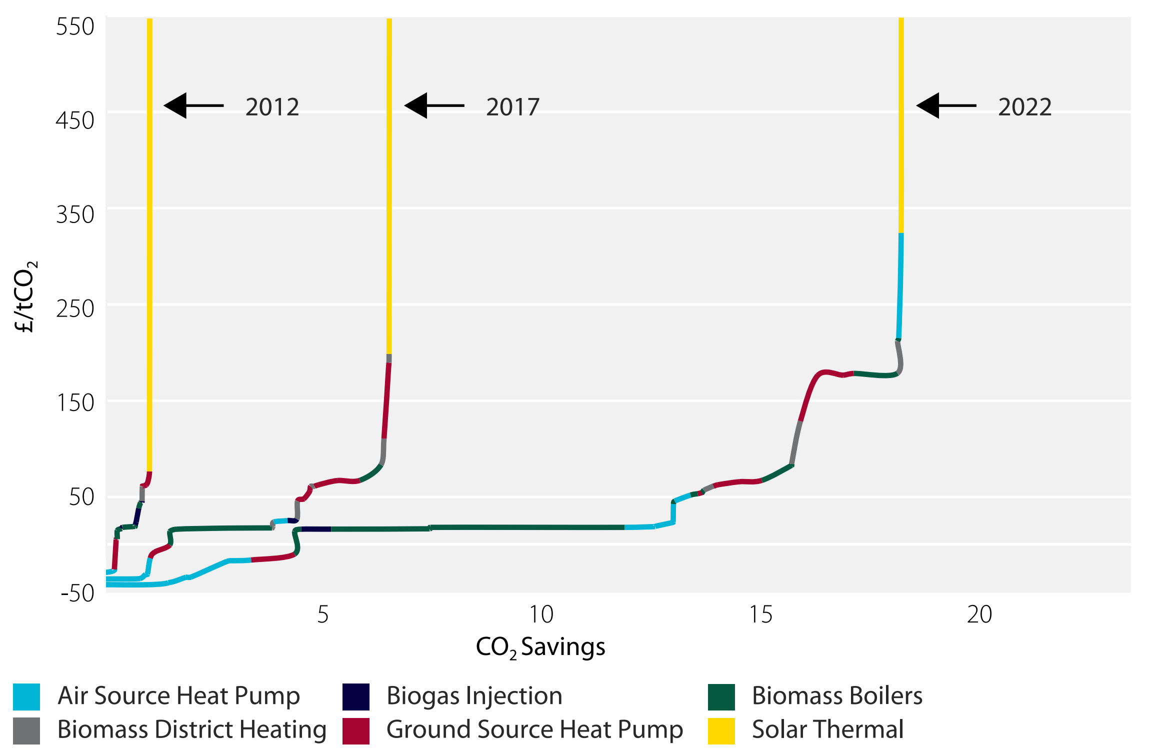
DECC uses a similar scenario in its Renewable Energy Strategy to show that a 12% penetration of renewable heat by 2020, in conjunction with an increase in renewable electricity generation and biofuels in transport, would achieve the 15% renewable energy target required in the EU context.

Figure 5.17 MACC for low, central and high scenarios in 2022



Source: NERA (2009).

Figure 5.18 MACC showing penetration in the central scenario over time



Source: NERA (2009).

It is reasonable to have a stretching target for renewable heat by 2020 because:

- This would make a very useful contribution to achieving the non-traded sector budget.
- The mix of technologies required to achieve high penetration would provide a portfolio of options for more wide-scale deployment in the 2020s.

We have assumed the Government's 12% heat share by 2020 for our Extended Ambition scenario and will use penetration rates over time towards the 12% as the basis for assessing progress in reducing emissions through renewable heat deployment (Figure 5.18).

However, we note that such a stretching target would be very expensive at the margin (e.g. costing hundreds of pounds per tonne of carbon saved). Slightly reducing the level of effort could therefore have a significant cost impact without undermining the contribution of renewable heat to meeting the non-traded sector budget.

We will not set out in advance indicators for the appropriate mix of technologies, given uncertainty over technical and economic characteristics and consumer attitudes. We will, however, seek to ensure overall target levels of penetration are achieved through a mix of technologies including biomass, heat pumps and biogas.

The appropriate path for decarbonisation of heat through the 2020s and beyond is currently unclear:

- There are uncertainties around availability of biogas and sustainable biomass.
- Innovation to improve performance and reduce costs may change the attractiveness of heat pumps.
- Depending on progress to improve energy efficiency there could be a significantly larger pool of houses where heat pumps could potentially be used.
- The consequences of increased electric heating for the power system – generation, transmission and distribution – are not well understood.

It is likely that the path will probably include a mix of biomass, heat pumps and biogas (e.g. with biomass/biogas used by industry, heat pumps used in the residential sector) and an approach based around developing a portfolio of options to 2020 is therefore justified.

For the period beyond 2020, the Committee will consider the appropriate path and pace of heat decarbonisation in more detail in the context of developing its advice on the level of the fourth budget, to be delivered to the Government by the end of 2010.

4. Emissions reductions in non-residential buildings and industry

We consider emissions reductions in non-residential buildings and industry in six parts:

(i) Technical emissions reduction potential

(ii) Emissions reductions in capped sectors

(iii) Emissions reductions in public sector buildings

(iv) Emissions reductions in uncapped sectors

(v) The role of EPCs and DECs

(vi) Indicators for non-residential buildings and industry.

(i) Technical emissions reduction potential

In our December 2008 report our analysis suggested that there is technical potential for emissions reduction through energy efficiency improvement costing less than £40/tCO_2 in non-residential buildings of approximately 14.5 MtCO_2.

- Improving the efficiency of heating and cooling buildings could save over 5 MtCO_2 in 2020.
- Better management of energy (from motion sensitive lights to optimising heating temperatures and timing) could save over 8 MtCO_2 in 2020.
- Use of more efficient lights and appliances has the potential to reduce emissions by around 1.5 MtCO_2 in 2020.

In industry, there is technical potential of 7 $MtCO_2$ available at zero or negative cost in 2020, through a range of measures around improvements in the efficiency of electrical machinery, heat generation, insulation and heat recovery.

As part of the analysis for this report, we asked Element Energy to provide their assessment of emissions reduction potential from non-residential buildings and industry. Their analysis suggested a similar order of magnitude of emissions reduction potential from non-residential buildings, but that emissions reduction potential from industry may be significantly higher than we had previously estimated. We are therefore confident that we have the right order of magnitude of emissions reduction potential for non-residential buildings. For industry, we regard our previous estimate as a lower bound on potential emissions reductions.

(ii) Emissions reductions in capped sectors

Approach in the December 2008 report

The December 2008 report distinguished between those sectors that are covered by a cap versus those where there is no cap. Capped sectors are covered by one of three schemes:

- The Carbon Reduction Commitment (CRC), which covers large non-energy intensive companies (e.g. supermarket chains) and public sector buildings (e.g. universities, hospitals).
- Climate Change Agreements, under which energy intensive industries are exempted from the Climate Change Levy subject to agreeing to improve energy efficiency/cut emissions.
- The EU ETS, which caps emissions from energy intensive industry at the European level.

Our approach was to assume that these schemes are effective in unlocking cost-effective emissions reductions – defined as costing less than our projected carbon price – and that realistically achievable emissions reduction potential from capped sectors is therefore 8 $MtCO_2$ in 2022.

Future work of the Committee

The Committee has been asked by the Government to advise on what the appropriate arrangements are for the second phase of the CRC running from 2013 to 2018. As part of this review, the Committee will consider:

- The appropriate cap for the second phase, given underlying emissions reduction potential
- The role of the CRC in providing incentives for renewable electricity and heat
- Complementary measures to support emissions reductions. The range of options here includes providing firms with better information about emissions reduction opportunities and how these can be addressed, to mandating installation of light and heating controls.

The Committee will report back on the CRC in 2010.

Further work is also required on more radical technology innovations that could result in deep emissions cuts in the energy intensive sectors. In particular, the application of Carbon Capture and Storage (CCS) technology to industries such as iron and steel, cement and refining may offer significant potential for reducing emissions.

The Committee acknowledges the potential importance of introducing new technologies to the energy-intensive sectors both for meeting carbon budgets and in the context of meeting longer term emissions reduction objectives. The Committee will consider opportunities for the use of new technology in industry in the context of providing its advice to Government on the fourth carbon budget (2023-2027) in 2010 as required under the Climate Change Act.

(iii) Emissions reductions in public sector buildings

The public sector comprises a range of institutions including central government, local authorities, schools, universities and hospitals which together account for 6% of emissions from buildings and industry. We estimate that the emissions reduction potential in this sector is around 2.5 $MtCO_2$ by 2022.

There are currently a number of initiatives aimed at reducing public sector emissions:

- The central government estate has established a target to reduce emissions in central government offices by 30% in 2020 relative to 1999/2000. Interim targets established in the context of agreeing departmental carbon budgets aim to achieve a 17% cut in emissions by 2010/11, with DECC committing to reduce its buildings emissions by 10% in 2009/10.
- Around 25% of local authorities have signed up to National Indicator 185 which requires them to report on reducing their emissions.
- The Greater London Authority is currently designing a facility that will provide financial and other support to London local authorities and public sector institutions seeking to reduce emissions.
- Emissions from central government departments, larger local authorities (including state schools), the NHS and large universities are covered by the CRC.
- The devolved administrations have made various commitments and have supporting programmes to improve energy efficiency (Box 5.9).

Both the Sustainable Development Commission and the Carbon Trust have stressed the importance of public sector emission reductions. They can:

- make an important contribution to meeting carbon budgets
- stimulate the low-carbon supply chain
- support behavioural change among users of public sector buildings.

Box 5.9 Devolved Administrations public sector energy efficiency targets

Northern Ireland

The following targets have been set for the public sector estate:

- Increase buildings' energy efficiency in terms of kWh of fuel and electricity used per square metre of building floor area by 15% by 2010/11, relative to a base year of 1999/2000;
- Reduce absolute CO_2 emissions from fuel and electricity used in buildings by 12.5% by 2010/11, relative to a base year of 1999/2000; and
- Reduce electricity consumption by 1% annually from 2007 to 2012 against the base year of 2006/07.

Scotland

The Scottish Government published a Carbon Management Plan in May 2009 that identified a range of carbon reduction projects that will contribute towards a 20% reduction in carbon emissions from a baseline of 2007/08 by 2014 which equates to a saving of almost 4 $ktCO_2$. These projects include building specific and organisational changes to help achieve the target.

Wales

The Welsh Assembly Government and Welsh local authorities are currently in the process of developing a carbon management plan in partnership with the Carbon Trust.

More generally, Government and local authorities cannot be credible leading a programme to reduce emissions without cutting their own emissions. The Committee therefore considers that all cost-effective emissions reduction potential (e.g. heating controls and energy efficient boilers) in central and local government buildings and public sector buildings covered by the CRC should be realised by 2018 (i.e. within 8 years, which is comparable with periods envisaged for widespread roll-out of measures in the residential sector and the end of the first capped phase of the CRC). We will monitor progress towards achieving of this objective in our annual progress reports.

(iv) Emissions reductions in uncapped sectors

SME emissions and emissions reduction potential

Our analysis presented in the December 2008 report suggested that around 45% of technical emissions reduction potential in non-residential buildings and industry comes from sectors which are currently not capped. We stated that this could realistically deliver 7 $MtCO_2$ under our extended scenario by 2022, which equates to 90% of the technical potential available at a cost less than £40/tCO_2.

This potential includes around 1.2 million Small & Medium Enterprises (SMEs), two-thirds of which employ less than five people. SMEs are extremely diverse, ranging from self-employed individuals working at home, to corner shops, restaurants and hotels, offices, garages and small manufacturers (Box 5.10)

Our approach in setting out achievable emissions reductions for non-capped sectors was to provide a range, with the top end of the range corresponding to an assumption that new policies with high powered incentives (providing information, encouragement, reducing hassle costs, providing financial support, etc.) are introduced and are successful in unlocking emissions reduction potential.

Box 5.10 Type of SMEs that receive assistance from the Carbon Trust

The Carbon Trust helped SMEs achieve reductions of 300,000 tCO_2 in 2007-08, which realised energy savings of £45m. Below are some examples of the type of SMEs the Carbon Trust has assisted:

Under the Carbon Trust's energy efficiency loan scheme, a Norfolk timber pallet manufacturer was awarded £100,000 to install energy efficiency equipment. It is estimated that the company has realised annual savings of £32,741 and 174 tCO_2.

A manufacturer of injection moulded plastic items received an £8,000 interest free loan to install motor controllers on the injection moulding machines. This has reduced the machines' electricity use by nearly 20 per cent, a saving of more than £5,000 a year.

A community centre in Manchester applied for an interest free loan of £7,025 to replace an old boiler more than 30 years old. The new boiler has reduced the centre's energy bill from £5,000 to about £3,600, while enabling reductions in emissions of nearly 4 tCO_2 per year.

An independent school in Essex received an interest free loan of £7,000 to install a new mechanised cover for its heated swimming pool. This reduced the annual cost of heating the pool from £8,500 to £6,500.

Policy levers for reducing SME emissions

The current policy framework for addressing SME emissions reductions is aimed at providing information and financial support:

- The Carbon Trust provides information on emissions reduction opportunities and interest free loans for energy efficiency improvement.
- The Enhanced Capital Allowance scheme provides businesses with 100% first year tax relief on capital expenditure on 61 different energy saving technologies.

The Carbon Trust is only able, however, to reach a very small proportion of SMEs, and the majority of emissions reduction potential remains and is likely to remain locked unless new policies are introduced. This is important given the large number of SMEs that do not consider energy a priority as it comprises a small proportion of total costs.

Options for new policy include:

- **Providing more financial support:** Current financial and institutional support provided by the Carbon Trust could be scaled up to cover a larger proportion of the SME population. It is not clear, however, whether this could ever lead to widespread uptake of measures for firms where reduction of energy costs is not currently a priority.
- **Extending the new residential sector delivery model to cover SMEs:** This would remove the barriers associated with taking up energy efficiency measures in the SME sector, namely lack of knowledge, expertise and finance. Some progress has already been made in this respect with the large energy companies in the UK entering voluntary agreements with Government to provide energy services to SMEs. There is a question, however, as to whether the voluntary basis of the scheme provides sufficient bite for energy suppliers to actively participate and whether the neighbourhood approach which could motivate households would provide the same incentives for SMEs.
- **Mandating implementation of measures:** As in the residential sector, regulatory measures may be required to achieve full take up of cost-effective emissions reduction potential (e.g. mandating a minimum EPC rating on sale or letting of property, or linking business rates to the EPC rating).

The Government has established a new project that is considering possible new policies to support SME emissions reduction. This is a crucial project given the magnitude of emissions reduction potential and the lack of a current policy framework, and we will continue to focus on this area going forward.

(v) The role of EPCs and DECs

Under the EU Energy Performance of Buildings Directive (EPBD), it is mandatory for all commercial and public buildings to have an Energy Performance Certificate (EPC) which assesses the energy efficiency of the building as an asset upon sale or letting. In addition, public buildings with a floor space over 1,000 square meters require a Display Energy Certificate (DEC) which shows the actual energy use of the building and associated CO_2 emissions over a 12 month period.

Already issued EPCs and DECs show that there is significant potential for emissions reductions:

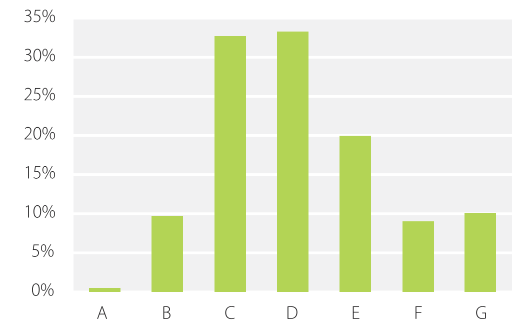
- Of the 115,000 buildings that had been issued an EPC by September 2009, 9% of these had the lowest G rating, suggesting scope for improved energy performance through cost-effective measures such as heating controls and energy efficient boilers (Figure 5.19).
- Of the 29,546 DECs lodged by August 2009, around 18% were given the lowest G rating, accounting for around 27% of total emissions. In comparison, C rated buildings, which were around 16% of the total, accounted for only 8.5% of emissions (Figure 5.20).

EPCs and DECs are therefore potentially useful in providing more transparency on emissions reduction opportunities in buildings and industry. Current usefulness is restricted, however, given limited coverage under the EU legislation; this has been a particular issue for the Committee in moving to a new property without a rating and where there is no obligation for the landlord to get one (Box 5.11).

The Committee therefore agrees with the Carbon Trust that new requirements should be introduced:

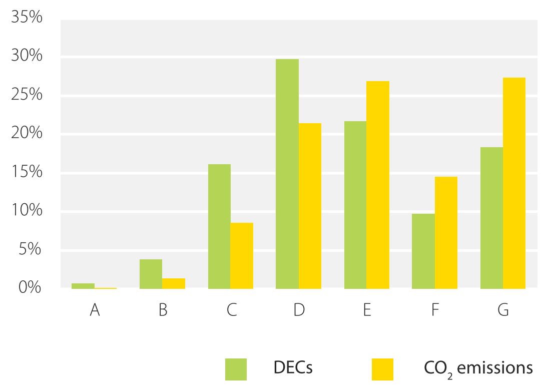
- All non-residential buildings to have an EPC in place by the end of the second budget period.
- Set minimum ratings such that all non-residential buildings have an EPC rating of F or higher by 2020. This should be achievable at a relatively low cost.

Figure 5.19 Distribution of EPCs by ratings by September 2009



Source: CLG (2009).

Figure 5.20 Distribution of DECs by ratings by August 2009



Source: CLG (2009).

- Roll-out DECs to all non-residential buildings by the end of the second budget period. This will give owners and users of buildings a better understanding of their CO_2 emissions. For smaller buildings, automated DECs could be an option so as to minimise the administrative burden on small firms.

This would:

- increase transparency which in itself could catalyse emissions reductions (e.g. where it is clear that a building has a poor EPC or DEC rating, this could put pressure on the landlord to undertake energy efficiency improvement).
- give a better understanding of where emissions reduction potential lies and form the basis for further policy to cut emissions (e.g. linking fiscal mechanisms to minimum ratings).
- allow effective monitoring of progress in reducing emissions via implementation of underlying measures.

Box 5.11 The CCC's experience in obtaining a DEC

In May 2009, the CCC moved office to a privately owned building near Victoria Station in London. Under the DEC guidelines, where a building is partly occupied by a public authority or a relevant institution with a floor space of at least 1,000m^2, the authority or institution is responsible for displaying a DEC and having a valid advisory report. Although the floor space we occupy is less than 1,000m^2 we wanted a DEC. However, given that we share common services such as water and heating with other occupants in the building, we had to rely on the landlord to obtain a DEC for the whole building. As there is no legal requirement for a private landlord to obtain a rating he declined our request to obtain one on a voluntary basis. We have since acquired an EPC with an E rating for the floor space we occupy. We are planning to implement the recommendations that are within our control such as adding daylight linked dimming to the existing lighting scheme. However, the measure that would offer the biggest saving as identified by the audit, the replacement of the heating boiler with a condensing one, is the responsibility of the landlord. We will continue discussions with our landlord to explore further energy efficiency options.

(vi) Indicators for non-residential buildings and industry

In setting out indicators of progress reducing emissions in non-residential buildings and industry we would ideally proceed as for residential buildings (i.e. set out trajectories for implementation of individual measures). However, for the time being we have decided against this approach:

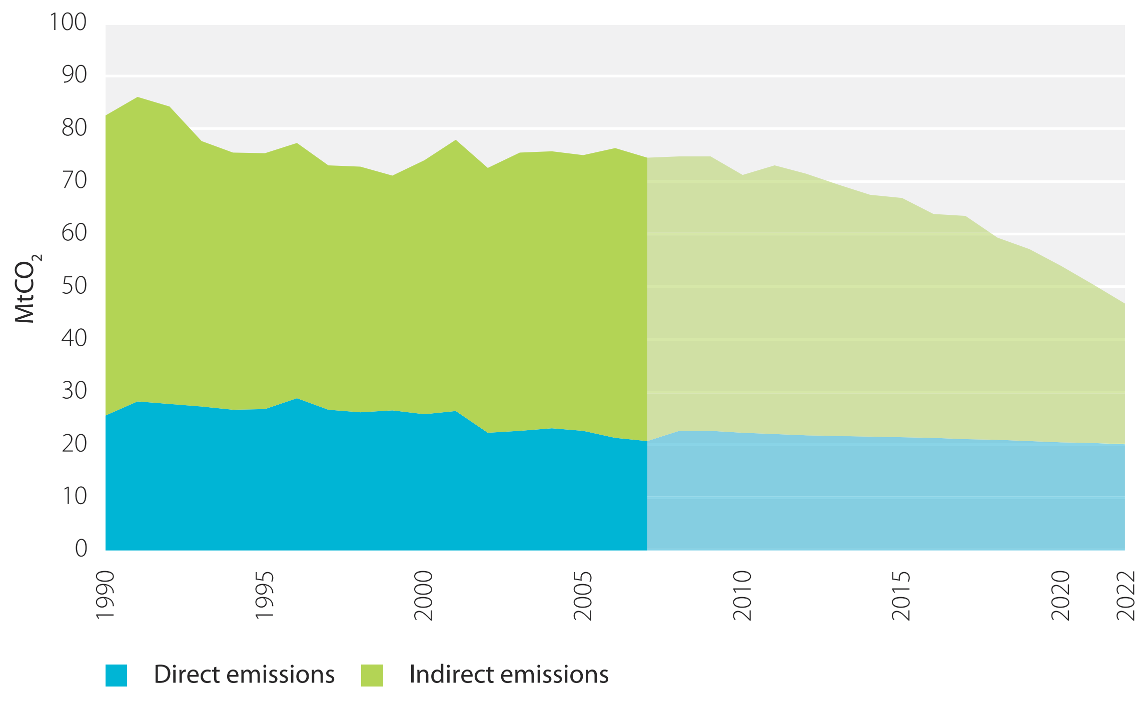
- There are numerous measures for reducing industry emissions. As much of industry is covered by the EU ETS, there are a set of cost-effective measures that we would expect to happen. We have therefore not set out individual indicators for industry but we may develop them in the future.
- There are no comprehensive sources of data for the implementation of key measures. We have recommended above that the evidence base for buildings emissions is improved (e.g through rolling out EPCs and DECs).

Therefore, in the near term we will base our monitoring framework on achieving the Extended Ambition emissions trajectory. The scenario includes all cost-effective emissions reduction potential from both capped and non-capped sectors.

It therefore assumes that effective policies are introduced for the non-capped sectors. The Committee believes that policies should be introduced, and will therefore use the Extended Ambition scenario as the benchmark for what the Government should seek to achieve (Figure 5.21).

In understanding the path of actual emissions relative to these trajectories, we will draw on any available evidence from EPCs and DECs and other sources (e.g. the Carbon Trust). When EPCs and DECs are rolled out more widely, we will revisit the issue of indicators and set out trajectories for implementation of measures and improvement of EPC/DEC ratings as appropriate.

Figure 5.21 Non-residential emissions trajectory under the extended ambition scenario 1990-2022



Source: CCC analysis.

5. Indicators for buildings and industry

Our indicators of progress for the buildings and industry sectors (Table 5.1) include:

- CO_2 emissions and final energy consumption figures for residential and non-residential buildings and for industry. We will monitor both direct and indirect emission and consumption figures.
- For the residential sector, we will monitor the installation of a range of energy efficiency measures (solid wall, cavity and loft insulation, uptake of new boilers and efficient wet and cold appliances).
- For all sectors we have listed policy milestones necessary to deliver progress (e.g. legislation for a post-CERT delivery framework).
- For renewable heat, we will monitor emissions reductions from renewable heat penetration.

Table 5.1 Buildings and industry indicators

Buildings and Industry		**Budget 1**	**Budget 2**	**Budget 3**
All buildings and industry				
Headline indicators				
CO_2 emissions (% change on 2007)*	direct	-9%	-11%	-15%
	indirect**	-11%	-28%	-58%
Final energy consumption (% change on 2007)	non-electricity	-10%	-18%	-23%
	electricity (centrally produced)***	-8% (-4%)	-7% (-9%)	-5% (-13%)
Residential buildings				
Headline indicators				
CO_2 emissions (indicative minimum % change on 2007)*	direct	-6%	-18%	-20%
	indirect**	-11%	-23%	-53%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-6%	-18%	-19%
	electricity (centrally produced)***	-5% (-5%)	-4% (-4%)	-3% (-3%)

Table 5.1 continued

Buildings and Industry	Budget 1	Budget 2	Budget 3
Supporting indicators			
Uptake of Solid Wall insulation (million homes, total additional installations compared to 2007 levels)	0.5	1.2	2.3
Uptake of Loft insulation (up to and including 100mm) (million homes, total additional installations compared to 2007 levels)	2.1	5.3	5.3
Uptake of Loft insulation (100mm +) (million homes, total additional installations compared to 2007 levels)	1.9	4.8	4.8
Uptake of Cavity wall insulation (million homes, total additional installations compared to 2007 levels)	3.5	7.5	7.5
Uptake of Energy efficient boilers (million homes, total additional installations compared to 2007 levels)	4.9	9	12
Uptake of Energy efficient appliances - Cold A++ rated (% of stock)	3%	18%	45%
Uptake of Energy efficient appliances - Wet A+ Rated (% of stock)	22%	53%	82%
Every house offered whole-house energy audit		by 2017	
Heat and Energy Saving Strategy finalised	2009		
New financing mechanism pilots operate and are evaluated	2011		
New financing mechanism budgeted and legislation in place if necessary	2011		
Post CERT delivery framework legislation in place	2011		
Other drivers			
Average SAP rating, Implementation of behavioural measures, Population (by age), Number of households (by type - building and occupants), Household disposable income, Electricity and gas prices, Appliance ownership			

Note: Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022
* These indicators should be considered jointly. Reductions in total emissions from buildings and industry reflect savings from renewable heat. We do not however set out in advance the split of these savings across sectors. Therefore emissions changes for individual sectors do not assume any savings from renewable heat and reflect a minimum level of change.
** Based on a reference projection net of electricity demand changes whose carbon intensity is assumed to be that of new build gas. Within our modelling of the power sector, emissions from electricity generation are lower than is represented here due to different assumptions about carbon intensity. The indirect emissions shown here are therefore conservative.
*** Figures show percentage changes in total electricity consumption including autogenerated electricity, and in centrally produced electricity only.

Key: Headline indicators | Implementation Indicators | Milestones | Other drivers

Table 5.1 continued

Buildings and Industry		Budget 1	Budget 2	Budget 3
Non-residential buildings				
Headline indicators				
CO_2 emissions (indicative minimum % change on 2007)*	direct	6%	2%	-3%
	indirect**	-9%	-22%	-51%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-4%	-8%	-13%
	electricity (centrally produced)***	-1% (-1%)	-1% (-1%)	-1% (-1%)
Supporting indicators				
Develop policy on SMEs		by October 2010		
Government decision on the following recommendations for EPCs and DECs:		by October 2010		
• All non-residential buildings to have an EPC			by 2017	
• All non-residential buildings to have a minimum EPC rating of F or higher				by 2020
• Roll out of DECs to non-public buildings			by 2017	
All public buildings covered by the CRC to realise all cost effective emissions change potential				by 2018
Other drivers				
Emissions and fuel consumption by subsector, GVA / GVA vs. GDP for each sub-sector, Electricity and gas prices				
Industry				
Headline indicators				
CO_2 emissions (indicative minimum % change on 2007)*	direct	-15%	-2%	8%
	indirect**	-12%	-35%	-66%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-20%	-21%	-19%
	electricity (centrally produced)***	-16% (-6%)	-11% (-18%)	-5% (-30%)
Other drivers				
Emissions and fuel consumption by subsector, GVA / GVA vs. GDP for each sub-sector, Electricity and gas prices				

Table 5.1 continued

Buildings and Industry	Budget 1	Budget 2	Budget 3
Renewable heat			
Headline indicators			
Renewable heat penetration	1%	5%	12% in 2020
Supporting indicators			
Renewable Heat Incentive in operation	from April 2011		
Other drivers			
Uptake and costs of renewable heat technologies (Biomass boilers, Solar thermal, GSHP and ASHP, District heating)			

Note: Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022
* These indicators should be considered jointly. Reductions in total emissions from buildings and industry reflect savings from renewable heat. We do not however set out in advance the split of these savings across sectors. Therefore emissions changes for individual sectors do not assume any savings from renewable heat and reflect a minimum level of change.
** Based on a reference projection net of electricity demand changes whose carbon intensity is assumed to be that of new build gas. Within our modelling of the power sector, emissions from electricity generation are lower than is represented here due to different assumptions about carbon intensity. The indirect emissions shown here are therefore conservative.
*** Figures show percentage changes in total electricity consumption including autogenerated electricity, and in centrally produced electricity only.

Key: Headline indicators Implementation Indicators Milestones Other drivers