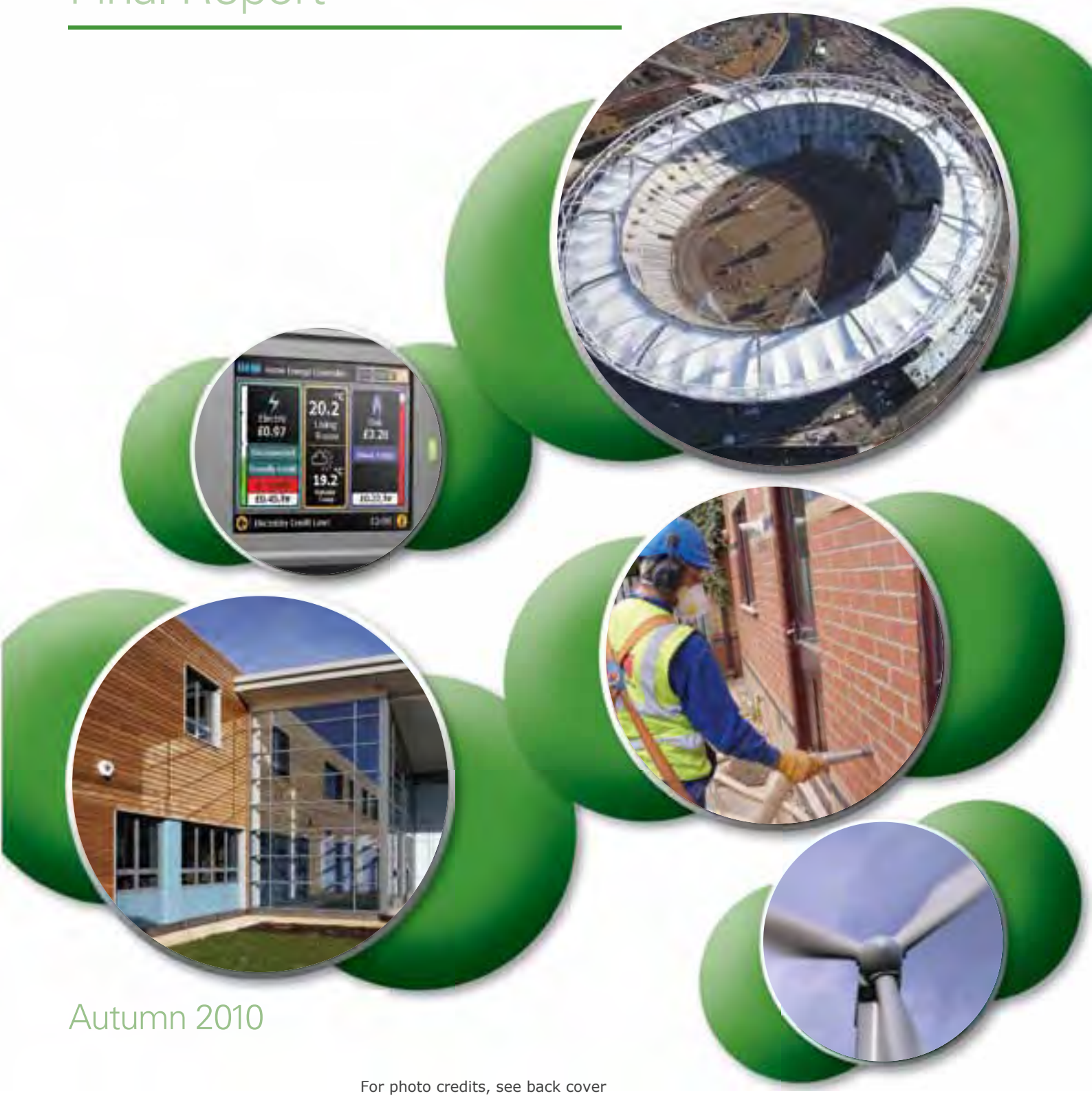
HM Government

Low Carbon Construction

Innovation & Growth Team

Final Report



Autumn 2010

For photo credits, see back cover

Foreword

"I have yet to see any problem, however complicated, which, when looked at properly, did not become still more complicated." Poul Anderson, New Scientist

The question that underlies the terms of reference given to the team that produced this report is a simple one: "Is the construction industry fit for purpose for the transition to a low carbon economy?"

Inevitably, the answer is not so simple. Even defining "the construction industry" is a challenge, given the extraordinary range in its activities (from the earliest conceptual thinking of world class designers through to the smallest item of maintenance or repair, long after the initial construction is complete); in the nature of its workload (from a nuclear power station to fitting a single socket outlet); and in the nature and scale of its businesses (from the global players through to almost a million individual tradesmen working alone). It is therefore unsurprising that the degree of awareness, engagement and readiness to deliver products and services that will enable the transition to a low carbon world is equally varied.

It is, however, no exaggeration to say that all of these businesses, with all of their differences of skill, experience and capacity, will need to be deeply engaged if we are to meet the commitment of the Climate Change Act to reduce our emissions by 80% by 2050, as so much of that transition depends upon the services of the construction industry in all its breadth and depth.

To begin to answer the question, there are British architects, engineers and other consultants working at home and around the world earning the UK a well-deserved reputation as leaders in sustainable design; construction companies and specialist contractors who, as well as building on their existing capacity to deliver the buildings and infrastructure that we need to support "greener" ways of living, are also putting sustainability at the very core of their own businesses; manufacturers producing innovative products and committing the serious investment required to bring them to market; materials producers, many of them intensive users of energy, completely changing their processes to reduce the impact of their operations; distributors promoting those products and developing the logistics necessary to deliver them where they are needed in the most user-friendly ways; and small businesses and individual tradesmen advising customers on simple things they can do to improve the energy efficiency of their buildings. There is also a host of professional and academic institutions, trade

associations and specialist interest groups who are deeply involved in research, development and dissemination around the subject of carbon and broader measures of sustainability

In summary, the industry is already demonstrating, in parts, that it has both the capacity and the inclination to play a full part in meeting the challenge of climate change, and converting that challenge into an opportunity for growth, both in the UK and in export markets.

For all of those already engaged, and the many still to be engaged, however, there are three crying needs: for **clarity** – for a clearer path through all the complexities which attend the transition to low carbon; for **co-operation** – for Government and industry to work together in finding that clarity and making plans; and for **confidence** – for market failure to be addressed so that building owners and occupiers are incentivised to become customers for commercial offers aimed at carbon reduction. In the meantime, there is a powerful sense of pent up potential in the industry.

There is broad acknowledgment within the industry that the transition to low carbon will also demand transformation of the way they do business. Some of the changes required will be radical. To make these changes the industry needs to know that it is doing so with a clear understanding of the future landscape, and with confidence in the emergence of a strong market for its wares.

Many of the recommendations in this report are directed to Government, only because the scale of the challenge, and the degree of market failure, is such that only Government can set the framework for action. This is not, however, to understate the challenge to the industry itself: to develop new products and services, to build skills and capacity, and to make the transformation in its own structure and practice that will deliver a transition to a low carbon built environment that is both affordable and assured.

Paul Morrell, Chair of Steering Group, Innovation and Growth Team.

Contents

1. Executive Summary

This is the final report of an Innovation and Growth Team ("IGT"), drawn from across the UK construction industry to consider how the UK construction industry can rise to the challenge of the low carbon agenda. It follows Emerging Findings published in March 2010, and builds on those findings, as charged by Mark Prisk MP, the Minister for Business and Enterprise in the Department for Business, Innovation and Skills; and the report has also been produced with the support DECC, CLG and DEFRA.

This report wholly replaces the Emerging Findings, with text that is still relevant brought forward to this final report. Unsurprisingly, since it is only 7 months since the publication of that preliminary report, the over-arching context remains much the same:

1. The United Kingdom's commitment to reduce carbon and other greenhouse gas emissions is now a matter of legal obligation. The strategy by which this might be achieved will reach deep into every aspect of the built environment, and depends for its delivery upon the construction industry working at its best. Over the next 40 years, the transition to low carbon can almost be read as a business plan for construction, bringing opportunities for growth.

2. For companies in the wider construction industry, the task is three-fold:

    - to de-carbonise their own business
    - to provide people with buildings that enable them to lead more energy efficient lives
    - to provide the infrastructure which enables the supply of clean energy and sustainable practices in other areas of the economy

3. This will require innovation – new ways of working and the acquisition of knowledge and skills that will provide competitive advantage at home and internationally, building on the United Kingdom's reputation as a world leader in sustainable design.

4. These opportunities exist at every scale, and while there remains much to resolve in a 40 year programme of work, there is much that can be done now, particularly in the existing building stock. This work, which extends right across the country, is the daily bread of one million small businesses that operate in the sector, and could provide each of them with a potential springboard to growth, and the country with a maturing supply chain.

5. A concentration on energy and carbon brings simplicity and rigour, and provides a new focus for action and a sense of priority; but carbon reduction is not the only critical issue for the industry, nor the only measure of sustainability, and plans across all measures, addressing both mitigation and adaptation, need to be integrated.

6. There is a general and growing awareness of the challenge, but few businesses have an accurate understanding of the sheer scale of the undertaking ahead; and there is a level of disbelief about whether or when the difficult decisions that will lead to the necessary changes in customer behaviour will be made.

> *"While buildings offer the largest share of cost-effective opportunities for GHG mitigation among the sectors examined, achieving a lower carbon future will require very significant efforts to enhance programmes and policies for energy efficiency in buildings and low-carbon energy sources well beyond what is happening today."*
>
> Fourth Assessment Report, Intergovernmental Panel on Climate Change, 2007

7. The construction industry's pivotal role in any carbon reduction programme creates the opportunity, almost the obligation, for it to take up a position of leadership – going beyond developing innovative products and services designed with carbon reduction in mind.

8. The construction industry has engaged positively with the issue of sustainability, with many examples of leading edge practice, and it stands ready to play its part in responding to the more focused challenge of carbon reduction; but there needs to be a quantum change in the response to that challenge if the commitments of the Climate Change Act are to be met.

9. This calls for active engagement with the process of identifying the main barriers to transformation, and the means of overcoming them – probably the biggest change management programme that the industry and the society it serves has faced since Victorian times.

10. The IGT has addressed these barriers through a series of work streams that represent sectors with essentially different markets, business models or primary drivers. There are, however, a number of common themes that recur throughout the report and which lead to a number of the key recommendations. These major themes, each of which has a corresponding barrier (or array of barriers) to progress, are:

    - **The need for clear leadership.** Leadership is required to set out the objective and identify the means of achieving it, to put in place plans that will do so, and then to

execute or track the progress of those plans. Primary leadership needs to come from Government, because of the degree of market failure and because plans for carbon reduction must reach into every fibre of the built environment, at a scale that is far beyond the reach of anybody other than Government. Beyond that, however, leadership needs to cascade: Local Authorities, as they are the means of releasing private sector action in many key asset areas such as social housing and infrastructure, but also to the construction industry itself, as it is the means of delivering so much of the practical response to the threat of climate change, and then to every level of the industry's supply chain.

- **Co-operation –** Notwithstanding the call for leadership by Government, they and industry should work closely together in developing plans to make the transition to low carbon in a way which will deliver the maximum benefits to the UK economy and create competitive, world-leading businesses.

- **The problem of complexity and confusing language –** There is complexity and over-crowding in almost every aspect of the landscape relating to carbon reduction, including responsibility in Government; the number of special interest groups and advisory bodies; the number of apparently uncoordinated research programmes; the mass of published policies, reports and initiatives, undertaken by a variety of Government Departments, or by NGO's incapable of absorption by businesses who need to focus on the more immediate interests of their clients and shareholders; a host of tools and methodologies, sometimes leading to quite different answers to the same questions; fundamentally different choices between competing technologies, with conflicting advice as to the effectiveness of each; and finally shifting terminology – so that, for example, "carbon" can sometimes mean carbon, sometimes carbon dioxide, and sometimes a carbon dioxide equivalent, and the definition of zero carbon is far more complex than that rightly aspirational term might suggest.

- **The absence of a transparent plan –** There needs to be a series of plans, which will cascade from national to local to individual business and customer level, and do so by sector. This needs to cut through the complexity to establish a basis upon which the industry and its customers can make their own plans and invest, set within a long term, stable framework that is just as vital to carbon reduction as the equivalent macro-economic framework is to economic growth

- **Industry structure and practice.** Reform of the industry and its working practices is generally acknowledged as a necessary part of increasing its competitiveness; but there is a consensus in the IGT that it is scarcely possible that the innovation and change that is essential to deliver effective and affordable low carbon solutions can

be secured through the industry as it is currently structured and engaged, particularly in the lack of collaborative integration of the supply chain, and in the silo-based habits of the industry's institutions.

- **Capacity and skills.** Delivery of a low carbon built environment will make demands on the industry that it is currently under-equipped to meet. It will need new skills and an increased quantity of existing skills from conceptual thinking to operation and use, in all layers of the supply chain – all to be found at a time when the industry has been badly weakened by the fall in its workload.

- **Incentivisation.** Clearly there is little point in setting objectives, making plans, and developing skills and capacity only to find there are no customers; and the almost universal perception in the industry is that only regulation will create mass demand for energy efficient retrofit of the domestic and sub-prime non-domestic building stock. A combination of the removal of barriers and the creation of incentives is therefore critical to the programme, and incentivisation is probably the most repeated word in this report

- **Affordability and funding.** Perhaps the most frequently asked question during the course of the IGT's work has been, "How are we going to pay for all of this?" There is no single answer, but it can only be through a combination of savings in energy bills, now or in the future; consumers placing a higher value on the parallel benefits of energy efficiency – warmth, comfort and wellbeing; avoiding the longer term costs of dealing with the immediate externalities of energy consumption; similarly, avoiding the cost consequences of inaction – a key message of the Stern Review; or subsidy. And the industry can clearly narrow or close an affordability gap by driving down costs through product or process innovation, or through economies of scale in the event of mass demand

11. Reversing the barriers implicit in the above is a necessary precondition to the required step change in the industry's response to the need to transform the built environment. This is addressed in the recommendations made in this report. But if the industry, with its clients, can overcome the barriers to action, then it stands on the threshold of five great opportunities:

    - to carry out a huge programme of work, stretching out over at least the next 40 years
    - to make use of that workload to reform the structure and practice of the industry
    - to export the products, knowledge and skills of a modernised industry
    - to play its part in readying society and the economy for a resource efficient future, beyond fossil fuels

- and to excite future generations of potential recruits into an industry with a noble cause and a secure future

12. The way that these themes impact on the separate work streams, and on the new and existing building stock within each, differs from sector to sector, but a simplified summary of the current status of each them, and their key issues, is set out below:

13. **New housing:** the regulatory framework is beginning to act, and can be expected to continue to do so, given clarity in future standards. Key issues are:

    - the need for a practical, workable definition of zero carbon, set on a nationwide basis
    - affordability, and the value attached (or not attached) by purchasers to energy efficiency and broader measures of sustainability
    - addressing the technical constraints associated with smaller sites
    - centralised and distributed energy policy, so that carbon is reduced in the most cost-effective way

14. **Existing housing:** work is in progress to identify appropriate treatments for different forms of construction, and this thinking needs to continue and to be developed at scale. Key issues are:

    - a perceived or actual disinclination to act on the part of householders, and the need to stimulate demand
    - the consequent need for a suite of measures beyond the Green Deal finance package, including regulation or fiscal measures, to ensure success
    - the need for an existing homes hub – a research, development, deployment and strategy group which can own the strategic research agenda for the sector, collect and disseminate the learning, and provide leadership for the industry to start planning for delivery
    - the development of practical measures of treatment, from room by room to whole house
    - the development of an accredited supply chain for the retrofit programme, with the necessary skills and practices
    - the use of the social housing stock to kick-start scale retrofit, utilising RMI investment and other funds

15. **New non-domestic buildings:** the picture is similar to new housing, with the regulatory framework expected to produce the necessary improvements in building performance,

and (as far as the commercial market is concerned) probably a higher preparedness to attach some value to energy efficiency, in the interests of future-proofing. Key issues are:

- the need to stimulate market demand for products and works designed for carbon reduction
- a linked need for innovative means of financing the transition to low carbon
- the invariable adoption of project level decision-making on the basis of appraisals founded on a whole life approach

16. **Existing non-domestic buildings:** here there is a broad range of circumstances, varying from prime properties, where the situation is similar to new build, through to older, lower investment grade buildings where the situation is more similar to the existing domestic stock, and the issues are generally the same.

17. **Infrastructure:** this is a diverse sector, but common themes are the need for a new approach to evaluating schemes, so that design and investment decisions are made on a basis that gives sufficient weight to the impact on carbon emissions; skills, and particularly the quest to deliver the work competitively using British resources; and, for infrastructure providers and their consumers, the issue of affordability. As a generalisation, whilst infrastructure is seen as critical to supporting a more energy efficient society, carbon reduction itself does not seem to be a priority in the design and construction of those facilities. This report proposes a very different approach to evaluating infrastructure projects, based on whole life (capital and operational) carbon performance. Other issues are:

    - the role of the industry in supporting the development of mission statements by infrastructure owners and operators for their infrastructure, that meet national policy requirements set down in the National Infrastructure Plan and through regulation
    - the role of the industry in developing evaluation models, founded on clear and realistic assumptions, that can interpret the mission statements in the language of civil engineering and permit system analyses to be used to confirm the proposed infrastructure solution
    - a new approach to the development of best practice, codes and standards, which should move away from a prescriptive to an output-lead basis
    - the urgent need to develop quantification methods for the sustainability assessment of infrastructure, supported by research into the opportunities for carbon reduction through better engineering

18. **Major Projects:** the need for a new organisation that can act as an effective knowledge network for the capture and exchange of lessons learned, but also accredit the energy performance and wider sustainability credentials of major projects.

19. Over-arching all of these sector-specific issues, there are specific actions for Government, to set a strategic framework, and for industry, to respond to it.

20. **For the industry,** the key issues are:

- to continue to transform itself in accordance with a well-established agenda for integration and modernisation
- working with its clients, to make the cost savings of 10-30% mooted as the rewards of that transformation, holding out the prospect of delivering zero or close to zero carbon buildings for no more than buildings conforming only to current Building Regulations
- particularly in respect of the existing stock, to develop practical, phased packages of work designed for energy efficiency that can be delivered assuredly and with minimum disruption
- to build the skills and capacity necessary to sustain a modernised industry and to deliver buildings that are both more energy efficient and more affordable

21. And finally **for Government:**

- to send out clear and constant signals, by both word and deed, that being "the greenest ever" will remain a priority for the Government, and that this will be backed by positive plans of action
- to establish regimes for management, cascading from a high level change management and programme management
- within that regime, to make a series of projects, each the subject of the Government's oversight and governance procedures for Major Projects
- to make a plan for each of those projects: detailed in the near term, grading to conceptual further into the future
- in making those plans, to give energy efficiency the same priority as energy generation – the former reducing the need for the latter, and doing so on a cost-effective basis
- to clarify the organisational landscape, making the greatest possible use of existing organisations, but allowing room for new ones to develop; and to offer a centre of gravity and connectivity, so that anybody seeking to give or receive a good idea knows how to connect
- to work with the industry, so that policy is informed by practical, researched propositions; so that plans are made with full knowledge of the capacity of the industry; and so that the industry can plan and invest with a knowledge of future plans

- to pursue policies that allow and encourage the industry and its customers to be an engine for economic growth, recognising that innovation, the development of skills, and investment in business and industry improvement all feed off workload
- to do whatever it takes to incentivise the market, particularly in the residential and sub-prime non-domestic sectors
- to consider proceeding on twin tracks: planning for regulation, whilst allowing for the possibility that it might not be required
- to recognise that it takes time to develop both the technical proposals and the supply chain to deliver new packages of work – such as "whole house" retrofit, and to take that time, but in the context of an agreed programme
- but also to recognise that there are some packages of work that are already known to be both technically feasible and cost effective, and that these can be implemented straight away – both to develop supply chains for a growing programme, and also to stimulate growth

22. Recommendations to address these issues and the barriers to change are set out in the report, and summarised in Annex A. Fundamental to them, though, is the need to stimulate demand; and if the industry is to lead the transformation of its product, it must first be confident of the transformation of the market. The evidence is that the clearest signal of this will be taken from well-designed regulatory standards, underpinned by the presumption of a stable and realistic price of carbon.

"Low-tech, green jobs and local services – such as improving building insulation and replacing obsolete heating and cooling equipment – have greater potential to generate jobs than the development of renewable technology solutions. For policy makers concerned with abating carbon emissions in the near term, pushing the adoption and diffusion of low carbon solutions is likely to make a bigger difference than technology production alone."

McKinsey Global Institute, March 2010

2. Carbon and the Built Environment

2.1 Policy and Strategy

The United Kingdom's commitment to reduce carbon and other greenhouse gas emissions is now a matter of legal obligation. Under the Climate Change Act 2008, emissions are targeted to fall by 26% by 2020 (by comparison with a 1990 baseline) and by no less than 80% to 2050.

To support this commitment, and broader issues around energy use, there is a range of tax, levy and market mechanisms in place. These are summarised in Annex D.

The Climate Change Act also requires the Government to establish a carbon budgeting system which caps emissions over five year periods, with three budgets set at a time, to set out a trajectory to 2050. The first three carbon budgets run from 2008–2012, 2013–2017 and 2018–2022, and the Government will announce the level of the fourth budget in March/ April 2011.

The broad strategy by which this might be achieved is set out in the Low Carbon Transition Plan published by the last Government, currently being reconsidered by the Coalition Government. It makes clear that the implications of a low carbon economy reach deep into every aspect of the construction industry, and that any plan for carbon reduction will depend upon the industry to be effective.

Headlines of UK Low Carbon Transition Plan as it relates to construction

Residential

Increased energy efficiency in homes to reduce emissions by 29% by 2020 (from 2008 levels)

All new homes to be zero carbon from 2016

Smart displays to be fitted to existing meters for two to three million households by 2016; and smart meters to all homes by 2020

Major retrofit programme to increase energy efficiency of existing stock

Non-Domestic Buildings

Increase in efficiency to reduce emissions by 13% by 2020 (from 2008 levels)

All new public sector buildings to be zero carbon from 2018, and private sector buildings by 2019

Infrastructure

A more flexible, smarter grid

New nuclear power stations to provide additional 16GW of power between 2018 and 2025

Major programme of wind power and marine energy to increase electricity from renewable sources to around 30% by 2020

Programme of carbon capture from coal-fired power stations

New green communities

Infrastructure to support a more sustainable transport system, to reduce transport emissions by 14% by 2020 (from 2008 levels), including sourcing 10% of UK transport energy from sustainable renewable sources by 2020

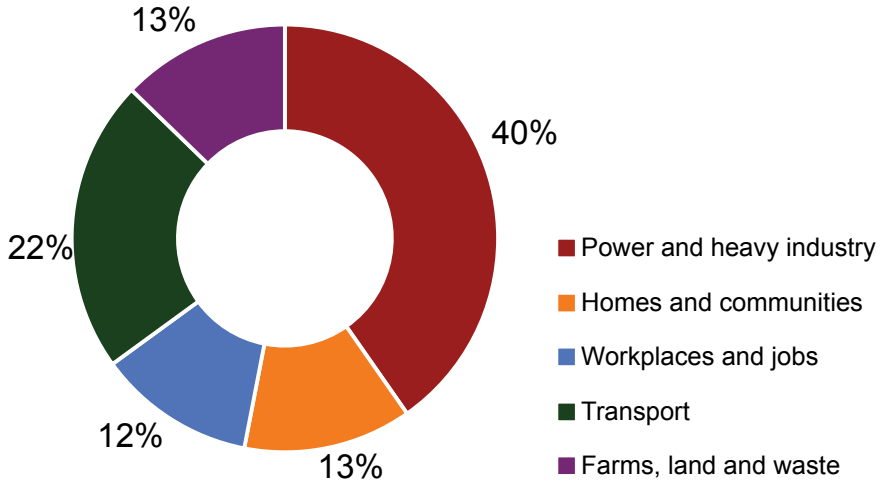
It is scarcely an exaggeration to say that, over the next 40 years, the Low Carbon Transition Plan is a business plan for construction.

So for companies in construction, the task is three-fold:

- to de-carbonise their own business, and to encourage the same habits throughout their supply chain

- to provide the owners and occupiers of both new and existing stock with buildings that emit less carbon in their construction, operation and decommissioning – saving them money in the process
- to provide the infrastructure that will supply clean energy and support sustainable practices in other areas of the economy, such as transport and agriculture

Figure 2.1: Expected sectoral contributions to net UK carbon account 2008 – 2022



Source Low Carbon Transition Plan

Representing 8.3% of the UK's gross value added (approximately £300 billion of output in 2009), and employing some 2.2 million people, the construction industry has always been of major importance to the economy. In the words of the House of Commons Business and Enterprise Committee report of 2008, "construction matters". There can scarcely be a time in its history, however, when the strategic importance of the industry has been greater – not just to renew the country's building stock, but to do so in a way that meets the needs of a new low carbon economy, and at a time of severe economic restraint.

This pivotal role creates the opportunity, and almost the obligation, for the construction industry to take up a position of leadership, going beyond the execution of the work to act as advocates in preparing the broader public sector, business and public opinion for what lies ahead, and setting an example in its own practices.

Overall, though, the task will require new thinking, new ways of doing familiar things, and the acquisition of skills. The reward for those who best rise to the opportunity will be the securing of competitive advantage at home and internationally.

2.2 Low Carbon Study by the Innovation and Growth Team

In recognition of both the challenge of innovation and the opportunity for growth implicit in the move to a low carbon economy, an Innovation and Growth Team ("IGT"), drawn from the construction industry and supported by Government, was commissioned to conduct a strategic review of the UK construction industry, specifically to consider how it can rise to that challenge and seize the opportunity. This Final Report follows Emerging Findings published in March 2010, and builds on those findings, as charged by Mark Prisk MP, the Minister for Business and Enterprise in the Department of Business Innovation and Skills.

The work of the team is principally being conducted through six working groups, under the oversight of a steering group.

The first three of the Working Groups are addressing different sectors of the industry:

- residential buildings, new and existing
- non-domestic buildings, new and existing
- infrastructure

In addition there is a cross-cutting working group, looking at issues common to all work streams; a Major Projects group which is looking in particular at how lessons learned on large scale works can be transferred to other projects, both large and small; and a young professionals group (the 2050 Group) looking at the position beyond 2022 through to 2050.

The broad remit of all of these groups (*inter alia*, and all in the context of carbon reduction) is:

- to assess the strengths, weaknesses, opportunities and threats to the UK construction industry
- to identify the barriers to improved performance by the UK construction industry, and to make recommendations
- to consider how the UK construction industry can rise to the challenge of the low carbon agenda
- and to produce a report which makes recommendations to Government and industry which are capable of being taken into account in policy making, and to produce an action plan for industry

Because a carbon reduction programme is so inextricably linked with the built environment, the scope of the Terms of Reference is potentially vast, and the production of an action plan for the industry depends first of all upon the establishment of an over-arching strategy and a plan for the whole programme. This is addressed in Section 3.1 of this report.

It is also important to acknowledge that the construction industry, buildings and carbon itself are all part of much bigger systems, and that, to get an action plan right, the interactions within and between these systems need to be understood.

In this report, "construction industry" is taken to mean all of those involved in the design and construction of the built environment. Buildings are, however, commissioned for a purpose, and carbon reduction and energy efficiency (and the terms tend to get used interchangeably in this report, although they are rather different things) need to be weighed against that purpose, and against the usual constraints of time, cost and fitness for purpose. Although this report does consider both embodied and operational energy (see Section 2.7 below), over the whole life of a built asset the operational energy will exceed, and sometimes far exceed, the energy consumed in creating the asset in the first place. This means that the way that the building will be used, and the efficiency with which it is capable of being used, are critical to carbon reduction.

To broaden things still further, the ownership and occupation of buildings are frequently separate, and this produces particular challenges where the interests of owner and occupier are not aligned. This is addressed in Chapter 6 of this report, but the point to make here is that an action plan that is designed to make the transition to a low carbon economy needs to consider the whole process from conceptual design through construction, into use and then to end of life; and also to consider the interests of all parties involved along that chain, and particularly the behaviours of the last in the chain – the occupier.

Carbon is also part of a system, not just serving as a proxy for all greenhouse gases, and often for energy itself, but also as part of a much wider set of measures of sustainability.

Finally, each built asset is part of a larger system, from the building itself (which in turn operates as a system) to a street, to a neighbourhood, to a town or city, to a county or district and finally into a nationwide skeleton of infrastructure. Again, carbon reduction plans need to consider the scope for improving existing performance at every scale.

It is with good reason that the Royal Academy of Engineering calls for a new attention to be paid to building engineering physics – effectively systems engineering of at least some of the systems involved.

2.3 Out of scope

With such wide-ranging terms of reference, the IGT could not expand its scope still further, and excluded the following from its work:

- other aspects of sustainability – resource efficiency, biodiversity, water conservation etc
- occupant behaviour
- the planning system
- adaptation to climate change

They are listed because, in spite of being out of scope, each is very much in play in carbon reduction and their importance is acknowledged here. For example:

- Resource efficiency: 10-15% of materials sent to a building site end up as waste. It follows that all of the carbon emitted in the materials extraction, manufacture and transport to site is also wasted, to which is then added the carbon emitted in transporting the materials away again and disposing of them.
- Occupant behaviour: the fabric and systems of a building and the behaviour of those occupying it are completely interlinked. A good building that is badly run will perform badly. The change management programme referred to above therefore relates every bit as much to the 62 million people who occupy the buildings as to the built environment itself. Cultural change needs to accompany technological change – and one pf the most interesting aspects of technology may be the way it can assist occupiers to run the building well – for example by simple to operate controls.
- Planning system: a double-sided coin that can make it difficult to implement measures designed for energy efficiency, or it can identify opportunities to create scale across development boundaries, and thereby open the door to more efficient possibilities – in distributed energy, for example.
- Adaptation: there are particular inter-dependencies between mitigation and adaptation, and these are addressed in section 2.4 below.

2.4 Adaptation

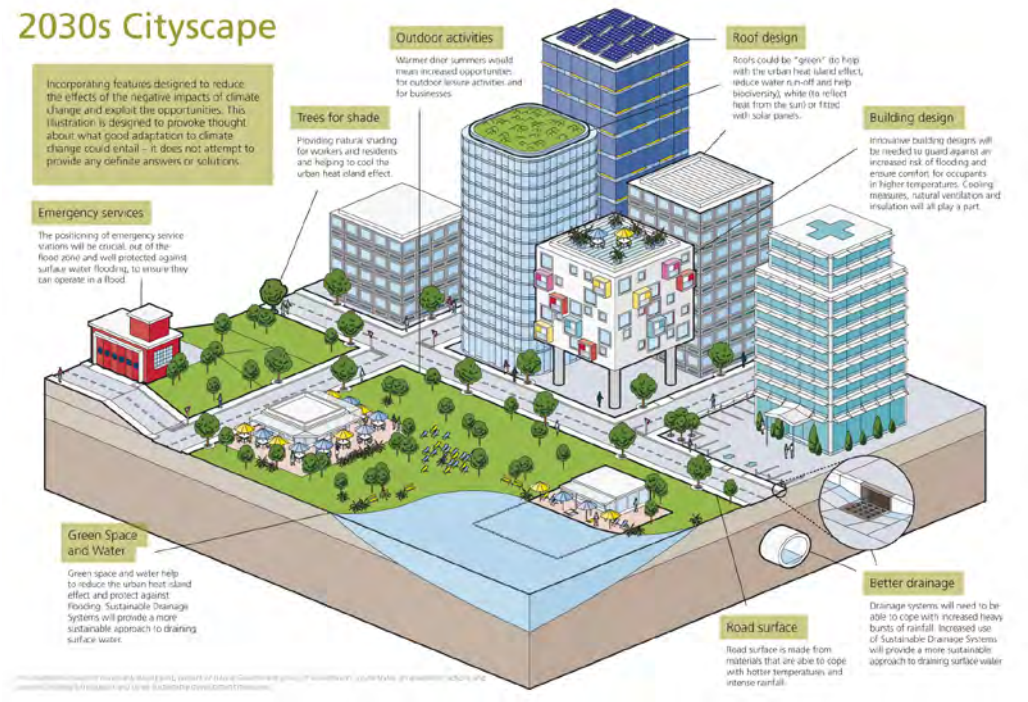
The projections of the International Panel on Climate Change (IPCC) show that, whatever mitigating action is taken, the rise in global temperature and its associated climatic effects are already set into the system. For the medium term, therefore, adaptation measures are as important as mitigation. It is, however, the subject of separate studies commissioned by DEFRA, and is therefore beyond the scope of this report – save for a general caution to the effect that actions designed for mitigation need to take fully into account the new design criteria that will apply as the climate warms; and that the interplay between adaptation and

mitigation needs to be kept under review by all designers to ensure that actions taken in the service of one do not damage the objectives of the other.

As always, there is a risk of unintended consequences – and the 2050 Group refer to just one: the health consequences of sealing our buildings, with a high degree of air tightness, to improve energy efficiency, but with a potentially detrimental effect upon air quality.

Many of the issues are the same – for example in respect of the limited drivers for individual action, the levers (communication and awareness, standards and regulations, fiscal incentives or penalties); the sequence leading to action (appreciation of the risk, understanding the impact, being motivated to act, knowing what to do, having the skills and capacity to do it, having access to the right products and services, and being mandated to act); the need for new skills and growth in existing skills; and many of the physical measures that would form part of an adaptation plan and also form part of mitigation strategies that need to be incorporated into new design.

Figure 2.2: 2030s Cityscape



Source Department for Environment, Food and Rural Affairs

There will also be significant overlap between the clients who will need to commission work in the interests of mitigation or adaptation, and in the supply chains that they will need to go to.

There therefore needs to be a high degree of connectivity between organisations, both in central and local Government, and in the private sector, charged with developing policies and plans for mitigation and adaptation, so that there is convergence wherever possible – and also so that interested parties do not find themselves called into multiple and apparently disconnected conversations or engaged in duplicative research.

Construction companies, like all companies, also need to recognise that climate change will have a direct and potentially costly impact on their own operations, and this argues for moving it from being an ornament in a corporate social responsibility policy to a mainstream business issue. In the words of Michael Porter, "the effects of climate on companies' operations are now so tangible and certain that the issue is best addressed with the tools of the strategist, not the philanthropist".[1]

2.5 First things first

There is one final piece of context before addressing the construction industry's role in carbon reduction.

One of the comments made on publication of the Emerging Findings was that it did not make enough of how much improvement in energy efficiency can sometimes be achieved by doing only a little. It is a fair comment, and illustrates the importance of regarding the design, construction, ownership, occupation and use of a building as being part of a system, in which all parts need to be considered and addressed together – rather than as a construction project in waiting.

There are many examples, particularly in the public estate, where programmes focused on the operation of the building have moved the DEC rating by one grade or more, without the need for disproportionate expense.

Typical measures taken to achieve this include:

- training users in the operation of the systems
- maintenance and commissioning of all systems so that, within the limitations of their age, they run to their design efficiency
- fitting simple controls to heating systems to optimise hours of operations
- balancing systems so that, for example, heating and cooling systems are not in conflict, with each responding to the other rather than to external temperature
- re-setting thermostats and allowing a wider set of acceptable temperatures – a bit cooler in winter, a bit warmer in summer

1 Grist: A Strategist Approach to Climate – Michael E Porter and Forest L Reinhart, Harvard Business Review, October 2007

- simply turning off equipment when not in operation, rather than leaving it on or on standby
- and many more low level actions to deal with heat loss, inefficient energy use by equipment and so forth

This is all in addition to the need to engage the users of a building to share the objective of reducing demand – the cultural/behavioural issue referred to above, without which much expenditure on physical measures can go to waste.

By a package of measures such as this, the Department for Energy and Climate Change (DECC) brought down its own energy bills by almost a third over the space of a year, whilst increasing the population of the building.

This points to a logical sequence in which to address energy or carbon reduction:

- to measure what is happening now
- to reduce demand
- to use the demand efficiently
- to use low or zero carbon energy where possible
- to measure again – and constantly feed back and act on the results of that measurement

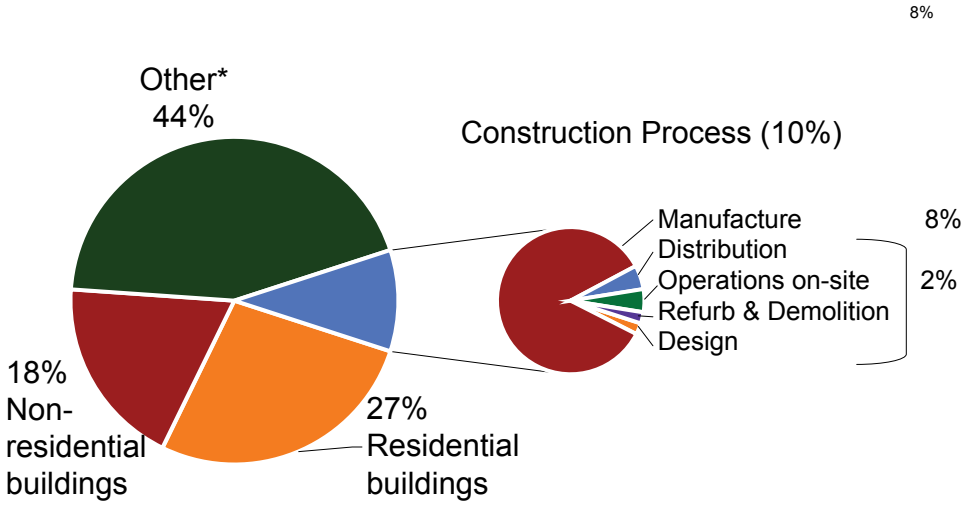
There are catchy phrases to capture this ("be mean, be lean, be clean" or "moderate, insulate, generate"), and this suggests a developing consensus; but the start and finish point needs to be measurement: to establish the performance of the building as currently constructed and operated, to model the effect of proposed measures for improvement, and to confirm that those improvements have been achieved. The roll-out of Energy Performance Certificates and Display Energy Certificates in non-domestic buildings would be a natural reinforcement of this process, making visible the consumption (and any improvement in it) not just to the public, but also to senior management, with prospects of motivating any well-run business to want to do well in every part of its business, and to guard against reputational risk.

Many of these points apply equally to brand new buildings, as post occupancy studies repeatedly show that buildings do not perform to their design criteria. This is addressed further in chapter 3 which looks at the structural issue in the industry as to how new buildings are brought into use.

2.6 Carbon in the Built Environment

It is often said that buildings are responsible for about half of the country's CO_2 emissions, and in one sense this is true.

Figure 2.3: Proportion of total UK CO_2 emissions that construction can influence



Source DECC, National Communication, Carbon Trust Report, BIS estimates

However, the figure is derived from operational energy – that is, where energy is consumed, and it would therefore be truer to say that this is the amount of energy consumed by *people* in buildings. The distinction is more than pedantic, because it demonstrates that behaviour is going to be as important, or more important, than technology in reducing emissions. For the industry, the question is how can it develop a built environment that supports and encourages a life lived at dramatically lower levels of energy consumption.

Furthermore, the 50% figure, being based on buildings in use, excludes embodied energy – that is, the energy consumed in the extraction or manufacture of the materials and products required for construction work, or in the process of transporting and assembling them. This is counted as the operational energy of the industrial and transport sectors.

However, the IGT regards its scope as being necessarily concerned with emissions from the whole life cycle of the process of design and construction, including this embodied energy, and also with emissions resulting from the use of the building *to the extent that the industry can feasibly influence them*. This is illustrated in Figure 2.3.

Figure 2.4: Broad phases of a building's life cycle

Source BIS estimates

As this figure demonstrates, the contribution of construction processes to total UK CO_2 emissions are themselves significant. However, choices made during the construction process have a significant influence on the performance of buildings, and it is therefore worth looking at the extent to which the industry can influence energy consumption, and associated emissions, over the whole life cycle.

The Emerging Findings report included an estimate of the amount of CO_2 emissions[2] for different elements of the construction process, which was an attempt to do this, and it is updated at Figure 2.4. This should not be interpreted as the amount of emissions the construction industry is directly responsible for.

The estimate in figure 2.4 (which is broadly consistent with a similar exercise conducted by the UK Green Building Council[3]). takes a holistic view of the CO_2 emissions across the broad areas of a building's life cycle:

- **Design:** emissions occurring from outset of a project through the process of design (energy and transport use by architects, planners and engineers, for example). However, the real scope for this sector to reduce CO_2 is through the impact design makes on emissions from occupation and use.
- **Manufacture:** emissions associated with the domestic production of construction products/materials as well as emissions embodied in imported products/materials.
- **Distribution:** emissions as materials and people are transported to and from site.
- **Construction:** direct and indirect CO_2 emissions (combustion and energy use) from on-site operations – but excluding refurbishment and demolition, which are accounted for separately below.
- **Operation (in use):** emissions resulting from the occupation and use of the asset, heavily influenced by occupier behaviour.

2 CO_2 makes up roughly five sixths of Greenhouse Gases (GHGs), which are targeted for reduction by the Kyoto Protocol and the Climate Change Act 2008 (CCA). The figures quoted here are limited to CO_2 because there is evidence that emissions of non-CO_2 GHGs as a result of energy and fuel use by the construction industry, and the buildings that it influences, are minimal, hence the greatest scope for reduction by construction lies in CO_2. It is noted however, that there are emissions of non-CO_2 GHGs in the manufacture of some construction products and materials and these would fall within the scope of the CCA.

3 UKGBC estimate uses the UK GHG inventory 1990 to 2006 (hence slight difference in numbers) and estimates cover of CO_2 emissions from Non-Dom. It applies a breakdown of building type applied to GHG inventory from BRE data (2002) (2.1 & 2.4). Includes unregulated use, as applies proportion of domestic carbon emissions to total carbon emissions.

- **Refurbishment/demolition:** direct and indirect emissions (again, combustion and energy use) from the process of refurbishment and from eventual demolition and disposal.

Figure 2.5: Amount of CO_2 emissions which the construction industry has the ability to influence 2008[4]

Sub-Sector	$MtCO_2$	% of total
Design	**1.3**	0.5%
Manufacture	**45.2**	15%
Distribution	**2.8**	1%
Construction	**2.6**	1%
Operation (in use)	**246.4**	83%
Refurb/Demolition	**1.3**	0.4%
Total	**298.4**	100%

Full details of the methodology used to produce this table, and the assumptions which underlie it, can be found on the IGT website (www.bis.gov.uk/policies/business-sectors/construction/low-carbon-construction-igt), but three headline messages emerge:

1. the amount of CO_2 emissions that construction can potentially influence is significant, accounting for almost 47% of total CO_2 emissions of the UK

2. emissions from occupation and use account for the largest proportion, over 80%, of total CO_2 emissions that construction can influence

3. manufacture (of construction products and materials) accounts for the largest amount of emissions within the process of construction

It must be stressed that this is a very high level exercise, and the result can only be a generalisation, as the data lacks the granularity that would permit a more precise calculation (and the same lack of data frustrated the aspiration of the IGT to produce indicative embodied carbon targets for different building types). New approaches to valuing embodied

4 Percentages do not added up to 100% due to rounding

carbon over the life cycle of a building also suggest that the proportion of embodied carbon to operational could be higher.

However, looking at the operational energy, and by way of an example, the Carbon Trust estimates the following allocation to various sources of consumption for housing (figure 2.6) and a non-domestic building (figure 2.7):

Figure 2.6: Carbon emissions by source – housing

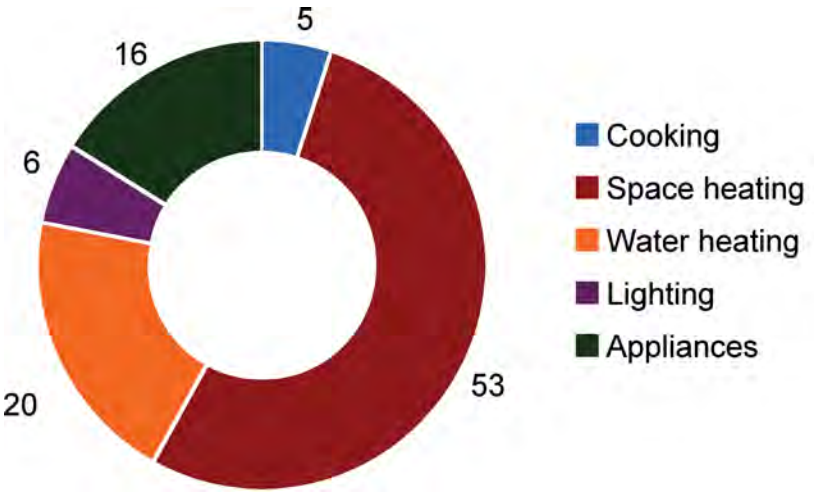
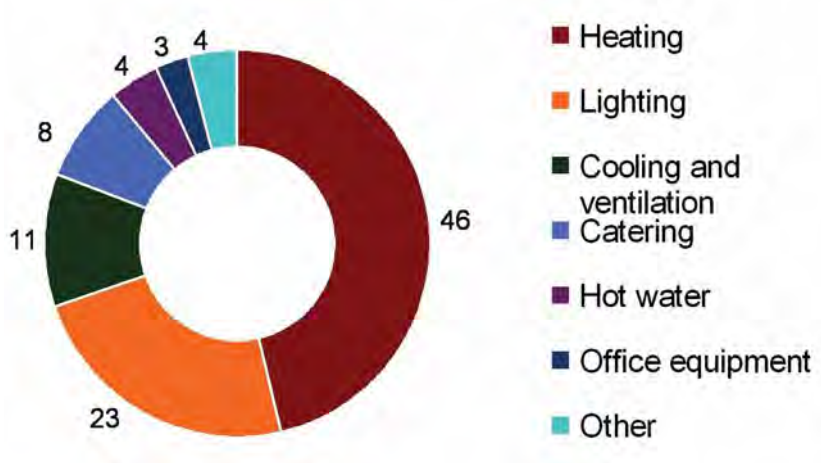


Figure 2.7: Carbon emissions by source – non-domestic building



This illustrates that the construction industry cannot (or should not) just dismiss operational energy as somebody else's problem – or somebody else's opportunity. With the possible exception of equipment and appliances, there is considerable scope for the industry to influence operational performance and each of these segments of consumption is an invitation to innovate. This is considered further in section 2.9 below.

2.7 Whole life carbon

2.7.1 Embodied energy

Concentrating on operational energy clearly avoids the risk of double-counting (given that all embodied energy was once operational energy somewhere in the supply chain), but the IGT feels that practical ways of addressing a reduction of carbon in the industry demands attention being paid to embodied energy, in order to engage the full supply chain.

This is not instead of paying due attention to operational energy, but rather in addition – so that "whole life carbon" becomes as important a means of appraisal as whole life cost should be.

Appraising in this way also avoids a number of unintended consequences of not doing so, including:

- that it would otherwise be possible to count as a good thing an "energy saving" product which consumes more energy in its manufacture than it can save over its working lifetime
- that imported materials would effectively arrive at the site "carbon free" in accounting terms, creating the risk that emissions are effectively exported rather than reduced ("carbon leakage"), and that UK manufacturers investing to reduce their emissions, or paying to offset them, are disadvantaged
- that there is less pressure to reduce the high levels of materials waste in the industry
- that unnecessary increases in carbon emissions may be created by demolishing and replacing a building, where the carbon benefit of recycling existing structures is not taken into account

Taking embodied energy into account in material or component selection can also be expected to stimulate innovation as supply chains look right through the project life cycle shown in figure 2.4, to identify carbon that could be taken out of the process through:

- design and material selection
- improved product design, and de-carbonising extraction/manufacturing processes
- better logistics between factory and site, including use of consolidation centres, low carbon vehicles etc
- better logistics on site, including reduction of double handling, just-in-time deliveries, reduced waste for disposal off site etc
- low carbon construction operations

Fundamentally, though, full attention paid to all the implications of the full life cycle of a product or component, from the extraction of raw materials upstream, down to the impacts of the product in use and its eventual disposal or recycling, is key to pulling good environmental habits right through to the supply chain, and in producing products which

have the minimal environmental impact over their whole life. Even if each individual party involved in the process considers their own operational energy, this will not produce the best outcome, as part of that outcome will have been locked in before the intended use is known.

2.7.2 Measurement

The way that the rules of the carbon marketplace are framed will also influence basic objectives in product design. If, for example, operational efficiency is rewarded, but resource efficiency is not, then manufacturers may be expected to develop products that perform well over their life, but for which the design life will be relatively short – leading to the embodied energy penalty of having to replace them more frequently.

It is also clear that, as operational energy reduces through the implementation of efficiency measures, the proportion of whole life carbon that is attributable to embodied energy increases. There are also grounds for believing that, if the analysis is properly conducted, the proportion already attributable to embodied energy is considerably greater than is typically quoted, based on the consensus derived from most exercises conducted to date. However, those exercises are generally conducted on the basis of all components in a building having an equivalent life, and take no note of the need to replace certain components at differing intervals over the life of the building. The "Redefining Zero" report sponsored by the Royal Institution of Chartered Surveyors shows how different the result can be when full account is taken of periodic component replacement over the life of the building. That study concludes that a realistic assessment of the proportion of whole life carbon that is embodied could be as high as 60% – and even this will increase as operational energy consumption is reduced.

Embodied energy is therefore important, and it needs to be brought into the systems used for appraisal of projects – and hence into the design decisions made in developing projects.

This leads to a substantial restatement, as a key recommendation, of a proposition made in the Emerging Findings report.

Recommendation 2.1: That as soon as a sufficiently rigorous assessment system is in place, the Treasury should introduce into the Green Book a requirement to conduct a whole-life (embodied + operational) carbon appraisal and that this is factored into feasibility studies on the basis of a realistic price for carbon.

As far as a "rigorous assessment system" is concerned, in the absence of an industry standard, many practices have been developing their own. This shows initiative, but it also creates uncertainty throughout the supply chain as product manufacturers, designers and other specifiers cannot be sure that the choices they make will invariably lead to a favourable

rating. The IGT has therefore convened a series of seminars for those working in this area, and particularly those who have developed a methodology for carbon profiling, to establish some common principles and agree which major issues need to be resolved in order to develop a standard approach.

The major points of principle upon which there was consensus are:

- The assessment would require a CO_2 equivalent figure for each year of a project's life, considering emissions in the year they occur and not distinguishing embodied from operational emissions.
- Sunk carbon costs should be disregarded, so the calculation essentially considers changes to the present situation.
- Embodied CO_2e in simple products should be calculated by multiplying the mass or area of a material by its intensity of CO_2e per m^3 or m^2. Complex products should be measured by the makers, progressively in Environmental Product Declaration (EPD) format.
- Operational emission figures would be based on the Building Energy Rating system.
- CEN-TC350, which will become available over the next two years, should be the basis of measuring CO_2e in products and projects. Products are assessed from 'cradle to factory gate' with projects adding transport (with DEFRA factors) and site work emissions to make the 'before-use' total. TC350 treats emissions from repair, maintenance and replacements as 'in-use' – that is, operational, not embodied, so it aligns with Capex and Opex definitions.
- Occupier plug or process loads are **not** included.
- There is an economic case for assessments to be estimates based on the top ten emitter elements. Little will be available at feasibility stage (Gateway 1) and indeed there is a need for some benchmark figures by building types. More would be available at 3A and 3B as a by-product of design.

And the major issues still requiring more work are:

- carbon that has been traded out by suppliers
- sequestered carbon in timber as there is no guarantee it will not eventually be emitted
- the use of recycled elements
- use or waste of by-products like steel slag
- the assumptions that should be made about the treatment of material at "end of life" (or rather the end of its planned life as a component of the project under consideration)
- the reconciliation of the above with carbon accounting principles operated by HM Treasury

There is also an obvious need for reliable data about product life. Data for the embodied calculations are not perfect now and are mostly taken from Bath University sources as they are publicly accessible. BSRIA is improving the data and tools. BRE sources are likely to be made

more accessible and product makers are producing Environmental Product Declarations with them.

There is likely to be controversy, and it is essential that any standard methodology is based on reliable evidence – both as to the qualities of a product or material, and (for example), as to how it might be treated at end of life.

Once in place, though, it can be anticipated that there will be rapid change in product qualities and product information as suppliers compete.

> The 2050 Group refer to a product that might usefully be targeted by proper account being taken of embodied energy: a premium wallpaper which sources the top third of a tree from Germany, ships the pulp to Thailand to weave a nylon thread through it (derived from oil, and rendering the product un-recyclable), shipping the paper to Mumbai for dyeing, and then shipping the finished product back to the UK for further international/national distribution.

The discussions highlighted the fact that the search for zero operational emissions may be at the cost of uneconomically raised embodied emissions. Whole life emissions must be the assessment basis. This may call for reconsideration of the language of policy.

Once agreed, a reliable methodology could also become a matter for regulation, possibly as an extension of Part L, covering the energy performance of (operation of) buildings, to facilitate a move to the integrated consideration of whole life carbon. This could only happen, though, once product data is widely available

Even on the evidence of this brief exercise, it is clear that there is a great deal of common ground, and there is also a body of knowledge and, through a number of organizations that predate the IGT, the good will to develop that knowledge into a methodology. However, that process needs to be undertaken with the imprimatur of Government, so that the result carries authority.

Recommendation 2.2: That the industry should agree with Government a standard method of measuring embodied carbon for use as a design tool and (as Recommendation 2.1 above) for the purposes of scheme appraisal.

2.8 Focus on energy and carbon reduction

Carbon reduction is not the only key issue for the industry, and all of the other items on the business improvement agenda (increased productivity through process improvement, the

elimination of waste, respect for people, properly negotiated terms of employment and rates of pay, higher levels of training, full regard to health and safety etc) remain undiminished.

Nor is energy efficiency the only measure of sustainability. Nonetheless, measures of sustainability have become so broad and varied that it is possible to claim that almost any new building is "green" on the grounds that it ticks a few of the boxes. A concentration on carbon (as shorthand for carbon dioxide or its equivalent) therefore does bring simplicity, and potentially rigour to the subject, providing focus and a sense of priority. The one qualification to this is that, given that a key objective must be energy reduction, rather than just switching to energy from cleaner sources (which may still be used wastefully) or to carbon trading, energy should be measured first when assessing the performance of a building, and then be converted to its CO_2 equivalent.

Attending to carbon reduction also draws in many other desiderata, including air quality, water conservation (water being carbon heavy in its treatment and distribution), resource efficiency (all waste arising from the construction process representing embodied energy that has also been wasted) – and, indeed, the efficient use of money. Taken to its logical conclusion, carbon will become another means of exchange, requiring the same management and accounting processes as money itself. If cash is king, carbon must be its queen.

2.9 Construction industry, sustainability and carbon reduction

2.9.1 Introduction

The IGT did not question the science of climate change, either of diagnosis or prescription, and started with the presumption that an 80% reduction in carbon emissions by 2050 is what has to happen, and looked at what has to happen first if it is to do so.

As a matter of observation, in all of the meetings and discussions that have gone into the report, skepticism about the science has hardly arisen, although there have been many who have wondered about the public appetite for the very tough decisions that will need to be made, and almost all have been daunted by the scale of the task. In the words of a member of the IGT Steering Group, "It is very difficult to commit to something that appears to be almost impossible". For the most part, of course, these discussions have been with a self-selecting group who are already engaged in the low carbon agenda in some shape or form; and this demonstrates both the strength of leadership and the surety of the way ahead if everyone is to follow.

In the meantime, the construction industry has engaged positively with the issue of sustainability since the word first came into common currency, and stands ready to play its part in responding to the more focused challenge of carbon reduction.

2.9.2 Sustainable Construction Strategy

Working with Government, the industry has also produced a Strategy for Sustainable Construction. Launched in June 2008, this strategy brings together a number of themes around the issue of sustainability, and sets out plans for improved performance.

The strategy has already had a number of successes including:

- The over-arching target for waste is to make a 50% reduction of construction, demolition and excavation waste going to landfill by 2012, compared to 2008. This is being driven forward by WRAP and annual savings to industry are estimated to be more than £200m.
- There is a target of a 15% reduction in carbon emissions from construction processes and associated transport compared to 2008 levels. An action plan was launched earlier this year, and it is estimated that implementing this plan should save the construction industry about £180m annually.
- In September 2010, a resource efficiency action plan for flooring was launched, as was a resource efficiency action plan for joinery.
- Industry has formed a Plasterboard Sustainability Partnership, and a Sustainability Action Plan for Plasterboard was published in October 2010.

The work of the IGT inevitably overlaps with the Strategy, but should not be seen as separate from it. The Strategic Forum for Construction and BIS are continuing to take the strategy forward, and as it is one of the complaints of the IGT that there is unnecessary multiplication and duplication of initiatives, plans which develop from this report should be played back into the Strategy for Sustainable Construction.

2.9.3 Opportunities for growth

There are already many examples of good practice, right through the supply chain (and sometimes with companies coming together in new partnerships to improve their offering). Examples were given in the Emerging Findings.

There is above to reference to each segment of an energy consumption chart being an invitation to innovate. Examples are:

- in **heating**: through improved fabric efficiency from higher levels of insulation in windows and façade construction, more efficient boilers, better optimising controls, heat recovery, new technologies (heat pumps, fuel cells etc)
- in **lighting**: through fittings achieving the same lighting levels at lower levels of consumption, lighting controls etc
- and **overall**: through new technologies for renewable energy

There are more examples in Annex E, which summarises the responses to a Construction Products Association questionnaire asking its members where they could see the main prospects for innovation that will deliver innovative low carbon technologies with potentially significant market opportunities.

The major opportunity, though, lies in the sheer breadth and diversity of the range of measures necessary to transform the built environment to serve and support a low carbon economy.

As noted in the introduction, the engagement of the industry is already deep and wide, with:

- a host of professional and academic institutions, trade associations and specialist interest groups who are deeply involved in education, research and the gathering and dissemination of best practice
- British architects, engineers and other consultants working at home and around the world earning the UK a well-deserved reputation as leaders in sustainable design
- construction companies and specialist contractors who, as well as building on their existing capacity to deliver the buildings and infrastructure that we need to support "greener" ways of living, are also putting sustainability at the very core of their own businesses
- manufacturers producing innovative products and committing the serious investment required to bring them to market
- materials producers, many of them intensive users of energy, completely changing their processes to reduce the impact of their operations; distributors promoting those products and developing the logistics necessary to deliver them where they are needed in the most user-friendly ways
- hundreds of thousands of small businesses and individual tradesmen advising customers on simple things they can do to improve the energy efficiency of their buildings

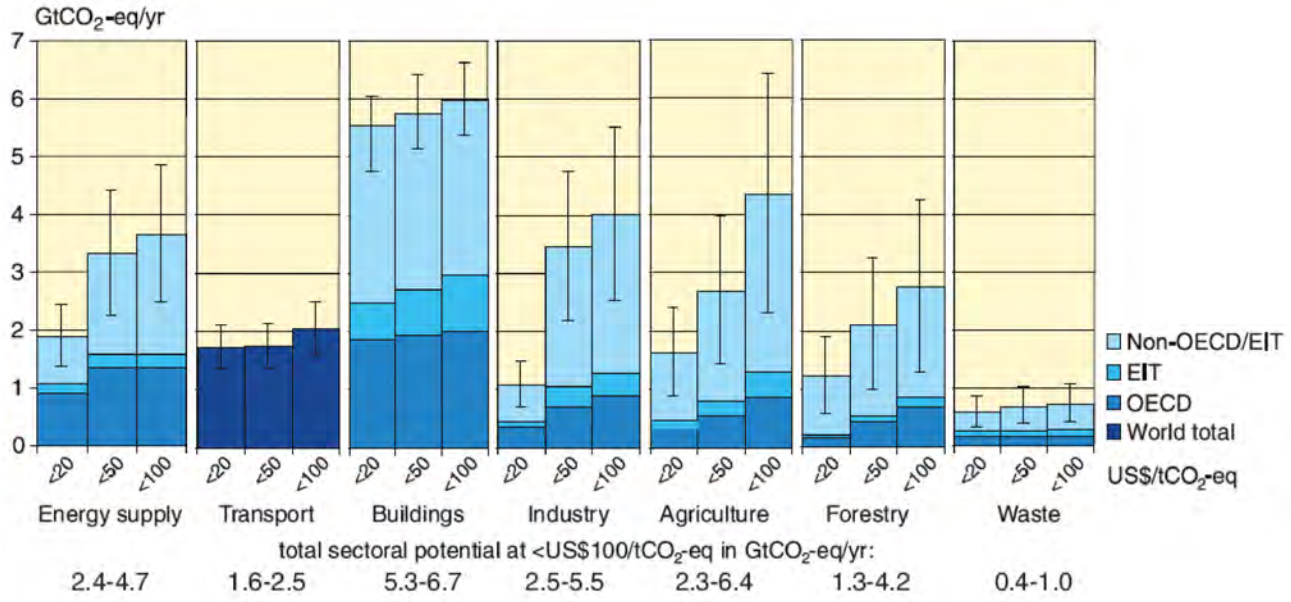
Every one of them, and all off those not yet engaged, therefore has a ready-made springboard for growth.

The involvement of small businesses is key. There are close to one million construction businesses employing less than 10 people, and they are in and out of people's homes and places of work on a daily basis. They therefore represent an enormous asset, both in their opportunity to advise householders and small business owners of some of the things they can do to reduce their energy consumption, and in their capacity to do the work.

They also represent an enormous opportunity for economic growth. If just 10% of those businesses added one employee, there would be another 100,000 people engaged in the industry, learning the new skills that will be required to build new supply chains.

While there remains much to resolve in a 40 year programme of work, there is much that needs to be done that can be done now, particularly in the existing building stock; and this work is also amongst the most cost effective ways of reducing energy consumption and carbon emissions.

Figure 2.8: Economic Mitigation Potential by Sector



Source: Fourth Report of the Intergovernmental Panel on Climate Change

There is therefore a unique opportunity to serve the needs of both carbon reduction and economic growth by incentivising the market and mobilising this workforce.

In the meantime, the industry is already demonstrating, albeit still in parts, that it has both the capacity and the inclination to play a full part in meeting the challenge of climate change, and converting that challenge into an opportunity for growth, both in the UK and in export markets.

On the subject of export markets, Annex F includes a paper prepared for the IGT by UKTI, summarising the prospects for UK businesses overseas.

The success that the UK has had in the past in exporting innovative processes, such as PFI, is notable. If the carbon reduction programme does build to scale at a pace and in a way that makes it a world leader, then there must be an opportunity to build on the UK's reputation for sustainable design, to develop a proposition for the implementation of a programme to decarbonise the built environment at mass scale – a prospect that every developed country in the world faces. If this proposition leads, then products and services will follow.

2.9.4 Leadership

There is considerable doubt, on the part of the industry as to whether and when action might be taken to incentivise the market. There is, however, much that the industry could do, in advance of the certainty of that market, by putting itself into the shoes of its potential customers, and demonstrating leadership. The evidence of this would be:

- acting as advocates for the need for change, with champions emerging from the leadership of the industry
- working with the Government to inform the development of a series of plans cascading from the national and strategic down to individual programmes and building types
- supporting the development of policy by sharing best practice and advising on the effectiveness and risks of putative plans
- initiating and collaborating with research programmes and stimulating innovation in new products and services
- developing the necessary skills and a supply chain
- addressing the structure of the industry itself to render it truly, in the words of the terms of reference for the IGT, "fit for purpose" for a low carbon economy
- setting an example in its own practices

Those engaged in the construction industry have the advantage, that many other businesses do have not, that the principles of sustainability bear a direct relationship to their core business and, as well as driving those principles right through the business, it can also be a growing part of the offer to customers.

It is also entirely consistent with the need to drive out waste for their own operations and from the normal practices of the industry, so that business competitiveness, value to customers, economic growth and carbon production all march together.

Repeatedly, the experience of those who pay this kind of attention to their own business is to find that the costs go down, as innovation uncovers better ways of doing things.

All of this is to demonstrate leadership. It is for the industry to decide whether it wants to take up this position.

2.10 Construction Products and Low Carbon Construction

2.10.1 Products in the low carbon built environment

The built environment is constructed from products: aggregates such as sand, gravel and rock through processed minerals such as cements, masonry and paints; timber from basic sawn elements to the most intricate joinery and processed boards; metals for structure, cladding, pipes, wiring and hardware; glass for windows and PV systems; plastics for insulation, pipes, windows, electrics and coatings. Add in the products that provide heating, cooling, ventilation, water supply both hot and cold, as well as drainage not forgetting the infrastructure of roads, railways, harbours, power stations and it is clear that the scope is vast.

All products have impacts on the environment. These can be divided into two main types:

- those from the manufacture of the product or extraction of the material (the embodied impact)
- those from the product's or material's use in the building (the operational impact)

The generally agreed way of assessing these impacts is to look at the whole life cycle of the building (construction, operation and end of life) and seek to optimise that by adjusting the design and product mix, rather than trying to optimise every individual product and then see how the building works.

Some products will have further direct impacts during their use such as heating and ventilating systems which use energy or in some cases generate energy. Others form part of the structure and help maintain a comfortable internal environment through provision of insulation, thermal mass, solar gain, daylight and air-tightness. Allocating these beneficial impacts to individual products is very problematic. For instance, how would the energy saving benefits of a wall be allocated to the individual products within it? So assessment is best done at the building level.

2.10.2 Improving the carbon performance of products and the built environment

Minimising the carbon emissions over the lifespan of a building is crucial. It is important to recognise that the lifespan of buildings is a vital part of this equation. Setting an appropriate lifespan is a key design decision. For instance dwellings are expected to have a lifespan of at

least sixty years but light industrial buildings are typically out of date within twenty or thirty years so there is no benefit in designing for longer than this.

In crude terms the basic structure would be expected to last at least as long as the expected life of the building whilst other elements could have shorter life spans as they would be replaced during the building's life e.g. windows, external cladding, internal partitions in offices and so on. The impacts of these replacements have to be added into the total impacts of the building over its life. Add in the operational impacts of running the building and the impacts of end of life (demolition, recycling, re-use and waste disposal) and the optimisation of the building's lifetime impacts becomes quite complex. Unfortunately simplifying it too much results in severely sub optimal solutions.

In the same way that changes to building regulations on energy, sound, water and fire have driven the market for new products and solutions, if there is a suitably robust and usable method for assessing and quantifying the lifetime impacts of buildings and a demand for them, a market will develop for low impact buildings and low impact products.

From a survey of product manufacturers the primary concern is whether a coherent market exists for low impact buildings or products. Regulation is seen as creating the strongest pull but financial incentives and desire for company growth are also strong drivers. Procurement methods that do not have low impact as a criterion with sufficient weight also militate against creating a market pull.

The existing proprietary methods of assessment have created generally small markets with particular requirements where the costs of entry cannot be recouped by companies, so they do not develop products for these markets. Developing further proprietary methods of assessment makes things worse as the markets get further divided and even smaller. The answer is to harmonise and have a single method to assess and measure impact. If it were based on European standards rather than UK standards then the commercial drivers would be even greater as products and solutions would have a potential market of more than 500 million people throughout Europe rather than 60 million in the UK.

The design and construction of low impact buildings will also need to involve the supply chain far more and far earlier than is typically the case now.

2.10.3 Product manufacturing in the UK

There are two distinct types of manufacturers – those who are UK owned and based supplying predominantly the UK market, and those companies that are foreign owned and based, or UK owned and with overseas operations, but can choose whether to have a manufacturing operation in the UK.

For the UK only company, the choice of whether to manufacture low impact products is straightforward. Is there a market for the products at a price that justifies the costs and risks of the investment and operating costs? In addition to financial costs there are numerous other issues including availability of labour, planning, energy costs and security, transport, taxes and regulation in general. The stronger the market and the lower the costs, the more likely it is that the business will be set up. In many cases the risks will include imported products coming in at a lower price, or better quality or with some other advantage.

For the company looking at whether to set up in the UK, the same questions will be asked on the market. However if the product is easily transported then the question of where it is to be manufactured is broader – for instance the company may find it cheaper to extend an existing factory in say Germany and export the products to the UK. Even if the product is to be manufactured in the UK and would be profitable, the multinational company will look at whether the return on the investment in the UK is the best that it can get in all the countries in which it operates. Therefore the UK has to be an attractive place to set up and do business.

The present method of measuring carbon emissions from the UK as a whole acts as a disincentive at a strategic level to increasing production of goods and services in the UK. The present system counts emissions from production of goods and services in the UK rather than the consumption of goods and services in the UK. So the Committee on Climate Change would view the production of low carbon goods in the UK as an increase in UK emissions whilst the importation of the same goods would result in no increase in UK emissions.

The answer to this is to switch to a consumption based emissions system. A number of NGOs and industry bodies support this approach as a more equitable allocation of responsibility for emissions reductions. As an example, the UK has reduced its emissions by shifting manufacturing to China and then importing the goods so maintaining the same level of consumption in the UK and the same overall emissions on a global scale. China is then berated by the West for not doing enough to reduce its emissions, caused in part by manufacturing goods for the West, whilst the UK looks good as, by this system, its emissions are seen to have fallen.

For industry the inequity is different but still there. With the present approach there is an incentive for government to move industry offshore to reduce UK emissions and then little or no incentive to buy the imported goods on anything but a price basis. The goods could be more carbon intensive than a low carbon equivalent in the UK, yet the present policy would show the high carbon imports as the best solution. By switching to a consumption based system the origin of the goods becomes irrelevant and the carbon content becomes highly relevant. Assuming the UK is an attractive place to do business, then a consumption based emissions system would encourage low carbon production rather than the present export of business and re-import of goods with no consideration given to embodied carbon.

The consumption based approach is entirely compatible with the IGT's proposition for a whole life carbon accounting system for buildings.

2.10.4 An informal case study in innovation

It was beyond the resources of the IGT to commission an independent survey of the industry on the subject of what would persuade product manufacturers to invest in the development of a new low carbon product, but the Construction Products Association did poll its members, and 95% of those responding believe that market confidence - a belief that there will be a level of demand that will provide an adequate return on investment - is the single most important factor in encouraging them to invest in innovation and low carbon technologies.

Ranked in order of importance, the factors believed to build that market confidence are:

- the regulatory framework
- macro-economic stability
- self-generated initiatives to improve competitive position
- financial incentives for purchasers
- long term government programmes (such as Warm Front, CERT etc)
- financial incentives for research and development

All 6 factors are rated as important, and there are only small differences of weighted average between them in the rankings. The regulatory framework is, however, rated as the most important issue and is seen as a way to guide the market, to provide long term visibility so that companies know that they are investing in the right technologies, and to give investors confidence that their investments do not carry too much risk.

The potential for poorly aimed or over-prescriptive regulation to stifle innovation is acknowledged, though; and all businesses are concerned that the impact of regulation, including the desire to stimulate the transition to low carbon, is weighed against the need to sustain viable business models.

The inflationary risk is one to consider right through the supply chain, and it is particularly relevant to product manufacture, where supply is less elastic, and where businesses have the choice or responding to demand either by increasing prices or by increasing capacity, or a combination of the two. There is therefore a fairly complex "chicken and egg" cycle here, if the growth in demand and the growth in capacity are to be kept in step to control prices. For more capital intensive businesses, there also needs to be confidence that demand will be sustained over the long term if they are to invest in the means of increasing capacity or developing new product lines; and even in more labour intensive operations, a similar situation exists in long-term investment in programmes of skills development.

There are also some interesting minority views – such as the suggestion that the move from a fragmented offer to clients (or one assembled in a fragmented way, at arm's length) to a truly integrated proposition, with all parts of the supply chain given an opportunity to address the challenge of the client's brief, would stimulate innovation and potentially new business models that offer more packaged solutions.

It is also the experience of manufacturers that products that reduce costs within the supply chain's own operations pick up far more quickly than demand for products where the saving accrues to the end user. Two contrasting examples illustrate the point:-

- in the space of about 2 years, the launch of the first PVC replacement fascia board transformed the market, although it cost twice as much to manufacture, because it saved time, waste and cost on site
- by contrast, a PVC guttering system manufactured from 80% recycled material, delivered at the same cost as virgin PVC and saving 70% carbon in manufacture, has taken off only slowly in the face of inertia

In the latter case, there is no saving to the installer, and this once again illustrates the barrier presented by a sequential, rather than integrated, process for design and specification. Without that integration, product manufacturers, and often installers, are separated from end users by several links in the supply chain; and those customers may never know what their choices could have been, given conservatism and a reluctance to take on risk on the part of the intermediate parties.

None of this is to suggest that the industry is passive, or is waiting for demand that may or may not come along. Product manufacturers exist in a competitive world, and, as for any business, their survival depends upon constant product development. There are many examples of this, where demand, or the prospect of demand, is sufficiently clear, including:

- Aerogel – a breakthrough insulation product that has very few competitors
- insulation manufacturers, including Rockwool, Kingspan and Knauf, developing products suitable to external applications
- a combination of new and established building materials used in the BASF house in Nottingham, to achieve code level 4, without the use of renewables, and with an annual space heating requirement of only 10 kwh/m2

There are many other examples in photovoltaics, the integration of renewables with roofing systems, underfloor heating and so forth; and 73% of those responding to the questionnaire do believe that it is possible for a product manufacturer to introduce an innovation that leads or creates demand.

In all of this, however, there is a sense of pent up potential. The research and development is there, and products are being tested in the market place, but there needs to be a step change in demand both to simulate further innovation, and to bring down prices through economies of scale.

There is a precedent for this in now familiar products, such as double glazing, which were introduced prior to being required by regulation, and which promoted some demand on their own merits over traditional glazing, but which went through that step change in demand when regulation was introduced. As double glazing is now the market norm, it is generally also less expensive than single glazing. The price of condensing boilers similarly fell sharply when first prescribed for boiler replacement.

Product manufactures also need to know the rules of the game – the basis upon which their products will be evaluated. This links to the balance between operational and embodied energy, which is addressed in chapter 2, section 2.7 of this report. An example drawn from the very early deliberations of the IGT was cited in the Emerging Findings. Questioned on the potential for innovation in his product, a major boiler manufacturer referred to the potential to produce a boiler with substantially improved performance in terms of operational energy consumption, but it would certainly be more expensive, and would probably have a shorter life. It therefore needs to be clear how consumers will balance these conflicting properties, and judge the product against one having poorer performance but lower capital cost.

In addition, manufacturers are considering their own processes, with the view to reducing their carbon footprint (for example, cement, plasterboard, unfired clay blocks etc); and they are also considering the environmental impact of products after they have left the factory, including lower energy materials handling, the limitation of waste, and the recycling of waste or the product at end of useful life.

Finally, 100% of the respondents referred to the potential and need to learn from overseas experience – and feel that, whilst acknowledging that resistance to change is a fairly universal characteristic, there is a particular degree of conservatism in the UK construction supply chain.

2.11 Summary

Preparing UK Construction for a low carbon and post fossil fuel future is a hugely challenging task, but the large investment needed will provide very significant co-benefits for the construction industry as well as its clients.

The higher standards of energy performance required to achieve carbon emission targets have considerable potential for better quality of domestic and work environments. The retrofit works required to cut the carbon emissions of a home can relatively easily catalyse material improvements of the facilities and living standards the home offers. It can do this in the first place simply because energy efficiency requires a focus on factors such as air quality and lighting design such that the end result is better than the starting point. Secondly, the works provide an opportunity to invest a little more to make the interior work better, for example through bringing in more natural light, or improve spacial planning.

There is also considerable potential in the journey to a post fossil fuel future to make the outdoor urban environment and public space more healthy and fitter for purpose. Re-design of the transport infrastructure as well as improvements in vehicle technologies to lower overall carbon emissions have been proven to improve air quality and even temperature regulation and water management through increase in the green cover. The provision of better facilities for people to cycle and walk have equally been shown to be beneficial for health and well being. Retrofit programmes at the neighbourhood and district scales that are required to deliver affordability provide the opportunity to take a whole system view of a locality such that the end result is not only a lower carbon footprint but also a more liveable place.

Once the industry accepts the need to adapt to a new era, one in which fossil fuels are neither of plentiful nor cheap it will force the adoption of higher efficiency of resource use and in turn better performance across the board. The construction industry has struggled to emulate the successive revolutions in performance that have characterised manufacture in the 19th and 20th centuries. The imperative of carbon reduction, and eventual elimination, will enable, if not drive the much needed change in practices to serve needs of the 21st century.

The following sections of this report therefore consider, first on an industry-wide basis, and then for each of the IGT workstreams, the status of each sector and the main barriers to the necessary transformation of construction-related businesses – probably the biggest change management programme that the industry has faced since Victorian times.

The context for this is that, if the industry can, with its clients, overcome those barriers, then it stands on the threshold of four great opportunities:

1. to carry out a quite spectacular programme of work, stretched out over at least the next 40 years

2. to make use of that workload to reform the structure and practice of the industry in the way espoused in many Government and industry reports

3. to export the products and skills of a modernised industry to countries following the UK's lead in reducing emissions from the built environment

4. to excite future generations of potential recruits into an industry with a secure future and a noble cause – at the very core of addressing probably the greatest challenge of our time

All of these opportunities are there to be taken.

3. Industry-wide Issues

3.1 Making a project

3.1.1 The problem of complexity

The issue of complexity comes up time and time again when discussing with the industry sustainability in general and the carbon reduction programme in particular. This complexity relates to almost every aspect of the agenda, including:

- the breadth of involvement across Whitehall, and the number of policy instruments and initiatives that are brought forward
- the crowded landscape of advisory bodies, delivery agencies and interest groups, often with overlapping programmes, and rarely with clarity of authority
- the massive volume of studies, reports and guidance, often conflicting and again with no clarity of authority
- the shifting language (of which this report is also probably guilty) whereby "carbon" can mean carbon, or carbon dioxide, or some or all greenhouse gases expressed as a carbon dioxide equivalent; and where the definition of "zero carbon" is far more complex than that rightly aspirational term might suggest

In the Emerging Findings, the IGT referred to the number of recent and current reports and initiatives relevant to carbon reduction undertaken by Government or NGOs or other interest groups as standing at 175 and rising, and the same database has now gone above 200.

The Emerging Findings also referred to a number of initiatives related just to energy efficiency in existing homes, and named 5; and on a trawl of academic institutions conducted as part of the preparation for this report, at least 40 research projects currently in progress have been identified.

Even for those so inclined, the enormous amount of reading that is required just to stay abreast of the subject, whilst all the while serving the shorter term interests of clients and shareholders, would be totally overwhelming, and certainly incapable of absorption. Furthermore, given that it is possible to read diametrically opposite advice about the same intervention, who are they to believe?

For both the construction industry and its clients, or potential clients, this adds up to an almost insurmountable problem.

So the first plea, in addressing the barriers to the required step change in the response of both the industry and its customers to the imperative of carbon reduction, is for some order and clarity.

3.1.2 A plan and a project

Whilst all of this activity doubtless represents progress and is a necessary part of the whole picture, what is harder to find is the picture itself – that is, a timed (and funded) plan by which construction and its product will be moved from the status quo to a series of actions and behaviours that will meet the commitments in the Climate Change Act. Nor, given the lack of incentives, will such a plan emerge from the construction industry acting alone, and its development therefore needs to be moved by Government, working with the industry.

Without a framework that everybody can understand and believe in, the problem of communication will not be solved simply by issuing more communications.

On the Government's part there is also perhaps an incomplete understanding of the detailed processes by which the enormous construction workload envisaged in the Low Carbon Transition Plan (or any successor plan) need to be planned and executed.

Out of a plan designed to meet the commitment of the Climate Change Act will come a series of projects which, collectively, can fairly be described as the biggest project in Government. That being so, it should be treated as a project, and there need to be put in place the preconditions for project success, including:

- leadership and governance
- the right people in place for all key posts, with a clearly defined role for which they are accountable, working within a defined organisational structure
- an appropriate culture
- clear objectives, informed by precedent, by research and by the practicalities of execution;
- programme and project management processes and skills
- a realistic programme, setting out milestones (or intermediate targets) – as no project that stretches out over 40 years could hope to succeed without opportunities to confirm the direction and speed of travel along the way
- a realistic, properly funded budget
- clear means of internal and external communication

The decarbonising programme should therefore be subject to the same governance and controls as any other public sector project designated as a Major Project, such as the London Olympics or Crossrail – each of which will be dwarfed by every segment of the transition to low carbon.

Recommendation 3.1: That the Government should treat the transition to low carbon as a series of major projects, subject to independent review, and with the normal controls that exist for Government projects that are so designated.

Considering the preconditions for a successful project then provides an agenda for putting those preconditions in place.

In the meantime, there is a good general awareness of the new focus on carbon reduction (and, on the evidence of the IGT's work to date, a very low level of cynicism about the science of climate change), but very few businesses have an accurate understanding of the sheer scale of the undertaking ahead; and there is a level of disbelief about whether (or at least when) the difficult decisions that will lead to the necessary changes in the built environment and in the behaviour of those who occupy it might be made.

3.1.3 Leadership

Leadership is required to set out the objective and identify the means of achieving it, to put in place plans that will do so, to create a level playing field for businesses to operate within and then to execute or track the progress of those plans.

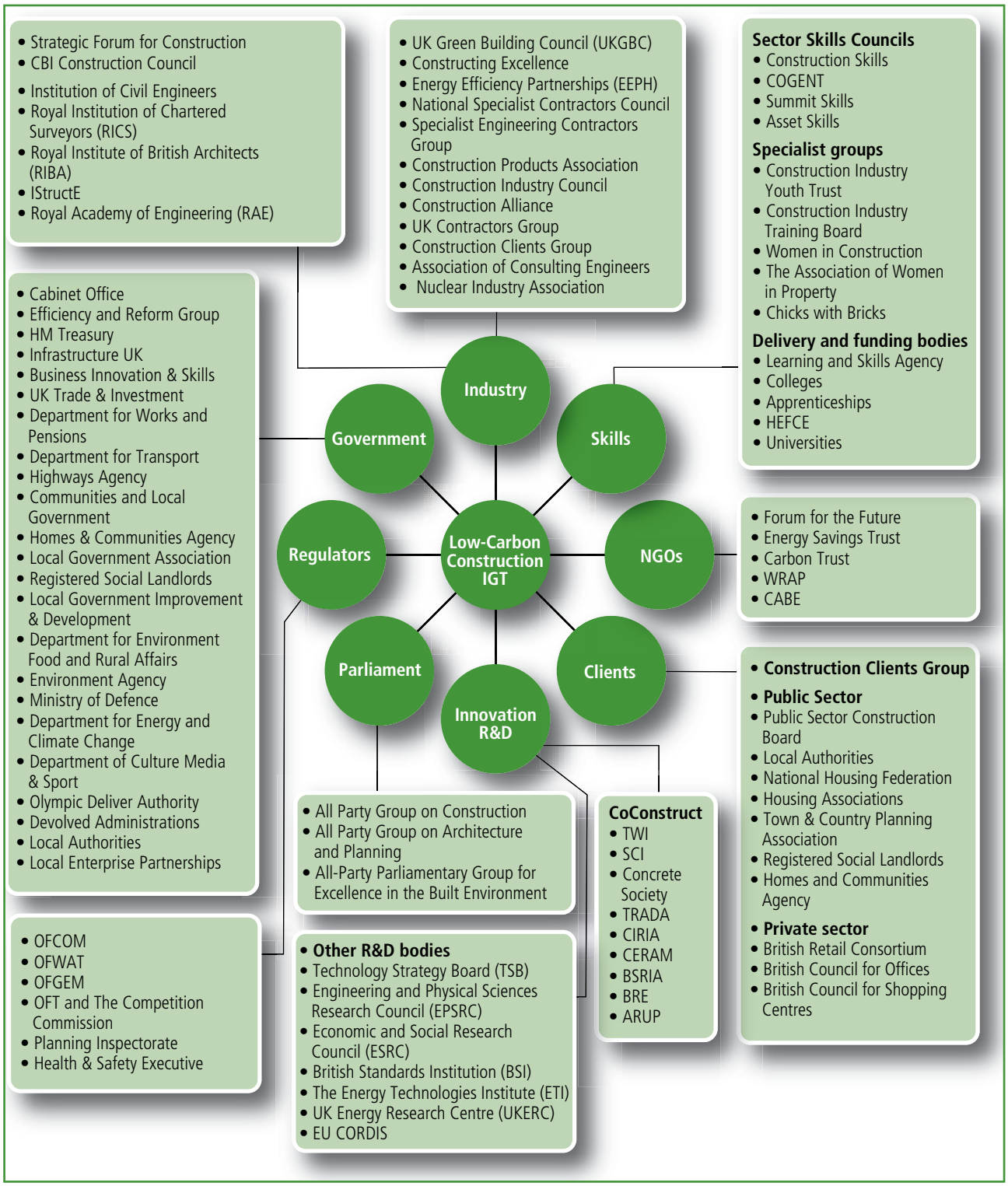
It is a shared obligation, and the opportunity for the industry to play its part is recognised; but primary leadership needs to come from Government, because of the degree of market failure (what Lord Stern called "the greatest market failure in history"), because most of the levers for the transition to low carbon are with Government, and because plans for carbon reduction must reach into every fibre of the built environment, at a scale that is far beyond the reach of anybody other than Government.

Beyond that, however, leadership needs to cascade: to local Government, certainly, but also to the construction industry itself, as it is the means of delivering so much of the practical response to the threat of climate change - and then to every level of the industry's supply chain.

3.1.4 Organisational landscape

At the commencement of the IGT's work, the Secretariat drew up a diagram of the parties who would have a direct interest in its work. An updated version of this is included as figure 3.1.

Figure 3.1 IGT stakeholder diagram



In part, this diagram, which is a simplified version of a full diagram that is as complex as chemistry, reflects the fragmentation of the industry – and that is a matter of history and of choice, and there is unlikely to be a quick, radical change.

However, during its brief period of existence, the IGT, though it has no authority, has enjoyed a great deal of good will from the industry and has been seen as a contact with Government.

As a consequence of that, it has been able to motivate or tap into a number of cross-organisation exercises dealing with issues around the transition to low carbon, including:

- a multi-disciplinary conference convened by the Construction lndustry Council to address the role of the institutions (see section 3.3 of this chapter)
- a meeting held between ConstructionSkills, Asset Skills and SummitSkills to discuss skills for low carbon construction (see section 3.4 of this chapter)
- a meeting of most of the construction–related institutions to discuss the procedure for issuing Codes and Standards (see section 3.5.4 of this chapter)
- a workshop facilitated by Energy Efficiency Partnership for Homes to consider a route map for the domestic retrofit (see chapter 5, section 5.5.3)
- a series of meetings with interested parties, facilitated by Energy Saving Trust, to discuss the principle of an Existing Homes Hub (see chapter 5, section 5.9)

In addition, there has been a host of bilateral discussions with individual organisations engaged in the low carbon agenda.

What is clear from all of those meetings is the level of knowledge and commitment possessed by so many people and organisations, and also their preparedness to share that knowledge and pool resources where that offers a fair chance of making progress.

There is therefore a pressing need to create an organisational structure which brings Government and the industry together. This structure will still be fairly complex, as it needs to honour a number of principles, including:

- that it should be capable of engaging all or most of the many existing organisations that have a positive role to play, notwithstanding their differing constitutions, memberships and areas of interest
- that each of those organisations should feel that it can connect to Government, so that they are also connected to policy and to plans of action
- because of the sheer breadth of the work involved in a transition of the built environment to low carbon, with a diversity of work that falls to sectors that operate in quite different ways, there will need to be a number of specialist bodies which can concentrate on one strand of work, drawing in the necessary expertise
- there also, however, need to be connections to other, overlapping aspects of sustainability where there is any interdependence, or where the experience and expertise required are the same
- ultimately there need to be connections to other aspects of the low carbon transition plan, again where there is any interdependence or shared interest

There will consequently be a networked structure which reaches beyond the construction industry; but for construction the importance is that it knows where authority lies and that it is connected.

Of course, new organisations will continually form and reform, and some will leave the field, and it would be neither practical nor desirable to prevent that.

Given the preparedness, even desire, to work together that has been demonstrated during the period of the IGT's work, a map of the field could allow both incumbents and new entrants to decide:-

- whether there is a need for any separate organisation, rather than joining an existing one
- which organisations could usefully work together, whether on the whole of their programme or specific parts of it
- where gaps need to be filled, and where duplication should be avoided

For all of them there is then a need for a centre of gravity, a hub – not necessarily a single one, but one relevant to their own area of practice.

A particular case in point is the activity that has grown up around the domestic retrofit. From being the "elephant in the room" only a few years ago, the challenge of upgrading the energy efficiency of the existing housing stock is now the subject of widespread attention. Starting, in the absence of large scale consumer demand, with the energy and commitment of a number of concerned individuals, there has developed a host of organisations, reports and research projects which have contributed to the debate and to the body of knowledge. This has become a valuable resource. Now, however, there is a high degree of overlap both in the organisations and in their activities, and this creates confusion on the part of the industry and its consumers as to where they might connect with an authoritative source of advice, or contribute their own ideas.

There is therefore a recommendation in this report for the creation of an Existing Homes Hub (see chapter 5, section 5.9) which can provide that point of connection – and it can be anticipated that this pattern will recreate itself in each specialist sector.

Recommendation 3.2: That Government and industry should establish and publish a transparent, co-ordinated structure for the many organisations involved in research, advice, policy development and delivery for carbon reduction, making clear the role, scope of work and authority of each, and how each connects to Government, whether directly or indirectly.

3.1.5 Culture

Culture links to behaviour, and behaviour is beyond the scope of this report – except to acknowledge, as in chapter 2, that it is inextricably linked to the efficacy of any physical measures taken to improve energy efficiency.

The one clear culture message that the industry would want to get over, however, is a call for Government and industry to work together. Whilst there are, in this report, many recommendations that commence "That Government should…", this is once again to do with market failure and who has the levers, but it must not be interpreted as the industry saying "after you".

Instead it wants to be closely involved - to be sighted on the development of policy, so that policy can be informed by the practicalities, technique, skills and capacity of construction; and also to be sighted on the planned trajectory of the transition programme, so that companies can make their own plans for investment in the development of products and services suited to the emerging market.

3.1.6 Programme and programme management

The Emerging Findings of the IGT made just one recommendation: to produce a programme management plan for the construction work which is implied by the former Low Carbon Transition Plan. This proved to be beyond reach within the time available, but this report does include illustrations of how such an exercise gets under way, looking at three levels of detail:

- a very broad block plan for the creation of an outline programme for national infrastructure, which could fairly be described as "a route map for a route map" – but the agreement of which is a necessary starting point before proceeding to a higher level of detail
- a similarly broad plan, but with one additional layer of detail, for the non-domestic building stock
- and a still further level of detail applied to a route map for the domestic retrofit

In all cases, the work done to commence these exercises demonstrates how much more work is required to finish them. Obviously they need to relate to a national framework (and, for all of them, the Pathways to 2050 report will, as it too gathers detail, form an important part of that framework) – but it is possible to work top down and bottom up at the same time, so that each exercise informs the other, rather than to complete everything sequentially, and therefore over a highly lengthened timeframe.

But an undertaking of this scale requires more than project (or even programme) management. At the highest level, there is no project or programme to manage. It needs to follow the proven principles of change management: a clear leadership team with a declared remit; a clear, communicable plan; the identification of champions; the creation of simple, early change initiatives to post quick wins; the winning of a critical mass of understanding and commitment to improve; the development of more detailed plans and the means to monitor them through execution; and the development of local leadership and individual ownership. Nothing less will make the majority of the country's 62 million people customers for energy efficiency programmes.

Organising this, and getting the right balance between central and devolved leadership, and then getting in place all of the means of delivery across all programmes (including many, of course, that do not relate to construction), is a task almost beyond imagining. In some ways it is like trying to foresee the progress of any massive programme of construction work that might stretch over 40 years. The difference here, though, is that the routes to market (or, indeed, the existence of a market in some sectors) are by no means clear - and that, unlike most forward programmes, there is a single purpose running through all of it which has to be accomplished: the re-creation of a built environment that delivers an 80% reduction in carbon emissions. Necessary parts of the programme cannot, therefore, simply be allowed to fall away.

This also acknowledges that we cannot, over a stretch of 40 years, predict what new and better solutions might yet arise – and we should not expect to be able to do so. Instead, room should be allowed for innovation, and the market should be used to pull improvements of both performance and cost effectiveness.

So, the plan that is required is, like any long-term business plan, a graduation from clarity in the early stages through to increasing room for flexibility in the longer term; and the long term picture will need to represent the best possible view of what might be done, allowing for better views to emerge. The decision as to whether or not to implement the current best view is then informed by a combination of confidence in the proposed measures, the practicalities of access and disruption, and the touchstone of cost effectiveness.

The starting expectation might be that the whole programme will take all of the four decades available to 2050, but this might then accelerate if innovation, reduced costs or higher energy prices justify it. Nor is there reason to stop if and when emissions are reduced to 20% of their 1990 levels if there is potential for still higher gains, given that it is likely that other industries will not be able to achieve the 80% figure that has to be the average across all sectors.

There are some aspects of the plan, however, for which infinite flexibility is not possible if progress is to be made. As the chapter of this report that deals with infrastructure makes plain, decisions about infrastructure have to operate over a period of about 40 years, and certain choices do need to be made about the fundaments of infrastructure if it is to be planned, consented and constructed in accordance with need. In addition, and equally important, the owners, funders and operators of facilities which depend upon that infrastructure need to know what and where the infrastructure is to be, and know that it will be there, in order to make their own plans and have the confidence to invest. And as one further ripple out from that central decision, those whose business is to serve those owners and operators, such as the construction industry in the whole length of its supply chain, need to know the same thing, so that their products and services are developed with the same degree of confidence.

Precisely what those long-term fixed assumptions need to be will emerge in the process of planning, but they certainly include basic decisions about generation, about the future of gas, and primary networks. In this respect, the Pathways to 2050 analysis issued by DECC in July of this year has earned respect within the industry, and there is a need for the industry to engage with the planning that will follow the call for evidence that accompanied that analysis, so that future plans are informed by the highest possible degree of advice on design, engineering and the practicalities of construction.

The next set of recommendations therefore relates to the creation of that programme, from high level strategy down to the development of plans within Government Departments'

workload, for whom the first step will be to establish a well crafted definition of "zero carbon" for their own project typology, recognising the distinctiveness of their programme of work, but the universality of the targeted 80% reduction in emissions.

Recommendation 3.3: That Government should publish an adequately detailed programme of actions expected to achieve the 2050 target of an 80% reduction in carbon emissions.

Recommendation 3.4: That the programme should include interim (say 5-yearly) milestones to show the expected trajectory of work to achieve the planned reductions, to provide the industry with some visibility of the possible nature and volume of work.

Recommendation 3.5: That each Government Department should develop and publish a strategy for producing low carbon buildings of each typology within its programme, consistent with the above programme and trajectory.

So, the transition to low carbon will be a Russian doll made up of a series of projects (fixing a school) that fit into a series of programmes (fixing all schools) that fit into an over-arching programme (low carbon built environment) and then into a higher level programme still (the national transition plan).

3.2 Construction industry structure and fitness for purpose

3.2.1 The agenda for change

As noted in the Emerging Findings, there have been many reports into the structure, conduct and performance of the construction industry – most recently those lead by Sir Michael Latham (*Trust and Money* 1993 and *Constructing the Team* 1994), Sir John Egan (*Rethinking Construction* 1998 and *Accelerating Change* 2001) and Andrew Wolstenholme (*Never Waste a Good Crisis* 2009).

There is no need for any great new thinking to supplement these reports. There is a fairly harmonised view of the developments needed to enable the industry to operate consistently at its best, and these principally comprise:

- greater integration of the supply chain, from design through construction to operation, with a shared customer focus
- committed client leadership and engagement in the process

- greater collaboration between clients and the supply chain, based on long-term relationships, utilising procurement routes and contractual arrangements designed for that purpose, and tested by performance measurement
- making design, product and construction choices on the basis of whole life value for money
- clear definition and adoption of best practice – re briefing, project management, parity of tendering, use of coordinated project documentation, timely payment through the supply chain etc
- increased and better coordinated research leading to greater technical and process innovation
- commitment to people – addressing culture, working conditions, training and skills
- improved product development, including offsite fabrication, intelligent use of standardisation or mass customisation, general adoption of Building Information Modelling etc.

There are good examples of **some** clients and **some** contractors working on **some** projects in accordance with these principles, and benefits have followed. However, as the Wolstenholme report shows, adoption has been slow, and the penetration of new ways of working low – and the new way of working of which most is expected is the integration of the supply chain.

3.2.2 Integration

Integration and, in its absence, a sense of separation from the opportunity to make a contribution that can deliver long term value, is a major concern amongst both product manufacturers and specialist trade contractors. In a Construction Products Association survey of its members, 100% of respondents believed that integration has a key part to play in the low carbon agenda. It is also interesting that although most benefit is still seen in working in a more integrated way with architects and clients, there is also a high degree of recognition of the potential benefit of working more closely with main contractors, specialist installers, builders merchants and other manufacturers and suppliers - with the latter perhaps pointing to the potential for more packaged solutions. This is once again to acknowledge that the response to producing more energy efficient buildings is fundamentally about systems thinking – one system with another, and all systems in concert with the building envelope and structure.

So thinking beyond the boundaries of an individual product or trade is key, both in developing the right design proposal and subsequently installing it in the most efficient way, in terms of both cost and carbon.

The IGT therefore holds to the view expressed in the Emerging Findings that it is scarcely conceivable that the optimal response to the challenge set by the commitments in the Climate Change Act will emerge from an industry that remains un-integrated.

One the propositions of the Emerging Findings was that the industry, working through a collaborative forum such as the Strategic Forum for Construction or Constructing Excellence, should produce "a tighter definition of how an integrated supply chain should come together, what the gains would be, and how the client's position could be protected against cost increases resulting from a lack of competitive tension".

This suggestion was indeed picked up by the Strategic Forum, and further guidance has been issued since the publication of the Emerging Findings. It reinforces the case for integration, but begs the question as to why, if integration is the way to drive cost out of construction, it is not adopted more widely by the supply side without client intervention.

It is not just intuition, but also experience that suggests why, for all the pronounced benefits of integrated working, the industry and its clients are slow to embrace them. It is about trust and respect – or rather a lack of either or both. So, as a worst case:

- clients fear that, without the apparent protection of a competitive tender, they will get a poor bargain in their dealings with the industry
- architects fear that, if tier one contractors have excessive influence in the process, then the principles of good design will be "dumbed down" and subordinated to ease or economy of construction, in disregard for whole life value
- contractors, as the mirror image of that, suspect that architects use their influence to indulge in unnecessarily whimsical or self-indulgent design
- trade contractors believe that tier one contractors are driven only by short term financial considerations, with little interest in the long term relationship and more interest in retaining their cash
- tier one contractors, again by contrast, fear that trade contractors are fickle, and will go to a better job if they can find one
- and materials producers and product manufacturers are scarcely in the game at all

It is a deliberately stark exaggeration, but one or more of these fears must be behind the industry's reluctance to move to a new model; and this underlines the wisdom of Sir Michael Latham's choice of title for his first report – *Trust and Money*.

Although there are many examples of effective collaborative working, at its best stretching right through the supply chain and with the client fully engaged, these projects are still very much in the minority. To a degree, this can be attributed to the irresistible pull of the status quo: in the so-called "traditional" method of procuring construction work, there are established hierarchies and roles, processes, contracts and other documentation, channels of communication and distribution, and lines of accountability. The process also gives the client at least one measure of value for money: that the job as defined could not, it seems, be bought for less.

However, there are signs of positive change. As a result of PFI and other forms of public/private partnership, there are also architects and engineers who have found working in common purpose with contractors rewarding – and contractors and deeper layers of the supply chain who have found the same.

Companies working in the supply chain of the regulated utilities have also found that the un-ambivalent nature of the task facing their clients ("We have this much work to do, and only this amount of money to do it with") demands both collaboration and innovation in the face of a non-negotiable cost benchmark.

So, it is to be hoped that progress towards integration will be steady, but it is also expected to be fairly slow. To meet the challenge of the Climate Change Act targets, the industry certainly needs to integrate, but there is no simple recommendation that can be made here which will deliver that, save that clients should reconsider forms of procurement that positively prevent an integrated offer coming forward; each party should consider whether and how distrust is obstructing a better way of doing business, and consider how that distrust can be broken down; and all parties should subsume their individual interests to the proper purpose of producing for their clients buildings that are high in value and low in carbon, measured over their whole life.

It is useful to regard carbon as a proxy, both for efficiency and for innovation; and to take this opportunity to serve all three simultaneously.

3.2.3 Procurement

In trying to bring about change in the way the construction industry (or any industry) does business, the power of public procurement as a lever is recognised. It is, however, a lever that needs a very big handle as it is, through public sector example, expected to deliver an almost endless list of desiderata. This imposes a heavy burden on what might appear to be a single

operation; but in reality procurement is part of a system which has to carry forward all that has gone before and secure all that is wanted thereafter. The burden is therefore one that it must carry, and many of the things that have been thought to have been deliverable through procurement are critical to the carbon reduction programme – from project appraisal on a whole life basis, to the development of trade skills, to the routine adoption of post occupancy evaluation.

However, to put the subject matter of this report into the context of procurement, there are four aspects to consider:

1. the scope, specification and performance of what is asked for.

2. the nature of the commercial arrangement that is contemplated.

3. how the industry will organise itself to respond to both of the above.

4. the operation of competition.

The first of these, whilst technically the most difficult, is nonetheless the easiest to frame. It requires no significant reform of the practice or structure of the industry, or of the way that public and private sector clients contract with it. It is "simply" a case of setting out what is required.

The nature of the commercial arrangements is potentially a very different thing. It also illustrates that all of these aspects of procurement are inter-related: if, for example, the work is to be procured under an arrangement that makes the provider responsible for the satisfactory performance of the facility at his own expense, then he will have an interest in making sure that it continues to perform properly, and does so on an economic basis. If, on the other hand, the provider's obligations cease at completion and the clearance of defects, then it is for the procurers to satisfy themselves that what is asked for prescriptively will deliver in performance. The first is, of course, a very simplified description of what happens under PFI and its derivatives; whilst the second is what happens under the so-called "traditional" means of procurement.

The same principles then run through the way that the industry will organise itself to meet its commercial obligations. If long-term performance is not a concern, then the provider will accept a proposal that is assembled by a team that is not under his direct control, and his principal interest in them will be in his assessment of their potential to put his own obligations at risk. If, on the other hand, those obligations extend to the efficient long-term performance of the asset, then he will want to put together a team that he trusts and take a detailed interest in their proposals as they develop.

The issue about competition is not just whether it operates, but also how it operates. If competitive lump sum tendering is the principal or only means by which a project is to be secured, then contractors will tend to innovate around how they assemble their price, and gains (for the client) are likely to be marginal - and also at risk for the usual contractual reasons. If, on the other hand, the wish is for the contractors to make a step change in price or performance, then that calls for innovation down in the supply chain – which in turn calls for a different procurement process.

Procurement and the associated contractual arrangements are (or should be) all about the allocation of risk. Experience shows that there is no single "right" answer, as the choice of approach needs to be determined by the characteristics of the client, the project, the project team and the market place. A recital of the resultant mix of possibilities is beyond the scope of this report, but if the above thesis is accepted, then there are certain things that can be said about choosing a route to market that serves the interest of long-term carbon reduction. These are:-

1. that the single most effective thing, in procurement/contract terms, that can serve that interest is a continuing responsibility, on the part of those who design and construct a building, for its performance thereafter.

2. that, in the experience of those acting as pioneers, zero or near-zero carbon buildings are showing a construction cost premium.

3. that, if zero or near-zero buildings are to be affordable, it follows that there needs to be a degree of innovation, whether in product or process, in order to eliminate cost; and this calls for an integrated team, so that those who actually make the products and execute the works can come up with ideas.

4. that procurement cannot make this innovation happen, but it can prevent it, by taking the design to a point that leaves insufficient room for significant innovation.

5. that, however a project is procured, choices must be made on a whole life basis.

In the Emerging Findings, one of the propositions was that a number of integrated teams might develop a delivery proposal to show how an alternative procurement framework might enable the team to drive down costs and deliver a "close to zero carbon" building for the same price as one built only to current Building Regulations.

Two outline proposals, different in their detail, have been submitted. Both will be taken forward for consideration as the Efficiency and Reform Group of the Cabinet Office develops a strategy for procurement with public sector clients, under the aegis of the Construction Clients Board. Both proposals meet the test of being integrated (design with construction, and construction right through its supply chain) and collaborative, whilst also maintaining the competitive tension which, in other industries, has driven innovation and their constantly improving offer to customers.

Recommendation 3.6: That Government (Efficiency and Reform Group, working with the Chief Construction Adviser) should investigate proposals received from the industry for alternative approaches to the procurement of integrated teams, to establish whether they could be developed into workable propositions, and thereafter be trialled, with a view to delivering, over time, a zero or close to zero carbon building for no more than a building built only to current Building Regulations.

3.3 The professional institutions

It is not possible to generalise about the professional institutions approach to the transition to low carbon construction, which fundamentally has to be owned by the whole industry, and which requires a higher degree of collaboration than has been the historical norm. Some institutions clearly, on behalf of their members, feel threatened by a breaking down of what may be seen as the old order; some see the pursuit of individual initiatives as potentially creating competitive advantage for their members, and presumably suspect that that competitive advantage is diluted if the initiative is shared with others; and others are passionate about the need for change and wholly collaborative.

Their umbrella body, the Construction Industry Council, has been unfailingly helpful to the IGT, and has convened workshops with its members and others to advance discussions about embodied energy, the production of Codes and Standards, and the role of institutions themselves.

As for the transition to low carbon itself (and as for all parts of the extended supply chain), challenge and opportunity come in equal measure in the changes of approach that will be necessary. Particular issues for the institutions are:

1. the needs for a greater amount of common ground in Further and Higher Education courses leading to a qualification in the built environment.

2. accommodating specialists (such a building physics engineers) whose practice operates across the traditional territories of the established institution;.

3. adopting a genuinely collaborative approach to develop a shared strategy for the transition to low carbon, and to extend that collaboration to the whole industry.

4. raising the bar on continuing professional development, given that except for the most recently qualified, carbon reduction is a new priority for the industry.

5. adapting existing practices to move in to a world of fully collaborative Building Information Modelling (see section 3.5.3 of this chapter).

6. sharing knowledge gathered from designing and delivering low-carbon buildings.

There are also issues around the measurement and allocation of CO2 emissions in the building lifecycle; awards schemes and what they reward; 'Soft Landings' and Building Performance Evaluation work in all disciplines; and the shared need to drive down cost.

No recommendation is called for. These are matters for contemplation by the institutions themselves.

3.4 Skills and resources

Skills is a theme picked up by all of the IGT's Working Groups. Each focused on the issue in some detail – both as a barrier to progress and as an opportunity for growth and innovation. A simple "cut and paste" would have resulted in 22 recommendations to Government and the industry.

This demonstrates both the significance of the issue for the construction industry and the challenge it presents in terms of the need for additional work to articulate the needs, roles and further questions for all of the participants in this complex field.

Broadly speaking, the recommendations focused around four general themes:

- the need to consider organisational issues in a low carbon context

- the need to improve understanding of existing capacity and capability
- the need for leadership
- future and new skills

Organisational issues

1. that Government should improve co-ordination of the plethora of training / skills initiatives, and the industry should be encouraged to participate actively.

2. that Government should seek to learn from overseas practice when reviewing the education, training and research infrastructure.

3. that the Built Environment skills landscape requires repositioning to support the low carbon agenda, with clearer interaction and integration between the various parties responsible for setting skills strategy and orchestrating resources.

4. that Sector Skills Councils, Industry Training Boards, Professional Institutions and other relevant industry bodies need to align activity in support of the low carbon agenda.

5. that a more co-ordinated approach is needed from Government working with the built environment skills bodies to make best use of skills and innovation funding at both national level and sub-regional level.

Understanding existing capacity and capability

6. that, based on the assumption that a major programme of refurbishment will start over the next 5 years, the industry must start by carrying out a full assessment of its ability to deliver and understand the investment needed in skills including assessors, trainers, auditors and professional services.

7. that Government should increase the focus on STEM skills by schools from age 8 to create a more competent foundation for the development of technical expertise.

8. that key industry institutions should identify and define the knowledge, standards and skills required for low carbon buildings. This should involve institutions such as CIBSE, RIBA, CIAT, RICS, CIOB & IFM coming together to:

- identify the emerging awareness, standards and skills needed both in their own disciplines and from others
- design the training needed for their own members
- organise its delivery – possibly using cross-institution programmes - and trainer competency assessment

9. that greater focus is required at both Higher and Further Education levels building on the existing work of the Built Environment Skills Alliance (BESA).

10. that a more proactive approach is needed to support SMEs to develop their capacity and capability to respond to emerging low carbon markets, either directly or via supply chains or clusters.

Leadership

11. that Clients and their supply chains should benefit from programmes such as the Cambridge Programme for Sustainable Leadership or UKGBC's Sustainability Leadership course – which make the case for sustainability for senior leadership.

12. that Government and the industry should address the demand side gap between political ambitions and business incentives, as businesses do not understand what will be required in a low carbon future and therefore aren't fully engaged in low carbon skills.

13. that the industry creates belief and motivation in the future of low carbon buildings in order to engage trained staff and to motivate other staff to train. If adequate, the incentives will avoid much public expenditure on training.

14. that the industry embraces the standards and skills necessary to their future by recognising the need to fund training of existing staff and recruitment of differently skilled people at all grades, applying such skills to their own carbon footprint as a test bed for successful delivery to customers.

15. that improved information on careers/low carbon is required in schools.

Future and new skills

16. that the industry should ensure that longer term feedback on the operation of buildings should be a key part of enhancing the skill base of designers and others in construction and property supply chains.

17. that training and educational organisations should give design for use and post occupancy outcomes a higher priority.

18. that the knowledge of low carbon standards and skills should be applied in major academic institutions to create a new discipline in Building Engineering Physics comparable to existing major engineering disciplines.

19. that this new discipline is:

    - disseminated to **existing professionals** and new undergraduates in large scale up-skilling and degree courses to chartered engineer levels
    - disseminated to **technical and managerial grades** (new and existing) in mid level courses using content which doesn't currently exist
    - disseminated to **craft grades** (new and existing) in craft training programmes (both construction trades and building services) revised to deliver the construction standards and low carbon competencies necessary to low energy/high performance buildings

20. that Government provides initial funding to create the body of knowledge in Building Engineering Physics and that this is conditional upon cross-discipline co-operation.

21. that the recommendations of the recent Royal Academy of Engineering Report on the discipline of building engineering physics should be implemented, where they relate to education and training.

22. that the Higher Education, Further Education and Schools curricula and supporting training provision will need to be repositioned over time to ensure new entrants to the Built Environment are more directly equipped to support the low carbon agenda.

Each of these recommendations is valuable in its own right, but collectively they demonstrate the same need to apply systems thinking to skills as to other aspects of the low carbon construction agenda. That is why the decision was taken that the biggest contribution the IGT could make was to look at the skills issue as a major cross cutting piece of work so that the specific merits of focused proposals could find their home in a wider skills, capability and industry improvement context.

The IGT therefore faced two issues – short term needs and longer term strategy. The two approaches, can - and should – be pursued in parallel. There is no need to hold back work on those things which simply must be done now.

For instance, there is every reason why someone fitting insulation in a loft should be clear why it is essential that the joints are properly mitred and meet so that heat loss is minimised and the insulation performs as expected. It is important to solve those problems and provide people working in the industry with the information they need to understand the importance of what they are doing. But solving that problem (and many others like it) does not address an over-arching need to consider how the built environment skills landscape might be reconsidered, better to deliver a low carbon built environment.

On 16 November, the Government published a Skills Strategy which set out a vision for reform of the Further Education and Skills system. This Strategy places a strong emphasis upon apprenticeships, with the numbers of adult apprenticeships available by 2014/15 being expanded by up to 75,000, leading to in excess of 200,000 starts a year. Employers are to be supported in addressing their skills needs through a new growth and innovation fund, including inviting proposals around new professional standards to drive industry competitiveness.

This is a good start and there is need for the construction industry to build on this outside the period of this IGT report.

The IGT has also had the benefit of a paper prepared jointly between Asset Skills, Construction Skills and Summit Skills, which has informed the above.

Recommendation 3.7: That Government, industry and the organisations themselves should investigate the desirability, practicality and means of merging Asset Skills, Construction Skills and Summit Skills, so that the integration that is a theme of this report is also reflected in the skills regime.

Recommendation 3.8: That a group comprising representatives from Government, the industry and skills providers is tasked with considering how, in the light of the changing skills landscape, greater collaboration, co-operation and integration between professions, between trades, between trades and professions, and between them and the construction products and materials industry can be promoted to develop a single strategic view on future skills needs.

There is a real opportunity to ensure the UK construction industry has the right skills and capability to deliver a low carbon built environment effectively, and that the UK economy secures maximum benefit from the opportunities that are created – both domestically and internationally.

3.5 Methodologies, tools and data

3.5.1 Where's the carbon?

Given a brief to consider ways that the industry could make its contribution towards a reduction of carbon, it was natural enough to start with the question "Where is the carbon?"

This proved difficult to answer at anything other than the highest level – and even establishing that for the footprint of the industry itself has proved difficult (see chapter 2, Section 2.6). The problem is data.

A constant cry during the IGT's work has been for reliable data that has some granularity, and for tools and methodologies which are standardised and truly diagnostic. In the absence of reliable data, there can be no reliable prescription; and in the absence of standarised tools and methodologies, those who need or want to get the work done have to make up their own, drawing their own boundaries, and thereby undermining their usefulness to third parties. This represents both waste and a missed opportunity.

Because of the pervasive nature of carbon, the data and research needs reach equally far. The critical data that is required, however, relates to how energy is being consumed, and therefore carbon emitted, now.

The data that we need is therefore how energy is being consumed in different building types, in different forms of construction for different building types, in different buildings of different types that are differently managed and so on. We need benchmarks so that occupiers who themselves need to measure and know what they are judging against; and we need standard methods both of collecting data and using it, so that data that is measured once can be used many times, rather than having to be re-measured, in slightly different ways, for many different purposes.

Recommendation 3.9: That Government and industry should agree a full schedule of data needs for the transition to a low carbon built environment, and a method, source of funds and programme for collecting, analysing and disseminating it.

The Emerging Findings also noted that the means of achieving purposeful progress on carbon reduction is also conditional upon the development of methodologies and tools which can be adopted as industry standards, backed by authoritative data so that they are trusted to produce the right outcome. This includes:

- carbon accounting systems, specifically in respect of "whole life" accounting
- more specific standards for carbon footprinting and labeling
- data on materials and product footprints, life cycle etc, on a rolling basis, keeping pace with the introduction of new products (which will involve addressing issues of intellectual property and disclosure)
- methodologies for testing the anticipated performance of design propositions

Recommendations are made elsewhere in the report in connection with accounting for embodied energy and whole life carbon; but specific reference was made in the Emerging Findings to the vital work required on developing the SAP and S-BEM programs for modeling the energy/carbon performance of domestic and non-domestic building designs.

3.5.2 Carbon compliance and innovation: SAP and S-BEM

The Building Regulations now require the use of energy/carbon calculation tools (principally SAP and S-BEM) to calculate the annual energy use and associated carbon emissions of a proposed building; compliance is achieved if the carbon emissions are equal to or less than a target value.

The tools require the user to specify a set of information describing key elements of the building and its services. This is combined with a built-in set of standardised assumptions about how the building is used and what temperatures, ventilation rates, lighting levels etc are to be provided. Both SAP and S-BEM are 'simplified' models, which have been reduced to the minimum complexity compatible with appropriate accuracy for the purpose.

Two principal issues arise:

- If the tools are to inspire confidence amongst all users and stakeholders, their predictions should be verified against monitored data from real buildings. No such monitoring is currently undertaken on a systematic basis particularly on modern low energy buildings
- Because the only way to show compliance for dwellings is via SAP, and for most other buildings S-BEM, if a particular energy saving or renewable technology is not modelled within SAP or S-BEM then it cannot show any advantage to the designer in terms of compliance with Part L – so unless the tools can rapidly incorporate innovative products, then they become barriers to the uptake of such products and solutions

For the tools to deliver a robust and defensible model of the integrated energy performance of a building, the algorithm describing the performance of each element of the building must be based on sound scientific evidence of how that element behaves across the full range of conditions to which it will be exposed. This creates a 'Catch 22' situation – in order to allow proper monitoring of the performance of a new product or system, it needs to be incorporated in a number of real buildings. But if the product is not modelled in the software, a building which relies on its performance cannot, in theory, be approved by Building Control for construction.

The development of a robust scientific evidence base for new products can be expensive. This is normally borne by the developers of such products but then the CCT team has to develop an algorithm to model the product.

For, Appendix Q offers a slightly long winded but standardised way of incorporating newer technologies; but for S-BEM there is no formal system, though a number of manufacturers are funding work for specific groups of products.

In order to address these issues, a number of changes are required to practices and procedures, principally revolving around:

1. mechanisms for the development and updating of the SAP/S-BEM software packages.

2. long term monitoring of a sufficient sample of buildings.

3. more open access to the SAP and S-BEM software.

4. the scale and source of funding available for this work.

The difficulties associated with accommodating innovative products and solutions are a particular concern. Giving full recognition to these innovations is key to achieving the long term objective of creating a low carbon construction industry and ensuring that companies in the industry are encouraged to take full advantage of the commercial opportunities that a low carbon agenda offers.

Recommendation 3.10: That a joint industry/Government group is formed, charged with making clear recommendations to resolve the difficulties summarised above, and a basis for the long term funding of the development and maintenance of carbon compliance tools.

3.5.3 Information technology

The potential for ICT to transform operations in the construction industry is much spoken of, but, excepting pockets of excellence, remains largely under-realised.

IT has a huge part to play, of course, in the engineering of systems which are designed to run efficiently at every scale from individual house to whole networks; and at the scale of individual buildings its capacity to operate (virtually) interactively with the people who live and work in them, learning user behaviours and preferences, can play a significant part in raising the level of awareness of the cost implications of making additional demands – for example, by giving instant feedback of the consequences of turning up heating, or turning on lights.

At the larger scale, these systems can be integrated into whole district systems, reducing peak loads on power grids and generating stations; and, utilising smart sensor/controller networks, it would be possible to optimise the use of community heating and power or the use of micro-renewable energy systems.

These are only some examples of the potential of a medium that is almost as universal as carbon itself.

The subject of this report is, however, the construction industry and the changes it will need to make to respond to a 40-year carbon reduction programme. As made clear elsewhere in this report, this is going to demand new levels of quality in construction, and new services – such as the speedy but accurate surveying of premises in order to plan retrofit work, modelling solutions and the management of the logistics necessary to roll out a retrofit programme at mass scale.

There is much else. It is, however, Building Information Modeling (BIM) that is seen as having the greatest potential to transform the habits – and eventually the structure – of the industry. It represents the latest incarnation of a logical progression from working in 2D, up to working in 3D but with all participants effectively going it alone to the exchange of information in 3D, and eventually to all consultants working in a shared digital environment. BIM not only enables integration, it virtually demands it; and if it is understood as being about far more than software, then it has the potential not just to reduce or eliminate error and unnecessary change, but also to cut out layers of waste and reduce transaction costs in the transmission of information around the supply chain.

Its particular significance in the context of carbon is not just that the importance of integration to a new, more reliable and less costly proposition that the industry needs to bring to the carbon reduction programme, but also as an instrument of systems engineering, with the potential to model different scenarios.

There is a danger of placing too large a burden on BIM and expecting it to be a silver bullet; but it does seem to be an idea whose time has come, and under the twin challenges of having to make buildings more accurately and at less cost, it is an opportunity that should not be allowed to pass by.

In a world in which some small businesses still do not have an internet connection, or with businesses who have considerable sunk investment in legacy systems which may not be appropriate to future ways of working, there are clearly barriers in the rapid adoption of BIM right across the industry. These are, however, barriers that can be expected to be overcome.

There is a recommendation in chapter 6 of this report, dealing with non-domestic buildings, about Government's use of BIM, but another recommendation for the wider industry follows.

Recommendation 3.11: That the industry should work, through a collaborative forum, to identify when the use of BIM is appropriate (in terms of the type or scale of project), what the barriers to its more widespread take-up are, and how those barriers might be surpassed, leading to an outline protocol for future ways of working.

When we have the means of modelling a building in three dimensions digitally, it is perverse to attempt to do so for the first time for real, under site conditions. As John Tocci, an American contractor who makes invariable use of BIM (whether or not the design comes to him in that form) puts it, "Every good building deserves to get built twice".

3.5.4 Codes and standards

The Emerging Findings included a proposition that "the professional bodies should propose the necessary regimes and funding that would enable a much more rapid cycle time for Best Practice, Codes and Standards" (Proposition 11).

The Construction Industry Council (CIC) consulted its members, by questionnaire and a workshop, to consider this question; and representatives of the IGT have also met with the British Standards Institute to discuss the same issue.

The principal messages were:-

1. The existing stock of Standards in the construction sector is huge: many professional organisations have a range of several hundred publications, and the larger ones have libraries which may exceed 20,000 volumes. There seems to be no "gateway" mechanism to check whether the perceived need for a new standard can be met by revising or updating an existing one.

2. As a consequence of these Standards, developed over a very long period of time, do not all join up, and there is a need for a process of simplification and clarification.

3. This is aggravated by difficulties of access, and this could be addressed by establishing a database of Standards that could be searched across a range of professional and other Standard-setting organisations.

4. There is no benchmark time for the production of new Standards. The RICS aims to achieve a new standard within one year once a business case has been approved, and most felt that it should be possible to develop a Standard within 2 years given the base data. This could, however, extend to 6 years for highly complex issues.

5. The critical determinants of the time taken to bring in a new Standard are:

   - the availability of all relevant data, knowledge and experience at the start of the exercise
   - the status of the document itself (Codes and Standards tend to take longer to produce than Best Practice)
   - the complexity of the subject
   - the extent to which the subject matter is controversial, and the prospects of unanimity amongst interested parties

6. The means of production is also important, with use increasingly being made of a hybrid model with a paid author and volunteer reviewers, replacing the "all volunteer" model. This is leading to shorter timescales for production.

7. The cost of producing Standards is as variable as the time it takes, with a very wide range of figures quoted. There is, however, an issue of funding, particularly in respect of the wholesale revision of Standards that could follow the prioritising of carbon reduction.

8. The professional institutions naturally see the promotion of Best Practice as core to their mission, and so much of the drive for new Standards comes from the institutions themselves.

9. Frequently, though, there is no demand for Best Practice at the point at which it is most needed, which is at the point of innovation. Once the demand is clear, the need for Standards runs right through the supply chain to the end user, and it is then required by all.

10. A coherent library of respected Standards represents an international asset, with a number of countries overseas looking to Britain as market leader in Standard-setting, creating an opportunity for services and products to follow.

Apart from the availability of data, the changes that are believed could best promote more rapid development of Standards are:

- improved accessibility to existing stock
- a greater anticipation of research requirements, so that an earlier start can be made on data collection
- more use of paid authorship
- new sources of funding for Standards relating to low carbon construction and sustainability more generally

Shortening the innovation cycle from identification of the need to widespread take-up across the industry is considered vital to achieving the full carbon reduction potential of each project, and this view is particularly held in the infrastructure sector; but it does seem that the professional bodies and other setters of Standards have processes by which they can be developed in good time.

However, implementation is seen as much of a problem as the development of Standards, and time needs to be allowed between the availability of a Standard and its implementation, to allow those to be bound by it to adapt their practice.

There are also issues around ease of access to existing Standards and the cost of developing new ones. It is for the professional bodies to decide whether they wish to make any proposals in respect of this.

In the meantime, if there is to be a more rapid uptake of Standards then the key would appear to lie in greater cooperation between all of those in the construction sector who seek and set the Standards.

3.6 Non-compliance and the invisibility of consumption

3.6.1 Introduction

Notwithstanding the benefits of the simplicity of a focus on carbon reduction, carbon remains the effect of inefficiency rather than its cause. The first duty must therefore be to reduce energy consumption, and the starting point for that, as far as the existing stock is concerned, is to get the building systems running as they should. Studies repeatedly show that buildings do not achieve their design criteria, in energy efficiency terms, when tested post-completion.

This may be the result of shortcomings in the original design, or in its execution, or in the way that the building is run, but given this fact and the size of the problem (with energy consumption having been measured at three or even four times the predicted level), it is extraordinary that so little priority is attached to seeing how buildings perform in practice; and this gives rise to three clear recommendations as a first line of defence against energy inefficiency:

- that proper attention is paid to the commissioning of buildings
- that post occupancy evaluation becomes as routine a part of bringing a new building into use as the construction itself
- that, beyond commissioning and post occupancy evaluation, there is a continuous process of measurement, and feedback and of acting on the indications of the data gathered

Recommendation 3.12: That Government and the industry should routinely embed the principles of "Soft Landings" into their contracts and processes, so that a building is not regarded as complete until it performs in accordance with its design criteria.

Recommendation 3.13: That Government should commission a programme of independently conducted, properly funded, published studies of the energy performance of buildings in the public estate built since the introduction of the 2006 revision of the building regulations by comparison with their design criteria.

The other two recommendations are covered elsewhere in this report:
Recommendations 6.20 – 24 re the measurement and display of energy performance, and Recommendation 6.25 re post occupancy evaluation.

For new buildings, there must also be a new emphasis on ensuring compliance in meeting design and regulatory standards in construction. The problem of non-compliance has long been recognised within the industry, but it is going to take on a critical importance as design

is increasingly directed towards energy efficiency. Unless the standards of workmanship necessary to deliver high levels of air-tightness, insulation etc are achieved, then the risk is that enormous sums of money could be expended without a commensurate reduction in emissions. Countering this risk is a matter of designing for ease of accurate installation, product development founded on the same principle, training of the workforce, testing for compliance, and finally enforcement.

3.6.2 Accreditation schemes

There are two categories of accreditation schemes, designed for quite different things:

- consumer protection schemes, designed to deal with dispute resolution, and sometimes offer redress, in the event of sub-standard performance by a registered provider
- and aspirational schemes, which are invariably voluntary, and which are designed to assist companies with raising their own game, and providing them with a badge for marketing purposes

Both are relevant to carbon reduction.

There is a range of aspirational accreditation schemes, from some which are very sector-specific, often operated by trade associations and others which are primarily aimed at the higher levels of corporate social responsibility, such as Carbon Disclosure or FTSE4Good. The degree of confirmation of competence and achievement is highly variable, with some being based on self-assessment, and others requiring external audit.

The multiplication of these schemes has the advantage of providing a range of entry levels for companies wanting to improve their sustainability credentials; but it also means that public perception is fragmented, and the public will have little understanding of which "badges" indicate little more than membership of an organisation, however virtuous; and which signify a level of external audit that has confirmed a commitment and competence which rises above business as usual.

The development of a scheme, and a decision as to whether or not to join it, is largely market-driven, and if it is working for those who have signed up, then there is no need for any action beyond that which the market initiates. The industry may, however, consider the development of a construction-specific standard, which would have the following characteristics:

- It would be sector-specific, but with different models for very different types of business within the supply chain
- It would have ranked levels of achievement – so that level 1 might mean that a business has measured its carbon footprint and has a strategy for sustainability, up to level 5

(which would signify that there is nothing more for the business to do other than pursue continuous improvement). This might mean that it could operate as a "scheme of schemes" licensing, for example, schemes operated by trade associations
- The accreditation would be by a body which is itself accredited (United Kingdom, Accreditation Service, for example)
- It would have (or be capable of having) credibility with consumers

To avoid the problem of multiplication and duplication referred to on so many subjects in this report, the scheme would probably need to be worked up with bodies who are already engaged in the provision of accreditation schemes, and there would obviously be a challenge to balance a level of accreditation that creates real brand value with the cost and (potential) bureaucracy that could accompany it.

The purpose, though, would be for the industry to raise standards collectively, across as much of the sector as possible, in a way that leads to real change and improvement.

It would also provide a unifying framework for a range of initiatives under consideration in construction (such as the Strategic Forum for Construction's campaign to reduce on-site emissions by 15%, and the suggestion in this report that construction-related companies should, as an act of leadership, sign up for the voluntary posting of Display Energy Certificates in their own buildings). Each such initiative, in common with separate plans born of the Sustainable Construction Strategy, could populate the achievement levels of the scheme.

Recommendation 3.14: That the industry should investigate the scope for setting up a construction-specific accreditation scheme for companies committed to improving their environmental credentials, considering also the different needs and the different business models across the supply chain, to establish the practicality and merits.

There may be no market demand for this, but the IGT considers it something that the industry could look at as part of a package of measures that could demonstrate leadership – but the development of a scheme, and a decision as to whether or not to join it, will be market driven. This is not an area for Government intervention.

By contrast, the accreditation of work in place, where that work relates to carbon reduction, is a matter of public interest. The efficacy of energy conservation measures is highly sensitive to the quality of workmanship, and the levels of air-tightness required for a high-performing envelope are far beyond anything required or achieved on the general run of construction – and even more so in respect of the general run of repair and maintenance work.

This is the kind of work that is likely to financed under the Green Deal, and if it fails, then there will be several consequences, all of them bad:

- The money will have been spent, and the carbon reduction will not have been achieved. This is, by any measure, a waste – but it also means that the money necessary to do the work properly has gone out of the system, loading the affordability barrier even more
- Money is also likely to be spent on dispute resolution – adding to the problem of an industry where fees paid to establish the facts and liability in respect of defects exceed the amount actually spent on physical remedies
- The brand of the Green Deal itself will be damaged – in the extreme, converting it from an incentive to a deterrent

There are real difficulties in establishing a formalised accreditation scheme for small building works, including:

- Drawing the boundaries: when does DIY or odd-jobbing become a business that needs to be regulated?
- Cost: by their nature the works undertaken by small businesses are themselves small, and the cost associated with setting up and policing an accreditation scheme could represent a considerable burden on those businesses
- Declaration: how does anybody responsible for accreditation know that the work is actually being undertaken?

Some of these difficulties are, however, manageable under a programme such as that to be financed by the Green Deal, as it is understood at the date of publication of this report.

- Suppliers offering retrofit systems to householders taking advantage of the Green Deal will eventually be receiving bank finance from an approved provider, and they will therefore be "in the system"
- It is likely that the works will have a value in excess of say £5,000 as that is the reason that the householder will be seeking the finance, so this holds out the prospect of the cost of a well run accreditation scheme being an acceptable margin on to the cost of the works themselves
- There is likely to be a fairly narrow range of generic packages that will be financed by the Green Deal, and setting and confirming standards should not therefore be a case of starting from scratch for every loan

There still remain some big questions, even beyond the principle of agreeing that there needs to be some form of accreditation scheme in the first place, the principal of which are:-

- Who is accredited: the Green Deal provider, or the specialist contractor who actually carries out the work?
- Is the subject of the accreditation the provider of the work (effectively a form of licensing) or the work itself (a matter of inspection and confirmation of compliance)?

- Is such a scheme required, advisable, practical and affordable?
- How will it be policed?
- What redress would be offered to an aggrieved consumer: dispute resolution, cash compensation or remedying of the works?
- Should such a scheme be developed and owned by the Government, or by the industry?
- Is it necessary to invent a new system, or could it build off an existing system, such as those operated by some of the trade associations – or, indeed, be a "scheme of schemes"?

Recommendation 3.15: That industry should work with Government to address the above questions with a view to developing a proposition that offers consumer protection to those commissioning work financed by the Green Deal.

If that question is answered in the positive, then there would also be virtue in the scheme being deigned so that it could be extended to other programmes raising an issue of public interest.

3.6.3 Building Regulations

The other line of defence is to widen the reach of Building Regulations, so that they extend further into the refurbishment market (and as a recommendation in the housing chapter of this report that consequential amendments should be subject to Building Regulations Approval; and/or whether there would be merit in extending some of the precedents set in the 2010 Building Regulations (for example in some elements being subject to test before acceptance, and some having to be installed by approved providers). It is assumed that these are matters that are already under consideration as part of the review for the 2013 Building Regulations, and no further recommendation is therefore made here.

Considering whether a proposition implemented through the Building Regulations could operate instead of, or as a supplement to a licensing/accreditation scheme should, however, form part of the review suggested in Recommendation 3.15.

3.7 Demand side incentivisation

3.7.1 Introduction

There are some words without which it would have been impossible to write this report without exhausting the Thesaurus. Two of the most-used are "challenge" and "incentivisation", and the two are linked. It was probably only the 2050 Group who saw the opportunities of the transition to low carbon first, with the challenges behind, rather than the other way around. What will turn challenge to opportunity in the mind of the rest is, without

doubt, the confidence that there will be a market for their goods and services – and there is little confidence that that will come about as market and social forces are currently aligned.

Instead, central to almost all discussions about addressing the existing stock is a concern that there is a still little customer appetite to commit to the expenditure necessary to improve the energy efficiency of their building, and the position for new buildings is little different. There will always be honourable exceptions to this generalisation, and some who will, through conviction or long-sightedness, choose to exceed statutory standards. They will, however, be balanced by an equal or greater number who, through cynicism or short-sightedness, will only grudgingly conform even to statutory standards.

For those making plans to deliver services and products to a low carbon market, the question is therefore what, over time, will make customers of all those people between these two extremes.

Clearly the levers available are any of the following, either singly or in combination:

- campaigns designed to convince the public that they should reduce their energy consumption, reinforced by public sector example
- regulation that effectively rations the carbon emissions attributable to a consumer
- regulation that prescribes standards that are designed to bring about a reduction in energy consumption
- fiscal penalties for consumption
- fiscal incentives for investment in measures designed for energy efficiency

Put another way, there has to be a presumption that consumers will be converted to energy efficiency on the basis of peer pressure or conviction; or that they will be priced or regulated out of energy consumption; or that they will be incentivised (most obviously by payment, subsidy or relief) to adopt products or practices that have the same effect.

Where people are inclined to act through a sense of personal or corporate social responsibility, then either they will have done so, or they are prevented from doing so by a barrier to action. These will include the lack of available capital, or a reluctance to invest in improving the energy efficiency of a building when it may be sold long before payback. These are the principal barriers that the proposed Green Deal will remove - and they are a necessary part of any package of measures designed to incentivise the market.

From the point of view of the construction industry, and whatever levers are used, there is a need for clear signal that there is going to be a wholesale take-up of low carbon solutions if companies are to have the confidence to invest in new products, methodologies and skills. Also.to meet the timetable of the Climate Change Act, those signals need to be in place very soon – and on the evidence of new build housing, and the operation of Part L and the introduction of the Code for Sustainable Homes, the surest signal is regulation, announced in advance, with clear dates for implementation. An approach to this is set out in section 3.2.4 of this chapter.

The second clear signal would be the promise of a stable or rising price of carbon, with a protected floor, so that investment in new low carbon products can be committed in the certain knowledge that they will have a value related to their capacity to reduce a purchaser's exposure to that price.

Other means of changing behaviour will work, of course, but the timescale over which they take effect, and thus the size of the market at any particular time, will inevitably be unpredictable; and in those circumstances it can be expected that the industry will follow, rather than lead, the change -and the trajectory of carbon reductions required will not be achieved.

There are approximately 25 million existing homes to be retrofitted by the end of 2050.

There are approximately 21 million minutes between now and the end of 2050.

The particular challenge that this sets for the existing housing stock is recognised. However, the application of an escalating standard for new housing, in the form of successive levels of the Code for Sustainable Homes, without any commensurate pressure to raise the energy

efficiency of existing homes, clearly has the potential to distort the market and act as a disincentive to developing new build homes.

3.7.2 Cost

There is also a disincentive to retrofit in the cost of treatment. Perhaps the most frequently question asked during the course of the IGT's work has been, "How are we going to pay for all of this?" There is no single answer, but it can only be through a combination of:

- savings in energy bills, now or in the future
- consumers placing a higher value on the parallel benefits of energy efficiency – warmth, comfort and wellbeing
- avoiding some of the costs of dealing with the immediate externalities of energy consumption
- similarly, avoiding the longer term cost consequences of inaction – a key message of the Stern Review
- or subsidy

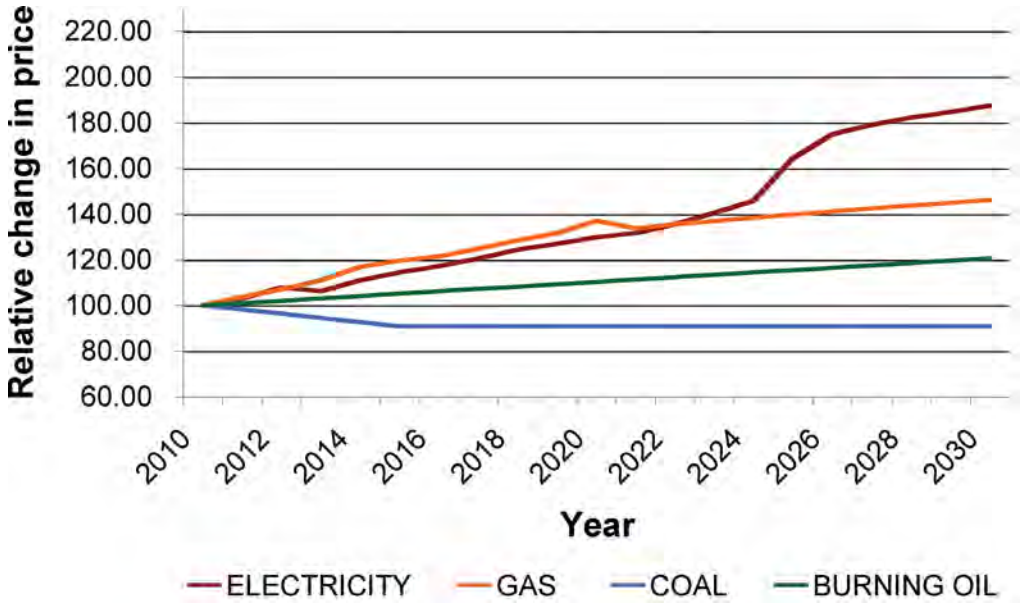
And the industry can clearly narrow or close an affordability gap by driving down costs through product or process innovation, or through economies of scale in the event of mass demand.

In the interim, though, it seems unlikely that there will be mass take-up of any package of measures that doesn't comply with the Green Deal's "golden rule: that the cost of financing the work must be covered by an equal or greater saving in energy costs.

3.7.3 Energy prices

A graph depicting the price of a basic fuels and electricity as projected by DECC over the next 20 years is included in figure 3.2.as a basis for considering whether rising fuel prices might incentivise the market – or at least persuade the supply side that the market will develop.

Figure 3.2: Forecast retail domestic full prices (2009 constant prices)



Looking at the trajectory over the next 15 years (that is, until 2025, when the price of electricity takes a fairly sharp upward (in order to repay investment in new technologies, specifically carbon capture and storage), the projection is for fuel prices to increase by about 2.5% per annum in real terms over that period. Whilst a 40% total increase might certainly be expected to bring about changes in behaviour, it might be questioned whether it will do so when the increase is comparatively gradual.

This suggests that energy prices are unlikely to have a radical effect upon demand, and therefore upon consumer action in seeking energy efficiency in the buildings they own or occupy over the next twenty years – and, of course, if they were to rise to a level where they would do so, then their benign effect in terms of driving down demand would be counter-balanced by a serious consequence of fuel poverty.

Thereafter, however, energy will become an increasing proportion of household expenditure (and, of course, most of the existing building stock will still be with us then, and the standards to which they are treated, and to which new buildings are constructed, will determine energy consumption thereafter).

3.7.4 Regulation

There is a clear consensus on the supply side that the strongest signal that there will be a sizeable and sustainable market for products and services designed around carbon reduction and energy efficiency would be regulation. Government policy on regulation is just as clear: that it should be the last resort, and (under the "one in, one out" rule) that new regulations can be introduced only when regulations having the same cost impact on business are retired.

The supply side consensus reflects an equally strong view that, in the absence of such regulation, or an increase in energy prices that would act almost as forcefully in reducing consumption, the market for those products and services will be limited; and this perception does seem to be supported by such opinion polling as has been conducted around the subject.

It certainly seems probable, given that the 80% reduction required in carbon emissions by 2050 can be achieved only if virtually every building is rendered as energy efficient as it can be (and there is also an expectation that reductions from the building sector may need to be greater than that, to compensate for other sectors that cannot achieve an 80% target), that at some point it will be necessary to require householders who have not been motivated by any other incentive to act.

If, therefore, it can be conceded that regulation might be required one day, but that there are many things that need to be done before that can happen, then it is not necessary to resolve this difference at this stage. Instead, it should be possible for Government and industry to agree those things that do have to happen in advance of regulation. These include:

1. The measures (prescriptive) or standards (performance) that would be required by the regulation.

2. Identifying trigger points for action – for example, by requiring a defined improvement in the rating of a building to be achieved whenever a property is sold, or by a given date irrespective of sale.

3. The baseline against which any improvement in performance would be measured, (such as an EPC rating), and the fitness for purpose of that benchmark.

4. The cost effectiveness of requiring those measures or standards, in terms of the cost of reducing a unit of emissions.

5. The availability of skills required for all parts of the process, from the measurement of benchmarks, and the specification and execution of the works, to the certification of compliance.

6. As an extension of this, the capacity of an organised supply chain to respond to the level of demand.

7. The development of an accreditation scheme to provide consumer confidence in the quality of the work.

8. The agreement of measures necessary to require and certify compliance.

9. An extensive programme of communications so that there is increased acceptance, on the part of consumers, of the principle of regulation – the present political difficulty of which is fully recognised by the industry.

10. The identification of regulations, of the necessary cost impact, to meet the requirements of the "one in, one out" rule.

11. The legislative process for the regulations themselves.

This programme would show the lead-in that would be required to be able to regulate, even assuming the political will.

It is also likely that the issue of capacity would be a key determinant in how and when regulation could be implemented, as doing so in a way that over-stretches the capacity of the industry would be inflationary, and would further risk the quality and compliance of the work. This would happen if, for example, all properties were required to be improved at the point of sale, given that houses typically change hands approximately every nine years.[5]

In parallel with this, and as part of the same programming exercise, time can be allowed for trying all other potential stimuli to action – so that, should it be necessary to implement regulation as the last resort, then there will be evidence as to whether or not every other resort has been tried and found wanting. If, of course, alternative levers have the desired effect, then there will no eventual need for regulation for anything other than exceptional cases.

If Government were also to make clear that regulation would indeed be implemented as a last resort, if necessary, and declare the date by which that might happen, then consumers should be more open to competitive propositions from the marketplace to carry out the work at a time that might be both more convenient and economic than if left until later.

5 English Housing Survey, CLG, 2010

4. Major Projects

4.1 Major Projects generally

4.1.1 Challenges presented by Major Projects

For the purposes of this report Major Projects have been taken as projects or programmes which have both the size and duration to create their own standards in the industry – projects that are sufficiently significant and structured in such a way that the usual market constraints can be influenced or changed. They should consequently be defined not by size, budget, physicality, location or building type but rather by the scale and importance of their impact (environmentally, socially or economically); and by what can be learned and transferred.

Such projects are generally (though not exclusively) led, sponsored, and procured within the public sector; and this gives both local and national Government the opportunity to take a lead in knowledge capture and dissemination, and setting standards for a number of criteria, including carbon reduction.

However they may be defined, Major Projects, provide the opportunity to implement measures that may not be practical or affordable on smaller schemes. These include:

- integrated planning, design and engineering
- collaborative, integrated procurement, including the use of framework agreements and working with all tiers of the supply chain
- specialist governance and management functions, including roles such as Carbon Manager, Logistics Manager etc
- championing innovative products and processes, including setting new standards and piloting new ways of working
- advanced HR policies, including labour engagement, industrial relations agreements, and specialist training and development for professionals, craftsmen and operatives
- other economies of scale, including the opportunity to apply neighbourhood level systems for heat and power

Taken together, these characteristics provide a unique opportunity to address the low carbon agenda, allowing specifiers, designers, clients, planners and contractors to test ideas and learn lessons – which can then be captured and communicated more widely.

The issues are therefore to do with planning, implementation and knowledge transfer.

However, to accompany the opportunities that scale brings, it also brings its own problems. Major Projects are so disparate that they fall outside conventional norms and it is therefore difficult to apply universal targets and standards (such as Building Regulations) as a mechanism for reducing carbon emissions.

For the same reason, there are no benchmarking schemes that could cover projects as diverse as railways, power stations, shopping centres and so on.

To address these challenges, a standard-bearing review body is required, where Major Projects can be assessed quickly and individually, using peer review skills and expert advice that may be outside the project team.

To achieve the maximum impact from Major Projects, it is also recommended that positive steps are taken to encourage them to be exemplars, that objectives are set for each project, and that learning is recorded and disseminated. The proposed body would also take on this role.

There is much about the establishment and operation of such a body that would need to be resolved to establish its viability. So in order to inform its creation, it is proposed that a working party be formed, made up of clients, professional bodies, designers, contractors and their supply chains to examine in detail:

1. the nature of the body – that is, whether it should be regulatory, public/private, charitable or a professional association

2. possible funding sources

3. the scope of its terms of reference – building projects, infrastructure, embedded energy, operational energy etc

4. its relationship to existing bodies, and the possible expansion of or amalgamation with any, such as

    (a) the UK Green Building Council – which already has a large industry-wide membership

    (b) any successor body to CABE – but with its remit widened to include carbon reduction and sustainability as an element of good design

    (c) the Major Projects Association

(d) the Institution of Civil Engineers – which has worldwide recognition and is already a regulatory body known for its knowledge base

(e) how best to establish the authority and credibility of the body with industry players – clients, engineers and designers, contractors and supply chains etc.

Recommendation 4.1: That the industry should set up a Working Group to consider the creation of a body which would become the authority whose stamp of approval would provide sustainability legitimacy for major projects, and be responsible for organising the capture and dissemination of knowledge and experience gained on projects that fall within its terms of reference.

4.1.2 Qualities, identity, composition and role

The body would need to have independence and authority; and public/private sector co-funding from multiple sources, possibly including a project levy or fee.

It would also need an identity. It could operate in a similar way to the Design Review process run by CABE (the Commission for Architecture and the Built Environment), whereby Design Review panels brainstorm the project and suggest improvements or ideas at an early stage in the design process. For major projects, the body would be comprised of recognised experts in their field, drawn from a national pool of individuals, plus observers from essential stakeholders such as the relevant local planning authority.

Unless the terms of reference to a successor body to CABE are extended to include carbon, other measures of design quality would remain the responsibility of CABE or any successor organisation thereto, so the new body could focus on carbon-e. The intention would be for it to 'critique' each major project and identify:

- specific ideas or themes for carbon reduction
- appropriately ambitious, verifiable targets for low levels of embodied and operational carbon emissions

Subject to the organisational landscape, it may be possible to integrate design and carbon review into a single critique, recognising the link between sustainability/low carbon and good design in general.

In addition, the body would:

- act as the repository of data culled from projects
- develop methodologies, consistent with industry-wide standards generally, where differentiation is required for Major Projects for consistent and practical measurement of carbon inputs/outputs
- consider how the benefits of scale that accrue to a Major Project (such as the use of low carbon concrete, or community heating and power projects) can be captured by grouping projects together; or, particularly for public sector projects, initiating rolling programmes for repeat building types
- conversely, consider how to scale down successful practice to render it accessible to smaller projects

4.1.3 Mandatory assessment of Major Projects?

The objective would be to move towards all Major Projects being subject to review, possibly as a condition of planning consent as is an Environmental Impact Assessment (EIA). As a *quid pro quo*, thought could be given to the determination of planning applications either within a specified period or by a national body that supplements the local planning authority, in a process similar to that now proposed for nationally strategic projects.

There could be a range of assessments to encourage excellence, from bronze and silver to gold. A lower level of assessment would be accompanied by recommendations that would increase the project's carbon performance to an upper level; and major public sector projects would have to achieve a minimum level of, say, silver.

Agreement would be needed on the range of issues to be included in all assessments and upon the boundaries of the exercise – for example whether or not to include travel of the workforce to the site, principles for assessing the lifespan of the project and so on.

4.1.4 Dissemination of data

Carbon reviews would be recorded and made public.

Similarly, a data base specific to Major Projects would be established, so that future projects can benefit from basic information sharing, especially on subjects that represent new research or areas that are not well understood at present. This may be particularly relevant to embodied carbon. The obvious model for information gathering is the 2012 Olympic site (see section 4.2 of this chapter), which has demonstrated how the resources available to Major Projects can greatly improve innovation and the flow of data and ideas.

4.1.5 Integration with existing assessment methods

Most, if not all, major projects are already subject to Environmental Impact Assessments (EIAs). However, as with the BREEAM method of assessment, many EIAs lack a sense of priority, with the various environmental issues given broadly equal status.

Recommendation 4.2: To recognise the urgency and importance of climate change, it is proposed that carbon reduction is given greater prominence in Environmental Impact Assessments, with a mandatory target or 'gateway' of performance derived from the assessment.

4.2 Building a Sustainable London 2012

4.2.1 Introduction

Sustainability was at the heart of London's bid to host the 2012 Olympic Games. From the outset, the Olympic Delivery Authority ('ODA') aimed to go beyond construction industry norms; to redefine best practice in sustainable development; and to demonstrate that the sustainability targets set for the project, and the tools and processes put in place to deliver them, are achievable and replicable. It is therefore a case study not just in the planning and delivery of Major Projects, but also in putting environmental impact at the core of a project. It does not just offer invaluable lessons in what can be achieved given adequate scale, but also in how aspects of that learning can be transferred to other projects of any scale. This is potentially a real, lasting legacy. It is essential that those lessons are captured to feed into future practice; and they are the natural stock of the review body proposed in Recommendation 4.1.

Olympic Park – July 2010

Source: London 2012

4.2.2 Strategy and delivery

In January 2007, the ODA published its Sustainable Development Strategy which includes a wide-ranging set of commitments and targets against 12 key themes: carbon, water, waste, materials, biodiversity, environmental impacts, supporting communities, transport and mobility, access, employment and business, health and well being and social inclusion. Six of these therefore relate directly to various aspects of environmental sustainability and, as a illustration of the impossibility of keeping the subject bounded in its own self-contained box, the others will have impacts beyond their immediate purpose.

To ensure the delivery of these commitments and that the targets are met, the ODA embedded sustainability requirements throughout its processes and project documentation. Including design briefs, planning, procurement and contractual arrangements.

Embedding the Sustainable Development Strategy in the Town Planning process has been key. The outline planning application included the Strategy as a supporting document, leading to its relevant targets being included in the planning obligations. These obligations include:

- a 50% reduction in carbon emissions for the built environment as at 2013, measured against 2006 Building Regulations
- 90% of materials (by weight) from demolition to be reused or recycled
- a 40% reduction of non-potable water demand
- the creation of 45 hectares of new habitat in legacy
- a BREEAM "Excellent" rating for all permanent buildings in legacy

The 12 key sustainability themes in the Strategy, including these planning obligations, were then developed into a clear programme of activities, with its own set of key performance indicators (KPIs). For example, the six environmental themes of carbon, water, waste, materials, biodiversity, and environmental impacts include 26 KPIs which are applied to each of the 17 Tier 1 contractors, for projects as diverse as land remediation, tunnelling, infrastructure including utilities and bridges, the construction of all the venues and landscaping.

The targets are applied at programme level and to individual projects. For example, the requirement to create 45 hectares of species rich habitat set down in the programme level Biodiversity Action Plan has been cascaded to relevant project teams for delivery.

Strategic thinking at programme level has also lead to value for money in addressing the best way to meet key sustainability targets. For example, the strategy that offered the best value for money in meeting the target to reduce carbon emissions by 50% across the development has been to invest in a large scale Combined Cooling Heating and Power plant and an extensive distribution network.

4.2.3 Tools and processes

The ODA developed a variety of processes and tools to support this programme and the work of those assuring it, and specifically to collect data and monitor the performance of contractors against the relevant commitments. These include:

- a detailed six week induction for each contractor, prior to starting work, covering a range of issues, including information on the core sustainability objectives and the targets they are expected to meet regular audits and inspections on project assurance
- a detailed on-line bespoke reporting mechanism to ensure each contractor reports against all of their environmental KPIs on a monthly basis through a self assessment tool which is designed to report on the cumulative performance for each theme across all Tier 1 projects; number of supporting documents and systems such as a Code of Construction Practice, the Environment and Sustainability Management System and a data collection tool to provide clear guidance to all contractors working on the project

There is also an independent assurance body, the Commission for a Sustainable London 2012, set up to monitor progress against the sustainability commitments made by the key delivery bodies for the Olympics and this provides an additional level of independent assurance.

4.2.4 Outcomes

Highlights of the project to date include:

- certification of an ISO14001 Environment and Sustainability Management System
- establishment of a Timber Supplier Panel to provide legal and sustainable timber to contractors
- stockpiling over 90% of material arising from demolitions for recycling, including the use of reclaimed paving stones and cobblestones in landscaping works
- use of 39% recycled materials in piling concrete for the foundations of the Aquatic Centre
- exceeding a target of transporting 50% of materials by weight to site by rail or water
- improvements to 3 kilometres of waterways within the Olympic Park
- an integrated approach to the design and engineering of the Velodrome that has significantly lightened the weight of the roof structure by comparison with comparable buildings, reducing its embodied energy and thereby the carbon emissions associated with its construction
- design of the Velodrome to be 30% more energy efficient than a building compliant with Part L of the 2006 Building Regulations

Olympic velodrome

Source: London 2012

Cumulatively, these and the many other commitments made and met on the Olympic Park, demonstrate how, in parallel with other inter-related sustainability objectives, carbon can be reduced, controlled and managed through innovative architecture and engineering, care in the selection, sourcing and use of materials and considerate construction practices – all delivered through an integrated team.

Practical trade-offs have had to be made, and there is learning in this too – but in its 2009 Annual Report, published in May 2010, the Commission for a Sustainable London 2012 commented that '*The sustainability objectives established shortly after the bid win remain robust and the ODA is on track to deliver most of them. The ODA continues to demonstrate best practice in sustainable construction*.'

Box 4.1

Key lessons

1. At the outset of the project develop a robust sustainability strategy that has support at the highest organisational level, covering the key environmental, social and economic drivers of the project.
2. Develop a set of measurable and deliverable key performance targets that have a clear relationship to the strategy and are meaningful and relevant to the project.
3. Embed sustainability targets in planning commitments, design briefs and procurement.
4. Use procurement as a tool to drive positive sustainability outcomes, working with the supply chain to deliver the best sustainability solutions.
5. Develop robust assurance tools and audit processes to monitor progress in meeting the sustainability strategy and KPIs for the design, tender and construction phases of the project.
6. Use self assessment tools where possible and adopt recognised well tested reporting standards. Wherever possible, adopt best practice tools, standards and processes and only develop new tools and processes where absolutely necessary.
7. Be strategic and consider value for money when considering the best way to meet the key sustainability targets.
8. Develop a culture in which everyone working on the project understands that sustainability is a core driver. Ensure there is basic compliance but encourage innovation.
9. At all times ensure that the strategy, performance criteria, tools and reporting mechanisms are clear and transparent.
10. Maintain a level of flexibility in the strategy so that new standards, technologies and processes can be adopted if and when they are appropriate.

4.2.5 Creating a step change in construction

The approach taken by the ODA has been tested with a range of contractors, demonstrating that the targets, systems and processes can be delivered. The achievements, on a project where budget, programme and much else are non-negotiable, have the potential to influence future large and small scale construction projects and organisations.

The ODA intends to publish a series of best practice guides that share some of the key lessons learned from the project, but thereafter it is vitally important that ownership is taken of the lessons learned; that they are made openly available and are widely disseminated; and that formal procedures are put in place to transfer that knowledge to similar strategic projects, and to capture new knowledge from them.

'*Whilst some aspects do require a critical mass of scale and value to be commercially justifiable, the overarching elements are entirely transferable to any project or programme. Most importantly by addressing these issues at the earliest point in the lifecycle it is possible in effect 'precondition for success.' Interestingly once established in the early days of the ODA, strategies have remained largely unaltered giving a stable base for performance*.'

Howard Shiplee, Head of Construction for the ODA

4.2.6 An opportunity too good to miss

In two years time, the world comes to London to see the 2012 Olympics. The construction of the Olympic Park is a construction success story, and a sustainability success story. 2012 therefore presents an unique opportunity to show what the industry can do, and this is an opportunity that should be seized, with a particular emphasis on converting thinking about sustainability and low carbon construction to practice on the ground and the prospects this creates for exports.

Recommendation 4.3: That industry and Government should work together to use the occasion of the London Olympics as a showcase of how to implement plans for a low carbon built environment, embracing design and engineering; works execution right through the supply chain; materials, product and component manufacture; and all other construction-related services.

Building a Sustainable London 2012

1 Olympic Stadium

- Lightest Olympic Stadium to date – minimising use of steel and reducing carbon footprint
- Unwanted gas pipelines used for the roof truss
- Recycled granite from King George V docks was used for the Stadium's river banks
- High recycled content used for concrete foundations
- Bird and bat boxes built-in

2 Aquatics Centre

- High recycled content used for concrete foundations
- Water used to clean the swimming pool filters will be recycled for toilet flushing
- 'Living wall' – biodiversity space for wildlife
- Sustainable timber used for cladding
- Bird and bat boxes built into Aquatics Centre bridge

3 Velodrome

- Light-weight venue design lowers carbon footprint
- Strategically placed roof lights will reduce the need for artificial light
- Almost 100% naturally ventilated
- Designed to reduce water consumption by over 70%
- Rainwater harvesting for toilet flushing and landscape irrigation

4 Handball Arena

- 100% recycled aggregate for piling
- Rainwater harvesting to reduce potable water demand
- 88 light pipes in the ceiling to allow natural light into the venue
- Working with the supply chain to ensure that the copper used will be from a responsible source

5 Olympic Village

- Will achieve the Government's new 'Code for Sustainable Homes Level Four' which is a national environmental standard, resulting in a 44% reduction in carbon emissions and 30% reduction in water use
- 40% of the roof space will be 'green roofs'

6 IBC/MPC

- 'Living roof' - biodiversity space for wildlife that will use materials reclaimed from site ie logs and seeds
- Bird and bat boxes
- Use of recycled water to flush the toilets and for other non-potable uses
- Off-site manufacture to minimise waste on site

7 Energy Centre

- Will provide efficient and low-carbon power to the Olympic Park
- Use new technology including biomass boilers and a Combined Cooling Heat and Power (CCHP) plant which captures the heat generated as a by-product of electricity production

8 Waterways

- Dredging has removed 30,000 tonnes of silt, gravel and rubble as well as tyres, shopping trolleys, timber and at least one car.
- Wetland bowls and rare wet woodlands already being formed in the north of the Park to create habitat and help manage floodwater
- More than 4,000 properties will benefit from a significantly reduced risk of flooding

9 Rail

- Over 50% of materials by weight are delivered by train including aggregate, kerbs and drainage units
- Waste removed from site via railways
- 500 tonnes of plasterboard and 100 pre-fabricated toilet pods have been delivered to the IBC/MPC site by rail
- 1.8 million tonnes of material delivered to the Olympic Park

10 Soil-washing

- One of the biggest clean-up operations of its kind
- Cleaning and reusing hundreds of thousands of tonnes of soil which would otherwise have to be transported off site
- A 'soil hospital' produced material suitable for reuse within the construction works

11 Concrete batching plant

- Supplies low-carbon concrete to all projects on the Park
- Helps reduce the embodied carbon of venues and infrastructure on the Park
- Raw materials are substituted with secondary or recycled materials such as by-products from coal power stations and steel manufacture

12 Parklands

- A new 100 hectare urban park that will provide a green space for people and wildlife
- More than 4,000 trees, 74,000 plants, 60,000 bulbs and 300,000 wetlands plants; one of the largest planting projects undertaken in the UK
- Also creating wildlife habitats including reedbeds, grasslands, ponds, woodlands, 525 bird boxes, 150 bat boxes and artificial otter holts

5. Housing

5.1 Executive Summary

There are currently nearly 27 million homes in the UK, each of whose energy consumption results in an average 5.4 tonnes[6] of CO_2 emissions per annum. In total, this equates to nearly 146 million tonnes of CO_2 per annum[7], 27% of the UK's total emissions (and 24% of our greenhouse-gas emissions). Some 81 million tonnes[8] of this is attributed to direct emissions from dwellings, with the balance from power stations generating their energy requirement. It is therefore of paramount importance that any programme set to reduce the production of CO_2 has at its heart a focus on the domestic sector.

Since the implementation of Part L of the Building Regulations in 2002, new housing has been the subject of progressive regulation that will ensure that its products' contribution to carbon emissions will continue to fall over the next decade. That said, there are outstanding challenges that will need to be addressed to deliver this aggressive programme, mainly focused around the cost of delivery.

Given that three quarters of the homes which will exist in 2050 have already been built, the key challenge for the industry and Government is the existing stock. Without such a focus, little can be done to reduce overall emissions; but to date there has been very limited engagement from the construction industry due to the lack of demand for refurbishment services intended for increased energy-efficiency.

The state of our existing stock reflects its age, and a process of mass refurbishment focused on energy-efficiency would have benefits that would go well beyond energy and carbon savings alone.

Perhaps the biggest challenge that exists, as a barrier to action, is the lack of customer demand for the sort of refurbishment required. Some progress has been made through historic programmes but, given the state of the public finances, it is likely that the changes needed in future will have to be mainly funded by customers themselves, albeit with improved access to up-front finance.

6 Zero Carbon Hub, "Towards Zero", June 2010
7 DECC, Table 362, UK Green-house gas emissions, http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/uk_emissions/2008_final/2008_final.aspx, 2008
8 DECC, Table 362, UK Green-house gas emissions, http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/uk_emissions/2008_final/2008_final.aspx, 2008

At present a lot of focus is being put on delivery of the Green Deal (see section 5.3.2 and 5.6) as a way of engaging customers. However, it is the view of the IGT that a suite of measures that includes regulation, fiscal incentives and penalties will be required in addition to ensure that the scale of refurbishment that is needed is delivered.

This will also have the benefits of faster industry engagement to deliver the supply chain needed; lower costs due to the scale of the roll-out; and increased investment in the technology to accelerate lower cost solutions.

To ensure there is adequate focus on delivery, the industry believes a programme management organisation must be put in place for existing homes along the lines of the successful Zero Carbon Hub ('ZCH') for new homes.

5.2 New Build

5.2.1 Background data

New housing is produced by over 5,000 separate firms, the bulk of which are privately owned and run. The top ten housebuilders, primarily publicly quoted companies, account for just under half of annual output. Social housing is mainly built alongside private housing, as a requirement of the regulatory/planning process, partially funded by social the housing grant under the National Affordable Housing programme.

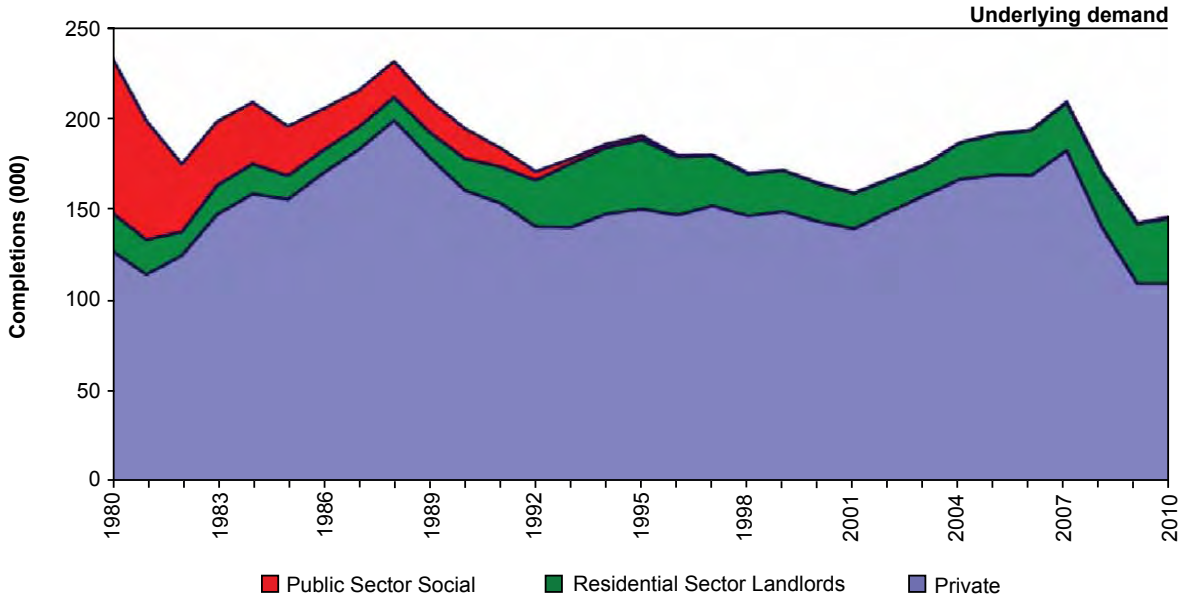
The bulk of new homes are delivered by traditional building methods, with some use of off-site manufacture where speed is critical.

The sector is subject to extensive regulation and the availability of suitable development land is controlled by a complex planning regime.

The market is highly cyclical, and is characterised by long term under-supply, with the previous Government setting a target to build 240,000 new homes per year by 2016. The demand for dwellings reflects demographics – principally birth and divorce rates, immigration and the ageing population.

Figure 5.1: Housing Completions (GB)

Historic build rates have only ever achieved the required output levels in the 1980's when social housing was delivered directly by the Public Sector.



Source: Experian Winter 2009 Forecasts.

The current output of the sector has now reduced to levels not seen since the 1920's. Based on previous trends, recovery is likely to be slow, given the shortage of consented land, the suppression of demand by the shortage of mortgage finance, and the limited capacity of the industry to fund a faster pace of development.

5.2.2 What is already being done?

The energy efficiency performance of new housing has been improving incrementally for a number of years, driven almost entirely by raised standards set by Building Regulations, and by the Homes and Communities Agency's quality standards linked to the Code for Sustainable Homes.

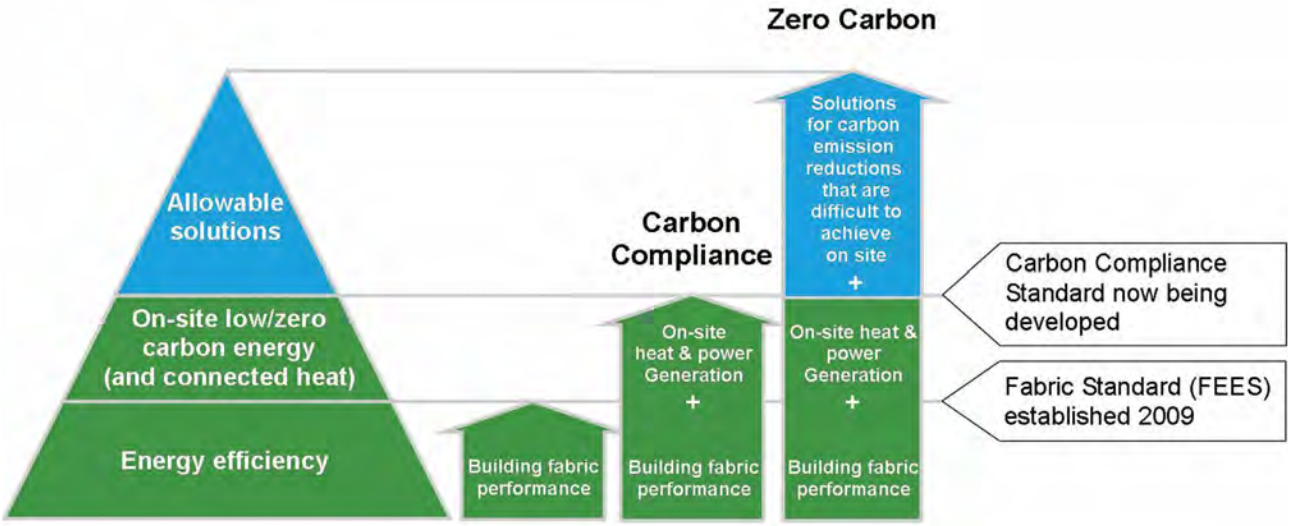
The average new home built to Part L of the 2006 Building Regulations emits around 3.2 tonnes of CO_2 per annum, against the average for an existing home of 5.4 tonnes[9].

The Government is committed to continuous improvements in the energy performance of new housing, and will ensure that from 2016 new homes will not add extra carbon dioxide to the atmosphere.

9 Zero Carbon Hub, "Towards Zero", June 2010

Figure 5.2: Impact of progressive regulation on existing homes

Progressive regulation is in place that will increase the standard required between now and 2016. This will involve improving the fabric of the building, deploying some renewable energy technologies and 'allowable solutions'.



Source: Zero Carbon Hub.

The Coalition's definition for 'zero carbon homes' is still awaited, but the Previous Government's emissions hierarchy framework, as illustrated above, envisaged three elements:

- treatment to the fabric and systems of the house designed for energy efficiency
- local (and possibly on-house) systems for low/zero carbon energy or connected heat
- "allowable solutions" to deal with carbon not mitigated on site – in ways still to be defined, but likely to include exports of low carbon or renewable heat to other developments, and possibly to include investments in accredited offsite renewables

Of particular importance is a decision on the overall carbon reduction required and the reduction to be achieved on site.

Importantly, progress is being made to deliver the new solutions and the technologies required to meet these tightening standards, with demonstration projects at the BRE and delivery of exemplar schemes such as the HCA Carbon Challenge Scheme at Hanham Hall in Bristol.

Hanham Hall is one of the first large scale Code for Sustainable Homes Level 6 developments in the UK. Energy for the homes will be produced by a central energy centre for heat and electricity. The houses are fabricated using an advanced timber frame system and can harvest rainwater.

Source: Barratt Developments PLC.

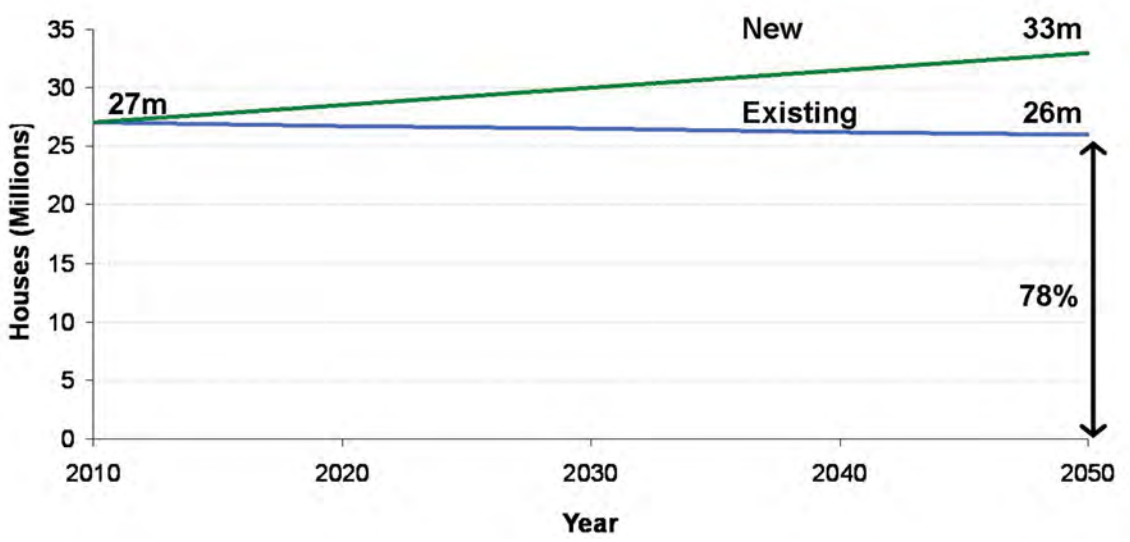
Currently, the industry is, in the main, achieving a 25% improvement over the 2006 Building Regulations standard for CO_2 emissions by improving fabric standards and use of appropriate renewable energy technology on existing house types.

A key focus for the industry is to maximise the reduction due to improved fabric performance, prior to incorporating additional technologies to meet the 44% improvement required from 2013. Trials in progress suggest that this may be achievable without the application of renewable technologies. The AIM C4 project (referred to later) is a collaborative research project looking to deliver such a result. If this can be achieved, the emissions of new homes will be reduced to 2.1 tonnes of CO_2 per annum.

While this may all be seen as encouraging, the reality is that new build, even at recovered levels of output, will have a small effect on the overall carbon footprint of housing in the period through to 2050.

Figure 5.3: New and existing domestic property projections

Even if the new build market recovers dramatically and achieves its long run average over the next 40 years, over 75% of the stock that will exist in 2050 already exists today.



Source: Barratt Developments Plc.

External estimates of the requirement for new homes by 2050 suggest an increase in total stock to around 36 million. Figure 5.3 assumes a recovery to historic build rates as it is unclear how the industry will increase above these; but if the industry did build sufficient homes to meet underlying demand, then the percentage of today's homes remaining in 2050 would reduce to about 72%.

5.2.3 Delivering new low carbon homes that are affordable

While it is fully anticipated that the costs of delivering new low carbon homes will fall, as they become mainstream and as technology delivers lower cost solutions, at present the cost of delivering a fully compliant zero carbon home is not viable. In an environment where there is both a shortage of new homes and the finance to support them, a solution is required that balances the need to reduce carbon with the cost of doing so.

As noted, the foundation for any zero carbon home must be to ensure that the fabric is delivered to a standard that minimises energy consumption. The Zero Carbon Hub has defined a Fabric Energy Efficiency Standard (FEES) which requires homes in the future to be sufficiently well insulated and adequately air-tight, and this regime is being tested through the HCA public land initiative.

Beyond this, what is needed is a flexible solution that allows for the fact that all sites are different and that at the very top end of the development size range, local renewables on a community scale could be viable. Equally, much more cost effective 'on-house' renewable energy solutions could become available in the future.

Where it is only practical and cost effective to deliver fabric improvements, the concept of a range of 'allowable solutions', including those that generate funds for either community energy solutions or retrofit of existing homes, could be very attractive.

5.2.4 The small house builder

As the energy and carbon performance of homes becomes more challenging, the complexity of solutions increases, and this has a particularly acute impact on the small house builder. They will have limited access to the technical resources needed to deliver the right solution for a given site, and the cost of regulation surrounding this will become ever more expensive. In reality, smaller builders will be reliant on the delivery of standardised solutions through the supply chain.

5.2.5 Sharing learning across the industry

The industry still has a lot to learn about how these new homes will perform, especially with inter-related issues such as summer overheating, air-tightness and indoor air quality. In reality, only when a large number of dwellings are occupied will the issues and learning really come through. Further information will also be generated by projects funded under the TSB Building Performance Evaluation competition, and its series of calls from now until 2012[10].

It is critical that the learning to date and in future are shared across the industry, to ensure the optimum solutions are then utilised to drive high volume production; and bodies such as the Technology Strategy Board must continue to support such processes.

Recommendation 5.1: That Government should publish a working nationwide definition of zero carbon and allowable solutions for new homes that takes full account of the real cost of delivery.

5.3 Existing stock

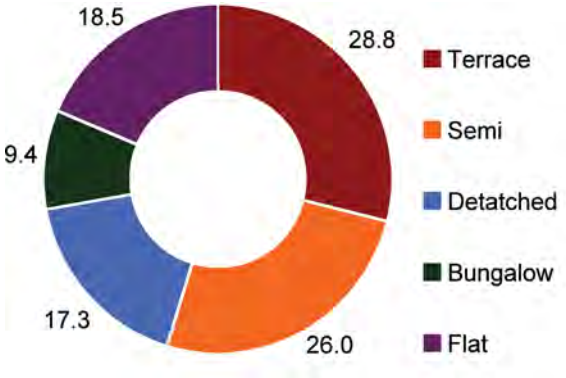
5.3.1 Background data

As at 31 March 2007 there were 26.65 million dwellings in the UK. From the English House Condition Survey 2008/9 it is possible to identify the stock composition in England by type, age and tenure.

This shows that the vast majority of homes are privately owned; that around 38% of the English stock is over 65 years old; and that despite the recent increase in the number of flats being built, they still make up less than 20% of the total.

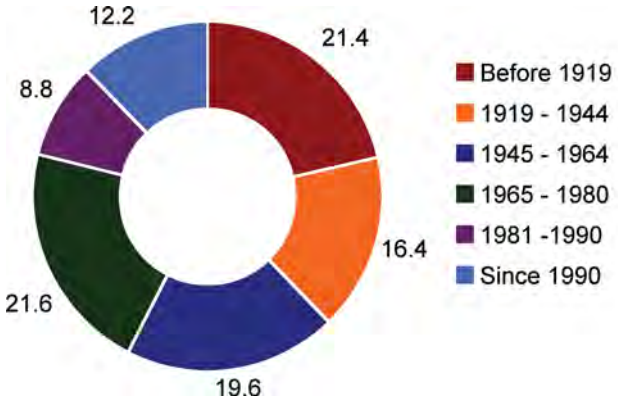
10 Technology Strategy Board, Low Impact Buildings Innovation Platform, http://www.innovateuk.org/content/competition/building-performance-evaluation-.ashx

Figure 5.4: Type of dwelling



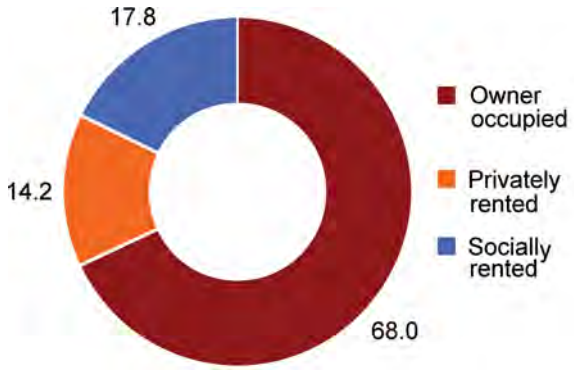
Source: English Housing Survey, 2009.

Figure 5.5: Age of existing Stock



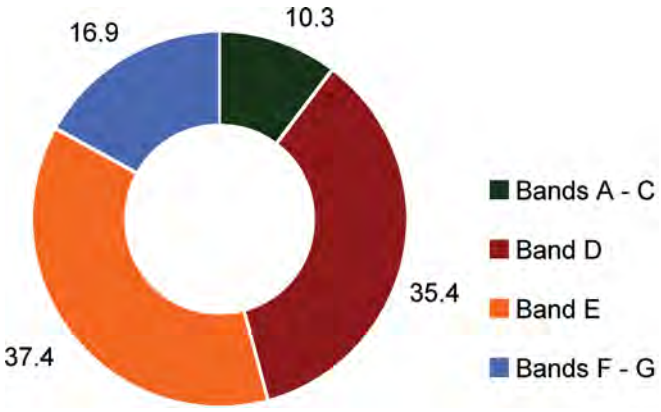
Source: English Housing Survey, 2009.

Figure 5.6: Tenure of Existing Stock



Source: English Housing Survey 2009.

Figure 5.7: Energy rating by band (2008)



Source: English Housing Survey 2009.

A large proportion of our housing stock requires multiple measures to bring it up to a 'decent' standard. This will include more expensive measures such as replacement heating systems and solid wall insulation. Provided installations continue at the currently incentivised rate, all "practical-to-fill" cavity wall and loft insulations in England and Wales are expected to be completed within 5 to 6 years.

As at 2008, the proportion of homes achieving the highest Energy Efficiency Ratings (A-C) was 10%; the majority of homes (73%) were in the middle bands (D or E); and 17% were in the lowest bands (F and G).

In April 2009, empty homes represented just under 3% of the total housing stock in England. Of nearly 800,000 empty homes in that month, just over 300,000 were privately owned and had been vacant for 6 months or longer. A number of these are likely to have fallen into serious disrepair and be beyond economic refurbishment.

In summary, the existing stock can be characterised as relatively old, its quality and condition varies significantly, and nearly a fifth is in the lowest two thermal performance bands. A large

number of "hard-to-treat" homes, primarily solid-walled properties, would need substantial investment, and whilst some progress has been made in improving energy rating, in 2007, the mean energy consumption per UK dwelling was rated as the 8th poorest across the EU27[11].

5.3.2 What is already being done?

There have been a number of schemes sponsored or required by Government, focused on improving the quality of existing housing and specifically their energy efficiency.

From 2002, the Energy Efficiency Commitment ('EEC'), now the Carbon Emissions Reduction Target ('CERT'), placed an obligation on energy suppliers to improve the energy efficiency of homes with a specific focus on vulnerable households. Measures included loft and cavity wall insulation and low energy light-bulbs. The third obligation phase was introduced in 2008 and will run to the end of 2012. This phase has an emphasis on insulation measures.

Warm Front is a Government funded scheme providing help to pay for heating and insulation improvements to privately owned or rented accommodation for more vulnerable consumers that meet specific criteria. The grants are up to £3,500 to £6,000 depending on the heating need.

The Decent Homes programme and standard ('DHS') was introduced for all property owned and managed by local councils and residential social landlords, and for grant support to vulnerable private households. The DHS is a minimum standard designed as a 'trigger for action' rather than an aspirational standard. Nonetheless, a broad range of home improvement measures has been carried out, including major repairs and improved energy efficiency.

Based on CLG estimates, the National Audit Office has reported that the total cost of all capital works undertaken by Local Authorities and social landlords on both home and wider neighbourhood improvements from 2000 to 2011 will be over £37 billion[12]. It is difficult to determine how much of this total was directed at energy efficiency in the social sector, but it includes up to £6 billion under the DHS, around a tenth of the total scheme spend of £2.5 billion under Warm Front and half of the £7 billion from the EEC/CERT obligation. In evidence to the recent Select Committee on Decent Homes, CLG estimated that by 2010, this activity would have reduced emissions by 8% from 2006 levels[13].

The Community Energy Savings Programme (CESP) has been introduced to target areas of low income. CESP targets a "whole house" approach at community scale, and is delivered in partnership between Local Authorities and energy companies. The scheme is funded by an obligation placed on the largest energy companies. It is expected to deliver £350 million

11 Odyssee database, http://www.odyssee-indicators.org/, unit consumption per dwelling scaled to EU average climate.
12 National Audit Office report HC212, "The Decent Homes Programme", January 2010
13 Beyond Decent Homes, Communities and Local Government evidence to House of Commons' CLG Select Committee, March 2010.

worth of energy efficiency measures to around 90,000 homes in 100 schemes in the most economically deprived areas of England, saving around 100,000 tonnes of CO_2 per annum.

More recently, 'feed in tariffs' (FITs) have been introduced to subsidise electricity micro-generation systems.

As announced in the Government's recent Spending Review, the Renewable Heat Incentive (RHI) will go ahead in 2011. The RHI will represent over £850 million of investment over the spending review period, seeking to drive a more-than-tenfold increase in renewable heat over the coming decade, and shifting it from a fringe industry firmly into the mainstream. In most cases, these investments would not provide reasonable payback, without some form of financial assistance or subsidy, as other forms of heat are currently cheaper.

The Government has committed to introduce a "Green Deal" to transform the uptake of energy efficiency measures in Britain as part of the Energy Security & Green Economy Bill. This will include an offer to households, and potentially businesses, of up-front finance to undertake energy improvement measures, with repayments over time offset by savings on energy bills. The money advanced will be attached to the meter, rather than the householder, and will be transferable – to a new householder in the event of a sale, or to a new energy company in the event of a change of supplier. The Green Deal therefore removes the barrier to action of someone who is inclined to improve energy efficiency but is deterred from doing so by lack of capital or by the fear that the house may be sold before the investment has been repaid through reduced energy bills.

The aim is to open up a new market in energy efficiency as energy companies, retailers and others are able to provide eligible measures for consumers supported by Green Deal financing. In parallel, there will be a new Energy Company Obligation, taking over from CERT and CESP when those schemes expire, focusing on the needs of the most vulnerable and those in hard-to-treat homes.

The work funded by these various initiatives falls within the total value of repair, maintenance and improvement ('RMI') work on existing housing stock. While this includes extensions and replacement kitchens and bathrooms, it has played a part in raising the quality of existing stock and, albeit by diversion from other RMI work, may be able to provide a source of funding going forward. Over the last three years, the RMI sector was worth an average £26.7 billion annually, of which over £16 billion was spent on private sector housing[14].

As a result of these programmes, the energy efficiency of the housing stock in England improved between 1996 and 2008, with the average SAP rating increasing from 42 to 51.

14 ONS and BIS Construction Statistics, 2010

The social housing sector was, on average, more energy efficient than the private sector, with the average SAP rating improving from 47 to 58 over the same period.

To deliver a major step change in the quality and energy efficiency of existing stock, a much more intrusive programme of 'whole home' retrofit will be required for a large number of the 27 million dwellings that exist, perhaps along similar lines to the CESP programme. While not precluding room-by-room approaches, a whole-house approach is likely to be more cost efficient – but there are considerable practical and financial barriers that are likely to limit the opportunities for this becoming the norm. This is considered further in section 5.5.4 of this chapter.

As part of the solution, it is also possible that an even more intrusive solution will be required in particular areas of very poor quality housing, involving a major new-build replacement programme.

Source: BRE National Refurbishment Centre, 2010.

There are now a number of demonstration projects addressing a more fundamental refurbishment of existing stock, with some already producing results. In the natural order of things, though, they have different sponsors, employing different teams who are trialing different technical approaches. Many buildings go un-monitored after the work, so that the efficacy of the measures in reducing energy consumption is untested; and organised feedback is only occasionally available to those who might follow.

It is vitally important that, to the greatest practical degree, the learning from everything that has been delivered to date and the work going on at present and hereafter is brought together to inform the right strategy for delivery, based on proven performance data and the practicalities of execution.

This must answer questions such as 'whole house' or 'measure by measure', 'street by street' or 'whole community', refurbishment or rebuild and what approach delivers the lowest cost result. Given the role of the customer or landlord in this decision process, and the impact on both, there can be no substitute for learned experience.

Recommendation 5.2: That further refurbishment pilots and trials should be encouraged, including through greater collaboration and monitored throughout to increase learning and experience and ensure the right roll-out strategy is delivered.

5.4 Setting the targets going forward

5.4.1 The challenge for the housing sector

Alongside EU and international climate change targets, the Climate Change Act (2008), commits the UK to reducing greenhouse gas emissions by 34% from 1990 levels by 2020; and to an 80% reduction by 2050. To achieve these targets, the household sector will need to reduce direct (i.e. non-traded) CO_2 emissions by 29% on 2008 levels by 2022, which equates to 24 $MtCO_2e$.

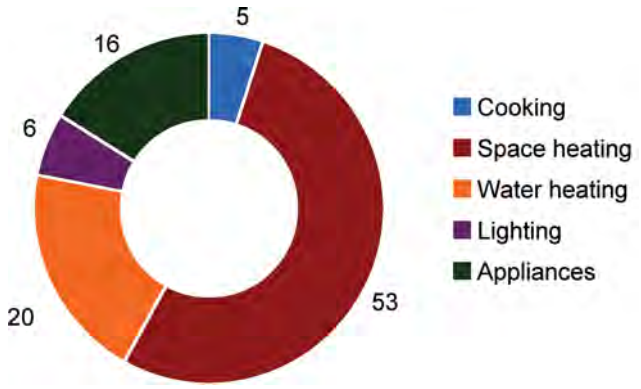
To ensure that a workable delivery plan is produced, and the opportunity for the industry is seized, it is important to understand what this means for the housing sector – and specifically for the existing stock, given the regulations proposed for new build.

5.4.2 Current sources of emissions and carbon reduction results

Of the total annual housing-related emissions of 146 million tonnes of CO_2, around 65 million tonnes is indirect, relating to electricity consumption. It is therefore, necessary to start with an understanding of what can be achieved through decarbonisation of the grid.

In addition, the cumulative benefit of new dwellings, as an increasing proportion of stock adding little or no carbon emissions, needs to be taken into account.

Figure 5.8: Domestic carbon emissions by source (2005)
Average household emissions 5.64 tonnes CO_2 per year
An analysis of total emissions shows the current make-up from household activities.



Source: Building a Greener Future: policy statement, DCLG, 2007.

5.4.3 Carbon reduction results

Drawing on whole British housing stock modelling work carried out by the Energy Saving Trust for this review, using their Housing Energy Model[15], it is possible to gain some indication of the likely effect of grid decarbonisation, zero carbon new build[16] and various energy efficiency measures to existing homes, including those built up to 2016. Figures 5.9A and B show the effect of applying these measures[17], first with a medium (50%) level of grid decarbonisation (figure 5.9A), and secondly with the grid decarbonising to 3.5% of its current level as predicted by DECC[18] (figure 5.9B).

The scenario presented by figure 5.9A achieves a 42% reduction from 1990 levels by 2050, and figure 5.9B achieves a 66% reduction.

Figure 5.9A

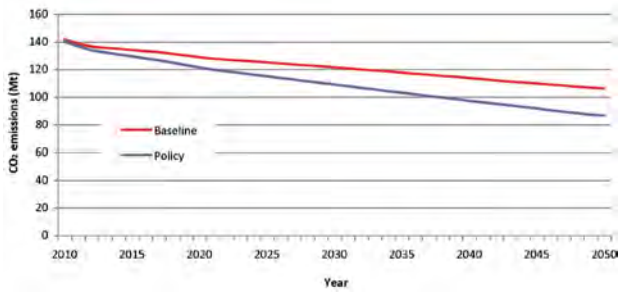
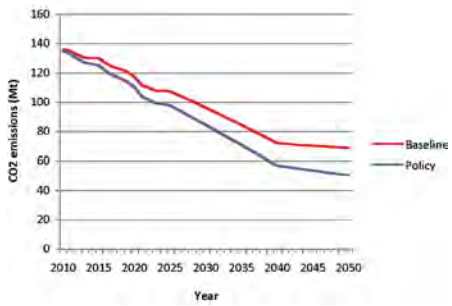


Figure 5.9B



15 Energy Saving Trust website, http://www.energysavingtrust.org.uk/About-us/What-we-do/Strategic-research/Housing-Energy-Model
16 The Government's Zero Carbon Homes policy for England is assumed to take effect in 2018, allowing two years for the lag between building regulation approval and actual construction of homes. Homes built after 2018 are modelled as having a 100% reduction in regulated emissions, but still emitting unregulated emissions.
17 A list of all energy efficiency measures applied can be found in Appendix X (these are on the summary page)
18 DECC electricity emissions factors. Table 1 of the supporting document for Valuation of energy use and greenhouse gas emissions for appraisal and evaluation – June 2010

In each case, the red baseline indicates the CO_2 savings that could be made without action to drive uptake of energy efficiency measures. It does, however, include measures installed as part of the normal churn of home upgrade and improvements.

Whilst these scenarios provide an insight into what may be achieved, current trends in energy behaviour show people are heating their homes to higher temperatures ("comfort taking") and increasing the use and size of their appliances, causing higher energy and CO_2 emissions which will offset some of the savings from improved efficiency. By 2050 some of this will be offset by a warmer climate and the need to heat our homes less, but overall the target becomes much more challenging (Figure 5.10A) despite the rapidly decarbonising grid – once again demonstrating the interplay between technology, the carbon intensity of its energy source and behaviour.

Figure 5.10A

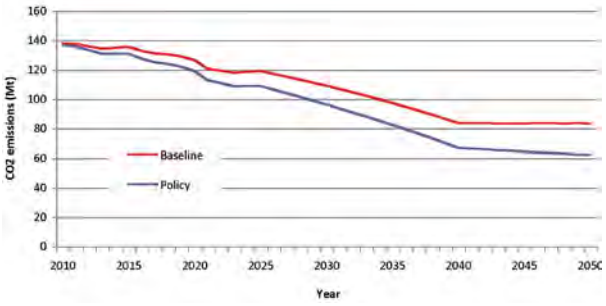
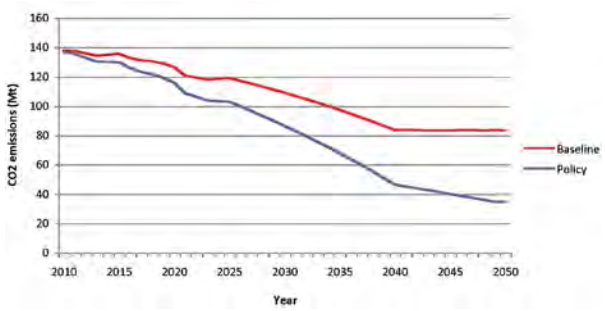


Figure 5.10B



This reduces the improvement in emissions achieved from 66% to just 58% – well short of the 80% target. To improve performance further from the housing sector would require substantially more to be invested in low carbon heat and energy solutions, alongside energy conservation measures. Figure 5.10B shows this is possible, obtaining a 77% reduction, but it would require substantial investment in heat pumps, biomass boilers, community CHP for apartments and solar thermal installations. The cost of achieving this at current prices will be prohibitive, so to achieve these sorts of outcomes, costs would need to fall substantially.

While the scenarios run above are helpful in pointing the way, there is a need for much more robust and accurate modelling to ensure that the implications of the targets are understood.

For more details on the modelling assumptions used in these scenarios, see box 5.3 at the end of this chapter.

Recommendation 5.3: That a consensus on both modelled and actual performance improvement data should be established from the various previous and current studies, through a knowledge-sharing process, to inform what actions need to be taken to deliver the overall target.

5.5 The new opportunity for the industry – The retrofit market

5.5.1 The existing retrofit market

Three types of organisation participate in the retrofit market today: large, specialist providers who deliver larger scale services directly to the social housing sector; large home improvement providers who focus on heating, double glazing and insulation services; and a growing number of smaller traders that focus on general improvement work in the private housing sector.

B&Q are preparing to enter the market to deliver "end-to–end" customer solutions under the Green Deal. This will include surveys, product solutions – including insulation, heating & micro-renewables, and installation services[18].

Source: B&Q Working Together Delivering the Green Deal, 2009.

As of today, there are very few providers marketing integrated, "whole house" refurbishment, although there are a number of potential new entrants examining the opportunity, including retailers such as B&Q, British Gas, Marks & Spencer and Tesco.

For harder to treat homes that require internal/external insulation, there are currently very few suppliers considering a customer offer.

The material/solution supply chain comprises a number of both large and small suppliers, especially in the area of insulation and heating. Perhaps the greatest challenge is to find lower cost and less intrusive treatments for solid wall insulation in individual houses, such as the pre-fabricated approaches that have been developed on the continent for apartment blocks[20].

19 Kingfisher B&Q presentation to IGT Housing Group, June 2010
20 International Energy Agency, Energy Conservation in Buildings and Community Systems Programme, Annex 50 project, http://www.empa-ren.ch/A50.htm

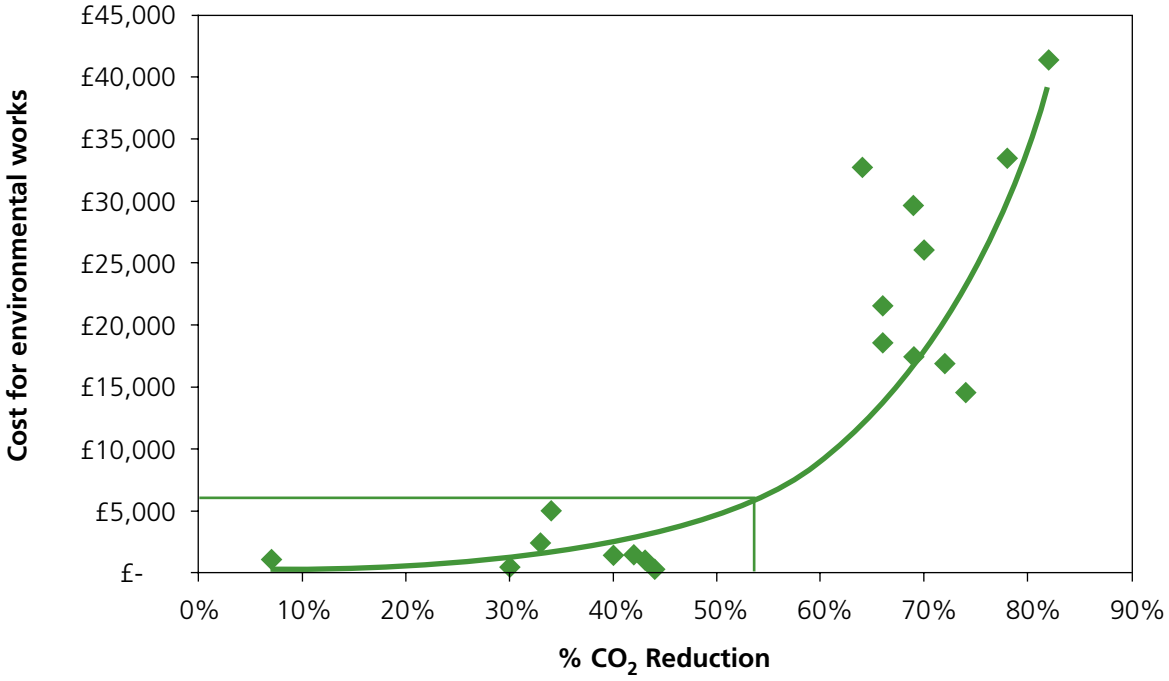
5.5.2 The scale of the opportunity

Depending on the scale of work required, which will be defined by the level of reduction targeted and the market response, the investment required to deliver the step change in emissions from existing stock will vary widely.

The key elements will be the extent to which solid-walled homes are dealt with, the rate of replacement of windows and heating systems, and the level of on-site investment in renewable technologies. It is assumed that a typical refurbishment, of the predominant house type, will include loft and cavity wall insulation, the installation of more efficient heating systems and controls, and general improvements in air-tightness.

Figure 5.11: Cost of environmental works vs CO_2 reduction

Based on actual results from the various demonstration trials run, the range of outcomes is very wide.



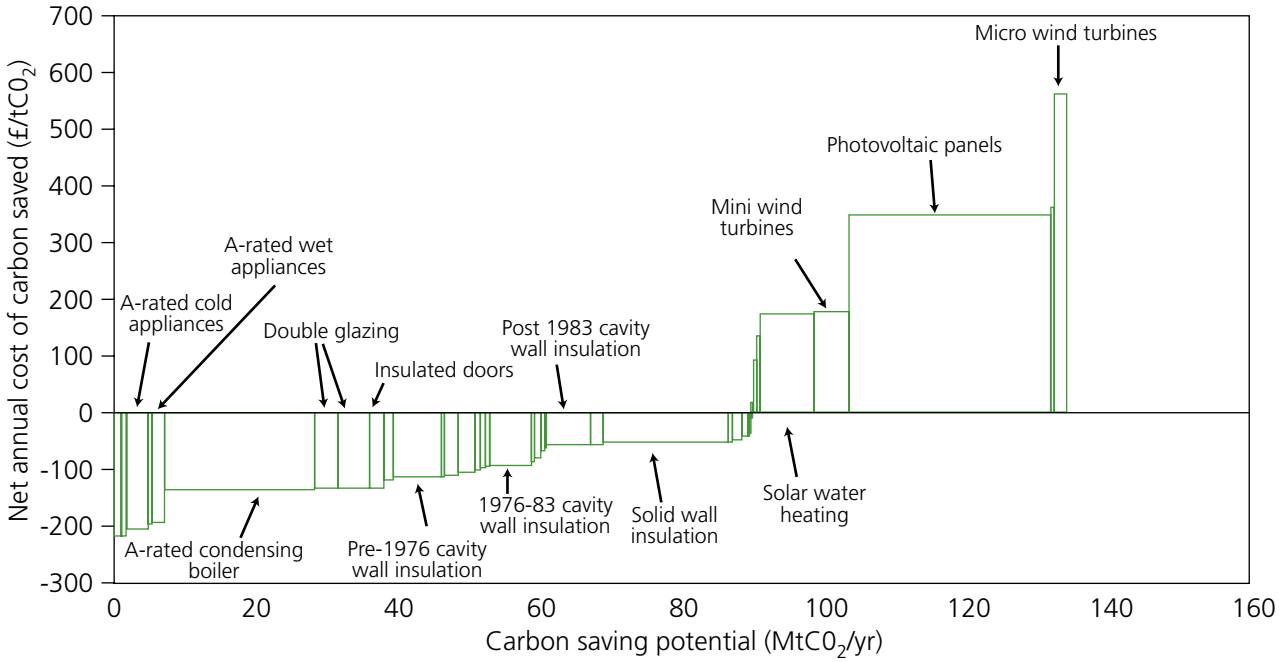
Source: House Builders Federation, The Outlook for New Home Building, 2010.

In our initial findings, based on reviewing some of the studies by others to date, refurbishing the fabric and gas-boiler heating system of an existing dwelling could cost between £2,500 and £15,000, depending on its type (apartments to semi-detached houses), base condition and structural form, obtaining a 50% to 74% reduction in regulated CO_2 emissions[21]. Sums of up to £35,000 per house have been quoted to obtain 80% or higher reductions[22]; much of the cost uplift to achieve this level of reduction being associated with "on building" micro-renewables. There are significant variations around this sum, depending on whether the approach is whole house, piece-meal or the concurrent installation of a package of measures.

21 Sustainable Refurbishment of the Existing Housing Stock, Interim Working Group Report, The Housing Forum, April 2009
22 Sustainable Refurbishment of the Existing Housing Stock, Interim Working Group Report, The Housing Forum, April 2009

Cost effectiveness of treatments will be critical, and given the range of possibilities and the range of payback periods applicable to individual measures, so will the need for reliable data and a trusted source of advice.

Figure 5.12: Cost-effectiveness of CO_2 emission savings in the existing stock
This figure shows the significant variation of cost of carbon abatement depending on the measures installed.[23]



Source: BRE Trust Report 2010.

How far households should be motivated or required to go must therefore take account of the reality of the current financial constraints and the key principle of minimising the cost of carbon abatement.

Based on the limited analysis of the information available today, it would be reasonable to assume that an overall investment of around £200 billion (at current prices, at a crude mean of £7,500 per dwelling) would be required by 2050 to deal with the fabric of homes, without any implementation of local energy solutions. This should deliver around a 60% reduction in regulated CO_2 emissions.

To minimise the cost of such an investment programme, standardised solutions must be delivered, properly demonstrated, and tested. This will require collaboration across the supply chain for product, installation and service. There are a number of social housing projects that would provide useful evidence of the benefits of such an approach.

23 'Energy efficiency in new and existing buildings: comparative costs and CO_2 savings'. Fiona MacKenzie et al, BRE Trust Report FB26, BRE Press, 2010.

Another way of analysing the investment required is to work from the UK Housing surveys and other recent surveys of installed and potential measures[24].

This would suggest the need to complete the technically and economically feasible portion of:

- solid wall insulation to 6.4m homes
- the cavities of between 6.5 million and 8.6 million homes estimated as unfilled[25] (including 3.9-5.8 million described as "hard-to-fill"[26], 1.6 million of which may be impossible[27]), plus a possible 4 million non-traditional homes, 2 million of which may be partially filled[28]
- full or partial window replacement on up to 6 million homes
- high efficiency boilers to 15.5 million homes
- some or better heating controls to 15 million homes
- full or additional loft insulation in 9 to 13 million homes[29, 30]

Based on current experience, this would equate to an investment of around £140 billion for England alone; and, if extrapolated for the whole of the UK, suggests an investment of around £170bn.

On this broad assumption, the value of new business to the construction industry (in its widest sense) could be around £5 billion per annum for 40 years.

5.5.3 A route map for the domestic retrofit

It is important that these broad estimates are further validated from practical experience, and that a detailed route map to 2050 is produced that lays out the broad programme of work required. This is by no means a simple process. In order to make a start adequate to demonstrate the scope of the exercise, and to inform the thinking of the IGT, a workshop was organised by the Energy Efficiency Partnership for Homes, supported by the UK Green Building Council and attended by a wide cross section of interested parties. The workshop was founded on a literature search conducted for EEPH, and an outline route map drawn up for the IGT.

24 2050 Route map for energy efficient housing, Summary report of evidence base – v1 draft, Purple Market Research for Energy Efficient Partnership for Homes, Sept. 2010
25 Estimates from; EST, Nov. 2010, based on GB housing surveys and installations under energy supplier obligation schemes since 2001, and Reference 17.
26 Davis Langdon and Inbuilt, Study for DECC on hard to fill cavities in domestic dwellings in GB, October 2010, page 9.
27 Cavity Wall Insulation technical potential estimates to BIS, from Cavity Insulation Guarantee Agency via National Insulation Association, November 2010
28 Estimates from; EST, Nov. 2010, based on GB housing surveys and installations under energy supplier obligation schemes since 2001, and Reference 17.
29 Estimates from; EST, Nov. 2010, based on GB housing surveys and installations under energy supplier obligation schemes since 2001, and Reference 17.
30 Cavity Wall Insulation technical potential estimates to BIS, from Cavity Insulation Guarantee Agency via National Insulation Association, November 2010

Both the report on evidence drawn from the literature search and a report on the workshop can be found on the websites of the Energy Efficiency Partnership for Homes (www.eeph.org.uk).

The current draft of the route map is appended at the end of this chapter, and it now needs to be developed to the next level of detail to take account of the following:

- a range of programmes designed to incentivise take-up by consumers
- an estimate of the volume of retrofits to be incentivised, by whatever means, showing the gradient of take-up over the 40 years – effectively, milestones upon which the industry can be sighted
- policy development and the passage of any necessary legislation
- data collection and research into the nature and condition of all of the stock to be treated, as a basis for developing informed propositions for treatment
- a fuller understanding of the external but related factors that frame the retrofit, including plans for de-carbonising the grid, the impact of smart controls etc.
- a working assumption of the "pattern book" of costed measures that could be applied to categories of dwellings of similar construction and condition, considering both the individual measures and the options for execution, from piecemeal (or "room by room") to "whole house" (see section 5.5.4 below)
- the commissioning of, and feedback from, demonstration or research projects designed to test the efficacy of proposed measures, and the logistics of implementation
- feedback from post-implementation evaluation of homes
- the development of the necessary tools and methodologies for measuring carbon, modelling building performance etc.
- the identification of adequate funding streams
- the development of new and additional skills and resources for surveys and diagnostics, the prescription of appropriate treatments, and the certification of the work to confirm compliance
- the creation of an enlarged supply chain adequate to deliver the work, including the development of new products and services
- skills training throughout the supply chain
- the development of accreditation schemes to underpin consumer confidence

Recommendation 5.4: That the industry and Government should develop the very preliminary route map drafted by the IGT into as detailed a plan of action as possible, looking at what needs to be delivered and how.

5.5.4 "Room by room" or "whole house"?

In considering the practical means of bringing the energy efficiency of the existing housing stock up to the standard that will be required to achieve the 2050 target of an 80% reduction in emissions, two extremes are advocated:

- a piecemeal "room by room" approach, which works with the cycle of repair and maintenance work required over a dwelling's lifetime
- or a "whole house" approach which implements a full package of measures, including everything contemplated as necessary to achieve the 2050 target, as a single operation

The first has the advantage of working with a cycle of work that would probably be carried out anyway, and spreading both the cost and the disruption over time.

The second has the advantage of concentrating the disruption, and reducing the cost of the total package of measures applied. It does, however, require the capital to be found (or borrowed) at one time; it could involve replacing an element that still has the potential for some years of adequate performance (hardly itself an energy efficient move); and it assumes that, at the point of executing the work, we know what a "whole house" package of effective measures would be – and that those measures all represent cost effective ways of reducing emissions at the time.

There are also grounds for saying[31] that a piecemeal approach locks in sub-optimal solutions, and thereafter makes it difficult or impossible to make further improvements.

As ever where two such extremes exist, and particularly given the scale of the stock to be treated, the answer is likely to cover both extremes and a wide range of possibilities between. The advantage of researching the "whole house" approach at this stage (as in the TSB *Retrofit for the Future* programme, and ETI's *Optimising Thermal Efficiency of Existing Homes study*) is that, as long as it is organised and monitored in the right way, the cost and contribution of each element of the treatment can be identified. Fundamentally, though, the two extremes can be reconciled by researching all of the implications (technical, logistical, financial etc) of each element of a full package of measures, so that an optimal solution can be developed for each building that balances these factors.

Given that, for many householders, the starting point is likely to be a package of measures financed by the Green Deal, there is also a degree of pragmatism in the phased approach. This also leaves room for part of the improvement in performance to met, more effectively or at lower cost, by innovations still to come.

31 See, for example, article by Diana Ürge-Vorsatz of the Centre for Climate Change and Sustainable Energy Policy at Hungary's Central European University

The one qualification to this would be if a "whole house" solution would be quite different technically from a progressive approach, and would be either far more effective or far less costly in reducing emissions. If, for example, a full whole house solution were, using existing technology, capable of increasing the energy performance of the building to the point at which a heating system is never or rarely required, then the contribution that this would make to increased comfort, reduced energy demand and reduced fuel poverty would be compelling; and this would argue against any piecemeal approach that denied that opportunity in the future without wholesale re-work.

For the industry, the challenge is to identify the packages, phased measures, and their logical sequence and timing to minimise cost and disruption, and to fit a practical cycle of repair and maintenance.

5.5.5 Product manufacturing in the UK

Today, approximately 80% of the materials and components used in construction is sourced from UK manufacturing facilities.

By taking a lead in the transformation of low carbon existing homes and zero carbon new homes, given the need for locally sourced material and installation, it is more likely that suppliers will retain or base their factories in the UK, creating employment and inward investment, provided there is sufficient evidence of a long-term market. There may be only a limited window of opportunity for this: the UK will procure solutions from overseas if R&D, leading to production, does not take place before strong demand arises in the home market.

Indeed, there are parallel opportunities outside the UK market. An 8-country EU market study of the northern European housing stock and renovation opportunities found there are 15 million solid-walled dwellings in France (over double the total in the UK), and 84% of which remain uninsulated[32].

5.6 Creating customer demand

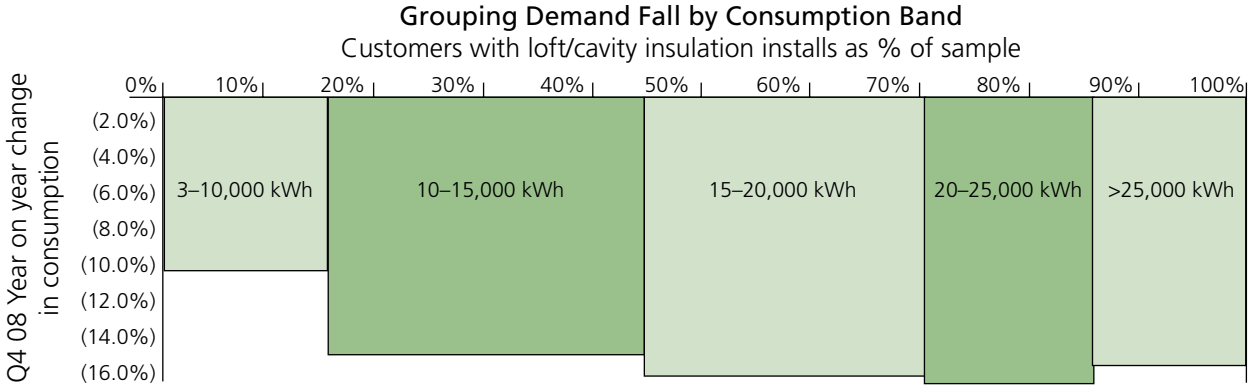
5.6.1 The barriers to take-up

While the schemes that have operated to date have enabled customers to address the lower cost opportunities that were available, a step change is now needed in the scale of delivery. The focus will need to shift to more expensive and disruptive measures with longer payback periods, such as solid wall insulation, novel heating systems, micro-generation, and to offering householders a holistic 'whole house' package.

32 Towards a sustainable Northern European housing stock, Itard, L. and Meijer, F., Delft University of Technology Report to European Construction ERA-net, Erabuild, 2008

Figure 15.13: Demand fall by consumption band

Research carried out on 4 million customers that had invested to reduce their energy consumption showed a healthy reduction in usage.[33]



Whilst higher consumers see greater savings, proportionally fewer are installing insulation products, reducing the consumption impact in these bands. This gives potential for greater falls if more high consumers begin to install insulation.

Source: British Gas, The role of the energy utilities in delivering the HEMS and the effectiveness of energy efficiency measures and advice.

Energy Saving Trust research shows that households have a positive attitude towards cutting their household bills through saving energy. The recent increase in energy prices has been shown to make people more aware of their behaviour and has brought about an increase in both interest in and installation of energy efficiency measures.

However, there are still barriers that prevent householders from going further. These include:

- householders do not know what to do, or where to go for reliable advice
- they cannot afford the upfront cost of the measures (34% of customers will not fit cavity wall insulation because they think it is too expensive)
- others don't believe the putative savings
- the financial payback periods are often too long
- the savings involved are too small to overcome the disruption involved (37% of consumers who could install loft insulation fall into this category)
- there are, irrespective of cost, concerns over the intrusive nature of the work (62% of customers with solid walls fall into this category)
- there are concerns over the health and comfort effects of air-tightness and over-heating;
- some householders just aren't interested

Recommendation 5.5: That Government, in formulating the Green Deal customer offering, should take full account of all relevant current trials, customer research and feedback from Energy Companies and Retailers.

33 British Gas, communication to Housing IGT Group, 2010

5.6.2 Creating demand by motivating households to act

To maximise take-up of measures, householders must be motivated to act. Different consumers are likely to respond to different propositions and a one-size fits all approach is unlikely to work.

Experience to date suggests that customers are much more motivated by increasing the comfort of their home and saving money, than by the idea of saving carbon. While over time the concept of carbon reduction may become main-stream it is unlikely to take hold for some time. Further research into interventions which can lead to the modification of attitudes and behaviours is required.

A key ingredient to a decision to act will be expectations around future energy costs. Government estimates suggest that by 2020, domestic electricity and gas prices will have increased by 30% and 37% respectively, and by 88% and 46% by 2050.[34]

To help get away from technical terminology and create a clear message about the benefits of living in a new home that is zero carbon, the ZCH and Energy Saving Trust produced a marketing strategy called *Marketing Tomorrow's New Homes*.[35]

As a new programme, the Green Deal will be an unfamiliar concept to householders so it is crucial that customers understand what the scheme is, where to go to take it up, and that every aspect of it is trustworthy. This will require investment in the overarching brand and the consistent promotion of standard messages. Trust in products, services and providers can be further developed through certification and accreditation schemes.

Many potential customers may consider the disruption suffered in taking action outweighs the benefits. It is therefore important that the Green Deal offers the opportunity of a seamless customer experience, with minimum effort. The Green Deal could be accessible through a range of providers including energy services companies, retailers, housing associations and Local Authorities; and greater trust is likely where the offer is made locally.

A technology-impartial adviser could perform the survey, which should be free to encourage maximum take-up. This adviser could ideally possess a combination of technical skills, to provide accurate credible assessments, and interpersonal skills, to engage with the householder and give them confidence to take action. Advisers should be accredited to a minimum standard.

34 DECC/HMT Guidance "Valuation of energy use and greenhouse gas emissions for appraisal and evaluation", June 2010

35 Marketing Tomorrow's New Homes – raising consumer demand for low and zero carbon living, Zero Carbon Hub and Energy Saving Trust, February 2010, http://www.zerocarbonhub.org/consumer.aspx

5.6.3 Going beyond the Green Deal

Unless there is far more certainty of demand, the construction industry will be slow to invest the funds needed to deliver the scale of activity required. It is therefore imperative that a whole host of other steps are taken that provide more confidence that demand will increase.

This will inevitably mean the introduction of a range of fiscal and regulatory measures to encourage/require the right action to be taken. It is envisaged that the measures would be fiscally neutral and introduced over time, so that the customer is encouraged to act sooner rather than later.

These could include:

- stamp duty increases or reductions dependent on the energy rating of the home when sold
- Council Tax rebates or increases related to the energy rating of the home
- utilisation of smart meters to incentivise energy usage reduction through tariffs
- Building Regulation changes that would require upgrades to energy efficiency before any other changes could be made to an existing dwelling
- regulation of the private owner occupier and rented sector
- incentives for RSLs/Local Authorities to bring forward Social Housing programmes
- VAT reductions on energy saving measures carried out alongside general maintenance or upgrades to the home

The Energy Performance Certificate would need to be enhanced to provide a basis for a number of these actions, and this would require investment in RSAP software updates, to deliver the right options for each home. However, this should not be seen as an obstacle to action.

The private rented sector should also be able to benefit from the Green Deal initiative; but, over time landlords should be required to invest in their properties to ensure they meet energy efficiency standards as part of their 'licence to operate'.

Consideration needs to be given to how more comprehensive schemes can be used to draw in consumers, such as street by street or whole communities. Apart from the obvious savings in cost that would result, there could be considerably less resistance to a scheme where there is collective participation.

Recommendation 5.6: That Government, in addition to the Green Deal finance package, should introduce a suite of measures including regulation, fiscal incentives and penalties are delivered to ensure success.

5.6.4 Financing the investment

Given the need to deliver a compelling set of propositions to customers, to deal with some of the more expensive "hard-to-treat" homes, and to protect those in fuel poverty, funding will be required to make this happen. Consideration should be given to the following sources:

- savings by customers from lower fuel bills, at current or projected prices
- continuation of the supplier obligation beyond 2012
- 'piggy backing' repairs and maintenance spend on social housing (covered later)
- the use of allowable solution funds generated from new build housing
- higher property valuations or rental returns as a result of improved energy performance

Work is already under way with the RICS to establish how the benefits of living in an improved home might be reflected in the valuation.

In addition, to control the "leakage" of any Green Deal funding, loan default costs must be minimised through pro-active management by energy companies.

5.7 The role of engineering and technology in delivery

Meeting targets for carbon reduction whilst improving the overall performance of UK housing will require a step change in the development and deployment of new technologies and production processes.

5.7.1 New Build

The UK housing industry has long been conservative in its approach. This has been exacerbated by consumer preference, planning regimes, low numbers of new homes and a very fragmented industry.

Evidence from other parts of the world demonstrates that major benefits can be gained from innovation that focuses on an engineering-systems approach to design and construction.

Japan has decades of experience in producing high quality manufactured housing incorporating new technologies and production systems that meet individual purchaser preferences.

Given the constraints, it would be easy to dismiss such a radical change for the new build industry, but there are critical lessons which should and already are being applied by some companies. These include:

- more collaboration between developers, suppliers and research organisations
- a greater focus on engineering and design, looking at systems (rather than component) solutions
- advancing on site and off site manufacturing processes

The aim of such changes is to deliver homes more quickly, to a higher quality and to meet new code standards at lower cost. An example of such collaborative research, development and demonstration is the AIMC4 project, aimed at achieving level 4 of the Code for Sustainable Homes energy requirement through fabric measures alone (see Box 5.1).

Box 5.1 AIM C4

What Is It?

- **A**pplication of **I**nnovative **M**aterials, Products and Processes to Meet Code for Sustainable Homes Level **4** Energy Performance without Renewables and at Code 3 Cost base.
- Build Partners – Barratt Developments, Crest Nicholson PLC, Stewart Milne
- Manufacture Partners – H&H Celcon (Aircrete Blocks), Stewart Milne (Timber Frame)
- Research & Technical Partners – BRE, Oxford Brookes University

How Will We Achieve Our Goals?

- 3–5 year project (1 year complete)
- Investment – £6.3 million
- TSB (Technology Strategy Board) Grant – £3.2 million
- Each Developer to construct minimum of 4no. houses each
- Key Aspects:
- Technical analysis of current housetypes
- Identify technology and product 'gaps'
- Sandpits (Supplier Forums) – Innovation and incubation
- Planning, detailed design and financial analysis
- Construction – productivity and waste monitoring
- Post Occupational Evaluation – Monitoring performance

5.7.2 Retrofit

Many of the technical solutions needed to satisfy energy reductions are available now but are often not priced at levels that would allow mass deployment, partly because of the labour-intensive processes required.

There is considerable cross-over between new build and retrofit in areas like windows, heating systems and insulation solutions.

However, there are specific challenges with retrofit in dealing with solid walled properties. Here the requirement is for ultra-high performance, easily applied insulative coating for internal and external purposes, systems solutions for apartment blocks, and engineered solutions that can be deployed in high volumes with limited failures.

To deliver these, the prime driver will be high volume. This will stimulate innovation, and comprehensive installer guidance.

5.7.3 Simulation and modelling in design and engineering

The investment in design processes and in computer modelling and the simulation of building performance and environmental impact needs to be embedded. For example, modelling physical attributes such as solar-gain and cooling loads is essential if energy use is to be reduced.

5.7.4 Design for manufacture, assembly and upgrade

Very little use is currently made in the UK housing industry of design and production techniques that have proven benefits in other industries. Future-proofing and design for subsequent retrofits is a further important area, well understood by other sectors. Components need standardised interfaces and protocols to make this practicable.

Process improvements to increase the quality, and reduce the cost, time and disruption of building refurbishment are also key.

5.7.5 New materials

New materials will be required that have the dual benefit of providing long-lasting easy-to-maintain buildings that conserve energy, whilst reducing the amount of embodied energy in their production. This will include new types of insulation material, particularly for solid wall retrofit, and heat storage technologies to take advantage of solar-thermal heat opportunities.

5.7.6 Renewable energy technologies

At present small scale renewable systems are expensive relative to the return they provide without subsidy. Maintenance costs need to be reduced substantially and solutions need to become more mainstream that can be integrated into the build process without looking like a retrofit product. Some renewables technologies need to be modified to deal with the particular challenges of the UK market, such as higher flow-temperature heat pumps.

The challenge and opportunity for the renewables industry is to produce ‘on/in house’ solutions that replace existing heating technology with energy generation from renewable sources at a similar cost.

5.7.7 Smart controls and smarter city technologies

The ability to measure, monitor and manage the use of energy, water and other utilities in homes can be provided through the use of smart metering and intelligent control systems in individual houses and multiple units. These can enable householders to understand and

influence their use of resources in a transparent manner, and could facilitate different charging mechanisms in the future.

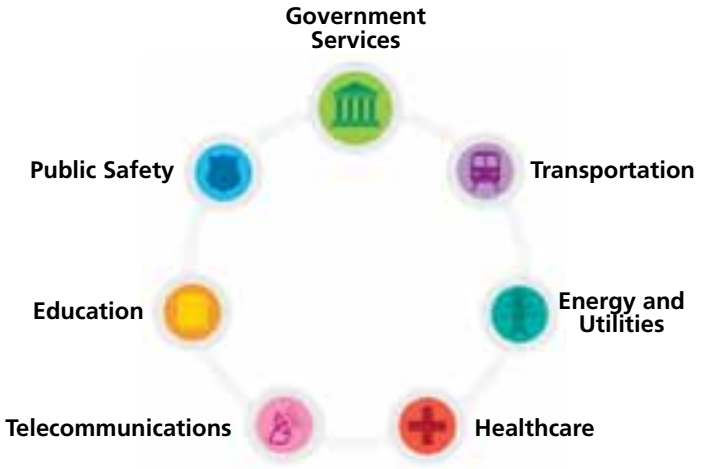
A spectrum of control interventions can be implemented, ranging from programmable thermostats with temperature setting according to the time of day, through to zoned occupancy detection for both heating and lighting control, variable-speed heating pumps and control strategies which include external temperature and light measurement.

Current intelligent controls can learn user behaviours and preferences, and offer web monitoring and tele-control from home computers and hand-held devices such as i-Phones. Further opportunities for energy saving will be available by integrating ventilation control functions, such as air-source heat reclaim with recovered heat routed to a hot water system.

Significantly, while these systems can reduce the energy consumption of individual dwellings, they can be integrated with greater benefit into whole district systems. This could have the benefit of reducing peak loads on power grids and generating stations.

Utilising smart sensor/controller networks, it would be possible to optimise the use of community heating and power or the use of micro-renewable energy systems.

To meet the challenge, man-made systems must come together and interact with one another



providing needed services to create an economically sound environment and improving the quality of life for all

An example of the new systems-wide approach is seen in IBM's Smarter Planet strategy. This involves pervasive sensing of energy, utilities equipment, services, transport and other city systems, creating data that in near real time, enabling performance to be assessed[35].

5.7.8 Planning

Planning policy is out of scope for this study, but future energy efficiency treatments to both new build and retrofit will clearly need to secure permission from the planning process.

This applies to different finishes (for example, brick-slip or timber cladding, or panellised systems), to increased product consistency and to the need for more flexibility when allowing for 'mass market' solutions.

This could all be supported by the use of better modelling and simulation technologies to help visualise the end result; or there could be a waiver or presumption of consent for some works – as for micro-generation systems currently. As we move towards a process that places the responsibility on local civic leadership, it is important that low carbon solutions are recognised as positive.

5.7.9 Appliance technology

Given one of the key challenges is the percentage of energy usage in the home from appliances, rather than heating, this could usefully become an area of focus for better technology applications or tighter regulation. Regulation in this area is currently set at a European level through the Eco Design Programme.

Recommendation 5.7: That the industry should establish a Platform or Panel with public-sector funders, to form a collective view on strategic research, development and deployment priorities, creating and owning a Strategic Retrofit Research Agenda.

5.8 Using the public sector to kickstart delivery

There is a significant opportunity to use the public sector to help kickstart delivery, to provide scale and greater security of demand.

5.8.1 Localism

The Coalition Government's localism agenda places with individual local authorities both the opportunity and the responsibility to take an overview of the energy efficiency of the entire stock within their area, and to use the planning system (and their own land) to provide the

36 IBM Institute for Business Value – Executive Report- A vision of smarter cities – GBE03227USEN.PDF

leadership necessary to achieve cost effective retrofit at scale. This could be extended as a specific objective of Local Enterprise Partnerships to promote an 'inter Local Authorities' approach to retrofit. The industry is, however, clear that any standards set for low carbon homes should have nationwide application, so that products and designs can be developed with the confidence that the market is national, taking full advantage of standardisation, offsite fabrication and economies of scale.

Local Government should be encouraged to play their role in the following key areas:

- acting as the authoritative voice and trusted intermediary when retrofit schemes are offered by energy companies or retailers
- providing an analysis of existing housing stock to ensure the maximum benefit is delivered by investment
- co-ordinating area-based approaches, including street-by-street or whole community and community energy solutions
- providing the key drive to improve social housing, whether directly owned or through residential social landlords
- enabling fiscal incentives and penalties through council tax banding related to the energy performance of individual dwellings

The public sector can provide the leadership, delivery framework and professional expertise necessary to create a mass market for standardised, validated retrofit treatments. In addition, the majority of public sector stock is held by relatively few landlords. This will drive down unit costs and provide a compelling commercial case for private landlords and home owners to follow suit.

5.8.2 The cost of the social housing retrofit

There are 4.5 million social rented homes in England which could cost an average £7,500 per unit (in a range of £3,000 to £10,000) to retrofit, to achieve a 60% reduction in CO_2 emissions from regulated energy (or £10,000 to £35,000 to achieve 80%).

To date, work on the existing public sector stock has focused on the Decent Homes Standard rather than energy efficiency, but an estimated 8% of the social stock will not have reached that standard by the end of 2010. This presents a potential opportunity to incorporate enhanced environmental standards into the works that need to be carried out on some of this stock, possibly using the existing supply chain.

At an estimated average unit cost of £7,500, the existing social stock will cost some £35 billion to bring up to a 60% target by 2050. Some £400 million of capital expenditure a year is currently spent on maintaining and improving the existing social stock, and some of this

could be diverted to energy efficiency. In addition, the following can contribute to funding or reducing the costs of retrofit:

- supplier obligation
- benefits of scale of procurement
- additional rental income that takes account of lower energy bills
- additional public sector investment, linked to changes in funding options
- allowable solutions from new build

5.8.3 The role of central Government

The HCA could help to orchestrate and accelerate a programme of locally based but large scale public sector retrofit by:

- working to aggregate investment to generate economies of scale
- facilitating the implementation of CERT/CESP to reach social landlords
- working with local authorities to ensure a transparent set of standards are in place
- making links with institutional investors and energy supply companies designed to attract funding for the programme as a whole

This should be supported by a comprehensive roll-out programme that gives everyone involved clarity of delivery, which is regularly reviewed, and monitored post-completion.

There is a consensus in the IGT that the greatest need in the housing sector is for a major retrofit project (or projects) on a neighbourhood scale, that is monitored throughout, so that the full cost and other implications of scale can be assessed. The experience of other product innovations (such as double glazing or condensing boilers) or development programmes is that scale produces substantial economies; and there is a need for more sophisticated understanding of cost than can be derived from modelling the cost of a single dwelling and multiplying it out. This goes to the root of affordability.

Recommendation 5.8: That social housing stock should be used to kick-start larger-scale retrofit using RMI investment and other funds.

5.9 An existing homes hub

In its Emerging Findings, the IGT recommended the creation of a low carbon Existing Homes Hub, mirroring the function of the Zero Carbon Hub for new homes. Since that time the IGT has motivated more detailed consideration of this amongst interested bodies[37], facilitated by the Energy Saving Trust.

37 British Energy Efficiency Forum, Building Research Establishment, Construction Products Association, Energy Efficiency Partnership for Homes, Energy Savings Trust, Energy Technologies Institute, Existing Homes Alliance, Institute for Sustainability, Manchester City Council, Technology Strategy Board, UK Green Building Council, World Wildlife Fund, Zero Carbon Hub and Government representatives from BIS, CLG, DECC.

These meetings confirmed the need for a Hub, and agreed the qualities that such a body needs to possess, principally comprising:

- *the* clear imprimatur of Government, with Ministerial engagement as appropriate
- but with joint ownership and co-funding between industry (broadly defined, to include key representatives from retail organisations, material suppliers, consumer bodies, installation organisations, skills providers, and academic and research bodies) and Government
- accountability for meeting clear objectives, overseen by an appropriate governance structure
- strong leadership, with a profile respected both in Government and industry
- independence – so that whilst it needs strong connections to industry and to special interest groups, it neither represents nor competes with those separate interests, nor duplicates their activities

In summary its purpose would be to ensure real alignment between Government policy and plans, the capacity and responsiveness of the construction and refurbishment industries, and the interests of householders. More specifically it would:

- develop a shared mission/vision between Government and industry for the large scale, low carbon refurbishment of the existing housing stock
- maximise private sector investment in low carbon refurbishment in line with that vision, and to minimise the risk around such investments
- ensure that the Government policy framework supports the vision and minimises the risk of negative outcomes
- coordinate (and, if necessary, commission) research, data gathering and capacity building, including indentifying and agreeing priorities and gaps to be filled
- on the basis of that research and the experience of its members, to disseminate findings, become a trusted and accessible repository of information and expertise, and set standards
- in the absence of large scale consumer demand, address the means of building consumer demand and facilitating a supply side response
- develop and take ownership of a route map for the transition to low carbon existing homes (see section 5.5.3 of this chapter)

The production and subsequent oversight of the implementation of that route map is then effectively the business plan for the Hub. The group was united in the view that the Hub should be remain light on its feet, and that the details of its programme should then be delivered through a number of work streams, making the maximum use of pre-existing organisations in an already crowded landscape.

The group also agreed that the hub could possibly be crafted out of one or more of the existing organisations working in this area, so long as it possesses or develops the properties espoused above, and is resourced and qualified for the role.

Recommendation 5.9: That Government, with the industry, should set up an Existing Homes Hub to bring together the key participants to formulate and monitor delivery of the retrofit programme, all in accordance with the principles set out above.

5.10 Creating a supply chain

Bringing all of these elements together should give the supply chain greater confidence to start the process of investment necessary to develop products and services designed to serve the energy efficiency market.

Once data is gathered on the size of the target, the measures that will need to be taken and the rate at which demand is expected to grow the industry can:

- identify gaps in the capacity of the industry, if any
- assess the investment needed in skills including assessors, trainers, auditors and professional services
- ensure that the material supply chain can deliver

This could be assisted by the development of modelling tools such as those provided by the EST that have been used in the preparation of this report.

Recommendation 5.10: That, based on the assumption that a major programme of refurbishment will start over the next five years, the industry must start by carrying out a full assessment of its ability to deliver.

In parallel, there is work to do on the standardisation of solutions, and on the accreditation and warranty process needed to protect customers. There can be no doubt that without strong consumer protection there could be a rapid loss in consumer confidence that could undermine the whole programme.

To ensure consistency of approach and a basis for delivering quality solutions the industry will need to embark on a process of putting in place a catalogue of standard solutions that reflect the variety of stock that exists.

By capturing, assessing and codifying this knowledge and putting it into a standard form relevant to builders and building control, good practice would be developed and maintained in an accessible way.

One is the Construction Products Association's practical guide to retrofit, referred to in Chapter 3 of this report.

Recommendation 5.11: That the industry should develop standardised solutions for the refurbishment of existing stock, covering the key processes that will be needed.

5.11 Compliance

5.11.1 Assurance processes

There is a plethora of initiatives and arrangements covering the upgrading of existing homes, including product standards, trade body guarantees and specific insurance.

These may be appropriate for customers wishing to have each measure installed separately, but they are unlikely to be sufficient for multiple measures or a whole house retrofit.

As a minimum the package should include:

- accredited surveyors/advisers supported by the right software tools to ensure the right measures are installed
- a clear set of standards that must be used to ensure the installation is up to specification
- contractor/installer accreditation including an initial vetting process and checks as work is delivered
- quality control visits to ensure what should have been installed has been, before any payments are triggered
- the usual building control, gas and electrical safety checks
- a code of practice which includes the provision of proper information, payment protection in the event of default, fair contracts, after sales support and dispute resolution processes
- an owner's manual describing how home-owners can benefit from measures installed

To ensure the cost of regulation is not so burdensome that installers are deterred or costs are prohibitive, it would be helpful to utilise or build on an existing scheme, such as Trustmark, which offers insurance-backed consumer protection, if it is felt appropriate.

5.11.2 Warranties

The scale of the programme that is required may also suggest a proper warranty scheme is put in place which is similar to that provided on new homes.

Although cover against the energy performance being less than projected is highly unlikely to be available, insurance backed protection could provide a safety net in the event that homeowners suffer from unfinished or defective workmanship, materials or equipment.

The repair, maintenance and improvement sector has a poor reputation, with relatively high levels of complaints and disputes, and contractor default is considerably higher than for the new build sector.

For these reasons, cover provided through existing insurance backed guarantee (IBG) schemes is more limited in scope and significantly more expensive (5 or 6 times) than new build. Undoubtedly, costs would reduce with the scale of work and the spreading of risks achieved through 'compulsory' financial protection as part of an assurance package. In addition, the proposed inspection regime would reduce risks.

If the rates of refurbishment envisaged are delivered, the value of work covered annually could be around one-quarter of the value of the new homes sector. Given that the premium rates (as a percentage of the cost of the work) will be several times higher than for new build, this would require a significant increase in the current insurance capacity, but it is likely to be attractive to the commercial insurance sector.

Notwithstanding the issues raised above, it is likely that any scheme put in place would have the following features:

- cover against loss of deposit or pre-payment, or, alternatively, the cost of completing the work
- an initial guarantee period of 1–2 years after completion covering breaches of the scheme standard referred to above
- a structural/fabric defect period of a further 5–8 years covering specified defects in the fabric and weather-tightness of the building
- and a home emergency assistance service in the first two years after completion to deal with problems such as electrical faults, plumbing leaks and failure or breakdown of energy efficiency systems

Recommendation 5.11: That the industry should, with insurance providers, investigate an assurance and insurance package that meets the needs of consumers.

Box 5.2
PRC Homes: a model from recent history?

In the post-war period, a variety of precast reinforced concrete (PRC) house-building systems were developed for the council house-building programme and, following the introduction of the Right to Buy legislation, many of these homes were sold to the tenants. In 1981 a fire in an Airey-type PRC house in Bradford exposed its structural elements, which were found to be in poor condition as a result of carbonation due to inadequate cover to the reinforcement. After a survey undertaken by BRE, more than 20 types of PRC home were designated defective and immediately became un-mortgageable. To restore public confidence and mortgageability, the Government set up a grant scheme which provided a 90% contribution towards the cost of repairs.

To ensure that the homes were repaired properly and public money was spent appropriately, the Government approached NHBC to set up and administer a repair scheme, which it did through a subsidiary called PRC Homes Ltd.

With representation from Government, lenders, local authority associations, NHBC and BRE, a PRC Assessment Committee was set up. Its first task was to establish the criteria for repairs that would achieve 'general mortgageability' (that is, with most lenders lending, and on normal terms). Key amongst these was that the repaired homes should have a life expectancy of 60 years, comparable to 'traditional' houses; and that all structural elements should be removed and replaced or made structurally redundant, rather than patch repaired, to remove doubts about whether their condition had been properly assessed and whether they may deteriorate subsequently.

Designers (mostly engineering practices and builders) were invited to develop repair systems for individual PRC house types, and each system was documented. The proposals were then submitted to the Assessment Committee for consideration, the Committee raising detailed technical queries on each.

A PRC Assessor (an engineering firm approved by the Committee) was then appointed to work with the designer, at that designer's expense, to resolve any queries and report back; and once the Committee was satisfied that all issues had been resolved, the repair system would be licensed.

NHBC then

- established a register of licensed PRC Repairers, with all firms joining the register subjected to technical and financial vetting, and then able to use a licensed repair system to undertake repairs registered with PRC Homes Ltd
- established a network of licensed 'PRC Inspectors' (mostly consulting engineers) who were required to undertake inspections at key stages and issue a 'PRC Certificate of Completion' upon satisfactory completion
- on satisfactory completion, issued a 10 year warranty, similar to the Buildmark warranty for new homes available at the time

Through this scheme, more than 13,000 homes were repaired, with grant assistance. Repair systems were developed for most of the defective PRC house types and many building firms entered the market, providing a reasonable degree of competition.

The PRC Scheme was generally successful in restoring general mortgageability, save on very poor estates; the level of customer satisfaction with repairs was generally good; and the level of claims against the warranty has been very low.

Box 5.3

Energy Saving Trust Housing Energy Model – Runs for BIS

October 2010

	Scenario summary	Baseline used
Scenario A	All energy efficiency measures applied; with internal temperatures and appliance use remain at 2010 levels. The grid decarbonises by half current levels by 2050. Measures 1–13 (see below) taken up by 2.5% of the stock each year	3. No baseline changes, grid decarbonisation down to 0.287kg CO2 / kWh by 2050
Scenario B	All energy efficiency measures applied, internal temperatures and appliance use remain at 2010 levels. The DECC grid decarbonisation projection is used. Measures 1–13 taken up by 2.5% of the stock each year	1. No baseline changes, DECC advanced grid decarbonisation
Scenario C	All energy efficiency measures applied internal temperatures and appliance use increase but the number of heating days decrease. The DECC grid decarbonisation scenario is used. Measures 1–13 taken up by 2.5% of the stock each year	6. Current trends continue in baseline, DECC advanced grid decarbonisation
Scenario D	All energy efficiency measures are applied plus high uptake of renewable measures. Internal temperatures and appliance use increase but the number of heating days decreases. The DECC grid decarbonisation scenario is used. Measures 1–18 (excluding 7) at various uptake rates	6. Current trends continue in baseline, DECC advanced grid decarbonisation

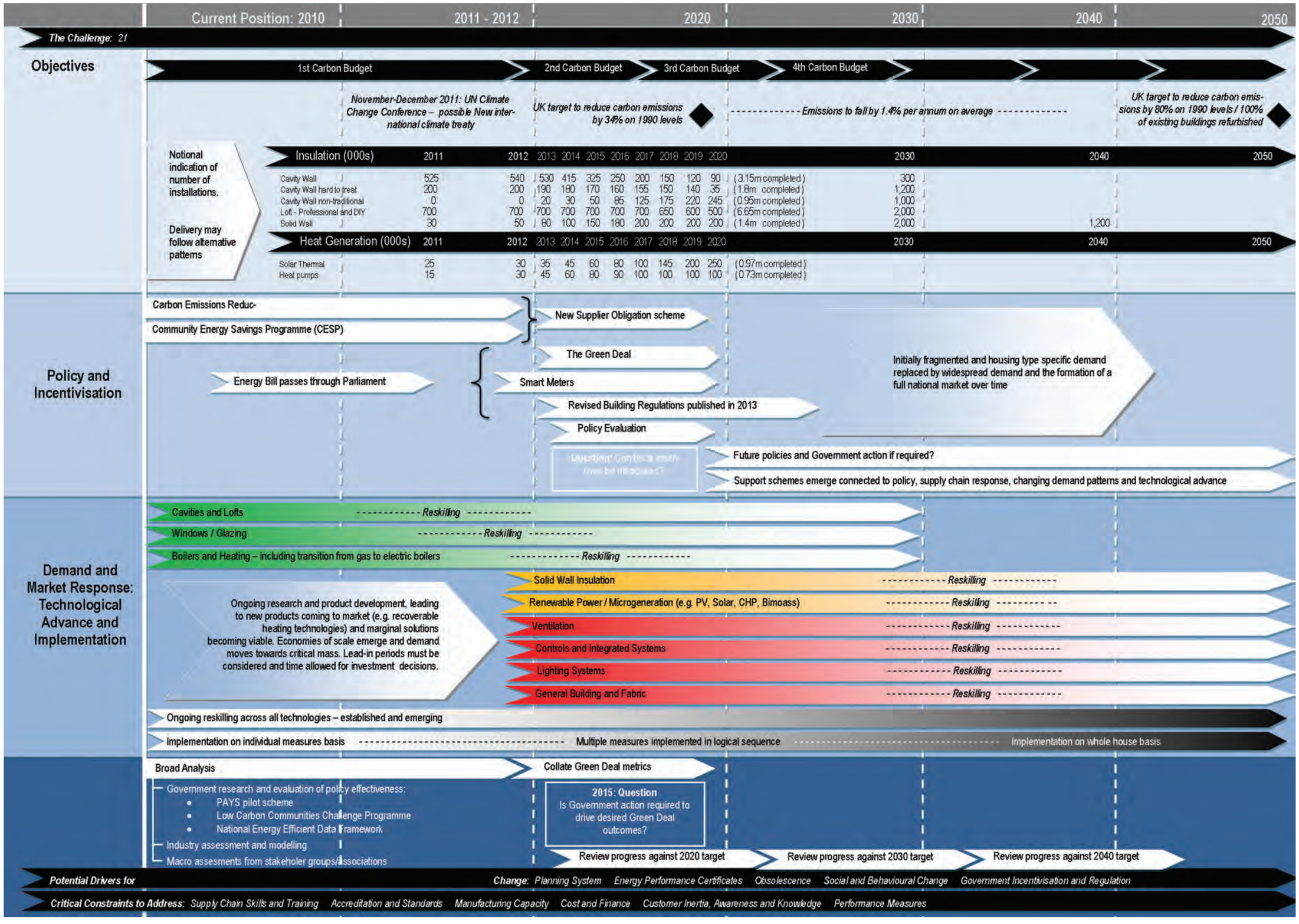
Box 5.3 (continued)

No.	Measures	Applied to:
1	Cavity wall insulation	all C20th homes (in poor condition)
2	Loft insulation – virgin and top-up	all terraced and semi/detached homes
3	Double glazing	all homes currently without
4	Reduced flow hot water fittings	all homes*
5	Low energy light bulbs	all homes
6	Draught proofing	all homes currently without
7	Condensing boiler replacement	all gas and oil heated homes
8	Internal solid wall insulation	pre 1919 flats
9	External solid wall insulation	pre 1919 terraced and semi/detached homes
10	Heating controls	all homes except those electrically heated
11	High performance foam insulated hot water cylinder	all homes
12	Primary pipe work insulation	all homes
13	Reduced infiltration for existing homes	all pre 1919 homes
14	ASHP	Approx 5m. Recent (post 1980) and old (20th century) terraced homes
	Reference: We've installed ASHPs in terraced homes but following the recommendations in our field trials they are only in recent (post 1980) homes. Additionally where energy efficiency measures have been installed in 20th century homes ASHP were installed	
15	Community CHP engine and heating network	Approx 4m. All flats on gas
	Reference: Blocks of flats are likely to provide a big enough heating demand to take advantage of CHP	

Box 5.3 (continued)

No.	Measures	Applied to:
16	Biomass boiler	Approx 4.5m. Very old (pre 1919) terraced homes
	Reference: Biomass is limited by the number of homes that could be supplied by UK biomass production. Flats are excluded as they are unlikely to have fuel storage room	
17	Ground source heat pump	Approx 3m. All post 1980 semi or detached homes
	Reference: We've installed GSHPs in semi and detached homes and following the recommendations in our field trials they are only in recent homes	
18	Solar thermal hot water	Approx 12m. 50% of all terraced, semi and detached homes
	Reference: Based on the quantitative analysis from the feed in tariff consultation (page 100) – which suggests 50% of houses could have PV. We have assumed availability of hot water tanks is not limiting http://www.decc.gov.uk/publications/basket.aspx?FilePath=Consultations\Renewable+Electricity+Financial+Incentives\1_20090715135352_e_%40%40_RelateddocElementPoyryreportonquantitativeissuesinFITsdesignFINAL.pdf&filetype=4&minwidth=true	

Housing Route Map


Current Position: 2010
2011 - 2012
2020
2030
2040
2050
The Challenge: 21
Objectives
1st Carbon Budget
2nd Carbon Budget
3rd Carbon Budget
4th Carbon Budget
November-December 2011: UN Climate Change Conference – possible New international climate treaty
UK target to reduce carbon emissions by 34% on 1990 levels
Emissions to fall by 1.4% per annum on average
UK target to reduce carbon emissions by 80% on 1990 levels / 100% of existing buildings refurbished
Notional indication of number of installations.
Delivery may follow alternative patterns
Insulation (000s)
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2030 2040 2050
Cavity Wall 525 540 530 415 325 250 200 150 120 90 (3.15m completed) 300
Cavity Wall hard to treat 200 200 190 180 170 160 155 150 140 35 (1.8m completed) 1,200
Cavity Wall non-traditional 0 0 20 30 50 85 125 175 220 245 (0.95m completed) 1,000
Loft - Professional and DIY 700 700 700 700 700 700 700 650 600 500 (6.65m completed) 2,000
Solid Wall 30 50 80 100 150 180 200 200 200 200 (1.4m completed) 2,000 1,200
Heat Generation (000s)
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2030 2040 2050
Solar Thermal 25 30 35 45 60 80 100 145 200 250 (0.97m completed)
Heat pumps 15 30 45 60 80 90 100 100 100 100 (0.73m completed)
Policy and Incentivisation
Carbon Emissions Reduc-
Community Energy Savings Programme (CESP)
New Supplier Obligation scheme
The Green Deal
Energy Bill passes through Parliament
Smart Meters
Revised Building Regulations published in 2013
Policy Evaluation
Initially fragmented and housing type specific demand replaced by widespread demand and the formation of a full national market over time
Future policies and Government action if required?
Support schemes emerge connected to policy, supply chain response, changing demand patterns and technological advance
Demand and Market Response: Technological Advance and Implementation
Cavities and Lofts
Windows / Glazing
Boilers and Heating – including transition from gas to electric boilers
Reskilling
Ongoing research and product development, leading to new products coming to market (e.g. recoverable heating technologies) and marginal solutions becoming viable. Economies of scale emerge and demand moves towards critical mass. Lead-in periods must be considered and time allowed for investment decisions.
Solid Wall Insulation
Renewable Power / Microgeneration (e.g. PV, Solar, CHP, Bimoass)
Ventilation
Controls and Integrated Systems
Lighting Systems
General Building and Fabric
Ongoing reskilling across all technologies – established and emerging
Implementation on individual measures basis
Multiple measures implemented in logical sequence
Implementation on whole house basis
Broad Analysis
Collate Green Deal metrics
Government research and evaluation of policy effectiveness:
PAYS pilot scheme
Low Carbon Communities Challenge Programme
National Energy Efficient Data Framework
Industry assessment and modelling
Macro assesments from stakeholer groups/associations
2015: Question
Is Government action required to drive desired Green Deal outcomes?
Review progress against 2020 target
Review progress against 2030 target
Review progress against 2040 target
Potential Drivers for Change: Planning System Energy Performance Certificates Obsolescence Social and Behavioural Change Government Incentivisation and Regulation
Critical Constraints to Address: Supply Chain Skills and Training Accreditation and Standards Manufacturing Capacity Cost and Finance Customer Inertia, Awareness and Knowledge Performance Measures

6. Non-Domestic Buildings

6.1 Executive Summary

6.1.1 The challenge

In order for the UK to meet the emissions reduction targets of the Climate Change Act, the energy performance of non-domestic buildings will need to be improved profoundly, since these buildings currently account for around 18% of all UK emissions.

To deliver this low carbon future, radical measures will be required to reform the construction industry: small changes to existing practices will be insufficient. Construction processes and financing will need to be rethought; and the importance of carbon to the industry and its clients needs to be made tangible and visible.

But in order for the industry to rise fully to this challenge, the Government needs to articulate clearly and urgently the framework within which industry can plan. For instance: to what degree, and on what timescale, will the electricity grid be decarbonised? And how will embodied carbon in materials and products be addressed in the nation's carbon budgets?

In the interim, this report presents a series of recommendations which, if implemented, will help the industry engage effectively with the low carbon agenda. The recommendations relating to non-domestic buildings have been laid out in an indicative route map at the end of this chapter. It presents a vision of where the various recommendations are positioned along the path to 2050.

As in the housing sector, most of the recommendations relate to improvements to existing buildings, since by 2050 around half the emissions from the non-domestic sector are likely to be from buildings constructed before 2020.

Some recommendations are aimed at improving the efficiency of the construction industry rather than being focused purely on the transition to low carbon, because the measures required to decarbonise the built environment coincide with those necessary for a general improvement in the industry's performance – for the modernisation of the industry's processes, as represented by the agenda of the Strategic Forum for Construction and independent bodies such as Constructing Excellence and Buildoffsite. There is inefficiency and waste in many of the industry's traditional ways of doing business; and modernisation

through the concerted development of techniques such as value-based procurement, lean processes, building information modelling, benchmarking and continuous improvement, offsite manufacture and supply chain integration will enable integrated project teams to deliver low carbon refurbishment and new build packages at the higher quality required and for significantly lower cost.

Integration is key to deliver a nearly zero carbon built environment; the industry must increasingly be structured to be integrated in the design, construction and operation of its products and services. This can be through increased use of pre-manufactured components or by integrated delivery through conventional teams; but to increase the likelihood of this approach both legislation and incentives need increasingly to be geared to outcomes, to the long term performance of the asset, rather than to operate at product and elemental levels. A properly integrated design and construction process will make the costs of client specification change highly visible and will lead to the improved delivery and performance of both new build and refurbished stock.

As in other sectors, the development of broader-based professional skills and cross-sector thinking, as recommended in the Royal Academy of Engineering report calling for a Building Physics Engineering approach will be critical to this.

An indicative route map for the transition is attached at the end of this chapter.

Three overarching priorities are identified, each supported by specific recommendations:

- incentivising owners and occupiers, including the introduction of effective regulation
- the provision of comprehensive, transparent and robust information
- the embedding of 21st Century integrated design and construction processes

6.1.2 Effective regulation and incentivising owners and occupiers

To create demand for low-carbon buildings through effective regulation and by incentivising owners and occupiers, there are the following recommendations for Government:

- to review the application of the Building Regulations to refurbishment and tenant fit-out, with a view to introducing more rigorous requirements (Recommendation 6.2)
- to support research into the level of non-compliance associated with the European Energy Performance of Buildings Directive ('EPBD') and Part L of the Building Regulations and the impact of this on carbon emissions; to review compliance mechanisms to ensure the greatest impact at the lowest cost to business; and to amend the EPBD and Part L compliance mechanisms accordingly (Recommendation 6.3)
- to institute a programme of long term monitoring to review the practical outcomes associated with the EPBD and Part L, to inform future revisions (Recommendation 6.4)

- to introduce minimum standards for existing buildings by mandating that all non-domestic buildings should have an EPC rating of F or better by 2020 (Recommendation 6.5)
- to signal a clear intention to use fiscal incentives if required (Recommendation 6.6)
- to create a low cost loan and/or "pay as you save" scheme for non-domestic buildings to unlock private investment, and an "energy efficiency obligation" to deliver energy efficiency in smaller energy users (Recommendations 6.7 & 6.8)
- to commit to public sector leadership in key areas, such as Green Leases and district heating networks (Recommendations 6.10 & 6.11)

6.1.3 Comprehensive, transparent and robust information

Specific recommendations to Government to support the provision of comprehensive, transparent and robust information on the carbon performance of buildings are:

- to commission research to understand how the market values low-carbon buildings – both today and looking into the future, and how incentives interact with the decisions made by owner-occupiers, property investors and tenants to build lower-carbon buildings and use them more efficiently (Recommendation 6.1)
- to require landlords and tenants co-operate to agree an Energy Management Plan for their buildings, to accompany the DEC (Recommendation 6.9)
- to bring forward the requirement for the posting of Display Energy Certificates (DECs) for all non-domestic buildings, with ratings and accompanying recommendations made widely available (Recommendation 6.20)
- to review the benchmarks used to calculate DEC and Energy Performance Certificate (EPC) ratings in order to ensure that they are consistent and robust, and effectively differentiate on energy performance for buildings of different types, and simplify the process to the greatest practical degree (Recommendation 6.21)
- work with the industry, to ensure that businesses have access to independent, objective advice and support on the implementation of energy efficiency measures (Recommendation 6.23)
- to require EPCs to be displayed at the point of marketing for non-domestic buildings in order to maximise their influence on buyers' decision-making. (Recommendation 6.24)
- through the Efficiency and Reform Group (ERG), to mandate a requirement for post-occupancy evaluation on all central Government projects, implemented through the procurement process (Recommendation 25)

6.1.4 Embedding 21st Century integrated processes

Specific recommendations to support this priority, first to Government, are:

- to mandate Building Information Modelling (BIM) methodology for central Government projects with a value greater than £50 million (Recommendation 6.14)
- to extend the right to claim enhanced capital allowances to low carbon whole building structures (Recommendation 6.16)
- to reinstate Industrial Buildings Allowances for low carbon buildings or components, including pre-manufactured, to reduce the cost base and encourage more efficient construction processes (Recommendation 6.17)
- to allow pre-acceptance for R&D tax credits (Recommendation 6.18)

And to the industry and its clients:

- to recognise the critical importance to the adoption of modern methods of construction of a design freeze that is set at the start of a project and rigorously adhered to, and consider how this can be routinely embedded into the practices of the industry (Recommendation 6.12)
- to update the lexicon published by Buildoffsite for inclusion in contracts used by the industry (Recommendation 6.13)
- to develop and adopt a "Comparator" tool which allows companies to assess accurately the lifecycle cost of different methods of construction, and the levels of risk implicit in that assessment (Recommendation 6.15)
- to explore the potential for accreditation schemes, such as those offered by BSI and Lloyd's Register, to be adopted more widely (Recommendation 6.19)
- to commit to the voluntary posting of Display Energy Certificates in their own buildings, following the practice mandated for public sector buildings and applying the same principles (Recommendation 6.22)

In addition to these three over-arching priorities, two further needs are critical to support the industry's transformation:

- the development of new and better skills
- improved data collection, reporting and use

6.1.5 Skills

To deliver a low carbon buildings sector will require a general up-skilling of all parts of the property and construction supply chain. However, for there to be a demand for this, there also need to be clear market incentives which encourage low carbon construction. Without this "pull" most initiatives aimed at up-skilling will have limited effectiveness. Creating suitable incentives is therefore the priority.

However, the issue of skills affects all parts of the built environment, and this is therefore dealt with in chapter 3 of this report.

6.1.6 Data collection, reporting and use

To improve data collection, reporting and use, there are the following recommendations for Government:

- to extend the use of Display Energy Certificates (DECs) and provision of access to energy data contained within them (Recommendation 6.1, complementary with Recommendation 6.24)
- to use the procurement process to increase formal, structured post-occupancy evaluation as a requirement for public buildings, and to incentivise its use for private construction (Recommendation 6.25)

The development of a methodology for the calculation whole life carbon, and its inclusion in codes and standards, is also seen as a priority in this sector; but as cross-industry issue this is covered in chapter 3 of this report.

6.2 Introduction

The IGT Buildings Group has considered the evidence relating to the internal and external measures required to move forward the sector so that it is able to deliver low carbon non-domestic buildings efficiently and consistently within a competitive market.

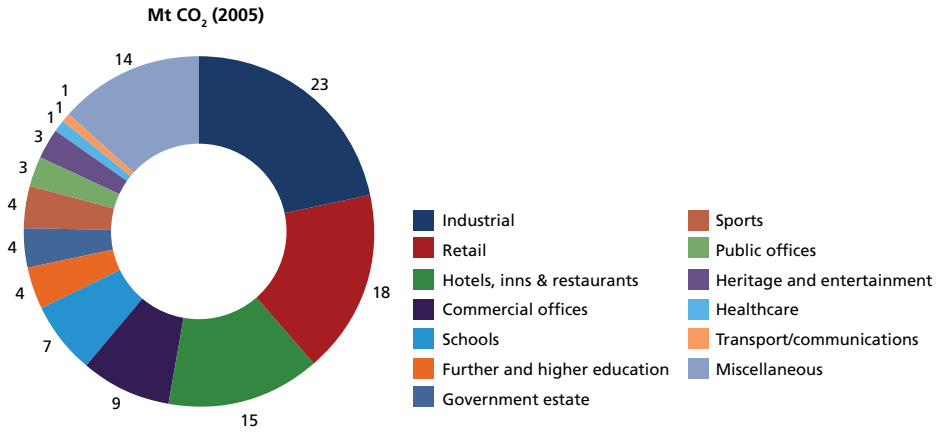
Although not explicitly addressed in the Emerging Findings published in March 2010, innovation, of both product and process, has been at the core of the Group's deliberations; and the Committee on Climate Change has also explored the issue of innovation in its report on *Building a Low-carbon Economy – the UK's Innovation Challenge*, published on 19 July of this year.

The Group has considered both new build and existing buildings, although members have agreed that the emphasis needs to be on measures to address the existing stock. While recognising that by 2050 a significant amount of emissions from non-domestic buildings may come from those constructed after 2020, the existing stock has far greater potential for reducing its carbon footprint in the short to medium term. Moreover, issues surrounding improvement of the existing stock are more intractable than those associated with new build.

The scale of the challenge is demonstrated by data compiled by the Carbon Trust. There are approximately 1.8 million non-domestic buildings in the UK, which are currently responsible for 18% of the country's total CO_2 emissions.

Figure 6.1: Emissions (%) by sector (2005)

Source: Carbon Trust 2009



Furthermore, three quarters of those buildings are more than 25 years old, and nearly one third are over 70 years old.

Figure 6.2: The age of non-domestic building stock

Source: Carbon Trust 2009

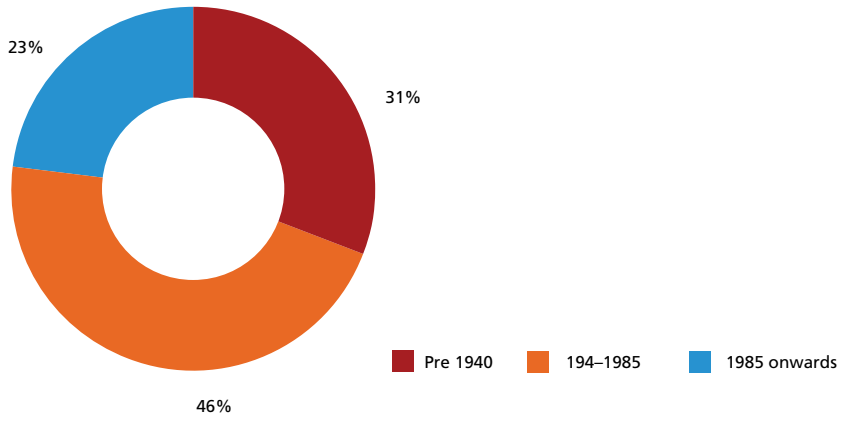
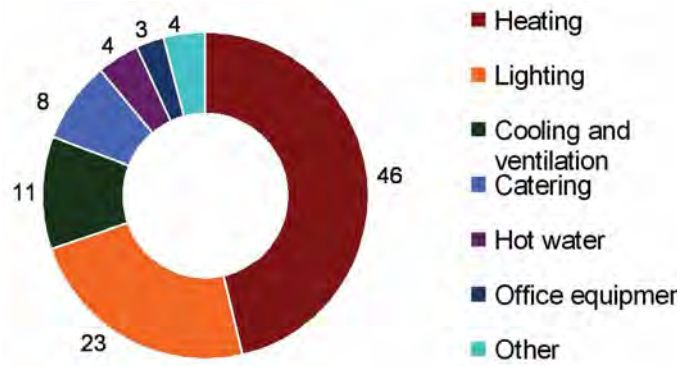


Figure 6.3 illustrates the significant potential to reduce carbon emissions from existing non-domestic buildings in the UK. The opportunity is to both reduce demand, for example by improving insulation, and improve the efficiency of systems, such as those for heating, lighting and ventilation.

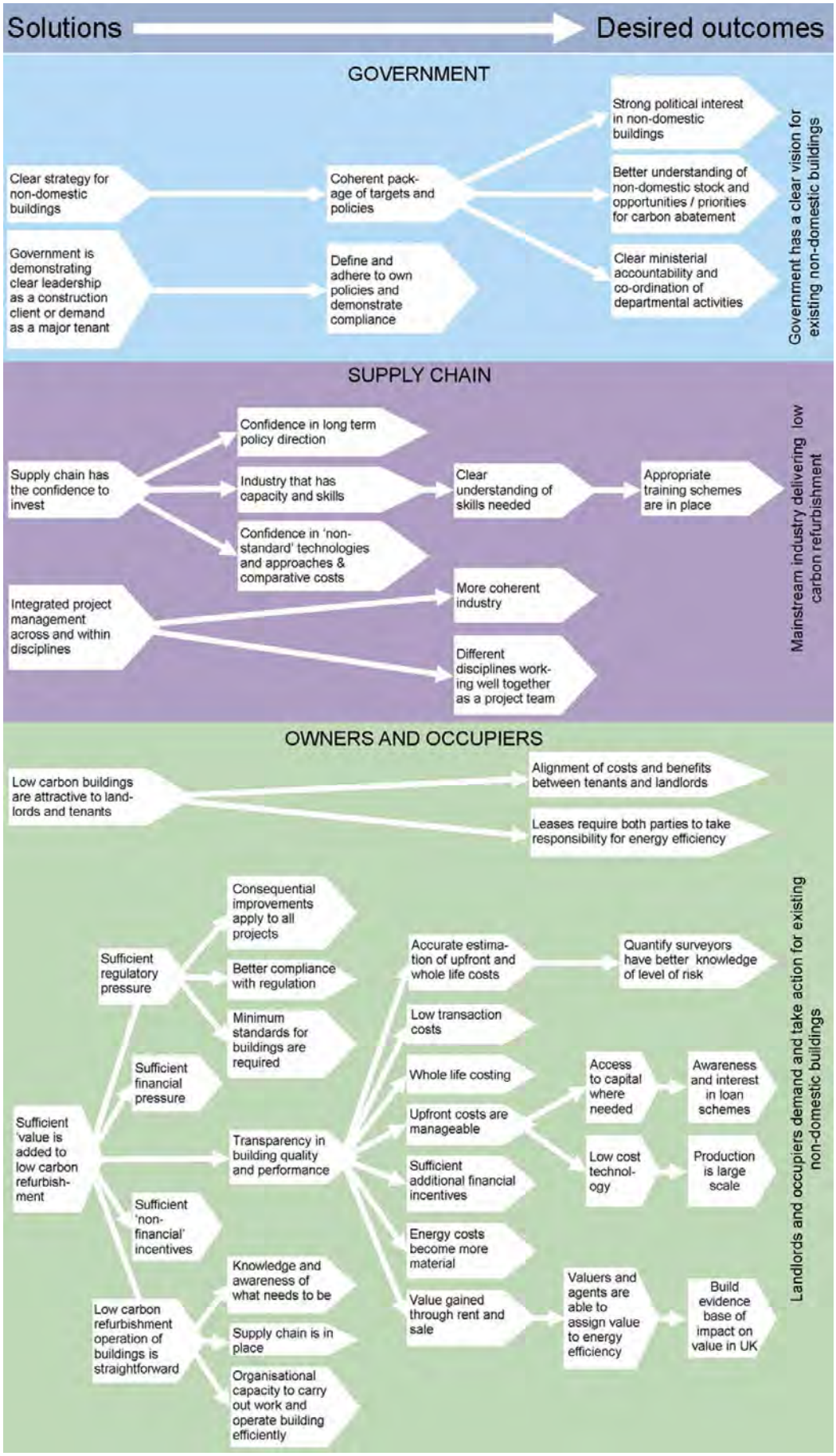
Figure 6.3: Energy usage in non-domestic buildings UK

Source: Carbon Trust Report, Building the future today, 2008.



There are also deep-rooted institutional barriers in the structure and practice of the construction and property industries that lead to a misalignment of interests in addressing the energy performance of the existing stock. Figure 6.3 attempts to identify the key relationships. It presents a view of the barriers within Government policy, the construction industry supply chain, and occupiers/owners, together with a vision of the low carbon solution.

Figure 6.4: Overcoming the barriers to the low carbon vision for non-domestic buildings



6.3 Incentives for action

6.3.1 Summary

Many of the opportunities to reduce the carbon emissions associated with new and existing buildings are, in simple terms, cost-effective. The Carbon Trust estimates that reducing the carbon emissions from the UK's non-domestic buildings by 35% by 2020 could result in a net cost saving to the UK economy of more than £4.5 billion.

However, analysis undertaken for this report has highlighted that there is a complex set of barriers throughout the property value chain which works against this objective. This calls for a focus on what drives demand from property owners, investors and occupiers, on the basis that many of the supply chain barriers can be overcome by the industry if there is a market for low-carbon buildings.

The main conclusion is that Government should renew its approach to reducing emissions from non-domestic buildings, by:

- sending a clear and unequivocal signal that a major improvement in the energy efficiency of the UK's existing building stock is both essential and a key Government priority, by committing to a comprehensive strategy to deliver it
- creating conditions that incentivise landlords and tenants to work together to improve the energy performance of buildings via a range of mechanisms, including regulation, incentives, and improved information

Our recommendations acknowledge that:

- what is "cost effective" for the UK as a whole may not work from the point of view of a particular stakeholder. For example, owner-occupiers may evaluate energy efficiency on the basis of a simple payback whereas property investors and fund managers take decisions based on what return they expect to realise from a building over several years – taking into account a range of factors including their expectations of future Government policy, trends in demand and returns available from other asset classes
- the split of incentives and responsibilities between landlords and tenants in rented property has been an intractable barrier to improving the energy performance of buildings and will require a concerted effort to understand the details of landlord/tenant relationships in different sectors and regions
- a range of policy measures are already in place – some tried and tested, while others are new and their impacts still untested

The aim in this report has therefore been to highlight areas for improvement in existing policies and some new measures needed to accelerate change in this sector.

Overarching priorities are:

- comprehensive, transparent and robust information on the carbon performance of buildings
- the creation of demand for low-carbon buildings through effective regulation and the incentivisation of owners and occupiers

6.3.2 Comprehensive, transparent and robust market information

Information is essential to enable a market to function efficiently. Robust, transparent and comprehensive information on energy and carbon performance is an essential prerequisite for the transformation of the UK's building stock. With good information, incentives can work more effectively by enabling better informed decisions, and Government can design better policies and ensure they are working.

A key barrier to progress is therefore the lack of readily available, robust and reliable data on energy use and energy performance in buildings.

The introduction of rating systems with a clear focus on energy that measure both the design performance of a building (Energy Performance Certificate – EPCs) and its actual operational energy use (Display Energy Certificates – DECs) is welcomed. Together, these ratings provide the foundation for better buildings, used better. However, a DEC is currently only required for public buildings. This is a missed opportunity, which is addressed in section 6.6.4 of this chapter.

It is widely acknowledged that unless there is a clear business case to invest in low-carbon buildings, the mainstream market will not take action. Hence, information about how the non-domestic property market in the UK values the energy efficiency of buildings is essential.

Some investors expect a divergence in the market valuation of low carbon buildings to emerge in the future, as they anticipate ever tighter regulations and increased demand from occupiers; and some take account of this by "future-proofing" their portfolios, but few actively invest in low carbon buildings[38].

Although there is a burgeoning body of literature, anecdote and opinion that makes the case that there should be a value differential for low carbon buildings, there is so far little material evidence of enhanced capital values, and only limited evidence of rental value differentiation from the US commercial office market[39].

38 UK-GBC, 2007, Report on carbon reductions in new non-domestic buildings
39 Is sustainability reflected in commercial property prices: an analysis of the evidence base", RICS Research Report, January 2010

This suggests that either existing incentives are failing to create the business case for low carbon buildings, or that there is a market failure of information. It is essential that we find out which.

Recommendation 6.1: That Government should commission research to understand how the market values low carbon buildings – both today and looking into the future, and how incentives interact with the decisions made by owner occupiers, property investors and tenants to build lower carbon buildings and use them more efficiently.

6.3.3 Creating demand: Reputation as a driver for action

Risks to an organisation's reputation can act as a driver to reduce their carbon emissions. This is particularly the case where organisations have a high profile, whether in the business world, with consumers or in public life, since they are more likely to see an impact on their share price or customer base if they attract negative publicity.

Reputation is more likely to drive behaviour if companies are required to report publicly on the energy performance of their property portfolios. However, the vast majority of organisations that operate within the built environment sector do not understand their carbon impact or know if it is getting better or worse year on year[40].

For large, non energy-intensive organisations, the Carbon Reduction Commitment Energy Efficiency scheme (CRC-EE) increases the transparency of organisations' carbon performance, enhancing reputational drivers to reduce emissions. Even in its early stages, there is anecdotal evidence that the scheme has focused attention at Board level, on the need to improve energy efficiency in large organisations. Making this the responsibility of the finance director through the financial accounting system would assist further. The threat to a business's reputation through public ranking of its energy performance in a league table is the key driver.

Other measures, such as the mandatory roll-out of DECs, would complement the CRC league table by making the energy performance of an organisation's buildings much more transparent and open to scrutiny. Section 85 of the Climate Change Act 2008 to regulate for mandatory corporate carbon reporting by 6th April 2012 should also encourage firms to be more transparent about their carbon footprint, including emissions from buildings.

6.3.4 Creating demand: Regulation as a driver for action

It is essential that incentives drive action across all types of organisations – both those included in the CRC-EE scheme and smaller energy users.

40 UK-GBC, 2008, Organisational Measurement and Reporting

6.3.4.1 Targeting large, non energy-intensive organisations

The CRC-EE aims to be an effective mechanism to ensure that large, non-energy intensive organisations deliver significant energy efficiency improvements over time.

After an initial set-up phase, participants will have to buy permits for their emissions from a limited pool. They will therefore be incentivised to make energy efficiency improvements – or work with their tenants where applicable – where the cost is less than the cost of purchasing permits.

The cap on emissions should be set at a sufficiently stretching level to seize the full opportunity to improve energy efficiency in a cost-effective way. This is likely to require a tighter cap than is currently anticipated: Carbon Trust analysis[41] suggests a total saving of more than 8MtCO_2e (~14%) could be achieved cost-effectively.

But as the CRC-EE places responsibility for purchasing allocations on the party whose name is on the energy bill, typically landlords, the scheme may not sufficiently incentivise tenants in rented property.

Further, there is a strong view in the industry (and particularly in the property sector) that the scheme needs to be simplified, and that its effectiveness needs to be monitored over time, and refined as necessary to deliver on its aims.

6.3.4.2 Fit-for-purpose building regulations

Developments in Building Regulations are driving unprecedented change in the new building industry, through the zero carbon target for housing and the forthcoming revisions to Part L in 2013 and 2016. They are likely to drive similar change in the new non-domestic buildings, given the Coalition Government's support for the aspiration that all new non-domestic buildings should be zero carbon from 2019.

However, regulation has not had the same impact on existing buildings. As a result it is likely that opportunities to make significant improvements in the performance of existing buildings – at a change of tenancy for example – are being missed, and higher carbon emissions are being "locked-in".

Recommendation 6.2: That Government should review the application of the Building Regulations to refurbishment and tenant fit-out, with a view to introducing more rigorous requirements.

41 Analysis of over 100,000 recommendations made by the Carbon Trust to thousands of organisations since 2001 – to be published shortly.

As an example, performance requirements for $kgCO_2/m^2$ could be introduced for major refurbishments in Part L2B of the Building Regulations, and more refurbishments could be brought within the scope of the regulations.

It is widely believed that compliance with the energy efficiency requirements of Building Regulations is poor. The National Audit Office recognised this in its 2008 report 'Programmes to reduce household energy consumption', when it concluded "There is a growing recognition that non-compliance may undermine the effectiveness of Building Regulations, especially as they become increasingly stringent; but as yet there is little concrete information on the extent of non-compliance, or how best to tackle it. There are also concerns, but little information, over the capacity of the construction supply chain to deliver more stringent energy standards."[42]

As more stringent demands are placed on the performance of buildings, it will be essential to ensure that poor compliance does not erode the potential gains. The Carbon Trust estimates that improving compliance could save ~1.3$MtCO_2e$ annually by 2020 and would be cost-effective[43].

Recommendation 6.3: That Government should support research into the level of non-compliance associated with the EPBD and Part L of the Building Regulations, and the impact of this non-compliance on carbon emissions; to review compliance mechanisms to ensure the greatest impact at the lowest cost to business; and to amend the EPBD and Part L compliance mechanisms accordingly.

In this context "non-compliance" should be taken to mean both the failure to comply with regulations, and failure to comply with the spirit of the regulations because of the range of interpretations possible in the standards, or of associated tools.

Recommendation 6.4: That Government should institute a programme of long term monitoring to review the practical outcomes associated with the EPBD and Part L, to inform future revisions.

6.3.4.3 Minimum standards for non-domestic buildings

Reputational drivers will only affect a proportion of the market. Building Regulations will only influence new buildings or those undergoing major refurbishments. A "Building MoT", whilst advocated by some, would still leave many bad buildings, even if they are operated as efficiently as they can be.

42 http://www.nao.org.uk/publications/0708/household_energy_consumption.aspx
43 "Building the future, today", Carbon Trust, CTC765, January 2010

It may therefore be necessary to implement regulations to target the worst performing buildings by simply making it illegal to sell, lease, or insure them after a certain date. The 6% of buildings with EPC "G" ratings are responsible for around 15% of carbon emissions. Although there will be some overlap with other measures, this would ensure that the worst-performing buildings do not slip through the net.

With sufficient time to plan, and support to ensure that advice and capital are available, it would not place an undue burden on businesses, as many of the necessary measures to upgrade the worst-performing buildings would be cost effective. It is estimated that the total investment required would be around £900 million, and the annual saving on energy bills would be around £600 million. Care should be taken to ensure that the measure does not incentivise perverse outcomes, such as demolition of G-rated buildings where the carbon emissions embodied in constructing a new building would outweigh the benefits.

Recommendation 6.5: That Government should introduce minimum standards for existing buildings by mandating that all non-domestic buildings should have an EPC-rating of F or better by 2020.

6.3.5 Creating demand: Financial drivers for action

If the existing economic incentives do not create a sufficiently compelling business case for the market to transform the UK's building stock, or if barriers cannot be overcome by other means, it may be necessary to introduce stronger fiscal incentives. The Government should clearly signal its intention to use such measures if necessary.

There is a range of measures that could incentivise different stakeholders[44] and these could be designed to be revenue neutral by rewarding the best buildings and penalising the worst performers. Examples include:

- Levying differential rates of Stamp Duty Land Tax for buildings based on their energy performance, as evidenced by the EPC. This would have an immediate and material effect on capital value, and would therefore incentivise building owners to improve their buildings
- Levying differential business rates for buildings based on their energy performance, as evidenced by the DEC. Energy costs are too low to be material to many non energy-intensive businesses, while business rates are typically responsible for 10% of their cost base. Applying differential business rates based on the operational energy performance of the building would impact immediately on the occupier and lead to a preference for more energy efficient buildings and an increased incentive to operate them more

44 Source: BPF

efficiently. However care would need to be taken to normalise occupancy in order to avoid perverse consequences

- Widening the scope of Enhanced Capital Allowances to include building energy efficiency measures, and examining ways to increase their effectiveness and take-up. A further useful measure would be to extend the provision which allows for some energy efficiency improvements to be discounted for the purposes of rating revaluation

However, we do not consider that sufficiently robust information on the energy performance of buildings is yet available on which to base differential taxation. It is therefore important that the robustness of EPCs and DECs is improved, in order to provide a solid basis for the use of fiscal incentives. (Section 6.6.4 considers DECs and EPCs in more detail.) It will also be important to consult widely and design carefully to avoid any potential unintended consequences.

Recommendation 6.6: That Government should signal its intention to use fiscal incentives to create market demand for low carbon buildings, and incentives to operate buildings better.

6.3.5.1 Targeting smaller energy users

Smaller energy users (those not covered by the CRC-EE) face particular barriers that make it more difficult for them to realise the value of energy efficiency opportunities. These include:

- hassle – as it is not core business, improving the energy efficiency of buildings is generally neglected by all sizes of company
- access to capital – smaller energy users find it more difficult to access capital for investments
- lack of expertise – smaller organisations are less able to sustain the specialist teams that can focus on energy efficiency

The large number of smaller energy users are together responsible for around half of non-domestic carbon emissions outside the EU-ETS – around 55-60MtCO_2e. While it may be cost-effective to address some of these by extending the CRC-EE to participants below the current threshold, the costs of the administrative burden would outweigh the benefits for the smallest energy users. The need is for schemes specifically designed to unlock energy saving opportunities among smaller energy users by creating incentives and providing access to capital.

A scheme to unlock the capital required to invest in cost-effective, but relatively capital-intensive, energy efficiency opportunities in smaller energy users by tying loans to the building, rather than the organisation is therefore needed. As many of the building energy

efficiency measures have attractive rates of return, we anticipate that the scheme could be financed by the private sector, perhaps with some public sector support through a vehicle comparable to the Green Investment Bank.

Recommendation 6.7: That Government should create a low cost loan and/or "pay-as-you-save" scheme to finance investments in capital intensive energy efficiency measures in non-domestic buildings.

Importantly, smaller energy users have implemented relatively few of the quick wins that are readily implementable and already proven. Carbon Trust consultants typically identify around twice the proportion of carbon saving opportunity in smaller energy users than in large companies. The main barrier to implementing these measures is not the availability of capital – the initial costs can be very low, but instead the "hassle" or the opportunity cost of a small organisation's scarce management time.

So, a complementary option would be to create an "energy efficiency obligation" scheme that would operate in a similar way to the existing CERT obligation on energy suppliers in the domestic sector. It would incentivise energy suppliers to take advantage of their existing routes to market, and of economies of scale, to offer energy efficiency measures to smaller energy users, overcoming the "hassle" barrier. An alternative would be to enable other commercial organisations to bid to fulfil the obligation, subsidised by the levy on energy bills.

The level of the obligation should be set to deliver simple, low-cost energy efficiency measures such as implementing energy management systems and optimising heating, ventilation and cooling controls. Such a scheme would be less appropriate to unlock the more capital intensive measures, as it socialises the cost across the group.

Article 6 of the EU Directive on Energy End Use Efficiency and Energy Services 2006/32/EC (commonly referred to as the Energy Services Directive) requires Member States to ensure that energy suppliers provide competitively priced energy services and audits to their customers, or to put in place voluntary or market based schemes with an equivalent effect. These Voluntary Agreements have just been extended to 2011.

Recommendation 6.8: That Government should create an "energy efficiency obligation" scheme obliging energy suppliers to drive uptake of low capital cost measures among smaller energy users, funded through a levy on energy bills.

Overcoming the barriers of access to capital and hassle will unlock savings of up to 4.9MtCO_2e at minimal cost to the taxpayer. Carbon Trust analysis suggests that the total capital required to be unlocked by the two schemes would be around £650 million.

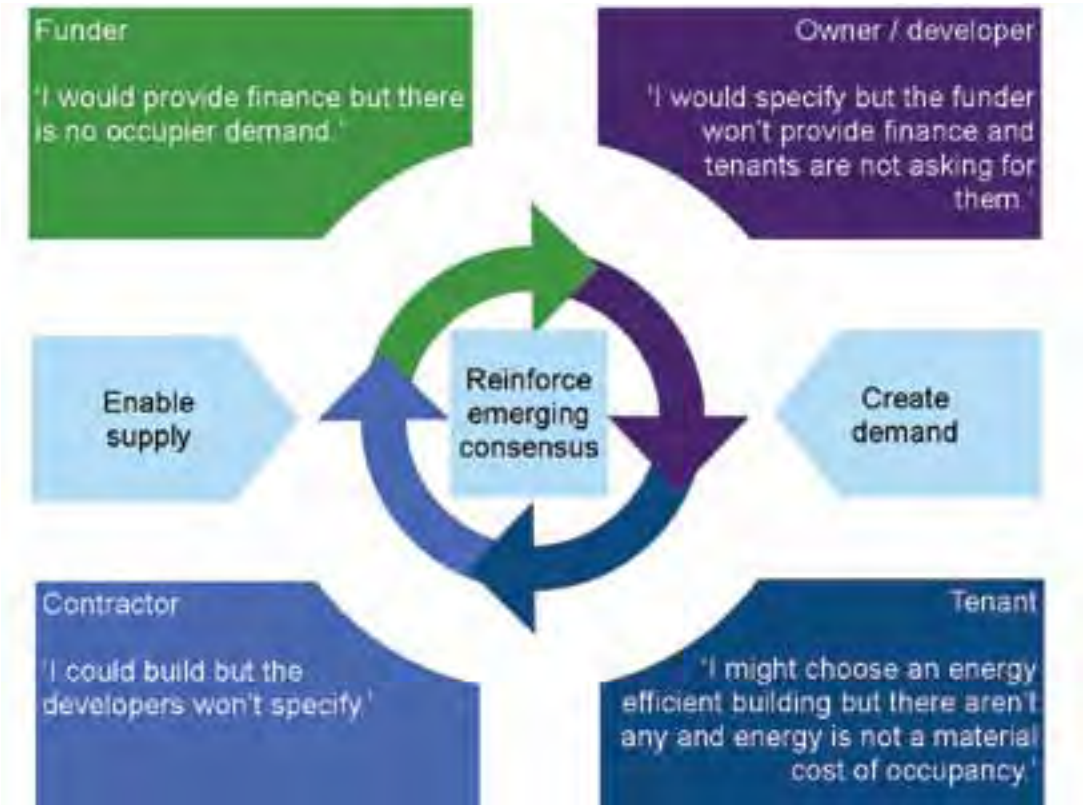
6.3.5.2 The landlord – tenant divide

The split of incentives and responsibilities between landlords and tenants in rented property comes up again and again as an intractable barrier to improving the energy performance of buildings. This so-called "circle of blame" could more accurately be called a "circle of inertia", with no single actor having sufficient incentive to act alone. As a result, both groups miss out on opportunities to make savings. It requires a concerted effort to understand the details of landlord/tenant relationships in different sectors and regions to unlock these opportunities. The following is proposed:

- create conditions that make it worthwhile for landlords and tenants to work together to improve energy performance of buildings
- provide the tools and information to enable co-operation between landlords and tenants

Figure 6.5: Circle of Inertia

The 'circle of inertia' can only be overcome if we create demand whilst also ensuring the supply chain are able to deliver.



The recommendations made in this report are designed to ensure that there are tangible incentives on both landlords and tenants, through CRC-EE, an "energy efficiency obligation", and perhaps fiscal incentives. However, it may be appropriate to require that landlords and tenants in rented property co-operate to develop an Energy Management Plan, including improvement targets and allocation of management responsibility, to accompany the DECs for their buildings. This could overcome the initial inertia that impedes effective co-operation

between landlords and tenants, even when both have incentives. To maximise their impact, landlords and tenants should be required to publish these plans.

Recommendation 6.9: That Government should require landlords and tenants co-operate to agree an Energy Management Plan for their buildings, to accompany the DEC.

The tools are largely in place: the "Green Lease toolkit" proposed by the Better Buildings Partnership[45] and LES-TER[46] for commercial offices provide frameworks in which landlords and tenants can co-operate; and the recommendation to increase the scope of DECs to all non-domestic buildings would provide an objective basis for constructive negotiation between landlords and tenants to allocate responsibility and set targets.

However, it may also be necessary to provide leadership to the market. In Australia, Green Leases have been mandatory for Government buildings for 15 years. This has built the case for the impact of such an arrangement and created widespread familiarity with the operation of Green Leases among landlords and tenants[47].

Recommendation 6.10: That Government should mandate the use of "Green Leases" for buildings occupied by the public sector.

6.3.6 Other barriers – remove co-ordination barriers to roll-out of district heating

The decisions relating to the wide scale implementation of district heating are very closely tied to the trajectory for decarbonisation of the grid supply. If grid supply is decarbonised then the economics of distributing heat may be compromised due to the very large and long term capital investments involved. While in many areas individual low carbon building solutions may be cost-effective, in areas of dense buildings, individual solutions may be very challenging to deliver and could potentially lead to significant challenges for infrastructure. In some situations district heating may be the best or only solution to delivering low carbon heat.

However, whilst in continental Europe there is a great deal of experience in planning, delivering and operating community scale networks, in the UK such experience is limited. Market penetration sits at less than 2%.

There are many barriers to the implementation of district heating, which have been well-rehearsed in a number of reports. One of the key barriers is the uncertainty of the customer base for district heat – and establishing a clear and predictable revenue stream is of course critical to project financing[48].

45 www.betterbuildingspartnership.co.uk
46 www.les-ter.org
47 IPF Green Lease Briefing Note, http://www.ipf.org.uk/mainwebsite/resources/document/ipf%20green%20leases%20breifing%20note.pdf
48 UK-GBC, 2010, Sustainable Community Infrastructure

In order to overcome this barrier, we recommend that public and private sector owners/ occupiers need to be encouraged to provide, support or subscribe to schemes that provide sustainable district energy.

Recommendation 6.11: That Government should address barriers to district heating networks by requiring public sector buildings to act as anchor loads, and encourage the private sector to do the same.

6.4 Construction and finance

6.4.1 Overarching priority: To embed 21st Century integrated processes.

If the construction industry is able to achieve maximum value for its clients and stakeholders throughout the supply chain, there will be significant efficiency gains and fundamental improvements to the industry's carbon footprint as a direct consequence.

These gains can be realised by accelerating the modernisation of the industry's processes as represented by the agenda of the Strategic Forum for Construction. There is inefficiency and waste in many forms in the industry, and modernisation through techniques such as (but not limited to) value-based procurement, lean processes, building information modelling, benchmarking and continuous improvement, offsite manufacture and supply chain integration will enable project teams to deliver low carbon refurbishment and new build packages at the higher quality required and for significantly lower cost.

The overriding considerations for a construction project are cost, time and quality, and where these coincide at the client's measure of value, and the single most important measure which would influence all of these positively would be the strict adherence to an early design freeze. The imposition of this discipline would not just drive down costs by severely restricting the use of design variations, it would significantly reduce the wastages in time, money and materials associated with late change; and above all it would enable a step change in industry practices towards industrialisation as proposed by the Egan report.[49]

49 For a case study on this approach, refer to http://www.baileysystems.co.uk/whistonhospital.html.

An example is the new Whiston Hospital built for the St Helens and Knowsley NHS Trust under a PFI by a consortium led by Taylor Woodrow (now Vinci). A determined effort was made by the design team to complete their work to much higher standards of detail, checking and approval – all at a much earlier stage than is normal in construction. This was done to enable offsite manufacture of major sections of the fabric, and particularly the M&E elements of the project, undertaken by NG Bailey. As a result of the time saved, assisted by major construction process changes which it enabled, the construction was completed and handed over 5 months early, enabling earlier occupation by the Trust.

Recommendation 6.12: That the industry and its clients should recognise the critical importance to the adoption of modern methods of construction of a design freeze date that is set at the start of a project and rigorously adhered to, and consider how this can be routinely embedded into the practices of the industry.

To help embed 21st Century construction processes, the language of construction also needs to be reconsidered. It is imperative to know costs and programme and to consider cash flow issues more closely.

6.4.2 Language

The language used in the industry needs to be overhauled: "intelligent construction" and "systems integration" will need to become the norm, along with the issues of whole life costing, quality, safety, sustainability, behaviour and culture.

Recommendation 6.13: That Buildoffsite should update its lexicon for inclusion in contracts used by the industry, adopting terminology relevant to a 21st century industry to facilitate the transformation of the industry to embrace low carbon.

The language of cost is well understood, but that of the product, what the client is actually paying for, less so. Financial return should be only one part of the decision making process. Alignment to an agreed strategic direction is also required, as are generation of shareholder wealth and the enhancement of stakeholder reputation. Carbon performance needs to be clearly articulated in terms of embedded and operational, and a clear demonstration of the financial and reputational benefits that accrue.

Lifetime energy costs of buildings are generally not asked for by clients. There may be scope for quantifying and presenting the energy performance of buildings in a standardised way, so that clients can visualise the lifetime energy performance of a product, design proposal or building in a way that aids their choices.

6.4.3 Knowing costs and programme

Meanwhile, for all the importance of whole life value, the industry itself needs to be far more tightly focused on the issues of cost and programme. Organisations within other sectors are aware of component costs to a degree still unimaginable in the construction industry; and the industry retains its unenviable record for delays – despite the usual and understandable fixation of its clients on those two issues.

An underlying problem is the lack of discipline in the industry. Initiating and accepting variation orders is the norm; and the expectation of this both offers the prospect of breaking any prior bargain once the project gets underway, and undermines any commitment to break the mould.

Not infrequently the problem is in defining what is required, rather than in the pricing: once scope is agreed, accurate pricing can follow. To produce near-zero carbon buildings, the process of "build and design", rather than "design then build", must stop. There is a widespread, but wrong, assumption that it is possible to produce high performing buildings by the use of add-on "green" products as an afterthought – the so-called "green bling". In reality, proper design – design that addresses the totality of a building and its systems – may well eliminate much of the plant and equipment formerly required to satisfy comfort requirements.

The use of Building Information Modelling (BIM) would also have a major impact on the ability to control cost and delivery to schedule by the better control and exchange of information within the supply chain, aiding integration and reducing risk – including uncertainty, rework and delay.

Recommendation 6.14: That Government should mandate the use of Building Information Modelling methodology for central Government projects with a value greater than £50 million.

A related problem is that, for some projects, clients and their Board members, may be quite unaware of the levels of uncertainty inherent in what they are being asked to approve – and who may respond to that lack of transparency either by making a potentially damaging decision or by retreating to a highly risk-averse conservatism.

Whilst the utilisation of techniques like Net Present Value appraisal has the apparent objectivity of mathematics, investment appraisal is not an exact science: the process is still subjective, especially in the initial stages of a project, when data is still scarce or incomplete. This subjectivity, coupled with a lack of security of price or programme, is a key driver behind the preference for a project management regime that offers multiple, staged decision points, allowing for postponement or cancellation at any stage. This staged approach to investment decisions clearly has the advantage of not having to commit large amounts of capital until risk is judged to be at a satisfactory level, but it also obstructs potentially more efficient ways of developing a building.

The particular challenge for innovative projects in this decision making process is the high level of uncertainty at conceptual stage and the time (and therefore cost) it takes to manage out that uncertainty whilst competing against tangible, apparently value-adding projects with shorter and more certain payback expectations.

Corporate Boards making investment decisions around innovative projects should do so with the full knowledge of the range of uncertainty involved defined in terms of calculated probability; and should have in place (and be offered by the industry) good control mechanisms in to ensure delivery as targeted.

Recommendation 6.15: That the industry should develop a "Comparator" tool which allows companies to assess accurately the lifecycle cost of different methods of construction and the levels of risk implicit in that assessment.

6.4.4 Cash flow

Speed and predictability of cash flow are strong positive drivers of change, slow and uncertain cash flow are strong brakes. Current market conditions are causing cash flow problems in supply chains, with some companies moving away from integrated teams and extending payment periods. Misalignment between expected and actual cash flows, create a real barrier to progress.

6.4.5 Tax

The previous Government introduced Enhanced Capital Allowances (ECAs). These allow items of plant to get 100% capital allowances in year 1, rather than the usual 20% annual allowance, where they are deemed energy efficient. These give a huge cash flow advantage; but to qualify, the items purchased and claimed have to appear on an HMRC online list or be accompanied by a certificate from a Government Department.

ECAs would be even more effective if they could be applied to a completed structure that incorporates innovative design and not just one that contains innovative products. It is possible, and indeed desirable, to design buildings with minimal mechanical and electrical equipment, but this would not presently attract ECA incentives. This is perverse since the completed building should have an enhanced capital value – but it is currently the manufacture of plant and machinery that is incentivised, rather than the more efficient buildings that would result from designing it out.

Recommendation 6.16: That Government should extend the right to claim Enhanced Capital Allowances to low carbon whole building structures.

Industrial Buildings Allowances (IBAs) were previously available on all industrial buildings and gave annual tax relief of 4% of the capital cost. Since April 2008, the allowances are being reduced by 1% per annum, leading to complete withdrawal by April 2011.

Recommendation 6.17: That Government should reinstate, or even increase, Industrial Buildings Allowances for low carbon buildings or components, including pre-manufactured, to reduce the cost base and encourage more efficient construction processes.

Under current R&D tax credit arrangements, £1 million can potentially attract £245,000 if the route is plotted correctly. In the Coalition Governments consultation on R&D tax credits, expected winter 2010, the industry could present a case for a specific scheme for low carbon construction. At present, the construction industry is making a relatively low number of claims under this scheme, in 2008-2009 only 125 claims were made and only £5 million of relief was received out of a total of £980 million[50].

Potential reasons for this may include the visibility of R&D tax credits. Claims are made *after* the expenditure has been incurred, and the benefit is normally hidden in the accounts as a line item in the notes to the tax rationale. If R&D proposals were accepted for tax credits in advance, this would allow the benefit to be factored into research proposals.

Recommendation 6.18: That Government should allow pre-acceptance of research and development proposals for R&D tax credits.

6.4.6 Payment schedules

Payment schedules used in the construction industry could be less onerous. There are advantages to the supply chain in having time-based milestone payments, related to identified

50 Department of Business Innovation & skills

work stages, without the detailed evaluations which are both expensive and which frequently lead to disputes. Lessons may be learnt from other sectors which use different Terms of Payment. Government leadership is already being demonstrated in this area.

6.4.7 Business models

The transition to low carbon presents an opportunity to looking at completely different business models for the production, ownership and occupation of buildings – such as the hiring or leasing, with ownership retained by the supplier. Rather than simply refurbishing existing structures, the buildings can be designed and constructed in such a way as to facilitate a second or third life, by allowing them to be relocated. This would apply in particular to "commodity" buildings, rather than signature buildings, but it would denote no less attention to the whole life value of the product. Indeed, that would be the primary objective, but with carbon factored in.

Such buildings would be long-life and re-usable, rather than temporary. Offsite construction is sympathetic to this approach. There is however an issue concerning if and how such buildings can be reused at the end of their lease periods. And it would likely only be applicable to some markets. For this concept to be successful there is a need for a critical mass to support the business model.

Fundamentally, though, new business models could create the link between those who design and develop buildings and those who have a direct interest in their subsequent performance in occupation and use. This can be missing from current development models.

6.4.8 Company accounts

Inclusion of an energy cost line in the Profit & Loss accounts would bring carbon to the attention of Boards. In the latest Companies Act, there is provision for a Statutory Instrument to require such a line, possibly in the form of a note to the accounts. It would, however, need to be carefully constructed to be meaningful.

6.4.9 Long term commitments

The Boards of businesses that own their buildings are particularly interested in reducing costs over the medium to long term, rather than just one-off savings. Efficiency improvements could be achieved by commitments to provide year-on-year cost reductions in return for a long term agreement; or by a commitment to supply say 10 buildings in a development programme for the price of 9.

Whatever the arrangement, a long term commitment means that suppliers do not have to start afresh each time, so transaction costs are reduced, there is continuous improvement, and economies of scale can accrue.

To realise the full potential to save cost and carbon, customers may need to accept some restriction of choice, so that cost constraint, energy efficiency and broader measures of sustainability become clear drivers.

6.4.10 Harvesting the benefits of innovation

Once in contract, there is limited incentive to identify cost savings if the financial benefits of that innovation are reaped entirely by the client. One way to achieve this may be to utilise the tax system or by greater use of intellectual property rights.

An example is the DG2 water pump – see Box 6.1

Box 6.1

Foremans Relocatable Building Systems is just one example of this innovative approach. The design of the 'build off-site' DG2 booster pumping station pushes the boundaries of modern construction thinking to deliver significant capital efficiencies and carbon reductions. Construction time on site has been reduced by 50%, and operational and capital carbon emissions are reduced by about 65%.

Source: Anglian Water and the @one Alliance.

6.4.11 Accreditation schemes

The industry would benefit from the wider adoption of global quality standards for processes and products which build to accreditation of a whole service offering.

In contrast to the oil, car and aerospace industries, which have global guidelines, the construction industry generally uses national schemes.

Registration schemes such as that offered by Lloyd's Register or by BSI under the ISO quality standards would provide an accreditation protocol that is global, providing endorsement for

low carbon building design, construction, manufacture, products and project management. They would ensure risks are controlled through defined processes. By the demonstration of best practice and by synchronising the supply chain this would improve "right first time, every time" delivered quality, and offer a higher degree of assurance to customers. It would also underpin an export offer in low carbon construction.

Here too BIM can provide the environment in which that synchronisation can take place.

Recommendation 6.19: That the industry should explore the potential for Accreditation Schemes, such as those operated by BSI and Lloyd's Register, to be adopted more widely.

6.4.12 Financing low carbon retrofit – an example

Energy Performance Contracting, by way of forging a continuity of interest from delivery through to occupation and use, may be a way of financing deep retrofits in buildings by using energy savings to fund energy efficiency measures.

An Energy Performance Contract is a partnership between a customer and an energy service company (Esco) that allows the customer to improve the energy efficiency of its facilities without the need for up-front capital. Typically, year-on-year carbon reductions are generated, reducing building energy consumption by more than 20%, and this is achieved without impacting existing operational budgets.

The mechanism is self-funding and transfers financial and equipment performance risk to the Esco. If the savings target isn't made, the Esco pays the difference.

In the US, as a direct result of the 2005 Energy Policy Act, more than $1.9billion has been invested in more than 400 EPC programmes. To date, however, uptake in the UK is very limited – perhaps inhibited by the traditional, price driven procurement approach. Currently only a few Escos are able to offer an Energy Performance Contract.

Government policy and market "push" has been focused on energy generation, rather than on energy conservation.

However, the IGT is aware of at least one alliance that is being formed to increase the uptake of this concept in the UK, involving commercial property owners and tenants, finance houses, equipment and energy suppliers, facilities management organisations and existing and potential Escos. Its remit is to identify specific impediments to widespread acceptance of Escos and to formulate a plan for overcoming these barriers.

Gazeley project at Chatterley Valley

An example of a development which embraces the concept of 21st Century low carbon building, is the G Park Blue Planet project by Gazeley EZW at Chatterley Valley (http://www.gparkblueplanet.com/). Opened in December 2008, this 32,000 sq m building has achieved a BREEAM "Outstanding" rating.

6.5 Skills

The successful delivery of low carbon buildings will be hugely influenced by the availability and application of appropriate skills at all levels of the construction and property supply chains.

Although there are many issues associated with the skills supply side, and indeed much that is being done to address these, the major challenge is the limited number of demand side measures which encourage the development of low carbon skills. This reflects the way in which the construction and property sector markets operate, and is both institutionalised and long term.

To deliver a low carbon buildings sector will require a general up-skilling of parts of the property and construction supply chain. However for there to be a demand for up-skilling requires clear market incentives which encourage low carbon construction, and without these drivers most skills initiatives will have limited effectiveness. Creating suitable incentives is therefore the priority.

However, the issue of skills affects all parts of the built environment, and this is therefore dealt with in chapter 3 of this report.

6.6 Improved data collection, reporting and use

6.6.1 Introduction

The chronic problem of data has already been highlighted in this report, but three specific actions are recommended in respect of non-domestic buildings:

- the use of procurement systems to increase formal, structured post- occupancy evaluation as a requirement for public buildings and incentivised for private buildings
- the extension of Display Energy Certificates (DECs) to private buildings and the provision of access to energy data contained within them
- the inclusion of both embodied and operational carbon in the standards (code for sustainable homes, and other schemes which may be directed at non-domestic buildings) in such a way that the same units are used so as to enable whole life carbon to be estimated

6.6.2 Background

Of seven principal barriers identified in the IGT's Emerging Findings report, published in March 2010, one (number 4, re "the evidential gap between design and performance") is wholly to do with data. Four others depend upon reliable data:

- number 3, re up-skilling to address design, construction and operation
- number 5, re the focus on whole life cost/value rather than initial capital cost
- number 6, re tools for CO_2 accounting
- number 7, re the lack of client drivers

Data is needed or will be used by:

- design teams, to enable and equip them to deliver better design (knowing how innovations perform in practice) for lower carbon buildings
- clients, to enable benchmarking and to develop the building brief for lower carbon buildings
- building users, to drive change towards lower carbon buildings and to manage them in operation
- and policy makers, to target plans and incentives, and to monitor progress

A number of key items relating to the collection and use of data emerged from a recent industry workshop convened at BIS:

- project decision makers (design teams and clients) do not use data even where it exists because it is, or is perceived to be:
  - fragmented
  - unvalidated
  - out of date
  - 'hidden' in academic papers or research reports
  - limited (partly because of fears over litigation)
  - and biased towards projects that have been successful

- data that would be useful to project decision makers seeking to improve the energy performance of buildings includes:
  - a database of consumption with a good level of granularity, with information on utilisation, special energy needs and design features, so that data sets are not distorted by ignoring such information
  - building case studies – energy consumption data, post occupancy evaluation, running costs, user management etc
  - embodied carbon data, to enable design and product choices to be made whole life carbon to be evaluated

- data would be more widely used if:
  - design tools are updated with new data
  - publications are updated with new data
  - software is updated against actual performance

A business case for the investment in improved data will be created by demand from design teams. This demand in turn will be created by demand from building owners (incentivised through regulation etc), who in turn will be influenced by occupiers once they are more knowledgeable about building performance (through DECs for example). This circle recreates itself in almost every issue addressed by the IGT.

6.6.3 Extension and use of DECs

6.6.3.1 Issue

Display Energy Certificates (DECs) show the actual energy usage of a building and, when displayed, raise awareness of this to all occupiers of the building and to the visiting public. They are currently mandatory only for buildings with a total usable floor area over 1,000m^2 that are occupied by a public authority or by an institution providing a public service and frequently visited by the public.

If the 80% reduction in carbon emissions required by 2050 is to be met, non-domestic buildings such as offices, shops, hotels and industrial buildings must make their contribution. At present, such buildings account for 18% of the UK's total carbon emissions – and this figure has been virtually static since 1990, because a reduction in emissions has been offset by a floor area increase.

Relying on the existing (2010) Building Regulations to improve performance is not enough. While new buildings will have substantially lower carbon emissions than existing buildings, the rate of demolition is so slow that emissions would actually *increase* by 30% by 2050.

6.6.3.2 Rationale

In its report *Building the Future Today*, the Carbon Trust has reported that the carbon footprint of the country's 1.8 million non-domestic buildings can be reduced by 35% by 2020, compared with 2005 levels, with a net benefit of £4.5 billion delivered to the UK economy through energy savings. Their analysis suggests a carbon reduction of 70 to 75% at no net cost to the UK: a major impact for little cost.

Action therefore needs to be incentivised, and the starting point for this has to be a reliable measure of current consumption, to create awareness and to establish a basis from which to measure improvement.

DECs can provide such a benchmark. In summary, they should:

- provide (by contrast with the EPC) a benchmark of real energy performance, from which year-on-year improvements can spring – and which can actually motivate the improvements where the rating is shown to be poor

- provide tenants (who are responsible for the DEC) with data that can differentiate buildings and therefore start to feed into customer preference – and hence value
- through feedback, provide a basis for the study of, and drawing of lessons from, differences between the predicted performance of a building (as evidenced by the EPC) and its actual performance (as evidenced by the DEC). Similarly, provide a body of data as to the first performance of the existing stock, and the efficacy of measures for improved performance
- provide a common measure of energy performance either singly or in aggregate for a portfolio of properties

With effect from July 2013, the obligation to display DECs will be extended to commercial buildings over 500m^2 in floor area. There is, however, considerable support (for example from the British Property Federation, the British Council for Offices and the British Council for Shopping Centres) for the idea of extending DECs into the private sector sooner than this.

For some, gathering this data will be necessary to meet their obligations under the Carbon Reduction Commitment. Others are already proactively collecting the data and displaying certificates.

If, however, there is to be market transformation, so that occupiers start to rate energy efficient buildings more highly than inefficient ones, then the display really needs to be mandatory – as otherwise those with poor buildings will simply opt out.

Recommendation 6.20: That Government should bring forward the mandatory requirement for the posting of Display Energy Certificates in all non-domestic buildings as quickly as possible, and in advance of the July 2013 date required by the EPBD, with ratings and accompanying recommendations made widely available.

It is acknowledged that there would need to be careful consideration of the costs of implementing this recommendation (as for all recommendations in this report), and in particular its impact on small and medium sized enterprises.

A clear trajectory should also be declared: for example, to improve DEC ratings from an average of an E rating today to C by 2020 (with all buildings achieving at least an F rating by the same date, where this is cost-effective), and to achieve A ratings by 2050. Currently, the biggest group of DECs, at 29%, are at the lowest (G) rating. 41% come in at F or lower, 63% at E or lower, and 87% at D or lower.

It is recognised, however, that there is a process to go through before new regulation could be brought in, and that time can also be used to address aspects of the DEC system that

could make them more truly diagnostic of the performance of the building or simpler to prepare, including:

- taking better account of occupational density or equivalent intensity of use – as more intensive use of an asset makes a useful contribution to energy efficiency when expressed in terms of emissions per person accommodated
- revisiting benchmarks to address concern (for example on the part of retail operators) that the system is insufficiently sensitive to different patterns of energy performance between different building types
- determining how to respond to inadequate data in rating a building
- simplifying the assessment process, particularly for portfolio owners

These issues are believed to be fixable – and worth fixing; and there should also be potential for interaction between smart meters and the DEC.

Recommendation 6.21: That the benchmarks used to calculate DEC ratings should be reviewed in order to ensure that they are consistent, robust and that they effectively differentiate on energy performance for buildings of different types, and the process should be simplified to the greatest practical degree.

In the meantime the things to be fixed are certainly not grounds for doing nothing. Many companies are already posting DECs, and during the course of the IGTs work others have shown a readiness to do so. The CBI has also indicated a preparedness to work with CLG to see how DECs could be encouraged in the commercial sector on a voluntary basis, to inform the process of suiting them to a mandatory roll-out for different types of commercial premises. To aid this process, the greater the degree of transparency the better, making the data accessible and increasing market pressure; so property owners might consider making DECs accessible online.

The IGT therefore re-states as a formal recommendation the proposition included in the Emerging Findings.

Recommendation 6.22: That companies operating in the construction and property sectors should, as an act of leadership but also to aid transformation of the market, commit to the voluntary posting of Display Energy Certificates in their own buildings, following the practice mandated for public sector buildings and applying the same principles.

The industry should also consider the need for an independent, authoritative and objective hands-on advice, implementation and support service for owners and users of F and G-rated buildings to help overcome the barriers to action and so accelerate improvements in this sector. There is, as yet, no visible move to establish a "Hub" of the kind recommended in the report for the existing housing sector, but the need and the logic are the same, particularly for the owners of older and possibly neglected buildings.

Once businesses understand the performance of the buildings they own and occupy, they need to understand what opportunities are available to improve it, and the present lack of this information in readily accessible form remains a barrier to action. This occurs right across the life-cycle of the built environment and is particularly acute in the case of carbon emissions from existing non-domestic buildings, where current data is inconsistent and incomplete [1]. Energy management is not business-critical for most organisations, and as a result they tend not to have the necessary skills and expertise. There is therefore a continuing need for Government intervention through the sponsorship of advisory and delivery bodies such as the Carbon Trust.

Recommendation 6.23: That the Government, working with the industry, should ensure that businesses have access to independent, objective advice and support on the implementation of energy efficiency measures.

There will be parallel issues relating to EPCs, and in addition there is a timing issue with EPCs. Information needs to be available at the point of decision-making. Currently, EPCs may not be made available until the completion of a sale, which undermines their value. It is also essential that the requirements to obtain and display an EPC are enforced.

Recommendation 6.24: That EPCs should be required to be displayed at the point of marketing for non-domestic buildings in order to maximise their influence on buyers' decision-making.

6.6.4 Post occupancy evaluation (POE)

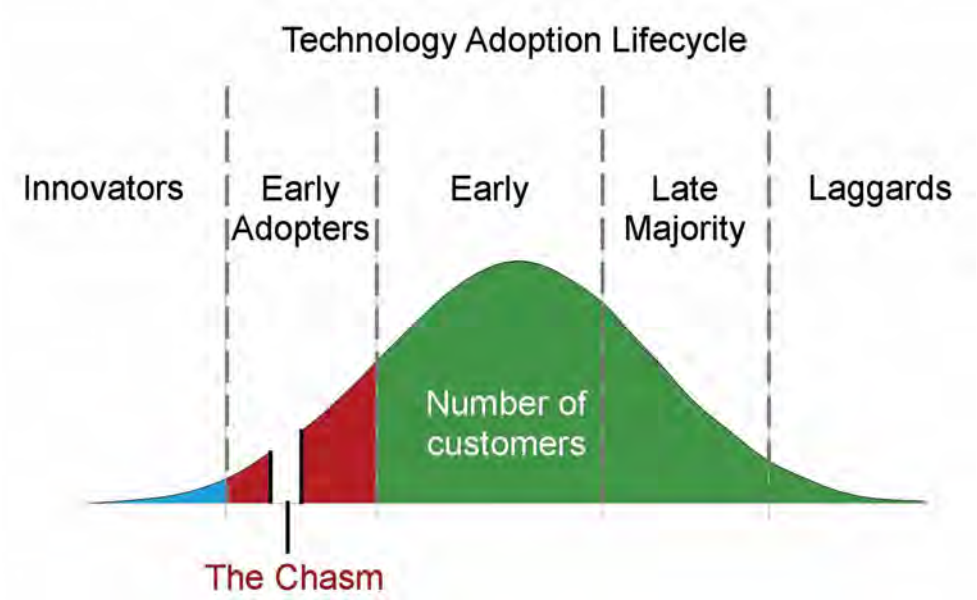
6.6.4.1 Issue

Rapid innovation is challenging conventional slow feedback mechanisms that provide evidence of actual, by comparison with predicted, performance. This is inhibiting uptake of new products and processes for lack of a solid basis for instilling investor confidence.

6.6.4.2 Rationale

The conventional route for the adoption of a disruptive innovation follows a normal distribution curve, peaking with "the early majority". Not all innovations make it through, however. Innovators will try pretty much anything, but without the development of confidence, or some other compelling force such as regulation, take-up will be very slow or the product can fail totally before widespread adoption (the "chasm" or "valley of death").

Figure 6.6: Technology Adoption Lifecycle



In general, it is difficult to isolate the effects of a construction innovation from the many other variables of operation, and so feedback on the value of individual innovative investments is rare. There is little incentive for individual contractors within construction teams to spend money on operational feedback, and frequently insufficient expertise by the occupier to establish long or short-term evaluation programmes. This is a market failure rather than a technological difficulty, and calls for practical incentivisation.

6.6.4.3 Gap analysis

POE methodologies exist in a number of forms, allowing competitive procurement of a POE programme. However, its take-up is very limited at present. There are isolated cases (such as the former *Building Schools for the Future* programme) where the value of POE has been recognised and outline requirement policy stated, but the programme has not been embedded in local procurement practice.

6.6.4.4 Basic cost/benefit analysis

The strategic brief for the Technology Strategy Board's *Energy Efficient Whitehall* competition provides helpful data on four government buildings recently subject to POE and intervention as a precursor to more radical changes. Analysis of just one year, following POE, on the four buildings reveals that savings over 6 years (50% savings over 5 years) yields simple financial benefits of £13 for every £1 expended. This equates to carbon abatement costs of £17/Tonne CO_2, which compares favourably with technologies such as air or ground source heat pumps.

6.6.4.5 Delivery body

The framework for public procurement is developed through the ERG, and it is essential for the ERG to have strong linkages with the private sector to provide information cross-over and to help deliver best practice. Decentralised procurement is likely to be more effective if ERG guidance is coupled with financial incentives. It can reasonably be argued that reduction in the use of energy is at least as valuable as the generation of green electricity, and usually considerably less expensive.

The cost of the exercise would generally fall to the project evaluated, or financial support could be a legitimate candidate for Community Energy Saving Programme (CESP)-type funding, where electricity tariff supplements are used to encourage carbon abatement measures. This approach would make the initiative cost-neutral to government.

6.6.4.6 Use of information arising

Outcomes from the POE processes are highly sensitive to context and are of principal value to the immediate supply chain of the project. In addition, any mandatory wider distribution of detailed results could result in uncritical and bland reporting, defeating the purpose of project and project team improvement. Additionally POE data is necessarily very detailed with potential security implications for some sites.

Given this, it is likely that learning will be largely viral, with lessons learned transmitted within participating companies as a means of avoiding future liabilities. Whilst recognising the attractiveness of harvesting feedback from large numbers of projects, the creation of a central repository and the systematic analysis of results would be costly and probably commercially unsustainable. However disclosure to valid research activities should be encouraged where circumstances permit, and lessons could be gathered within Government, or private sector special interest bodies, and disseminated on a non-attributed basis.

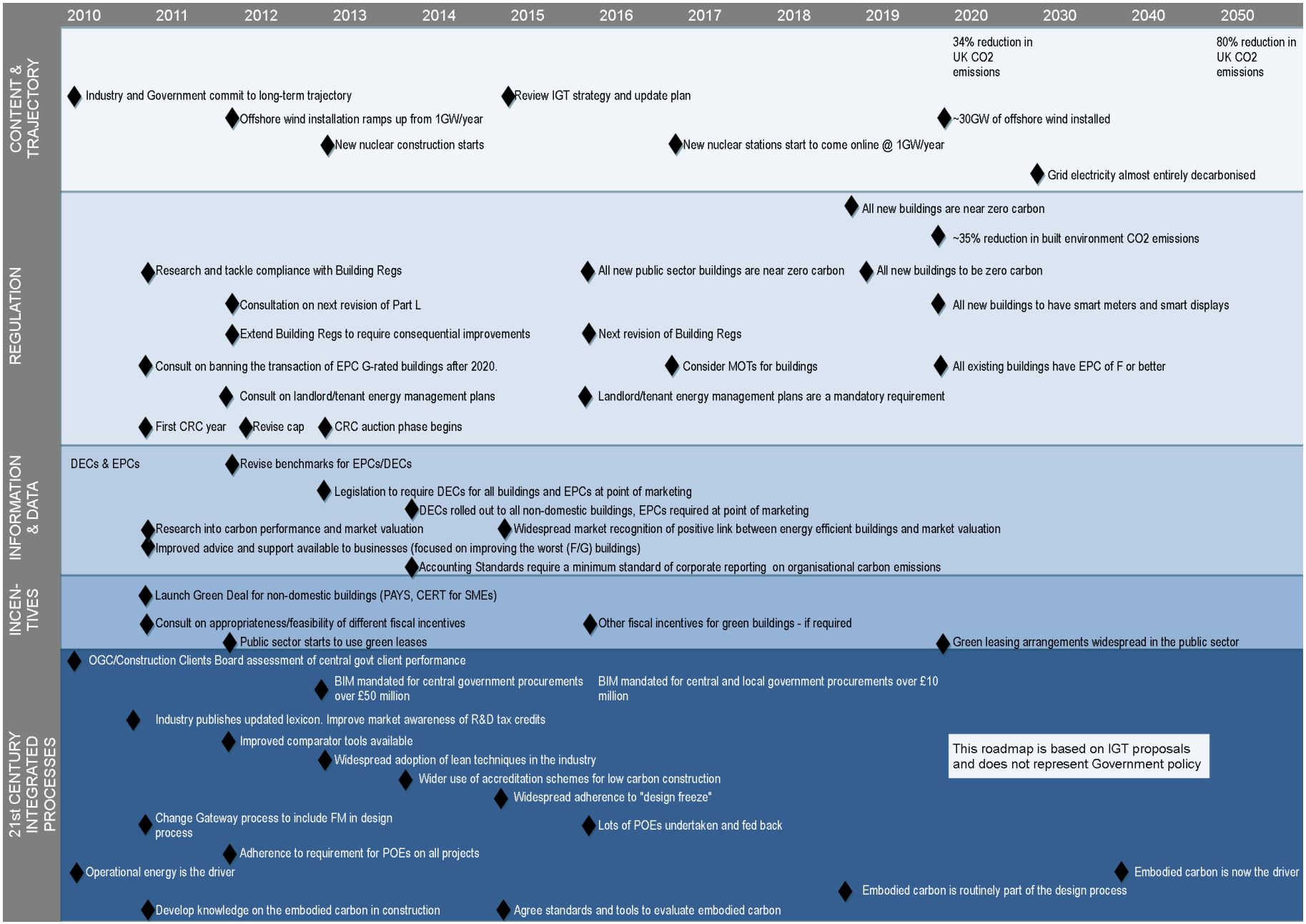
6.6.4.7 Delivery responsibility

Once activated as a requirement through the ERG, the ongoing responsibility for procurement of POE would be devolved to each project. Actual contracting purchase of POE is likely to be through a main contractor responsibility alongside other compulsory activities such as air tightness measurement. Wherever procured it is important that POE is understood to be a process involving all the construction team, operator and user interests.

Recommendation 6.25: That Government, though the ERG, should mandate a requirement for post-occupancy evaluation on all central Government projects, implemented through the procurement process and requiring the involvement of design and construction members beyond the point of practical completion.

6.7 Embodied Carbon

As with skills, the issue of embodied carbon (or energy) affects all aspects of the built environment, and so this too is dealt with as a cross-industry issue in this report (see chapter 3).


2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2030
2040
2050
CONTENT & TRAJECTORY
34% reduction in UK CO2 emissions
80% reduction in UK CO2 emissions
Industry and Government commit to long-term trajectory
Review IGT strategy and update plan
Offshore wind installation ramps up from 1GW/year
~30GW of offshore wind installed
New nuclear construction starts
New nuclear stations start to come online @ 1GW/year
Grid electricity almost entirely decarbonised
REGULATION
All new buildings are near zero carbon
~35% reduction in built environment CO2 emissions
Research and tackle compliance with Building Regs
All new public sector buildings are near zero carbon
All new buildings to be zero carbon
Consultation on next revision of Part L
All new buildings to have smart meters and smart displays
Extend Building Regs to require consequential improvements
Next revision of Building Regs
Consult on banning the transaction of EPC G-rated buildings after 2020.
Consider MOTs for buildings
All existing buildings have EPC of F or better
Consult on landlord/tenant energy management plans
Landlord/tenant energy management plans are a mandatory requirement
First CRC year
Revise cap
CRC auction phase begins
INFORMATION & DATA
DECs & EPCs
Revise benchmarks for EPCs/DECs
Legislation to require DECs for all buildings and EPCs at point of marketing
DECs rolled out to all non-domestic buildings, EPCs required at point of marketing
Research into carbon performance and market valuation
Widespread market recognition of positive link between energy efficient buildings and market valuation
Improved advice and support available to businesses (focused on improving the worst (F/G) buildings)
Accounting Standards require a minimum standard of corporate reporting on organisational carbon emissions
INCEN-TIVES
Launch Green Deal for non-domestic buildings (PAYS, CERT for SMEs)
Consult on appropriateness/feasibility of different fiscal incentives
Other fiscal incentives for green buildings - if required
Public sector starts to use green leases
Green leasing arrangements widespread in the public sector
21st CENTURY INTEGRATED PROCESSES
OGC/Construction Clients Board assessment of central govt client performance
BIM mandated for central government procurements over £50 million
BIM mandated for central and local government procurements over £10 million
Industry publishes updated lexicon. Improve market awareness of R&D tax credits
Improved comparator tools available
Widespread adoption of lean techniques in the industry
Wider use of accreditation schemes for low carbon construction
Widespread adherence to "design freeze"
This roadmap is based on IGT proposals and does not represent Government policy
Change Gateway process to include FM in design process
Lots of POEs undertaken and fed back
Adherence to requirement for POEs on all projects
Operational energy is the driver
Embodied carbon is now the driver
Embodied carbon is routinely part of the design process
Develop knowledge on the embodied carbon in construction
Agree standards and tools to evaluate embodied carbon

7. Infrastructure

7.1 Introduction

Our future quality of life and economic prosperity depend upon existing and new infrastructure. There would be little societal and economic activity without energy generation and distribution, water supply and disposal, transportation by rail, road, sea and air, waste reuse and disposal, and communications. Flood defences protect our homes and businesses from inundation by river and sea. Effective infrastructure is therefore essential for supporting economic growth and productivity, and for promoting social wellbeing, playing a key part in spreading the means to generate national wealth around the whole nation. Infrastructure networks also play a vital role in supporting an increasingly mobile business community to function and to compete in global markets.

Conversely, ineffective infrastructure creates an overhead burden on the nation as a whole – in 2005, the CBI estimated that road congestion costs the UK up to £20 billion per year[51].

The nature of our national infrastructure therefore needs to be a primary driver in the move towards a low carbon economy.

However, many of the largest sources of carbon emissions are currently associated with the construction, operation and maintenance and, in particular, usage of infrastructure – especially in the energy, transport, water and waste sectors.

It follows, though, that infrastructure also provides the opportunity to establish a carbon benefit stream over very long time horizons. Greening the electricity supply grid, for example, or constructing new rail systems that lead people to travel less by road or air, will bring substantial carbon and other benefits to our society.

However, with extremely challenging and tightening carbon reduction targets, lengthy lead times, and unfavourable investment and delivery conditions for new and upgraded infrastructure, there is a critical, time-sensitive need for concerted action by industry and Government. These reductions can only be accomplished by a holistic vision which marries the goals for national prosperity and development with practical steps towards implementing low carbon solutions – and the DECC 2050 Pathways Analysis report, published in July of this year

51 '*Roads – Delivering Choice and Reliability*', Department of Transport, July 2008, quoted in National Infrastructure Plan.

reconciles many of those drivers, and provides a basis for making the critical choices that will determine the nature of our strategic infrastructure for generations to come.

7.2 The UK infrastructure sector today

Many of the industry-wide issues outlined in this report apply equally to infrastructure, but the infrastructure sector also has particular characteristics.

Each sub-sector (road, rail, water etc) is vertically structured with a few key players, which militates against innovation or cross-fertilisation of knowledge and learning from other parts of the industry – whether within the UK or internationally. Furthermore, this vertical structure is poorly integrated, with a small number of very large players and a large number of smaller sub-contractors.

The relatively small number of clients generally fall into one of four categories:

- Central and Local Government and their delivery agencies (such as the Highways Agency, Transport Scotland or Transport for London)
- organisations such as Network Rail
- regulated utilities (such as in the energy and water sectors)
- and privately owned facilities (such as ports and airports)

The majority of operators are privatised and all are effectively regulated, with long term investment decisions guided by Government, either through funding or the planning process. Even where infrastructure is not technically subject to regulation (such as the highway network), its modus operandi – for example in scheme evaluation, prioritisation etc, operated through a single agency, leads to practice comparable to the regulated industries in the way projects are brought forward.

By its nature, infrastructure provides a support function to the wider economy, and is either implicitly or explicitly rationed either by price (peak hour tickets, for example) or by availability (for example by congestion), or both.

Infrastructure projects also have significant interface with wider social and economic policy and their performance is highly visible to the population, which is increasingly intolerant of failure, so resilience and dependability are prime considerations.

Typically, infrastructure provides a single function throughout its design life. Infrastructure that does reach the end of its useful life can be re-used for new purposes (such as the redevelopment of former docks or airfields for housing), but more often land used for infrastructure is simply re-used and upgraded ad infinitum (as in road widening, sewage systems, railway corridors and the like). As an example, the A5 trunk route originated as part

of the Roman road Itera II. In Anglo-Saxon times the route became known as Watling Street, then became a major national highway in 1815 by Act of Parliament, and was only partially replaced by the parallel M1/M6 corridor from about 1960.

Given the historic lack of client appetite for innovation in infrastructure, there is a real or perceived culture of risk aversion in the UK, with no coherent industry-wide strategy or leadership for research and development. Consequently, companies working in the sector (designers, contractors and suppliers) typically develop competitive advantage via cost efficiency rather than investment in cutting edge innovation; and this applies equally to steps that might be taken towards the provision of low carbon solutions. This needs to change. The goal for the industry must be to design and deliver infrastructure which results in improved carbon efficiency, at lower cost, in ways that meet the needs of the nation. This change towards a more innovative approach can be guided by industry, but needs to be driven by client demand.

Britain's infrastructure now faces unprecedented cross-sector challenges, which include:

- the transition to a low carbon economy
- the cost of replacing or modernising ageing infrastructure assets
- responding to increasing levels of demand, including those caused by population growth
- improving the resilience of infrastructure to man-made and natural shocks, including those caused by climate change

7.3 The National Infrastructure Plan

The Government has recently published the first UK National Infrastructure Plan which aims to provide a broad, integrated, cross-sectoral vision and plan for the infrastructure investment required to underpin the UK's growth.

The ambition is to provide clarity of the infrastructure which the country needs, to identify the key barriers to mobilising private sector resources and to commit public resources where necessary. Specific actions required include smarter use of public funding, improved private sector investment models, actions to encourage new sources of private capital and actions

to address regulatory barriers that stand in the way of greater private sector investment. It notes that some £200 billion of investment is planned in infrastructure investment over the next five years; and Infrastructure UK (IUK) estimates that demand for investment in economic infrastructure could be in the range £40-50 billion per annum until 2030 and possibly beyond. This is significantly above historical levels.

The National Infrastructure Plan will be updated on a regular basis, with the first update by the end of 2011. The Economic Affairs Committee of the Cabinet, chaired by the Chancellor of the Exchequer, with support from IUK, will take a new role coordinating infrastructure planning, prioritisation and policy development across Government. Infrastructure UK will also engage with future departmental infrastructure investment plans to ensure they are consistent with the Government's overall approach.

7.4 The role of the economic regulators

In its Emerging Findings, the IGT set out a number of propositions for review of the role and duties of the economic regulators in the context of treating carbon reduction as a priority in infrastructure programmes (Propositions12, 13 and 14).

As noted, addressing regulatory barriers that stand in the way of greater private sector investment is a key action for IUK, which has established an expert panel to inform it in its discussions with the regulators. Its view is that economic regulation is an important enabler of infrastructure investment, and that the existing regime of independent economic regulation has supported the delivery of significantly higher levels of investment compared to the position before privatisation – for example, the £85 billion invested in water infrastructure over the last 20 years.

The industry also acknowledges that the constraint of economic regulation has produced good examples of the integration that is sought more widely in construction, with infrastructure providers and their supply chains working together to complete the necessary programme of work within the cost/price limits allowed by the regulator. This form of cost-led approach, whilst still meeting all of the performance criteria, could be a model for wider adoption in the public works programme beyond the regulated sector.

IUK's view is that it is vital that the independence of the economic regulators and the consistency, certainty and credibility of the existing regime is retained.

However, it is important to consider whether every aspect of the existing regime remains fit to respond to the future investment challenge. IUK's work in this area has identified a number of issues. These are not common to all sectors but include:

- duties of regulators: regulators having a multitude of duties, some of which reflect wider environmental and social objectives, and it not always clear how they should balance these
- clarity of long-term strategy:
  - regulators being given insufficient clarity of long term strategic direction and the balance of different objectives by Government
  - regulated companies being provided with limited clarity by regulators around the regulatory outputs against which they are required to deliver
  - regulated companies carrying out inconsistent amounts of long term business planning without it always being clear how regulators have taken these long term plans into account as part of the price setting process
- dialogue between regulators: regulators engaging between themselves only on a limited, informal basis as to how they might achieve common objectives – such as how they approach similar aspects of price control, promoting competition and addressing consumer impacts including affordability

To address these issues, the Government is taking the following actions:

- The Department of Energy and Climate Change and the Department for Environment, Food and Rural Affairs are conducting reviews of the roles and functions of, respectively, Ofgem and Ofwat, while some of the regulators are reviewing their approach to price setting
- The Department for Business, Innovation and Skills (BIS), working with Infrastructure UK, will publish a common set of principles for economic regulation; with BIS coordinating work across Departments to ensure that competition and consumer outcomes are delivered effectively (including across regulated sectors) in the context of the Government's wider reforms of competition and consumer bodies
- in light of the reviews referred to above, and the review to consider extending the use of the regulatory asset base model, the Government will report, by summer 2011, on whether further cross-sectoral action is required, drawing on the conclusions of these reviews and on the views of key stakeholders and recognising the need to maintain investor certainty.

7.5 Infrastructure in a low carbon economy

De-carbonising infrastructure presents a number of particular challenges for the construction sector and for political decision making. As with other areas of the built environment, the characteristics of infrastructure in a low carbon economy must include low embodied energy and low through-life operational carbon costs. The semi-permanent nature of infrastructure means, however, that infrastructure must also be designed and constructed to be flexible, adaptable and easily upgraded (or downgraded) to meet changing demand through the adoption of new technologies and materials through life.

Other than perhaps at limited times in our history (e.g. in the Victorian era or in the 1950s), and in common with the general habit of the construction industry and its clients, the UK approach to the provision of infrastructure has been to focus on the initial construction and associated capital cost, with minimal attention to the requirement for lifelong maintenance or future upgrade. The lack of an integrated approach to infrastructure policy has meant that projects are reviewed on their individual merits rather than as part of a wider system, or system of systems. This too needs to change in a low carbon economy; and the conceptual design of infrastructure must be developed by engineers to meet not only the local project requirements but also to ensure that the solution is optimised within the wider policy framework.

Designing agile infrastructure systems that minimise the embodied and whole life carbon costs of the constructed elements, by balancing these against the carbon benefit stream that the system provides to the wider economy, requires a paradigm shift for the construction industry.

Three major themes are identified that have particular resonance across infrastructure:

- the challenge of optimising the wider performance of infrastructure in favour of carbon reductions – the question of compromise

- the impact of the very long life of infrastructure projects on carbon reduction – the question of duration
- the capacity of the construction industry to de-carbonise specific infrastructure projects – the question of balancing capital carbon (CapCarb) reduction against operational carbon (OpCarb) reduction

Each of these themes touches on a range of issues for the industry, and these are explored below.

7.6 Opportunities for carbon reduction – the question of compromise

7.6.1 Carbon as a new driver

Optimising the performance of infrastructure is challenging. There are a number of key performance requirements which need to be weighed and balanced, including:

- health & safety
- accessibility
- various sustainability drivers, including land use, landscape, ecology and biodiversity, the historic environment, water, energy, material use, waste management, transport effects on neighbours, relations with the local community, considerate constructors etc
- other obligations to society, such as contributions under Section 108 agreements, Building Regulations and the need to provide a proportion of affordable housing in developments
- resilience (for critical infrastructure, at least) to maintain or restore capacity in the event of failure, however unlikely

To this list is now added the challenge of carbon minimisation, not only in the permanent works but through operation and use, on a whole life basis.

With the exception of carbon, none of these requirements are mutually exclusive. It is possible to set and achieve high targets in all of these social and environmental requirements on the same infrastructure project, albeit at a price.

Carbon is different. De-carbonising infrastructure by other than a "business as usual" approach requires making difficult decisions over performance.

Today, carbon minimisation for infrastructure projects means choosing the "least bad" construction option that satisfies all other sustainability parameters. Decisions principally take place around the selection of materials and techniques once a concept solution has already been determined, and design is already advanced. Over a period of years, innovation in

construction materials and methods will gradually reduce the embodied carbon in infrastructure projects; but while a useful and necessary way forward, this business-as-usual trajectory does not address the opportunity to achieve substantive carbon reductions in infrastructure through an integrated approach to the evaluation of options and performance.

A step change in carbon reduction in infrastructure requires the key decisions to be made much earlier in the design process, at the concept stage, based on evaluation by the industry of the overarching delivery requirements, against potential compromises on accessibility, landscape, ecology, biodiversity or other issues – all in order to minimise the capital and operational carbon through life.

Radical compromise based on better, tighter engineering may be acceptable and should be tested. Conventional wisdom that factors of safety cover up for random errors or provide a level playing field for the choice of construction materials must be challenged, as any resulting over-design represents wastage and a carbon opportunity cost.

Research will be needed to tease out where margins are included in infrastructure design that are leading to the use of unnecessary material or over-engineering. For example, infrastructure will be designed for extreme loading events (hurricane force winds, earthquake loading, extreme rainfall) where the probability that this event occurs may be extremely low. An increased tolerance of damage under extreme events, through more detailed modelling of infrastructure performance, would also lead to substantive carbon reductions. Lessons from other industries (such as the aerospace sector) should be applied to infrastructure, with increased requirements for testing and rigorous failure mode analysis.

Designing in points of weakness in infrastructure that could be replaced in the event of overload, and using technology to monitor safety, is another opportunity to create a step change in design philosophy. Such a change would reduce both cost and carbon, as design solutions become optimised.

Paradoxically, better resilience in infrastructure provision may allow such solutions to be implemented, as the consequences of failure of an individual component diminish.

Recommendation 7.1: That infrastructure owners, policy makers and regulators should set out clearly the policy context and performance requirements for their infrastructure needs and engage with the industry to agree optimal conceptual infrastructure solutions that facilitate substantive carbon reduction before determining any specific approach.

7.6.2 Codes and standards

In the delivery of better engineering for infrastructure, the weight of Standards, Specifications, Guides and supporting documents creates a large inertia against change. As an example, a recent review of requirements in basements and underground structures showed that there are 163 such references covering just the structural and geotechnical aspects of the design[52]. Many traditional guides in this sector are out of date and incompatible with the new Eurocodes; and introducing new concepts can take many years, especially in the case of proposals to reduce design margins.

Conflicting requirements and conservative design lead to over specification. For example, requirements for maximum crack widths are traditionally based on damage classifications that stem from the 1970s. The control of crack widths in concrete to prevent water ingress into underground structures requires meeting very onerous requirements, calling for substantial additional steel reinforcement and concrete cover. Is this always necessary?

Relaxing such requirements by even a small margin could in many cases reduce cost and carbon; and current industry research into techniques for optimising the design of underground structures suggest that there are substantive savings of both materials and cost to be achieved through better engineering.

The time frame for the development of Codes, Standards and Best Practice Guidance is considered in chapter 2 of this report, but shortening all parts of the innovation cycle, from identification of the need to widespread take-up across industry, is particularly vital to achieving the full carbon reduction potential from infrastructure projects.

One development that would allow more rapid evolution of better standards would be if more research into low carbon infrastructure was commissioned and the results more widely disseminated. The various infrastructure operators should be stimulated to commission more applied research within their field of endeavour, and the quantum and value of such research could be assessed by their regulator as a measure of the health of their industry.

52 *'An update on basement legislation Codes and Guides'*, Andrew Bond (Geocentrix) and Duncan Nicholson (Arup), Emap Basements and Underground Structures Conference, 6 October 2010.

7.6.3 Tools, methodologies and data

The development of quantifiable measures for the assessment of the environmental sustainability of infrastructure is essential.

There are several standards for carbon quantification and other relevant environmental measures that are relevant. At the European level, and as noted in chapter 2 of this report, CEN/TC350 is developing a European framework standard for assessment methodologies relating to buildings and construction materials. Whilst the emphasis is currently on buildings, much of this work, particularly on construction materials, is highly relevant to the wider built environment, including infrastructure.

Careful consideration should be given to the boundaries to be set for life cycle assessment, including the consideration of transport burdens at all stages, and the balance between embodied impacts and operational benefits (such as reductions in congestion), where these can be influenced by design decisions.

CEEQUAL, which is owned jointly by a range of shareholders including the Institution of Civil Engineers (ICE), Crane Environmental, CIRIA, the BRE Trust and Costain, is an assessment and awards scheme for civil engineering projects. It is focused on environmental management rather than quantified performance targets, and is neither a quantification nor carbon measurement tool.

As currently framed, CEEQUAL provides a measurement of the degree to which environmental management has been incorporated within a civil engineering project, and provides a broad assessment of the degree to which environmental sustainability has been taken into account through the procurement process. However, non-carbon aspects make up more than 90% of the marks and it provides no guidance on the overall contribution of the asset to a low carbon economy or to the achievement of broader sustainability goals.

BREEAM is an environmental assessment method that does provide quantification of impacts but with a focus on buildings through the different life cycle stages. Whilst there are significant differences in the evaluation of environmental and sustainability impacts for infrastructure projects, BREEAM provides a useful model which could probably be adapted.

Research is needed to establish the scientific basis for new standards for infrastructure assessment, and there is no reason why this could not be a holistic carbon assessment tool set within the context of a system for measuring broader aspects of sustainability. Any such tool does, however, need to recognise that many of the most substantial changes necessary to reduce overall carbon usage have to be made early in the project evaluation process before the detail adequate to draw up fully measured Bills of Quantities is available.

Recommendation 7.2: That the industry needs to develop models to support the evaluation of optimal conceptual infrastructure solutions and detailed approaches that take a systems engineering approach to the balancing of the capital and operational carbon costs and benefits.

Alongside the application of quantification methods for infrastructure to assist decision making and design, the collection of data on the performance of buildings and infrastructure will provide valuable evidence of the actual through life impact of the construction works. Such smart data will provide real-time evidence of overload, environmental impact and safety that can inform future maintenance and upgrade decisions, all directed at maximising the potential for carbon reduction. The use of instrumentation on major civil engineering works is well established during the construction phase. Research is needed on how such technology may be deployed, monitored and interpreted through life on all infrastructure projects.

Comment is necessary on a suitable discount rate for carbon. The long lifetime of infrastructure and the economic benefits that infrastructure provides for future generations suggests that the discount rate for carbon in the consideration of projects should be significantly lower than for other types of construction project. Resolution of this issue is important for the construction industry in the evaluation of carbon reduction potential for future infrastructure solutions, particularly when infrastructure is seen as a system of systems. Without clear guidance on the long term discount rate for strategic carbon reductions on future infrastructure projects the opportunity to identify major carbon reductions will be limited to 'business as usual' project de-carbonising – through material selection, for example.

7.6.4 Education and training

The roll out of new techniques and better engineering requires a transformation of the education, training and continuing profession development activity for construction professionals active in the infrastructure sector.

Typically professional training of chartered engineers is overseen predominantly by the institutions and is robustly managed up to the level of Chartered Engineer. Beyond this, Continuing Professional Development is patchy and there is no concerted effort by industry to enforce training throughout a career. This is a cultural issue for the sector that is a potential barrier to the implementation of new techniques or the updating of existing methods. Old practices are perpetuated due to lack of awareness of new ones. Although new tools and analytical methods may be rolled out rapidly (particularly numerical analyses and modelling), experience shows that the underlying design principles and approaches evolve very slowly.

In the transition to a low carbon economy, there will be a requirement to fulfil new roles in the evaluation of options for infrastructure, and in the design of infrastructure that will

require new skills and techniques to be learnt and applied in a short time scale. New skills will reflect the introduction of new decision making tools, it is likely that senior and mid-career engineers will be most affected.

The challenge of re-training mid-career construction professionals with long experience of infrastructure project delivery to adopt new design and evaluation methods should not be underestimated. Furthermore, many clients responsible for infrastructure assets are dominated by professionals from other backgrounds, and the industry needs to consider how to communicate effectively with client organisations if they are to see the full benefit of any re-training programme for their own professionals.

The involvement of the professional institutions, particularly the Royal Academy of Engineering in communicating the importance of re-training for low carbon design will be critical to the early achievement of carbon reduction targets on current infrastructure projects. Research is needed in this area as well, to ensure that evaluation models developed by the construction industry for infrastructure are effectively deployed throughout the supply chain.

7.7 The impact of long project life on carbon reduction – the question of duration

Most national infrastructure has an effectively indefinite life. Demographic changes and political pressure to improve the connectivity of the nation faced with the drivers of wealth creation and quality of life means that the country needs more, not less infrastructure in the decades ahead.

In July 2010, DECC published its valuable report (2050 Pathways Analysis) on the long term issues surrounding the UK's energy supply and demand requirements. The six pathways analysed are not prioritised, and nor are they yet policy, but they do provide a framework for consideration as to how the UK may achieve its carbon reduction goals. The DECC study is supported by a pathways calculator to facilitate comparison between options.

The role of the regulators, considered earlier in this chapter, is fundamental to steering infrastructure owners towards consideration of the reduction of carbon. The Energy Act 2010, directed at the regulation of the gas and electricity suppliers, is an example of such legislation. By creating a clear framework for the regulators that incorporates carbon reduction alongside consumer price, the justification of future infrastructure projects will be required to prioritise carbon over wider sustainability issues. This in turn provides a steer for infrastructure owners to develop long term policies that incorporate carbon reduction as a key driver for option evaluation by the construction industry.

Planning also has a role to play, through consideration of the National Policy Statements (NPS). Promoters of new infrastructure projects are required to comply with planning requirements in order to gain statutory consent; and in assessing a scheme, the planning authority is obliged to give full regard to all relevant NPS designated by Parliament. Inclusion of carbon reduction requirements in the NPS is therefore another important policy driver. The wider framework now emerging from the work of UK and DECC should provide a basis for the construction industry to cooperate with infrastructure owners in the development of long term infrastructure policy for carbon reduction. Developing such policy is essential if the industry is to identify major opportunities for carbon reduction in infrastructure projects at a conceptual level before de-carbonising the chosen solution in detail.

In this respect, the work of the ICE Learned Society Committee to create a route map towards lower carbon infrastructure is welcomed (see section 7.9).

7.8 Capital carbon v operational carbon – the question of balance

Evaluation models are needed for infrastructure projects that can provide a basis for decision making that takes into account not only the Operating Cost of Carbon (OpCarb) but also the Capital Investment of Carbon (CapCarb), in the context of the wider advantages and benefits for society and the very long lifetime of the built assets.

Balance is about recognising that to maximise the potential for carbon reduction from infrastructure projects requires consideration of the OpCarb as part of the wide system. The important function of infrastructure for a proper functioning and prosperous civil society through life has already been referred to. Before the proposed solution is confirmed (for example, a new road widening scheme, rail network upgrade, sewer system replacement), it must be assessed as part of a complete system and tested against the requirement to maximise the potential for carbon reduction on a whole life basis.

As in general construction, adequate tools to do this do not exist at present, although the ICE work discussed above will form an important element once verified data has become available.

The majority of capital carbon emissions in infrastructure projects are embodied in the construction materials used (notably the production of concrete, steel and asphalt

from raw materials) with additional contributions occurring in transportation and construction work. For infrastructure the contributions from transport can be much larger, particularly for earth fill where the embodied carbon in a bulk excavated material is much lower than one that has been manufactured.

There is an urgent need to gather data for typical infrastructure projects across the sectors (Energy, Transport, Water, Communication and other infrastructure) comparing the embodied energy for creation and maintenance and make comparisons to operational energy in usage, although it is recognised that there will be difficulties in making data comparable between relatively unique infrastructure facilities. Thus a new dual carriageway that contributes towards national connectivity without generating new discretionary traffic in a way that eradicates congestion could be seen as very beneficial while the same carriageway in the same location that encourages longer range commuting and out of town shopping could be seen as detrimental to the low carbon future.

The DECC 2050 pathways document anticipates that Nuclear power will be a major component of the UK's ambitions to decarbonise its electricity supply and proposes that major growth in nuclear generating capacity would be one of the most effective ways to create the grid base load necessary for a decarbonised future. Seen as part of a wider system of systems, the expansion of nuclear power would make a substantial contribution to reducing operational carbon in the transport sector, as well as allowing our transport networks to cut down their direct emissions and noise and hence local disturbance to the communities they pass through.

The Eddington Transport Study, published in 2006, identified many of the same system issues and provides a valuable reference for the new paradigm. The transport network is the backbone of the UK economy, so there is clearly a national interest in directing investment in an effective and efficient manner. Eddington commented on the need to remove pinch points in the road network – crucial to the minimisation of operational carbon as maintaining constant speed and steady flow will maximise engine efficiency. However the UK's rail network is already working at capacity and only minor increases in capacity will be unlocked by the eradication of pinch points. To encourage more people out of their cars and to encourage freight to switch from road to rail, new trunk rail capacity is urgently required.

In addition, to encourage more balanced prosperity across the UK, connectivity from London to the regions needs to be improved. The Eddington report proposed that the transport network should allow business meetings to be accomplished in a journey over a single day. Such rapid connectivity should compete effectively with domestic air travel, which could in turn reduce domestic air travel and liberate scarce runway capacity in the south-east of England. This would allow greater international air capacity to be added to fuel economic growth without taking up significantly more land or causing more pollution to the

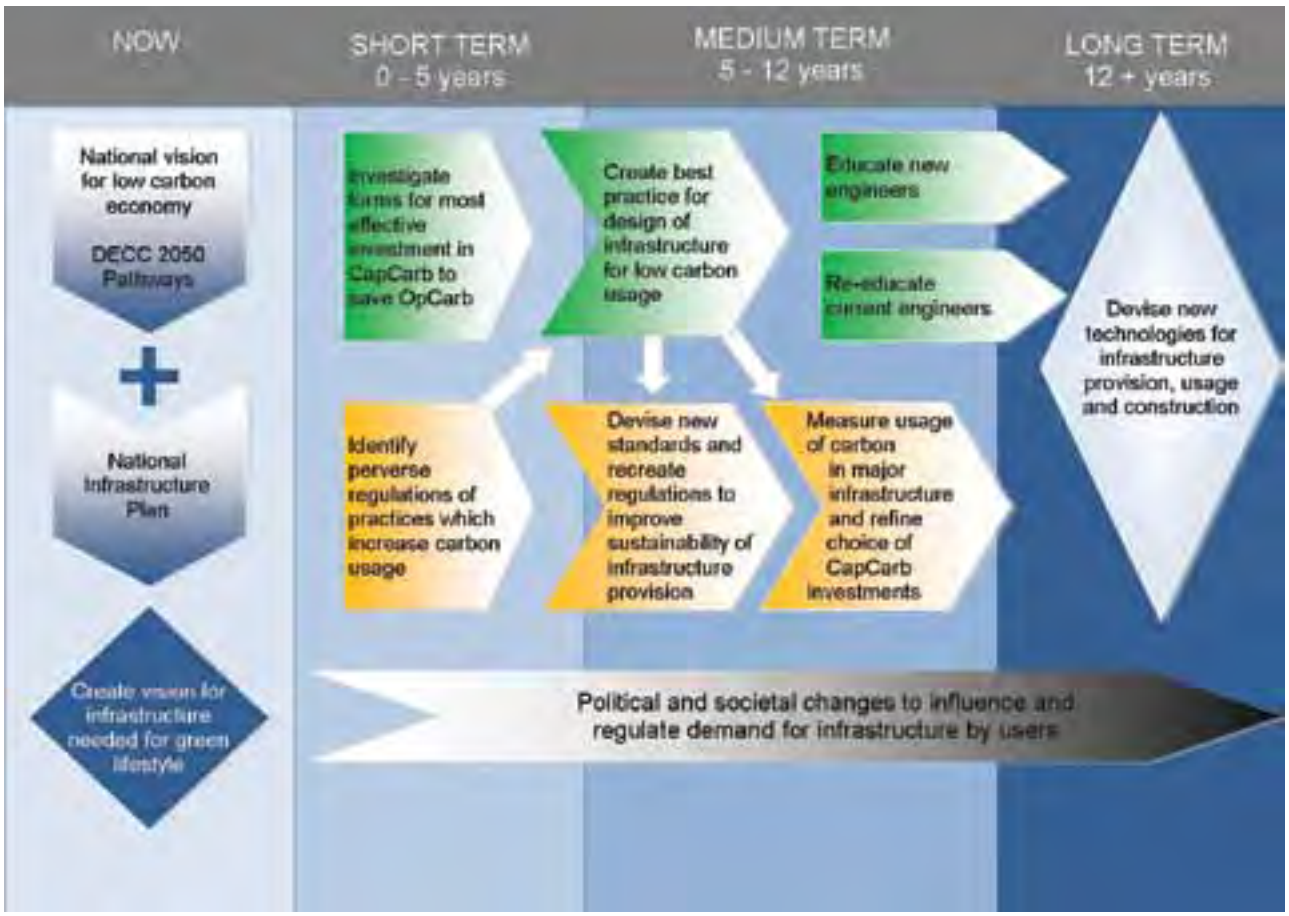
communities around the south-east's busy airports. Hence the creation of an effective domestic rail network, including high speed rail, which encourages people to switch from car or plane to train, should have many broad benefits for the economy without significant increases in carbon usage, especially if the power for the trains can be drawn from a decarbonised grid.

Working with the infrastructure owners, the construction industry needs to recognise that, because balancing the embodied carbon and operational carbon is essential to maximising carbon reduction potential, this will require a radically new design approach – in addition to any measures to de-carbonise individual projects through material selection and construction methods and to de-carbonise the construction supply chain itself.

Recommendation 7.3: That the industry should research opportunities to achieve substantive reductions in carbon from better engineering of infrastructure (through design, standards, specifications and measurement) and roll out the new evaluation models and approaches through industry-wide programmes of training and professional development.

Figure 7.1: Infrastructure Routemap

Source: Institute of Civil Engineers.



7.9 A low carbon infrastructure route map to 2050

The Institution of Civil Engineers has set in train a process to lead to a low carbon route map towards 2050. The purpose of this route map, which is intended to be usable by October 2011, is to ensure that the professions who create infrastructure together with their clients are clear on the major step changes necessary to prioritise carbon reduction. Given the long periods of service, clarity is needed now about the form of infrastructure that will be needed in 2050 to ensure that the transition is made as rapidly as possible if the infrastructure sector is to play its part in the 80% reduction required.

A broad framework for the exercise (a route map for the route map) is included and the steps that have been provisionally identified are:

1. To gather accurate data showing the current amount of carbon used in each of the principal areas of infrastructure and the split between carbon invested in the creation of the asset ("Capital Carbon" or CapCarb) and carbon used in its operation ("Operational Carbon" or OpCarb). In most aspects of infrastructure, OpCarb is expected to dwarf CapCarb, so investment of carbon in creating facilities that use less carbon in operation is a sound national investment.

2. To identify the future shape of infrastructure required, the nation needs to have greater clarity on the reason for its usage of carbon. For example, transport is a major user of carbon but is also vital for the generation and of wealth right across the country, so such paradoxes need to be addressed – the questions of compromise and balance.

3. To challenge current design and construction practices and assess whether design codes or regulations need to change where they perversely increase CapCarb without proportionate benefits.

4. To define the best practice guidance steps for low carbon infrastructure needed for both clients conceiving and commissioning infrastructure projects and for the professional teams who realise those projects.

5. To propose a programme of education to ensure that new professionals embarking on their careers, as well as professionals who are already qualified, are equipped with the skills necessary to change the way things are done.

6. To create a regime where new technologies, methods and products with the promise to reduce carbon usage by infrastructure can be quickly assessed, trialled and experience disseminated.

7. To stimulate an environment where the CapCarb and OpCarb used in each part of infrastructure is continually measured and the results digested and fed back into industry in ways that are easily understood so that innovation is encouraged.

These steps are consistent with the DECC 2050 pathways and the National Infrastructure Plan in the clarity those documents provide about the future shape of the UK's national infrastructure. As fundamental examples, a decarbonised UK economy will need twice as much electricity generation capacity, a smarter grid and efficient methods of energy storage.

Road transport is always going to be a significant component of the transport network and the trunk road network needs investment to cut the carbon wasted by congestion at pinch points; and for some routes increased grade separation and flatter alignments to reduce the carbon that would be expended by those heavy goods journeys not amenable to being switched to rail or water.

Box 7.1 An example of OpCarb vs CapCarb

Recent research at Cambridge University is beginning to show how consideration of the carbon reduction potential from infrastructure must balance OpCarb and CapCarb in the concept stages if the maximum carbon reduction is to be achieved. In one example of the analysis of a new motorway project, the OpCarb component is shown to vastly exceed the CapCarb over even quite short evaluation periods. Consideration of the road alignment shows that as heavy vehicles use considerably more energy to climb steep gradients, it is a great deal more effective in terms of carbon reduction over the project lifetime to reduce motorway gradients to a minimum in the construction phase through additional earthworks. A "business as usual" approach, focused on just de-carbonising the construction works in isolation, would conclude that minimising cut and fill by following the topography contours would be the appropriate solution.

If we are to meet the commitments of the Climate Change Act, then carbon reduction needs to be taken into virtually every design decision in this way, from concept to final detail.

7.10 Specific elements of the plan to decarbonise

It is clear that all infrastructure will be affected by prioritising carbon reduction, but four elements are key to the transition plan.

7.10.1 Distributed energy and heat

As noted in the IGT's Emerging Findings, a substantial part of the challenge to produce zero carbon new buildings, and to reduce the carbon emissions of existing ones, will need to come

from a programme of delivering renewable energy. It is currently envisaged that this will take the form of a number of distributed energy solutions, irrespective of the overall energy strategy for de-carbonising the grid.

There are likely to be substantial crossovers between new and existing, residential and non-residential properties. Indeed, if heat and power are taken together there are real benefits in looking at all sectors together.

However, looking just at zero carbon new-build housing, the 'stand alone' cost of the energy component, delivered through micro generation technology, is currently estimated at between £8,500 and £11,200 per dwelling[53]. Even at the lower range, and based on an annual new build programme of between 219,000 dwellings[54] and 240,000 dwellings, the total investment could amount to say £2 billion to £2.75 billion per annum if individual dwelling solutions are deployed.

If this is extended to existing housing, and to non-domestic buildings, then the figure grows very considerably and makes it essential to explore more cost-effective solutions. This could be by:

- systems that cover multiple buildings and building types (community solutions)
- economies of scale
- product and process innovation providing more efficient and/or cheaper systems

The opportunities for creating scale should be a matter for study by local authorities, and the Local Carbon Frameworks pilot programme now being taken forward in DECC, which challenges local authorities to work with individuals, householders, commerce, business communities and others to optimise carbon reduction at the local level, presents an opportunity of doing that.

Whilst it is for local authorities to consider what could be generated locally, this needs to be addressed within the context of what might be better delivered centrally, via a de-carbonised grid, in the interests of overall efficiency. Local authorities also need the skills and resources to assess the potential for deploying renewable energy or district heat (whether by CHP or a conventional district heating system in their region.

There is great potential for a well-meaning programme to fail to deliver its potential, given that the choice of an appropriate system flows from a careful analysis of demand – and this is once again likely to be hindered by poor or absent data.

53 Zero Carbon Homes Impact Assessment, Table 7, Department for Communities and Local Government, July 2009.
54 Assumed supply of housing, as Zero Carbon Homes Impact Assessment, for Communities and Local Government, July 2009.

The industry might therefore consider the practicality of producing an "expert system" which, although it can never substitute for a fully engineered proposal, may give local authorities and communities considering local heat or power a framework within which to test the principle at the outset, and the detail as it emerges.

7.10.2 Support infrastructure for electric vehicles

As more and more electric vehicles appear on the road, there will be a need for the infrastructure – principally charging points – to support it. At first these may be on-street or in public car parks (the City of Westminster has 12 on street and 48 in its car parks), or in shopping centres (Leicester's Highcross Centre has over 100), but will eventually be as widespread as parking spaces themselves.

The 'Plugged-In Places' infrastructure framework was launched on 19 November 2009 with the objective of creating a critical mass of infrastructure in between 3 and 6 lead cities or regions in the UK, to support the early market for electric vehicles. The Government has asserted its commitment to mandate a national recharging network in the Coalition Agreement and has now started the bidding process for the second round of funding under the 'Plugged in Places' scheme. The lessons learned from these cities or regions would then be used to inform the future development of a national recharging infrastructure.

Apart from the work involved in laying in this infrastructure, the requirements of electric cars will need to be reflected at every scale of building, urban design and national infrastructure.

7.10.3 High speed rail

Following public consultation and subject to decision by the Coalition Government and the passage of enabling legislation, the first HS2 route will run from London to Birmingham, with a connection to the existing rail network at Lichfield.

The proposal as published, in HS2 Ltd's report, comprises 205km of route, of which approximately 20km will be tunnelled. In addition some 45 significant viaducts would be required along with around 250 smaller bridge structures and 4 major stations. At current UK rates, the mid-point construction cost, with margin for risk, is estimated at £16.6 billion.

The proposed construction period assumes commencement of works in late 2017, with construction completion in early 2024, followed by testing and commissioning. The critical path is expected to run through the tunnelling and the major works needed to reconstruct and expand London Euston station.

As part of its Report to Government[55], HS2 Ltd carried out a high level qualitative assessment of the capacity of the UK construction industry.

55 *'High Speed Rail: London to the West Midlands and Beyond'* submitted by HS2 Ltd on 31 December 2009 and published by the Secretary of State for Transport on 11 March 2010

Assuming Crossrail is built to its currently published programme, there will be a relatively small gap in time between the conclusion of the major tunnel and station works on that programme and the commencement of similar activity on HS2. This is by far the most significant deliverability factor considered. Crossrail has developed proposals for a tunnelling academy to ensure appropriately skilled labour and HS2 Ltd has pledged support for this initiative and to maintain its momentum after the lifespan of that programme assuming the HS2 proposal is implemented.

The extensive earthworks and structural activity on the line of route generally are not considered exceptionally demanding when spread over the construction timescale.

On the basis of this work, and assuming no significant concurrent construction resource challenges in other, non-transport sectors (such as energy), HS2 Ltd judged that the project is within the capacity of the industry without risk of abnormal price inflation arising from overheating, even though the project is expected to create 10,000 jobs.

Both the previous and current governments have stated support to the creation, over time, of a high speed rail network beyond the initial proposal from London to Birmingham, so this is the fist phase of a potentially long-running programme.

7.10.4 Nuclear power

The National Infrastructure Plan has confirmed that new nuclear power stations will be part of the solution for decarbonising UK electricity generation, provided that no public subsidy is required. The various private sector consortia that are gearing up for new build have a stated intent to deliver up to 16 GWe by 2025. This amounts to 10-15 new reactors each costing approximately €5bn billion (of which over £1.5 billion is in civil engineering and building works), which will represent a total investment in the UK of approaching £100 billion once all supporting works are included.

There are a number of other challenges faced by government and potential investors, including obtaining nuclear site licences, planning consents and permits; ensuring other infrastructure will be able to accept the new power plants; the restructuring of the energy market and a desire for a carbon floor price to support low carbon generation, as well as confidence in the on-going capital and operational costs stretching over several decades.

Given that the last nuclear power station in the UK became operational 15 years ago, the challenge to the domestic industry is to develop the ability to compete with existing overseas supply chains to deliver the required standards of safety, 'nuclear' (right first time) quality, predictability and reliability of delivery on time and budget, and to demonstrate their ability to develop stakeholder relations including with local communities, productivity and positive industrial relations.

Skills perceived as being in short supply include specialist steel workers with experience of working on nuclear power plants and site supervisory staff who understood the high technical and quality demands of building and running a nuclear power plant.

This needs major investment in the UK supply chain by leading companies in the skills capacity and capability to support new build: programme management and technical support, engineering and construction, and the provision of plant and equipment. For those seeking to sell into this market, and for the sake of a healthy and skilled construction sector, there is no time to lose: it cannot wait until firm orders are secured.

There is also a desire to work with SMEs and establish joint ventures at all levels to work more efficiently and share best practice.

An exercise on lessons learned from the recent and current nuclear programme, conducted by Lancaster University for the engineering alliance "Engineering the Future", which includes the Institution of Civil Engineers and Royal Academy of Engineering, reached some key findings in respect of design and construction, including:

- that there needs to be a highly qualified team to develop the design, secure the safety case, and plan the procurement and construction schedule in collaboration with main contractors
- that trade contractors need to be of high quality and experienced in nuclear construction or taught the necessary skills and requirements for quality and compliance

New build on this scale will create upwards of 18,000 sustainable new jobs and training opportunities in both nuclear (c 40%) and conventional (c 60%)[56] construction, at a time when it will not only have to continue to support the existing nuclear fleet plus decommissioning activities (the Nuclear Decommissioning Authority spends roughly £3 billion each year clearing up the sites of former nuclear facilities across the country and operating its remaining commercial facilities), but also face competition for resources from other large scale infrastructure developments, such as Crossrail and HS2 if approved.

A forthcoming 'toolkit' to be published by the Civil Engineering Contractors Association provides specific practical advice on how many of these challenges can be overcome, leading companies through a detailed check lists across the key client requirements.

Other UK industry and best practice bodies such as the Nuclear Industry Association (NIA), Constructing Excellence, Cogent, the Nuclear Advanced Manufacturing Research Centre (NAMRC) and various institutions also need to continue support the industry to address all the challenges.

The issues that face those seeking to entering these markets are those reiterated throughout this report: skills and compliance, collaboration, integration of the supply chain, modern ways of working including BIM, offsite manufacture and the principles of lean production.

There is also a running issue about the relative costs of construction in the UK and overseas, including continental mainland. This is the subject of a separate study by IUK that will report in December, but initial findings, published in the National Infrastructure Plan confirm that the outturn costs of civil engineering infrastructure works in the UK are high in comparison with the rest of Europe, for a range of reasons that go beyond the construction process itself; but also that there are opportunities to deliver projects more efficiently.

Affordability of strategic assets is always going to be a matter of national interest – and particularly for facilities (such as nuclear power) for which the providers have real choices as to where around the world they make their investments. To add to the challenges of skills and modernisation, therefore, it is critical that the wider industry engages with the findings of the IUK study in order to explore every avenue for improved efficiency of both the industry and its product.

The prize is potentially a world-class industry with an exportable offer.

56 Construction Excellence.

7.11 Conclusions

Four key messages flow from the analysis of infrastructure requirements in a low carbon economy.

The first concerns the role of the construction industry in supporting the development by infrastructure owners and operators of policy statements – effectively mission statements for their infrastructure that meet national policy requirements as set down in the NIP and through regulation.

The second concerns the role of the construction industry in developing agreed evaluation models that can interpret those mission statements in the language of civil engineering and permit system analysis to be used to confirm the proposed infrastructure solution. These solutions must balance the investment in new or upgraded infrastructure in CapCarb terms against the OpCarb used in its operation. The assumptions underlying the methodology must be clear and realistic.

The third concerns the urgent need to develop quantification methods for the sustainability assessment of infrastructure. Such measurement tools will need to be supported by research into the opportunities for carbon reduction through better engineering – defined here as solutions that are optimised against key performance criteria, as opposed to solutions that are demonstrated to meet minimum standards across a broad-based checklist. Consideration should also be given to the current fully measured Bill of Quantities approach to quantification, which is less realistic for infrastructure projects and encourages assessment at too late a stage.

The fourth concerns the preparedness of the construction industry, in the full depth of the supply chain, to seize the opportunity of this long-running programme of major works.

And cutting through all four themes, the development of a new design paradigm, supported by new evaluation tools, and new demands made on the supply chain, will require a transformation towards the education and training of new entrants to the engineering professions and to major contracting, and a new emphasis on the re-training and professional development of mid-career engineers.

8. 2050 Group

8.1 Introduction

The 2050 Group, the membership of which is listed in Annexe A, was convened as an integral part of the IGT principally because this is the generation (around 30 years old) that will be moving into leadership roles in the industry as the challenge of combating climate change ratchets up a level. The Second Report of the Committee on Climate Change, issued in June of this year, indicated the need for a step change in the implementation of measures designed to reduce emissions if we are to meet the statutory carbon budgets, and things will get tougher as we move beyond 2020, with at least two-thirds of the reduction still to find and the easy wins already taken.

The Group was asked to look forward to that time and consider two things:

1. whether the principles being applied in considering reductions to date, and over the next decade, set the right trajectory for the period beyond 2020

2. how the structure of the industry might need to differ so that it is best organised to meet the challenges beyond 2020 - in short, what kind of industry they feel they will need to be working in if construction is it to make its full contribution to decarbonising the economy

This is a summary of its full report, which can be accessed on the IGT website.

8.2 Consensus recommendations

Based on its own deliberations, and a wide range of interviews across the industry, the Group made a number of recommendations which coincided with those emerging from the other workstreams of the IGT. These recommendations, made to a broad range of audiences – from the Government through to the Group itself, included:

For Government:

Government needs to incentivise change and innovation in the drive towards a low carbon built environment, and should therefore:

- lead the way on whole life carbon procurement
- encourage low carbon behavioural change more widely across society
- establish the right combination of other incentives or penalties, including the use of legislation if necessary, within the context of a long-term plan
- adopt procurement methods that take into account and reward the value created in carbon reduction, and judge proposals on a whole life basis
- ensure that local authority planning departments have the right skills to identify carbon reduction opportunities that may occur on single buildings, or at development, street or neighbourhood scale, or in the way a development is served by infrastructure

For the industry:

The 2050 Group made more recommendations for the construction industry than any of the other workstreams. Its headline concern is that the industry should not view potential changes to its traditional business models as a threat, but should concentrate on the opportunities presented to it and on the global prize.

Recommendations for industry which were common with other workstreams included:

- the role of the industry in educating its customers and itself - for example, through the creation of centres of excellence
- the development of clear plans for housing, schools and health programmes and infrastructure to allow businesses to plan and invest
- more effective collaboration between the institutions - for example, through the establishment of cross institution advisory panels
- simplification of the delivery of standards
- above all, a more integrated industry

There is also much common ground about the changes in the structure and practice of the industry that will be a necessary part of it rendering itself fit for the transition to low carbon, including:

- greater collaboration and integration, and more interdisciplinary working, commencing with education
- the use of standardised and simplified appraisal and assessment tools (BREEAM, LEED, Cradle to Cradle, Carbon Profiling etc), and the clear labelling of construction products with verified data on their embodied carbon, energy performance and environmental standards
- more prefabrication/modular construction potentially leading to standardised products suitable for export
- increased use of passive techniques
- more sophisticated controls
- the formal accreditation of the end result
- the routine use of post-occupancy evaluation

8.3 Unique recommendations

The Group also made a number of recommendations which were unique. These are covered in more detail below.

8.3.1 A unified industry

The Group envisage a future beyond 2020 in which holistically designed, low carbon sustainable buildings and structures are the norm, not an afterthought or something that is done to gain a "reward". In this world, the better control of waste, increased use of passive techniques that minimise energy and water consumption, more prefabrication and modularization are anticipated as the ways in which buildings are designed, built and operated.

The Group is wary of rating tools that could lead to a "tick box" mentality as this could do more harm than good, stifling innovation.

A key challenge is to ensure that current industry leaders are not hostages to tradition and established ways of doing business, and shy away from making the changes that will be required if the UK is to meet its Climate Change Act commitments.

Before any of the changes the Group is seeking can be made, Government, the industry and the institutions need to adapt and secure real behavioural change in their own dealings. This can only be achieved through a bottom up approach to multidisciplinary education, starting

with undergraduates and apprentices and rising right up through each organisation and the industry.

The Group believe that it is necessary for this process to begin now. It is not enough for the industry to maintain the status quo and its predominantly reactive stance.

Many in the construction industry have called for more co-operation and collaboration across the whole of the industry – between contractors, their supply chain and the professions, to provide a unified sense of purpose for the sector. The Group consider that mutual recognition is needed across many specialist roles and disciplines, focussed on a quality end product that continues to fulfil the role it is designed for, and which is in demand and valued.

Furthermore, a more integrated industry will be in a better position to communicate with the public as to how buildings work, and how buildings and their systems can be operated to suit their lifestyle at a lower level of energy consumption. This will lead to a low carbon consensus – whilst reducing costs through increased demand.

The Group consider that membership bodies such as the Construction Industry Council or UK Green Building Council could lead collaborative, cross industry communication, ensuring that all parties are simultaneously consulted, informed and trained as each new initiative, legislative change or new or improved technology is launched.

However, consistency of message and standards is critical, and both messages and standards need to carry authority.

Recommendation 8.1: That a multidisciplinary consultation platform is established now, with Government support, to bring together all of the professional, practical and academic energies of the built environment.

8.3.2 Overseas learning and opportunities for export

It is a feature of the Group's report that it looks positively on the overseas opportunities that would emerge for UK businesses from a shift to a low carbon economy.

Paradoxically there is much to be learned from abroad, and many successful practices that have tested in other countries that can be adopted here.

Recommendation 8.2: That Government and industry should work towards greater shared knowledge with other countries and become more unified in their approach to reducing emissions.

Innovation and research should be viewed as both a potential saviour at home and a unique selling point for the UK overseas. A major innovation push, particularly in infrastructure can provide solutions to the UK's carbon and distributed energy challenges, but there is a need to invest in, and encourage, new approaches.

The Group believes that the level of innovation required to hit the 2050 carbon target will not be a linear process, with a start and an end, but rather that change must constantly be encouraged and driven.

The most radical change in technology or approach will become the norm if it is adopted globally, and the UK must seize this opportunity, and lead and manage the change in how design, procurement, construction and facilities management are delivered to achieve a low carbon outcome.

Being a global leader would allow UK construction companies and professionals to sell their skills and products internationally. This should go hand in hand with global leadership in education on the broader theme of sustainability.

8.3.3 Health and well-being

The Group is concerned that, in the haste to move to a low carbon economy, there is a danger of unintended consequences, particularly in respect of health.

Recommendation 8.3: That to avoid the risk of a new generation of sick buildings, the promotion of the health and well-being of occupiers should be placed on an equal footing with the current emphasis on carbon reduction.

Indoor air quality is one such risk. The Group consider there to be a worrying absence of skills regarding indoor air quality in low carbon buildings. This should be addressed as a priority. It is felt that each construction project should have a mandatory Indoor Air Quality Management Strategy Plan agreed by the integrated design at the start of the project. Indoor contaminant targets should be regulated and third party testing of all interior fit-outs and retrofits should be carried out as standard.

Recommendation 8.4: That the industry should agree and implement Indoor Air Quality standards to include Indoor Air Quality plans, and enforceable targets for a maximum allowable concentration of toxic contaminants and emissions in interior environments for buildings with sealed envelopes.

8.4 Behaviour change

The Group want to see more ownership in terms of both fiscal and social responsibility. The drivers for change can be fed into our supply chains and national infrastructure system but ownership identification will drive social change by moving "business as usual" towards carbon reduction commitments. The construction industry needs to recognise and reward innovation and change, not just in its products, but also in its processes and its culture.

In addition, there are tangible opportunities and benefits associated with behavioural change of building users. For instance, reducing the energy demand of buildings to half the current usage can allow the remaining demand to be met by a mix of renewable energy and micro technologies.

To help deliver this behavioural change, the Group feels that a dramatic shift is needed in Government policies, generating greater confidence in the direction of long-term policy and how it will underpin future demand for low carbon technologies, upon which the industry's decision makers can rely.

8.5 The longer term

Finally, some of the Group's thinking reflects the fact that they are looking further into the future. They anticipate a time when the easy wins will all have been taken and there will be tough choices to make about taking down and replacing poorly performing buildings.

More positively, new or emerging technologies may come to our aid, possibly including nanotechnology, more materials designed on the principles of biomimicry, and nuclear fusion.

8.6 Summary

In summary the Group sees the opportunities as well as the challenges of the transition to a low carbon economy. They want to be part of a progressive, socially responsible industry that has modernised both its products and its processes; but they believe that the foundations for that modernisation must be laid now, and they hope themselves to be drivers of change.

Their final recommendation reinforces their commitment to that programme of change:

Recommendation 8.5: That the 2050 Group should continue to work together after the completion of the IGT's final report.

9. Next Steps and Engagement

Although the product of the industry and Government working together, this report is classified as a report by industry to Government. The next formal step is for the Government to respond, which is expected to be in Spring 2011; and it is then for the industry and Government to work together again briefly, to establish what action might be taken forward, and who would be responsible for undertaking it.

The IGT itself will meet twice more: once to consider the Government response, and then once at the end of 2011 – that is, a year after the publication of this report, to review progress.

In the meantime, where recommendations in this report are directed towards the industry, no assumption is made as to who might pick up that recommendation, except in one or two special cases.

"Industry" is also intended to be drawn wide, to embrace the full range of the construction, property and facilities management sectors; on both client and supplier sides, incorporating all parts of each; and including professional, academic and other institutions and special interest groups whose interest extends to the subject matter of this report.

Over the next few months, up to the date of the government response, any individual, company or institution who is interested in picking up or contributing to the work of taking forward a recommendation in this report (or who thinks they are doing or have already done some of that work) is invited to register with the IGT website (www.bis.gov.uk/policies/business-sectors/construction/low-carbon-construction-igt). After the Government response the IGT will seek to put together self-directing teams who can then take that work forward.

There are also recommendations that are implied in the report but not specifically flagged for action; doubtless others that should have been expressed or implied but are absent; and finally some that do not meet with universal approval. These too are legitimate material for a response to the website.

If it can stimulate debate, and play some part in developing a consensus as to the way ahead, it will have more than served its purpose.

10. Acknowledgements

The membership of all of the IGT groups is listed in Annexe B to this report – over 100 people, drawn from industry and Government, and the core IGT team acknowledges the work and assistance of all.

In addition, there have been regular meetings with a cross-Whitehall group drawn from all stakeholder Departments, and their co-operation and assistance is also acknowledged with thanks.

Finally, there have been many studies and reports that have informed these findings, and many organisations and individuals who have offered their assistance to the work of the IGT, whether through their own programmes of work or by direct involvement in the preparation of this report. The contribution of all of those listed in Annexe C, and the many who are not, is gratefully acknowledged.

Annex A: Summary of Recommendations

Carbon and the built environment

Recommendation 2.1: That as soon as a sufficiently rigorous assessment system is in place, the Treasury should introduce into the Green Book a requirement to conduct a whole-life (embodied + operational) carbon appraisal and that this is factored into feasibility studies on the basis of a realistic price for carbon.

Recommendation 2.2: That the industry should agree with Government a standard method of measuring embodied carbon for use as a design tool and (as Recommendation 2.1 above) for the purposes of scheme appraisal.

Cross- industry issues

Recommendation 3.1: That the Government should treat the transition to low carbon as a series of major projects, subject to independent review, and with the normal controls that exist for Government projects that are so designated.

Recommendation 3.2: That Government and industry should establish and publish a transparent, co-ordinated structure for the many organisations involved in research, advice, policy development and delivery for carbon reduction, making clear the role, scope of work and authority of each, and how each connects to Government, whether directly or indirectly.

Recommendation 3.3: That the Government should published an adequately detailed programme of actions expected to achieve the 2050 target of an 80% reduction in carbon emissions.

Recommendation 3.4: That the programme should include interim (say 5-yearly) milestones to show the expected trajectory of work to achieve the planned reductions, to provide the industry with some visibility of the possible nature and volume of work.

Recommendation 3.5: That each Government Department should develop and publish a strategy for producing low carbon buildings of each typology within its programme, consistent with the above programme and trajectory.

Recommendation 3.6: That Government (Efficiency and Reform Group, working with the Chief Construction Adviser) should investigate proposals received from the industry for alternative approaches to the procurement of integrated teams, to establish whether they could be developed into workable propositions, and thereafter be trialled, with a view to delivering, over time, a zero or close to zero carbon building for no more than a building built only to current Building Regulations.

Recommendation 3.7: That Government, industry and the organisations themselves should investigate the desirability, practicality and means of merging Asset Skills, Construction Skills and Summit Skills, so that the integration that is a theme of this report is also reflected in the skills regime.

Recommendation 3.8: That a group comprising representatives from Government, the industry and skills providers is tasked with considering how, in the light of the changing skills landscape, greater collaboration, co-operation and integration between professions, between trades, between trades and professions, and between them and the construction products and materials industry can be promoted to develop a single strategic view on future skills needs.

Recommendation 3.9: That Government and industry should agree a full schedule of data needs for the transition to a low carbon built environment, and a method, source of funds and programme for collecting, analysing and disseminating it.

Recommendation 3.10: That a joint industry/Government group is formed, charged with making clear recommendations to resolve the difficulties summarised above, and a basis for the long term funding of the development and maintenance of carbon compliance tools.

Recommendation 3.11: That the industry should work, through a collaborative forum, to identify when the use of BIM is appropriate (in terms of the type or scale of project), what the barriers to its more widespread take-up are, and how those barriers might be surpassed, leading to an outline protocol for future ways of working.

Recommendation 3.12: That Government and the industry should routinely embed the principles of "Soft Landings" into their contracts and processes, so that a building is not regarded as complete until it performs in accordance with its design criteria.

Recommendation 3.13: That Government should commission a programme of independently conducted, properly funded, published studies of the energy performance of buildings in the public estate built since the introduction of the 2006 revision of the building regulations by comparison with their design criteria.

Recommendation 3.14: That the industry should investigate the scope for setting up a construction-specific accreditation scheme for companies committed to improving their environmental credentials, considering also the different needs and the different business models across the supply chain, to establish the practicality and merits.

Recommendation 3.15: That industry should work with Government to address the above questions with a view to developing a proposition that offers consumer protection to those commissioning work financed by the Green Deal.

Major Projects

Recommendation 4.1: That the industry should set up a Working Group to consider the creation of a body (hereafter Major Projects Review Group, or 'the MPRG') which would become the authority whose stamp of approval would provide sustainability legitimacy for major projects, and be responsible for organizing the capture and dissemination of knowledge and experience gained on projects that fall within its terms of reference.

Recommendation 4.2: To recognise the urgency and importance of climate change, it is proposed that carbon reduction is given greater prominence in Environmental Impact Assessments, with a mandatory target or 'gateway' of performance derived from the MPRG assessment.

Recommendation 4.3: That the industry and Government should work together to use the occasion of the London Olympics as a showcase of how to implement plans for a low carbon built environment, embracing design and engineering; works execution right through the supply chain; materials, product and component manufacture; and all other construction-related services.

Housing

Recommendation 5.1: That Government should publish a working nationwide definition of zero carbon and allowable solutions for new homes that takes full account of the real cost of delivery.

Recommendation 5.2: That further pilots and trials should be encouraged through greater collaboration, and monitored throughout to increase learning and experience, and to ensure the right roll-out strategy is delivered.

Recommendation 5.3: That a consensus on both modelled and actual performance improvement data should be established from the various previous and current studies, through a knowledge-sharing process, to inform what actions need to be taken to deliver the overall target.

Recommendation 5.4: That the industry and Government should develop the very preliminary route map drafted by the IGT into as detailed a plan of action as possible, looking at what needs to be delivered and how.

Recommendation 5.5: That Government, in formulating the Green Deal customer offering, should take full account of all relevant current trials, customer research and feedback from Energy Companies and Retailers.

Recommendation 5.6: That Government, in addition to the Green Deal finance package, should introduce a suite of measures including regulation, fiscal incentives and penalties to ensure success.

Recommendation 5.7: That the industry should establish a Platform or Panel with public-sector funders, to form a collective view on strategic research, development and deployment priorities, creating and owning a Strategic Retrofit Research Agenda.

Recommendation 5.8: That social housing stock should be used to kick start larger-scale retrofit using RMI investment and other funds.

Recommendation 5.9: That Government, with the industry, should set up an Existing Homes Hub to bring together the key participants to formulate and monitor delivery of the retrofit programme, all in accordance with the principles set out above.

Recommendation 5.10: That, based on the assumption that a major programme of refurbishment will start over the next five years, the industry should start by carrying out a full assessment of its ability to deliver.

Recommendation 5.11: That the industry should develop standardised solutions for the refurbishment of existing stock, covering the key processes that will be needed.

Recommendation 5.12: That the industry should, with insurance providers, investigate an assurance and insurance package that meets the needs of consumers.

Non-Domestic Buildings

Recommendation 6.1: That Government should commission research to understand how the market values low carbon buildings – both today and looking into the future, and how incentives interact with the decisions made by owner occupiers, property investors and tenants to build lower carbon buildings and use them more efficiently.

Recommendation 6.2: That Government should review the application of the Building Regulations to refurbishment and tenant fit-out, with a view to introducing more rigorous requirements.

Recommendation 6.3: That Government should support research into the level of non-compliance associated with the EPBD and Part L of the Building Regulations, and the impact of this non-compliance on carbon emissions; to review compliance mechanisms to ensure the greatest impact at the lowest cost to business; and to amend the EPBD and Part L compliance mechanisms accordingly.

Recommendation 6.4: That Government should institute a programme of long term monitoring to review the practical outcomes associated with the EPBD and Part L, to inform future revisions.

Recommendation 6.5: That Government should introduce minimum standards for existing buildings by mandating that all non-domestic buildings should have an EPC-rating of F or better by 2020.

Recommendation 6.6: That Government should signal its intention to use fiscal incentives to create market demand for low carbon buildings, and incentives to operate buildings better.

Recommendation 6.7: That Government should create a low cost loan and/or "pay-as-you-save" scheme to finance investments in capital intensive energy efficiency measures in non-domestic buildings.

Recommendation 6.8: That Government should create an "energy efficiency obligation" scheme obliging energy suppliers to drive uptake of low capital cost measures among smaller energy users, funded through a levy on energy bills.

Recommendation 6.9: That Government should require landlords and tenants co-operate to agree an Energy Management Plan for their buildings, to accompany the DEC.

Recommendation 6.10: That Government should mandate the use of "Green Leases" for buildings occupied by the public sector.

Recommendation 6.11: That Government should address barriers to district heating networks by requiring public sector buildings to act as anchor loads, and encourage the private sector to do the same.

Recommendation 6.12: That the industry and its clients should recognise the critical importance to the adoption of modern methods of construction of a design freeze date that is set at the start of a project and rigorously adhered to, and consider how this can be routinely embedded into the practices of the industry.

Recommendation 6.13: That the industry should work with Buildoffsite to update its lexicon for inclusion in contracts used by the industry, adopting terminology relevant to a 21st century industry, to facilitate the transition to low carbon.

Recommendation 6.14: That Government should mandate the use of Building Information Modelling for central Government projects with a value greater than £50 million.

Recommendation 6.15: That the industry should develop a "Comparator" tool which allows companies to assess accurately the lifecycle cost of different methods of construction and the levels of risk implicit in that assessment.

Recommendation 6.16: That Government should extend the right to claim Enhanced Capital Allowances to low carbon whole building structures.

Recommendation 6.17: That Government should reinstate, or even increase, Industrial Buildings Allowances for low carbon buildings or components, including pre-manufactured, to reduce the cost base and encourage more efficient construction processes.

Recommendation 6.18: That Government should allow pre-acceptance of research and development proposals for R&D tax credits.

Recommendation 6.19: That the industry should explore the potential for Accreditation Schemes, such as those operated by BSI and Lloyd's Register, to be adopted more widely.

Recommendation 6.20: That Government should bring forward the mandatory requirement for the posting of Display Energy Certificates in all non-domestic buildings as quickly as possible, and in advance of the July 2013 date required by the EPBD, with ratings and accompanying recommendations made widely available.

Recommendation 6.21: That Government should commission a review of the benchmarks used to calculate DEC ratings in order to ensure that they are consistent and robust, and that they effectively differentiate on energy performance for buildings of different types; and that the process should be simplified to the greatest practical degree.

Recommendation 6.22: That companies operating in the construction and property sectors should, as an act of leadership but also to aid transformation of the market, commit to the voluntary posting of Display Energy Certificates in their own buildings, following the practice mandated for public sector buildings and applying the same principles.

Recommendation 6.23: That Government, working with the industry, should ensure that businesses have access to independent, objective advice and support on the implementation of energy efficiency measures.

Recommendation 6.24: That Government should require EPCs to be displayed at the point of marketing for non-domestic buildings in order to maximise their influence on buyers' decision-making.

Recommendation 6.25: That Government, though the ERG, should mandate a requirement for post-occupancy evaluation on all central Government projects, implemented through the procurement process and requiring the involvement of design and construction members beyond the point of practical completion.

Infrastructure

Recommendation 7.1: That infrastructure owners, policy makers and regulators should set out clearly the policy context and performance requirements for their infrastructure needs and engage with the industry to agree optimal conceptual infrastructure solutions that facilitate substantive carbon reduction before determining any specific approach.

Recommendation 7.2: That the industry needs to develop models to support the evaluation of optimal conceptual infrastructure solutions and detailed approaches that take a systems engineering approach to the balancing of the capital and operational carbon costs and benefits.

Recommendation 7.3: That the industry should research opportunities to achieve substantive reductions in carbon from better engineering of infrastructure (through design, standards, specifications and measurement) and roll out the new evaluation models and approaches through industry-wide programmes of training and professional development.

2050 Group

Recommendation 8.1: That a multidisciplinary consultation platform should be established now, with Government support, to bring together all of the professional, practical and academic energies of the built environment.

Recommendation 8.2: That Government and industry should work towards greater shared knowledge with other countries and become more unified in their approach to reducing emissions.

Recommendation 8.3: That, to avoid the risk of a new generation of sick buildings, the promotion of the health and well-being of occupiers should be placed on an equal footing with the current emphasis on carbon reduction.

Recommendation 8.4: That the industry should agree and implement Indoor Air Quality standards to include Indoor Air Quality plans, and enforceable targets for a maximum allowable concentration of toxic contaminants and emissions in interior environments for buildings with sealed envelopes.

Recommendation 8.5: That the 2050 Group should continue to work together after the completion of the IGT's final report.

Annex B: Members of the IGT Steering Group and Working Groups

Steering Group

- Paul Morrell, Chief Construction Adviser, BIS (Chair)
- John Armitt, Chairman, Olympic Delivery Authority
- Keith Clarke, CEO, Atkins
- Mark Clare, Chief Executive, Barratt Developments plc
- Keith Clarke, CEO, Atkins
- Dr Stewart Davies, Industry Commissioner, Sustainable Development Commission
- Tony Douglas, CEO, Abu Dhabi Ports Company
- Terry Hill, Chairman Global Transport, Arup;
- Janice Munday, Director, Advanced Manufacturing and Services, BIS
- Nick Pollard, CEO, Bovis Lend Lease UK
- Sunand Prasad, Senior Partner, Penoyre & Prasad
- Nick Raynsford MP, formerly Chairman, Strategic Forum for Construction
- Richard Soper, Managing Director, Bosch Thermotechnology
- Phil Wynn-Owen, Director General for National Climate Change, DECC
- Annabella Coldrick, BIS (Secretary Nov 09 – Mar 10)
- Douglas Matheson, BIS (Secretary Apr 10 – Oct 10)
- Jessica Moore, BIS (Secretary Oct 10 – Nov 10)

Housing Working Group

- Mark Clare, Chief Executive, Barratt Developments (Chair)
- Trevor Beattie, Corporate Director, Homes & Communities Agency
- Professor David Gann, Imperial College Business School; and Group Innovation Executive, Laing O'Rourke
- Neil Jefferson, General Manager, NHBC
- Dave Sheridan, Chief Operating Officer, Apollo Group
- Stephen Stone, Chief Executive, Crest Nicholson
- John Tebbit, Industry Affairs Director, Construction Products Association
- Professor Jeremy Watson, Global Research, Arup
- Gearoid Lane, British Gas
- Samantha Waugh, DECC
- Peter Matthew, CLG
- Peter Whittington, BIS (Secretary)

Non-Domestic Buildings Working Group

- Tony Douglas, CEO, Abu Dhabi Ports Company (Chair)
- Andrew Eastwell, Chief Executive, BSRIA
- Richard Guy, Carbon Trust
- Mike Forster, Strategy Director, BAA
- Richard John, National Energy Foundation
- Paul King, CEO, UK Green Building Council
- Michelle McDowell, Chair, Civil & Structural Engineering, BDP
- Richard Ogden, Chairman, Buildoffsite
- Tom Paul, Business Development, Kingspan
- Liz Peace, Chief Executive, British Property Federation
- John Rivett, Director of Design & Engineering, Wates Group
- Don Ward, Chief Executive, Constructing Excellence
- Stuart Bean, CBI
- Andrew Minson, Head of the Concrete Centre
- Tom Foulkes, Director General, ICE
- Sarah Fielder, CLG
- Clover Summers, CLG
- Dean Thomas, DECC
- John Newman, BIS (Secretary)

Infrastructure Working Group

- Keith Clarke, CEO, Atkins (Co-Chair)
- Dr Scott Steedman, Royal Academy of Engineering (Co-Chair)
- Chris Bolt, Rail Regulator and Arbiter, Tube Lines
- Humphrey Cadoux-Hudson, Managing Director, EDF Power and Nuclear
- Andrew Comer, Director of Infrastructure and Environment, Buro Happold
- James Stewart, Chief Executive, Infrastructure UK
- Graham Watts, Chief Executive, Construction Industry Council
- Tom Foulkes, Director General, Institution of Civil Engineers
- Tim Chapman, Director, Arup
- Barry Blackwell, BIS (Co-Secretary)
- Michael McDermott, BIS (Co-Secretary)

Institute of Civil Engineers Infrastructure Expert Panel

- Peter Hansford, President, ICE
- Paul Buchanan, Director, Colin Buchanan
- Tim Chapman, Director, Arup
- Barry Clarke, Professor of Engineering, University of Leeds
- Peter Guthrie OBE, Professor in Engineering for Sustainable Development, University of Cambridge
- Mike Napier, Strategy & Business Development Manager, Costain
- Martin Pedley, Managing Director, Cementation Foundation Skanska
- Derek Salkeld, Chairman, DS+A Risk Analysis
- Neil Sandberg, Managing Director, Sandberg
- Simon Whalley, Senior Policy Executive, ICE

Major Projects Working Group

- John Armitt, Chair, Olympic Delivery Authority (Chair)
- Murray Bean, Director Construction Solutions, Corus
- Rab Bennetts, Director, Bennetts Associates
- Professor Will Hughes, Reading University
- Andrew McNaughton, Chief Operating Officer, Balfour Beatty
- Roger Madelin, Joint Chief Executive, Argent Group Plc.
- Dervilla Mitchell, Director, Arup
- Barry Blackwell, BIS (Co-Secretary)
- Michael McDermott, BIS (Co-Secretary)

Cross-Cutting Working Group

- Paul Morrell, Chief Construction Adviser, BIS (Chair)
- Michael Ankers, Chief Executive, Construction Products Association
- Cal Bailey, Marketing and Sustainability Director, NG Bailey
- Peter Bonfield, Chief Executive, Building Research Establishment
- Tim Clarke, Divisional Managing Director, Scottish Division, Balfour Beatty
- Tony Iles, Associate Director, Atkins
- Henry Le Fleming, Partner, PricewaterhouseCoopers
- Professor Phillip Jones, Cardiff University
- Richard Saxon, Client Advisor, RIBA
- Sunand Prasad, Senior Partner, Penoyre & Prasad
- Nick Scott, BIS
- Tony Mulcahy, BIS (Secretary)

2050 Group

- Matthew Byrne, Nottingham University
- Robert Corbyn, Director, Low Carbon Energy Assessors Ltd (for the RICS)
- Gareth Evans, CIPHE
- Crystal Fernandes, National Housing Federation
- Nathan Jarman, Turner & Townsend
- Anastasia Kiochou, CIC
- Robert MacDonald, Zero Carbon Hub (for the NHBC)
- Emma Nicholson, Rider Levett Bucknall (for the CIOB)
- Dr Kieran Owens, Queens University Belfast (for the ICE)
- Antonio Pisano, Sheppard Robson (for the RIBA)
- Mark Renshaw, Elliott Wood Partnership (for the IStructE)
- Andrew Stanford, INSIGHT (for the CIAT)
- Anna Whitehead, BIDA
- David Whysall, Turner & Townsend (for Constructing Excellence)
- Morwenna Wilson, Arup (for CIBSE)
- Hannah Collie, CIC (Secretary)

Annex C: Consultees

We would like to thank the following organisations for providing information, advice and support to the IGT and extend our gratitude to the many individuals who have generously given their time and counsel.

- Abu Dhabi Ports Company
- Aldersgate Group
- Alliance of Sector Skills Council
- Anglian Water
- Apollo Group
- Argent Group Plc.
- Arup
- Asset Skills
- Association of Concrete Industrial Flooring Contractors
- Association of Consultant Architects
- Association for Consultancy and Engineering
- Association of Interior Specialists
- Association for Project Safety
- Association of Sealant Applicators Ltd
- Association of Specialist Fire Protection
- Association of Specialist Underpinning Contractors plus
- Atkins
- BAA
- Babcock International
- Baggeley Construction
- Balfour Beatty
- BAM Nuttall
- Barratt Developments
- Bathroom Manufacturers Association
- BDP
- Bennetts Associates
- BIDA
- BIID
- Bosch Thermotechnology
- Bovis Lend Lease UK
- BRE Global
- Brick Development Association
- British Aggregates Association
- British Association of Reinforcement
- British Blind and Shutter Association
- British Ceramic Confederation
- British Drilling Association
- British Electrotechnical and Allied Manufacturers Association
- British Gas
- British Geomembrane Association
- British Gypsum
- British Institute of Facilities Management
- British Institute of Interior Design
- British Marine Aggregates Producers' Association
- British Non Ferrous Metals Federation
- British Plastics Federation
- British Precast Concrete Federation
- British Property Federation
- British Rigid Urethane Foam Manufacturers Association
- British Woodworking Federation
- BSRIA
- Build Off-Site

- Builders Merchants Federation
- Building design
- Building Research Establishment
- Buildoffsite
- Building Services Research and Information Association
- Building SMART
- Burro Happold
- Cala Group
- Carbon free group
- Carbon Trust
- Cardiff University
- Carillion
- Cementation Foundation Skanska
- Cementitious Slag Makers Association
- Chartered Institute of Building
- Chartered Institution of Building Services Engineers
- Chartered Institute of Architectural Technologists
- Chartered Institute of Highways and Transportation
- Chartered Institute of Housing
- Chartered Institute of Plumbing and Heating Engineering
- Construction Institute Research and Information Association
- CITB
- Construction Products Association
- ConstructionSkills
- Civil Engineering Contractors Association
- Clay Pipe Development Association
- Clay Roof Tile Council
- Colin Buchanan
- Comet Consulting
- Commission for Architecture and the Built Environment
- Concrete Centre
- Concrete Repair Association
- Confederation of British Industry
- Confederation of Construction Specialists
- Constructing Excellence
- Construction Clients' Group
- Construction Industry Council
- Construction Skills
- Contract Flooring Association
- Contructing Excellence
- Corus Group
- Costain
- Council for Aluminium in Building
- Creagh Concrete Products Limited
- Crest Nicholson
- Cylon Active Energy
- Cyntra
- Deloitte LLP
- Department for Business Innovations and Skills
- Department for Communities and Local Government
- Department for Environment Food and Rural Affairs
- Department of Finance and Personnel in Northern Ireland
- Department for Transport
- Door and Hardware Federation
- Drilling and Sawing Association
- DS+A Risk Analysis
- East Midlands Development Agency
- EC Harris
- EDF Energy
- Efficiency & Reform Group
- Elliott Wood Partnership for the IStructE
- Energy Efficiency Partnership for Homes
- Energy Technologies Institute
- Engineered Panels in Construction
- Environment Agency
- Engineering and Physical Sciences Research Council
- Energy Savings Trust

- Eurisol-UK
- European Phenolic Foam Association
- Existing Homes Alliance
- Energy Savings Trust
- Faithful + Gould
- Fall Arrest Safety Equipment Training
- Federation of Master Builders
- Federation of Piling Specialists
- Flat Glass Manufacturers Association
- Franklin and Andrews
- Future Conversations
- Futurestream Atelier One
- Good Homes Alliance
- Glass and Glazing Federation
- Guild of Architectural Ironmongers
- Gypsum Products Development Association
- Halcrow
- Hemplime Construction Products Association
- Henry Boot
- Heriot-Watt University
- Highways Agency
- Home Builders Federation
- Homes and Communities Agency
- House Builders Association
- Housing Forum
- Hot Water Association
- HVCA
- ICL Estates
- Imperial College Business School
- Inbuilt Consultancy
- Infrastructure UK
- Institute of Highway Engineers
- Institution of Civil Engineers
- IStructE – Institution of Structural Engineers
- Insulated Render and Cladding Association
- Investment Property Forum
- Kier
- King Shaw Associates
- Kingspan
- Laing O'Rourke
- Lafarge
- Lead Sheet Association
- Lloyd's Register
- Local Authority Building Control
- London South Bank University
- Low Carbon Energy Assessors
- Mastic Asphalt Council
- McCarthy and Stone
- Metal Cladding and Roofing Manufacturers Association
- Midas
- Miller Group
- Mineral Products Association
- Mott MacDonald
- National Association of Rooflight Manufacturers
- National Energy Foundation
- National Federation of Roofing Contractors
- National Federation of Terrazzo Marble and Mosaic Specialists
- National House Building Council
- National Housing Federation
- National Insulation Association
- National Specialist Contractor's Council
- NG Bailey
- NIBC
- Nottingham University
- Nuclear Industry Association
- Olympic Delivery Authority
- Painting and Decorating Association
- Penoyre & Prasad
- PricewaterhouseCoopers
- PRP
- Prupim
- Queens University Belfast

- Ramboll
- Reading University
- Resin Flooring Association
- ResPublica
- Rider Levett Bucknall
- Royal Academy of Engineering
- Royal Institute of British Architects
- Royal Institution of Chartered Surveyors
- Rural and Industrial Design and Building Association
- Rural Town Planning Institute
- Sandberg
- Scottish and Southern Energy
- Scottish Master Wrights and Builders Association
- SGB Services
- Sheppard Robson
- Simons Group
- Single Ply Roofing Association
- Sir Robert McAlpine
- Skanska UK
- Society of British Gas Industries
- Society of British Water and Wastewater Industries
- South Bank University
- Specialist Access Engineering and Maintenance Association
- Specialists Contractors' Group
- Speedy Hire
- SPONGE – Sustainable Development Network for Property and Construction Professionals who share an interest in Sustainable Development
- Sports and Play Construction Association
- Stace LLP
- Steel Lintel Manufacturers Association
- Steel Window Association
- Strategic Forum for Construction
- Sturgis Associates LLP
- SummitSkills
- Sustainable Development Commission
- Sustainable Development Network for Property and Construction Professionals
- Taylor Wimpey
- Taylor Woodrow
- Thames Water plc
- The Edge
- The Tile Association
- The Union of Construction Allied Trades and Technicians
- Timber Trade Federation
- Technology Strategy Board
- Tube Lines
- Turner & Townsend
- UCL Bartlett
- UK Contractors Group
- UK Green Building Council
- UK Steel Association
- UK Timber Frame Association
- UK Trade and Investment
- Unite
- University College London
- University of Bath
- University of Cambridge
- University of Leeds
- University of Loughborough
- Wates Group
- Wood Panel Industries Federation
- WRAP – Waste and Resources Action Programme
- WSP Group
- Zero Carbon Hub

Annex D: Carbon, Major Climate Change and Energy Policies

Tax, Levy and market mechanisms

Policy	Objective	Payee
Renewable Obligation	Main support scheme for large-scale renewable electricity projects in the UK by placing an obligation on suppliers of electricity to source an increasing proportion of their electricity from renewable sources.	Energy companies
EU ETS	EU emission trading scheme. Each EU member state must develop a National Allocation Plan (NAP) approved by the European Commission. This sets an overall cap on the total emissions allowed from all the installations covered by the System. This is converted into allowances (1 allowance equals 1 tonne of CO_2) which are then distributed by EU member states to installations covered by the System.	Energy companies and energy intensive industries
Carbon Reduction Commitment	Mandatory Carbon Cap and Trade Scheme for large non-energy intensive business and public sector organisations. Companies will buy carbon allowances to cover their carbon emissions. The revenue generated from carbon auctions will be redistributed between the scheme's participants. Each company will receive a larger or smaller amount than they originally paid for their carbon allowance, according to their performance in the CRC league table.	Large non-energy intensive industries

Policy	Objective	Payee
Feed-in-Tariffs	Support for small-scale renewable electricity via a requirement on electricity suppliers to pay a tariff to Small-scale low-carbon generators.	Energy companies
Renewable heat incentive	Financial support to stimulate uptake of renewable heat.	Paid directly by HM Treasury.
Climate Change Levy	Tax on the use of energy in industry, commerce and the public sector.	Business and public sector
Enhanced Capital Allowances	100 per cent first-year Tax relief in the form of Enhanced Capital Allowances (ECA) allow the full cost of an investment in designated energy-saving plant and machinery to be written off against the taxable profits of the period in which the investment is made.	Treasury
Product Policy	Sets minimum energy efficiency standards for energy using products. Includes the Framework Directive for the Eco-design of Energy Using Products (EuP).	Product manufacturers
Building Regulations	Energy efficiency requirements (including progressive tightening of Part L) of Building Regulations.	Builders, clients
Zero-Carbon Homes (ZCH)	All new homes to be built to a zero carbon standard from 2016.	Builders, clients
Zero Carbon for New Non-Domestic	All new non-domestic to be built to zero carbon standard from 2019.	Builders, clients
Carbon Emission Reduction Target (CERT)	Obligation on energy suppliers to increase the uptake of energy efficiency and carbon reduction measures in the Household sector.	Energy companies

Policy	Objective	Payee
Community Energy Savings Programme	Requires gas and electricity suppliers and electricity generators to deliver energy saving measures to domestic consumers in specific low income areas of Great Britain. CESP has been designed to promote a 'whole house' approach and to treat as many properties as possible in defined areas.	Energy companies
EPBD	Requires all EU countries to enhance their building regulations (minimum energy performance requirements), set standards for major refurbishments, and to introduce energy certification schemes for buildings (EPCs & DECs in UK). All countries are also required to have inspections of boilers and air-conditioners.	Property owners and occupiers
Smart Metering	Roll-out of smart or advanced meters to non-domestic and domestic customers not previously required to have them.	Energy companies

Annex E: Opportunities in Product Development

Example responses to a questionnaire circulated by the Construction Products Association to its members asking *"Where in your sector of the industry do you see the main focus for innovation that will deliver innovative low carbon technologies that will potentially have significant market opportunities?"*

Heating/hot water

- Providing comfort whilst reducing heating load (or not adding to peak load), in combination with the right thermal fabric
- Recovering low grade heat
- Approved renewable energy technologies
- Alternative energy/heat technologies – photo-voltaics, heat pumps, fuel cells
- Improving gas-tightness of facings on PIR & PUR panels
- Use of waste hot water

Cooling

- Adaptation response to global warming
- Modelling/ future proofing for overheating or cooling, combined with the right (lightweight or heavyweight) thermal fabric
- Shading
- Heat management pigments
- Phase change technologies

Lighting

- More sophisticated lighting controls
- DC lighting
- Raised lighting levels or architectural "scene setting" without additional energy consumption

Wiring and controls

- Whole house systems, and the interplay between technology and consumer behaviour
- Switching appliances on and off

- Controlling speed of fans and motors
- Plug and play wiring

Fabric (excluding glazing)

- Increasing air-tightness
- Reducing cold bridging (e.g. thermal break wall ties)
- Increasing insulation performance, including carbon negative walling materials and products for "hard to treat" buildings (e.g. aesthetically acceptable external insulation)
- Innovations in timber frame construction, particularly in prefabrication
- Gel insulants
- Internal clay blocks

Glazing

- Effective shading
- Energy efficient (e.g. PassivHaus standard) windows
- Specialist glass and coatings

Other

- Recycling
- Power distribution
- A low carbon material handling option
- Dealing with construction waste
- Power Management – encouraging users and installers to think more appropriately about their electrical equipment and treat this as an asset

Annex F: Export Opportunities in Low Carbon Construction

1. UK International Strengths

The construction industry makes an important contribution to the competitiveness and prosperity of the UK economy. By far the most active sub-sect of the construction industry in terms of exporting/working overseas is construction services where the UK has some of the strongest internationally and the reputation of this section of the industry is second to none.

Major UK engineering consultancies, architectural, cost consultants and commercial practices lead Europe and are highly placed in world league tables in terms of reputation and quality of services. UK procurement methods and innovative cost saving methods have become British trade marks: the design and build solution, guaranteed maximum price (GMP) method, partnerships, framework agreements, gain/pain share contracts, asset management contracts, PFI/PPP asset management. British trained commercial staff form the core of the commercial departments of international clients, contractors and consultants. British standards, codes and products are also recognised and respected internationally.

2. The transition to low carbon construction

The transition to a low carbon resource efficient economy is a global environmental and economic imperative and represents a huge economic opportunity for the UK internationally. HM Government's action to address the UK sustainability agenda dates back to 1999 leading to the 2008 Climate Change Act introducing the world's first long term legally binding framework to tackle the danger of climate change.

The UK's holistic approach embeds Low Carbon throughout the entire construction process with its world leading architects and engineers developing energy efficient and sustainable buildings. The UK Construction sector leverages its unique expertise and experience by drawing together ideas from all around the world to provide comprehensive, Low Carbon construction solutions. The first green building was coined in the UK in 1996 (INTEGER Millennium House at BRE) and subsequently in Hong Kong and Beijing.

UK firms are now creating designs for low carbon cities around the world using UK and international standards and best practice. The Building Research Establishment (BRE) created BREEAM the world's longest established and most widely used environmental assessment method for buildings. BRE has also an established track record in tailoring the bespoke BREEAM method for buildings and developments outside the UK ensuring that it is adapted to the requirements and context of a particular region of the world.

With world class research capability, UK construction products and services deliver cost effective carbon reduction for buildings and developments. Lime Technology for example has developed a product range which significantly reduces CO_2 emissions from the construction industry.

3. How is UKTI Supporting a Low Carbon Construction Industry?

UK Trade & Investment is the government organisation that helps UK-based companies succeed in the global economy and assists overseas companies to bring their high-quality investment to the UK. The role of UKTI is of great significance to the UK's sustainable development. The support we provide to UK businesses helps them continue to contribute to the UK economy, maintaining jobs for UK workers and supporting the communities within which they operate.

The Government's coalition agreement stated that **UKTI will become champions for British companies that develop and export innovative green technologies around the world.** UKTI will be delivering on this statement by refocusing its efforts to build the UK's reputation globally as a partner of choice for low carbon business. At least a third of activities provided sectorally to business by UK Trade & Investment's Head Office in 2010/11 will focus on business opportunities for UK companies with low carbon solutions.

Recent UKTI commissioned research[56] has identified China, India, US and Brazil as offering the greatest immediate opportunities for UK Businesses' with Low Carbon solutions. As a result of this research UKTI is focusing on delivering opportunities to UK businesses for these markets. UKTI will support business to access other markets through mainstreaming low carbon across all sectors and across the UKTI regional and overseas network.

The low carbon agenda underpins and is a key driver of the UKTI Infrastructure Directorate's work promoting UK capabilities overseas. Key elements of this work are the China Sustainable Cities initiative, UK in Brazil Infrastructure month and the development of initiatives looking at high value global opportunities.

56 (Circus, 20 April 2010) 'UK Trade and Investment Low Carbon Market Prioritisation and Messaging'.

UKTI Construction Sector Team has been developing promotional activity in support of UK companies in this field since 2005. 38 inward and outward missions have taken place since 2005 which have either entirely or partially focused on low carbon construction. In 2009 in order to raise awareness of the UK's capabilities within the wider UKTI network in the UK and overseas we organised a briefing course on low carbon construction for 25 commercial officers and UK staff covering key markets. In 2010/11 all of the Construction team's mission will contain a strong low carbon element with a target of 80% of all events showcasing the UK's low carbon offer moving to 100% in future years.

To support the knowledge of UKTI's international network we have undertaken a review of the UK construction sector's strengths & capabilities in delivering sustainable building, infrastructure and communities. This is being further developed to provide an international audience with information on the UK's capability and expertise in low carbon construction. Appropriate marketing resources will be developed with industry to showcase the UK's Low Carbon Construction capabilities. Work on this area has already commenced with UKTI publishing in July 2010 a series of articles highlighting UK company capabilities in China.

UKTI Construction Team will work with sector stakeholders to identify low carbon opportunities in international markets (initially China, Brazil, India and the USA) and identify international showcase opportunities for UK capabilities. Key to this will be the identification of the key areas of UK industry capabilities and the work universities are doing around near to market technologies, incubator areas and research capabilities.

Other sector teams within UKTI also have a focus on low carbon and support their industries develop internationally for example the Energy team will in financial year 2010/11 see around £1m (50% of their programme budget) spent on activities directly addressing the low carbon agenda. Other teams are starting to develop a focus on low carbon include railways, ports, airports and environment.

London 2012 provides the UK with an unrivalled opportunity to showcase its low carbon capabilities in delivering a 'sustainable and green' games. This attracts considerable interest from international visitors. UKTI is working with the Government Olympic Executive (GOE) and the Olympic Delivery Authority (ODA) to showcase London 2012 to appropriate international visitors and UKTI sector teams (particularly construction and global sports projects) are working to help the UK companies involved to promote this capability to future host cities.

UK Trade and Investment

Photo credits

Front page

Offshore wind turbine - http://www.flickr.com/photos/pjh/185488411/
Cavity install - SIG plc, installing cavity wall insulation;
Off-site construction, Bewdley School - Yorkon
Olympics Velodrome - London 2012
PRI Home Energy Controller

This publication is also available on our website at http://www.bis.gov.uk

Any enquiries regarding this publication should be sent to:
Department for Business, Innovation and Skills
1 Victoria Street
London SW1H 0ET
Tel: 020 7215 5000

If you require this publication in an alternative format, email enquiries@bis.gsi.gov.uk, or call 020 7215 5000.

Printed in the UK on recycled paper containing a minimum of 75% post consumer waste
First published November 2010. BIS/11/10/NP.
URN 10/1266