CARBON TRUST

Building the future, today

Transforming the economic and carbon performance of the buildings we work in

Contents

Preface

Carbon emissions from the UK's non-domestic buildings, comprised of commercial offices, hotels, shops, schools, hospitals, factories and other buildings, are responsible for 18% of the UK's total. These emissions have fallen only slightly since 1990, yet going forward they need to reduce by at least 80% by 2050 if our buildings are to play their fair share in achieving the UK's carbon reduction targets. In fact, the Government has stated its ambition for emissions from all buildings to be 'close to zero' by 2050.

How can this be achieved – both in terms of Government policy and action from industry? The Carbon Trust has been considering this question and would like to help start a dialogue across Government and the non-domestic building sector that tackles this question.

To begin this dialogue, we have carried out a detailed analysis of the non-domestic building sector and assessed the steps required to deliver a truly low carbon building stock. We have also conducted in-depth interviews with around 70 key stakeholders from across the entire sector, and developed a model which predicts emissions to 2050 for non-domestic buildings under a broad range of different scenarios.

The feedback from the sector is that they are looking to the Government for direction – a road map laying out the carbon reduction that is required and the policies that will be rolled out to achieve it. So our first step, in what will hopefully become an ongoing conversation, is to publish this report focused on this road map and potential policy options for the Government to consider.

We will subsequently follow this up with reports on the implications for and potential actions needed from the developers, designers, builders and users of non-domestic buildings.

The overall conclusion from this publication is that non-domestic buildings represent a clear 'win-win' opportunity. Not only can this sector deliver more carbon reductions, faster, than the UK's current and intended carbon budgets, but in doing so it can save at least £4bn for the UK economy by 2020, increase security of energy supply and provide UK workers with better, more productive buildings.

To achieve this requires a transformation in the delivery of cost-effective energy efficiency over the next decade. This transformation requires a renewed focus on the non-domestic buildings sector, with a clear strategy for reaping the full opportunity; and policies that deliver 'better buildings, used better', by targeting both the buildings, and the users of those buildings.

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Executive summary

Non-domestic buildings can and must play a leading role in the UK's transition to a low carbon economy. Rapid, far-reaching action by the Government and the industry can make this happen and maximise the economic benefits.

Key findings

This sector matters

- Non-domestic buildings present a significant opportunity to economically reduce the UK's carbon footprint:
  - A 35% CO_2 reduction by 2020 vs. 2005 can be achieved with a net benefit to the UK of at least £4bn[1].
  - Reductions of 70-75% by 2050 can be achieved at no net cost[2], using options which exist today.
  - Accelerating emissions reductions to 2020, compared to pathways where action is delayed, will lead to a significant reduction in the cumulative cost to 2050 of achieving an 80% CO_2 reduction.

Big opportunity, big challenge

- Almost all of the carbon reduction measures that are available today will need to be implemented to achieve an 80% reduction by 2050 – there is no 'either or'. The electricity supply will need to decarbonise, both new and existing buildings will need to use less energy and low/zero carbon energy generation on and near buildings will be needed.
- Thus the order and speed at which these measures are implemented is the critical choice if costs are to be minimised. The focus for carbon reduction should be:
  - **Up to 2020:** implement almost all **cost-effective energy efficiency** potential in non-domestic buildings. This will require the vast majority of buildings to undergo some level of improvement, with the implementation rate for cost-effective measures increasing from less than 40% today to at least 90%. Most of this opportunity utilises simple, low-cost measures such as lighting and heating controls, or better energy management and building user behaviours.
  - **Beyond 2020:** currently expensive energy efficiency measures will need to be implemented alongside low/zero carbon energy generation, with a more integrated approach used at all stages in a building's development.
- All of the above calls for a **transformation** in the scale and speed of carbon reduction compared to the past – emissions have remained roughly constant over the last two decades. The past shows us that the carbon reduction will not just happen, even where measures pay back rapidly, due to a range of barriers on both the demand side (e.g. immateriality of energy costs) and the supply side (e.g. non-compliance with Building Regulations).

A strategy for non-domestic buildings

- To create the step change in activity across this sector will require Government intervention to catalyse the market into action. There is demand from within the sector for Government to take a leadership role by laying out a clearly defined strategy for carbon reduction across all non-domestic buildings.
- Such a strategy should include two key elements:

1. **Direction setting:** a clearly laid-out ambition for the level of carbon reduction that is required from the sector, and the rolling out of Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs)[3] to all buildings in order to:
   - Communicate the target emissions trajectory in a language that resonates with the industry – see *Chart ES-a* which shows that the average building will need to improve by four DEC ratings, from E to A, by 2050.
   - Aid the users and owners of buildings to understand their energy performance, and areas for improvement.
   - Help Government to better understand the performance and quality of all non-domestic buildings.

[1] Cumulative benefit to 2020; 35% reduction includes impact of electricity grid decarbonisation, and is above the UK's overall 'intended' budget of 31% vs. 2005.

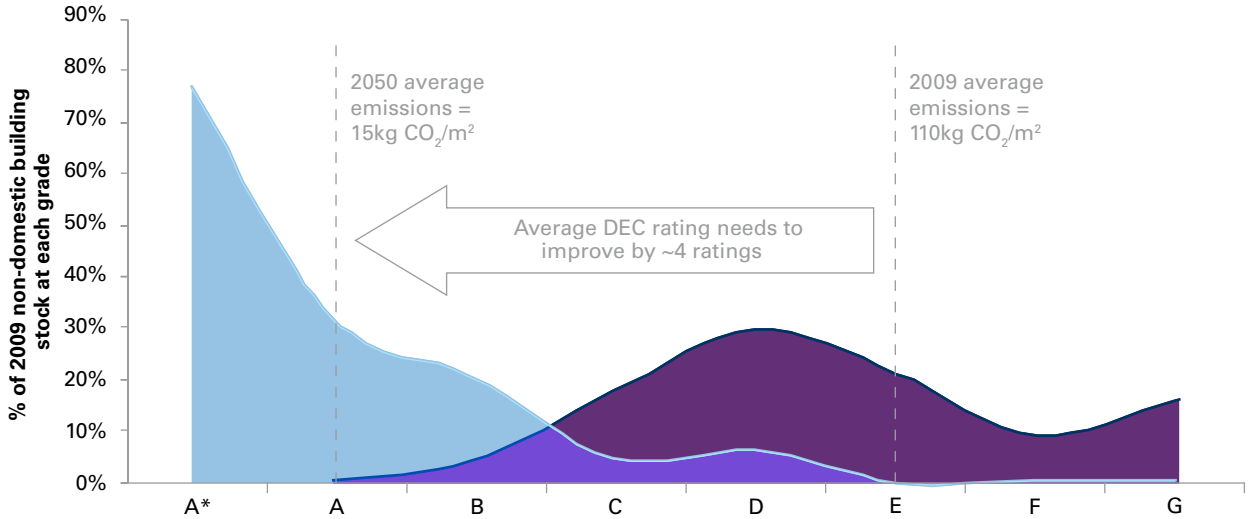
[2] Cumulative cost to 2050.

[3] Certificates that describe the buildings' in-use performance (using the DEC – an operational rating) and quality (using the EPC – an asset rating).

2. **Policy packages:** an integrated set of policies that both encourage low carbon buildings and encourage organisations to utilise them more effectively leading to 'better buildings, used better'.

- Focusing initially on the period to 2020, we have developed a policy package that could catalyse the required change. The policy options include utilising existing policies – the Building Regulations, Zero Carbon new buildings and the Carbon Reduction Commitment – which will be vital mechanisms to drive significant carbon reductions. But more is needed, as not all the barriers can be removed using existing policy mechanisms, so we have developed a small number of new policies to target the gaps. For example:
  - **Public sector leadership:** public sector to implement all cost-effective options from DEC advisory reports within the seven-year lifetime of the report.
  - **Minimum building standards:** all buildings to achieve at least an F-rated EPC by 2020 (where cost-effective).
  - **'CERT' for SMEs:** develop national programme led by the energy suppliers to install simple, low-cost energy efficiency measures in SME buildings, paid for by a small increase in SME energy bills.
- Taken as a whole, this policy package could address all the barriers, target all the cost-effective carbon reduction, and maximise the cost savings for the UK.
- Beyond 2020, the specific policies will likely need to change. We will need to be in a position to continue to reduce carbon emissions, even after almost all of the cost-effective measures have been implemented. The measures to be implemented across the building stock between 2020 and 2050 are more expensive and complex such as improvements to a building's fabric (e.g. higher levels of insulation and air tightness) or the installation of low carbon energy generation (e.g. biomass CHP, ground source heat pumps). It will often require a building to be vacated, and will need a more integrated, holistic approach to the specification, design, build, handover and use of buildings. Therefore action is needed now (in parallel to those above) to:
  - Drive innovation in, and lower the cost of, energy efficiency measures and renewable technologies.
  - Build the capabilities of the industry to specify, design, build, commission and properly use low carbon buildings.
- Achieving all of these changes needed over the short, medium and long term will require a comprehensive implementation plan, with clarity on objectives and responsibilities but it will be worth it to deliver a truly low carbon building stock.

***Chart ES-a** Shift in DEC distribution from 2009-2050 required to meet an 80% reduction in CO_2 emissions*



	A*	A	B	C	D	E	F	G
2009 carbon distribution	0%	0.1%	2%	10%	24%	22%	12%	29%
2050 carbon distribution	0%	19%	36%	14%	26%	2%	1%	1%

Source: Department for Communities and Local Government data for public sector buildings (August 2009); Carbon Trust analysis

Better buildings, used better

The UK's stock of 1.8m non-domestic buildings[4], responsible for around 18% of total CO_2 emissions, has an important role to play in the transition to a low carbon economy. These buildings use around 300TWh of energy a year, (equivalent to the entire primary energy supply of Switzerland[5]), predominantly to heat, ventilate and light the spaces in which the UK's economy generates its income (see *Chart ES-b*).

Multiple studies[6] have shown that there is a large potential for carbon emissions reduction from non-domestic buildings, much of which is cost-effective[7] using low-cost technologies and solutions which exist today. And yet emissions from non-domestic buildings have remained roughly constant over the past two decades (see *Chart ES-c*). What is preventing the implementation of even the cost-effective carbon reduction measures? And what role can Government play in catalysing the sector to move the emissions onto a downward trajectory?

This report attempts to answer these questions. But first we need to understand the elements which together add up to create the total emissions from a building, and therefore what might be done to reduce those emissions.

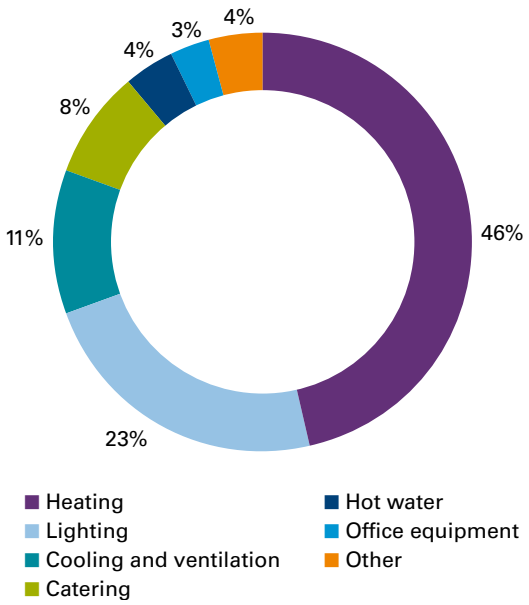
At its most simplistic, the total emissions from any building are based on the quality of the building as designed and built, combined with how well the building is operated. It is the sum of, and interaction between, all of the actions of different players through the 'building journey' that leads to the final carbon emissions from any individual building.

Thus, what is needed as we aim to transition towards a low carbon building stock is both:

- Better buildings…
- …used better.

This theme underlies much of the thinking contained within this report. If we can deliver against these two ambitions, the UK will be well on its way towards creating the low carbon economy of the future.

***Chart ES-b** Carbon emissions by end use in the UK's non-domestic buildings, %*



100% = 106MtCO_2
Source: BRE (2005); Carbon Trust analysis

This report aims to describe some concrete actions which can be taken to help deliver better buildings, used better, starting with the assumption that non-domestic buildings will need to reduce their emissions by at least 80% by 2050 – a reduction from 106MtCO_2 p.a. to 21MtCO_2 or less.

We begin by describing the scale of the opportunity, in terms of carbon reduction potential available today, and the economic benefits of implementing these measures rapidly. We also describe the challenge that exists in moving from theoretical potential, to actual implementation across non-domestic buildings.

Next, we outline the case for Government to take more of a leadership role in the transformation to a low carbon building stock, and describe the high level elements of what this leadership could entail.

Finally, we describe a policy framework, and a detailed set of policy options which combined could lead to the scale of carbon reduction needed to achieve the 80% ambition.

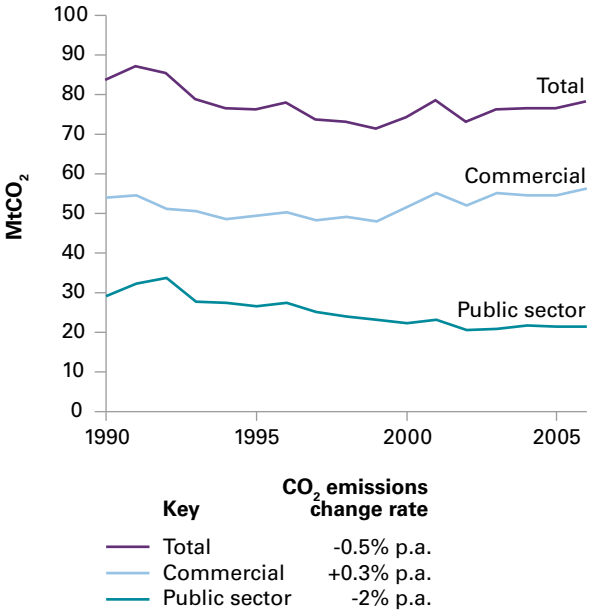
[4] Our definition of 'non-domestic buildings' includes commercial and public sector buildings, plus the building-related emissions only from industrial buildings (i.e. excluding industrial process emissions), unless stated otherwise.

[5] 300TWh final energy use (or 1080 PJ) equals the Total Primary Energy Supply of Switzerland of 1,077 PJ (Source: IEA energy data, 2007).

[6] McKinsey 2030 carbon abatement cost curves (global/UK), IPCC, BRE N-DEEM, CCC.

[7] 'Cost-effective' defined as measures with negative £/ton CO_2 abatement over their lifetime (upfront and ongoing costs offset by energy savings) using a discount rate of 10%.

***Chart ES-c** Historical carbon emissions from 1990-2006 for non-domestic buildings (public sector and commercial buildings only)*



Source: Committee on Climate Change (Dec 2008)

Big opportunity, big challenge

The Carbon Trust, with support from Arup (a global firm of consulting engineers), has conducted a detailed analysis of the non-domestic building sector and what is required to deliver a truly low carbon building stock. We have carried out in-depth interviews with ~70 key stakeholders from across the entire sector[8], and developed a model that predicts emissions to 2050 for non-domestic buildings under a broad range of scenarios. Using the emissions model, we have developed a 'Success Scenario' which alters the timing of the implementation of different measures in order to minimise the total cost to the UK, whilst still achieving an 80% reduction in emissions by 2050.

Our analyses have led to four key insights, which help to shape our conclusions for the non-domestic building sector:

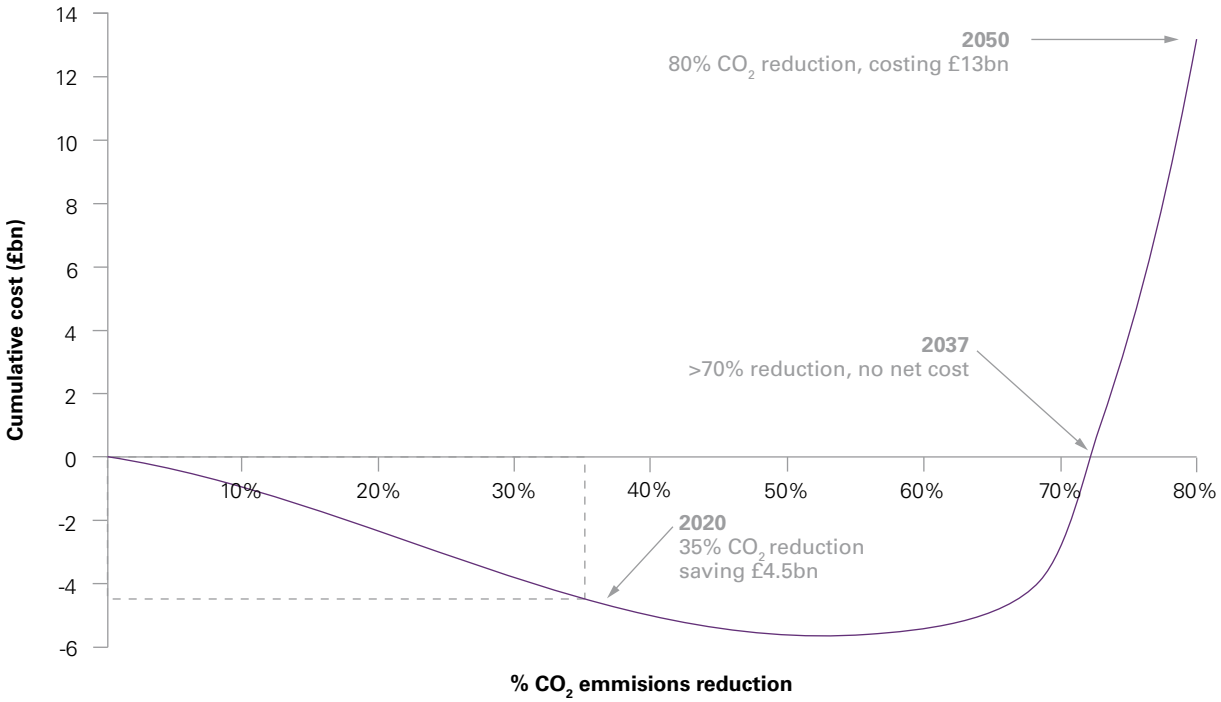
1. **A large economic opportunity.** The financial benefit to the UK in reducing emissions from non-domestic buildings could reach £4.5bn (cumulative to 2020), with carbon reductions of 70-75% being possible at no net cost (see *Chart ES-d* which shows the cumulative cost/benefit against the cumulative carbon reductions for our Success Scenario).
2. **Little choice in the measures which need to be implemented.** To get to at least an 80% reduction in carbon emissions by 2050, will require all of the following:
   - Huge reduction in net energy demand[9] from buildings as well as rapid decarbonisation of the electricity grid.
   - Improvements in both new and existing buildings. Around 60% of today's buildings will still exist in 2050, and will represent 40-45% of the total floor space. Emissions from both categories are therefore important.
   - Large scale implementation of both energy efficiency measures (cost-effective and currently non-cost-effective) and low/zero carbon energy generation.
3. **Order and speed of implementation are critical.** Given the lack of choice long term, when these measures are implemented is therefore a much more vital issue (e.g. when and how quickly to implement energy efficiency measures or low carbon energy generation) as timing of implementation is the key driver of cumulative cost. Our Success Scenario has concentrated on altering the order of measures in order to minimise the total cumulative cost to 2050 of achieving an 80% carbon reduction.
4. **Market barriers leading to a 'circle of inertia'.** The challenge of reaching at least 80% carbon reduction by 2050 is made more difficult due to a large number of diverse and interacting market barriers such as the landlord-tenant divide. These interact with a complex industry to create a 'circle of inertia' where inaction in one area of the industry leads to inaction elsewhere.

We now give more detail on the third and fourth insights in the following two sections. Further detail on the first two insights can be found in Chapter 2 of the full report.

[8] See *Chart ES-g* for a diagramatic description of the different industries within the non-domestic buildings sector.

[9] Energy demand minus on and near-site energy generation.

Chart ES-d *Cumulative net cost against cumulative carbon saving for non-domestic buildings Success Scenario up to 2050*



Note: other scenarios, such as those which achieve less than 35% reductions by 2020, will have a different cumulative cost profile, all with a greater cumulative cost to achieve an 80% reduction by 2050.

Source: Carbon Trust and Arup analysis

Order and speed of implementation

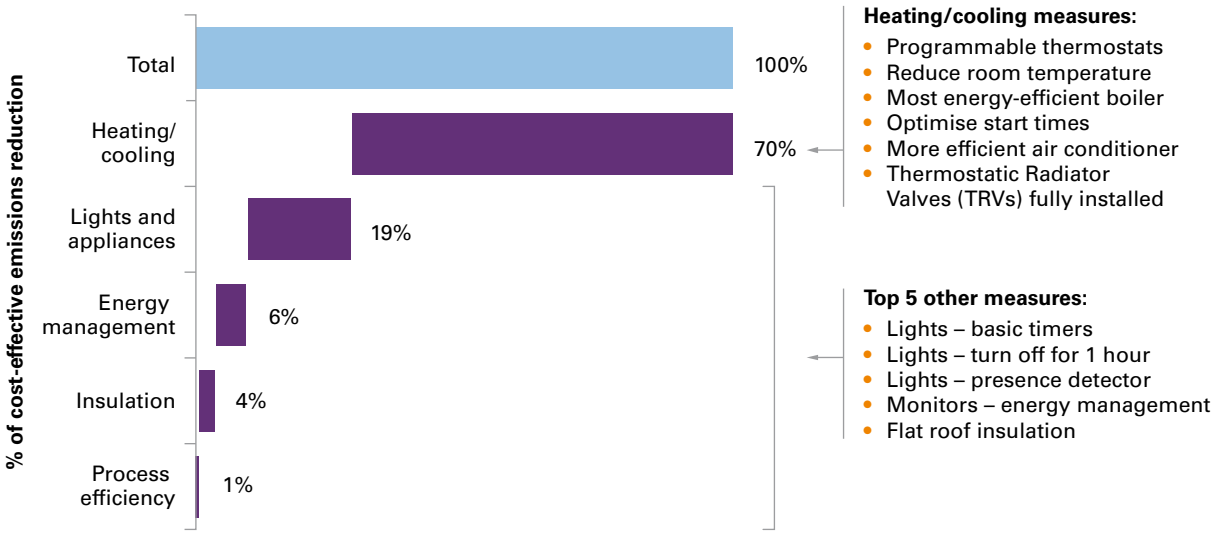
The Success Scenario shows that the cost[10] of achieving an 80% reduction in emissions could fall from over £50bn[11] (cumulative to 2050) to ~£13bn if the following high level steps are taken:

- First, implement almost all of the simple, cost-effective energy efficiency measures by 2020. This will require a step-change in the uptake of cost-effective measures in existing buildings, from less than 40% – the implementation rate of cost-effective measures as seen by the Carbon Trust in working directly with more than 15,000 organisations since 2001 – to 90% or higher. In addition, more buildings will need to undergo improvements each year. The scale of the challenge in achieving this should not be underestimated. But the economic and carbon opportunity in meeting this challenge is large if action is taken to rapidly implement these measures – net benefit to the UK could be £4.5bn cumulative to 2020, with a CO_2 reduction of 35% vs. 2005 levels, as shown in *Chart ES-d* above.

[10] Upfront and maintenance costs minus energy savings (discounted at 10%).

[11] If all carbon reduction measures are implemented into the building stock gradually from today through to 2050.

Chart ES-e *Cost-effective energy efficiency measures carbon abatement potential in existing non-domestic buildings in the UK*



Note: 'cost-effective' defined as measures with negative £/ton CO_2 abatement over their lifetime (upfront and ongoing costs offset by energy savings) using a discount rate of 10%. Carbon reduction potential includes impact of interaction between measures, for example more efficient lights combined with timers.

Source: Committee on Climate Change data for public sector and commercial buildings (i.e. excluding industrial); Carbon Trust analysis

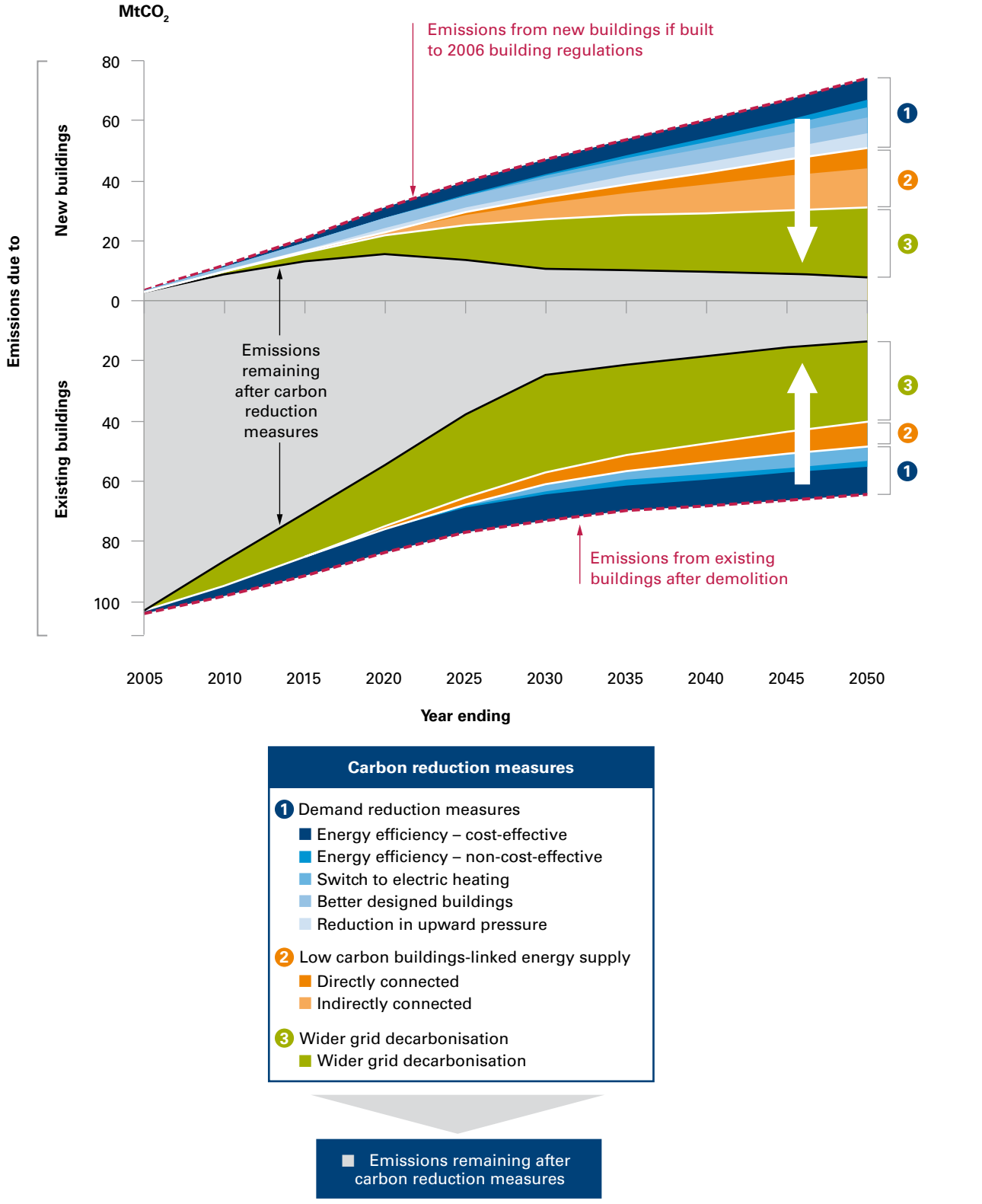
Chart ES-e shows a breakdown of the negative cost portion of the Committee on Climate Change's cost curve for non-domestic buildings[12], highlighting the fact that the measures we are talking about are predominantly simple ones, requiring no or low upfront expenditure, without large-scale refurbishment or vacation of the building. Implementation of the cost-effective measures today should lead to a ~15% reduction in carbon emissions[13] across the existing stock of ~1.8m non-domestic properties. Thus we are talking about a relatively shallow intervention being required across a broad number of buildings. The potential in new buildings is higher, with cost-effective carbon reduction potential of ~45% compared to new buildings built to 2006 Building Regulations. However, as only around 1% of the stock each year is new buildings, the absolute potential to 2020 is less than that from existing buildings.

- Second, from 2020 to 2050, on/near-site low carbon energy generation, currently non-cost-effective energy efficiency measures, and electrical-based heating (once the grid has decarbonised sufficiently) will need to be implemented at scale and a much lower cost than today, as part of a more holistic, integrated approach to new build and refurbishment design, build and use. Compared to the broad roll-out of cost-effective measures needed over the next decade the interventions needed are likely to be deep – greater carbon reduction, more complex solutions, more major refurbishment requiring a more skilled workforce – although cover a narrower number of buildings each year (as more activity will take place at major intervention points such as refurbishment or new build).

[12] For public sector and commercial buildings only i.e. not including opportunities for carbon reduction in industrial buildings. (Our analysis shows similar types and scale of opportunity for industrial buildings as for commercial and public sector, so conclusions from *Chart ES-b* remain valid for all non-domestic buildings.) The cost curve shows opportunities in existing buildings only, and is based on outputs from BRE's N-DEEM model.

[13] Assuming current carbon intensity for electricity and gas.

Chart ES-f *'Wedge chart' showing how the emissions from new and existing buildings can be reduced (compared to a 'do nothing' scenario) through reduced demand from buildings, low/zero carbon energy generation linked to the building, and wider grid decarbonisation*



Note: Carbon dioxide emissions savings are normalised across all interventions.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

Chart ES-f shows the output emissions for our modelled Success Scenario for both new and existing buildings. This 'wedge chart' shows the expected emissions from a 'do nothing' scenario, and then builds in carbon reduction 'wedges' (such as reducing demand from buildings through energy efficiency measures) to achieve an 80% reduction by 2050, at the lowest cumulative cost to the UK.

To deliver the Success Scenario the supply chain, driven by the market and by Government policy[14], will need to have transformed into being ready to implement the radically different approaches and solutions that will be needed; innovation will need to have delivered a greater range of implementable carbon reduction options at lower cost; and the Government and industry will need to have a better understanding of the building stock and the drivers of its emissions. None of this will be straightforward to achieve, and will require concerted action on all sides to be delivered.

Market barriers leading to a 'circle of inertia'

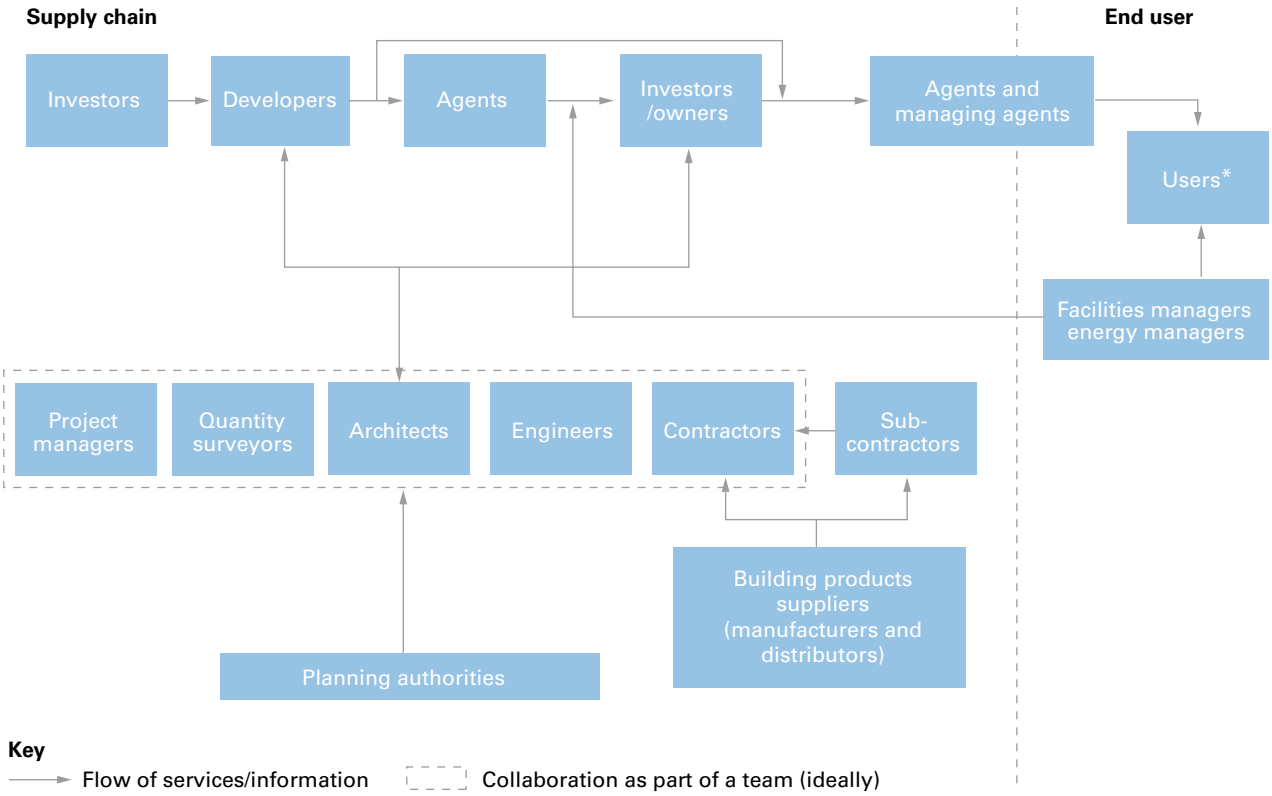
Our interviewees described at least 24 separate barriers to more rapid development of new and existing low carbon buildings from financial barriers, 'hidden' costs and the landlord-tenant divide through to lack of knowledge on what measures to implement or how to operate a low carbon building, and capability issues within the supply chain.

The most mentioned example was the lack of material incentive for the building industry or the users of buildings to change how they operate, based purely on the potential to save energy costs from the creation of more low carbon new builds and refurbishments. The £4.5bn net benefit to the UK by 2020 described earlier is significant in terms of the energy spend from organisations in non-domestic buildings – the net benefit is created by energy cost savings from a reduction of 16% in the energy intensity per square metre achieved by 2020.

However, £4.5bn is small relative to the £65bn spent annually on the construction of new non-domestic buildings and the refurbishment of existing non-domestic buildings. And for building owners and users, any energy savings can appear small relative to their overall cost base – energy can account for as little as 1-2% compared to staff, rent, business rates and other costs.

[14] See *Chart ES-g* for our definition of the players involved in the non-domestic building industry.

Chart ES-g *Non-domestic buildings sector – supply chain and end users*



*Tenants or owner occupiers.

Source: Carbon Trust analysis

In addition to the long list of barriers that exist, there are also a large number of additional complexities, specifically:

- **Building stock:** a multitude of different building forms, sizes, uses and ages, plus a complex inter-play within every building between heat and cooling demand, building fabric, solar gain, use of daylight, passive measures etc.
- **Non-domestic building sector:** a community of different industries including investors, developers, designers, builders, owners, landlords, tenants and more, all impacting the eventual CO_2 emissions (see *Chart ES-g* above).

Chart ES-h *The non-domestic buildings 'circle of inertia'*

Source: Carbon Trust

- **Building 'journey':** each stage – specification and briefing > design > build and fit-out > handover > use > refurbish/change use – impacts the end emissions in different ways, and the different players play different roles at each stage.
- **Policy landscape:** a large number of existing policies impact non-domestic buildings, although most are not specifically targeted at this sector.

These market barriers and complexities combine to create a 'circle of inertia' where inaction from one part of the sector, leads to inaction elsewhere (see *Chart ES-h* above).

Government action

Given the lack of emissions reduction in the past, the size of the carbon reduction opportunity, the challenge to realise it and the climate change consequences of inaction, Government has the opportunity to take a leadership role in shaping and delivering the scale and speed of change required. This leadership should build on the Government's Low Carbon Transition Plan[15] by setting out a clearly defined strategy focused specifically on delivering a low carbon non-domestic building stock. By bringing the focus on to this often forgotten sector, the Government can catalyse the sector to act by creating the policy framework designed to remove the critical market failures which currently exist, turning the 'circle of inertia' into a 'circle of momentum'.

The strategy should have two main elements:

1. **Direction setting:** a clearly laid-out ambition for the level of carbon emissions reduction that is required from the sector, and the rolling out of Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs)[16] to all buildings in order to communicate the target emission levels in a language that resonates with the industry. The ambition should be to define a trajectory for carbon emissions reduction that minimises the cost to the UK, whilst clearly signalling to the industry the level of action that will be expected from them.
2. **Policy packages:** develop a set of coherent, integrated and detailed policy packages which together combine to meet the target emissions trajectory. The policies should encourage both low carbon buildings and encourage organisations to utilise them more effectively leading to 'better buildings, used better'.

1. Direction setting

Emissions trajectory for the sector

One of the most frequent comments throughout our interviews was the 'lack of clarity' for the industry on the carbon reduction levels that they will be expected to achieve, and the desire for Government to take a leadership role by laying out a clear, outcome-driven, long-term direction for the industry. Meeting this demand should be the first aim of a strategy for non-domestic buildings. The purpose is to set the challenge – stretching, but achievable – so that those responsible for emissions from non-domestic buildings know what the demands placed on them will be so they can have certainty in their investments over an extended time scale. This will involve defining a target trajectory for emissions – specific CO_2 targets for different time periods defined for the sector as part of the UK's carbon budgets. Critically, the pathway needs to be set to achieve the required reductions at the lowest cost to the UK.

Our Success Scenario analysis shows that a carbon reduction target of 35% by 2020 (vs. 2005 levels) should be one of the points along the lowest cost pathway to an 80% carbon reduction.

Moving more slowly by (a) matching the UK's 'intended' carbon budget of a reduction in emissions of 31% by 2020 (vs. 2005 levels)[17] in non-domestic buildings emissions, and (b) still achieving an 80% reduction in emissions from non-domestic buildings by 2050, would cost a cumulative total of £26bn by 2050. The 35% carbon reduction by 2020 of the Success Scenario reduces the cumulative cost to 2050 (of meeting an 80% reduction) to £13bn, as shown in *Chart ES-d* – a reduction in the long-term cost to the UK of ~£13bn[18] through increased benefits from quicker implementation of cost-effective energy efficiency measures, and reduced need for renewables beyond 2020 (as there will be less demand for energy). The cost reduction is even greater if we move more slowly to 2020. The relative cost difference could exceed £40bn if 2020 emissions levels are 29% less than 2005 – our optimistic scenario if current/expected trends and policies continue.

[15] The UK Low Carbon Transition Plan: National Strategy for Climate and Energy, DECC, July 2009.

[16] Certificates that describe the buildings' in-use performance (using the DEC – an operational rating) and quality (using the EPC – an asset rating).

[17] 21% reduction vs. 2005 levels, or 34% vs. 1990, is the current 'Interim' budget level for all UK emissions. The Government have stated their ambition to increase this to 31% vs. 2005 (42% vs. 1990), the 'Intended' carbon budget, in the presence of a global agreement on legally binding carbon reductions.

[18] Cumulative cost to 2050 of achieving an 80% emissions reduction with a 35% reduction by 2020 is ~£13bn. This increases to ~£26bn if the pathway of non-domestic buildings emissions to 80% in 2050 reaches a 31% reduction in 2020, and £56bn if the 2020 reduction is 29%.

By 2050, Government is already talking about non-domestic buildings emissions 'approaching zero'[19]. Our analyses suggest that going beyond 80% is very difficult using today's technologies and approaches for reducing carbon. And yet, in the non-domestic buildings sector a 70-75% reduction is possible at no net cost to the UK (using current measures), and 80% is technically possible using measures which can be implemented today. No other large sector in the UK economy can make both of these claims, so with sufficient innovation it is possible that this sector will continue to lead others in terms of potential to reduce carbon, and may therefore be capable of going beyond 80% by 2050.

"The main issue is a lack of clarity from Government – what's going to happen, and what do we need to do"

Developer

Communicating the emissions trajectory

These sector specific carbon budgets need to be translated into a language that is tangible to the day-to-day business and activities of those in the buildings sector.

We believe that Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs) should be the central elements of this language (see Sidebox on next page for more information on DECs and EPCs).

DECs and EPCs, if rolled out to all non-domestic buildings, can be used to clearly communicate the average improvement needed to meet the carbon budgets. For instance, DEC ratings will need to improve by around four ratings on average by 2050 versus today, from E to A; the 'distribution shift' needed by 2020 is at least two ratings (see *Chart ES-a*, which is based on the distribution of DEC ratings for large public sector buildings, and assumes they are representative of the entire non-domestic stock).

Beyond communicating Government expectations for non-domestic buildings, rolling out DECs and EPCs has other benefits. It will create transparency of building performance for both owners and users of buildings. Too often today, a lack of transparency leads to inaction, as the benefits are not clear. The certificates remove this barrier, and should help to catalyse more action to reduce emissions as seen in the Department of Energy and Climate Change building on Whitehall Place in London where an initially poor DEC rating led to significant improvements being made (see the case study at the end of the Executive Summary).

The use of both certificates together is important, as carbon reductions can be made from both:

- Cutting emissions through better end user behaviours (i.e. using the building better) – measured by the DEC rating.
- Improving the quality of the buildings (i.e. creating better buildings) – signalled by the EPC rating, with the impact of improvements on actual emissions being seen in the DEC rating.

Finally, collation of the ratings for all buildings will also help Government to monitor and diagnose the quality of, and carbon emissions from, all non-domestic buildings, helping to highlight successes and pinpoint areas for improvement.

[19] Low Carbon Transition Plan.

Consequently, we believe that Government could take four steps beyond setting the sector specific carbon budgets, in order to fully deliver a clear direction to the industry:

1. **Roll out DECs** to all non-domestic buildings by 2015, potentially using automated DECs for smaller buildings via the proposed 'Data Framework'[20] in order to reduce the costs and bureaucracy for SMEs. Set a time limit of 2015 for all buildings to also have an EPC in place.
2. **Set up a new Government programme** to monitor and diagnose non-domestic building stock performance based on the DEC and EPC database.

"A prerequisite for any effective Government policy to improve the energy efficiency of the existing stock is a consistent and transparent system of collecting and measuring actual energy use data. At the moment this is still not available in the UK, thereby preventing further policy development"

All Party Urban Development Group report 'Greening UK cities' buildings', 2008

3. **Refine DECs and EPCs:** continue to improve the benchmarks (including developing a broader range), software, process, transparency and compliance to ensure the ratings are fit-for-purpose, trusted within the industry and truly reflect the energy performance of the vast majority of buildings.
4. **Communicate expectations** that non-domestic buildings will deliver relatively more carbon emission reductions by 2020 than the UK as a whole and the implications for the average shift in DEC (and potentially EPC) rating needed to deliver this level of reduction. The Government could then signal that policies will be tightened or added to ensure that this occurs, and provide support to the sector to catalyse action.

The difference between DECs and EPCs

The two ratings show different aspects of a building's total energy performance. A Display Energy Certificate (DEC), or operational rating, records the actual CO_2 emissions from a building over the course of a year, and benchmarks them against buildings of similar use. An Energy Performance Certificate (EPC), or asset rating, models the theoretical, as designed, energy efficiency of a particular building, based on the performance potential of the building itself (the fabric) and its services (such as heating, ventilation and lighting), compared to a benchmark. The building quality (the EPC) has a large impact on the total emissions (the DEC), but does not explain all emissions. Other factors such as unregulated loads (e.g. IT, plug-in appliances) or building user behaviour also create emissions, which are reflected in the DEC.

The DEC, as the rating which captures all actual CO_2 emissions, is the most important rating. However, in order to understand what is driving these emissions, the EPC is critical in separating the influence of building quality from other influences such as end user behaviours. Consider two offices with the same DEC rating, but very different EPC ratings. One is a poor, inefficient building, used well by the occupant, where the opportunities to reduce carbon will be in improving the building itself. The second is an efficient building, used badly, where behavioural, end user focused measures are the best option for carbon reduction. Hence, to truly understand the energy used, and carbon emitted from a building, a building needs both certificates.

Introduced by the Government in 2008 as part of the implementation of the EU's Energy Performance of Buildings Directive, currently, only large public sector buildings are required to have a DEC, whereas all buildings require an EPC upon sale or lease.

[20] The Non-domestic Energy Efficiency Data Framework (NEED) is currently being piloted by DECC to test its feasibility. It aims to combine a range of existing datasets relating to the non-domestic built stock with information on meter points and energy consumption.

2. Policy packages

Setting a clear direction for the industry is a first, important step, but is not enough in itself to drive the scale of carbon reduction required from our buildings.

In addition, Government policy packages will be needed in order to create the conditions within which the sector can deliver the optimum level of carbon reduction – the target emissions trajectory laid out in the 'direction setting'.

The 'package' aspect is critical – the individual policies will need to be effective in their own right and each will have specific objectives being targeted; but they will also need to integrate effectively and clearly with the other policies to achieve the overall outcome.

Timing and purpose of Government policies

In developing policy, the high level timing and purpose should be clarified first.

- Timing: **before 2020 or after 2020.**
- Purpose: target carbon reductions **now** (i.e. during the specified time period) or in the **future** (i.e. with a view to the next time period).

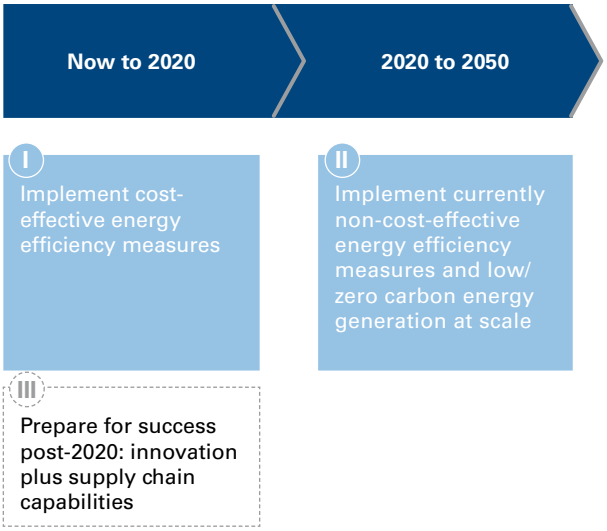
Thus, as *Chart ES-i* shows, we consider three separate areas where action is needed:

Carbon reduction to 2020 – policies here need to target the implementation of the simple, low-cost measures that our Success Scenario shows need to be implemented by 2020 in order to optimise the cost of achieving 80% by 2050.

Carbon reduction after 2020 – policies will need to drive implementation of the more expensive, complex measures.

Preparing for success after 2020 – policies will need to drive action before 2020, which leads to a greater range and lower cost of carbon reduction options being available post 2020.

***Chart ES-i** High level steps to a low carbon building stock*



I Carbon reduction to 2020

Our analysis has shown that the primary focus of policy initially should be on the action needed now to deliver a 35% carbon reduction by 2020 through implementation of almost all of the cost-effective measures in both new and existing buildings. This could reduce annual emissions by 37MtCO_2, from 106MtCO_2 in 2005 to 69MtCO_2 in 2020 (around half of this reduction will come from expected decarbonisation of the grid). It will create £4.5bn of net benefit to the UK.

Removing all the barriers

We have developed a set of policies which could catalyse the required change within the sector. They are shown in *Chart ES-k*, and fit within a framework which aims for 'better buildings, used better' by:

- **Targeting buildings,** and
- **Targeting organisations** which both own and use buildings.

It is important that the policies target both of these areas, as each has its own set of barriers which need to be overcome.

***Chart ES-j** Barriers to 'better buildings, used better' – barriers specific to the implementation of cost-effective measures over the next decade only*

Barriers to:	
Better buildings	**Used better**
1. Landlord-tenant divide 2. Shortage of whole life costing approach at all stages	
3. Lack of perceived material value in developing low carbon buildings 4. Lack of ability in supply chain to deliver truly low carbon buildings 5. Non-compliance with Building Regulations 6. Slow refurbishment cycle	7. Lack of motivation due to transaction costs, lack of awareness/information, or lack of transparency in building performance 8. Immateriality of energy costs/savings

When considering the specific barriers to rapid implementation of cost-effective energy efficiency, the long list of 24 barriers mentioned by the sector can be synthesised to eight key barriers (although others may still be relevant in specific circumstances). Some of these are barriers to the creation of more low carbon buildings, some are barriers to the organisations within buildings using them properly, and some barriers affect both areas (see *Chart ES-j*). Thus, for a high probability of meeting a 2020 carbon reduction target of 35% (and hence maximise the economic benefit), the policy framework needs to target both in order for there to be sufficient confidence that the scale and speed of carbon reduction required will be achieved – reducing less carbon, less quickly will cost the UK billions of pounds, and could lead to Government missing its legally binding carbon budgets.

Targeting all the carbon

The policy framework also needs to ensure that the full range of cost-effective carbon emission reduction potential is covered by the policy packages. Current and expected policies do not achieve this, and there is therefore a need for a small number of new policies.

Starting with policies aimed at delivering better buildings, the key mechanism here is the Building Regulations which set the standards for 'major interventions' – new buildings and major refurbishments – including the current ambition for Zero Carbon new build by 2019[21]. This policy, if tightened sufficiently over time, extended to include all sources of building emissions, and properly complied with, could target 50% of the cost-effective carbon reduction opportunity. The Carbon Trust's Design Advice programme also helps to deliver carbon reduction during major interventions, by working with motivated clients to go beyond the minimum standards set by the Building Regulations.

[21] Which will likely be implemented through the Building Regulations.

However, there is a gap for the two-thirds of buildings which will not undergo a major intervention by 2020 – additional policies are needed for buildings whilst 'in-use'. We suggest the following options for Government to consider:

- **Public sector leadership:** public sector to implement cost-effective options from DEC advisory reports within the seven-year lifetime of the report.
- **Minimum building standards:** all buildings to achieve at least an F-rated EPC by 2020 (where cost-effective).
- **Building focused advice:** a pro-active advice and support programme targeting cost-effective improvements in the poorest buildings – those with F and G-rated DEC/EPC certificates.

Moving on to the policies targeting organisations, the main mechanism here is the Carbon Reduction Commitment (CRC), a cap-and-trade scheme for ~5,000 large, non-energy intensive organisations, explicitly aimed at increasing the uptake of cost-effective energy efficiency measures. Starting in 2010/11, it is likely to cover around half of the emissions from non-domestic buildings, and a similar level of the cost-effective carbon reduction opportunity. In addition, the Carbon Trust's Carbon Management advice programmes will continue to help these and other organisations to identify and implement carbon savings.

However, there is a policy gap for those organisations that do not use enough energy to be included in the CRC – the SMEs for who top down, regulatory policies are unlikely to be as effective[22]. Again, we have suggested some policy options that could target this area:

- **'CERT' for SMEs:** develop a national programme led by the energy suppliers to install the simple, low-cost energy efficiency measures, paid for by a marginal increase in SME energy bills.
- **Longer term loans for SMEs**: loans of over four-year duration for energy efficient equipment, paid for from the energy savings made, similar to the Government's current proposal for the domestic sector in the Heat and Energy Savings consultation. These would be in addition to the current loans scheme run by the Carbon Trust.

Thus, the policy framework within which we have developed the detail of our four policy packages (see *Chart ES-k*) is:

- **Target buildings**
  1. At major interventions
  2. Whilst in use
- **Target organisations**
  3. CRC
  4. Non-CRC.

In addition, we have described a list of further, more radical policies, which Government can introduce if the emissions trajectory falls behind target. These include linking fiscal mechanisms such as business rates to DEC ratings, mandating the use of green leases, and additional/tighter product standards.

II Carbon reduction after 2020

By 2020, the objective is that all the cost-effective energy efficiency measures will have been implemented across the non-domestic stock. Beyond 2020, almost all technical carbon reduction potential will need to be implemented, much of which is not currently cost-effective. This includes more costly energy efficiency and renewable technologies, requiring £50bn in capital investment by 2050.

It is likely that the specific policies to encourage continued carbon reductions will need to evolve to be more suitable to measures which currently have a net cost to the UK. The framework of targeting both buildings and the users of buildings may still be applicable, but we do not attempt to detail specific policies for after 2020.

Instead, it is more important for now to consider the actions which need to happen over the next decade which can improve the industry's ability to deliver carbon reductions after 2020.

[22] Industrial organisations under the Climate Change Agreements regime are also not captured by the CRC. However, we focus our new policies on SMEs as this is the sector with the most significant policy gaps.

Preparing for success after 2020

The measures which need to be implemented after 2020 present a whole new challenge for the entire sector, quite different to the implementation of low-cost, cost-effective measures. Government policies are required now which will lead to large scale innovation and a transformation in the industry's capabilities:

- **Large scale innovation** support across a range of technologies and approaches to develop a greater range of carbon reduction options, at a lower cost than today. This includes building fabric measures, more efficient building services and equipment, low/zero carbon energy generation (with implications for the UK's Renewable Energy Strategy, see below) alongside 'softer', non-technology based innovations in the specification, design, construction and use of buildings.

  An important component in the actions needed to achieve greater innovation, is the approach the UK takes more broadly towards supporting innovation. The Carbon Trust has recently published a major new study that answers this issue across the full range of low carbon technologies (LCTs), not just those for non-domestic buildings. The report concludes that:

  - There is a compelling case for the UK to support low carbon innovation; and
  - That a new 'technology focused' approach, bringing together both technology prioritisation and technology support customisation, will radically improve the cost-effectiveness of UK LCT innovation.

  Full detail can be found in the report, 'Focus for Success: a new approach to commercialising low carbon technologies'.

- **A transformation of the non-domestic buildings industry capability** to deliver low carbon buildings, through defining best practice at every stage of the building journey; assessing the gaps to best practice which currently exist; and the rolling out of education and training programmes to fill these gaps.

These actions are needed now, in parallel to the policy packages described to stimulate energy efficiency out to 2020, in order to ensure the emissions trajectory continues on a downward path even once all the low-cost energy efficiency measures have been implemented.

Interaction with the Renewable Energy Strategy

There are clear interactions between:

- Building and organisation focused policies which aim to reduce carbon emissions over time, including through the use of on/near site renewables; and
- The Renewable Energy Strategy (RES), which describes the UK's broader ambitions for greater levels of renewable energy generation – 15% of total energy supply to come from renewables by 2020.

A consideration of carbon reduction in non-domestic buildings leads to three important points which should be built in to the Government's development of policies and actions relating to renewables:

- **Large scale renewables and broader grid decarbonisation:** achieving 80%+ reductions in emissions in non-domestic buildings requires rapid decarbonisation of the grid, along the lines of the trajectory recommended by the Committee on Climate Change.
- **Energy efficiency before on/near site renewables:** it is important that on/near site renewables are not supported at the expense of more cost-effective carbon reduction measures such as energy conservation, management and efficiency. The Government's proposed hierarchy of measures to achieve Zero Carbon new buildings, which sets a minimum required level of energy efficiency before other options can be used, is an example of an appropriate approach to achieve this aim.
- **Going beyond 35% by 2020?:** our Success Scenario does not require significant implementation of on/near site renewables before 2020. The RES expects up to 15% of heat demand from the non-domestic sector to be met through technologies such as biomass CHP and heat pumps. This should be on top of the energy efficiency measures in the Success Scenario leading to overall carbon reductions from non-domestic buildings potentially going beyond the 35% reduction in 2020.

Whilst implementing this level of renewables sooner than in our Success Scenario will have a financial cost (£940m p.a. in 2020 according to the RES), there are clear benefits:

- 8.5MtCO_2 of reduction in 2020.
- Creation of new industries (and associated jobs) which could position the UK as a global leader in specific technology areas.
- Creation of a supply chain capable of delivering on/near site renewables at scale and a lower cost than today, which will be required beyond 2020 in both domestic and non-domestic buildings.

"…sources are very often either incomplete, out of date, of unknown representativeness, missing key data at least in part, incorporate inconsistent and incompatible classifications, or commonly, several of the above"

UK-GBC report for DCLG: 'Carbon reductions in new non-domestic buildings', December 2007

Act now

Implementing the strategy we have outlined will not be a simple undertaking. We would suggest that adopting a comprehensive implementation plan will increase clarity of responsibilities across the many Government departments and external stakeholders involved and increase the urgency of action. This plan should cover at least the following six areas:

1. **Measurement** of the building stock
2. **Understanding of future opportunity** for carbon reduction
3. **Setting the direction** of emissions trajectory
4. **Develop policies** for buildings and organisations
5. **Drive innovation** to reduce future costs and increase the range and scale of options
6. **Improve supply chain** capabilities and business models.

There is broad agreement across the industry and Government that the current level of understanding of the non-domestic building stock and its emissions reduction potential is poor, especially compared to domestic buildings.

However, there is enough information for action to begin. The Government should not delay action due to a lack of comprehensive data and can urgently begin to implement the early, and simple, actions described in this report – setting a clear direction and a focus on implementing cost-effective opportunities. In parallel, the Government can also take a lead in coordinating a coherent programme of knowledge development and 'learning-by-doing' to help inform and iterate policies in the future.

A positive future

The outcome will be a truly low carbon stock of non-domestic buildings playing its part in the UK's transition to a low carbon economy; an industry with the ability to deliver, and create increased value from, high quality, innovative products; and buildings which are more comfortable, more productive, more valuable, and more desirable than today.

Chart ES-k *Policy packages to deliver a low carbon non-domestic building stock in the UK – the next decade*

Transforming the delivery of cost-effective measures up to 2020		
Targeting buildings	1. Policy package for **major interventions** (new build, major refurbishment) – target up to 13.1MtCO$_2$	**Building Regulations for new buildings – Part L2A (10.7MtCO$_2$):** tighten in line with current Government proposals for 2010 and 2013, plus the ambition to deliver Zero Carbon new builds by 2019. Potentially extend to cover 'unregulated' loads before 2019.
		Building Regulations for existing building major refurbishment – Part L2B (2.4MtCO$_2$): change to be consistent with Part L2A, using CO$_2$/m^2 as the key output measure; tighten regulation to achieve average 15% reduction in CO$_2$/m^2 by 2020 (i.e. drive implementation of cost-effective measures) and 70% by 2050 (to meet our Success Scenario). To 2020 this policy will impact ~15% of existing buildings.
		Enforcement bodies and regulation compliance (1.3MtCO$_2$): increase Building Control Body resources, people, training and tools, and improve the Building Regulations themselves, to deliver greater compliance with all building related regulations. Need to measure compliance levels, and assess if the Government's proposals for improvements (as part of the 2010 Building Regulations) deliver greater compliance.
		Advice • **Carbon Trust 'Design Advice' (1.3MtCO$_2$)** for large-scale new build and refurbishment projects with a significant low carbon ambition to go beyond Building Regulations.
	2. Policy package to drive improvements across the stock **whilst in-use** – target up to 13.2MtCO$_2$	**Public sector leadership (2.4MtCO$_2$):** mandate implementation of cost-effective measures on DEC Advisory Reports (within lifetime of DEC i.e. seven years).
		Minimum building standards (4.8MtCO$_2$): all buildings must have an EPC rating of F or higher by 2020, and potentially E by 2025 (where cost-effective to do so).
		Advice • **Pro-active, building focused advice (1.0MtCO$_2$):** advice targeted at buildings with a particular focus on pro-actively improving F and G-rated buildings, alongside detailed 'how to' advice on implementation of Top 10-20 DEC/EPC Advisory report measures for all.

Key Existing policy | New policy

Chart ES-k *Policy packages to deliver a low carbon non-domestic building stock in the UK – the next decade (Continued)*

Transforming the delivery of cost-effective measures up to 2020		
Targeting organisations	3. CRC policy package – target up to 13.1MtCO$_2$	**CRC (13.1MtCO$_2$):** ensure cap is tightened to deliver emissions reductions of up to 10MtCO$_2$ through implementation of the cost-effective energy efficiency measures in the buildings of the included organisations.
		Public sector loans (2.4MtCO$_2$): Salix loans for public sector organisations to continue.
		Advice • **Organisation focused advice (1.8MtCO$_2$):** Carbon Trust's Public and Private Sector Carbon Management and Energy Surveys (complementary to the pro-active, buildings focused advice described above).
	4. Non-CRC policy package – target up to 13.2MtCO$_2$	**CERT for SMEs (4.9MtCO$_2$):** extend supplier obligation into SMEs, setting up a new 5-10 year programme focusing on the simple, cost-effective measures in existing buildings. Maximum capital required from increased energy bills is ~£650m total if this programme were to target 100% implementation of the measures. However, this figure will reduce based on the size of the loans programme (next policy).
		Loans (2.4MtCO$_2$): target the CO$_2$ reduction potential in existing SME buildings not covered by the supplier obligation (above). • **Less than 4 years:** re-cycle Carbon Trust loans scheme to cover additional investment of up to £200m over the next 5-10 years.
		• **Greater than 4 years:** develop longer term loans, paid for through savings on energy bills (linked to the building, not the organisation).
		Advice • **Organisation focused advice (1.5MtCO$_2$):** one Day Energy Surveys, Sectoral programmes, publications and advice line support (complementary with the pro-active, buildings focused advice described above).
Optional additional policies if required	**Fiscal incentives:** link existing fiscal mechanisms such as stamp duty, business rates or Climate Change Levy levels to EPCs and/or DECs.	
	Mandatory green leases: mandate use of green leases across public sector within 3-5 years, as per the Australian model, to drive behaviour change and overcome the landlord-tenant divide. Follow up by extending into commercial and/or industrial properties.	
	Product standards: introduce additional or tighter product standards (compared to current and proposed EU regulations) for building fabric, services and other related equipment. Continue to work with EU bodies to ensure challenging minimum standards for equipment are set for critical items, such as air-conditioners.	

Key Existing policy New policy

Description of carbon potential in Chart ES-k

The carbon reduction that each individual policy option or policy package can target, as shown in *Chart ES-k*, is calculated under the following conditions (Chapter 3 of the full report gives more detail):

- The numbers describe the maximum carbon reduction potential from cost-effective measures which could be targeted.
- The total carbon reduction potential by 2020 is 26.3MtCO$_2$. This figure is:
  - relative to 2020 emissions of 112.8MtCO$_2$ (today's existing buildings plus additional new build floor area at 2006 standards); and
  - before consideration of the impact of grid decarbonisation to focus on emission reduction due to improvements in the buildings. Including the further impact of grid decarbonisation leads to our Success Scenario, where 2020 emissions reach 69MtCO$_2$.
- From a building's perspective, around half of the 26MtCO$_2$ potential is in buildings which undergo 'major interventions' over the next decade, with the other half from buildings whilst in-use. From an organisational perspective, approximately half of the potential will be from organisations captured by the CRC with the rest being in non-CRC organisations (predominantly SMEs).
- Some of the policies (and this targeted carbon) deliberately overlap in order to drive both better buildings, and better use of buildings.

Case Study

Department of Energy and Climate Change
DEC rating improved through implementation of simple, low-cost measures

When the Department of Energy and Climate Change (DECC) was formed, it aimed to demonstrate what an energy efficient department could look like. When it moved into its Whitehall HQ – a building with one of the worst energy performance ratings in Whitehall – it rose to the challenge and set about improving its carbon management, with help from the Carbon Trust. Resulting work has enabled the Department to bring the building's monthly operational rating from a G to a D, and to save a potential £74,000 a year with a payback on investment of just over a year.

Simple measures

DECC's most significant savings have resulted from 'low visibility' measures:

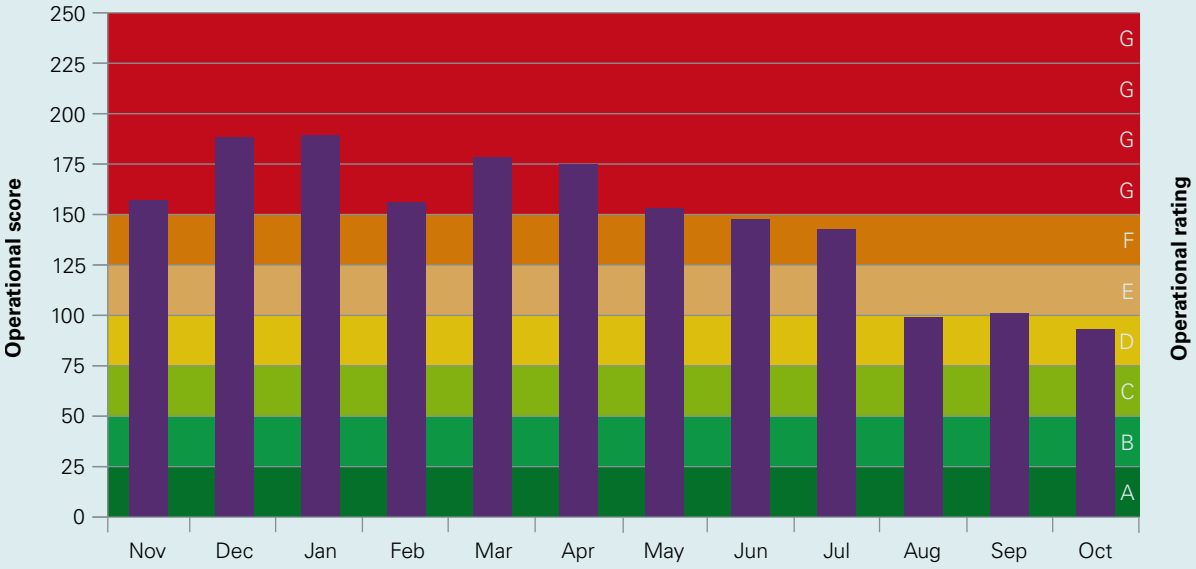
- **Lighting.** The first activity was a focus on the lighting which has been changed to be as energy efficient as possible, while still meeting the needs of ministers and staff. For example, inefficient tungsten halogen spotlights in the atrium and over bathroom mirrors were replaced with compact fluorescents, which last 15 times longer. Unnecessary fittings in waiting rooms and corridors have been removed, and lights throughout the building are now motion and daylight sensitive, coming on only when an area is occupied, and when daylight is below a certain level.
- **Heating, cooling and ventilation.** "Previously, the facilities management team were very responsive to individual complaints on temperature," says Jenny McInnes of DECC's building team. "So we'd end up with the heating and air conditioning in adjacent areas fighting each other." All ceiling fans are now set to the same default level, and come on at 8.30am and go off at 5pm. Jenny acknowledges that this isn't ideal for everyone, but says: "We're trying to be firm but fair; in large offices with lots of natural variability there will always be some complaints – one person will be too hot while the person next to them is too cold. We're trying to encourage people to dress for the weather."
- **IT.** DECC's server rooms need to run 24/7 and require constant cooling. So they have invested in a small, dedicated chilling plant to meet this need more economically, only cooling the location requiring attention. DECC has received a loan from Salix finance to meet the capital cost of the new chiller and expects to see immediate savings to energy bills.
- **Measurement.** The building has smart meters which monitor consumption of gas, electricity and water, and DECC plans to introduce real-time displays linked to the meters to allow staff to see where resources are being used.

"The measures which make the most difference to our efficiency are things which staff and visitors don't even notice," says Jenny. "This shows that you can make big changes without compromising comfort levels."

Results

- **Monthly operational rating from G to D.** For the first few months CO_2 emissions rose steadily as more staff and equipment moved into the building. However, since March 2009 the levels have fallen steadily (see *Chart ES-I*).
- **Per capita, emissions have fallen by 35%,** or nearly a tonne of CO_2 a head. DECC is on track to reduce emissions by its goal of 10% compared with business as usual by the end of the 2009/10 financial year, and has now set itself a further target of a 10% carbon reduction in 2010.
- **Payback of 1.1 years on investment.** Cost of £81,000 with expected annual savings of £74,000.

Chart ES-I *Monthly DEC (operational) rating and score, 2008-2009*



"We've made most of our savings simply by looking more closely at how long things like lights and heaters are left on"

Jenny McInnes, DECC Building Team

Which of the policy options we have outlined could relate to this case study?

- Roll out DECs and EPCs: the G rating has driven real action.
- Public Sector Leadership: this would encourage other public sector bodies to follow DECC's example.
- Minimum building standards: The DECC example shows that simple cost-effective measures can make a real difference, showing that moving almost all G-rated buildings to an F rating should be feasible.
- Salix loans were used to fund some of the improvements.
- Carbon Trust advice and support: helped DECC to select the best measures, and to implement them.

Part A
Introduction

The carbon emissions from the office you may be sitting in right now, reading this publication, can most likely be cut by around 15% with a small number of simple measures such as installing sensors that turn off the lights when you go home.

These measures will pay back within less than four years and then continue to save your business money. What's more, there are policies to incentivise your business to implement these measures and a large number of regulations to make sure your builder incorporates them into your next major renovation.

So why have emissions from non-domestic buildings hardly reduced for the last two decades? And if there is an opportunity to save large amounts of money, why hasn't the market delivered?

This part of the report answers these questions. It throws a spotlight onto the large opportunity to improve the carbon performance of the UK's non-domestic buildings, which would not only save carbon emissions, but also save the UK £4-5bn over the next decade, improve energy security and give the workforce a better working environment. It explains why realising this opportunity is a significant challenge, despite all the existing measures in place.

And it shows that the only way to address these challenges is for the Government to address the significant, mutually reinforcing barriers and complexities. By taking up this mandate and implementing the actions outlined in the following chapters, the baton can then be passed to industry to deliver the savings.

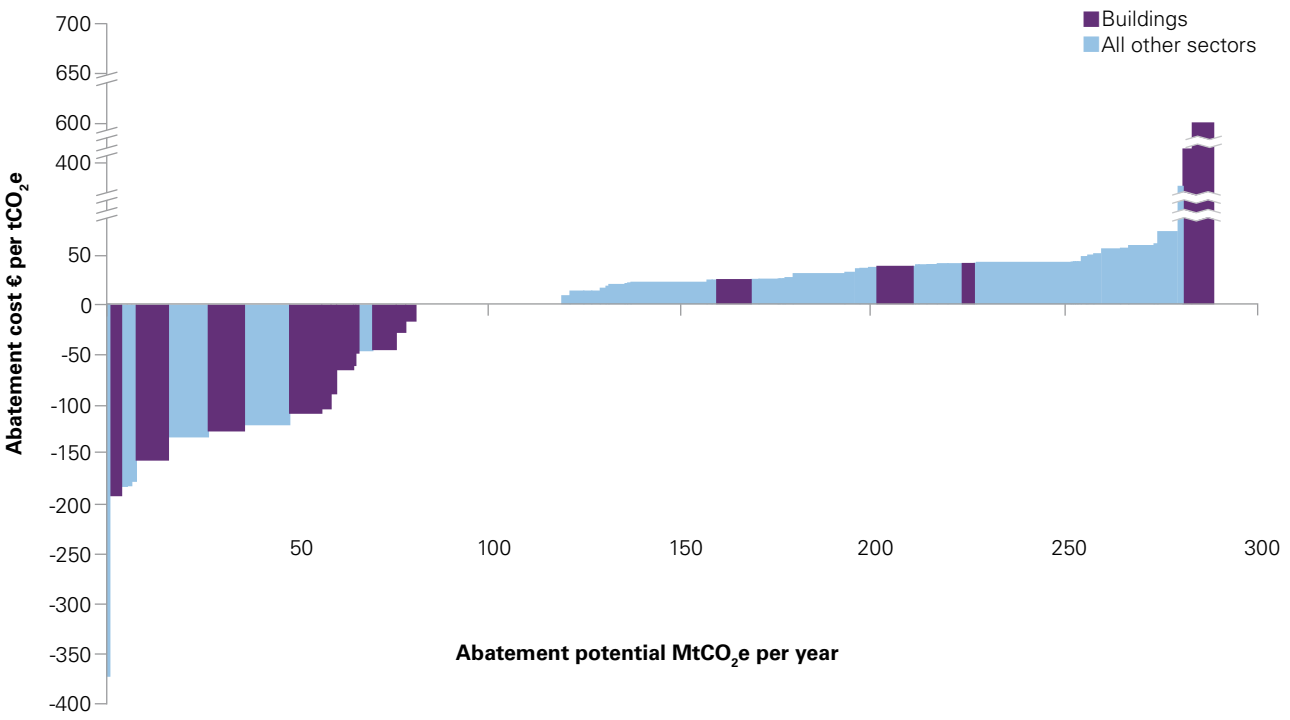
1 The case for additional Government action

Without additional Government action targeted at non-domestic buildings, a big opportunity to cut both carbon emissions and energy costs could be lost. Significant, mutually reinforcing barriers and complexities mean that emissions have been flat rather than on a trajectory towards an 80% reduction by 2050. Government action can address these and enable industry to unlock this opportunity.

Key findings

- There is a big opportunity to cut carbon emissions and generate financial benefits:
  - Non-domestic buildings produce nearly a fifth of the UK's carbon emissions.
  - Reducing 15% of these emissions from existing buildings and 45% from new buildings is cost-effective using technologies and approaches which exist today.
  - Implementing most of this opportunity could lead to a net economic benefit of £4-5bn by 2020.
- Despite this large economic opportunity, emissions from non-domestic buildings have hardly reduced for the last two decades. And yet by 2050 they will potentially need to reduce by at least 80%.
- We interviewed more than 70 leaders across the industry to understand why they have not taken advantage of this opportunity. They identified a large number of barriers and complexities that combine to create a 'circle of inertia'. There was a clear consensus that additional action and leadership from Government is required to overcome these issues.
- There is therefore a clear mandate for additional targeted action from Government.

Chart 1a *UK marginal abatement cost curve, 2030*



*'Business as usual' based on emissions growth driven mainly by increasing demand for energy and transport.

Source: CBI 'Climate Change Everyone's Business'; McKinsey UK cost curve

A big opportunity to cut carbon and generate financial benefits

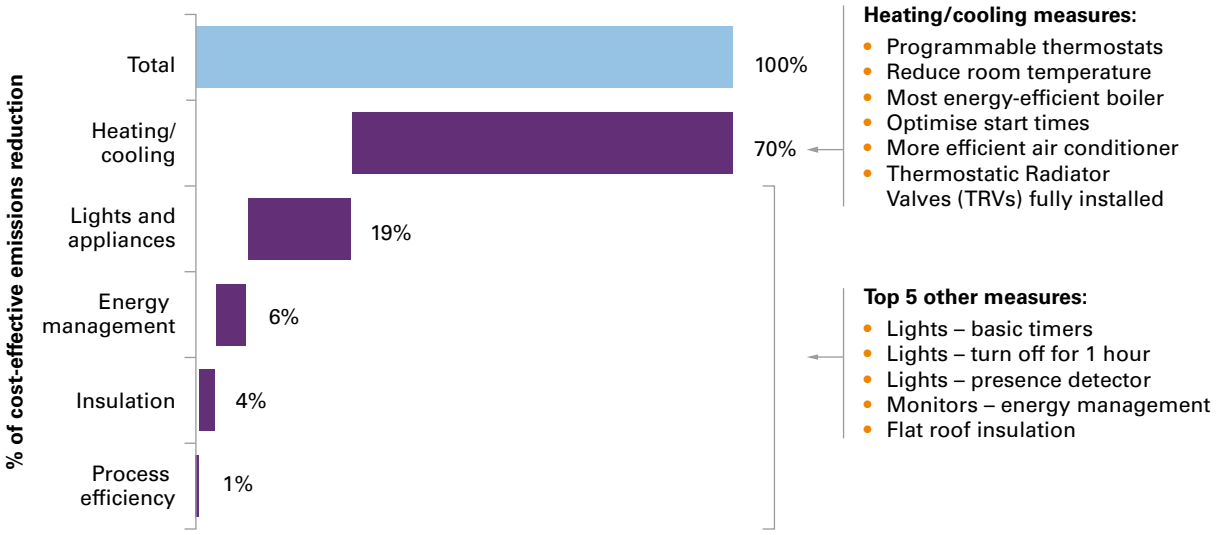
The UK has legally binding targets for carbon emission reductions of 80% by 2050 (vs. 1990), alongside interim 'carbon budgets' for each of the next three five-year periods, starting in 2008. On the advice of the Committee on Climate Change, a carbon budget of 34% for 2020 has been set – this could rise to 42% if a global agreement on carbon reductions is reached in Copenhagen at the end of 2009. But what do all these targets mean for non-domestic buildings? Should they reduce emissions by more or less than the overall UK targets?

Ultimately the answer comes down to how much carbon can be saved from the non-domestic building stock, and the cost of that carbon reduction potential compared to opportunities in other sectors of the economy.

Buildings represent 45% of the UK's carbon emissions, with around 40% of these emissions coming from non-domestic buildings (see *Sidebox 1i* 'Non-domestic buildings 101' over the page for more information on non-domestic buildings and their emissions). There are three main sets of measures which can be implemented to reduce the carbon emissions from buildings:

- Energy conservation and efficiency measures to building fabric, services, equipment (e.g. IT) as well as end user behaviours;
- On- and near-site renewable and low carbon generation technologies such as heat pumps and solar hot water; and
- Decarbonisation of energy supplied to buildings, in particular, grid-delivered electricity.

Chart 1b *Carbon abatement potential of cost-effective energy efficiency measures in existing non-domestic buildings in the UK – combined, these measures could reduce total emissions by ~15%*



Note: the potential carbon reduction from the different measures assumes that all measures are implemented together, and are therefore additive.

Source: CCC (data for public sector and commercial buildings, excl. Industrial); Carbon Trust analysis

McKinsey's global abatement cost curves for 2030 suggest that in the UK cost-effective carbon emission reduction potential is heavily skewed towards building-related measures, covering both domestic and non-domestic buildings – see *Chart 1a*. More detailed cost curves, such as those developed for the Committee on Climate Change[1] describe the carbon reduction opportunity within existing non-domestic buildings. These show that there is an opportunity for carbon reduction of over 40% from energy efficiency measures and on-site renewables using existing or close-to-market technologies.

The cost-effective opportunity is significant, with ~15% reductions being possible across the non-domestic stock at a cumulative net benefit to the UK of £4-5bn by 2020[2]. Almost all this saving can be achieved with the top 11 simple measures in the cost curve. These measures are no or low-cost actions, or payback within less than four years (see *Chart 1b* for more detail):

- **No-cost options:** optimising heating start times, turning down thermostats, turning off lights, energy management at monitors.
- **Low-cost options:** programmable thermostats, thermostatic radiator valves (TRVs), presence detectors for lights.
- **Payback <4 years:** energy-efficient boilers, energy-efficient lighting, more efficient air conditioning.

[1] Based on BRE's N-DEEM (Non-Domestic Energy and Emissions Model) database which assesses the opportunity for carbon reduction from non-domestic buildings in the UK.

[2] Chapter 2 expands on the analysis used to calculate the net benefit.

1i. Non-domestic buildings 101

Non-domestic buildings emissions include both:

Direct emissions – all the emissions released from the building (e.g. due to burning gas in boilers) excluding those from industrial processes (which are ~80% of industrial emissions).

Indirect emissions – all the emissions released outside the building but directly caused by energy used in the building – mostly the emissions from coal and gas power stations to create the electricity used in the buildings.

Non-domestic buildings account for 18% of the UK's carbon emissions – a smaller amount than domestic buildings' 26% but of comparable size. Non-domestic buildings are all the buildings we work in – they cover a broad array of sectors with different shapes and sizes (from offices to hospitals), each requiring different amounts of heating, lighting and other end uses and each a different age and therefore built to hugely varying building standards and regulations.

A broad array of sectors

Non-domestic buildings cover three groups, each with significant levels of emissions: commercial, public sector and industry. *Chart 1c* shows how these three groups then break down again into a broad array of sectors, with two-thirds of emissions coming from the four biggest contributors: industrial, retail, hotels/inns/restaurants and commercial offices.

More heating, lighting or other end use?

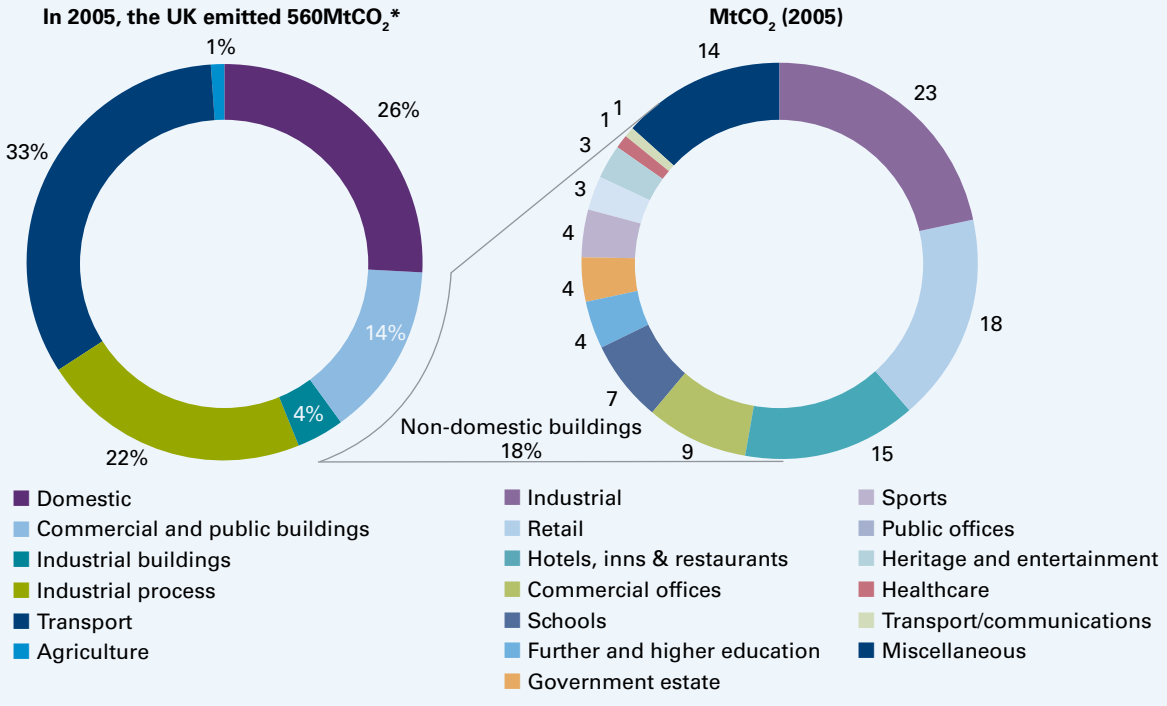
Nearly half of non-domestic buildings' emissions currently come from heat, just under a quarter from lighting and the remainder split between cooling and everything else (see *Chart 1d)*.

This end-use split varies significantly by sector (see *Chart 1e)*. For instance, in retail lighting is the biggest end use, whilst in hospitality the biggest end use is catering.

An old building stock

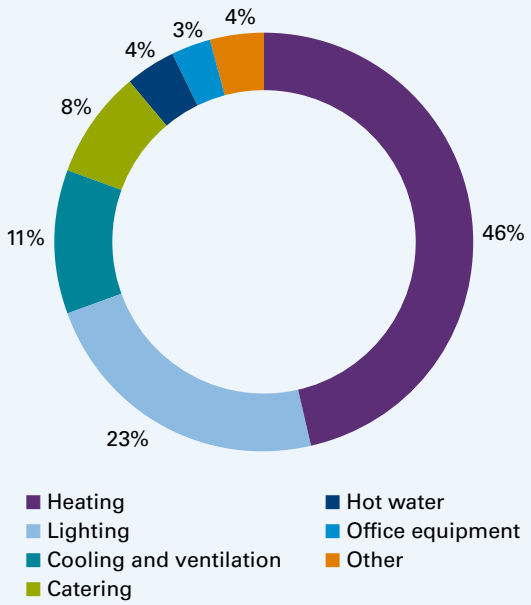
More than three-quarters of non-domestic buildings were built before 1985 and therefore pre-date any Building Regulations. By 2050, half of these buildings will still be standing. Nearly a third of non-domestic buildings were built before the Second World War.

Chart 1c *Breakdown of non-domestic buildings emissions by sector*



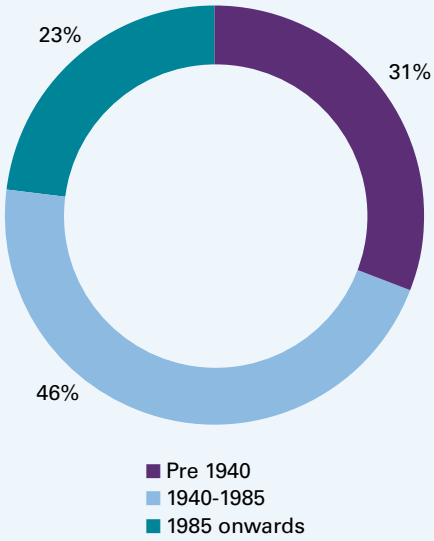
*Source: Digest of UK Energy Statistics; BRE

Chart 1d *CO_2 emissions by end use (2005)*



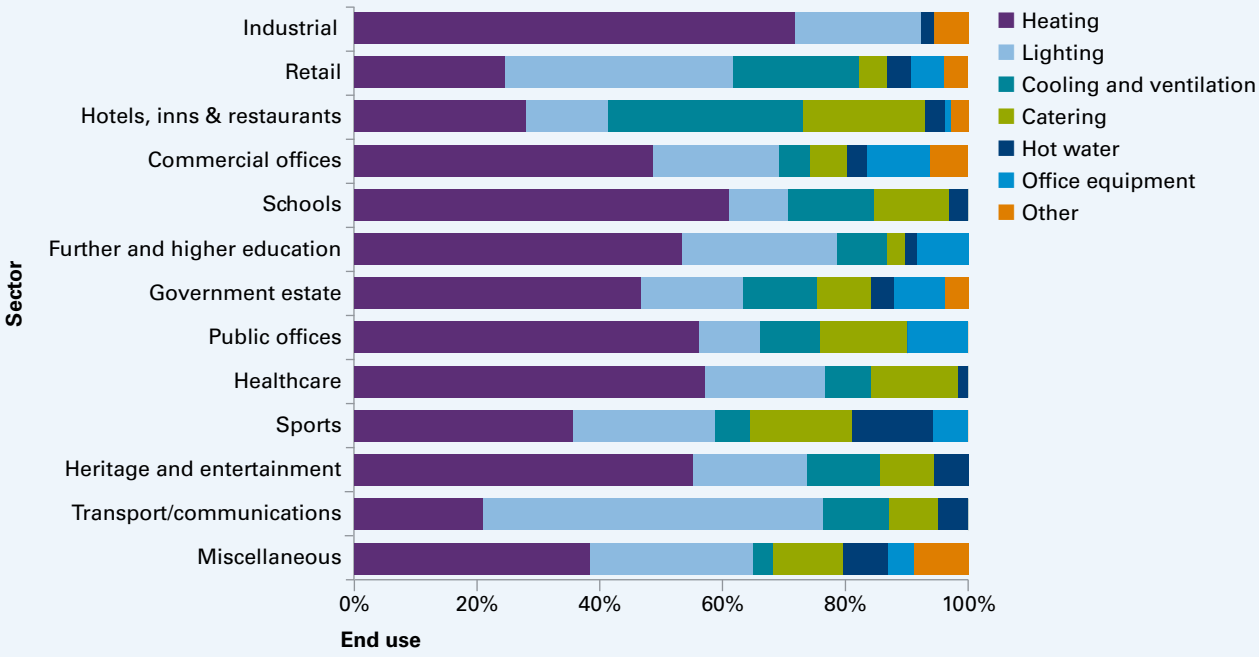
Source: BRE; Carbon Trust analysis

Chart 1f *Age of non-domestic buildings (2005)*



Source: BRE

Chart 1e *Breakdown of CO_2 emissions by end use in each sector (2005)*



Source: BRE, Carbon Trust analysis

The Carbon Trust's experience over the last eight years – helping tens of thousands of organisations save 23MtCO_2 and make direct cost savings of around £1.4bn – lends weight to these conclusions. The experience of one of our clients, Maxim Logistics (described in a case study at the end of this chapter), is a great example of how simple energy efficiency measures can be. By installing energy-efficient lighting with sensors in their warehouses, they saved more than 41% off their energy bills and will be able to pay back our zero interest loans in less than two years.

Combining the energy efficiency opportunity with production of renewable electricity and heat on and near the building, and the decarbonisation of grid delivered electricity by up to 90%, means that non-domestic buildings' carbon emissions have the potential to be reduced by at least 80% long term – the 'Success Scenario' in Chapter 3 gives more detail on how this can be achieved.

The size of this opportunity, and particularly the cost-effective opportunity that is available today, means that at the very least buildings should play their fair share in the UK's transition to a low carbon economy, and quite possibly be required to go further and faster, than most other sectors of the UK economy.

But let's not look at this opportunity as being only about saving carbon, energy and money. There is also an opportunity here to deliver better buildings into the stock, and to increase the skills and capabilities of the UK building industry. Well-designed low carbon buildings can be more comfortable, more productive, more valuable, and more desirable than those which exist today. Our work with Maxim Logistics was just one such example, where even though there were less lights, the warehouse is brighter, improving working conditions for staff. *Sidebox 1ii*, 'Business benefits of low carbon non–domestic buildings' outlines the broad set of benefits based on research conducted by BRE for the Carbon Trust in Scotland.

1ii. Business benefits of low carbon non-domestic buildings

The Carbon Trust Scotland commissioned research by an occupational psychologist at BRE to conduct a series of interviews with business, building and facilities managers and focus groups with occupants of low carbon buildings. Topics explored included whether they had perceived productivity, job satisfaction and loyalty to have increased since moving into a low carbon building. The research uncovered the following eight key business benefits:

1. Reduced operational costs e.g. utility costs and other running costs such as facilities' staff time, paper and travel.
2. Expected increase in asset value over a standard speculative building.
3. High levels of daylight, good air quality and natural ventilation had a positive impact on occupant health and well being, compared with occupants' previous air-conditioned premises.
4. Open plan, transparent offices (as a consequence of natural ventilation strategy and increased daylight penetration) encourage communication and break down silos. The research suggests this can have a positive impact on staff – colleagues and managers are more accessible.
5. Award-winning low carbon buildings provide excellent profile raising and marketing opportunities. Visitors (clients and local community) enjoy visiting the building and are encouraged to attend meetings and events.
6. Raised awareness of sustainability amongst occupants, encouraging pro environmental behaviour at work that spills over to the home environment.
7. Improved image amongst staff who feel it is important to work in a sustainable building, and enhanced amenities for staff which contribute to making staff feel valued at work.
8. There is some indication that a sustainable building can have a positive impact on recruitment.

More information can be found at www.carbontrust.co.uk

A big challenge

Not nearly enough energy efficiency measures are being implemented, despite this large cost-effective opportunity. Over the last two decades, absolute emissions from non-domestic buildings have hardly declined *(see Chart 1g below)*. Energy efficiency measures have improved emissions per square foot. However, floor space has increased year-on-year, driven by population and economic growth. Other factors have and could continue to increase the energy demand of buildings – for instance increased use of air conditioning. If emissions continue to decline at their historic rate of 0.5% p.a., the total reduction by 2050 will be less than 25% rather than the 80% emissions reduction target.

There are three key reasons that carbon reduction measures are not being implemented:

- A diverse set of barriers;
- The complexity of the building stock, industry, building journey and policy landscape; and
- The barriers and complexity combining to form a 'circle of inertia'.

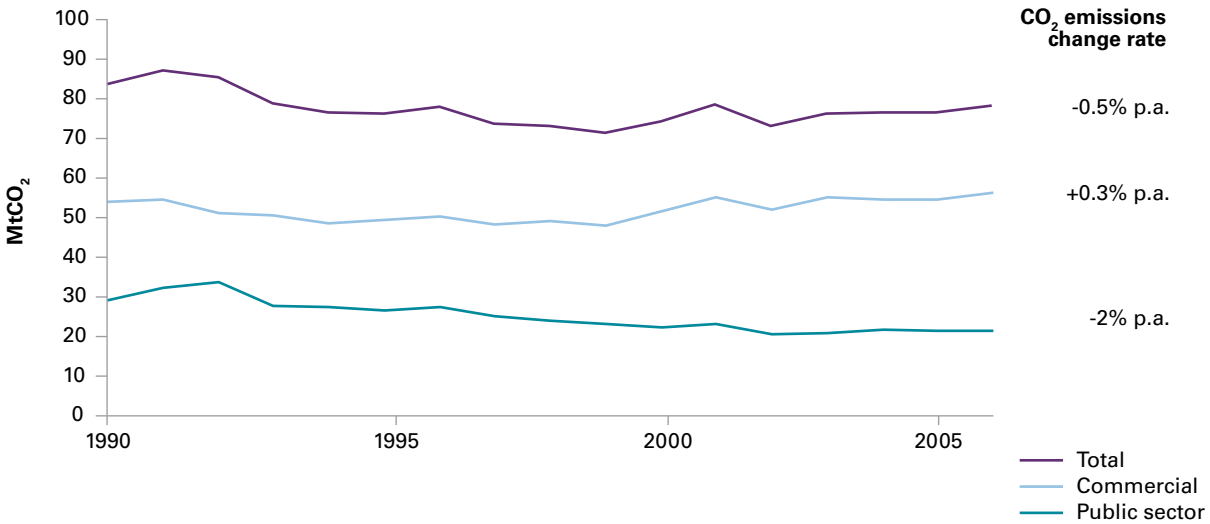
A diverse set of barriers

As part of our analysis for this report, we conducted a series of in-depth interviews with more than 70 individuals from across the entire non-domestic building sector. *Sidebox 1iii* 'Carbon Trust interview programme' (over the page) gives more detail on the interviewees, the questions asked, and what we learned.

A key output from the interviews was a long list of at least 24 separate barriers, raised without prompting, to more rapid development of low carbon new and existing buildings. These barriers are shown in *Chart 1h*. They reflected a lack of demand to implement the measures, a lack of awareness and information, issues with the design/build team alignment (including a lack of low carbon building skills) and issues with operation of the buildings.

Almost half of the barriers were concentrated around the lack of demand for low carbon buildings and measures that reduce emissions. Two of these are worth further discussion: the landlord-tenant divide, which is potentially the hardest barrier to remove; and immateriality of savings, which was mentioned the most often by the interviewees.

Chart 1g *Historical annual emissions from 1990-2006 from commercial and public sector non-domestic buildings in the UK*



Source: Committee on Climate Change (Dec 2008)

Chart 1h *Barriers to reducing emissions from non-domestic buildings mentioned by interviewees*

Lack of demand – both end user and within value chain

- Landlord-tenant divide
- Immaterial savings
- Lack of clarity and direction from Government
- Lack of perceived material value in development of low carbon buildings
- Lack of capital, e.g. spending freeze
- High transaction costs
- Misinformed on cost-benefit
- Lack of motivation
- Separate capex and opex budgets/ no lifecycle costing
- Lack of CSR incentive
- Lack of client management skill to procure/operate low carbon building

Awareness and information

- Lack of post-occupancy evaluation and feedback
- Information unavailable on:
  - buildings' energy use and emissions
  - cost-benefit of measures to improve building performance
  - support programmes
- Lack of awareness of all the above

Design/build team alignment

- Lack of skills and knowledge to design and construct low carbon buildings
- Lack of coordination/collaboration across supply chain
- Poor commissioning and handover
- Lack of compliance
- Liability issues
- Perverse incentives of fee structures

Operations

- Operating problems including behavioural issues delaying payback
- Increase in unregulated load

Structural inputs

- Slow refurbishment cycle
- Demolition rate

Source: interviews with more than 70 industry directors and managers

Landlord-tenant divide

The landlord-tenant divide is the situation where one party (landlord or tenant) has no incentive to invest in carbon reducing measures as the other party receives the benefit of the investment (such as the energy savings). For example, where a tenant pays a fixed service charge for the energy they use, they have no incentive to invest time or money in behavioural or physical measures, as they will still be charged the same amount. For a landlord, the return on an investment in say, upgrading the heating and lighting controls, may be reduced if the tenant pays the energy bill and therefore receives the benefit of reduced energy costs.

This 'mis-aligned incentive' between investment and the resulting benefit is one of, if not the most, critical and stubborn barriers towards the implementation of improvement measures in the non-domestic building stock. As such, it is worth particular attention. The supporting information 'Landlord-tenant divide' in Chapter 3 breaks down these issues, outlines options to overcome the divide and assesses how the policy package in Chapter 3 addresses them.

Immaterial savings

Another key barrier slowing the reduction in carbon emissions from non-domestic buildings is the immateriality of the economic incentive to increase the number of low carbon new and refurbished buildings for both the buildings industry and the end users of buildings.

The building industry in the UK is huge, responsible for around 8% of GDP. According to the Office for National Statistics, annual spend on non-domestic buildings is ~£65bn, with £40bn on new buildings, and £25bn on refurbishment. Our analysis, described in more detail in Chapter 2, shows that implementation of almost all of the cost-effective energy efficiency measures in existing buildings could create a cumulative net benefit to the UK of £4-5bn by 2020. This is a significant benefit, and one that should be targeted as an important opportunity to improve the competitiveness of the UK. However, from the perspective of the non-domestic buildings industry, it represents only around 0.5% of total revenues. Given that this benefit will be shared between the supply chain and the eventual owners and users of the building, the industry has not as a whole made energy cost savings a strategic priority.

For many sectors, the energy bill for end users associated with their use of buildings is 1-2% of their total costs. These costs can be reduced by 15% with quick paybacks but the savings can be considered as immaterial compared to other opportunities that these organisations might choose to focus on.

1iii. Carbon Trust interview programme

Who did we interview?

As part of this study, we interviewed more than 70 individuals from the non-domestic buildings sector. We covered more than ten types of companies, from architects to equipment suppliers to investors to facilities managers. These companies service both the international and UK markets, and within the UK all its different geographies. They included large, market leaders and smaller independent and niche players. The interviewees represented different levels of seniority, from directors to managers and contractors.

What did we ask?

The interviews went to a significant level of detail, lasting on average more than an hour. The interview topics included:

- How the interviewee's sector is structured, including the major sources of value.
- What the general industry trends and drivers are, their impact on carbon emission reduction and how they may change in the future.
- Whether there is an increasing momentum towards a low carbon non-domestic building stock, what the drivers are and how value in the interviewee's sector is impacted.
- What the key barriers to achieving an 80% reduction by 2050 are.
- What actions (policy and market) will be most effective in achieving the 2050 goal.

What did we learn?

- **The industry's mindset:** the industry has progressed significantly over the last few years, and acknowledges the need to change to reduce carbon emissions. But it does not understand what this change will look like and wants some clear direction on what is required, particularly from Government.
- **Barriers:** interviewees were able to describe a very large number of separate but interacting barriers. These are summarised in *Chart 1h*.
- **Still looking for a solution:** as is common for an industry at this stage of the carbon journey, whilst interviewees understood the barriers they did not yet have many solutions for how Government, or the industry itself, could drive rapid carbon reductions.

The complexity of the building stock, industry, building journey and policy landscape

The barriers are made all the more difficult to overcome because of the complexity associated with non-domestic buildings. This complexity takes a number of different forms:

- A complex building stock.
- A complex industry.
- A complex 'building journey'.
- A confusing policy landscape.

A complex building stock

Unlike the domestic sector there is no typical non-domestic building. Instead, they come in a large number of shapes, sizes and ages. Three-quarters of buildings standing today were built before 1985 – before there was any regulatory requirement on energy performance – with nearly a third having been built before 1940. Non-domestic buildings have a large range of sizes too – around a quarter of floorspace, but less than 1% by number, is in buildings over 10,000m^2. Nearly a fifth of the floorspace comes from the 75% of properties by number which are under 250m^2.

Non-domestic buildings are used for a large number of very different activities across a broad range of different sectors. Commercial offices, retail, hospitality, public sector and industrial buildings all have different absolute carbon emissions as well as energy profiles as shown previously in *Chart 1e.*

The different sectors all have different objectives for their buildings, with the cost of energy often a low strategic priority. For example:

- Retailers are focused on sales and footfall.
- Hospitality on customer comfort and enjoyment.
- Offices and the public sector on staff recruitment/ retention and productivity.
- Hospitals on patient comfort and cleanliness.
- Industry on productivity and cleanliness.

A complex industry

The non-domestic building industry is very complex, with a large number of players involved – see *Chart 1i.* From the upstream supply chain – investors, developers, and agents – through the downstream supply chain – the design team, contractors, building equipment and material suppliers, and inspectors – to the owners, tenants and facilities managers, all of these different players will have some influence on the eventual CO_2 emissions from any building. The industry is also very fragmented with a large number of small players responsible for a large share of the activity in the industry. There are limited interactions across the different sectors within the industry, leading to 'silo' behaviour. For example, agents often have little interaction with designers, and product manufacturers may have little contact with the investors and developers who are procuring the buildings. Finally, the industry has a conservative mindset, as described in the Government Office of Science's Foresight Report on Sustainable Energy Management and the Built Environment:

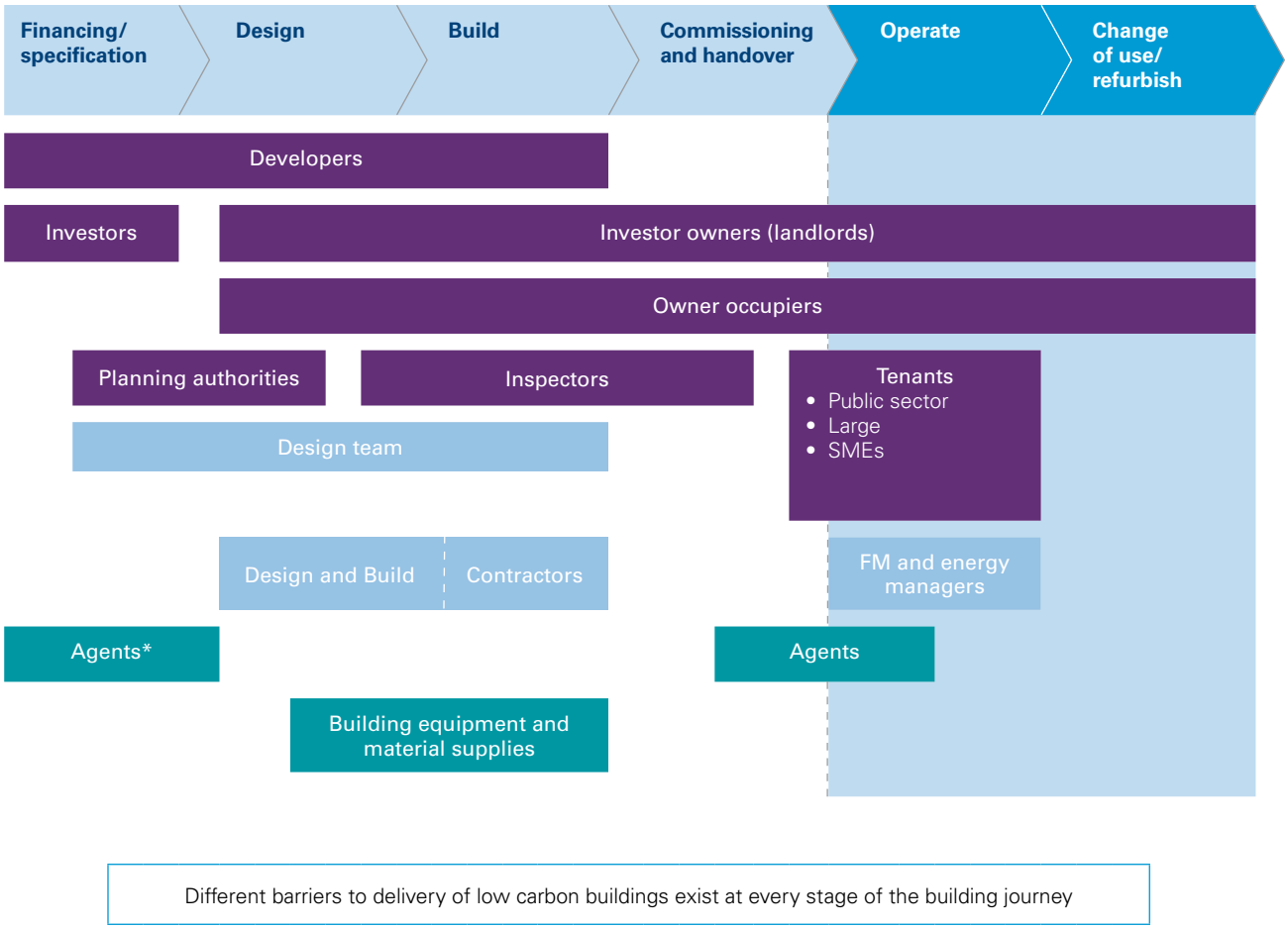
"The non-domestic development industry is markedly conservative in its approach. The culture in the industry is often risk averse"

'Sustainable Energy Management and the Built Environment', Government Office for Science

A complex 'building journey'

The 'building journey' also adds complexity. Each stage of the journey – as shown in *Chart 1i,* from specification, design, and build, through to handover, use and refurbishment or change of use – will impact the end emissions in different ways, and the different players play different roles at each stage.

Chart 1i *Non-domestic buildings supply chain*



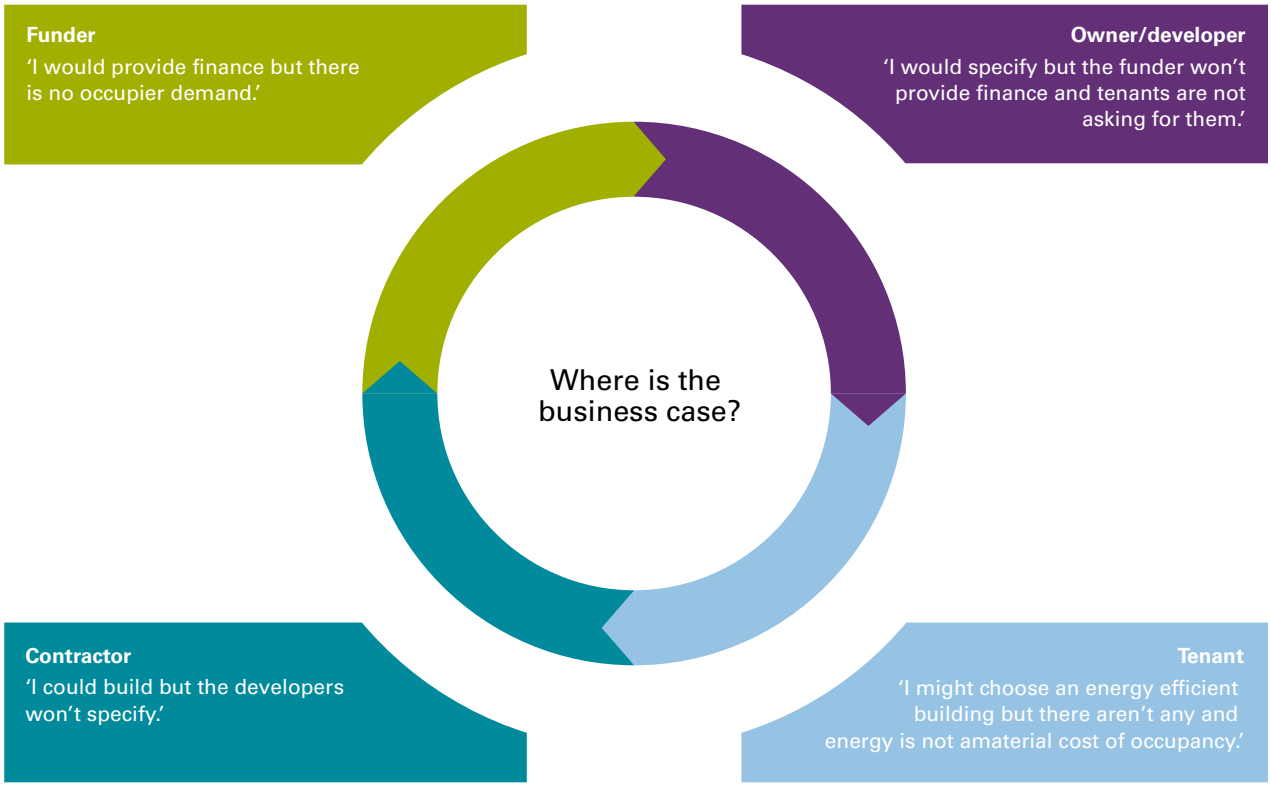
Different barriers to delivery of low carbon buildings exist at every stage of the building journey

n High level decision-making n Execution of brief/contract and associated decision-making n Supply of products/transaction

*Provide market intelligence

Source: Interviews; Carbon Trust analysis

Chart 1j *Circle of inertia*



A confusing policy landscape

There are a large number of existing policies that are relevant to non-domestic buildings. These include UK implementation of multiple EU targets and directives as well as English, Welsh, Scottish and Northern Irish Building Regulations, planning law and taxes. These all interact with voluntary schemes, Government-funded advice programmes and loan schemes. And the Government is proposing some ambitious new policies, such as Zero Carbon new non-domestic buildings by 2019.

Chart 1k at the end of this chapter attempts to summarise these different policies. It is currently not clear how all these policies come together to form a coherent whole.

> "Overall, the regulatory regime applicable to the sustainability of buildings is currently a confusing space"
>
> 'Policy context,' UK-GBC 'Making the Case for a Code of Sustainable Buildings,' March 2009

The barriers and complexity combining to form a 'circle of inertia'

All of the complexity and the barriers described previously can be mutually reinforcing, each one making the removal of others more difficult. This leads to the 'circle of inertia', shown in *Chart 1j,* whereby barriers and complexities which impact other areas of the industry, lead to inactivity across the entire sector.

A mandate for additional Government action

Whilst this may all seem very daunting, given the sheer number of issues described in this chapter, we believe that overcoming the barriers is not an insurmountable challenge. It will, however, require concerted Government action from the outset if the momentum is to be developed that will turn the emissions trajectory from its current, flat path, to one which shows large scale reductions over time. In other words, there is a clear mandate for additional Government action.

This additional Government action should take two forms. First, the industry needs to have a clear understanding of what carbon emissions reduction it will be expected to achieve and by when; Chapter 2 outlines what this trajectory could look like and how it should be communicated. Chapter 3 then outlines a joined-up set of policies that map against the carbon reduction required.

With additional action from Government, in the form of increased direction and a joined-up set of policies, the challenges outlined in this chapter can be addressed and the very real opportunities can be realised. The result will not only be significant reduction in carbon emissions but also increased energy security, improved buildings for the UK's workforce and large economic benefits.

Case study:

Maxim Logistics Group, Giving green lighting the green light

Following an on-site carbon survey, Maxim Logistics Group, a haulage, freight and warehousing company, used an energy efficiency loan to install new energy saving lighting for its main warehouse. The changes have improved working conditions by making the warehouse brighter, while cutting the company's annual energy bill by almost 41%.

Maxim Logistics have two sites in Corby, Northamptonshire. Eager to cut costs and reduce its carbon footprint, the company called in the Carbon Trust to carry out an on-site carbon survey and identify potential savings. The survey highlighted that warehouse lighting accounted for 93% of the company's annual energy spend, which at the time was £54,000.

No-cost options

As the warehouse's 93 staff work 24-hour shifts during the week, one problem was the amount of energy being used overnight. So the first recommendation was that the company start monitoring this and set targets for reducing it.

To support this, and encourage staff to be more energy conscious, the Carbon Trust also gave Maxim Logistics Group free employee engagement materials to highlight the importance of saving energy.

Spending to save

Even with careful monitoring, the traditional, energy-intensive fluorescent lighting system was still far from ideal. So a further recommendation from the survey was that the company replace it with more modern, energy-efficient equivalents that were fit for purpose.

After careful investigation, the company decided on the most suitable option and applied for an interest-free Energy Efficiency Loan from the Carbon Trust. It received £44,400 towards the new lighting, which cost just over £60,000. As the new system is on the Energy Technology List (ETL)[3], the company could also apply for a 100% tax break as part of the Enhanced Capital Allowance (ECA) scheme.

Because the new lighting is more efficient, Maxim Logistics Group has been able to halve the number of fluorescent strips in its main warehouse, without comprising the working environment. Where there had previously been eight in each of the aisles, there are now just four. Two are on permanently, while the other two are lit at 10% with motion sensors to boost the light to 75% when the space is occupied.

Reducing the number of lights has brought down the company's monthly energy consumption from 44,500kWh to just 28,000kWh – significantly reducing both its energy spend and carbon footprint. Over 80% of this saving is due to having the dimmable lights in all the aisles, which lets the team reduce the output when aisles are not being used. As some of the more narrow aisles are only occupied for just over an hour each day, this has made a huge impact.

The company's energy costs for November 2008, the first full month with the new lighting, were £1,850 lower than those of November 2007. Thanks to its expected monthly savings and reduced maintenance costs, Maxim Logistics Group will have paid off the loan in under two years.

[3] The Energy Technology List (ETL) lists equipment that meets published energy-saving criteria. It covers 15 technologies and 54 sub-technologies, each with its own performance criteria. For more information, see www.eca.gov.uk/etl2

A brighter future

Although there are fewer lights, the warehouse is now actually brighter. With the old system, illumination levels (measured in lux) had generally been around 70 lux, but had dropped over time. The new system gives levels of 130-150 lux, even with the two lamps on dimmer – making the warehouse feel brighter and improving working conditions for staff.

The project is a great example of how saving energy can actually improve a working environment rather than compromise it. Maxim is now looking at how it can make energy savings at its other site.

"Our new lighting system in the warehouse has improved the working environment, and is now more energy-efficient and more economic to run"

Anna Zaka, Environmental Manager,
Maxim Logistics Group Ltd

Current and future Government policies

Chart 1k *Targets and regulations*

Category	Name	Description
Overall targets	EU 20/20/20 targets	EU-wide target of 20% greenhouse gas emissions reduction vs. 1990 levels (or 30% by 2020 if global action is taken), 20% of power from renewables and 20% cut in energy consumption compared with projected trends by 2020.
	UK targets	Carbon budgets tightening to a 34% reduction in greenhouse gas emissions vs. 1990 levels and 15% of power from renewables by 2020.
'Top down' and targeted at organisations	Carbon Reduction Commitment (CRC)	The CRC will apply mandatory emissions trading to cut carbon emissions from large commercial and public sector organisations.
'Bottom up' and targeted at buildings	Building Regulations*	**Building Regulations for new buildings (Part L2A):** sets out minimum energy efficiency standards. The latest 2006 regulations have an estimated 28% improvement on 2002 Part L. Updates planned for 2010 and 2013 are likely to increase these standards. **Zero Carbon non-domestic buildings (under consultation):** from 2019, all new non-domestic buildings to have zero net carbon emissions, achieved through a hierarchy of measures including renewables.
		Building Regulations for existing buildings (Part L2B): applies to any replacements to building envelope components, including windows, ventilation equipment and mechanical and electrical services. Overall building energy performance must be improved when major refurbishments are conducted for buildings over 1,000m^2.
		Enforcement bodies and regulation compliance: ensures compliance with the Building Regulations. This function is carried out by a Building Control Body (BCB), either the local authority building control service or a private sector Approved Inspector (AI).
		Sullivan report (Scotland): a low carbon building standards strategy to increase energy efficiency and reduce carbon emissions for Scotland's buildings.
	Planning	**Planning Policy Statement 1:** sets out the overarching planning policies on the delivery of sustainable development through the planning system. **Merton Rule:** requires the use of renewable energy onsite (varying levels required, typically 10-20%) to reduce annual carbon dioxide (CO_2) emissions in the built environment; adopted by around half of the UK's Local Authorities, predominantly for new buildings. **Section 106:** additional requirements can be made by any planning authority to promote sustainability outside of the building. **London Plan:** the Mayor's spatial development strategy requires developments to make the fullest contribution to the mitigation of and adaptation to climate change and to minimise emissions of carbon dioxide.
	EU Energy Performance of Buildings Directive (EPBD)	The UK has implemented the EU Directive by mandating that all properties – homes, commercial and public buildings – when bought, sold, built or rented need an Energy Performance Certificate (EPC). Larger public buildings also need a display energy certificate (DEC). Both provide A-G efficiency ratings and recommendations for improvement, the EPC based on the quality of the building, the DEC on how it is used.
	EU Energy Services Directive	The Directive imposes various obligations on member states, including a requirement that: specified energy companies promote energy efficiency to their customers, final customers receive energy metering, and an indicative 9% energy savings target is met by 2016 – with public sector playing an exemplary role in helping achieve this. The UK had a number of measures already in place and is meeting any gaps through voluntary agreements and implementing requirements to provide comparisons of consumption information on residential gas and electricity bills.

Chart 1k (continued) *Taxes, advice, loans and voluntary schemes*

Category	Name	Description
Taxes and related policies	Climate Change Levy (CCL) and Climate Change Agreements (CCA)	The CCL taxes the use of energy in industry, commerce and the public sector to encourage energy efficiency. CCAs allow energy-intensive business users to receive an 80% discount from the CCL, in return for meeting energy efficiency or carbon saving targets.
	Enhanced Capital Allowances	Enable businesses to buy energy-efficient equipment using a 100% rate of tax allowance in the year of purchase.
	Stamp Duty Land Tax (SDLT)	Payable on the purchase or transfer of property or land in the UK where the amount paid is above a certain threshold. Zero Carbon homes receive SDLT relief.
	Business rates	Non-domestic rates are a tax on the occupation of all non-domestic property. Currently do not include provisions for energy efficiency.
Advice	Carbon Trust Energy Surveys and Advice	Free surveys for organisations with an annual energy spend of over £50,000 – identify immediate energy-saving opportunities with no or low-cost of implementation and offer practical advice to help reduce business costs over time. Smaller energy users can access a dedicated helpline, website and targeted publications.
	Carbon Trust Carbon Management	A systematic approach for large companies that can be applied to all aspects of a business, from energy use to procurement, branding and community relations.
	Carbon Trust Building Design Advice	Helps to identify carbon savings in new and renovation projects. Support ranges from self-help guidance, to free or subsidised design and construction consultancy advice to help you maximise opportunities for specifying energy-efficient plant and fabric.
Loans	Carbon Trust Loans	Interest free, unsecured loans up to £400,000 available to all companies that do not fall under the CRC – repaid over a period of up to four years.
	Salix loans	Public sector interest free loans to pay for the installation of a wide range of energy efficiency measures.
Voluntary schemes	Strategy for Sustainable Construction	A joint industry and Government initiative that will bring together diverse regulations and initiatives relating to sustainability; set and commit to higher standards to help achieve sustainability in specific areas; and make specific commitments to take the sustainable construction agenda forward.
	Building voluntary schemes and drivers	Voluntary schemes may be strong drivers for refurbishing buildings to low carbon standards or are used by some organisations to impose standards on buildings they occupy. BREEAM** has for many years been accepted by industry as a general standard for assessing the environmental sustainability of non-domestic buildings.
	Green leases	Green leases are legal contracts that form the basis for landlords and tenants to work together to improve the carbon performance of a building.
	CSR	Many organisations have environmental policies and regularly report on their Corporate Social Responsibility (CSR). Carbon emissions form a key element of this, with energy efficiency credentials often highlighted as an indicator of a responsible approach in the community.
	The Carbon Trust Standard	The Carbon Trust Standard is awarded to organisations that have genuinely reduced their carbon footprint and committed to making further reductions year on year. It qualifies as evidence of 'early action' under the CRC league table, providing a potential financial benefit.

*Part L applies to England and Wales. Different Building Regulations apply in Scotland and Northern Ireland.

**The BRE Environmental Assessment Method (BREEAM) and tools are 'designed to help construction professionals understand and mitigate the environmental impacts of the developments they design and build'.

Part B

A strategy for non-domestic buildings

We have asked the question, "What would an 80% reduction in carbon emissions from non-domestic buildings by 2050 mean, both in terms of Government policies and action from the non-domestic buildings sector?".

The previous chapter showed the large scale of the challenge in delivering such a large reduction in carbon emissions, even though there is significant reduction potential. But simply describing the problems is not enough, although it is a critical first step. Instead, real, coherent solutions are needed.

We thus propose that the Government needs to take a leadership role in bringing about the transition to a low carbon building stock, as part of the UK's overall transition to a low carbon economy.

We believe that the first step for the Government in taking leadership is to define a clear strategy for its policies relating to non-domestic buildings.

"We need long-term improvement targets for existing buildings. A consistent, coherent set of policies is needed"

Trade Association representative (Carbon Trust interview)

This strategy has two main elements:

- **Direction setting:** set a long-term carbon emissions trajectory for the non-domestic buildings sector with:
  - Detail on the emissions reductions needed over different time frames and the carbon reduction measures which can be implemented to meet the trajectory.
  - A description of how the trajectory can be measured, monitored and communicated to the industry.
- **Policies:** put in place a joined up set of policies aimed at achieving the carbon emissions trajectory as per the Direction setting, and which:
  - Brings all the policies under one integrated framework with a clear link between each policy and a clear description of how the group of policies should achieve the stated carbon reduction objectives.
  - Delivers better buildings, used better, by covering the complex interaction between the physical buildings, the energy delivered to them, and the organisations that own and use them.

2 Direction setting

The non-domestic building sector needs the Government to set a clear, outcome-driven direction for the entire industry. This includes setting tougher carbon budgets than for other sectors to create a net economic gain in the near term and minimise the cost of decarbonising the building stock to 2050.

Key findings

- The Government needs to set tougher carbon budgets for the non-domestic buildings sector, going beyond the UK's carbon budget of a 21-31% reduction by 2020 (vs. 2005 levels), to reach 35%.
- This tougher carbon budget is the most cost-effective pathway for the UK, with a reduction in cost to 2050 of at least £13bn[1].
- Up to 2020 it can be achieved by implementing almost all cost-effective measures.
- Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs) need to become central to the industry as a means of communicating the required change because they:
  - Provide a true understanding of the energy used and carbon emitted from a building.
  - Can be used to communicate a clear signal of the improvement needed to meet carbon budgets for the industry and within Government.
  - Act as a mechanism through which to target carbon emissions reductions.
  - Help Government manage overall performance and reduce the risk of not meeting targets.
- The average DEC (Operational Rating) for all buildings will need to improve by at least two rating bands by 2020, and four bands by 2050.

[1] Compared to the pathway implied by the 31% UK 'intended' target. The saving against the 21% target would be even greater. Note that these are cumulative net costs and savings are calculated by summing net annual costs across the given date range. Net annual costs discount ongoing energy savings and maintenance costs with a discount rate of 10%.

Introduction

The first element of the strategy required for non-domestic buildings is for the Government to set a clear, outcome-driven, long-term direction for the industry. This involves **defining a target trajectory for emissions** – specific CO_2 targets defined for non-domestic buildings as part of the UK's carbon budgets – set to achieve the required reductions at the lowest cost to the UK. This trajectory then needs to be **communicated in a language that is meaningful to the industry**.

Why Government direction is needed

The most consistent theme across the wide range of in-depth interviews we conducted across the sector was the need for Government to set the direction.

> "The main issue is a lack of clarity from Government – what's going to happen, and what do we need to do"
>
> Developer

The multitude of players involved in the procurement, design, build and use of non-domestic buildings want to better understand what they need to achieve, in terms of year-on-year carbon emissions reduction. They need clarity, consistency and long-term certainty if they are to be able to implement the large scale improvements that are required:

- Setting an over-riding emissions trajectory will help to deliver the clarity sought by the industry, and create a framework into which EU, UK and local policies can all be placed and assessed.
- In addition, the industry, and especially investors, also need long-term certainty. This is particularly for those investing in innovation and capital-intensive projects, who need to be confident that demand driven by Government policy will be at a level high enough to drive attractive returns some years after their upfront investment.

But what should this trajectory be? Should non-domestic buildings deliver more or less emissions reductions than other sectors? How does one go about answering this question? And once the trajectory is defined, how will the industry know what it needs to achieve and if it is on track or not?

> "All industry wants to know is what the target is"
>
> Investor

This chapter answers these questions across two sections:

- **Section 2.1: Defining a target emissions trajectory** – the first section explains how this target emissions trajectory could be defined, based on modeling emissions from now to 2050. We outline the modeling methodology that we developed for this study together with Arup. We then look in detail at the implied emissions trajectory up to 2020 and then from 2020 to 2050, comparing it to the overall trajectory for UK emissions. We extract some interesting insights, including the types of measures that industry will need to implement and how much they could cost or save the UK.
- **Section 2.2: Communicating the trajectory** – in the second section, we show how this trajectory can be communicated to the industry in a language that is meaningful for them, and define a set of specific steps that Government needs to take beyond setting the overall trajectory.

2.1 Defining a target emissions trajectory

It's a matter of timing, not 'either/or'

What should the target trajectory for emissions be, and what are our options for reducing emissions to meet the trajectory? By 2050 there are no options – every building-related carbon abatement measure is required, in addition to decarbonising the electrical grid. Thus in the long term, the issue is not one about choosing between focusing on new build or existing buildings, on energy efficiency or renewables. All these measures are required. So let's not have an 'either/or' debate.

The real choice is in the timing and speed of implementation of the range of measures.

Simplistically, to minimise costs, cost-effective measures should be implemented at scale as soon as possible and full deployment of non-cost-effective measures delayed until their cost has been reduced. The extent of delay possible whilst still achieving an 80% reduction is limited by the rate of new build and refurbishment and the ability of the supply chain to ramp up delivery. Innovation should be incentivised during this delay so that by the time the measures which were non-cost-effective need to be introduced they have become more economically attractive and potentially even cost-effective.

There are then a number of other goals, such as meeting EU Renewable Energy Targets, increasing energy security and becoming a global leader in 'green technology', which can be met by bringing forward the deployment of earlier stage technologies, many of which are not yet cost-effective. The latter, becoming a global leader in a new technology area, can create economic gains if a significant market share in both domestic and export markets are achieved.

Modelling non-domestic buildings emissions to 2050

The Carbon Trust has worked together with Arup to develop a model to analyse these dynamics in more detail. Using this model, we developed a 'Success Scenario' that delivers 80% carbon emissions reduction by 2050 at the lowest cost. (The methodology behind this modelling and the Success Scenario is outlined in more detail in *Sidebox 2iv* 'DeCODE model[2]' at the end of this chapter.)

Any model is a necessarily simplified version of the real world. For instance, we purposely modelled the building stock as a whole and not all buildings on a one-by-one basis. The model's inputs do not cover the broad array of exceptions in an industry as complex as this one. Given the layers of assumptions that are required, its outputs should be taken as directional and not as accurate forecasts applicable to every building. Despite these caveats, the model offers some important insights, which inform many of the conclusions outlined in this report, and which will be described in detail throughout the following sections.

[2] DeCODE (Determining carbon opportunities in the non-domestic environment)

The 'wedge chart' of carbon emissions to 2050

The main output from the model is the 'wedge chart' (see *Chart 2a*). This shows the emissions from non-domestic buildings up to 2050 – the top half represents the emissions from new buildings, the bottom half the emissions from today's existing buildings.

Starting with the top half, the full area shows how nearly 80MtCO_2 would be added by 2050 by new buildings if no additional measures to curb this emissions growth were introduced. More specifically:

- New buildings continue to be built to existing (2006) regulations.
- The UK's electricity power generation continues to produce the same level of emissions as today.

The full area of the bottom half of *Chart 2a* shows how emissions would start from 2005's 106MtCO_2 and decrease to ~60MtCO_2 by 2050 purely from business-as-usual demolition rates.

So without any additional measures, the combined emissions from new and existing buildings would total nearly 140MtCO_2 by 2050 – an increase of over 30% instead of the required 80% decrease.

Three different types of emissions reduction measure can then be applied to differing extents:

1. **Demand reduction measures,** including energy efficiency.
2. **Low carbon buildings-linked energy supply:** both directly connected on- and near-site generation and indirectly connected offsite generation[3].
3. **Wider grid decarbonisation**[4].

Each measure slices off a 'wedge' of carbon from the chart. The remaining grey area shows the resulting emissions from non-domestic buildings from 2005 to 2050.

To slice off large enough wedges so that by 2050 non-domestic buildings emissions (the grey area in the chart) reduce by 80% requires all three types of measure to be applied to their fullest extents. In other words, almost all currently known carbon reduction measures need to be applied.

The Success Scenario that we developed delivers this 80% reduction at the lowest cost. All the carbon reduction measures need to be implemented, but costs can be reduced by implementing the cost-effective measures as soon as possible and delaying the non-cost-effective measures. (*Chart 2r* in *Sidebox 2v* at the end of this chapter: 'Scenarios run in DeCODE' explains the timing of measures in more detail.) This approach saves at least £30bn by 2050 compared to evenly spreading the measures. (It should be noted that the Success Scenario is likely to be more cost-effective than reality. For instance, meeting the Renewable Energy Strategy will require more non-cost-effective renewables to be delivered earlier.)

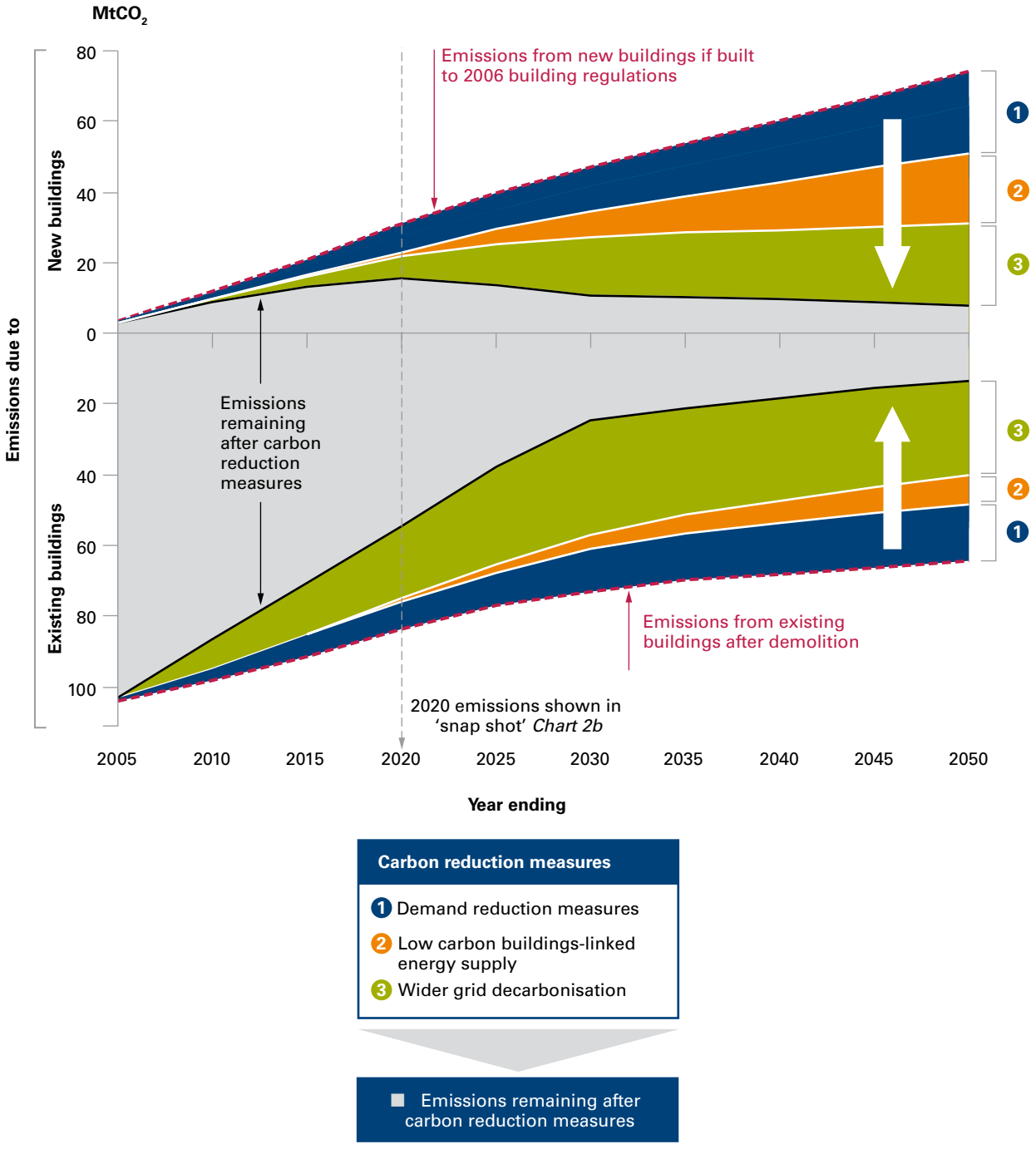
The subsequent sections describe the measures required to deliver this saving in more detail, starting with the period from now to 2020, followed by 2020 to 2050:

- **Emissions trajectory to 2020**: we outline the trajectory to 2020 compared to the Government's intended UK carbon budget. We then describe in detail the measures that will need to be implemented, across: 1 demand reduction measures, 2 low carbon buildings-linked supply and 3 wider grid decarbonisation.
- **Cost savings to 2020**: we then analyse the cumulative cost savings that are possible up to 2020, the required capital investment to realise these savings, and how they would be affected if the UK over or under-delivered against the trajectory.
- **Success after 2020**: we outline the measures and associated costs that will need to be implemented after 2020, first looking at new buildings and then at the existing stock.

[3] As part of the Allowable Solutions for Zero Carbon new non-domestic buildings from 2019.

[4] In addition to that potentially driven by Zero Carbon new buildings – see *Sidebox 2iii:* 'What's the difference between offsite buildings low carbon energy supply and wider grid decarbonisation?'

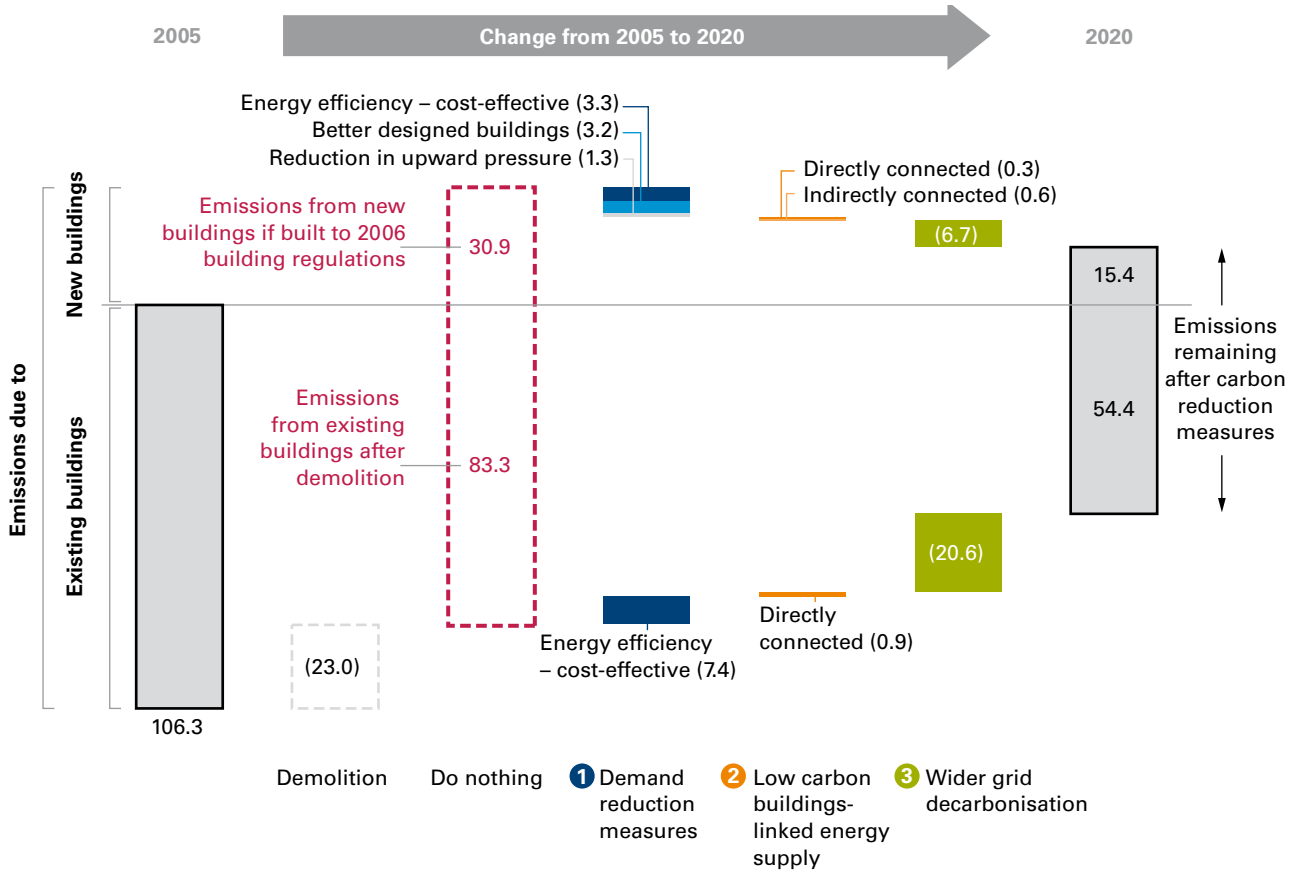
Chart 2a *'Wedge chart' of the Success Scenario: emissions from non-domestic buildings up to 2050 in both new buildings and existing buildings – before and after carbon reduction measures*



Note: CO_2 emissions savings are normalised across all interventions.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

Chart 2b *'Snap shot' of emissions reduction in new buildings and existing buildings in Success Scenario by 2020*



Note: the full impact of each measure applied on its own was calculated. These individual impacts were then reduced by the same factor so that they would add up to the total emissions reduction when all measures were applied together.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

Emissions trajectory to 2020

Over the next decade the UK should focus on implementing almost all potential cost-effective measures in order to maximise the carbon reduction potential at the lowest possible cost. Alongside decarbonising grid electricity[5], these measures deliver a 35% reduction in carbon dioxide emissions (vs. 2005), more than the Government's intended carbon budget of 31% (vs. 2005) across all UK emissions.

Chart 2b shows how cost-effective measures can reduce emissions between now and 2020. It is a 'snap shot' of the Success Scenario wedge chart (*Chart 2a*) described above. Just as with the wedge chart, new buildings' emissions are shown in the top half and existing buildings in the bottom half. The bars on the left show the emissions with no additional measures – equivalent to the full area of the wedge chart. The three middle bars then correspond to the three types of carbon reduction measures (the three wedges):

1. Demand reduction measures – split into specific measures.
2. Low carbon buildings-linked energy supply: both directly connected on- and near-site generation and indirectly connected offsite generation.
3. Wider grid decarbonisation.

The resulting emissions in 2020 are then shown on the right-hand side. Under the Success Scenario, emissions from new buildings built between today and 2020 will be a half of what they would have been under a 'do nothing' scenario. The emissions from today's existing buildings that are not demolished will reduce by just under a third, with almost every building undergoing some level of upgrade between now and 2020.

Let's look at the three types of carbon reduction measure in more detail up to 2020:

1 Demand reduction measures

Cost-effective demand reduction measures deliver similarly sized savings in both new and existing buildings:

New buildings

As well as incorporating energy efficiency measures, new buildings can be cost-effectively redesigned. As a result, the combination of demand reduction measures in new buildings delivers more than grid decarbonisation, as shown in *Chart 2b.*

The cost-effective demand reduction measures in new buildings save in total 7.8MtCO_2 by 2020 and include the following:

- **Cost-effective energy efficiency measures** – requiring a 45% reduction beyond current building regulations – saving 3.3MtCO_2 by 2020.
- **A shift towards better designed buildings** – represented by the building of more shallow plan, naturally ventilated new buildings. The Success Scenario requires around two-thirds of new buildings to be shallow plan, naturally ventilated. Saves 3.2MtCO_2 by 2020.
- **A reduction in the upward pressure on carbon emissions** from behavioural impacts, changing expectations of comfort levels in the building environment, additional non-regulated loads, and growth in floor space. The Success Scenario reduces this upward pressure by ~20% versus current trends, through using floor space growth as a proxy for all upward pressure on emissions. Saves 1.3MtCO_2 by 2020.

Existing buildings

Chapter 1 showed that simple energy efficiency measures can deliver a cost-effective carbon reduction of around 15% (at a constant grid factor) in existing buildings. Taking into account natural rates of demolition, and that grid decarbonisation reduces the carbon saved from electricity demand reduction measures, the Success Scenario reduces existing building emissions by 7.4MtCO_2 by 2020.

[5] Along the trajectory as suggested in the Committee on Climate Change December 2008 report.

2 Low carbon buildings-linked energy supply

The Success Scenario focuses on implementing only cost-effective measures to 2020. Our model included cost forecasts for gas CHP; biomass CHP; biomass heat; large, medium and small wind; PV; ground-source heat pumps; and solar hot water. By 2020, only gas CHP was forecast to be cost-effective on average across the buildings stock without financial support. We modelled the installation of 1,500 gas CHP units of a medium size (such as those used in hospitals[6]) by 2020, saving 1.2MtCO_2. In new buildings there is also a small 0.6MtCO_2 saving from offsite renewables. This is due to zero-carbon new non-domestic being implemented in 2019, assuming that offsite renewables are an allowable solution.

As discussed the model is purposefully simplified, including modelling the stock and not building-by-building. In reality a significant amount of onsite renewables could also be required by 2020 because:

- On a building-by-building basis, in some circumstances onsite renewables are cost-effective: for instance, whilst biomass is not cost-effective on average, experience from the Carbon Trust's Biomass technology programme shows that this technology can be cost-effective for buildings in rural areas that are not connected to the gas network. There are around 30,000 of these buildings, representing up to 10% of non-domestic heat by 2020.
- Meeting the EU's Renewable Energy Targets for the UK could require significant on- and near-site renewables: The Government's central scenario for meeting the targets has 60TWh of on- and near-site renewables for non-domestic buildings by 2020, delivering 15% of heat and 3% of electricity.
- Installing onsite renewables before 2020 will help drive these technologies down their learning curves, reducing costs through economies of scale and innovation. Costs will then be lower, and the supply chain more developed, for the large ramp-up in capacities that could be required post 2020. It is critical that if renewables are installed more rapidly for the reasons described, that the imperative and focus remains on implementing cost-effective energy efficiency. (This is discussed further in *Sidebox 2i* 'Meeting the Renewable Energy Targets whilst not compromising energy efficiency', overleaf.)

3 Wider grid decarbonisation

The Success Scenario depends on significant decarbonisation of the grid[7], which in turn requires a step change in delivering low carbon generation in the UK. Should the power sector under-deliver, other sectors, including non-domestic buildings, will need to compensate if the UK is to meet it's emission targets.

In new buildings, grid decarbonisation delivers nearly half of the reduction shown in *Chart 2b*. In existing buildings it is relatively more important, delivering 70% of the reduction.

[6] Gas CHP is currently a carbon saving technology as it uses gas, which has a lower carbon intensity than grid delivered electricity today, to efficiently produce both electricity and heat. However, as the electrical grid decarbonises, its carbon impact reduces, until it reaches a stage around 2025/2030 where it will add carbon, not reduce it, relative to grid delivered electricity. Thus gas CHP installations should be implemented on a 'once only' basis, and be easily replaceable with a Zero Carbon alternative such as biomass CHP, at the end of its life.

[7] This report is focused on non-domestic buildings and therefore takes the CCC's scenario as an input where the grid emissions factor reduces to 350g/kWh by 2020 from 562g/kWh in 2005.

Cost savings to 2020

Delivering the cost-effective measures in non-domestic buildings not only results in these buildings delivering more than the average UK carbon budget, but will also create a net cumulative saving for the UK of £4-5bn by 2020.

Indeed failure to deliver these measures would be expensive. Non-domestic buildings would not accrue the year-on-year cost savings to the UK, leading to an increased overall cost of getting to 80% by 2050. Additional carbon emissions will also be baked into the new builds, leading to more emissions needing to be reduced later (potentially at a higher cost). In new builds, the best and cheapest opportunity to implement the cost-effective measures is before the building is operational. In existing buildings, not implementing the cost-effective measures as soon as possible may mean the opportunity is lost due to the gradual demolition of the stock.

Our modelling gives a sense of scale of these additional costs. *Chart 2c* shows that in two scenarios where less carbon reduction is achieved by 2020, the optimistic current trajectory and UK 'intended' target, cumulative net costs by 2050 rise significantly compared to the Success Scenario: rises of £41bn and £13bn respectively. This is because less energy efficiency is implemented by 2020 and so:

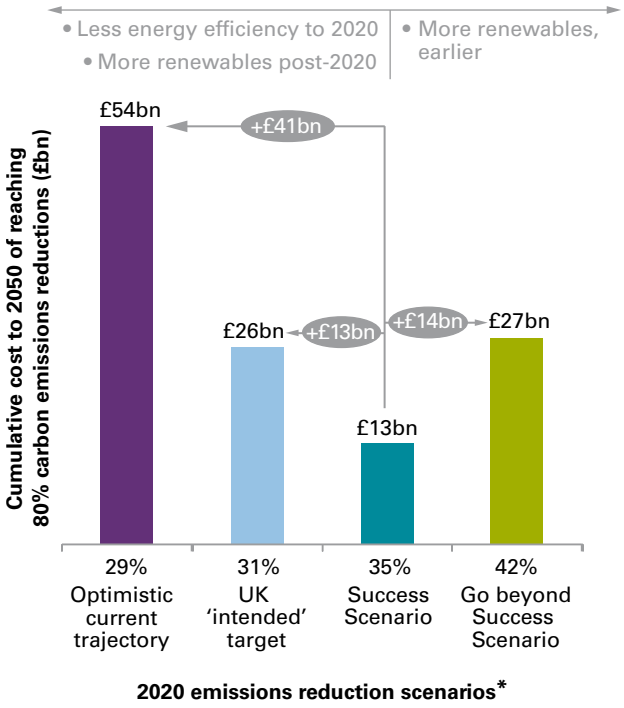
- There are fewer years up to 2050 to benefit from the energy savings.
- To get back onto an 80% reduction trajectory by 2050, more non-cost-effective measures (e.g. renewables) are required post 2020.

Delivering more than the Success Scenario is also expensive – a 10% additional reduction achieved through non-cost-effective measures costs an additional £14bn by 2050.

Perhaps surprisingly, the upfront capital required is relatively small. Implementing almost all of the cost-effective measures will require a total capital investment of only around £1.5bn over the next 10 years. This investment is equivalent to increasing new build and refurbishment budgets by less than 0.1% – *Sidebox 2ii* 'Carbon reduction potential from low cost measures' on page 58 shows that such low cost, cost-effective measures can in the real world deliver the ~15% carbon reduction assumed in the inputs to DeCODE.

This investment leads to gross cumulative savings of £6bn (and more thereafter), creating the net cumulative saving for the UK of £4-5bn by 2020 described above.

Chart 2c *Cumulative net costs by 2050 of the Success Scenario compared to an optimistic current trajectory, UK 'intended target', and over-delivering on 2020 by 10%*



*Percentage reduction compared to 2005

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

However, implementing the Success Scenario up to 2020 will be tough – whilst the economics show it to be the preferred scenario, the real challenge will be in the delivery. It requires that 90-95% of cost-effective energy efficiency measures are implemented in new and existing buildings. For those organisations supported by the Carbon Trust, average implementation rates are currently only around 40%, due to the large number of barriers that exist (more detail on the barriers is given in Chapter 1). We expect that this figure is significantly lower for most other organisations.

Achieving this step change in energy efficiency delivery will require a comprehensive set of policies that target both buildings and the organisations that use them. Chapter 3 explains how such policy packages can be constructed and then illustrates this approach by detailing an example set of policies that, as a whole, could deliver the transformation required.

2i. Meeting the Renewable Energy Strategy whilst not compromising energy efficiency

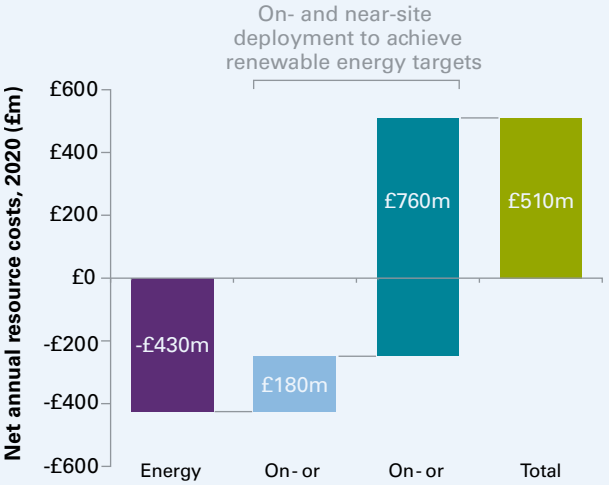
The Success Scenario incorporates both significant amounts of low carbon buildings-linked energy supply and wider grid decarbonisation by 2050. But it delays implementation of the former, including on- and near-site renewables, until after 2020. This is because the Success Scenario was modelled to be the most cost-effective pathway to an 80% emissions reduction by 2050. Delaying the implementation of low carbon buildings-linked energy supply gives these technologies more time to reduce their costs before large-scale rollout. (See the subheadings '2 Low carbon buildings-linked energy supply' in the main text of this chapter for a more detailed breakdown of their role in the Success Scenario, before and after 2020.)

However, the UK has to deliver 15% of its energy from renewable sources by 2020 to meet EU targets. The Government has developed a comprehensive Renewable Energy Strategy (RES) to achieve this. This includes an illustrative mix of different types of renewables technology in 2020 based on the analysis for DECC's 'lead scenario'. This mix includes a significant amount of on- and near-site renewables in non-domestic buildings. This is mostly renewable heat (29TWh for spatial heating and hot water[8]), with a small amount of renewable electricity generation (3TWh).

As well as contributing to the EU renewable energy targets, delivering the RES on- and near-site renewables in non-domestic buildings would deliver an additional carbon saving of 4MtCO$_2$ by 2020 and help put the UK on a trajectory to meeting its 2050 emissions targets, particularly by accelerating deployment of renewable technologies.

These benefits come with an annual resource cost of nearly £1bn (though this cost can be reduced through innovation and supply chain development – see Chapter 3). *Chart 2d* shows how this cost and additional carbon saving break down across heat and electricity renewables:

Chart 2d *Net resource cost of energy efficiency and on-site renewables in 2020 in scenario where Renewable Energy Strategy plans are adopted: Non-domestic sector*



	Energy efficiency measures	On- or near-site electricity renewables*	On- or near-site heat renewables	Total non-domestic buildings cost estimates
Carbon abatement				
MtCO$_2$e	11.0**	0.8	3.4	15.2
£/tCO$_2$e	-£39.1	£213	£225	£34

*For electricity renewables – assume costs and carbon savings are distributed across domestic and non-domestic proportional to total electricity demand.

**Excludes the additional 3.2MtCO$_2$ from better designed new buildings and 1.3MtCO$_2$ from a reduction in upward pressure.

Source: DECC Renewable Energy Strategy (July, 2009), CCC, Arup, Carbon Trust analysis

[8] Industrial process-related heat is not in the scope of this study.

Heat renewables

The 29TWh of on- and near-site spatial heating and hot water in the RES saves 3.4MtCO_2 at an annual net resource cost of £760m by 2020. Based on the cost assumptions in the RES, the cost is concentrated in the 9TWh of ground-source heat pump (GSHP) heat, costing £620m (£700/tCO_2). The 12TWh of air source heat pump heat (ASHP) costs £130m (£110/tCO_2) whilst the 8TWh of biomass heat is estimated to be cost neutral[9].

The RES helps put the UK on track to deliver the significant amounts of renewable heat and electric heating (including ASHP and GSHP) that our Success Scenario implies is required by 2050, as shown in *Chart 2e*. By 2050, renewable heat technologies (represented by biomass and biomass CHP in the DeCODE model) could need to deliver around a third of non-domestic heating, with electric heating delivering more than a half.

Electricity renewables

The 3TWh of on- and near-site renewable electricity generation in the RES has an annual net resource cost of £180m by 2020. These small-scale technologies are significantly more expensive than large-scale renewables, with small to medium-sized wind power, and solar PV having carbon costs of over £200/tCO_2. (This compares to less than £80tCO_2 and £130/tCO_2 for large scale onshore and offshore wind power respectively[10].)

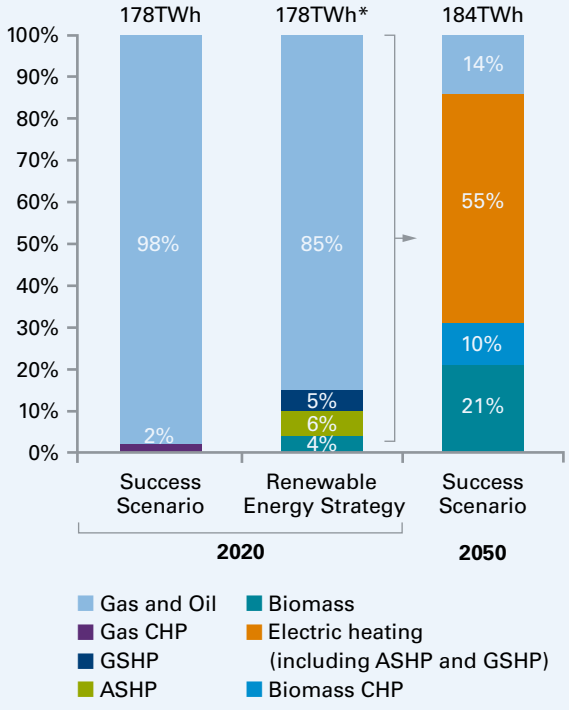
Accelerating a relatively small amount before 2020 will help drive these technologies down their learning curves. Costs will then be lower for the large ramp-up in capacities required to deliver Zero Carbon Buildings from 2019 – see 'Success after 2020' (page 59) in this chapter.

Continue to prioritise energy efficiency

Chart 2d shows how the combined cost of the on- and near-site renewables are more than twice the savings from energy efficiency measures by 2020, turning an annual saving of £430m to a net annual resource cost of £510m by 2020.

It is crucial that installation of non-cost-effective renewables is not at the expense of implementing cost-effective energy efficiency measures. Indeed, implementing energy efficiency is complementary to meeting the renewable energy targets – energy efficiency reduces the total energy demand and therefore the absolute amount of renewables required. If the Government decides to incentivise the 32TWh of onsite renewables it believes is necessary to meet the renewable energy targets, it needs to ensure that the 4MtCO_2 this saves is not at the expense of the 11MtCO_2[11] from energy efficiency measures.

***Chart 2e** Non-domestic buildings heat consumption by fuel type – Renewable Energy Strategy (2020) compared to Success Scenario (2020, 2050)*



*For the purposes of this analysis the total heat consumption from the Success Scenario is applied across both 2020 columns.

Source: DECC Renewable Energy Strategy (July, 2009), CCC, Arup, Carbon Trust analysis

[9] The RES assumption that biomass heat is cost neutral in non-domestic buildings is potentially optimistic; whilst biomass heat can be cost-effective, this is only the case in a minority of off-grid locations, which will generate less than 8TWh.

[10] 2020 values; Source: E&Y, Carbon Trust analysis.

[11] Excludes the additional 3.2MtCO_2 from better designed new buildings and 1.3MtCO_2 from a reduction in upward pressure.

2ii. Carbon reduction potential from low cost measures

Comprehensive cost-curves for the UK's non-domestic buildings are all based on one source – BRE's N-DEEM[12] database (see the Committee on Climate Change December 2008 report, Chapter 6, for an example). In trying to describe the cost and scale of carbon abatement potential for an entire sector, cost curves like those from the N-DEEM database need to rely on a series of assumptions and approximations, defined from a top-down perspective. They are not built up by assessing every actual carbon reduction opportunity for an entire sector, and adding them up.

For non-domestic buildings, we have used N-DEEM outputs in our emissions model, to represent the opportunity to reduce carbon from the implementation of energy efficiency measures in existing buildings. Some are cost-effective, and some are not.

These cost curves show:

1. A ~15% carbon reduction potential from cost- effective energy efficiency measures.
2. That the up-front capital required for these cost-effective measures is in the region of £1.3bn, or ~£100 per ton annual CO_2 reduction. (This £100/ton figure represents the one-off capital cost which will be more than offset by the energy savings that accrue in subsequent years for these cost-effective measures. It is not a comparable cost to carbon credits such as those in the EU emissions trading scheme.)

But does the real world show that carbon reductions in the region of 15% can be achieved using low cost measures? Our experience of working with buildings and their users since 2001 would suggest that the answer is yes.

- The Carbon Trust have collected data on every carbon reduction measure recommended to the organisations we have worked with directly. This includes following up with these organisations to find out which measures have been implemented. Looking at the types of measure implemented, we can draw the following approximate conclusions:
  - The cost-effective energy efficiency measures recommended had a potential carbon reduction of 12% for commercial organisations, and 13% for the public sector.
- The Carbon Trust's Low Carbon Buildings Accelerator, a detailed demonstration project with 10 large scale refurbishments, shows the following outcomes for two categories of simple, low-cost measures:
  - Building controls: CO_2 savings of 4-10% are achievable with an up front investment of less than £65-150 per ton of annual carbon reduction and payback in within 1 year.
  - Lighting: CO_2 savings of 3-7% are achievable with an up front investment of as little as £120 per ton, although significantly more can be invested in more complex lighting schemes. Paybacks of 1-5 years should be possible.

Roughly combining the above figures implies that CO_2 savings of 12% are achievable with an up front investment close to £100 per ton of annual carbon reduction (and quick payback periods), very much in line with the conclusions from the cost curves.

[12] Non-Domestic Energy and Emissions Model.

Success after 2020

Nearly all the carbon abatement measures that exist today will need to be implemented to reduce carbon in non-domestic buildings by 80% by 2050. Decarbonising the grid is critical, but is not enough.

New buildings will need to be designed, constructed and operated such that they add no additional net emissions to the buildings stock. This goes beyond using the most energy efficient pieces of kit and bolting on some renewables. The whole building process will need to be optimised.

Existing buildings will also need to have the full range of measures applied, particularly making the most of major refurbishment opportunities.

Onsite renewables will play a crucial abatement role for both new and existing buildings, potentially delivering a third of the abatement required.

Achieving 80% by 2050 with today's technologies and approaches will cost ~£13bn[13]. This net positive cost is mostly due to the final 5% of carbon savings. New technologies and approaches will be required to reduce this cost and increase design and delivery options.

Chart 2f and *2g* provide a more detailed breakdown of our Success Scenario trajectory and its end result in 2050. In this section we lay out the implications first for new buildings and then second for existing buildings.

[13] Cumulative sum of the net annual costs to 2050.

New buildings

The Government's ambition is that every new non-domestic building built from 2019 onwards will need to be 'Zero Carbon' i.e. not have any net emissions.

Our analysis supports the Government's ambition, showing it to be in line with our lowest cost pathway to an 80% emissions reduction by 2050. The Success Scenario was not constrained to deliver Zero Carbon new buildings – it is simply the most cost-effective pathway to an 80% reduction by 2050. Nevertheless, it approximately achieves Zero Carbon new build from 2019.

This can be seen in the top half of the wedge chart (*Chart 2f*), showing the emissions of new buildings out to 2050. Zero net emissions can be achieved through the combination of the first two types of measure described earlier:

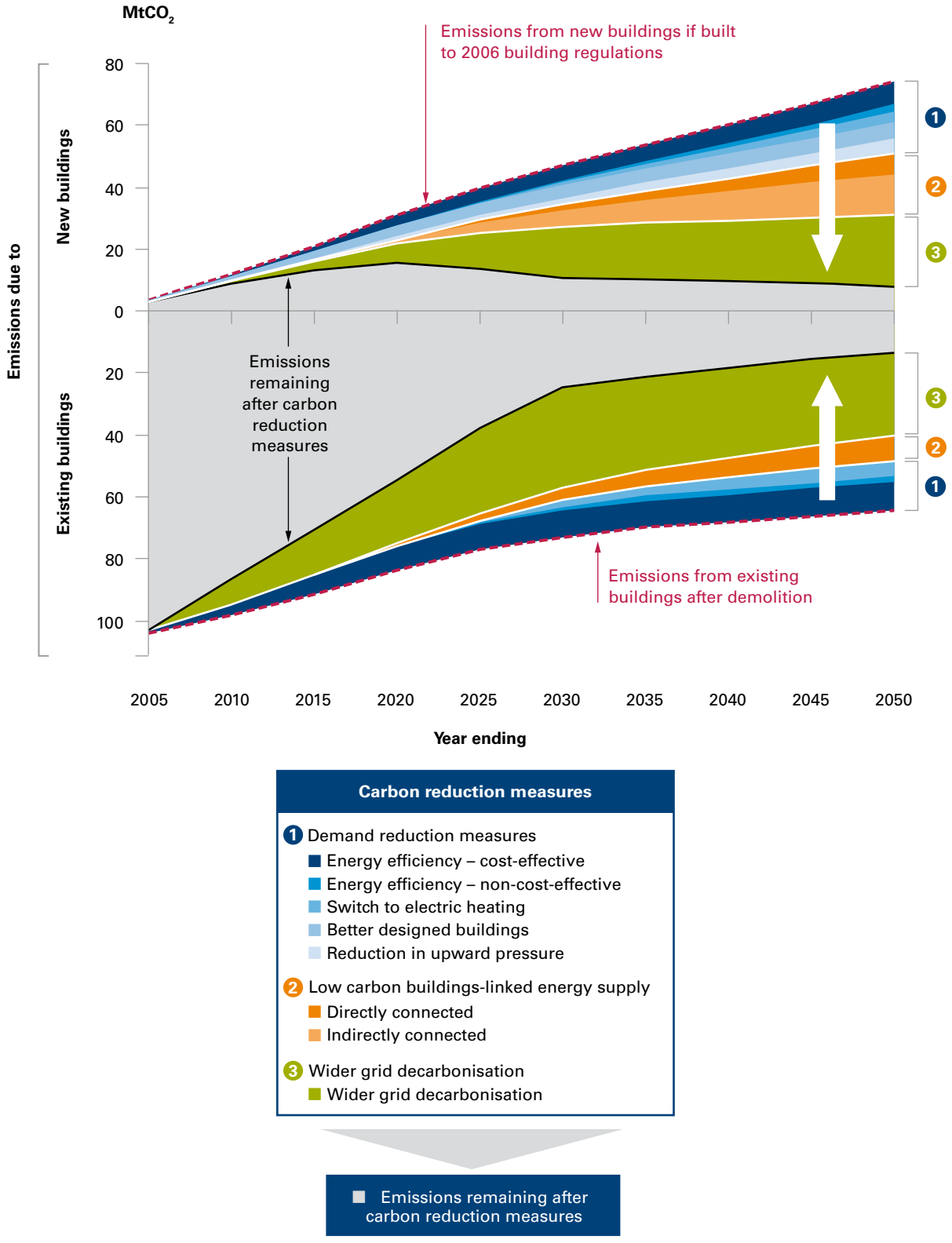
1. Demand reduction measures.
2. Low carbon buildings-linked energy supply: both directly connected on- and near-site generation and indirectly connected offsite generation.

In the top half of *Chart 2f*, you can see that if you were to apply these two measures, effectively 'slicing off' the two wedges 1 and 2, the remaining emissions (the line above the green area) are approximately flat from 2019.

Chart 2f also shows that after the third measure is applied, wider grid decarbonisation 3, emissions from new non-domestic buildings will effectively need to reduce from 2020 to 2050. (*Sidebox 2iii* at the end of this chapter 'What's the difference between 'offsite low carbon buildings energy supply' and 'wider grid decarbonisation'?', explains the difference between wedges 2 and 3).

Achieving Zero Carbon new buildings from 2019 will be a significant challenge, requiring the full range of current abatement measures. These are described in further detail below. The measures' impact and associated cost are summarised in the top half of the 2050 'snap shot' (see *Chart 2g*), showing the per annum emissions reductions in new building emissions and their cumulative net costs by 2050.

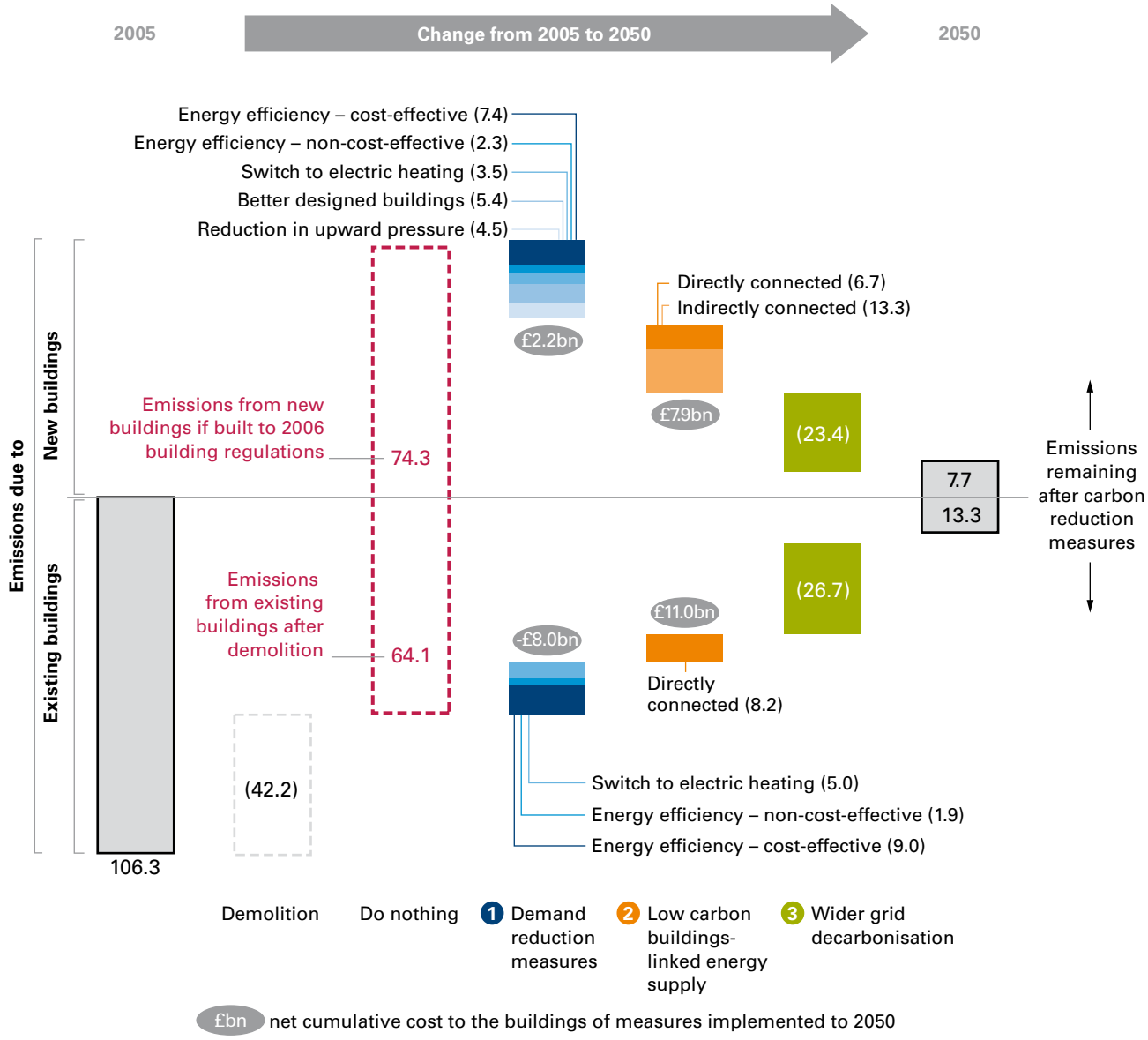
Chart 2f *'Wedge chart' of the Success Scenario: emissions from non-domestic buildings up to 2050 in both new buildings and existing buildings to achieve 80% reduction – before and after carbon reduction measures (with split within each type of measure)*



Note: Carbon dioxide emissions savings are normalised across all interventions.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

***Chart 2g** 'Snap shot' of emissions reduction in new buildings and existing buildings in Success Scenario by 2050*



Note: the full impact of each measure applied on its own was calculated. These individual impacts were then reduced by the same factor so that they would add up to the total emissions reduction when all measures were applied together.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

1 Demand reduction measures in new buildings

The following five measures are all required to achieve Zero Carbon new buildings as part of the overall 80% emissions reduction by 2050:

- **Cost-effective energy efficiency**: new buildings should obviously continue to incorporate cost-effective energy efficiency measures. These continue to save more carbon than any other demand reduction measure – 7.4MtCO_2 by 2050.
- **Non-cost-effective energy efficiency**: buildings will need to incorporate measures which are currently non-cost-effective. These will include the most efficient cooling systems, insulation and glazing options, saving 2.3MtCO_2 by 2050.
- **Switching to electric heating**: once grid electricity has lower carbon emissions than gas, some heating should switch to electrical technologies. Saves 3.5MtCO_2 by 2050.
- **Continued better design of buildings**: by 2020, the design of all new buildings will need to have been improved. Not only will almost every signal component need to be highly efficient, but the whole building will need to be designed holistically so these components work together and not against each other. Construction, commissioning and operation will all also need to be flawless. In the Success Scenario this is conservatively represented by more shallow plan, naturally ventilated new buildings, driving a 5.4MtCO_2 emissions reduction by 2050 – nearly as much as onsite renewables but at a fraction of the cost.
- **An ongoing reduction in upward pressure on carbon emissions** from behavioural impacts and floor space growth, as described for up to 2020. Saves 4.5MtCO_2 by 2050.

In addition to the current technologies that were modelled, innovation will provide new options that are not yet incorporated into our cost curve. Some of these could be cost-effective before 2020, such as LED lighting and chilled beams. Others, such as phase change materials, are further away from full commercialisation. None are considered to be 'silver bullets' but each contributes to increasing the chance of reaching an 80% emissions reduction across the non-domestic building stock.

2 Low carbon buildings-linked energy supply in new buildings

Low carbon buildings-linked energy supply will be required to achieve Zero Carbon new buildings. The Government proposes to allow two types in its hierarchy of Zero Carbon measures[14], as shown in *Chart 2m* in *Sidebox 2iii* (see page 73):

- **Directly connected** on-site generation, such as a medium-sized wind turbine wired up to a building and near-site generation, such as a district CHP system shared across a business park. Defined as 'Carbon compliance' measures under the Government's proposed hierarchy.
- **Indirectly connected** offsite generation, such as a large-scale wind farm, that need not be located by the building but instead is connected to the electricity grid. Defined as an 'Allowable Solution' under the Government's proposed hiearchy.

Both directly and indirectly connected low carbon generation are likely to be needed to achieve zero carbon new buildings.

Up to 2020 almost no directly connected generation is needed for non-domestic buildings to reach carbon emission targets cost-effectively, though significant amounts are needed to meet EU renewable energy targets. After 2020, directly connected generation can contribute significantly to non-domestic buildings reaching the 80% target – in our Success Scenario directly connected generation provides around 30% of new building's electricity demand and 15% of heat by 2050, reducing emissions by 6.7MtCO_2 at a net cumulative cost of c.£8bn up to 2050. In the medium term, the technologies that can make the greatest contribution costing below £200/tCO_2 include biomass, biomass CHP, micro CHP, medium-size wind power, biogas, solar hot water and heat pumps. In the longer term, new technologies that could have come down their cost curves could include third generation solar electricity and fuel cell technologies.

Indirectly connected offsite generation such as large-scale renewables can also significantly contribute to this abatement. In general, it may be more cost-effective for buildings to pay for large-scale indirect generation than for small-scale generation directly connected to the building. In our model, wind power (on and offshore) was used as a proxy for indirectly connected offsite generation. This saves 13.3MtCO_2 by 2050, twice that saved by directly connected generation, at less than a third of the cost, c.£2bn net cumulative to 2050.

[14] Definition of Zero Carbon Homes and Non-Domestic Buildings: Consultation; DCLG (December 2008)

3 Wider grid decarbonisation contribution to new buildings emissions reduction

The grid will need to continue to be decarbonised, with the majority of the remaining decarbonisation being completed by around 2030[15] (see *Sidebox 2iii* 'What's the difference between 'offsite low carbon buildings energy supply' and 'wider grid decarbonisation'?').

The total cost of emissions reductions in new buildings

The cumulative net cost of achieving the changes described in new buildings from 2020 is c.£11bn. Three quarters of this cost is for the low carbon energy supply measures.

Existing buildings

The bottom half of *Chart 2g* summarises the impact of the measures on existing buildings by 2050. More than 60% of today's existing buildings will still be standing in 2050. These will have had most of the cost-effective measures installed by 2020 (7.4MtCO_2 of the 9.0MtCO_2 by 2050). Between 2020 and 2050 they will need to implement all the outstanding measures, which are currently non-cost-effective. Combined with wider grid decarbonisation, these measures will need to reduce emissions from existing buildings that are still standing by 2050 by nearly 80%.

The outstanding, non-cost-effective measures will include:

1 Demand reduction measures in existing buildings

Whilst some non-cost-effective energy efficiency will be required from 2020 to 2050, switching to electric heating has a larger impact:

- **Non-cost-effective energy efficiency**: applying technologies which are cost-effective in some buildings more broadly to buildings that are less adaptable (for instance installing energy-efficient lighting to buildings that need to have all their light fixtures changed) as well as more extensive upgrades to the building's walls, roof and glazing to improve its thermal efficiency and air tightness. Many of these measures will require some vacation of the building, even if only confined to an area of a floor at a time. These 'major refurbishments' happen infrequently, often between tenancies. These opportunities will need to be exploited to achieve the maximum carbon abatement. In the model these measures save 1.9MtCO_2 by 2050 at a significant upfront cost of £9.6bn.
- **Switching to electric heating**: switching some heating to electricity sources once the grid has decarbonised could significantly reduce the emissions from existing buildings (a 5MtCO_2 reduction by 2050 in the Success Scenario).

2 Low carbon buildings-linked energy supply in existing buildings

Significant directly connected on- and near-site generation (129TWh) will need to be retrofitted to existing buildings by 2050. This can save a comparable amount of carbon emissions (8MtCO_2) as energy efficiency measures, but at a cumulative net cost of around £11bn.

3 Wider grid decarbonisation contribution to existing buildings emissions reduction

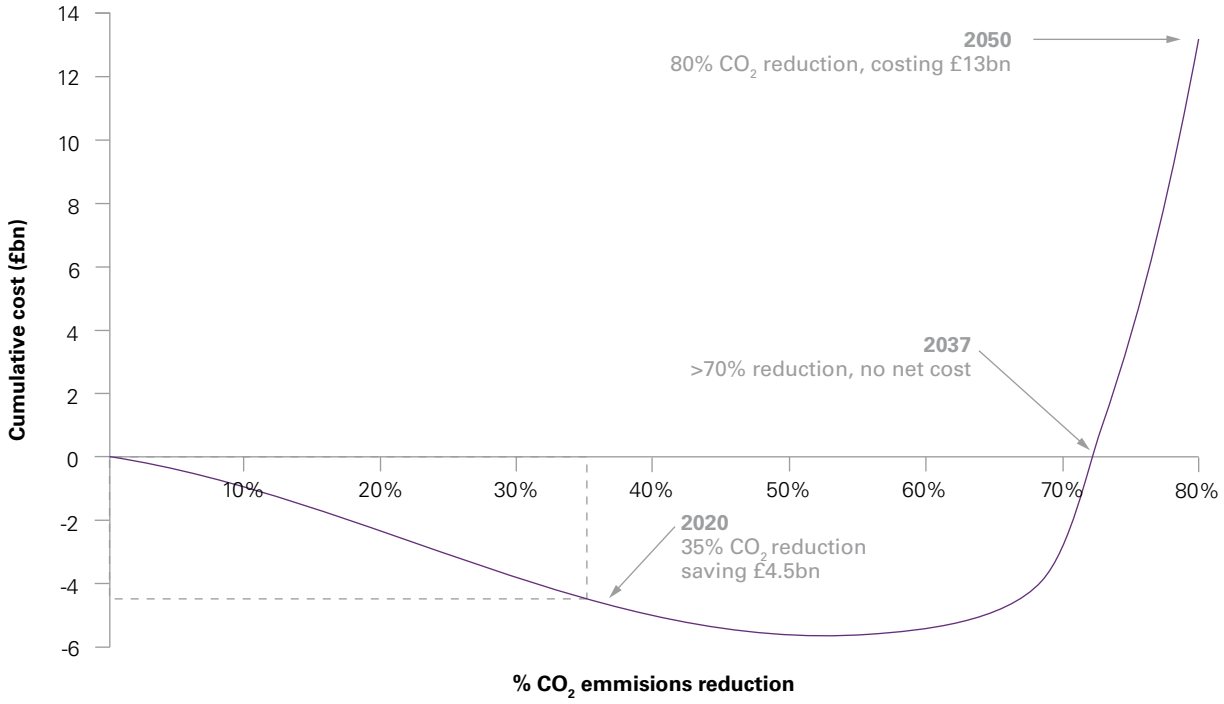
As described above, the grid will continue to be decarbonised from 2020, increasing the emissions reduction from 2020's 20.6MtCO_2 to 26.7MtCO_2 by 2050.

The total cost of refurbishing existing buildings

The cumulative net cost of refurbishing buildings from 2020 could be c.£6bn, even with the benefits accruing from the already implemented cost-effective energy efficiency measures, unless the costs of existing technologies are reduced and new technologies and approaches are adopted.

[15] The CCC's grid emissions factors were used in the analysis, decreasing from 350g/kWh in 2020 to 80g/kWh in 2030 onwards.

Chart 2h *Cumulative net cost against cumulative carbon saving for non-domestic buildings Success Scenario up to 2050*



Source: Carbon trust analysis

The opportunity to reduce costs post 2020

The combined cost of carbon abatement across new and existing buildings to 2050 could be considerable. In our Success Scenario we estimate this as a cumulative net cost of c.£13bn, requiring a capital investment of £63bn – an increase on annual construction and refurbishment investment of 2-5%.

Chart 2h shows that the majority of this cost is concentrated in the final 10% of emissions reductions. Up to 2020, the cost-effective energy efficiency measures achieve a 35% emissions reduction and save £4.5bn. After 2020, these cost-effective energy efficiency measures continue to make additional savings, but start to be offset by non-cost-effective energy efficiency and low carbon buildings-linked generation measures. Finally, the most expensive measures that deliver the final 10% emissions reduction turn the £4.5bn saving into a £13bn cost.

Furthermore, non-domestic buildings could need to deliver more than an 80% reduction. Zero or even negative carbon targets for buildings have already been proposed both in the UK and internationally. Our model incorporates almost every existing measure available but can go no further than 80%.

The UK should therefore focus on both reducing the cost of buildings abatement and developing new options to increase the potential for buildings abatement. This can be achieved through innovation, operational approaches and changing social norms. The policies required to deliver these improvements are outlined in Chapter 3.

2.2 Communicating the trajectory

Section 2.1 of this chapter explained how a target emissions trajectory could be defined. Section 2.2 shows how Government can use this trajectory in setting clear expectations for industry. Once a percentage target is set, how does an organisation know if it is on track and therefore if it needs to reduce its emissions more rapidly? The Government needs to communicate in a language that is meaningful for the industry. This section illustrates why Display Energy Certicates (DECs) and Energy Performance Certificates (EPCs) should be the central elements of this language. Finally, it outlines the specific steps that we believe Government should take beyond setting the overall emissions trajectory via the carbon budgets.

Setting clear expectations for industry

As outlined in Section 2.1, the lowest cost pathway to achieve an 80% reduction in carbon emissions from non-domestic buildings requires a ~35% reduction to be met in 2020.

The Government needs to create the long-term certainty demanded by the industry by:

- **Setting specific, binding, carbon budgets for the non-domestic buildings industry.**
- **Setting these carbon budgets to be tougher than for the UK as a whole**, going beyond the UK's carbon budget of 21-31% by 2020 (vs. 2005 levels), to reach ~35%.

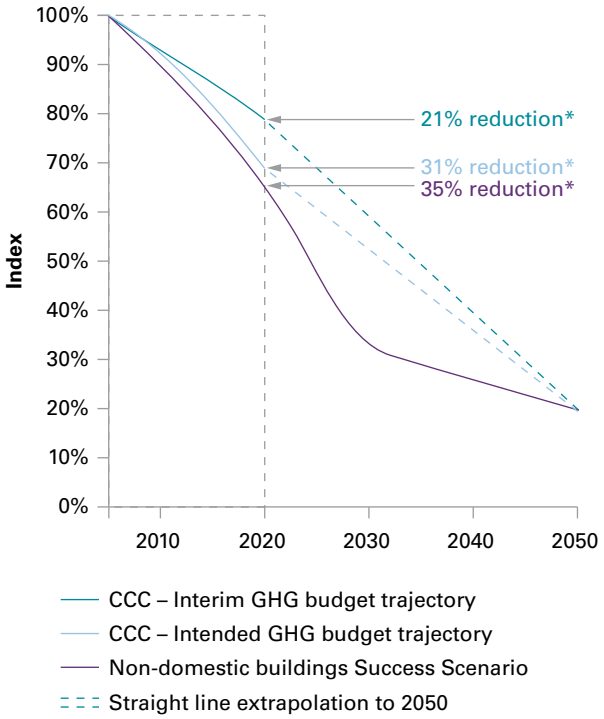
This recommended pathway from today to 2020 compared to the carbon budgets, applied pro-rata to non-domestic buildings, is outlined in *Chart 2i*, and makes clear the accelerated trajectory over the next decade required to minimise the cost to the UK.

In addition, the Government should clearly state the ambition for the level of reduction needed by 2050. As described earlier, we believe that non-domestic buildings have the potential to play more than their fair share of the UK's total carbon reduction of 80%.

With Government committing to this non-domestic buildings pathway, industry will know what it has to deliver overall. If it is under-delivering, it should expect additional regulation, penalties and/or incentives. Conversely, if it is over-delivering it should expect the Government to refrain from more punitive potential actions (as outlined in Chapter 3: Policy Options for Government).

Finally, it may be useful for the overall non-domestic emission pathway to be broken down into sectors e.g. retail, offices, hospitality, schools, warehouse etc. This will help organisations in these sectors know whether their sector is on target or not. There is already a precedent in the proposed 2010 building regulations, where different sectors will be expected to reduce their emissions by different levels based on their pattern of use across lighting, heating and cooling etc., each of which has a different level of cost-effective carbon abatement potential.

Chart 2i *Non-domestic buildings Success Scenario emissions trajectory from 2005-2050 compared to UK carbon budgets*



*all versus 2005 emissions.

Source: CCC, Carbon trust analysis

A language that is meaningful for the industry

The carbon emissions trajectory we have described should clarify the average reduction required across the non-domestic building stock. But how does an organisation know whether it is currently above or below average and therefore whether it needs to reduce the emissions from its buildings by more or less than 35% by 2020 and 80% (or more) by 2050? The industry needs a language that converts these high level targets into metrics that are directly relevant to its buildings.

We believe that Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs) should be the central elements of this language because they:

- Provide a true understanding of the energy used, and carbon emitted from a building.
- Communicate a clear signal of the improvement needed to meet carbon budgets for the industry and within Government.
- Act as a mechanism through which to target carbon emissions reductions.
- Help Government manage overall performance and reduce risk of not meeting targets.

These reasons are outlined in further detail below.

A true understanding of the energy used

Introduced by the Government in 2008 as part of the implementation of the Energy Performance of Buildings Directive, DECs and EPCs both characterise buildings with A* to G ratings, similar to the ratings on household goods like refrigerators. The two ratings show different aspects of a building's total energy performance, as shown in *Chart 2j*.

A DEC (or operational rating) records the actual CO_2/m^2 emissions from a building over the course of a year, and benchmarks them against buildings of similar use. An EPC (or asset rating) models the theoretical, as designed, energy efficiency of a particular building, based on the performance potential of the building itself (the fabric) and its services (such as heating, ventilation and lighting), compared to a benchmark. It is also stated in CO_2/m^2. The EPC assumes an average use profile for each building of a particular type/use, and does not therefore represent the building as used.

The building quality (the EPC), has a large impact on the total emissions (the DEC), but does not explain all emissions. An approximation is that the EPC, which covers those loads currently regulated under the building regulations, explains around three-quarters of the overall emissions, with a quarter therefore being 'unregulated'. These include other factors, such as process loads (e.g. IT) or building user behaviours, which also create or reduce emissions. Hence, to truly understand the energy used/carbon emitted from a building, and what is driving these emissions, all buildings should eventually have both certificates. Currently, only large public sector buildings are required to have a DEC, whereas all buildings require an EPC upon sale or lease.

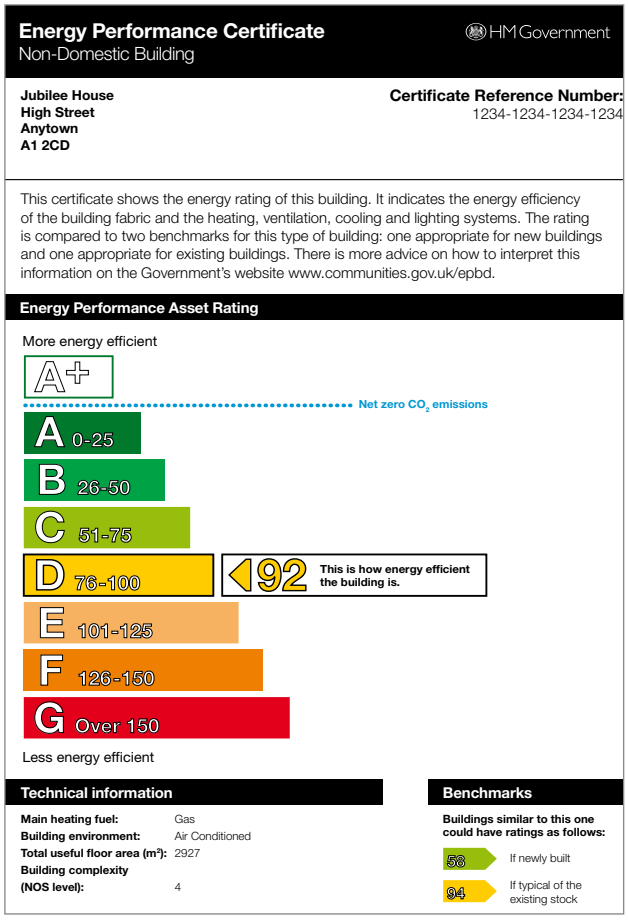
Chart 2j *DECs and EPCs – to reduce carbon emissions from our buildings requires buildings that are both built to a higher quality and used correctly*

Key elements and differences of the certificates

	Rating type	How assessed	Covers	Required	Frequency
Display Energy Certificate (DEC)	Operational – how the building is used	Real data from meters etc over 1-year	100% of carbon emissions/energy use	Large public sector buildings only	Annual (advisory report every 7-years)
Energy Performance Certificate (EPC)	Asset – quality (as designed)	Theoretical using a model of the building	Covers regulated loads only (heating, ventilation, cooling, lighting, hot water); around three-quarters of a typical building's emissions	On sale or lease for all buildings	10-year renewal

Go to CLG's website for more up-to-date information on DECs and EPCs and their implementation: www.communities.gov.uk

Example Energy Performance Certificate



Energy Performance Certificate
Non-Domestic Building

HM Government

Jubilee House
High Street
Anytown
A1 2CD

Certificate Reference Number:
1234-1234-1234-1234

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

More energy efficient

A+

Net zero CO_2 emissions

A 0-25

B 26-50

C 51-75

D 76-100 — 92 This is how energy efficient the building is.

E 101-125

F 126-150

G Over 150

Less energy efficient

Technical information

Main heating fuel:	Gas
Building environment:	Air Conditioned
Total useful floor area (m^2):	2927
Building complexity (NOS level):	4

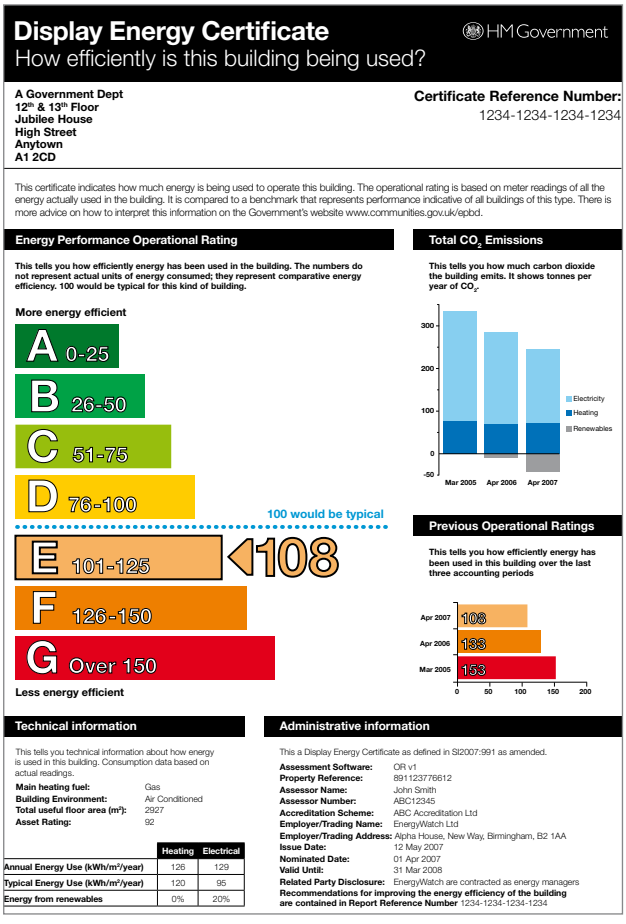
Benchmarks

Buildings similar to this one could have ratings as follows:

56 If newly built

94 If typical of the existing stock

Example Display Energy Certificate



Display Energy Certificate
How efficiently is this building being used?

HM Government

A Government Dept
12th & 13th Floor
Jubilee House
High Street
Anytown
A1 2CD

Certificate Reference Number:
1234-1234-1234-1234

This certificate indicates how much energy is being used to operate this building. The operational rating is based on meter readings of all the energy actually used in the building. It is compared to a benchmark that represents performance indicative of all buildings of this type. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Operational Rating

This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.

More energy efficient

A 0-25

B 26-50

C 51-75

D 76-100

100 would be typical

E 101-125 — 108

F 126-150

G Over 150

Less energy efficient

Total CO_2 Emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

300
200
100
0
-50

Electricity
Heating
Renewables

Mar 2005 Apr 2006 Apr 2007

Previous Operational Ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods

Apr 2007 108
Apr 2006 133
Mar 2005 153

0 50 100 150 200

Technical information

This tells you technical information about how energy is used in this building. Consumption data based on actual readings.

Main heating fuel:	Gas
Building Environment:	Air Conditioned
Total useful floor area (m^2):	2927
Asset Rating:	92

	Heating	Electrical
Annual Energy Use (kWh/m^2/year)	126	129
Typical Energy Use (kWh/m^2/year)	120	95
Energy from renewables	0%	20%

Administrative information

This a Display Energy Certificate as defined in SI2007:991 as amended.

Assessment Software:	OR v1
Property Reference:	891123776612
Assessor Name:	John Smith
Assessor Number:	ABC12345
Accreditation Scheme:	ABC Accreditation Ltd
Employer/Trading Name:	EnergyWatch Ltd
Employer/Trading Address:	Alpha House, New Way, Birmingham, B2 1AA
Issue Date:	12 May 2007
Nominated Date:	01 Apr 2007
Valid Until:	31 Mar 2008
Related Party Disclosure:	EnergyWatch are contracted as energy managers
Recommendations for improving the energy efficiency of the building are contained in Report Reference Number	1234-1234-1234-1234

A clear signal

DECs and EPCs should be used by the Government to clearly communicate the average improvement needed to meet the carbon budgets:

- From improving the quality of the buildings through increased EPC ratings.
- From both improving the quality of the buildings and then using them better, through the DEC ratings.

Government should anchor the improvement on the DEC, as this represents the actual emissions and therefore is directly related to the emissions pathway discussed above. This will ensure that all output emissions are captured, even those from sources we can't conceive of today.

Government can then set expectations for the implied improvement in EPCs. An obvious, if approximate, rule of thumb is that for each improvement in EPC rating (say from E to D), a three-quarter rating improvement in the DEC could be expected, assuming all other variables, such as behavioural impacts and grid decarbonisation, remain constant.

Our analysis has shown that DEC ratings will need to improve by over two ratings by 2020, from an average of E to C. The improvement needs to be a little more than four ratings by 2050, from an average of E to A. *Chart 2k* illustrates this overall improvement from 2008 to 2020 to 2050.

The improvement required without grid decarbonisation is possibly more relevant to industry as it describes the pressure that will be applied to the building on its own, outside of any external influences. For instance, on this basis, grid decarbonisation will improve the DEC rating of today's existing buildings that are still standing in 2050 by around two ratings. The remaining two ratings will need to be achieved through improving the use of the building or improving the underlying building. The EPC, which represents the performance of the underlying building, will therefore need to improve by more than ~two rating bands (using the rule of thumb above).

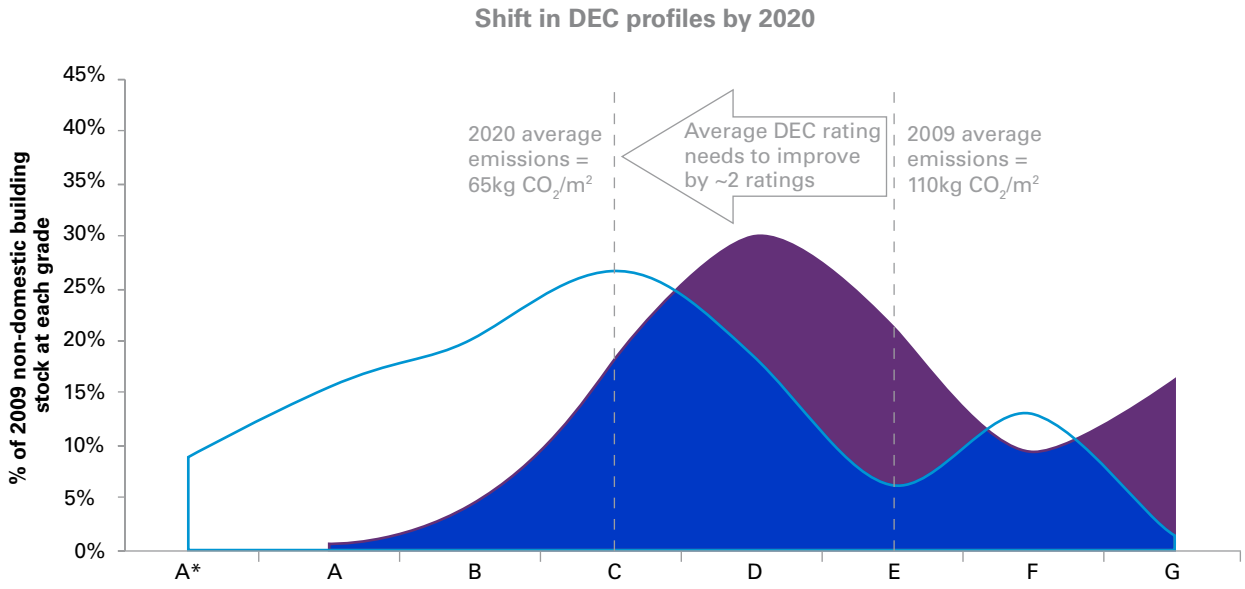
Carbon Trust experience with existing buildings in our Low Carbon Building Accelerator (LCBA)[16] suggest this improvement is possible but challenging. This programme of real, large-scale refurbishment of non-domestic buildings attempted to bring a low carbon ethos to the core of each project, whilst still requiring a viable business case for each refurbishment.

Chart 2l shows that the EPC ratings were normally able to be improved by one rating, with two ratings occasionally being possible. DEC ratings were more difficult to improve given upward pressure on emissions from unregulated loads, greater intensity of floor space, or poor commissioning of the building management system.

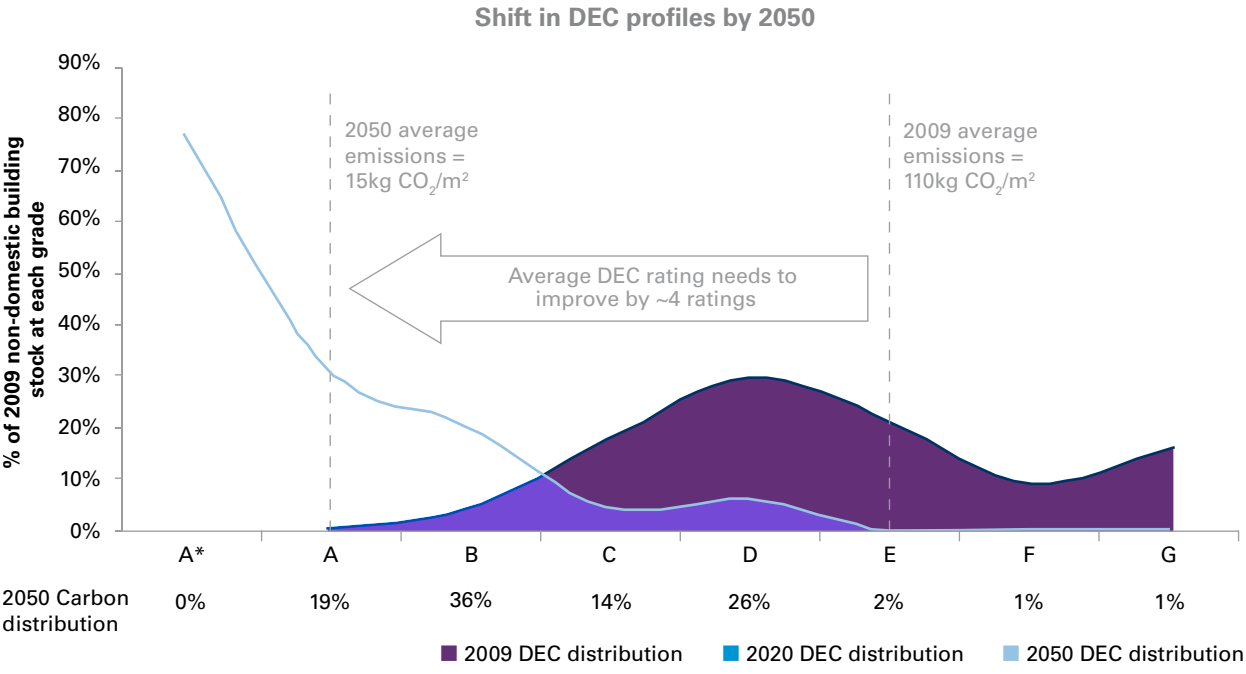
Using DECs and EPCs also translates the improvement required to particular sectors with no additional calculation required. This is because DECs and EPCs are already benchmarked by sector. For instance an E-rated retail building has a higher CO_2/m^2 than an E-rated office. But both will likely need to improve to an A rating, in order to achieve an 80% reduction by 2050 in total emissions.

[16] The LCBA is a Carbon Trust technology programme that focuses on gathering data and demonstrating expertise in the energy-efficient refurbishment of non-residential buildings.

Chart 2k *Shift in overall DEC profiles required from 2009 through to 2020 and 2050*



	A*	A	B	C	D	E	F	G
2009 Carbon distribution	0%	0.1%	1%	9%	22%	27%	14%	27%
2020 Carbon distribution	0%	4%	11%	22%	21%	11%	28%	3%



	A*	A	B	C	D	E	F	G
2050 Carbon distribution	0%	19%	36%	14%	26%	2%	1%	1%

Date	Carbon reduction versus today	Average improvement in rating	Bottom end	Top end
2020	35%	~2 rating bands (E to C)	Almost no G ratings	~15% A/A*
2050	80%	~4 rating bands (E to A)	Almost no E, F & G ratings	~75% A/A*

Source: DCLG (data); Carbon Trust and Arup analysis

A mechanism through which to target carbon emissions reductions

DECs and EPCs can then be used as a mechanism to align incentives and regulation to individual buildings performance. Chapter 3: 'Policy options for Government' recommends a number of different policies that target specific improvements in DEC or EPC ratings across the building stock.

Chart 2I *EPC improvement seen in the Carbon Trust's Low Carbon Buildings Accelerator (LCBA)*

Site	EPC before	EPC after	Measures
Site 1	D	C	Minor refurbishment that increased energy efficiency of lighting, heating and hot water systems
Site 2	C	B	Minor refurbishment that improved equipment efficiencies and controls; one roof section had insulation added
Site 3	D	B	Major* refurbishmenrt including incorporating natural ventilation, efficient lighting and new Buildings Management System (BMS)

*Major refurbishment defined in LCBA as requiring prolonged vacation of building.

Help Government manage performance and reduce risk

Collation of the ratings for all buildings will also help Government to monitor and manage the quality of, and carbon emissions from, all non-domestic buildings.

Government will be able to monitor whether non-domestic buildings are on target to meet their budgets, not only overall, but by new and existing buildings, by building rating and by sector. This will help to inform whether to focus additional policies on: new or existing buildings, particular sector types, and/or particular performance levels of buildings.

"A prerequisite for any effective Government policy to improve the energy efficiency of existing stock is a consistent and transparent system of collecting and measuring actual energy use data. At the moment this is still not available in the UK, thereby preventing further policy development"

All Party Urban Development Group, 2008

What the Government needs to do

Consequently, Government needs to take four specific steps beyond setting the overall emissions trajectory via the carbon budgets:

1. Roll out DECs to all non-domestic buildings by 2015. Use centralised DECs via the Data Framework[17] for smaller buildings. EPCs should also be in place for all buildings by 2015, in order to deliver full transparency on the quality, and use, of non-domestic buildings.
2. Communicate expectations that non-domestic buildings will deliver more carbon emission reductions by 2020 than the UK as a whole and the implications for the average shift in DEC rating needed to deliver this level of reduction.
3. Set up a Government programme to monitor, diagnose and manage non-domestic building stock performance based on the DEC and EPC registry. This could be directed/set up/run by the Committee on Climate Change or some other delivery body.
4. Refine DECs and EPCs: continue to improve the benchmarks, software, process, transparency, compliance etc. to ensure the ratings are fit-for-purpose, fairly represent the buildings they are rating and are trusted within the industry. Ensure the certificates do not incentivise undesirable actions such as using more floor space less intensively.

Implementing the actions outlined in this chapter will lead to a clearly communicated, long-term direction for the industry to follow and plan to, and a greater understanding for Government and industry of the quality of our buildings, the total carbon emissions coming from them, and the drivers of those emissions.

[17] The National Energy Efficiency Data Framework is being piloted by DECC to link information together from existing databases covering all buildings in the UK, combining data from energy suppliers, buildings, installers and other sources.

Supporting information for Chapter 2

2iii. What's the difference between 'offsite low carbon buildings energy supply' and 'wider grid decarbonisation'?

As part of the Government's proposed definition for a Zero Carbon building[18] there are two different categories of 'low carbon buildings-linked energy supply' that may be allowed – directly and indirectly connected generation. Alongside these, there will be wider grid decarbonisation to meet UK emissions and renewable energy targets. These are numbered on *Chart 2m* as:

2 Low carbon buildings-linked energy supply:

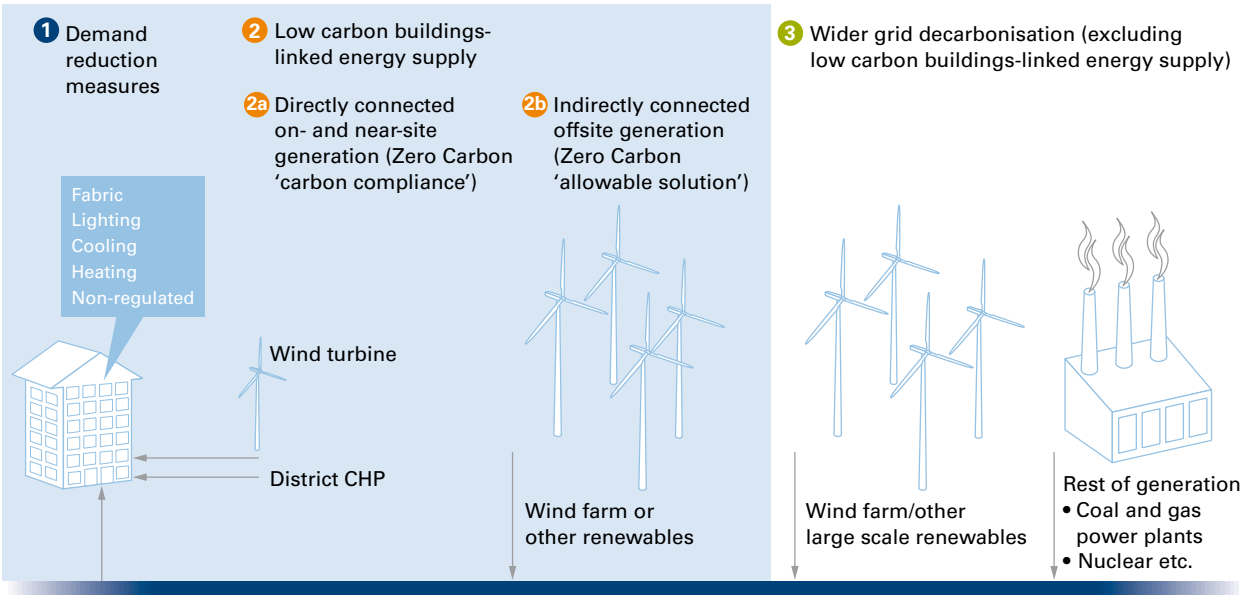
- 2a Directly connected generation, either onsite (e.g. a wind turbine on the buildings' grounds) or near-site (e.g. a district CHP unit).
- 2b Indirectly connected offsite generation (e.g. a large-scale wind farm) that the building pays for and owns but is not directly connected to.

3 Wider grid decarbonisation (excluding low carbon buildings energy supply).

In our modelling, we included the emissions reduction from all these, and assigned the costs of the carbon reduction from 'low carbon buildings-linked energy supply' 2 to the buildings themselves.

One critical issue remained – to avoid 'double counting' between the grid emissions factor and the low carbon buildings-linked energy supply 2. The grid emissions factor is calculated taking the current, mostly fossil fuel generation and deducting all future grid decarbonisation, including indirectly connected offsite generation 2b. If we were then to also net off all the low carbon buildings-linked energy supply, 2a and 2b, we would be deducting indirectly connected offsite generation 2b twice, double counting its carbon reduction. To overcome this, for the emissions factor used in DeCODE we only deducted the wider grid decarbonisation 3 from the current, mostly fossil fuel generation.

Chart 2m *Schematic of types of carbon reduction measures applied to non-domestic buildings, including measures contributing to a 'Zero Carbon building'*

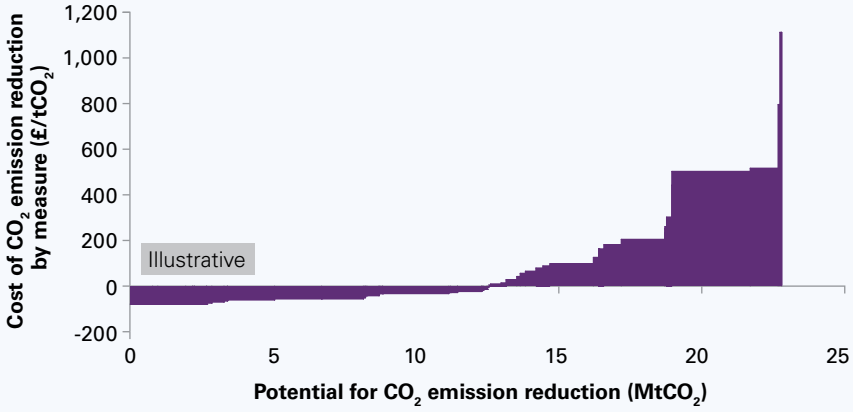


[18] Definition of Zero Carbon Homes and Non-Domestic Buildings: Consultation; DCLG (December 2008).

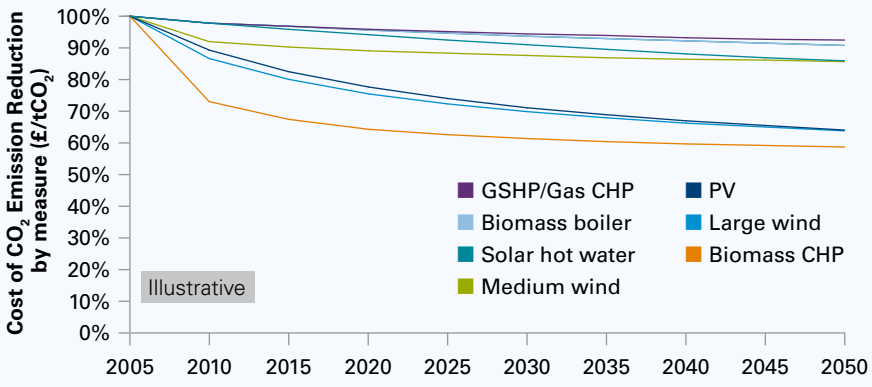
2iv. The DeCODE model (continues over next pages)
Introduction

Chart 2n *Schematic of DeCODE: (i) key inputs, (ii) parameters and (iii) outputs (next page)*

	(i) Inputs	
Categories	**Fixed values based on past Carbon Trust research and external sources**	
Stock	**Non-domestic building stocks' emissions for each sector** (e.g. retail, commercial offices), based on: • Sector floor area • End use energy consumption (by heating, lighting, cooling & ventilation, catering, hot water and office equipment) and the type of energy used in each (electricity, gas, oil) • Energy emissions factors	
Measures	1 Demand reduction measures	Energy efficiency Marginal Abatement Cost Curves (MACC) for energy efficiency in both new and existing buildings for a given point in time*. These show how much carbon each measure can save and the associated cost**.
	2 Low carbon buildings-linked energy supply	**Low carbon supply cost curves** from a selection of low carbon and renewable energy technologies for off-, on- and near-site use. Cost curves show how the costs of renewables will reduce over time due to innovation and economies of scale.
	3 Wider grid decarbonisation	**Overall grid emissions factors** from 2005 to 2050, taken from the Committee on Climate Change, from 0.562kgCO_2/kWh in 2005 to 0.080kgCO_2/kWh from 2030 onwards.



*The cost curves change with time as measures are implemented, buildings are demolished, or carbon intensity of electricity changes.
**Both of these values are incremental over 'business-as-usual'.



Source: Arup; Ernst and Young, Carbon Trust

(ii) Parameters
'Levers' that can be pulled to create different scenarios
• Rate at which measures will get implemented due to the building cycle – New build rate – Refurbishment rate (different rates for major or minor) – Demolition rate
• Percentage of energy efficiency measures implemented in each new building or refurbishment, applied separately for cost-effective and non-cost-effective measures • A shift towards better designed buildings, represented by increasing the percentage of shallow plan buildings, by sector. • Change to the fuel mix by energy end use: gas, electricity & oil
• Electrical energy and heat produced each year (TWh) by each type of technology, for: – Offsite – On- and near-site
• Grid emissions factors not related to non-domestic buildings: emissions savings from any offsite low carbon electricity supply related to buildings is deducted from the grid emissions to avoid double counting

Model development

The Carbon Trust worked together with Arup to create the DeCODE model[18]. *Chart 2n* is a schematic illustrating what this does. DeCODE's inputs are the building stock's emissions and the measures that can be applied to reduce these emissions. It then applies a set of parameters that set the measures that are applied and how quickly these measures disseminate throughout the building stock. Its outputs are a 'wedge curve' (*Chart 2o*) that shows the emissions trajectory for new and existing buildings over time, and a 'snap shot' of the wedge curve (*Chart 2p*), emphasising the impact of each measure.

Simplifying assumptions

This model has taken the following approach:

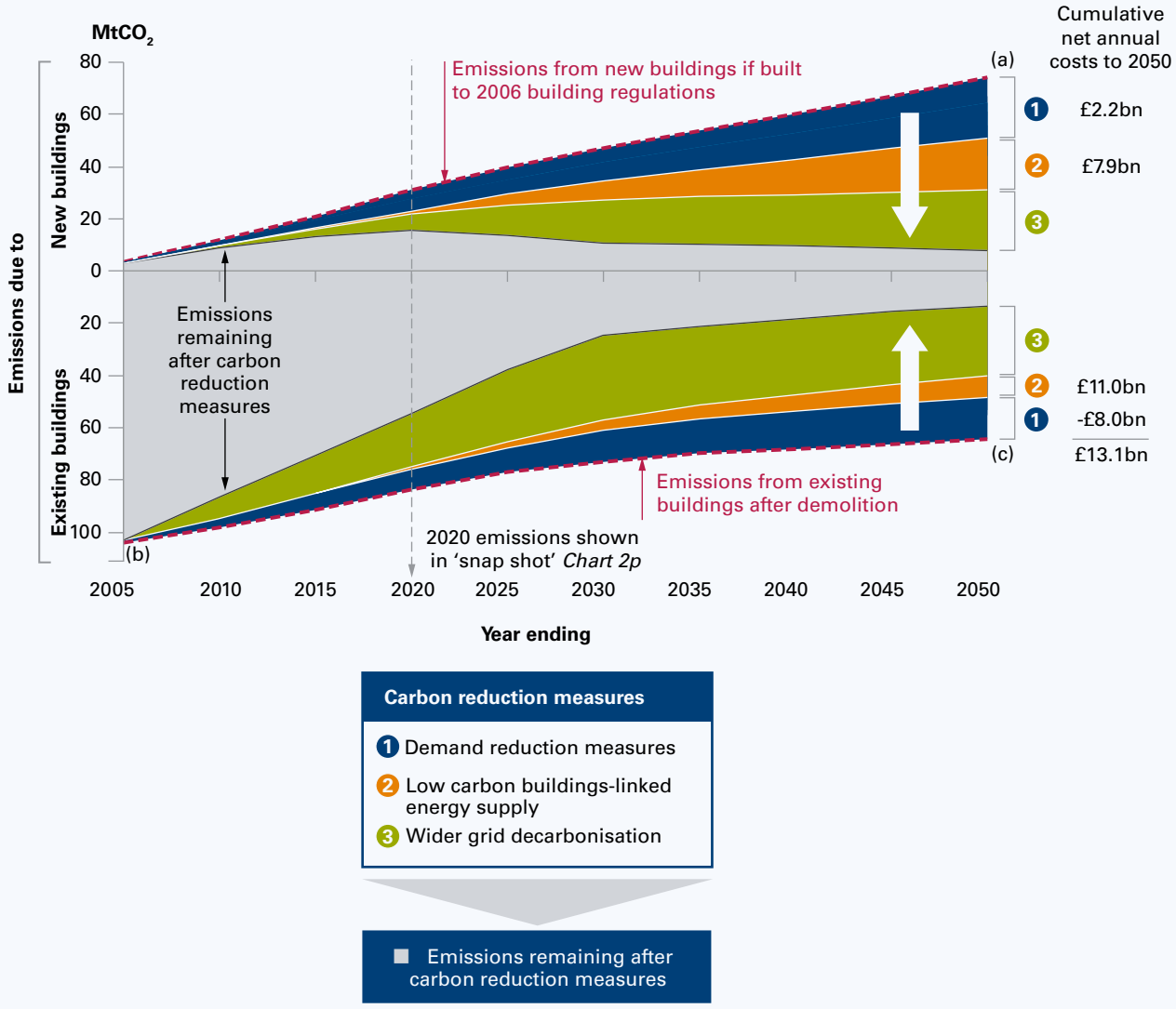
- Modelled the whole building stock, not building by building.
- No learning curve applied to cost of energy efficiency measures (but there is to renewables).
- No embedded carbon because it is a relatively small proportion of total emissions and can be targeted separate to end use emissions.
- No cost for changing from fossil fuel based to electrical heating and hot water.
- No cost for improved design.
- No 'hidden costs' reflecting increased managerial support costs to implement measures.

[18] Determining carbon opportunities in the non-domestic environment.

(iii) Outputs

Contribution of each measure to emissions reduction and the resulting emissions. Net annual costs and associated capital costs (by year and cumulative) – by measure and overall.

Chart 2o *'Wedge chart' of non-domestic CO_2 emissions*



Note: CO_2 emissions savings are normalised across all interventions.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

The 'Wedge chart' shows the CO_2 emissions from 2005 to 2050. Emissions from new buildings built over that timescale are shown in the top half, emissions from today's existing buildings are shown in the bottom half.
Starting with the top half, the full area shows how nearly 80MtCO_2 (point (a) on the chart) would be added by 2050 with no additional measures, or more specifically if:

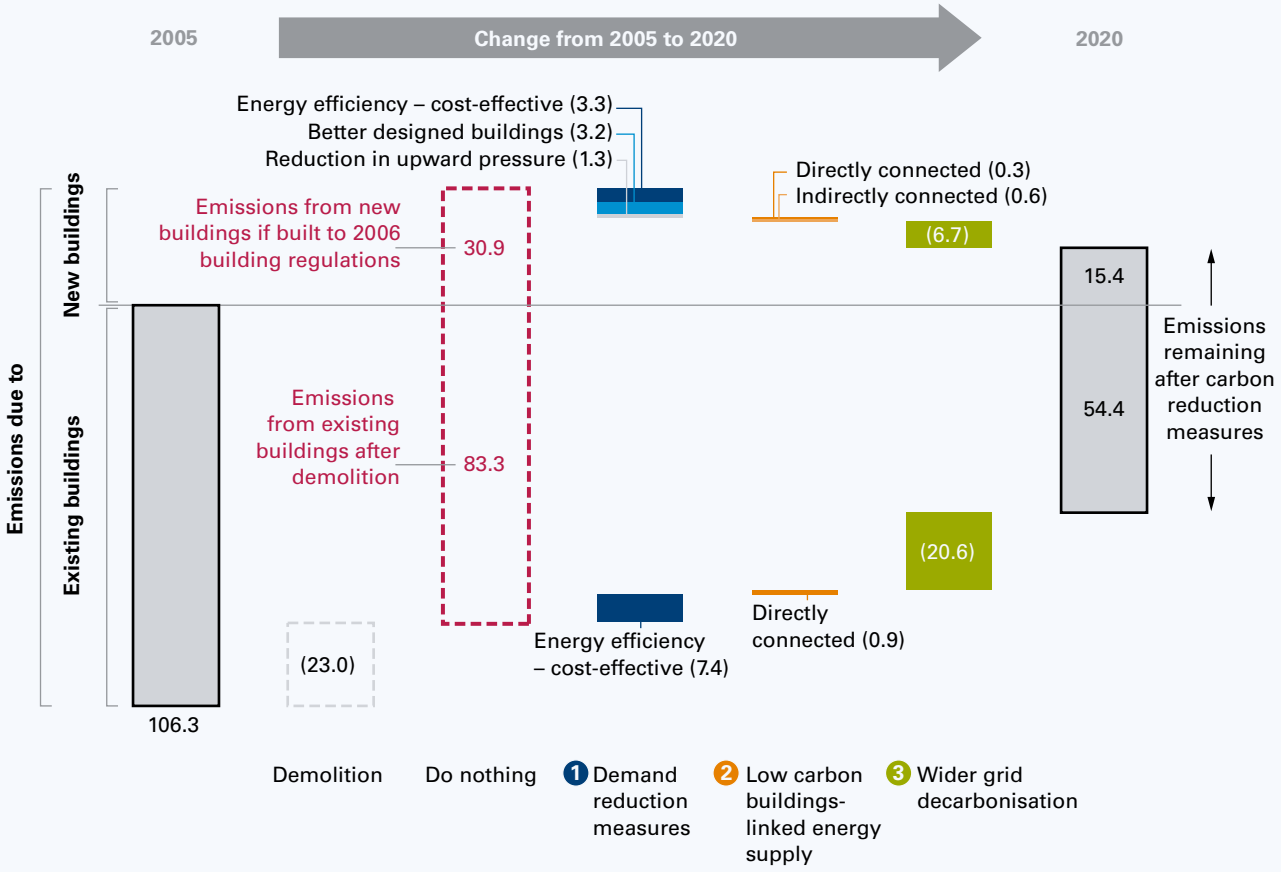
- New buildings continued to be constructed to existing (2006) regulations.
- The UK's electricity power generation continued to produce the same level of emissions.

The full area of the bottom half shows how emissions would start from 2005's 106MtCO_2 (point (b) and decrease to ~60MtCO_2 (point (c)) by 2050 purely from business-as-usual demolition. Without any additional measures, the combined emissions from new and existing buildings would total nearly 140MtCO_2 by 2050 (the distance between (a) and (c)).
The three different types of emissions reduction measures can then be applied to differing extents. Each measure slices off a 'wedge' of carbon from the chart (wedges 1, 2 and 3). The remaining grey area shows the resulting emissions from non-domestic buildings from 2005 to 2050.

(iii) Outputs (continued)

Contribution of each measure to emissions reduction and the resulting emissions.

Chart 2p *'Snap shot chart' of non-domestic CO_2 emissions of new and existing buildings in 2020, before and after the application of carbon reduction measures*



Note: CO_2 emissions savings are normalised across all interventions.

Source: Carbon Trust and Arup analysis; data from BRE and Carbon Trust

This chart is a 'snap shot' of the wedge chart described above. Just as with the wedge chart, new buildings' emissions are shown in the top half and existing buildings in the bottom half. The bars on the left show the emissions with no additional measures – equivalent to the full area of the wedge chart. The three middle bars then correspond to the three types carbon reduction measures (the three wedges). The resulting emissions in 2020 are then shown on the right-hand side.

2v. Scenarios run in DeCODE

A number of different scenarios were created by running the DeCODE model with different sets of parameters.

Comparison scenarios

First, a 'do nothing' scenario and business-as-usual scenario were created to act as anchor points against which the other scenarios can be compared:

- 'Do nothing' scenario: has no additional measures applied. Buildings are demolished at the current rate and replaced at current 2006 regulations. It is the starting point to which all the other scenarios can be compared. In the wedge chart (see *Chart 2o*) it represents the red dotted lines, before any measures are applied.
- Optimistic current trajectory: the Government already plans to tighten building regulations; this scenario reflects these plans. This is a simplified version, for instance it does not reflect the impact of the planned CRC.

An 80% reduction by 2050

Neither of these scenarios achieves an 80% reduction by 2050. To do so, all the carbon reduction measures need to be applied, with the parameters in DeCODE almost set at their maximums:

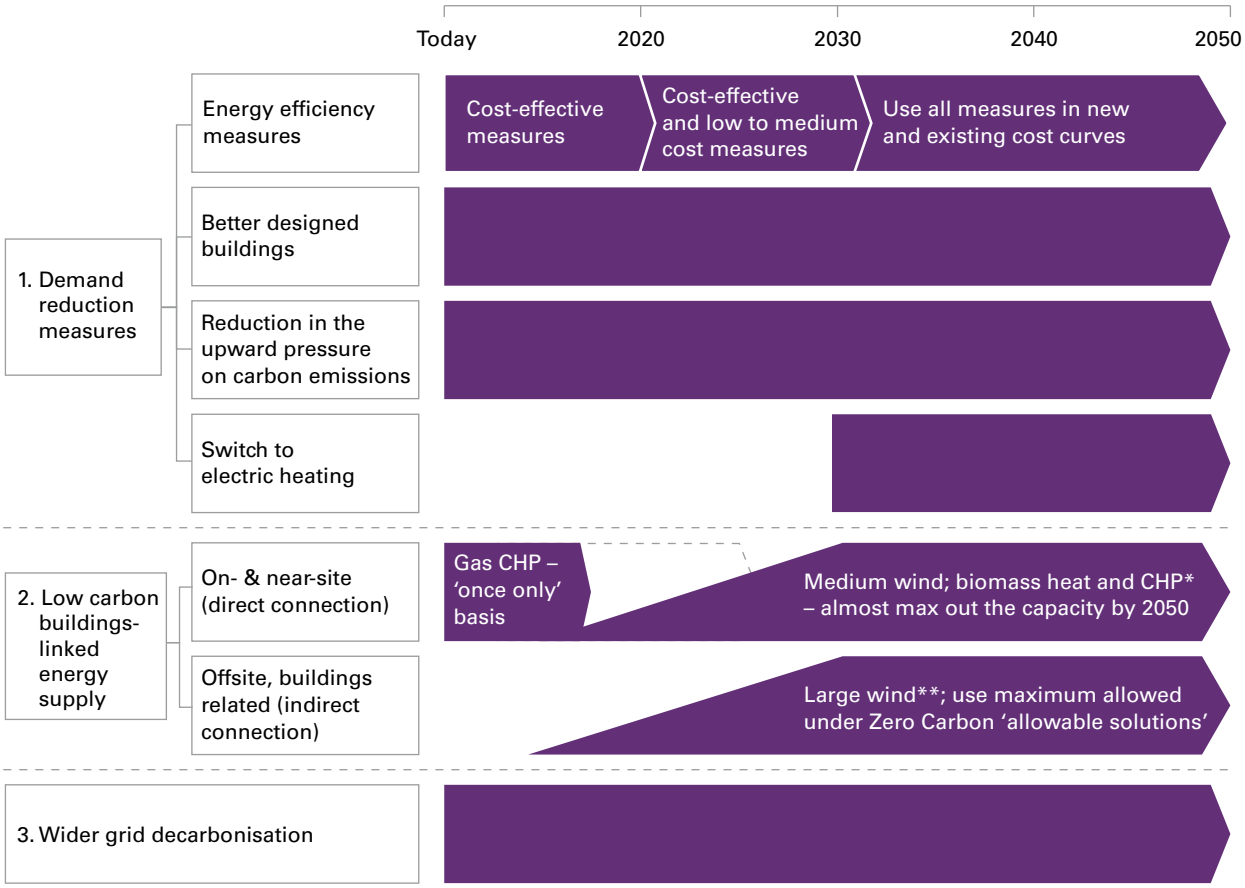
- Evenly spread measures: first, we created a scenario that simply spreads the implementation of these measures evenly over time from 2005 to 2020. This was not considered a sensible scenario but instead acts as a useful starting point.
- Success Scenario: the Success Scenario has a single objective: to minimise the cost of achieving an 80% reduction by 2050. We did not explicitly constrain the scenario to achieve the CCC's targets or to implement Zero Carbon new build by 2019 (though the Success Scenario achieves both these anyway). Costs are minimised by optimising when the measures are implemented. Simplistically, the cost-effective measures are implemented as soon as possible and non-cost-effective measures are delayed. *Chart 2r* illustrates the timing of the different measures in the Success Scenario.
- Sensitivities against the Success Scenario: two sensitivities were then created:
  - 10% beyond Success Scenario: implements non-cost-effective measures before 2020 to achieve an additional 10% carbon reduction by 2020.
  - UK 'intended' target: implements less cost-effective energy efficiency measures before 2020 so that non-domestic buildings only achieve a carbon reduction by 2020 equivalent to the CCC's 'intended target' of 31% from 2005.

Chart 2q details the parameters for each scenario in more detail.

Chart 2q *DeCODE parameters for scenarios*

DeCODE parameters		Scenario			
		Do nothing	**Optimistic current trajectory**	**80% reduction by 2050**	
				Evenly spread	**Success Scenario**
Stock		New build, refurbishment and demolition at current rates.		• Reduce new build rate in offices by a half to reflect the reduced upward pressure on emissions. • Increase unregulated refurbishment rate from 6.5% to 8.0% to implement cost-effective measures by 2020.	
Measures	1. Demand reduction measures	• Replace demolished buildings with new ones built to 2006 Part L regs. • No improvement in energy efficiency of existing stock. • 90% compliance rates for all new builds.	The planned increase of Part L to 25% by 2010 and 44% by 2013 are achieved by implementation of 90% of cost-effective EE measures. After 2020, Zero Carbon means no additional emissions.	All the parameters are set to their maximums, spread out over time.	All the parameters are set to their maximums, but optimised over time as illustrated in *Chart 2r*. Energy efficiency measures and low carbon supply with similar costs per tonne of CO_2 are installed at similar times. Cost-effective measures are implemented before 2020, measures up to £200/tCO_2 are implemented up to 2030 and measures beyond £500/tCO_2 implemented from 2030 to 2050.
	2. Low carbon buildings-linked energy supply	None	Implemented to fill the gap between the energy efficiency measures and achieving Zero Carbon from 2019.	2.4TWh of low carbon supply installed each year from 2005 to 2050.	3.4TWh of low carbon supply installed each year from 2020 to 2050.
	3. Wider grid decarbonisation	No grid decarbonisation	As produced by the CCC, excluding any offsite renewables associated with Zero Carbon buildings to avoid double counting.		

Chart 2r *Timing of measures in the Success Scenario*



*DeCODE models a subset of potential small-scale low carbon supply technologies. Others could include micro CHP, biogas, solar hot water and heat pumps.

**DeCODE models large wind, both on- and offshore, as a proxy for all large-scale renewables.

3 Policy options for Government

Policies are required that target both buildings and the organisations that use them. Existing policies need to be aligned with the delivery of all cost-effective measures, complemented by a limited set of new policies. Additional action is also required now to prepare for the future by driving innovation and increasing the supply chain's capabilities to deliver low carbon buildings.

Key findings

- There are three areas where policies are needed which target:
  - Carbon reduction to 2020, with a focus on implementing almost all the cost-effective carbon reduction potential.
  - Carbon reduction from 2020 to 2050, when almost the entire technical carbon reduction potential will be required to be implemented, much of it more complex and expensive than the measures to 2020.
  - Preparing for success after 2020, with policies aimed at ensuring the carbon reduction post-2020 is possible at sufficient scale and the lowest possible cost.
- For carbon reduction to 2020, the current policies in place – primarily the CRC and Building Regulations – whilst representing important drivers of change, do not remove all the barriers and target all the cost-effective carbon reduction potential. Additional policies are needed.
- These additional policies need to target both the buildings and the organisations that own/use them in order to remove all the barriers to more low carbon buildings.
- To target buildings the following new policies could be considered:
  - Public sector leadership through the implementation of all cost-effective options.
  - Minimum building standards with almost no G-rated buildings by 2020.
  - Building focused advice for those with F and G-rated DEC/EPC certificates.
- To target organisations, the following new policy options could be considered:
  - The Supplier Obligation 'CERT' extended/adapted for SMEs to drive installation of the simplest, low-cost energy efficiency measures.
  - Long-term loans for energy efficient equipment, paid for from the energy savings made, and which remain with the building where the improvements are made.
- Beyond 2020, almost all possible carbon reduction potential will need to be implemented, requiring another step-change in this sector. Whilst the detailed policies to deliver this can not be defined today, it is likely that the framework of targeting both the buildings, and the organisations that own/use them, will still be applicable.
- It is more important to consider the actions needed in the short to medium term that will ensure the industry can implement the more complex and expensive measures needed in the longer term. To achieve this, it is critical that over the next decade real energy and resources are put behind:
  - Driving increased innovation in low carbon energy generation and energy efficiency technologies and approaches to create a larger number of cheaper options for carbon reduction in the future.
  - Creating a supply chain with the ability to create genuinely low and Zero Carbon buildings as standard practice.

Introduction

Setting a clear direction for the industry is a first, important step towards creating a low carbon non-domestic building stock. But it is not enough in itself to drive the scale of carbon reduction required from our buildings.

In addition, Government policy packages will be needed in order to create the conditions within which the sector can deliver the optimum level of carbon reduction – the target emissions trajectory laid out in Chapter 2 'Direction setting'.

This chapter describes a range of policy options, combined into coherent packages, for Government to consider. In Section 3.1, we describe the potential policy packages for three different timeframes and objectives. The main focus is on the policies which are targeted at driving implementation of almost all of the cost-effective energy efficiency measures between now and 2020, and we explain why we have selected the specific policies listed and the framework within which we have placed them. Section 3.2 then describes each of the underlying policies that could populate the policy packages, including the rationale behind each and issues to be considered in their implementation.

It should be made clear at the outset that these are suggestions for Government to assess, within a clear policy framework and strategy for the sector. There are of course other policy ideas which are worthy of being considered, as part of a dialogue between Government, industry and other stakeholders, and we hope that the options we highlight can be included as part of this conversation.

The emphasis on policy 'packages' is also important. The individual policies will need to be effective in their own right and each will have specific objectives being targeted; but they will also need to integrate effectively and clearly with the other policies to achieve the overall outcome.

3.1 Policy packages and framework

Timing and purpose of Government policies

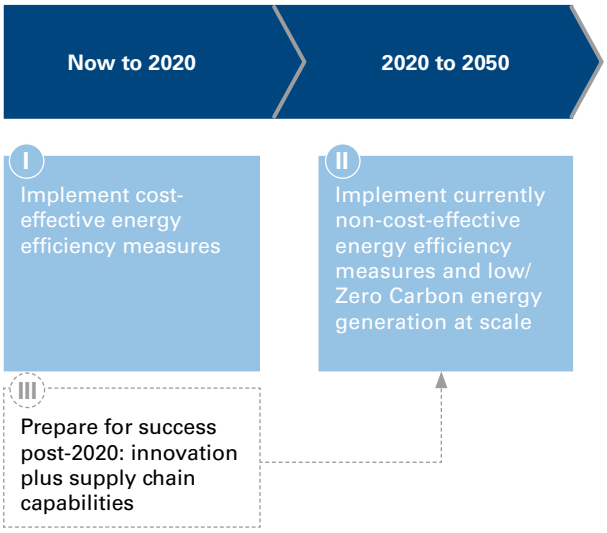
Chart 3a shows three separate areas where action is needed:

I **Carbon reduction to 2020:** policies here need to target the implementation of the simple, low-cost measures that our Success Scenario shows needs to be implemented by 2020 in order to optimise the cost of achieving 80% by 2050.

II **Carbon reduction after 2020:** policies will need to drive implementation of more expensive, complex measures and approaches.

III **Preparing for success after 2020:** policies will need to drive action before 2020 which leads to a greater range of lower cost carbon reduction options being available post 2020.

Chart 3a *High level steps to a low carbon non-domestic building stock*



Carbon reduction to 2020

Our analysis has shown that the primary focus of policy initially should be on the action needed now to deliver a 35% carbon reduction by 2020 through implementation of almost all of the cost-effective measures in both new and existing buildings. This could reduce annual CO_2 emissions by 37MtCO_2, from 106MtCO_2 in 2005 to 69MtCO_2 in 2020 (around half of this reduction will come from expected decarbonisation of the grid). It will create £4-5bn of net (cumulative) benefit to the UK.

To achieve this, policies will need to:

- Remove the barriers to low carbon buildings.
- Target all of the cost-effective carbon reduction potential.

Removing all the barriers

We have developed a set of policies which could catalyse the required change within the sector. They are shown in *Chart 3c* (overleaf), and fit within a framework which aims for 'better buildings, used better' by:

- **Targeting buildings;** and
- **Targeting organisations** which own and/or use buildings.

It is important that the policies target both of these areas, as each has its own set of barriers which need to be overcome if the scale and speed of carbon reduction described in our direction setting is to be achieved. If one barrier is left standing, the full carbon reduction potential may be difficult to realise.

When considering the specific barriers to rapid implementation of cost-effective energy efficiency, the long list of 24 barriers described in Chapter 2 can be synthesised to 8 key barriers (although others may still be relevant in specific circumstances).

The eight specific barriers can be categorised into those which reduce/prevent the creation of better low carbon buildings, those which impact the organisations within buildings using them properly, and some barriers which affect both areas (see *Chart 3b*).

***Chart 3b** Barriers to 'better buildings, used better' – those specific to the implementation of cost-effective measures over the next decade only*

Barriers to:	
Better buildings	**Used better**
1. Landlord-tenant divide	
2. Shortage of whole life costing approach at all stages	
3. Lack of perceived material value in developing low carbon buildings	7. Lack of motivation due to transaction costs, lack of awareness/information, or lack of transparency in building performance
4. Lack of ability in supply chain to deliver truly low carbon buildings	8. Immateriality of energy costs/savings
5. Non-compliance with Building Regulations	
6. Slow refurbishment cycle	

1. The landlord-tenant divide, prevalent in a significant proportion of the non-domestic building stock. It is the mis-alignment between investment in carbon reduction and the receipt of the economic benefit due to the investment. *Sidebox 3v* (see page 110) describes this barrier further, and outlines a process whereby this particularly 'sticky' barrier can be removed over time.
2. Shortage of whole life costing approach by building specifiers, designers, owners and users, leading to a perceived lack of business case for low carbon options.
3. Lack of perceived material value in developing low carbon buildings e.g. any future energy savings are small compared to the investment in constructing a building, and thus does not alter the business case.
4. Ability of the supply chain to implement the measures at a huge scale, correctly and quickly.
5. Non-compliance with Building Regulations, especially in the existing stock. Includes design of buildings, build quality and lack of full, effective commissioning.
6. Slow refurbishment rate reduces opportunity to improve existing stock at speed required.
7. Lack of motivation to improve energy efficiency of buildings especially due to transaction costs for SMEs; lack of awareness/knowledge of what to do to reduce carbon/energy use; or lack of transparency in building performance.
8. Immateriality of energy costs/savings relative to other costs for the users of buildings e.g. staff costs.

Thus, for a high probability of meeting a 2020 carbon reduction target of 35% (and hence maximise the economic benefit), the policy framework needs to target both buildings and organisations in order for there to be sufficient confidence that the scale and speed of carbon reduction required will be achieved – reducing less carbon, less quickly will cost the UK billions of pounds, and could lead to Government missing its legally binding carbon budgets.

It is difficult to quantitatively calculate the impact of policies versus the barriers, so uncertainty will remain over whether any set of policies will fully remove all of the relevant barriers. This backs up our belief that the DEC database, if spanning all non-domestic buildings, will be invaluable to monitor the performance of the building stock against the target emissions trajectory, and therefore to diagnose where policies need to be adjusted or complemented with new ones if the emissions reduction targets are not met.

Targeting all the carbon

The policy framework needs to ensure that the full range of cost-effective carbon emission reduction potential is covered by the policy packages. Current and expected policies do not achieve this, and there is therefore a need for a small number of new policies.

We have developed our policy packages and underlying policy options by using the following three stages:

1. **Evaluate carbon reduction potential:** calculate the scale of the carbon reduction opportunity from the implementation of all cost-effective measures i.e. set the goal for the policies as a coherent whole.
2. **Assess 'coverage' of current policies:** compare the key policy drivers that currently exist to the targeted carbon reduction and the need to remove barriers (to both better buildings, and to those buildings being used better) in order to understand the gaps in current policy.
3. **Develop new policies:** fill the policy gaps to increase the probability that the targeted carbon reduction, and the associated economic benefit, is realised.

Evaluate carbon reduction potential

The first step in testing the coverage of the policy framework is to calculate the scale of the carbon reduction that is being targeted. This carbon reduction will come from the implementation of almost all the cost-effective measures in both the existing stock (that is not demolished over the next decade), and new buildings built between now and 2020.

Sidebox 3iv (see page 109) describes the calculation showing how we have reached our target carbon reduction of 26MtCO_2. It is based on outputs from the emissions model developed with Arup.

To be more precise, the total carbon reduction is:

- **20MtCO_2** compared to the starting emissions of 106MtCO_2; or
- **26MtCO_2** compared to the emissions from the starting existing buildings plus additional new build floor space to 2020.

These numbers are before the decarbonisation of the grid is included. Adding the impact of grid decarbonisation achieves the 35% carbon reduction by 2020 described in Chapter 2 (37MtCO_2 reduction from starting emissions of 106MtCO_2). However, for simplicity, this chapter considers carbon reduction potential from specific policies in relation to a full potential of 26MtCO_2 described above.

Chart 3c *Policy packages to deliver a low carbon non-domestic building stock in the UK – the next decade*

Transforming the delivery of cost-effective measures up to 2020		
Targeting buildings	1. Policy package for **major interventions** (new build, major refurbishment)	**Building Regulations for new buildings – Part L2A**: tighten in line with current Government proposals for 2010 and 2013, plus the ambition to deliver Zero Carbon new buildings by 2019. Potentially extend to cover 'unregulated' loads before 2019.
		Building Regulations for existing building major refurbishment – Part L2B: change to be consistent with Part L2A, using CO_2/m^2 as the key output measure; tighten regulation to achieve average 15% reduction in CO_2/m^2 by 2020 (i.e. drive implementation of cost-effective measures) and at least 70% by 2050 (to meet our Success Scenario). To 2020 this policy will impact <15% of existing buildings.
		Enforcement bodies and regulation compliance: increase Building Control Body resources, people, training and tools, and improve the Building Regulations themselves, to deliver greater compliance with all building-related regulations. Need to measure compliance levels, and assess if the Government's proposals for improvements (as part of the 2010 Building Regulations) deliver greater compliance.
		Advice • **Carbon Trust 'Design Advice'** for large-scale new build and refurbishment projects with a significant low carbon ambition.
	2. Policy package to drive improvement across the stock **whilst in-use**	**Public sector leadership:** mandate implementation of cost-effective measures on DEC Advisory Reports (within lifetime of Advisory Report i.e. 7 years).
		Minimum building standards: all buildings must have an EPC rating of F or higher by 2020, and potentially E by 2025 (where cost-effective to do so).
		Advice • **Pro-active, building focused advice:** advice targeted at buildings with a particular focus on pro-actively improving F and G-rated buildings, alongside detailed 'how to' advice on implementation of Top 10-20 DEC/EPC Advisory Report measures for all.
Key	Existing	New

Continued overleaf

When approaching from the building perspective, ~50% of the opportunity (13.3MtCO_2 of the 26.3MtCO_2) comes from 'major interventions' (new buildings and major refurbishments covered by the Building Regulations) which will impact around one-third of the 2020 floor space. From the perspective of the organisations who own and use the buildings, ~50% of the opportunity lies within those that will be captured by the CRC.

Thus in the following sections, the policy framework within which we have developed the detail of our four policy packages is:

- Target buildings
  1. At major interventions.
  2. Whilst in-use.
- Target organisations
  3. CRC.
  4. Non-CRC.

This is shown in *Chart 3c* where the underlying policies are placed within this framework.

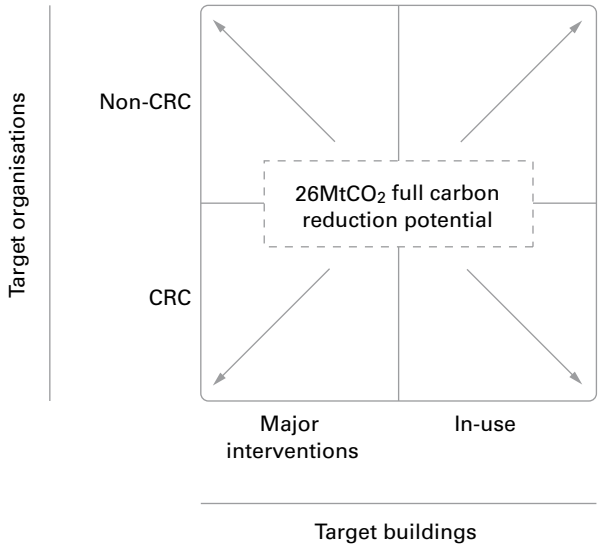
Chart 3c *Policy packages to deliver a low carbon non-domestic building stock in the UK – the next decade (continued)*

Transforming the delivery of cost-effective measures up to 2020		
Targeting organisations	3. CRC policy package	**CRC:** ensure cap is tightened to deliver emissions reductions of up to 10MtCO_2 through implementation of the cost-effective energy efficiency measures in the new and existing buildings of the included organisations.
		Public sector loans: Salix loans for all public sector organisations to continue.
		Advice • **Organisation focused advice:** Carbon Trust's Public and Private Sector Carbon Management and Energy Surveys (complementary to the pro-active, buildings focused advice described above).
	4. Non-CRC policy package	**CERT for SMEs:** extend supplier obligation into SMEs, setting up a new 5-10 year programme focusing on the simple, cost-effective measures in existing buildings. Maximum capital required from increased energy bills is ~£650m if this programme were to target 100% implementation of the measures. However, this figure will reduce based on the size of the loans programme (next policy).
		Loans: target the CO_2 reduction potential in existing SME buildings not covered by the supplier obligation (above). • **Loans paid back in less than 4 years:** re-cycle Carbon Trust loans scheme to cover additional investment of up to £200m over the next 5-10 years.
		• **Loans paid back in greater than 4 years:** develop longer term loans, paid for through savings on energy bills (linked to the building, not the organisation).
		Advice • **Organisation focused advice:** One Day Site Surveys, Sectoral programmes, publications and helpline advice for SMEs (complementary with the pro-active, buildings focused advice described above).
Optional additional policies if required	**Fiscal incentives:** link existing fiscal mechanisms such as stamp duty, business rates or Climate Change Levy levels to EPCs and/or DECs.	
	Mandatory green leases: mandate use of green leases across public sector within 3-5 years, as per the Australian model, to drive behaviour change and overcome the landlord-tenant divide. Follow up by extending into commercial and/or industrial properties.	
	Product standards: introduce additional or tighter product standards (compared to current and proposed EU regulations) for building fabric, services and other related equipment. Continue to work with EU bodies to ensure challenging minimum standards for equipment are set for critical items, such as air conditioners.	
	Key Existing New	

Chart 3d illustrates this framework, and how it maps to the total carbon reduction potential. The total area of the chart represents the 26MtCO$_2$ reduction potential, and each quadrant is of roughly equal size, representing around 6-7MtCO$_2$ reduction potential.

We will use this chart to 'map' policies against the 26MtCO$_2$ potential, by assessing how they target buildings and/or the owner/user. Thus we will be able to see the relative importance of each of the policy packages (by comparing their area on the chart), as well as the interaction between them. For example, any policy which covers half of the area in the chart is targeting half of the carbon reduction potential (although this does not necessarily mean it will be successful, as it may not target all the relevant barriers itself).

***Chart 3d** Illustration of the policy framework mapped to the full carbon reduction potential*



Assess 'coverage' of current policies

Before starting to 'map' the current policies against the carbon reduction potential, it is instructive to categorise policies into two main groups:

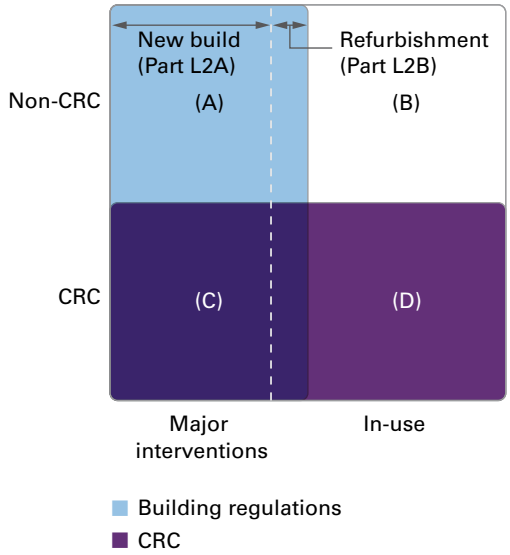
- **Driver policies:** the primary mechanisms for reducing carbon emissions in a specific area e.g. the Carbon Reduction Commitment for large non-energy-intensive organisations.
- **Enabling policies:** support broad target areas by helping to catalyse impact by overcoming specific barriers (e.g. loans programmes for SMEs or public sector), or which support specific policies (e.g. building control which enforces Building Regulations).

Starting with policies aimed at delivering better buildings, the key mechanism here is the Building Regulations which set the standards for 'major interventions' – new buildings and major refurbishments – including the current ambition for Zero Carbon new build by 2019[1]. These policies, if tightened sufficiently over time, and extended to include all sources of building emissions, could deliver ~50% of the cost-effective carbon reduction opportunity by targeting 'major interventions'. The Carbon Trust's Design Advice programme also enables delivery of carbon reduction during major interventions, by working with motivated clients to go beyond the minimum standards set by the Building Regulations (although its scale is currently small relative to the 2-3% of floorspace every year being built new or undergoing major refurbishment).

Moving on to the policies targeting organisations, the main mechanism here is the Carbon Reduction Commitment (CRC), a cap-and-trade scheme for ~5,000 large, non-energy-intensive organisations, explicitly aimed at increasing the uptake of cost-effective energy efficiency measures. Starting in 2010/11, it is likely to cover around half of the emissions from non-domestic buildings, and a similar level of the cost-effective carbon reduction opportunity. In addition, the Carbon Trust's Carbon Management advice programmes will continue to help these and other organisations to identify and implement carbon savings, and the Climate Change Levy will increase the cost of emitting carbon for all organisations who pay it (at 0.15p/kWh for gas and coal, and 0.43p/kWh for electricity, the levy adds ~15% to typical energy bills for UK businesses).

[1] Which will likely be implemented through the Building Regulations.

***Chart 3e** Illustrative mapping of current policies against the full carbon reduction potential*



Both of these driver policies (Building Regulations and CRC) need to be set at the correct level to target the full potential across all the buildings or users they will influence:

- **CRC:** should be set to achieve reduction of 9.9MtCO_2 vs current emissions (before impact of grid decarbonisation).
- **Building Regulations:** should target 45% improvements vs. 2006 in new buildings as soon as possible (tightening requirements by 25% in 2010 and 44% in 2013 as currently planned should achieve most of this), and the ambition for Zero Carbon new build by 2019, is the right target, with the right timing. For existing buildings, the regulations should ensure the ~15% cost-effective potential is delivered in all major refurbishments.

Chart 3e illustrates these two driving policy mechanisms mapped against the carbon reduction potential.

The two key conclusions that can be drawn from the policy mapping in *Chart 3e* are:

Building Regulations and CRC have an important role to play: around 75% of the carbon reduction potential will be impacted in some way by the Building Regulations and the CRC, if they are set at the correct levels.

However, additional policies are needed: only 25% of the 26MtCO_2 of cost-effective carbon reduction potential has policies targeting both the building and the owner/user, and can therefore have sufficient confidence that all barriers can be removed (quadrant (C) in *Chart 3e*).

In quadrants (A), (B) and (D) where there is not a driver policy targeting both the building, and the organisations that own/use it, we can consider (i) introducing additional policies or, (ii) ensuring that the policy in place is sufficiently robust, or has enough 'supporting' mechanisms such as advice programmes, to deliver a high level of confidence that the carbon reduction will be implemented.

Develop new policies

We now define potential options to strengthen the policy coverage across each of the quadrants in *Chart 3e*:

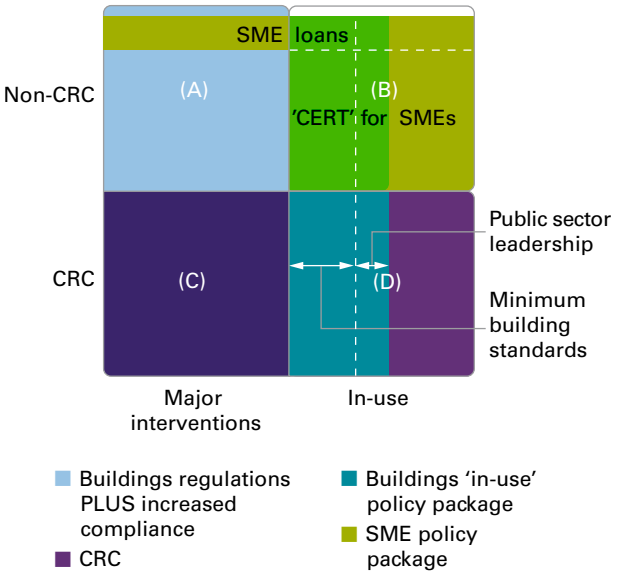
Quadrant A (and C): ensure compliance with Building Regulations and deliver advice for major interventions:

For buildings undergoing major interventions, the key driver of emissions reductions are the Building Regulations – compliance levels, currently less than 100%[2], need to improve if the full potential is to be realised. Design Advice programmes could also be expanded to support organisations in delivering lower carbon buildings by going beyond the Building Regulations where cost-effective.

Compliance is particularly important in quadrant A, where the Building Regulations are the only driving mechanism. However, improved compliance, and Design Advice, will also support the CRC organisations to implement more carbon reduction, faster (i.e. in quadrant (C)).

[2] No comprehensive data exists on compliance levels with the Building Regulations. In Section 3.2 we describe more details on how compliance levels should be first measured, then improved.

Chart 3f *Illustrative mapping of our suggested policy packages against the full carbon reduction potential*



Quadrants B and D *(see Chart 3f)*: develop new policies targeting buildings 'in-use':

For all organisations there is a gap for the majority of the existing stock of buildings which will not undergo a major intervention by 2020 – additional policies are needed for buildings whilst 'in-use'. We suggest the following options for Government to consider:

- **Public sector leadership:** public sector to implement cost-effective options from DEC advisory reports within the seven-year lifetime of the report.
- **Minimum building standards:** all buildings to achieve at least an F-rated EPC by 2020 (where cost-effective).
- **Building focused advice:** a pro-active advice and support programme targeting cost-effective improvements in the poorest buildings – those with F and G-rated DEC/EPC certificates – alongside detailed 'how to' advice on implementation of Top 10-20 DEC/EPC Advisory Report measures for all buildings. This will act as an enabling policy to the above driver policies.

Quadrant B: Non-CRC organisation's 'in-use' buildings:

Even with the 'in-use' policies described above, non-CRC organisations 'in-use' buildings are still not fully covered – organisational barriers to implementation of cost-effective measures are still likely to remain.

Again, we take a more supportive approach for the non-CRC organisations, augmenting the above policies with a new SME policy package which will not increase the burden on SMEs:

- **'CERT' for SMEs:** develop a national programme led by the energy suppliers to install the simple, low-cost energy efficiency measures in existing buildings, paid for by a small increase in SME energy bills.
- **Longer term loans:** loans of over four-year duration for energy efficient equipment, paid for from the energy savings made, similar to the Government's current proposal for the domestic sector in the Heat and Energy Savings consultation. These would complement the continuation of the current SME loans scheme (managed by the Carbon Trust).

Chart 3f shows how the additional policies/policy packages map against the full carbon reduction potential.

Only 0.2MtCO_2, or less than 1%, of the 26MtCO_2 carbon reduction potential is not targeted by any policies. We do not consider this to be large enough to warrant development of further policies.

One major area (of ~6MtCO_2 reduction potential) remains that does not have policies targeting both the buildings and the organisation – the right-hand side rectangle in quadrants B and D representing good to average (A to E-rated) non-public sector 'in-use' buildings. In quadrant B, where CERT and SME loans will be available to all, it is important that these policies pay particular attention to those buildings/organisations which will not fall under the public sector leadership or minimum building standards policies, as otherwise no policy mechanism will be applied. In quadrant D, the cap-and-trade mechanism of the CRC should be strong enough to drive change for those under this scheme. And importantly, the buildings focused advice will bring technical expertise and implementation advice to all in-use buildings, driving further implementation of measures. We therefore do not suggest additional policies for any of these areas.

II Carbon reduction after 2020

By 2020, the intention is that all the cost-effective energy efficiency measures will have been implemented across the non-domestic stock. After 2020 all new buildings will need to be Zero Carbon and existing buildings that are not demolished will need to halve their emissions as they stand in 2020, despite the fact that they will already have implemented all currently cost-effective measures. This will require almost all possible carbon reduction potential to be implemented, much of which is not currently cost-effective, and also requires greater upfront expenditure (£50bn in capital investment by 2050 could be needed, compared to ~£1.5bn for the cost-effective measures over the next decade). Achieving this will be a huge challenge – a second step change in carbon reduction will need to take place.

It is likely that the specific policies to encourage continued carbon reductions will need to evolve to be more suitable to these more complex, expensive measures which currently have a net cost to the UK. The framework of targeting both buildings and the users of buildings may still be applicable, but we do not attempt to detail specific policies for after 2020.

Instead, it is more important for now to consider the actions which need to happen over the next decade which can improve the industry's ability to deliver carbon reductions after 2020.

III Preparing for success after 2020

The measures which need to be implemented after 2020 present a whole new challenge for the entire sector, quite different to the implementation of low-cost, cost-effective measures. Government policies will be required which will lead to:

- Large scale **innovation** support across a range of technologies and approaches to develop a greater range of carbon reduction options, at a lower cost than today. This includes building fabric measures, more efficient building services and equipment, and low/Zero Carbon energy generation. The Renewable Energy Strategy will help put in place the incentive mechanisms which will help drive innovation and deployment of renewable technologies (see *Sidebox 3i* overleaf).
- A transformation of the non-domestic **supply chain capability** to implement new solutions as part of an integrated approach to the development, design, construction and use of genuinely low carbon buildings – just bolting on low carbon solutions will not be enough.

These actions are needed now, in parallel to the policy packages described above, to ensure the emissions trajectory continues on a downward path even once all the low-cost energy efficiency measures have been implemented.

Innovation

Achieving 80% reductions in carbon emissions from non-domestic buildings could cost the UK a net cumulative total of ~£13bn by 2050, and yet a reduction of 70-75% should be possible at no net cost. Thus the costs escalate as we get towards the last remaining potential – implementing today's technologies only just has the potential to achieve an 80% reduction. Most of the cost is concentrated in a small number of measures including the more expensive low carbon energy generation technologies.

Therefore, if we need to reduce carbon emissions beyond 80%, or wish to reach this level at a lower cost, a broader range of carbon reduction options is needed – innovation is required to both reduce the cost of achieving an 80% reduction by 2050 and to increase the options to achieve it.

So how should the UK go about delivering the innovation that is needed?

Focus for success – an approach for innovation in the UK

More innovation is required, but what should the UK do about it? Should we actively support it, or should we wait for other countries to invest in R&D and the installation of these technologies whilst they are not cost-effective – then buy them once the costs go down? And what is the best approach to support innovation? The Carbon Trust has recently published a major new study[3] that answers these questions across the full range of low carbon technologies (LCTs), not just those for non-domestic buildings.
The report concludes that:

- There is a compelling case for the UK to support low carbon innovation.
- A new 'technology focused' approach, bringing together both technology prioritisation and technology customisation, will radically improve the cost-effectiveness of UK LCT innovation.

Sidebox 3vi (see page 115) gives more detail on the report and its findings.

From the perspective of carbon reductions in non-domestic buildings, it is important that as part of the UK's overall approach to innovation that sufficient focus, time and resources are given to those technologies with significant potential for low-cost carbon reduction in this sector. Further, a genuinely low carbon building stock requires more than new technologies – innovative approaches to the specification, design and construction of buildings will be needed; innovative business models to deliver carbon reduction measures or to change the landlord-tenant relationship will be needed; and innovative routes to altering end user behaviours will also be required. All of this will necessitate innovation to be supported and progressed rapidly, from the development of new ideas through to the refinement, piloting and rollout of new approaches and methodologies.

3i. Renewable incentive mechanisms

A significant amount of renewable power generation will be required to meet the UK's emission and renewable energy targets both by 2020 and 2050. Given most of these technologies are currently not cost-effective, how is the Government planning to incentivise their deployment and drive innovation and reduce their costs?

The Government's Renewable Energy Strategy outlines three incentive mechanisms to support renewable technologies:

1. A modified version of the existing Renewables Obligation will support large-scale renewable power generation.
2. The Government has announced that micro-generation feed-in tariffs will support the smaller power generation that are likely to be installed on-site.
3. A separate Renewable Heat Incentive (RHI) will support biomass, heat pump and other on- and near-site renewable heat technologies.

Supply chain capability

Implementing today's cost-effective measures need not place significant new demands on the supply chain. Most cost-effective carbon savings can be achieved with a small set of relatively simple, low-cost measures, such as replacing worn-out boilers and installing energy-efficient lighting and appropriate controls.

However the new and refurbished buildings after 2020 will need to be very different from those of today. The entire supply chain that can deliver and maintain such buildings will need to have a very different set of capabilities across every stage of the 'building journey', from:

- The upstream supply chain (developers, investors, advisors) who will need to specify and procure buildings differently.
- The designers (architects, engineers) who will need to design Zero Carbon new buildings and creative low carbon refurbishments.

[3] 'Focus for success – a new approach to commercialising low carbon technologies.'

- All those involved in the construction process who will need to deliver high quality, airtight buildings which match the design.
- All those who run buildings (facility and energy managers) who need to maintain the as-commissioned performance and drive behaviour change.

During our interview programme, around half of the interviewees defined either 'a lack of skills & knowledge to deliver low carbon' and/or 'the design-out of low carbon measures' as critical barriers within the supply chain which are preventing the creation of more low carbon buildings.

"Contractor skills are a barrier, even for large global companies"

Commercial building user

As the *Sidebox 3ii* (see next page) explains, design teams of the future will need to use an integrated process starting from the inception of the building all the way through to several years after occupation. And the design itself will need to incorporate low carbon options to reduce energy demand, use energy more efficiently, and reduce the carbon intensity of the energy that is used. Whilst examples do exist where these approaches have been successfully employed, it is not currently standard practice across the non-domestic sector, and yet by 2020 these capabilities will need to be embedded into the supply chain. Otherwise, the buildings of the future will disappoint, and carbon emissions will remain stubbornly high.

We believe there are three important actions, requiring a cross-industry approach, that will be needed to create a step-change in capabilities across the various professions involved.

1. Define best practice

There are currently pockets of best practice low carbon buildings within the non-domestic sector, but these will need to become standard practice if the required emissions trajectory is to be followed from 2020 onwards. Best practice is needed across the overall work stages of a building, as well as for the individual elements and activities. In order to both define low carbon best practice, and show the capability gaps that exist, an approach using 'competency matrices' could be used. These competency matrices would define:

- The full list of capabilities required for all specialties involved in the development of a low carbon building e.g. the range of areas in which an architect could have expertise.
- What a score of 5 (best practice) or 0 (no skills in this area) looks like. The Carbon Trust in Scotland has recently developed such competency matrices as a tool for procurement teams to assess their own skills and identify the gaps that they need to contract in[4]. These matrices could be extended and updated, with input from across the many stakeholders involved – professional institutions, Government, companies, and individual professionals and practitioners – to develop an agreed set of matrices which define best practice, based on experience of what has been achieved in cutting edge projects to date.

2. Assess the capability gaps

Once best practice has been defined, a programme of assessments could then be conducted, perhaps led by the professional institutions, to compare the capabilities of entire sectors, companies and individuals to the best practice benchmarks.

3. Fill the capability gaps

Finally, the education and training to fill the capability gaps will need to be delivered. This will involve a large number of organisations such as the professional institutions, Government, Skills Councils, individual companies and universities and colleges. The challenge will be to agree on what the programme looks like, who is responsible for its delivery, and who should pay for it. Yet, it is critical that within the next 5-10 years, the non-domestic building sector is able to deliver, as standard, a quality of building far superior to those being delivered today.

"There aren't enough skilled professional engineers or architects to design low carbon systems"

Architect

[4] Elements of these specific matrices are: Organisational Management, Client Values at project inception, Process & Finance, Site Selection & Planning, Sustainability, Operating energy minimisation, Passive Design, Productive Workplace, Investment & Whole Life Costs, Operational Costs, Construction, Operation, Contracts.

3ii. Critical elements in the creation of a low carbon building

A low carbon building has an integrated design process which incorporates the energy-carbon hierarchy:

1. An integrated process

The Carbon Trust's experience working with multiple customers has highlighted the many issues that exist through the entire 'building journey' from the initial vision all the way through to several years after the building is occupied. For a building to be truly low carbon, every issue at every stage will need to be dealt with, and the multitude of different professions involved will need to understand their role in ensuring this happens, and how their behaviours affect other stages in the process.

Our 'Low carbon refurbishment of buildings' management guide highlighted several key actions, in the context of large refurbishment projects, which could help deliver lower carbon buildings:

- Secure commitment from the senior team by agreeing low carbon objectives as part of the project vision statement.
- Establish the current carbon footprint of the building and set carbon reduction targets for the refurbishment.
- Consult building occupants and key stakeholders at the beginning of the process and ensure project buy-in from the design team and site workers.
- Appoint a carbon champion at an early stage of the project to maintain a focus on energy use implications of design decisions.
- Integrate low carbon design into the general building design and don't treat it as an add-on.
- Use a whole life cost analysis to evaluate low carbon systems and components.
- Ensure high quality commissioning for energy efficiency, allocating a specific budget for the purpose.

Recently, The Usable Buildings Trust and BSRIA launched the 'Soft Landings' framework in order to help overcome many of these issues through better briefing, design, handover and building performance in use. It is a process for designers and constructors to improve the operational performance of buildings and provide valuable feedback to project teams. It involves:

- Achieving greater clarity at the inception and briefing stages about client needs and required outcomes.
- Placing greater emphasis on building readiness, by designer and constructor having greater involvement during the pre-handover and commissioning stages.
- A resident Soft Landings team located on-site during the users' initial settling-in period.
- Remaining involved for 1-3 years after occupation, during and beyond the defects liability period to resolve outstanding issues.

Further information can be found at www.bsria.co.uk/services/design/soft-landings

2. Use the 'energy-carbon hierarchy' to deliver a low carbon design

Low carbon buildings employ a range of features that are designed to minimize the energy used, and carbon emitted, broadly outlined under the following approaches, in priority order:

- **Passive Design:** the building is designed to avoid the use of energy, so stays warm in the colder months without overheating in summer. It is likely to make good use of natural light and natural ventilation, and have high levels of air tightness and insulation.
- **Active Design:** the energy using plant and equipment in the building is highly efficient and well controlled, so the minimum amount of energy is used, and only when needed. For example daylight sensors switching on low energy T2 bulbs only when natural lighting levels are too low.
- **Use of Renewable Energy:** equipment is installed at the building to exploit natural energy and so reduce the need for carbon-intensive imported energy. Solar hot water, heat pumps and biomass boilers all fall under this category.

"If we halve the demand, double the efficiency and halve the carbon in the supplies, you are down to one-eighth of the carbon"

Bill Bordass, Usable Buildings Trust

3.2 Policy detail for options targeting carbon reduction to 2020

Chart 3c outlined our proposed policy framework and gave a brief description of each of the individual policies contained within each of the four policy packages:

- Policies targeting buildings:
  1. Policy package for major intervention (new build, major refurbishment).
  2. Policy package to drive improvement across the stock whilst in-use.
- Policies targeting organisations:
  3. CRC policy package.
  4. Non-CRC policy package

This section goes into more detail for each policy option, describing the rationale for the policy, detail on how it could be implemented, and where possible, other implementation issues such as costs or responsibilities.

Sidebox 3vii (see page 117) summarises the potential carbon reduction that each policy could target (as a stand-alone policy) as described through this section.

Policies targeting buildings

1. Policy package for major interventions

Building Regulations address major intervention events in a building's life. The regulations covering conservation of fuel and power in England and Wales are covered in Part L (more specifically, L2 covers non-domestic, L1 covers domestic). In Scotland, the equivalent is Part J, and in Northern Ireland it is Part F[5].

New construction is targeted by Part L2A and major refurbishments are targeted by Part L2B. Both of these need to be tightened to deliver all cost-effective opportunities. To maintain compliance, building control and/or other enforcement bodies will need to be strengthened.

Building Regulations for new buildings (Part L2A) – tighten existing policy to target 10.7MtCO_2

The greatest carbon saving opportunity for any building is in its initial construction. Most buildings that are constructed over the next decade will still be standing in 2050, so it is critical that the most is made of this opportunity.

Our Success Scenario analysis in Chapter 2 shows that the most cost-effective path to meet an overall reduction of 80% by 2050 is to implement all the cost-effective new build measures as soon as possible (delivering 10.7MtCO_2 reduction by 2020) and to ensure that new builds do not add any additional net emissions from around 2020 onwards. This analysis is in line with the Government's proposal of achieving Zero Carbon new non-domestic buildings by 2019. Thus this ambition fits with the aim of reducing carbon at the lowest possible cost.

The Building Regulations impacting emissions from new buildings, Part L2A (which sets a target CO_2/m^2 for each building), should therefore be tightened to deliver the full set of cost-effective measures and to put new buildings onto the path to reach Zero Carbon by 2019, in line with current proposals. This requires a 25% reduction in regulated emissions[6] in 2010 versus 2006; increasing to 44% in 2013 (again versus 2006).

A further reduction could be considered in 2016 to smooth the transition to Zero Carbon whilst still remaining cost-effective. Our analysis indicates that new builds could go beyond a 44% reduction level, with a 58% cost-effective reduction in regulated emissions being possible today (given that regulated emissions account for ~75% of expected emissions from new buildings, the 58% reduction potential equates to a ~45% reduction in total emissions).

The Government could also consider including all building emissions for new buildings in Part L2A earlier than when the target for Zero Carbon new buildings is introduced in 2019. In other words, also regulating the level of emissions from, for example, 'plug-in loads' such as computers and catering equipment. This would create more options for cheaper, cost-effective emissions reductions, potentially taking the cost-effective opportunity from the total emissions to beyond 50%. This can be achieved in the same way as for the Zero Carbon buildings target – by assuming average loads for plug-in equipment etc. in the National Calculation Methodology (NCM) building model tool, SBEM[7].

[5] From here on we will talk about 'Part L', but assume this covers the equivalent regulation in Scotland and Northern Ireland.

[6] From here on we will talk about 'Part L', but assume this covers the equivalent regulation in Scotland and Northern Ireland.

[7] SBEM – Simplified Building Energy Model. Its accuracy should be continuously improved, reflecting the actual performance of buildings as measured by DECs. This is another reason to implement DECs for all buildings.

Part L2A has proved reasonably effective in improving new buildings (although comprehensive evidence of its impact is not available) and as an existing policy can drive change relatively quickly. A number of issues need to be addressed to ensure it delivers the 10.7MtCO_2 reductions that the Success Scenario demands of it:

- As Part L2A is tightened, particularly as it approaches the Zero Carbon target and potentially cannot be met with cost-effective measures, compliance will become a larger issue and will require increased building control resource and capabilities. The strengthened building control required is discussed below.
- The soon to be finalised definition for the Zero Carbon target should lead to the cheapest solutions for the UK being selected where possible, so long as the emissions reductions are real, additional and verifiable. The Government's proposed hierarchy – first, achieving a minimum level of efficiency; second, meeting 'carbon compliance' through further energy efficiency or directly connected low/Zero Carbon energy generation; finally, reaching Zero Carbon using a range of 'allowable solutions', such as allowing a certain percentage of offsite low carbon electricity – should be capable of achieving this. However, the interaction with the existing incentive mechanism for large scale renewables (the Renewables Obligation) needs to be considered.
- What happens after 2020, when all new buildings are theoretically Zero Carbon, needs to be considered. The decarbonisation of the grid will mean that achieving Zero Carbon will become easier. This unintended consequence should be avoided, so the definition for Zero Carbon will need to evolve, and tighten, over time. This could lead to it including a tightening energy efficiency requirement, a maximum energy use level which would reduce over time, or the inclusion of embodied carbon into the definition for Zero Carbon (this also targets embodied carbon as it becomes a higher percentage of a building's emissions).
- There is a need to ensure the assumptions for unregulated (and regulated) loads in the NCM model (SBEM) fairly represent the actual, average energy use. The database of DECs and EPCs should help here, but additional research is likely to be required. SBEM will also need to be continually developed to ensure it gives the correct level of carbon reduction to the range of different technologies and approaches which can be employed.

Building Regulations for major refurbishment of existing buildings (Part L2B) – tighten existing policy to target 2.4MtCO_2

The second largest opportunity to cost-effectively reduce a building's carbon emissions, after its initial construction, is during a major refurbishment. A greater range of measures (with larger carbon reduction opportunity) is possible because often major refurbishments occur when the building is not occupied. This allows significant upgrades to the building's fabric, heating, lighting and cooling systems. In addition, the business case for saving carbon improves. With significant changes already planned as 'business-as-usual', the business case for reducing carbon should only include the incremental cost of, for instance, a more efficient air conditioning unit over the one that would have normally been installed, rather than the full cost of the unit.

To make the most of this opportunity the Building Regulations for major refurbishments, Part L2B, should be tightened to deliver the full cost-effective opportunity. This is an effective way to use the regulatory tools that are already at our disposal with minimal delays. For the ~15% of buildings likely to undergo a major refurbishment before 2020, implementation of the entire cost-effective potential (~15% carbon reduction) would lead to total emissions reducing by 2.4MtCO_2.

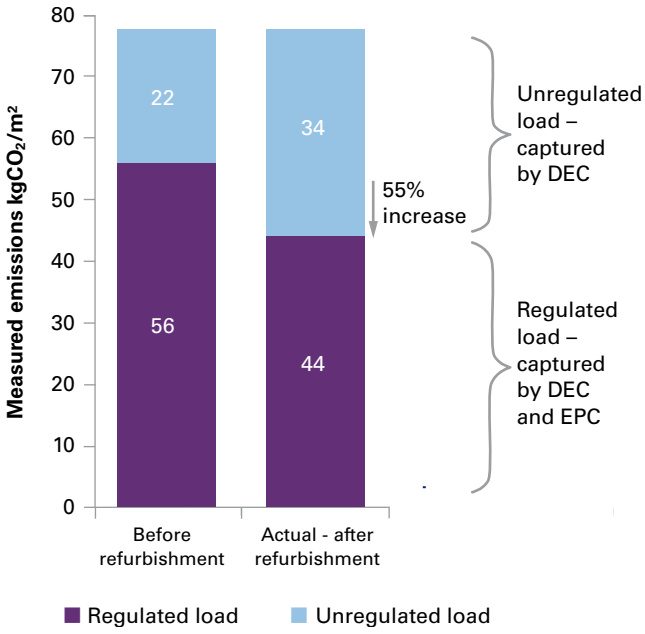
To achieve this will require:

- Moving to a kilogram of CO_2 per square metre ($kgCO_2/m^2$) approach. Part L2B is currently an elemental approach. In other words each element, such as new glazing or a new heating system, needs to meet certain standards. Instead, Part L2B should move to a $kgCO_2/m^2$ target (as is the case in Part L2A for new builds), where the refurbishment needs to achieve a certain level of emissions, through whichever approaches are deemed most suitable by the design team.
- Setting the $kgCO_2/m^2$ reduction target at or near the average cost-effective opportunity, currently 15%. Further analysis and consultation will be required to set the correct target level, and to define how it will be applied.

After 2020 the reduction target could be gradually tightened to improve today's average buildings performance (from 115kgCO_2/m^2 to the 34kgCO_2/m^2 required of them by 2050). This would imply an increase in the reduction target of ~8% every 3 years (2010, 2013 etc.). Just over half of this improvement could be delivered by decarbonised grid electricity, requiring an improvement from the building of ~4% every 3 years. This gradual tightening could encourage earlier major refurbishment – if refurbishment in a building was delayed for 3 years it would have to deliver 8% more than if it were done immediately. However a reduction of 8% every 3 years could potentially not be cost-effective – further analysis is needed to define how far and how fast the existing stock can be improved (beyond the cost-effective measures). Pushing refurbishment too hard could have the opposite effect to that desired – building owners could simply decide not to refurbish. So an alternative option is to continue to set reduction levels at the limit of cost-effective opportunities.

The Government could consider including all the building's emissions within the scope of Part L2B – in the same way as the option described above for Part L2A. In the refurbishment projects in the Carbon Trust's Low Carbon Building Accelerator, any reduction in regulated emissions was often undermined by an increase in non-regulated process emissions – *Chart 3g* shows an example profile of measured emissions before and after refurbishment for one particular project. Incorporating all emissions into Part L2B would help address this issue.

***Chart 3g** Example refurbishment of a high street retail business*



Source: Carbon Trust

Another option to be considered is to broaden the proportion of refurbishments that come under Part L2B. Part L2B will currently only impact around 15% of existing buildings by 2020. This is because the definition of a major refurbishment is relatively narrow – any refurbishment where the spend is over 25% of the value of the building or is impacting over 25% of the building e.g. a building with four floors where the refurbishment is taking place in more than one floor.

However we recommend keeping this option in reserve for now, monitoring the impact of the full policy framework and only broadening the proportion of refurbishments that come under Part L2B if non-domestic buildings under-perform compared to the planned emissions trajectory. Achieving compliance of Part L2B is, anecdotally, already more difficult than Part L2A. Achieving compliance of a broader Part L2B will be even more problematic.

The modelling required to implement these proposed changes to Part L2B need not place much of an additional burden on industry. Implementing the move to a $kgCO_2/m^2$ approach will require all buildings that are having a major refurbishment to be modelled (using SBEM or other approved software). However if all buildings were required to have an EPC by 2015, as recommended, then the buildings would need to be modelled anyway. And going forward, building owners are likely to benefit from proving their buildings EPC ratings have improved after a major refurbishment as the market may assign greater value to more efficient buildings (as seen in the US and Australia) or regulations link building performance to fiscal mechanisms such as business rates.

The biggest implementation issue is likely to be compliance, even though in most cases the measures will be cost-effective. As is the case for Part L2A, compliance issues can be addressed by strengthened building control.

Enforcement bodies & regulation compliance – strengthen existing mechanism to target 1.3MtCO$_2$

High levels of compliance with the Building Regulations is required even as the regulations are tightened, otherwise the carbon reduction opportunity will be lost, leading to overall carbon targets being missed, or measures being required at an additional cost to the UK. EPCs and DECs also need to be implemented correctly. Both of these objectives can be achieved by understanding the levels of compliance, providing sufficient resource to Building Control, and improving the regulations themselves:

- **Understanding the levels of compliance:** there is currently little information of the level of compliance with Building Regulations. The Government should make it a priority to improve the measurement of compliance rates. The overall monitoring of non-domestic buildings emissions through the collation of DECs should help to show the levels of compliance on a stock level, though additional measurement will also be required at a building level.
- **Sufficient resources:** strengthening the current enforcement bodies will require greater resources in terms of money, people and training. In particular, dedicated Part L/J inspectors for large buildings (>1000m^2, which account for ~70% of total non-domestic floorspace) could ensure a continual focus on energy performance throughout the development of new buildings and major refurbishments.

  Assuming around 2,500 of these large buildings are built or undergo major refurbishment every year, assigning 10 man-days to each building from a Part L/J inspector (spaced out from the inception stage through to handover), could require an additional £5m per year. A similar amount may be required to increase the time spent on Part L for the remaining 30% of floorspace where the buildings are less than 1000m^2, and where the inspectors will check compliance with the full set of Building Regulations (Parts A to P).

  Consequently, an initial, rough estimate for the increased cost could be ~£10m per year. This would be a good investment if compliance were to increase by 10%, as expected in the Government's proposals for Part L in 2010. Thus, if the last 10% of the cumulative net benefit to 2020 were put down to increased compliance, the ~£100m additional cost to increase compliance would be offset by the ~£225m benefit[8], and be responsible for ~1.3MtCO$_2$ reduction by 2020.
- **Improving the regulations themselves:** the regulations themselves can also be altered to improve compliance rates. For instance, design factors can be made more conservative so that the in-going assumption is a high level of energy loss unless a specific set of approaches are implemented. Accredited Construction Details (ACDs) can ensure that enhanced benefits that are modelled are installed.

The Government has recognised that compliance of Building Regulations is currently an issue and is working towards rectifying it. It has proposed a number of measures in the 2010 buildings regulations, currently out for consultation. These include measures to improve the regulations (more conservative design factors and ACDs), as well as increased air tightness tests, commissioning processes, education and training. This is a significant step in the right direction. The Government should measure the impact of these changes and will then be able to see whether they are sufficient or if additional improvements need to be made.

[8] Half of total carbon reduction potential is covered by the Building Regulations, so improving compliance could target the last 10% of half of the total net benefit to 2020 of £4-5bn i.e. 10% x 0.5 x £4.5bn = £225m.

2. Policy package to drive improvement across the building stock whilst 'in-use'

Building Regulations will impact around a third of the 2020 building stock over the next decade, and can target around half of the carbon reduction potential. Policies are also needed to directly drive improvement across the remaining two-thirds of the 2020 building stock (around 75% of today's building stock). Broadly speaking, these should be focused on delivering the simple, low-cost, cost-effective measures, which can be implemented in buildings that are occupied.

Two different approaches can be taken, one for public sector buildings (accounting for ~20% of the total non-domestic floorspace), and one for the commercial and industrial sectors. The public sector can take the lead, with a mandate to implement all cost-effective measures, initially in all large buildings. The Government could then take a more phased and less prescriptive approach to commercial and industrial buildings, with minimum standards focused on upgrading the poorest performing buildings. Both policies should be supported by a pro-active, building focused advice programme.

Public sector leadership – new policy to target 2.4MtCO_2

The Committee on Climate Change's recent report stated 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"

We believe this can be achieved by leveraging the DECs that are already in place for all large public sector buildings. Government can mandate all practicable measures outlined in the Advisory Report for public sector buildings that accompanies each DEC, within the lifetime of the report i.e. seven years. These measures are specific to each building[9] and are only listed if the accredited assessor judges them to be cost-effective. The public sector organisation could apply to be exempted from any measures that it can prove are not cost-effective. This exemption could also incorporate any heritage buildings used by the public sector where planning rules would prevent the measure from being implemented.

The DEC should be used in the case of public sector buildings, rather than the EPC, because the DEC includes all the building's emissions and measures on the DEC Advisory Report include behavioural measures which do not require much upfront investment.

This policy could save up to 2.4MtCO_2, whilst also catalysing the low carbon refurbishment supply chain and save the taxpayer at least £100m p.a. once all measures have been implemented:

- The ~40,000 existing large[10] public sector buildings addressed by this policy represent a large enough market that it would make a real difference to CO_2 emissions. Public sector buildings represent ~20% of non-domestic buildings floor space and our rough calculations based on the current DEC database and other Government data suggest that more than 90% of this floor space is in large buildings which require a DEC.
- The scale of this policy would significantly catalyse the supply chain to be able to better deliver energy efficiency retrofits to buildings and could encourage new business models for retrofit to be developed.
- This policy has an attractive business case for the taxpayer. Implementing all the cost-effective measures in large public sector buildings could lead to annual savings of more than £100m p.a. in energy costs. The total capital over seven years is not large – of the order of £300m, or £40-50m per annum – and would have the added benefit of acting as a fiscal stimulus to the economy.

[9] The DEC assessor selects the measures, from a long, generic list, that are appropriate for a particularly building and can add customised recommendations as well.

[10] Over 1000m^2; number of buildings covered would increase if floor area threshold drops to 250m^2 under proposed EPBD2.

This policy would also meet the UK's obligations under the EU's Energy Services Directive which demands that Member States should show public sector leadership in improving energy efficiency.

There are a number of issues that would need to be addressed to implement this policy. These include:

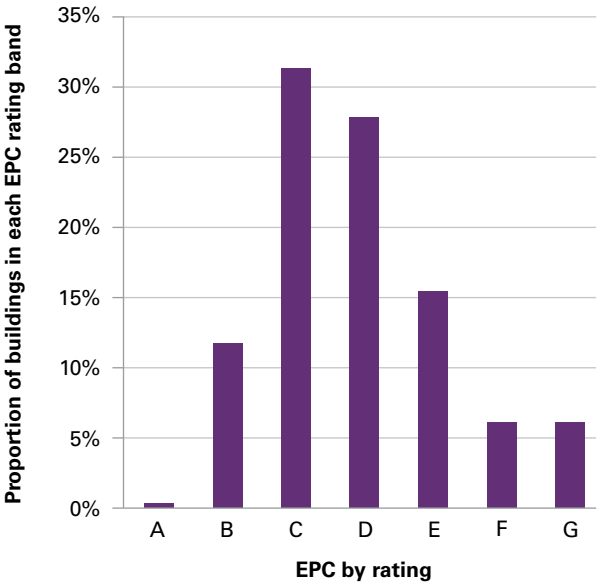
- **How to implement the measures in a public sector building that is owned by a private sector landlord:** this policy should apply to buildings that are used by the public sector but are owned by a private sector landlord. Public sector buildings typically have long leases, so the measures should pay back within the period of most leases. However, mechanisms will need to be created to ensure that the private sector landlord is sufficiently incentivised to implement any measures on the DEC that require a significant capital investment. This could include a commercial ESCO model where a third party makes the investment and benefits from the energy savings, or the use of a green lease. *Sidebox 3v* (see page 110) gives more detail on potential approaches and options for removing the landlord-tenant divide.
- **How to audit whether the measures have been implemented:** the most practical and cost-effective approach is likely to be sampling. All public sector buildings would submit the list of measures that they have implemented, evidence to prove implementation (such as reports, invoices or photographs of installations) and reasons why any measures were not implemented, such as proof they would not be cost-effective or were impractical. A random sample of 5-10% of submissions would then be subject to an on-site audit – 200-400 buildings per year over the next decade.
- **If and how to extend the policy to smaller buildings:** although the large public sector buildings account for 90%+ of floor space/emissions/carbon reduction potential, there are still a much larger number of small public sector buildings. There is a question of whether it is worth addressing these through this policy or instead to rely on Building Regulations and the SME policy package outlined later. Even though we recommend DECs for all buildings, it is possible that it will not be cost-effective for DECs for small buildings to have advisory reports. So the measures on the EPC report could be used instead.
- **How to enforce the mandate:** there are a number of options for how to enforce the mandate. These include:
  - **Commercial penalties:** the public sector organisations occupying the building could be levied fines or have its budget cut if it fails to implement all the cost-effective measures in its DECs.
  - **Transparency:** annual reporting at a local level of EPC and DEC distributions, and the percentage of cost-effective measures implemented (and reasons for where they haven't been or date for when they will be).
  - **League tables:** similar to the above, but implementation of measures ranked into a league table to promote competition and early action.

Minimum building standards – new policy to target 4.8MtCO_2

The Government could consider introducing a policy which proactively focuses on the UK's worst performing non-domestic buildings. This opportunity can be realised by mandating minimum Energy Performance Certificate levels for non-domestic buildings. Such a minimum standard for buildings would need to be backed up by technical advice and loans for the organisations impacted, in order to support the changes which are being mandated.

The minimum standard could be set so that all commercial and industrial buildings have at least an F-rated EPC by 2020 with a further option to increase this minimum standard to an E in 2025. Owners could also be given the choice to implement all the measures on their buildings' DECs instead, as per the public sector leadership programme outlined above. Both options of course require legislation that all buildings must have an EPC and DEC. These certificates should be rolled out by 2015 to give organisations sufficient time to make improvements.

***Chart 3h** EPC distribution, August 2009*



Source: Department for Communities and Local Government

Such a policy would only impact around 6% of the building stock (according to the current distribution of EPCs – see *Chart 3h*), and yet impact almost 15% of the total emissions. Improving the average G-rated building to an average F could reduce overall carbon emissions by 4.8MtCO_2, and would be possible for the vast majority of buildings using the simple, low-cost, cost-effective measures we believe are the key between now and 2020 (for an example of the impact of these simple measures, see the case study on DECC's office in Whitehall Place discussed in the Executive Summary).

The independent Committee on Climate Change has backed this policy option in the 1st progress review report (October 2009):

"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)"

We suggest that the default for commercial and industrial buildings is a minimum EPC rating rather than implementing all the DEC Advisory report measures (as in the public sector) for a number of reasons:

- EPCs represent the quality of the building. This aligns with the principle, which is to target the performance of the underlying building.
- EPCs are not volatile. Once a building has obtained a certain EPC rating its performance is unlikely to vary year-on-year (at least in the short term) – compared to DECs where performance depends on how a building is used year-on-year.
- EPCs are the responsibility of owners, who have the greatest scope to impact a building's emissions, as shown in *Sidebox 3v* (see page 110) on the landlord-tenant divide.
- Auditing that an EPC is at least an F is simpler and cheaper than checking all DEC Advisory Report measures have been implemented.
- Owners have the full range of choice in the measures they want to use, (as per the Building Regulations, assuming the NCM software will be able to calculate the CO_2 benefit for all potential measures).
- The public sector leadership programme leverages the fact that DECs already exist for public sector buildings.
- Owners can still opt for implementing all measures on a DEC instead, if they would prefer.

Owners would not have to implement any non-cost-effective measures, though the onus would be on them to prove these measures are not cost-effective. Similarly owners of heritage buildings, as per current Building Regulations, may need to be treated differently given their special circumstances and constraints. The details of these exemptions and how they would be processed would need to be addressed during policy development.

At first, creating a minimum performance level for all buildings may seem to be an overly robust mechanism. However, this approach has several benefits:

- This policy is targeted but material: 75% of emissions are regulated and therefore represented by the EPC when considering the entire stock. This policy would target the lowest 6% of buildings, with an average improvement of at least 24% leading to a 4% reduction for the entire stock.
- It re-sets expectations away from incremental, backward-looking improvement. Zero Carbon will stand at one end of the scale – setting the new high standard for the future's new buildings; minimum standards will stand at the other end of the scale – improving the worst existing buildings.
- The measures to improve these buildings are cost-effective and will therefore create a net benefit to the building (although the landlord and tenant may need to create a financial arrangement e.g. through a green lease, to share the benefits of their actions and investment). The worst performing buildings should have the greatest potential to reduce their carbon emissions, and maximise energy savings, through implementation of these measures.
- The 2020 timeframe allows building owners enough time to make the best economic decision for their properties, including making the improvements at the same time as a scheduled 'business-as-usual' refurbishment.

Compliance could be a crucial issue, and is likely best delivered through commercial rather than legal repercussions. For instance, all G-rated buildings could have stamp duty and business rates that are higher than for all other buildings so the owner would face issues in selling or letting the property. Alternatively the Government could also fine building owners. These commercial measures are likely to be more practical than legal measures, such as preventing the letting of G-rated buildings or an extreme measure of preventing G-rated buildings being used. The most appropriate compliance approach would need to be developed further by Government in detailing this policy.

Any penalties associated with lack of compliance are likely to only impact significantly less than 1% of buildings:

- Only 6% of non-domestic buildings currently with certificates are G-rated.
- Some will not be able to reach an F rating even after implementation of all feasible, cost-effective measures. These buildings, likely to include heritage buildings and other existing buildings with unique constraints on what improvements can be made, should be exempted from having to achieve an F rating once they have proven they have implemented all possible cost-effective measures.
- The majority of G-rated buildings should be able to achieve at least an F rating by implementing cost-effective measures. Given the economic imperative, the driving policies in place, plus the available support in the form of advice, this should leave only a small group of buildings that should be directly subject to any penalties.

Advice – expand/continue current programmes ('Design Advice'/organisation focused advice) and introduce a new, building focused option

As can be seen in *Chart 3c*, within each of our policy packages some level of Advice is included. The Carbon Trust's experience of working with thousands of organisations since 2001 shows that this is necessary to overcome non-financial barriers such as:

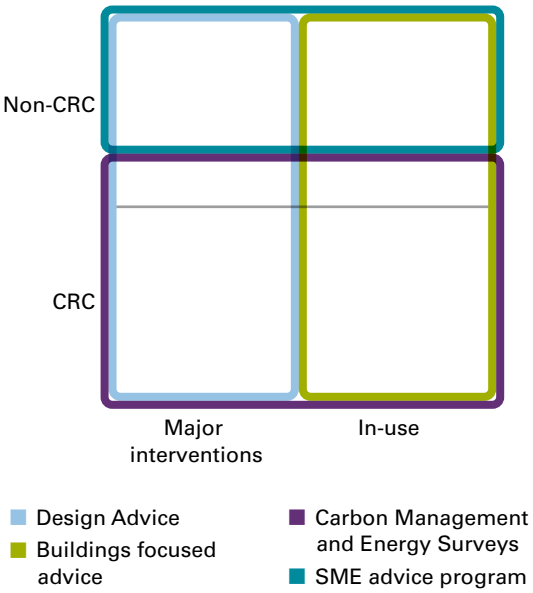
- Transaction costs.
- Lack of knowledge on which measures to implement.
- Lack of understanding of the business case/other benefits.
- Lack of motivation.

There are four different forms of advice we believe will help increase the rate (and lower the costs) of implementation of the cost-effective measures into the non-domestic building stock:

- 'Design Advice' during major interventions
- Pro-active, building focused advice, for buildings in-use
- Carbon management programmes for larger organisations (including many not large enough to be in the CRC)
- Advice programmes targeting SMEs.

Together, these advice programmes can target a significant proportion of the full volume of carbon reduction potential, by focusing on both the buildings, and the organisations using them (*Chart 3i*). Of course, on their own they can not be expected to achieve all of the carbon reduction, but they are important in underpinning other policies to ensure the full potential is realised.

Chart 3i *Mapping of advice programmes to the carbon reduction potential in buildings and organisations*



Source: Carbon Trust analysis

1. Advice during a major intervention – expand Design Advice programme to target up to 1.2MtCO_2 reduction by 2020

The Carbon Trust's current 'Strategic Design Advice' programme part-funds expert low carbon consultancy support for large scale new build or refurbishment projects, including master planning. The consultants bring past experience of working on low carbon projects, and a constant focus on embedding low carbon into the specification, design, build and handover stages of the project. We have seen many examples in the past where a low carbon ambition for a building gradually becomes eroded through the process, leading to significantly less carbon reduction than first anticipated. Having low carbon consultants as part of the design team helps to overcome this specific issue. The aim for projects covered by this programme needs to ambitious, where the client has a strong desire to go significantly further than Building Regulations would require, albeit while still focusing on finding cost-effective solutions to reduce carbon.

Currently the scale of this programme is relatively small in order to ensure quality of service to our customers, but there is potential for this to be expanded, given enough time to source and train the expert consultants, and to find projects with the required level of ambition.

2. Pro-active, building focused advice – target worst performing buildings to deliver up to 1MtCO$_2$ reduction

Advice targeted at existing buildings through proactively contacting those with F and G ratings (EPC and/or DEC), should increase the uptake of cost-effective energy efficiency measures. This advice programme could offer a survey to these poorly performing buildings, in order to detail specific improvement measures (where the building is large enough), and help drive through to implementation. This policy would support the 'minimum building standard' and 'public sector leadership' policies described above, and help more G-rated buildings to meet the F rating without the need to resort to penalties for non-compliance.

This programme could be extended to also support the A to E-rated buildings by including detailed implementation advice for the top 10-20 DEC/EPC Advisory Report measures, delivered through any or all of the following:

- Phone line implementation support.
- Lists of accredited products and companies.
- Written publications with sufficient detail for the owner and user of the building to be able to implement the measures.
- Case studies to bring the 'theory' into the real world.

This building focused advice programme could be for all buildings, or just the public sector and/or SMEs, and would be complementary to the organisation focused advice (see next two forms of advice) where significant opportunity may lie in an organisation's poorest buildings, and where specific, targeted advice will help to realise this opportunity.

3. Carbon Management and energy survey programmes – up to 1.8MtCO$_2$ annual CO$_2$ reduction in 2020

Helps large and medium-sized organisations and the public sector to measure their carbon footprint, and to identify and implement carbon reduction opportunities. In 2008/09 the Carbon Trust made over 3,000 site visits to customers, cutting at least 1.3MtCO$_2$ and helping them to save at least £165m. Further, this advice is helping organisations to think about their broader strategy in relation to carbon, covering areas such as supply chain emissions, travel, and the carbon footprint of the products and services they offer to market.

4. Advice programmes targeting SMEs – up to 1.45MtCO$_2$ reduction

Publications, phone line support and events such as 'One-to-many' workshops to share ideas on carbon reduction measures, are all available to the hundreds of thousands of SMEs through the Carbon Trust.

Policies targeting organisations

As well as policies directly targeted to produce better buildings, policies are needed to incentivise organisations to better use their buildings and to overcome the organisational barriers outlined earlier.

The Government has already made strong progress in this area with the introduction of the CRC for large organisations. In addition, the Carbon Trust provide advice for organisations and interest-free loans for SMEs and the public sector are delivered through the Carbon Trust and Salix Finance respectively.

The CRC needs to be aligned to deliver the cost-effective opportunity. Organisations that are not in the CRC should be targeted by a SME package that increases support, including long-term loans linked to the building and the introduction of an equivalent to the Carbon Emissions Reduction Target (CERT). These options are outlined in detail below.

3. CRC policy package

CRC – set cap at 9.9MtCO$_2$ to meet cost-effective opportunity (targeting 13.1MtCO$_2$ total)

The CRC is the lead policy mechanism to improve the end use carbon efficiency of large, non-energy-intensive UK organisations. The objective of the CRC is to increase the uptake of energy efficiency measures.

The CRC assigns a cost to carbon emissions via a cap-and-trade scheme. It also recognises that pricing mechanisms will not be enough for non-energy-intensive businesses, where energy costs are often only a very small proportion of an organisation's cost base. The CRC adds a reputational incentive through the increased transparency brought about both through the process of measuring and trading emissions and by the act of grading organisations on their carbon performance and publishing those results in league tables. Assigning a cost to carbon emissions and increasing transparency should raise energy efficiency up the management agenda.

The question that remains is 'At what level should the CRC cap be set?', in order that it drives real carbon reductions that would not otherwise have happened, whilst not putting onerous, expensive demands onto the organisations involved.

As described previously, we believe the total carbon reduction potential, relative to today's emissions from non-domestic buildings is 19.8MtCO_2. The Government should therefore tighten the CRC cap to deliver emission reductions that match this level. Assuming the CRC targets 50% of non-domestic buildings emissions, and carbon reduction potential, this suggests a cap of 9.9MtCO_2. This figure excludes any carbon reduction from industrial process emissions captured by the CRC, and so the final cap should be higher (depending on Government's calculations for the potential reduction from industrial process emissions, which are outside the scope of this report). And of course, this figure is before the impact of grid decarbonisation is included i.e. it is the expected carbon reduction from non-domestic buildings within the CRC in a world where electricity does not decarbonise. Including the impact of grid decarbonisation (from 560gCO_2/kWh today to 350gCO_2/kWh in 2020) the total emissions in our Success Scenario are 69MtCO_2 in 2020, a reduction of 37MtCO_2. This suggests a cap for CRC organisations of 34.5MtCO_2, a reduction of 18.5MtCO_2.

Loans – continue to fund the public sector to target 2.4MtCO_2

Interest-free loans for carbon reduction measures by public sector organisations captured by the CRC, should continue via the Salix Finance loans programme[11], as these help to overcome two particularly influential barriers to these organisations:

- A lack of ability to access external capital is directly targeted through these loans.
- Management decisions on allocating capital to carbon reduction projects versus other activity areas should not be an issue as the capital for carbon reduction is now from a different 'pot'.

In the April 2009 budget, the Government committed significant new loan funding of £55m for the public sector to be disbursed through Salix this year. Assuming a lesser annual commitment of £20m p.a. to 2020, Salix loans could lead to carbon reductions of up to 2.4MtCO_2 by 2020.

Commercial/industrial organisations that are subject to the CRC are large[12] and so should be able to access sufficient levels of financing. The CRC will also help these businesses to overcome internal capital allocation issues, as the reputational effect will push carbon reduction further up the priority list of senior managers, and the cost of carbon under the scheme will change the business case for investment, increasing the return on investment in carbon reduction measures.

Carbon Management Advice

As described above, in order to support, and accelerate, the carbon reduction from CRC organisations, by helping them to overcome any remaining barriers e.g. lack of knowledge on what/how to implement specific carbon reduction opportunities.

4. Non-CRC policy package

The organisations that are not covered by the CRC should be given increased Government support to drive implementation of the cost-effective energy efficiency measures. These are organisations that spend less than £500,000 a year on electricity and will mostly be small and medium-sized enterprises (SMEs). These organisations have less capacity to handle any bureaucratic burden associated with new policies. Policies should therefore either target SMEs indirectly (e.g. through their energy suppliers), or through simple schemes which remove, rather than create, transaction costs.

The SME package of policies we suggest are:

- Carbon Emissions Reduction Target (CERT) for SMEs
- Loans, paid back in:
  - Less than 4 years
  - More than 4 years, linked to the building
- SME advice programme.

These are outlined in detail below.

In addition, industrial organisations included in Climate Change Agreements (CCAs) will not be in the CRC. For these organisations, the majority of their emissions will be process oriented, and are therefore outside of the scope of this report. However, it is important that any CCA for a sector should consider the cost-effective opportunity from the buildings of the included organisations, and that almost all of this potential is targeted to have been implemented by 2020.

[11] Open to all public sector organisations, not just those included in the CRC.

[12] >6,000 MWh of electricity consumption.

CERT for SMEs – target up to 4.9MtCO$_2$

SMEs face specific barriers to the implementation of even the simplest measures: lack of capital, lack of awareness/knowledge on what to do, and a shortage of time and resource to assess the options. Tackling these barriers from a top-down manner is difficult. On the other hand, placing the onus for implementing the simple, cost-effective measures on the energy suppliers, as the current CERT scheme does for the domestic sector, not only addresses these barriers but utilises the purchasing power and economies of scale of energy suppliers. This approach could also help to overcome the landlord-tenant divide as the cost is not borne by either side of the divide.

The Government already has a policy in place for households in the form of CERT – the third, three-year phase of the energy supplier obligation. Suppliers are given a specific carbon reduction target. The suppliers have the choice of how they deliver this target, subject to a number of constraints.

The Government could extend CERT to SMEs, or create a parallel programme focused on SMEs, based on similar principles to CERT. As an option, the Government could start by limiting the programme to the smallest organisations, whose buildings and emission reduction measures are structurally more equivalent to those of households. It could then decide later if medium-sized enterprises should be included.

The objective would be to set the CERT carbon reduction target to deliver a specified proportion of the ~7.8MtCO$_2$[13] of cost-effective potential in existing buildings occupied by SMEs. Analysis of our cost curves suggest that 63% of the cost-effective carbon reduction potential comes from installation of controls and sensors, as well as optimising the use of these controls (and those already in place). Thus 4.9MtCO$_2$ reduction could be possible, with the investment required being of the order of £300-400m over a period of up to 10 years. Given the low annual capital required, the simplicity and small number of the measures, and the need for them to be implemented across a large number of buildings, a 'top down' implementation scheme such as CERT could be an efficient mechanism for delivery of the carbon reduction potential.

3iii. Carbon Trust SME loans scheme

The interest free Energy Efficiency Loans Scheme was launched in February 2003.

Since that time over £80m has been loaned to SMEs to enable them to purchase energy-saving equipment, with carbon dioxide savings of over 500,000tCO$_2$, and energy cost savings of £80m.

The National Audit Office, a UK Government body set up to ensure tax payers money is spent wisely, concluded that 94% of the loans scheme customers would not have purchased energy-saving equipment without the funding provided.

Loans – target up to 2.4MtCO$_2$

Loans are particularly useful for SMEs because they have greater difficultly accessing funding compared to larger organisations.

Loans can target the measures that are not delivered by CERT – typically those with larger upfront capital costs. The loans programme could be outcome driven i.e. focused on delivering a carbon target. For the measures not included in CERT (as described above) loans of £300-400m could target carbon reductions of around 2.4MtCO$_2$ from cost-effective measures (probably split across both existing, refurbished, and new buildings).

Loans less than 4 years – extend Carbon Trust scheme

The Government provides interest-free loans to organisations not in the CRC, delivered through the Carbon Trust loans scheme – see *Sidebox 3iii* for more detail. The loans are unsecured with no arrangement fees and have a straightforward application process. They can be for any amount between £3,000 and £400,000 and can be repaid over a period of up to four years.

This year the Government announced a significant increase in the funding for the SME loans scheme as part of the UK's fiscal stimulus, with £84m to be committed over two years. The Government could allow a proportion of these loans to be 'recycled'. In other words allow the money that is paid back to be used to finance new loans. This could create an additional £200m in investment in cost-effective carbon reduction in SMEs over the next 10 years, above and beyond the investment from previous and current loan funds.

[13] Half of the 15.6MtCO$_2$ potential in the 2020 non-domestic building stock which exists today.

Loans more than 4 years – new scheme

The Government could also provide funds for longer term loans or leverage private sector capital to create loan funds. These could be linked to the building (rather than the organisation) along similar lines to the "Invest to Save" schemes being considered for domestic properties, whereby loans are paid back through energy bills. If an organisation moves location, the loan does not move with them, but would continue to be paid back by the next user of the building (who is receiving the benefit of the investment).

These loans could be delivered in such a way that the SMEs need only sign up for the scheme. Energy Saving Companies (ESCOs) could identify the emissions saving opportunities and manage the installation and maintenance of any measures, minimising any transaction costs for the SMEs.

SME advice programmes

As described above, in order to support, and accelerate carbon reduction from non-CRC organisations. In addition, the building focused advice would potentially lead to more SMEs receiving detailed advice where their buildings are of a poor level of energy performance.

Optional additional measures if required

The action package must be clearly linked to the strategic direction and can be altered and/or strengthened as required to ensure the emissions from the sector follow the targeted trajectory.

The first option is of course to refine or tighten all of the measures described above, but other policy options may need to be considered, including:

- Fiscal incentives linked to building performance
- Mandatory green leases
- Additional or tighter product standards.

Fiscal incentives

It is possible that the business case for implementing cost-effective measures will still not be attractive enough even with the four recommended policy packages. Whilst cost-effective measures by definition yield a return, the return could be too little compared to other business opportunities for that company, or the absolute savings too immaterial to justify the time and effort required from an organisation's management. Energy costs for non-energy intensive companies are typically only 1-2% of costs, so the 15% cost-effective improvement could be immaterial. This is particularly the case for companies not in the CRC, who will not be impacted by a price of carbon and, most being SMEs, will have higher relative transaction costs.

Fiscal incentives could be introduced to alter the business case – exaggerating the cost reductions from implementing energy efficiency measures. Incentives/penalties in terms of existing fiscal mechanisms such as stamp duty, business rates or the Climate Change Levy could be linked to building performance metrics such as EPC and/or DEC ratings/scores. The objective would be to increase the cost of increasing emissions and the benefit of reducing emissions more than the simple energy savings themselves. This could be revenue neutral, where A-rated buildings benefit from a reduction in costs, G-rated buildings are subject to an increase, with a sliding scale in-between these ratings. The size of the percentage increase/decrease could be increased over time. The fiscal incentive should transparently increase the value of more efficient properties – surveyors should easily be able to apply a differing valuation to buildings with different levels of energy efficiency, a task which is difficult today given the lack of transparency on the energy performance of most buildings.

For instance, business rates are material – they increase the rent paid by an organisation by almost 50%. Consider a service sector company with the following cost base:

- Rent plus business rates account for a third of the cost base (this is quite typical for a services based company)
- Employees salaries ~65%
- Energy costs only 1-2%.

Thus business rates would be responsible for around 10% of the cost base, and increasing them by a margin of 10-20% would therefore be equivalent to doubling energy costs. In addition, business rates are listed as a cost per square metre when a building is up for lease. In other words business rates are already transparently linked to a building's value and any changes to business rates would directly affect this value.

Fiscal incentives are therefore likely to have significant impact. They could drive higher uptake of energy efficiency measures but, given the very magnitude of their impact, are likely to increase the risk of significant unintended consequences. We therefore suggest keeping them in reserve and only introducing them if the sector does not respond sufficiently to the four suggested policy packages.

Mandatory green leases

Green leases are legal contracts that form the basis for landlords and tenants to work together to improve the carbon performance of a building. They capture an agreement between the landlord and tenant, including:

- Obligations to achieve energy and carbon performance targets
- Commitment to install and maintain measures that allow the target to be met.
- How to allocate the costs and benefits of the measures.

Green leases can be 'light green' – with no/minimal real consequences for failure, or 'dark green' – with penalties for failure to meet the lease conditions, including damages, rate abatement, indemnities, recovery of costs and even termination.

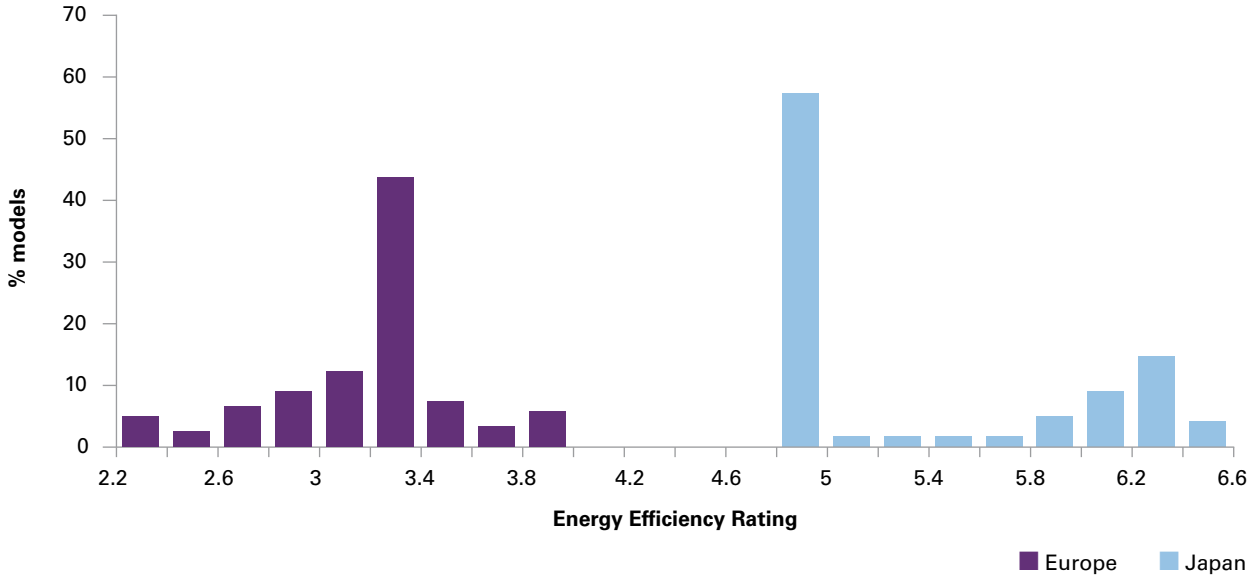
The Australian Government has mandated green leases for all new leases in offices occupied by Government agencies meaning that thousands of green leases have been put in place since 2006. The Australian green lease is a self-contained generic document forming a legally enforceable management framework. Key elements of the lease are:

- Agreed energy efficiency level for the building/ Australian Building Greenhouse Rating
- Separate digital metering
- Energy management plan
- Building management committee.

There are eight 'Green Lease Schedules', different depending on who pays the bills, the size of the building and whether the building has a sole, majority or minority tenant.

In the UK market, green leases are not widespread, although the Better Buildings Partnership, a collaboration of some of the UK's leading commercial property owners, have produced a guide to green leases, aimed at encouraging greater uptake of green leases, and to help define the elements of the lease where a tenant and landlord decide to work together. In addition, a roll out of DECs and EPCs to all buildings would give a clear, objective measure of a building's performance, on which future green leases could be based.

Chart 3j *Distribution of air conditioning by energy efficiency rating (EER) for EU and Japan*



Source: BRE

The UK Government could mandate green leases across the public sector within 3-5 years, along similar lines to the Australian scheme. This would drive significant change in public sector buildings, and help to support the implementation of DEC recommendations as we proposed earlier.

With a critical mass of green leases, commercial and industry tenants and landlords could realise their benefits – with resulting step change in take-up through market forces. Alternatively, the Government could choose to extend the mandate to these sectors.

Additional/tighter product standards

Product standards should be effective tools to reduce carbon in non-domestic buildings. The top ten cost-effective measures deliver the majority of the opportunity to save energy and carbon, so a targeted number of standards can have significant impact. Product standards overcome barriers such as lack of knowledge/awareness and transaction costs as the choice is removed to specify inefficient equipment.

Air conditioning 'in particular' would benefit from new minimum standards as this is one of the major areas for growing energy use and carbon emissions. And yet, as *Chart 3j* shows, the average efficiency of air conditioning in the EU is significantly behind that of Japan, where a concerted effort has been placed on increasing energy efficiency of air conditioning.

Other possible products include fans and Thermostatic Radiator Valves (TRV) as standard on all new radiators, as well as extending standards to construction materials, such as glazing and insulation.

Product labelling and standards are mostly set at the EU level – which is why they are not included in the suggested policy packages for the UK Government. The UK Government can play an important role by being an active advocate within the EU – supporting additional labelling and standards being developed within the Ecodesign directive, focusing on products that would have a large cost-effective saving in non-domestic buildings.

There are then options to push performance beyond the minimum set by the EU, should this be necessary.

Supporting information for Chapter 3

3iv. Calculating the full cost-effective carbon reduction potential

The building stock will change between now and 2020, creating both upward and downward pressures on CO_2 emissions. *Chart 3k* shows how the emissions could change if the full cost-effective carbon reduction potential were to be implemented into the building stock.

First, between 2005 and 2020, there will be additional floor space added to the non-domestic stock, driven by population and economic growth. If these buildings are built to 2006 Building Regulation standards, they would add 6.5MtCO_2, leading to a total of 112.8MtCO_2. However, we know that there is a large carbon reduction potential beyond 2006 standards – our modelling has shown there to be a ~45% cost-effective carbon reduction potential from energy efficiency measures, which if fully implemented would reduce the emissions by 2.9MtCO_2.

Next, a proportion of today's buildings will be demolished between now and 2020. Assuming current trends continue, this would lead to a reduction of 13.9MtCO_2. These buildings will be replaced by new buildings, which if built to 2006 standards would add back 10.9MtCO_2 (3MtCO_2 less than the buildings that were demolished). However, as above, implementing the ~45% carbon reduction potential beyond 2006 standards, would lead to a further reduction in emissions of 4.8MtCO_2 (a total net improvement of 7.8MtCO_2 compared to the buildings that were demolished).

Finally, for those existing buildings which will still be standing in 2020, our cost curves suggest that there is a ~15% carbon reduction potential from cost-effective energy efficiency measures, which if implemented would reduce emissions by a further 15.6MtCO_2.

The combined impact of implementing the full cost-effective potential would be a carbon reduction of:

- **19.8MtCO_2** compared to the starting emissions (106.3MtCO_2), or
- **26.3MtCO_2** compared to the emissions from the starting existing buildings plus the additional new build floor space (112.8MtCO_2).

This is therefore the full carbon reduction potential that the policies need to target between now and 2020.

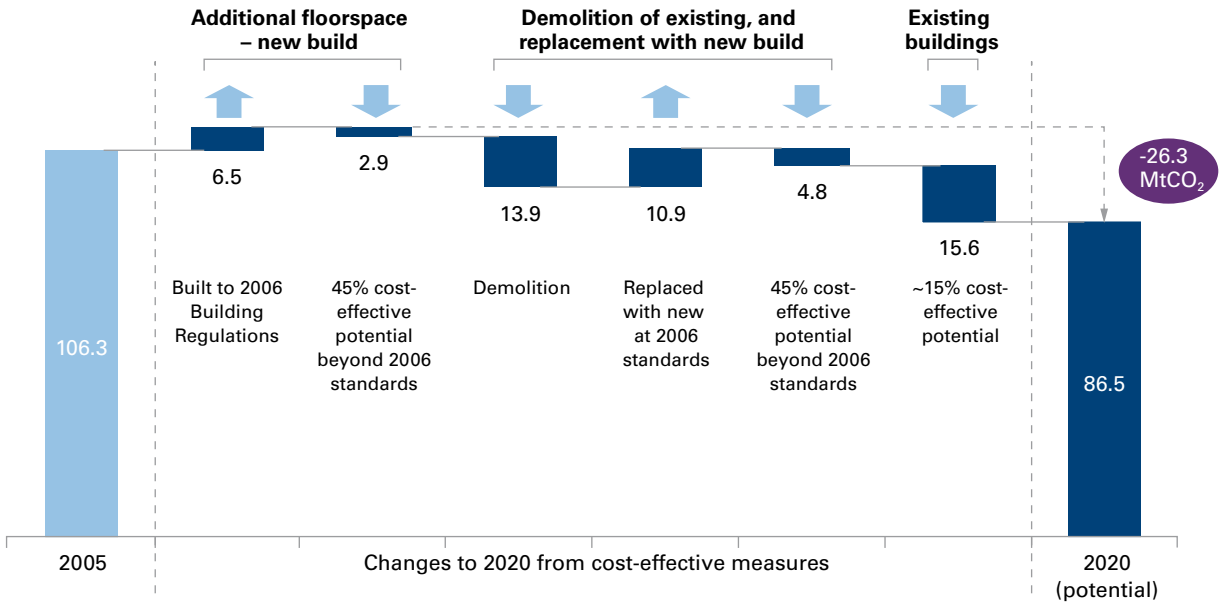
Of course, this is in a hypothetical world where the electricity being delivered to the buildings remains at a fixed carbon intensity. In reality, this will not be the case, and emissions will reduce further due to the decarbonisation of the grid which will occur in parallel to the improvements to the building stock (we assume the grid changes from 560 gCO_2/kWh of delivered electricity today, to 350 gCO_2/kWh in 2020, as per the Committee on Climate Change's calculations for what is needed to achieve the UK's overall carbon reduction targets).

Combined, this level of grid decarbonisation, and the implementation of almost all the cost-effective potential described above, leads to the 'Success Scenario' described in Chapter 2 – total emissions of 69MtCO_2, a reduction of 37MtCO_2 compared to the start emissions in 2005.

In fact, our Success Scenario, before consideration of grid decarbonisation, achieves total emissions of 94.4MtCO_2 in 2020, a reduction of 18.1MtCO_2, or 7.9MtCO_2 less than if all of the 26MtCO_2 cost-effective potential above was implemented. By 2020, this is equivalent to ~70% of the 26MtCO_2 being actually implemented in our Success Scenario – this is due to the rate at which buildings are built or refurbished. Unless all the policies are implemented at full strength immediately, the stock turnover means that not all of the carbon reduction potential can be delivered in reality by 2020. However, the objective for the policy packages should still be set by the theoretical maximum of 26MtCO_2 (and of course, some of the gap between the 18MtCO_2 and 26MtCO_2 will be met in the years after 2020 as more buildings are impacted by the full strength policies).

Given the complexity of considering grid decarbonisation in parallel with energy demand reduction from buildings, when developing policies specifically focused on reducing the emissions from the non-domestic building stock it is probably simpler to consider the grid as fixed when calculating the targeted carbon reduction, but then remember to include the impact of grid decarbonisation in calculating the effectiveness of policies in reducing actual emissions.

Chart 3k *Breakdown of total carbon reduction potential to 2020 ($MtCO_2$)*



Source: Carbon Trust analysis

3v. Landlord-tenant divide

What is this divide?

The landlord-tenant divide is the situation where one party (landlord or tenant) has no incentive to invest in carbon reducing measures as the other party receives the benefit of the investment (such as the energy savings). For example, where a tenant pays a fixed service charge for the energy they use, they have no incentive to invest time or money in behavioural or physical measures, as they will still be charged the same amount. For a landlord, the return on an investment in say, upgrading the heating and lighting controls, may be reduced if the tenant pays the energy bill and therefore receives the benefit of reduced energy costs.

"A lot of the control is with the occupiers. We provide the space and design the building but we can't control how the tenants use it – it's their job to make sure it works as efficiently as possible"

Commercial Landlord

This 'mis-aligned incentive' between investment and the resulting benefit is one of, if not the most, critical and stubborn barriers towards the implementation of improvement measures in the non-domestic building stock. This is largely due to the high proportion of landlord-owned buildings in this sector (especially compared to the high proportion of owner-occupiers in the domestic sector). The data in this area is poor, but approximations suggest that up to 90% of commercial office, and 50% of retail property for example, has a landlord-tenant relationship in place. This highlights the fact that delivering a non-domestic building stock with 80% less carbon emissions will require this particular barrier to be overcome.

"The initiatives we invest in are highly impacted by the fact that we're tenants. We have no control over things like the air conditioning. We can only really do the small changes"

Commercial Tenant

There is, though, one important positive. Over the next decade the focus, as already explained elsewhere in this report, needs to be on implementing almost all of the cost-effective energy efficiency opportunity. The upfront cost to achieve this, according to our cost curves, is around £1.3bn, or perhaps £150m per year. This is relatively small compared to the energy bills for commercial and public sector organisations, and the total investment in new and refurbished non-domestic buildings of ~£65bn per year. Thus, whilst the misalignment is real and leads to inaction, its scale is not large in relative financial terms.

The landlord-tenant relationship will always exist in the non-domestic building sector, yet little has been achieved in overcoming the mis-aligned incentive. And whilst the divide can at first appear quite straightforward, in reality there are a large number of very different landlord-tenant relationships, dependent on:

- Who pays the energy bill – landlord, tenant, or a combination of both?
- Who can implement the carbon reduction measures and who uses the energy?
- Is the building multi or single tenanted and what size are the organisations – are they included in the CRC?
- The multitude of different contract types, durations etc.
- The desire of either party to work towards reducing energy use and carbon emissions.

What are the options to overcome the divide?

Put simply, the aim must be to ensure that the incentive to invest is there for both landlords and tenants, by aligning the incentive with the benefits. This will require solutions specific to each type of landlord-tenant relationship, so there is no single, silver bullet solution that will work in all situations. It will require the industry and Government to work together to develop the incentives and penalties relevant to almost every situation.

It will take time to develop the solutions needed to overcome the landlord-tenant divide. Yet there is real urgency in the need to implement the cost-effective energy efficiency measures into the buildings. Therefore in the short term, the policy package implemented by Government needs to be tested against its ability to overcome the divide and lead to implementation of the measures – below we have assessed our list of policy options on this basis.

But in the medium to long term a full solution needs to be developed which removes the divide, rather than simply (pragmatically) plastering over the cracks. We believe that two high level principles need to be followed in order to achieve this.

First, **responsibility for all carbon emissions must be assigned,** with no ambiguity on which emissions either the landlord or tenant are responsible for. Too often the fact that a landlord-tenant relationship is involved leads to no responsibility being assigned, and therefore little or no action being taken to reduce emissions and save energy.

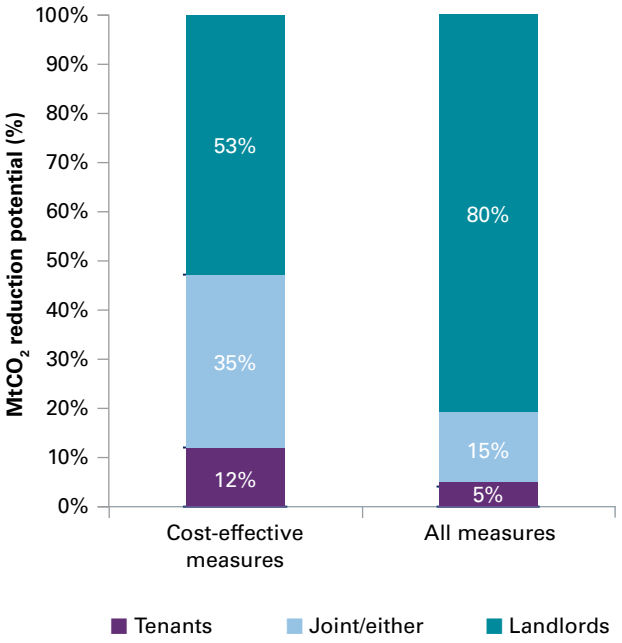
Ideally, responsibility for a building's in-use emissions would be split across landlords and tenants, with clear ownership on both sides of the divide for those emissions that each party has greater power to reduce. However, this is often difficult in practice, so responsibility may initially need to be given to one side or other of the divide. *Chart 3l* shows that landlords have more ability to implement the energy efficiency measures which are included in the CCC cost curves for commercial and public sector buildings – up to 88% of cost-effective measures are within the remit of the landlord to change. Thus, a starting point could be to consider landlords as the default owner of all carbon emissions in landlord-owned properties.

There are additional reasons to consider landlords as the initial owners of all emissions:

1. Landlords are building professionals, tenants are not, thus landlords have more knowledge of the measures which can be implemented to reduce energy use and how to implement them cost-effectively.
2. Landlords tend to be larger organisations, with multiple buildings, and greater access to capital for the required investment, and more opportunity to create economies of scale in upgrading buildings.
3. Landlords do not have to choose between investing in their buildings or their business (as tenants do) – their buildings are their business.
4. Around 75% of carbon emissions are from 'regulated loads' (heating, ventilation, cooling, hot water, lighting) so the landlord's choice of fabric and efficiency of building services is more responsible for the overall emissions than the tenant's behaviours (although their impact is still important).

It is likely that assigning responsibility for carbon emissions within buildings can only be achieved through government regulation such as the Carbon Reduction Commitment (CRC) which assigns responsibility to the energy bill payer. An additional option for Government is to alter the cost of the CO_2 once it has been assigned an owner. This could be achieved through the CRC, a carbon tax or by linking fiscal mechanisms such as business rates to emissions. This should spur more rapid action as the penalty for doing nothing becomes higher, and the benefit of acting becomes clearer.

***Chart 3I** Responsibility/ability to implement carbon reduction measures*



Source: CCC data, Carbon Trust analysis

However, landlords are not responsible for using most of the energy in buildings, and some of the carbon reduction measures are wholly or partly dependent on the tenant's actions in their use of the buildings e.g. using heating controls correctly, or running 'switch it off' campaigns. The second principle, therefore, is to develop and use a **toolkit of measures to align incentives** across the landlord-tenant divide. Critically, until now, there has been little incentive for either party to act. However, the previous principle should ensure that at least one party has a strong incentive to reduce emissions, creating a clear rationale for them to change the current relationship with the other party. The aim here is for the two parties to agree between them how to re-assign responsibility for emissions, develop incentives/penalties for reducing or not reducing emissions, and therefore all pull in the same direction. Thus the onus here is on the landlords and tenants, with Government not being involved.

The solutions exist today for landlords and tenants to work together. There are a number of examples for how win-win situations can be created by sharing the benefits of implementing cost-effective measures. These range from green leases, LES-TER for offices[14] , the use of ESCOs, post build contracts, voluntary DECs, and simply sharing energy use information. Other new, innovative solutions could also be developed, driven by the greater incentive for action from the first step. These could include new business models for refurbishment such as the Carbon Trust's Low Carbon Workplace (which aims to create value from very low carbon refurbishment and operation of offices) and new energy performance contracts between all parties.

However, in the UK context, none of these solutions is being used at significant scale. Industry and Government need to work together to develop these options fully. For instance, the Better Building Partnership has developed a guide to green leases which now needs to be tried in real situations, with the lessons learned shared among all relevant stakeholders, and the guide itself then updated.

Government can also help by using its position as a large scale tenant. In Australia, their government has mandated that all government buildings have a green lease in place, and they have worked with the industry to develop a detailed set of leases applicable in different situations.

This has lead to a large part of the market using green leases, with the added benefit that the lessons learned from their introduction and use now means that commercial organisations are seeing more use of similar leases. Underlying all of this is the rollout of DECs and EPCs that we believe is essential in creating the understanding for landlords and tenants of both the quality of the buildings, and how effectively the buildings are being used.

Overall, the solutions need to be applied on a case by case basis, given the specifics of any particular relationship, but the ownership of the CO_2 emissions (and the associated cost) drives use of the solutions.

Call to action

It is imperative that the elements of this long-term solution are put in place as soon as possible. Landlords, tenants, other stakeholders and Government need to start working together to:

1. Define the future we are trying to create – what does the 2020 world with no landlord-tenant divide look like?
2. Define the actions needed to get there.
3. Develop a UK-focused solutions toolkit.

The Carbon Trust would like to work collaboratively with other organisations to ensure that this happens.

Testing current policies in the short term

The pragmatic, short term approach is to ensure that the policies in place are sufficient to overcome most elements of the divide and ensure the majority of cost-effective energy efficiency measures are implemented as soon as possible. We believe that our policy options, outlined in Chapter 3, achieve this.

Chart 3m shows a 'quick and dirty' analysis which has broken down the issue by (1) who pays the bill, (2) what size is the bill paying organisation, and (3) who has the ability to implement the carbon reduction measures. It assesses the organisation focused policies against this breakdown.

It shows that often the investment and benefit are already broadly aligned. Our approximations would suggest that ~75% of the emission reduction potential is in a situation where the bill payer is able to make the investment.

Our suggested policy package could take the implementation of the cost-effective measures up to nearly 90%, with some of the underlying, building targeted policies such as rolling out DECs and EPCs, minimum building standards and Zero Carbon new buildings helping to fill the 10% gap.

[14] Landlord Energy Statement-Tenant Energy Review, a methodology for measuring carbon emissions in offices and assigning responsibility between landlords and tenants.

Chart 3m *How the landlord-tenant divide breaks down (some numbers estimated)*

Who pays energy bill	Size of bill payer	Cost-effective measures to be implemented		
		Physical, landlord influenced (53%)	**Physical, landlord or tenant (35%)**	**Behavioural, tenant (12%)**
Landlord (70%[e])	Large – in CRC (60%[e])	37% CRC incentivises landlord to implement measures and change relationship with tenant over time to ensure they use the building efficiently.		5% CRC drives landlords to change contractual relationship with tenants, to incentivise energy reduction.
	Small (40%[e])	25% Incentive aligned between investment and energy savings; however, other, non-financial barriers may prevent uptake of measures (transaction costs, lack of awareness/knowledge, immateriality of energy costs, lack of access to capital). The non-CRC package is targeted at removing these barriers through a combination of loans, CERT and building focused advice.		3% POTENTIAL GAP: possibly not enough drivers to encourage landlords to change the contractual relationship with tenants. No incentive for the tenant to change behaviours. CERT could target implementation of some of the measures.
Tenant (30%[e])	Large – in CRC (50%[e])	8% Tenant incentivised via CRC to pay for measures and seek new contractual relationships over time with the landlord (these are large tenants).	7% CRC should drive tenants to implement these measures.	
	Small – not in CRC (50%[e])	8% POTENTIAL GAP: little incentive driving change in either landlord or tenant. Non-CRC package may help the tenant to implement some of the smaller, simpler, cheaper measures.	7% SME package should overcome the non-financial barriers to help tenants implement most of the measures under their influence (and for which they receive the energy cost savings).	

Additional drivers of change

- Building focused advice, Carbon Management, One Day Energy Surveys, Strategic Design Advice and SME advice programmes will help enable implementation of all measures described above.
- 'Minimum building standards', DECs and EPCs for all buildings (which help show landlords and tenants the performance of their buildings and also incentivise landlords to implement measures, or allow tenants to implement measures as better certificate ratings should increase rental/sale values) and tightening Building Regulations will drive implementation of some of the measures across all of the splits described above.
- Public sector leadership should create an additional driver for action in the public sector.

e: estimate, not based on real data

3vi. Focus for success

The Carbon Trust's recent report, 'Focus for success', examines why the UK should support low carbon technologies (LCTs), how the UK innovation system currently works and how it needs to evolve to meet these new challenges. It was based on the results of an in-depth economic, engineering and commercial analysis of a sample of six low carbon technology families which included two related to the buildings sector – a new highly energy efficient lighting technology (solid state lighting which includes LEDs and organic LEDs) and a microgeneration heat technology (fuel cell micro combined heat and power). The report is therefore highly relevant to innovation of buildings technologies and offers a methodology to identify where the UK should focus its resources. The report calls for the UK to accelerate the move towards an innovation policy which is 'technology focused' based upon customised, technology specific support for carefully prioritised LCTs. The key findings, and their implications for innovation in non-domestic buildings, are as follows:

(a) The UK should support low carbon technology innovation

The study sets out a clear case for the UK to support the development of low carbon technology (LCT) which will put the UK in a better position to address climate change and to reap economic benefits. The UK will need to deploy new and emerging LCTs to be able to meet climate change related targets as deploying existing technologies will not be enough. However, a variety of market failures mean that public support, from the UK or elsewhere, is required to commercialise LCTs. In many cases LCTs will commercialise through public support given by other states, so the UK has a choice: play an active and leading role in the innovation of one or more LCTs; or wait and deploy LCTs developed abroad. Detailed analysis of the six LCTs examined in the report shows that the UK, by being an active player in technology development, could well generate significant net economic benefit and/or unlock technologies which will make a material contribution to UK climate change related targets. The potential prize here is significant – with effective innovation support the sample of LCTs analysed have the potential by 2050 to create around 175,000 jobs, £25bn of annual revenues for the UK and save ~110MtCO_2 per annum.

(b) Carefully prioritise LCTs

The UK needs to make smart investments in LCT innovation by accelerating the move towards greater technology prioritisation and away from explicit technology neutrality. As stated above, LCTs present significant opportunities to create economic benefit for the UK and reduce carbon emissions. However, the costs of commercialising LCTs are very high e.g. in net present value terms the costs of commercialising a renewable energy generation technology in its early stages of development such as wave power could be around £11bn out to 2050. In a resource constrained environment, these large-scale, short-term costs and longer-term and uncertain economic benefits mean that the UK can only have a global impact in a limited number of LCTs. So, the UK needs to move towards systematic and transparent prioritisation of support for LCTs.

There is also a need to distinguish between earlier stage technologies, with lower development costs and higher uncertainty, and later stage technologies, where greater focus is needed because deployment support costs are high (on average around 40 times higher than the RD&D stage). This prioritisation should be done at the family level (e.g. solid state lighting) rather than at the product level.

The study developed and tested a possible framework based on contribution to UK climate change related targets and net economic benefit. This sets the overall approach for each LCT for the UK. For example, solid state lighting (SSL) is needed to meet the 80% target but is likely to commercialise rapidly irrespective of UK support as the market is global and development is driven by multinational companies with a global perspective. As deployment support costs are now likely to be quite small, the UK could generate net economic benefit in niche markets and parts of the supply chain (e.g. specialist luminaire design and manufacture), however, even in the best case this is unlikely to be substantial. Deployment of SSL represents a material and cost-effective carbon opportunity in the near-to-medium term. The UK's approach should be, at minimum, to deploy at scale when the technology is proven and cost-effective and in preparation remove all relevant barriers at minimum cost.

(c) Customise LCT support

At the same time there is also a need to accelerate the move towards greater technology customisation of LCT innovation support and away from generic policy mechanisms. The most cost-effective way to support the commercialisation of LCTs is on a highly technology specific basis because the engineering and commercial barriers, and the solutions that need to be put in place, vary considerably by technology. For example, while solid state lighting and an energy storage technology such as flow cell batteries could both require new product standards, the process of putting these in place is highly bespoke and there are very few economies available from doing these activities in parallel. Also, once a LCT has been prioritised, all the relevant solutions need to be put in place in order for the LCT to commercialise. These solutions include not only traditional innovation activities (e.g. R&D grants) but also both market pull and barrier removal activities (e.g. revenue support and regulatory changes) which are often not considered as part of innovation support.

(d) A new approach

A 'technology focused' approach brings together these two elements – technology prioritisation and technology customisation – to improve radically the cost-effectiveness of UK LCT innovation. This is very different from previous policies of supporting individual companies in sunset industries or creating national champions.
A technology focused approach will support new growth markets and stimulate competition across the range of companies and products in each market. It is compatible with recent policy changes and with the overall carbon mitigation framework in the UK, as it complements technology-neutral carbon pricing mechanisms which are designed to stimulate the mass adoption of proven LCTs. This approach also integrates innovation support with manufacturing and regional activities to maximise economic benefit for the UK. Greater adoption of a technology focused approach is a real opportunity for the UK. It increases the chances that public money is well spent, by focusing on key technologies for the UK and on the individual requirements of the technology.
A technology focused approach will also increase the likelihood of the UK capturing value and jobs from the transition to a low carbon economy as well as helping to ensure the delivery of UK climate change related targets.

The report concludes with the recommendations that the UK should:

- Adopt and implement a framework for prioritising the commercialisation of LCTs from a national perspective. The framework developed during the course of this study could be a starting point.
- Design customised technology policies and programmes and coordinate the key LCT innovation activities (i.e. market 'pull', technology 'push' and barrier removal), so that comprehensive, joined-up support is provided to priority LCTs.
- Integrate innovation and business support strategies and activities to ensure the economic development potential of LCT innovation is realised.

The Government has broadly endorsed this new approach and therefore it is hoped that further progress will be made quickly, much of which will be relevant to identifying and prioritising support for those building technologies which show the most cost-effective way to deliver carbon reductions for targets and generating economic benefit for the UK.

3vii. Carbon reduction potential targeted by individual policies

Note: overlaps between policies not considered. Therefore sum of policies exceeds 26MtCO$_2$ (the full cost-effective carbon reduction potential)

		Policy	Description	Carbon targeted* (Mtons CO_2)	Assumptions/calculations
Targeting buildings	1. Policy package for major interventions	Building Regulations for new buildings – Part L2A/Zero Carbon new build from 2019	As per current expectations for 2010/13/19	10.7	• 45% carbon reduction potential vs 2006 standards in all new buildings • Further improvement to 2006 levels for demolished and new build
		Building Regulations for major refurbishments – Part L2B	Include CO_2/m^2 target; tighten over long term	2.4	• ~15% of today's buildings undergo major refurb by 2020 • 15% CO_2 reduction achieved in these buildings • Starting emissions of 106MtCO$_2$ in existing stock
		Compliance with Building Regulations above	Part L specific assessors; increase resources, training etc	1.3	• Responsible for the last 10% of the opportunity in new and refurbished buildings
		Advice (Design Advice)	Extend to a larger number of buildings	1.25	• Assume 1,000 buildings/projects over 10 years • Assume 50,000m^2 each • Improve by 25kgCO_2/m^2 to compared to not receiving advice
	2. Policy package to drive improvement across the building stock whilst 'in-use'	Public sector leadership	Mandate implementation of all DEC measures	2.4	• 22MtCO$_2$ emissions in public sector in 2007, with ~95% being in large buildings with a DEC • 10% of floor space demolished and 15% major refurb captured by Building Regulations • 15% cost-effective improvement potential on average in the remaining, 'in-use' buildings
		Minimum building standards	Almost no Gs in 2020	4.8	• 6% of buildings are G-rated, creating 15% of CO_2 emissions • 30% improvement from average G to average F
		Advice – building focused	F&Gs to receive significant support; lighter touch implementation support for A to E rated buildings	1.0	• 75% of buildings in existing stock remaining in 2020 • F&G: work with 10% of these buildings to deliver the 15% cost-effective potential (total of 41% of all emissions from buildings with F&G rated DEC) • Work with 20% of A to E rated buildings to deliver 5% improvements

Key 'Driver' policies 'Enabling' policies

Continued overleaf

3vii. Carbon reduction potential targeted by individual policies (continued)

		Policy	Description	Carbon targeted* (Mtons CO_2)	Assumptions/calculations
Targeting organisations	3. CRC policy package	CRC	Tighten cap to 9.9MtCO_2 (vs. baseline)	13.1 (including carbon from new build to 2020)	• 50% of non-domestic buildings emissions and carbon reduction potential captured by CRC • Set target at full cost-effective potential 9.9MtCO_2 vs. 2008
		Public sector loans by Salix	Say, £20m p.a.	2.4	• Assume £20m p.a. for 10 years to give £200m total investment • Total capex for all cost-effective measures across all non-domestic buildings is £1.3bn, to achieve 15% CO_2 reduction (from 106MtCO_2) • Assume equal investment per ton CO_2 reduction across public sector, commercial and industrial buildings
		Advice – Carbon Management and site surveys		1.8	• Last year for Carbon Trust: 1.4MtCO_2 implemented, which if continued could deliver ~4.5MtCO_2 total on-going annual reduction • Around 60% of this is buildings related • Estimate that two-thirds of carbon from CM/site survey clients is included in the CRC
	4. Non-CRC policy package	CERT for SMEs	Top, simple measures implemented in all non-CRC organisations	4.9	• Non-CRC orgs cover 50% of CO_2 reduction potential of 15% (from 106MtCO_2) • 63% of cost-effective potential is from sensors, controls, and using controls correctly
		Loans: <4 years Loans: >4 years	Assume £300-400m over 10 years (set to be enough to pay for the non-CERT measures)	2.4	• Non-CERT measures (i.e. the 37% of the cost-effective potential not included in CERT) cover ~2.9MtCO_2, and require investment of ~£450m • Note that some of the loans would likely be used in new/refurbished buildings to pay for more efficient equipment at these intervention points
		Advice – SME		1.45	• Last year for Carbon Trust: 1.4 MtCO_2 implemented, which if continued could deliver ~4.5MtCO_2 total on-going annual reduction • Around 60% of this is buildings related. • Estimate that one-third of the carbon from CM/site survey clients is not captured by the CRC • Plus, assume this advice can help deliver 10% of the savings from SME loans

Key 'Driver' policies 'Enabling' policies

*Relative to a 'do nothing' scenario as described in *Sidebox 3iv,* against which the total cost-effective carbon reduction potential is 26.3MtCO_2.

Part C

From strategy to transformation

4. Implementation

Throughout this report, we have re-iterated the need for a joined-up approach to carbon reduction from non-domestic buildings. We started by outlining a strategy specifically for this sector, and then described the components of the strategy. In Chapter 2 we discussed the need for the direction to be set by Government, and the first critical action of rolling out DECs and EPCs to all non-domestic buildings as a means of setting this direction. In Chapter 3, we then suggested a policy package aimed at driving the market to implement almost all cost-effective measures in the next decade and explained why additional action is required now to create the innovation and supply chain of the future.

But how do all of these different elements fit together? Chapter 4 suggests an approach for combining the various elements of the strategy we have described in this report. It illustrates the various workstreams that would be needed to implement the strategy fully, explains how the different workstreams would interact, gives an example of an implementation plan for one specific workstream and finally discusses responsibilities – what could be done, by when and by whom.

4 Implementation

This report has outlined a joined-up strategy for carbon reduction from non-domestic buildings. To deliver the transformation that is required, implementation of the elements of this strategy will also need to be joined-up. Success requires a plan, clear accountability and leadership.

Key findings

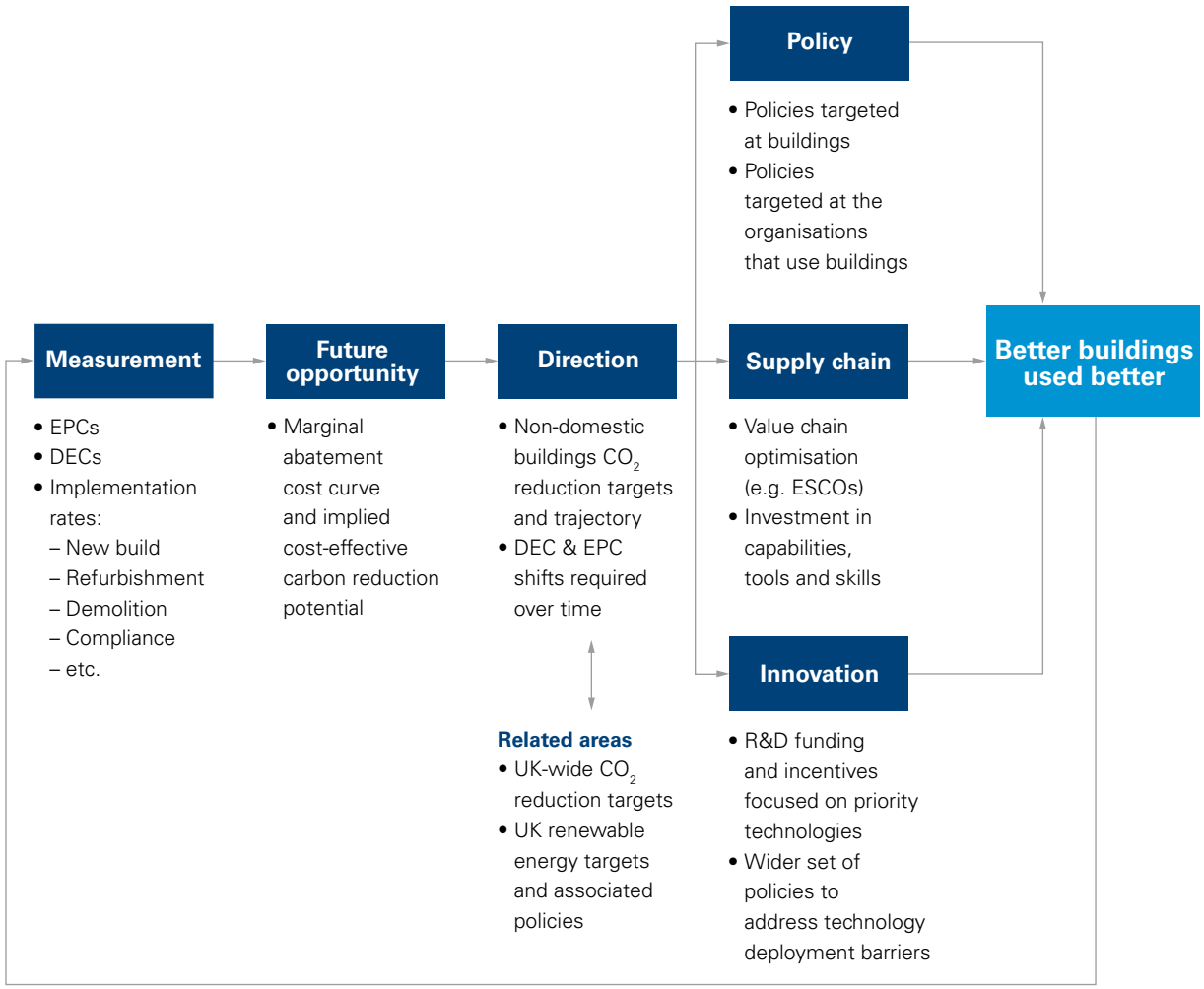
- All the elements of this report fit together to create a joined-up strategy to deliver the overall objective: better buildings, used better (see *Chart 4a* overleaf).
- Implementing these elements, and making sure they continue to create a coherent whole, is not a trivial task – the following approach will be required:
  - Develop implementation plans for each workstream.
  - Map out the interactions across the workstreams.
  - Clarify responsibilities.
- The Government could also consider creating an organisation to assume overall accountability for the development of a low carbon non-domestic building stock. This will contribute to creating the joined-up approach proposed by this report, backed up by the leadership required to successfully meet the huge deployment challenge that lies ahead.

How everything fits together

Chart 4a attempts to illustrate on one page the different workstreams that would be needed to implement our suggested strategy, and shows the interactions between the workstreams. Increased measurement of the current building stock is required, alongside an improved understanding of the future opportunity for carbon reduction in non-domestic buildings. Combined, this will allow the Government to give the sector a clear direction of what will be required in terms of carbon reduction and associated investment:

- **Measurement:** EPCs and DECs to be rolled out to all buildings to support measurement of both the quality of the building stock and the in-use carbon emissions (among other benefits). The implementation rates of measures due to the building cycle (e.g. the rate at which buildings are built, refurbished and demolished) also need to be measured to understand how quickly the building stock is changing.

***Chart 4a** Workstream overview*



- **Future opportunity:** measurement feeds an increased knowledge of the current building stock and suggests opportunities to improve it over time. More accurate marginal abatement cost curves should be developed to understand the opportunity to reduce carbon emissions and how much this will cost – in particular the size of the cost-effective opportunity and the potential economic benefit to the UK (our data suggests this is ~15% for existing buildings, and up to 45% for new buildings compared to 2006 building standards). This data needs to be continually evolved over time, in particular to reflect the more accurate understanding developed from the collation of DECs and EPCs.
- **Direction:** the scenario analysis we developed in Chapter 2 can then be used to determine the most cost-effective trajectory to 2020 and beyond, and the measures required to achieve it (e.g. low-cost controls versus more capital-intensive upgrades to the building fabric). Government can then compare this carbon emissions trajectory and associated costs with those in other sectors and UK-wide carbon reduction and renewable energy targets. Expectations can then be set for whether non-domestic buildings need to deliver more or less than the UK-wide targets, whether this will be cost-effective, and how much capital investment will be required. This can then be translated into what is required in terms of DEC/EPC improvement.

With a clear understanding of the carbon and renewable energy targets in this sector, policies and the action required to drive innovation and supply chain improvements required to enable these policies can be delivered.

- **Policy:** policies need to target both buildings and the organisations that use them. Existing policies can be tightened and new policies developed and implemented to capture the full cost-effective carbon saving. The impact of these policies can be monitored using the DEC/EPC database, and the policies can then be adjusted, and potentially new policies launched, to ensure the UK stays on track in meeting its targets and maximising economic benefits.
- **Innovation:** R&D funding and joint public/private demonstration programmes and exemplar buildings are critical to increasing our understanding of what is possible, reducing costs and educating the supply chain. Incentive mechanisms are likely to be necessary to support non-cost-effective renewables if the UK is to meet its Renewable Energy Targets. To maximise the economic benefit to the UK, public funding of both R&D and incentives should be focused and a wider set of policies developed to remove any barriers to technology deployment such as existing planning and grid restrictions.
- **Supply chain:** the structure of the supply chain will adapt to exploit new market opportunities that are unlocked by policy. For instance, Energy Service Companies (ESCOs) are likely to exploit the increased savings due to higher carbon prices and renewable energy incentives. The supply chain also needs to invest in developing the new capabilities and skills required to realise these new opportunities, though joint public/private schemes may be required in particular areas where market failures continue.

These six workstreams combine to deliver the overall objective: better buildings, used better. The improvements in the buildings and their use then needs to be measured, fed back into the measurement workstream and then the cycle continues in an ongoing feedback loop.

The options for Government actions outlined in this report are summarised and aligned against the six workstreams in *Chart 4b* (see overleaf). Throughout the earlier chapters of this report we have elaborated on these options and emphasised that rolling out DECs to all non-domestic buildings is critical to unlocking many of them.

To illustrate these options, we have developed them to the next level of detail. For example we have developed a model to determine the most cost-effective way to reduce emissions by 80% by 2050 and outlined a set of policies, some new, some updates to existing policies, that focus on the cost-effective carbon reduction up to 2020.

We now do the same for the implementation plan, describing how the six workstreams could be developed further, and detailing one particular workstream as an example.

Chart 4b *Summary of options for action, deadlines and next issues to be addressed*

Workstream	Options for action	Deadline	Next issues to be addressed
Measurement	• Roll out DECs to all non-domestic buildings. EPCs to be in place for all buildings.	2015	• Should the UK be a step ahead of EU EPBD timetable? • Timelines and actions required? • Feasibility for small buildings?
	• Set up a Government programme to monitor, diagnose and manage non-domestic building stock performance based on DEC and EPC registry and implementation rates.	2010	• Who should be responsible? • How?
	• Refine DECs and EPCs.	Ongoing	• How to manage updates to ensure comparability over time?
Future opportunity	• Set up a central or coordinated knowledge programme.	2010	• Who should be responsible? • What data should be prioritised? • How to best collect and disseminate knowledge?
	• Refine MACC.	Ongoing	• How to collect data?
Direction	• Communicate expectations that non-domestic buildings will deliver more carbon emission reductions by 2020 than the UK as a whole.	2010	• Optimum carbon reduction pathway given relative performance of other sectors?
	• Translate targets into a language the industry can relate to – the average shift in DEC ratings required.	2010	• Calculate shifts for different sectors?
Policy	• Create a set of policy packages targeted at both buildings and their users.	2010	• What policies does Government select and refine to drive improvement across the building stock and to drive SMEs to use their buildings properly? • How can policies be integrated across departments? • Who has overall accountability for delivering change?
Innovation	• Prioritise families of low carbon technologies based on contribution to UK climate change related targets and net economic benefit then customise policy support.	2010	• Who decides the subsequent prioritisation across Government departments?
	• Refine electricity FITs and the RHI.	2011	• How to ensure focus also remains on cost-effective energy efficiency measures?
Supply chain	• Define supply chain best practice and assess the gaps compared to today's performance.	Ongoing	• Who is responsible for supply chain best practice? • How to best collect and disseminate best practice?
	• Improve skills and deliver new capabilities through education, training and certification.	Ongoing	• What skills and capabilities need to be prioritised? • What Government support is required?

Workstream implementation plans

To address the next set of issues summarised in *Chart 4b* and then implement the options for action is not a trivial task. It is important to clarify what needs to get done, by when and by whom, and to ensure the whole programme hangs together.

The Zero Carbon hub is a successful model for how to programme manage this complexity in the buildings sector. The Zero Carbon hub is a public/private partnership established to take day-to-day operational responsibility for co-ordinating delivery of low and Zero Carbon new homes. It has divided the actions required to achieve its objective into workstreams, much as we are recommending, and outlined a high-level implementation plan against each workstream. It then tracks progress of these workstreams using simple but effective red/amber/green traffic light status reporting.

A similar approach could be taken in implementing non-domestic buildings policy as follows:

- Develop implementation plans for each workstream.
- Map out the interactions across the workstreams.
- Clarify responsibilities.

Develop implementation plans for each workstream

An implementation plan needs to be developed for each workstream. This can be in a standard Gantt chart format. It should be kept as simple as possible so that it can be easily communicated to the industry and kept up-to-date.

Each workstream will need to be front-loaded, work in parallel and be iterated over time:

- **Front-load:** the urgency of action in non-domestic buildings requires significant development across all workstreams over the next year. All the workstreams need to be set up and assigned to owners.
- **Work in parallel:** as outlined in *Chart 4a* all the workstreams are dependent on each other. However, just because the measurement workstream feeds future opportunity, which feeds direction, which feeds policy, and so on, does not mean that these workstreams needs to run sequentially. Chapters 2 and 3 of this report have demonstrated that with today's data, clearer direction and policy development are both possible. Instead, each workstream should kick off and run concurrently.
- **Iterate:** the emphasis should be on delivering the workstreams earlier rather than trying to perfect them upfront. This is particularly true whilst measures are cost-effective and capital costs are less than 1% of total investment in the sector. The measurement workstream will provide feedback on how well the initial set of policies and other workstreams are working. They can then be iterated to make sure all the cost-effective carbon reduction is being targeted, benefits are accruing to the parties making the investments and implementation costs are being minimised. For entirely new policies, particularly those with a risk of unforeseen consequences such as introducing fiscal incentives, pilots could be used before a national rollout.

To illustrate these principles, we have developed an example high-level implementation plan for the most complex workstream, policy.

Policy implementation plan example

In Chapter 3 we outlined an example set of policies and showed how these can be assessed to ensure they address all the barriers and hence deliver all the carbon reduction required, cost-effectively. Going forward the Government will need to choose the specific policies it wants to develop further, taking into account its priorities. It can then assess these policies against the same criteria we used in Chapter 3 to ensure they also deliver all the carbon reduction required, cost-effectively.

No matter the specific policies the Government chooses, Chapter 3 showed that policies need to be targeted at buildings and the organisations using them.

Chart 4c (overleaf) illustrates an example policy workstream implementation plan split into this structure:

- Policies targeted at buildings:
  1. Policies for major intervention opportunities.
  2. Policies to drive implementation across the building stock whilst in-use.
- Policies targeted at organisations:
  3. CRC policy package.
  4. Non-CRC policy package.

The two policy packages that would require the most development are the policy package to drive improvement across the building stock whilst in-use and the policy package to drive organisations not in the CRC to use their buildings better. Both of these are new or contain significant new components.

Chart 4c *Example workstream implementation plan – policy*

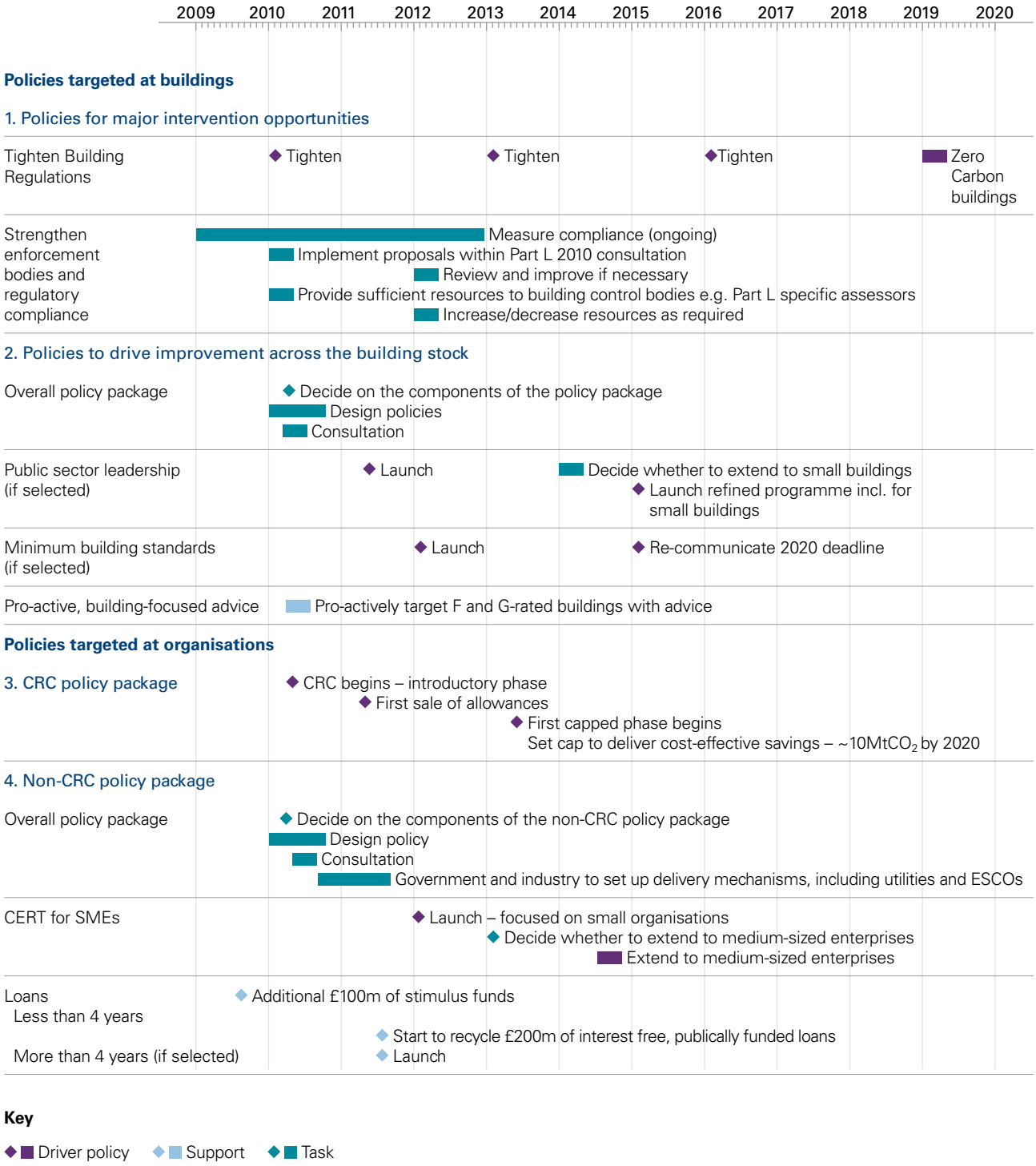


***Chart 4d** Summary of policy timings*

Year	Driver policy	Support
Pre-2009	• Building Regulations: – 1985: Part L2A and L2B introduced – 2002: CO_2/m^2 targets introduced – 2006: tightened – 25% less emissions than 2002 regs – 2008: EPCs for all buildings on sale or lease – 2009: DECs for public sector buildings	• 2001: Carbon Trust surveys, advice & certification • 2003: Carbon Trust loans – less than 4 years (£80m to date) • 2005: Salix Finance loans for public sector
2009		• Carbon Trust loans – less than 4 years – additional £100m of stimulus funds • Salix loans – £60m for public sector
2010	• CRC – launched • Building Regulations (Part L2A, L2B) tightened – 25% less emissions than 2006 regs	• Pro-active buildings-focused advice • Feed-in tariffs for small-scale electricity generation technologies
2011	• CRC – first sale of allowance • Public sector leadership	• Loans – less than 4 years – recycle current stimulus funds • Loans – more than 4 years • Renewable Heat Incentive
2012	• Minimum building standards announced • CERT for small companies	
2013	• CRC – first capped phase begins • Building Regulations (Part L2A, L2B) tightened – 44% less emissions than 2006 regs	
2014	• CERT for medium-sized companies	
2015	• DECs and EPCs in all buildings • Public sector leadership – extend to small buildings	
2016	• Building Regulations (Part L2A, L2B) tightened further and potentially include all emissions	
2017	• Potentially tighten or launch new policies if emissions are off-track	
2018		
2019	• Zero Carbon non-domestic buildings	
2020	• Minimum building standards enforced	

The Government will need to go through its standard policy development process, with work front-loaded to design the policies to the next level of detail, consult with industry and potentially pilot the more innovative and impactful components.

This work can happen in parallel with the other workstreams. For instance, the DECs and their recommendations are already in place to enable the public sector leadership policy to be developed and implemented.

Similarly, CERT for SMEs could be developed with an initial, conservative estimate for the cost-effective carbon target for the utilities and rollout can initially be focused on small companies. *Chart 4d* shows a summary of potential policy timings.

The policies can then be iterated. For instance, for public sector leadership, the measures to ensure compliance can be ramped up or down depending on compliance rates. For CERT for SMEs, depending on how successful the scheme has been with small companies, the decision can be taken on whether the programme should be extended to medium-sized companies.

Map out the interaction across the workstreams

The six workstreams are all dependent on each other. These interdependencies need to be incorporated into the implementation plans. For instance, in the policy workstream implementation plan example (see *Chart 4c*), the updates in direction – whether non-domestic buildings are improving quickly enough – will drive whether policies are tightened or new policies are introduced over time. The latest understanding of the remaining cost-effective potential will be a key input to how far Building Regulations can be tightened in 2013 and 2016. The extent to which SME loans have led to actual emission improvements will influence whether more radical policies such as linking business rates to building emissions performance are needed to drive further action.

Clarify responsibilities

Clear responsibilities are required, not only for the individual actions, but for each workstream, for programme management across the workstreams, and for overall accountability for non-domestic carbon reductions.

Responsibility for individual actions

Responsibilities are relatively clear for individual policy and innovation actions. CLG is responsible for future updates of Building Regulations and EPCs/DECs. DECC is responsible for the ongoing implementation of the CRC and setting micro-generation feed-in tariffs and the Renewable Heat Incentive. The Carbon Trust is responsible for delivering advice to commercial and public sector organisations, for driving forward innovation in low carbon technologies, and for running the SME Energy Efficiency Loans scheme. Responsibilities for the other actions need to be assigned.

Responsibility for workstream implementation

Each workstream requires different skills, resources and governance as shown in *Chart 4e*. Skills range from a deep understanding of the models and methodology of DECs and EPCs required to continually improve their design, to the hands-on experience of constructing and refurbishing buildings required to lead supply chain best practice. Resources include access to the DEC and EPC registry required for measurement and access to data from demonstration exemplar buildings to increase knowledge. Governance models vary from a need for an independent body to provide direction (such as the Committee on Climate Change (CCC)) to potentially creating joint public/private partnerships to improve supply chain capabilities. These differences in skills, resources and governance should clarify who should take on responsibility for each workstream.

Responsibility for programme management across the workstreams

Lessons should be learnt from the Zero Carbon Hub – a good example in this sector of one organisation taking on the responsibility for managing the complex set of implementation plans and ongoing status reporting required to properly programme manage the road to Zero Carbon domestic buildings by 2016. A similar approach could be adopted for the wider set of policies required to decarbonise the UK's non-domestic buildings stock.

Overall accountability for non-domestic building carbon reduction

As we have discussed previously, the simple fact that the non-domestic buildings sector is rarely considered as a coherent whole, is partly responsible for the slow reduction in overall carbon emissions since 1990. A lack of accountability has lead to a lack of action.

Thus the Government could consider creating an organisation to assume this overall accountability for the development of a low carbon non-domestic building stock, and to deliver this sector's part in the overall transition to a low carbon economy.

This organisation could be created within a single Government department such as DECC, or as part of a cross-functional initiative involving several Government departments and bodies. For example, as with the nuclear and renewables sectors, where the Office of Nuclear Development (OND) and the Office of Renewable Energy Deployment (ORED) have been created, an Office for Low Carbon Non-domestic Buildings could be developed.

Whichever organisational structure is selected, their objective will be to bring all of the different elements of the strategy together in one place, and to assign responsibility for delivery across the multiple stakeholders involved.

This report has shown that delivering the rapid carbon reduction opportunity that exists in non-domestic buildings is a huge deployment challenge. It will require significant leadership, not only to manage cross-departmental and stakeholder engagement, but also to drive the massive social behaviour change required across the UK. This new organisation could take on this leadership role, become the key focus for the entire sector, and help to create the direction and certainty that is currently lacking.

Chart 4e *Workstream skills, resources and governance*

Workstream	Skills	Resources	Governance issues
Measurement	• Data collection and analysis • Deep understanding of the models and methodology of DECs and EPCs	• DEC and EPC registry • Access to meter data	• Data framework could require partnership with utility companies to access meter data
Future opportunity	• Credible understanding of the industry based on real-life, practical experience • The research and analysis capability to update and validate MAC curve	• Access to real-life data from demonstration buildings • IT system to store and disseminate knowledge	• Open source to avoid intellectual property issues
Direction	• An understanding of how to prioritise carbon emission reductions in non-domestic buildings against other sectors • Scenario modelling skills	• Sector carbon reduction scenario models • Access to industry experts	• Recommendations from an independent body
Policy	• Policy development	• Sufficient resources to achieve compliance	• Ownership of buildings performance • Coordination across Government departments
Innovation	• Expertise in buildings technology • Project management expertise	• Prioritisation framework • Public R&D funds	• Technology prioritisation informed by an independent body given need for objective and robust factbase to make decisions
Supply chain	• Understanding of industry best practice based on real-life experience • Process and quality management approaches • Business development • Experience of managing education, training and certification schemes	• Access to best practice buildings supply chain demonstrations • Education and training facilities	• Potentially use joint public/private initiatives • Certification by independent body

The start of a dialogue

This report does not begin to claim to have all the answers. This is a complex sector, with a complex set of barriers and at the moment much of the data is poor. The objective of this report is therefore to start a dialogue across Government and the many industry stakeholders of the best way to set and achieve carbon targets, increase security of supply, maximise the economic benefit and jobs and continue to give the UK's workforce better buildings to work in.

The idea is for Government to adapt our suggestions to fit its priorities and wider policy objectives. We hope that industry comments on the priority it places on achieving carbon targets as cost-effectively as possible and provides feedback on the individual suggestions.

The Carbon Trust is keen to continue to help address these issues throughout this ongoing collaboration across Government and Industry.

The Carbon Trust was set up by Government in 2001 as an independent company.

The Carbon Trust's mission is to accelerate the move to a low carbon economy, by working with organisations to reduce carbon emissions now and develop commercial low carbon technologies for the future.

We cut carbon emissions now

- By providing business and the public sector with expert advice, finance and accreditation.
- By stimulating demand for low carbon products and services.

We cut future carbon emissions

- By developing new low carbon technologies through project funding and management, investment and collaboration.
- By identifying market barriers and practical ways to overcome them.

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ACT ON CO_2 is the Government's initiative to help individuals understand and reduce their carbon footprint. Visit http://actonco2.direct.gov.uk for more information.

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