The UK's approach to the thermal refurbishment of non-domestic buildings

A missed opportunity for bigger carbon emission reductions?

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1 SUMMARY OF OPPORTUNITY

In order to help meet Government's carbon reduction targets, the UK as a whole must address its inefficient non-domestic building stock. The scale of the challenge, to refurbish up to 2 million existing non-domestic buildings and achieve at least an 80 per cent cut in carbon emissions by 2050[1], is somewhat daunting, and clearly cannot be done by a business as usual approach.

Much of the existing non-domestic building stock can be characterized as having poor energy performance[2]. Many buildings have poor fabric, inefficient plant, poor controls and low levels of occupant energy awareness. Overheating is common, leading to increased cooling demand. Improved controls and the appropriate use of thermal mass, glazing, shading and ventilation are important to mitigate overheating.

Refurbishment of such buildings represents an opportunity because making cost effective energy performance improvements could reduce greenhouse gas emissions by 20 - 23Mt per year while also benefiting energy security and competitiveness.

There is already a missed opportunity for cost effective emission reductions that could have led to the retention and growth of employment in the construction industry. In as far as the climate change impacts of buildings are being addressed at this time, the focus largely remains on the performance of new buildings and the decarbonization of buildings energy supply.

There are several reasons for low levels of energy performance and the slow progress with making improvements. There are also several drivers for better energy performance. Unfortunately, the barriers currently outweigh the drivers in most instances, and this will not change unless a specific effort is made to accelerate refurbishment of non-domestic buildings

Caleb believes that the following needs to happen to achieve a step-change in refurbishment:-

- Better application of the Trias Energetica (Energy hierarchy) framework in policy & practice – where the first focus is on 'designing out' the need for energy use in buildings as part of their refurbishments

- A scaled-up Refurbishment programme with third party funding guaranteed by Government & paid back from savings – possibly along the lines of Salix Finance, as currently offered to public sector organizations

[1] Interim advice by the Committee on Climate Change; Lord Turner of Ecchinswell; October 2008
[2] Altering existing buildings in the UK; Energy Policy 36 (2008) 4482-4486; Simon Roberts

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- A commitment to concentrate on implementing readily available tried-and-tested solutions, in preference to newer, more risky technologies (e.g. urban wind power)

- A commitment to place a high priority on the energy security & employment potential of buildings and to maximize these via thermal refurbishment measures

Specifically, Caleb proposes that there should be up-front capital funding for beneficiaries willing to commit to achieving EPC/DEC Rating ‘C’ based on implementing Energy Performance Report recommendations. Energy Performance Reports are key outputs from the buildings energy performance certification process, but their implementation is discretionary at this time.

Caleb has modeled a range of potential benefits and costs associated with building fabric based refurbishment measures and can confirm that: -

- A programme of accelerated refurbishment of the non-domestic building stock could be achieved at a cost of £1.96 billion per year. This could save 0.36 $MtCO_2$ per year through a package of thermal insulation measures with an assumed lifetime of 20 years. It would also result in financial savings of £450 million per year

- Over the period 2010 - 2022, a yearly average of 54 million m^2, or 8% of the technically available non-domestic building stock would be refurbished to a DEC/EPC rating of 'C'. This would achieve annualized savings of nearly 4.74$MtCO_{2e}$ per year in 2022 - approximately 2% of the UK’s ‘none traded’ carbon dioxide budget.[3] - from tried & tested fabric insulation measures alone

- The total cost of thermally refurbishing the non-domestic building stock to a DEC/EPC Rating of 'C' by 2022 would be £24.55billion, and related financial savings would be in the region of £5.65 billion per year

- An accelerated refurbishment programme focusing on 'tried & tested' thermal efficiency measures could be delivered with a cost effectiveness of £30 - £35/tonne CO_2; an average life time benefit of £120 per tonne CO_2 and an average simple payback rate of <5years. Total energy cost savings would be over £40 billion between 2010 and 2022

- Depending on the scheduling of work between 50,000 and 75,000 long-term jobs could be created or retained in the construction sector on the basis of an

[3] CCC interim budget for 2022 from averaged emissions over 3rd Budget Period 2018-2022, as indicated on Page 20; Building a low-carbon economy – the UK’s contribution to tackling climate change; CCC, 2008

average of 100 person years gained from each £1million investment in buildings energy efficiency[4]

- Energy Security could be enhanced, with primary energy savings of 24,000 GWh per annum – equivalent to 1.25% of total primary energy requirements in 2022

Now is the time to accelerate the refurbishment of non-domestic buildings. A survey[5] for the World Business Council for Sustainable Development shows that buildings professionals in Europe and other parts of the world routinely misjudge the costs & benefits of energy efficient buildings. They seriously over-estimate the cost of achieving energy efficiency and underestimate the potential to reduce emissions. The cost of completing energy efficiency refurbishments is often lower than estimated by building professionals, building owners & users – particularly if done on a 'whole building' basis. Meanwhile the climate, energy security and employment benefits of accelerated refurbishment are significant and increasingly important for the country as a whole.

[4] Climate change and employment: Case of the UK; CES-ETUC Study; 2006
[5] Our Vision: A world in which buildings consume zero net energy; EEB #2; WBCSD; 2008

2 PURPOSE & TIMING OF THIS REPORT

2.1 PURPOSE OF THIS REPORT

This report provides a review of carbon emission reduction and economic costs & benefits arising from an accelerated refurbishment of the UK's non-domestic building stock. It identifies the key drivers & barriers associated with regulatory, economic and practical fate of the refurbishment effort. It then proceeds to propose ways to increase refurbishment through a specific focus on energy demand reduction, the wider implementation of tried and tested solutions, and the value of maximising energy security and construction employment. It also proposes the delivery of up-front zero or low interest loans that are triggered by a beneficiaries' commitment to achieve EPC/DEC rating 'C' in their buildings by implementing relevant recommendations from EPC/DEC reports. These loans are then paid back from financial savings associated with better energy efficiency and carbon performance.

2.2 TIMING OF THE REPORT

In responding to climate change and the need for energy security, the Government has recently set up the Department of Energy &Climate Change. It has also charged the Committee on Climate Change (CCC) to advise it on the best routes to achieving an 80% reduction of greenhouse gas emissions by 2050. The Climate Change Act, under which these reductions will be delivered, sets legally binding emission reduction budgets at intervals to 2050. The UK Government must respond to CCC proposals[6] by setting out policies to achieve the budgets, including an interim emission reduction target of 26% against a 1990 baseline by 2020.

The UK already has a variety of policies and measures designed to improve energy performance in buildings and to reduce greenhouse gas emissions from them. The Building Regulation's Part L guidance is periodically reviewed and upgraded and the recasting of the European Performance of Buildings Directive (EPBD) should theoretically result in a more rigorous management of energy performance in buildings. The UK Green Building Council (UKGBC) recently completed a consultation on the development of a Code for Sustainable Buildings with a view of coming up with firm proposals by March 2009.

Despite of these efforts to improve energy performance in buildings, relatively few of the UK's policies & measures are targeted at a large scale thermal improvement of the existing building stock. This is particularly evident for non-domestic buildings. Yet, it is well understood that more energy efficient buildings need to be at the frontline of emission reduction efforts. None of the policies currently underway, or the proposals

[6] Building a Low Carbon Economy – The UK's contribution to tackling climate change; CCC; 2008

for buildings arising from the CCC, will make sufficient an inroad on tackling the climate change impact of the existing non-domestic building stock to meet a level of reduction commensurate with the 2050 target.

The perfect time for a government backed effort of systematically refurbishing existing non-domestic buildings was probably 10 to 20 years ago. Now is another opportunity to implement an accelerated thermal refurbishment programme as part of a 'Green New Deal' package of measures designed to stimulate the economy. Accelerated large-scale refurbishment would result in early emission reductions, cost savings and the retaining and/or building up of employment in the construction industry at a time when the sector is under threat from the economic recession. With this report we are aiming to contribute ideas & evidence on how to best achieve more and better refurbishment of the existing non-domestic building stock.

The UK Government and the opposition parties are also in the process of preparing or promoting various 'green new deal' policies designed to arrest loss of employment and/or the generation of new 'green' jobs. Very few of these interventions are, as yet, taking much account of the potential climate, energy security, employment or financial benefits available from accelerated buildings refurbishment of non-domestic buildings. Caleb and Kingspan are therefore taking this opportunity to contribute to the debate.

3 THE CASE FOR ACCELERATED THERMAL REFURBISHMENT OF NON-DOMESTIC BUILDINGS

3.1 POOR ENERGY PERFORMANCE OF EXISTING BUILDINGS

There is a wide consensus that Buildings, as major energy consumers and sources of greenhouse gas emissions, must play an important part in mitigating Climate Change. But there are a range of challenges that must be addressed before we can see the benefits. It is estimated that 40%[7] of the buildings that will be standing in 2050 pre-date the introduction of Part L. Although there has been increased focus on measures to reduce the emissions from new buildings, the existing building stock remains largely untouched and many refurbishment projects miss opportunities to reduce emissions and deliver energy efficient buildings.

While overall emissions from non-domestic buildings have fallen by 12% over the period 1990 – 2006, this was largely due to fuel-switching efforts in the 1990's. Public sector emissions are down 26% for the same reason. Overall public sector energy consumption was flat during this period

Corporate sector emissions rose by 4% - with growing outputs driving higher demand for energy despite efficiency improvements. Data from UKGBC members and work carried out by Heriot-Watt University[8] has shown that electricity use in commercial non-domestic buildings has risen very closely in line with floor space, i.e. all the energy efficiency measures of Building Regulations have been negated by an increased use of energy for small power uses, which is likely to have had an impact on cooling energy use.

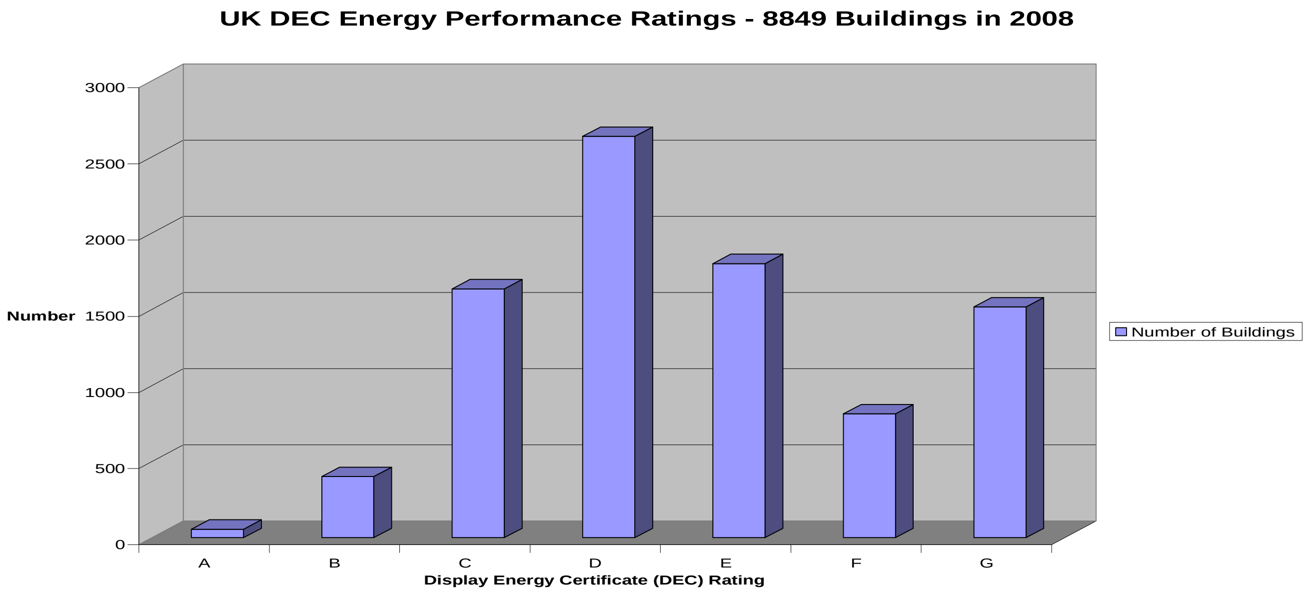
Energy demand in the existing building stock must be tackled now if we are to meet any of the Government targets for carbon reductions by 2050, and achieve better energy security. Past efforts to reduce carbon emissions from existing non-domestic buildings have had limited success. Reasons for this include:

- Poor understanding and knowledge of the non-domesticc building stock
- Poor understanding and knowledge of how people use energy in buildings, how they interact with new technology and how they respond to energy conservation initiatives
- A shortage of openly available energy use data matched with details of physical form, occupant characteristics and installed appliances and services

[7] Low Carbon Buildings Initiatives: Non-domestic Refurbishment; Carbon Trust, 2006
[8] Report on carbon reductions in new non-domestic buildings; UKGBC; 2007

- High adoption costs (management time) needed to achieve improvements
- Market or regulatory failures such as landlord-tenant problem- where any energy performance improvements are to the benefit of the tenant while the cost of measures fall on to the landlord, who may not be able to recover the investment costs from the tenant
- Attitudes and split incentives within organizations, making the adoption of life-cycle costing approaches (for instance) or communication between energy managers & budget holders more difficult

A recent review of unpublished data on energy performance of existing public buildings requested under the Freedom of Information Act[9] found that one in six of public buildings that have been through an energy audit to obtain display energy certificates received the lowest possible energy efficiency rating. The energy performance breakdown is summarised below: -



Three quarters of the tested buildings received an energy efficiency rating of below ‘C’. While Caleb has not found comparable aggregated data for non-domestic EPCs, we nevertheless conclude that the EPC ratings distribution is unlikely to be better than the DEC rating distribution. A study by the University of Oxford’s Environmental Change Institute does provide an EPC distribution for domestic buildings.[10] This indicates that 94% of the UK domestic building stock falls below a ‘C’ rating. While

[9] Government buildings emit more CO2 than all of Kenya; Robert Booth; The Guardian; 23/12/08
[10] Home Truths: A Low-Carbon Strategy to reduce UK Housing Emissions by 80% by 2050; Boardman; 2007

these ratings are not directly comparable, ECI's findings are broadly in line with Caleb's conclusions that around 80% of non-domestic buildings could be rated below 'C'.

The Government expects to save 5Mt CO_2 from non-domestic buildings by 2020 via existing policy levers such as Climate Change Agreements (CCA), the proposed Carbon Reduction Commitment (CRC) as well as the tightening of Building Regulations. CCA's have been made with a variety of industrial sectors. In return for agreed investments in energy reductions, the firms get an 80% tax break on the Climate Change Levy.

It is unclear what proportion of these CCA savings really are occurring in the factory building envelope itself, as opposed to making the factory process itself more efficient.[11]

The Committee on Climate Change claims that emission reductions from existing non-domestic buildings can be achieved via binding policy levers (CCA, CRC) and from actions involving firms not currently covered by binding policy levers.

Despite the increasing legislative and market drivers for low carbon buildings, the principal drivers for the decision to refurbish a building are still primarily to update the brand format, improve the quality of the building for the occupants or attract higher rental values and new tenants, rather than reducing carbon emissions. The level of ambition for improving the existing non-domestic stock tends to be relatively low when compared to the emission reduction targets we must achieve. There appears to be little expectation that the relatively low targets we currently work towards will be achievable much before 2020.

3.2 A CLIMATE CHANGE POLICY IMPERATIVE

The UK is introducing a long term legally binding framework to tackle carbon dioxide emissions through the Climate Change Act. The CCC has recently advised the Government that the UK should be aiming to reduce greenhouse gas emissions by at least 80 per cent below 1990 levels by 2050. The CCC has now also set out what reductions should be achieved in the first three five-year carbon budgets, up to 2022, including making recommendations on where the greatest opportunities for reductions are to be made. The Government will need to respond to this during spring 2009, setting out the high-level policies that will ensure the first three carbon budgets are met.

[11] The Warren Report: The forgotten sector at the heart of UK's effort to cut carbon emissions; Energy in Buildings & Industry; Andrew Warren; Sept. 08

The carbon budgets are likely to be tackled through a combination of binding and non-binding policies and measures. These including the implementation of the EU-ETS, Industry Agreements, the Carbon Reduction Commitment, improved energy performance of goods & services and efforts to decarbonize the energy supply via renewables, nuclear energy and more. The improved energy performance of buildings also forms part of the proposed solutions, but the focus to date has been on new buildings and fuel switching, when the real task is an accelerated thermal & energy refurbishment of existing buildings.

3.3 AN ENERGY SECURITY IMPERATIVE

Energy prices are expected to continue to rise in the coming years whilst reliance on foreign energy supplies is expected to grow to 70% of Europe's energy consumption by 2030[12] . The EU's economic stability and prosperity will therefore be increasingly dependent on the political and economic strategies of its suppliers, and vulnerable to both. This level of exposure is mirrored in the UK, with the additional challenge that, due to geography, we are at the tail-end of gas supply lines from Russia. The UK may also experience capacity constraints in electrical energy, largely because of the alleged under-investment in generating capacity over the last decades.

To ensure Europe's energy security, the Commission and national governments must take energy efficiency targets seriously. The EU's Energy Services Directive requires Member States to achieve a 9% reduction in final energy use by 2016 and to outline how they would achieve this. However, the recently released National Energy Efficiency Action Plans have in most cases displayed a lack of imagination and ambition, relegating and ignoring the immense potential of energy efficiency to deliver savings.[13]

Based on consultation responses[14] to the European Commission's second strategic energy review, energy security is affected by the following factors: -

- Shortages of fossil fuel supplies
- High fossil fuel prices
- Political pressure from suppliers or transit countries
- Inadequate investment in energy production and infrastructure

[12] Commission Green Paper: A European strategy for sustainable, competitive & secure energy [COM (2006) 105]
[13] Energy Efficiency Watch: Screening of National Energy Efficiency Action Plans; Wuppertal Institut GmbH & Ecofys; 2007
[14] Report on public consultation prior to the 2nd strategic energy review; DG-TREN; 2008

- Impact of EU climate strategy
- Inadequate energy efficiency measures
- Lack of information; cost of renewables
- Lack of incentives for investment in energy efficiency (to building owners)
- Widespread tendency to prefer large-scale traditional energy solutions (as opposed to demand reduction or distributed energy options)
- Lack of financing and lack of construction/building sector skills
- Inadequate regulations

Any attempt to reduce the dependency on imported energy which fails to reduce current energy demand is unsustainable. The message is therefore clear: energy efficiency is not an alternative to energy security; it is a vital component in achieving it.

3.4 A MISSED OPPORTUNITY?

3.4.1 INTRODUCTION

There are then several benefits from an accelerated refurbishment effort, including the opportunity to achieve early and cost effective emission reductions, a reduction in the need for costly new energy supply infrastructure – offering a contribution to energy security goals, a proven employment retention or growth and financial savings that feed through to the wider economy. The Carbon Trust estimates that £1bn/pa can be saved from a large scale implementation of non-domestic building refurbishment, using existing technologies.[15]

3.4.2 HIGH EMISSION REDUCTION POTENTIAL

Non-domestic buildings emit over 100 million tons of CO_2 per year. This represents some 18% of the UK's total emissions. Of this, there are different assessments of what might be the technical potential and realistic potential emissions savings. The Carbon Trust[16] identified a technical potential for 37 million tonnes (Mt) of carbon dioxide savings, of which 20 - 23 Mt are a realistic potential. Earlier findings by the

[15] Low Carbon Buildings Initiatives: Non-domestic Refurbishment; Carbon Trust, 2006
[16] Ibid

BRE[17] support this assessment, showing that the cost effective potential is 20% of total emissions for a package of measures that include loft and cavity wall insulation, the fitting of low energy heating, lighting equipment and timers and the use of low energy electrical equipment and accessories. The CCC identified a technical emissions reduction potential of almost 34 $MtCO_2$ for non-domestic Buildings, of which 13.5 $MtCO_2$ is available at a cost of <£40/tCO_2,

Variety of Views on Emission Reduction Potential				
Source	**Total Emissions [$MtCO_2$ per year]**	**Technical Potential [$MtCO_2$ per year]**	**Economic Potential @ <£40/t CO_2 saved [$MtCO_2$ per year]**	**Economic Potential @ <£40/t CO_2 saved [$MtCO_2$ per year] *Fabric Insulation only***
CCC Baseline for current policies	100 e	34	5	-
Carbon Trust	100	37	20	-
BRE/Pout	99 e	35	19.8	-
CCC 1st Budget Period Proposal	100 e	34	13.5	<2
McKinsey	-	-	-	3.2 – 4.6
Caleb 98	-	-	-	3.9
Caleb	112	34 - 46	20 - 23	2 – 5.3

The total 'economic potential' identified by the CCC is almost three times the current effort, but is still well short of the cost effectiveness identified by the Carbon Trust, BRE & Caleb. (Ie.13.5 Mt vis a vis 20 - 23Mt).

The potential for cost-effective fabric insulation measures identified by the CCC is below that of other sources. Caleb estimates that the annual emission reduction potential available from cost effective fabric insulation measures is in the range of 3.2-5.3 $MtCO_2$ – with a realistic potential of 4.6Mt CO_2 per year.

3.4.3 POTENTIAL FOR JOB RETENTION AND EMPLOYMENT GROWTH

The UK already spends £27 billion per year on commercial & public refurbishment[18]. Some 64% of this spend relates to commercial buildings and the rest to public buildings. For a marginal extra cost, these refurbishments could be energy efficient. Energy efficient refurbishment presents a potentially large market and would lead to the creation of tens of thousands of new 'green collar' jobs at a time when jobs in the construction sector and elsewhere are increasingly under pressure.

[17] Carbon dioxide emissions from non-domestic buildings: 2000 and beyond; Pout, McKenzie, Bettle; 2002
[18] Caleb estimate based on 2006 GDP & Construction Industry & other data incl. 'Background to the refurbishment & maintenance of Buildings; www.palgrave.com; 2002

Programmes to reduce CO_2 emissions from existing buildings are job creation engines. With government assistance, it would be possible to establish an effective programme to give fresh impetus to the labour market. In Germany, for every billion € invested, around 25,000 jobs are being safeguarded or created in the construction industry and its up- and downstream industries every year[19]. In the UK, an investment of £1.96 billion per year could represent some 58,800 jobs based on a similar rule of thumb.

Improving energy efficiency in buildings is a particularly effective way to stimulate employment in the places where it is needed most, and to employ people who have the greatest trouble in finding jobs. In terms of direct employment, energy efficiency in buildings is a labour intensive sector, engaging many small, geographically dispersed installation companies. Furthermore, lower fuel bills mean more money to spend on non-energy items (and the labour intensity in sectors stimulated by general consumption exceeds that in the energy supply sector). Thus indirect employment is stimulated by the energy savings, for years after the work is completed. Ultimately, energy efficiency contributes to economic efficiency and growth, which creates more wealth and employment opportunities.

There are three main reasons why energy efficiency has positive effects in terms of job creation:[20]

- Manufacturing and installing energy efficiency measures are labour intensive activities compared to energy supply, and to many sectors in which the government chooses to invest public sector funds. This effect accounts for direct employment gains of 10 to 30 person-years of employment per £1 million spent, and almost 60 person-years where job creation and training are made a priority

- If the energy savings are cost effective, the result is that consumers divert expenditure from energy into the more labour intensive general consumption sector. This effect typically generates an additional 70 person years of employment in the wider economy per £1 million spent, over the lifetime of the energy saving investment

- Work in manufacturing and installing energy efficiency measures is accessible to people who suffer the highest rates of unemployment in the UK, given that it is manual labour, and the work is dispersed across the country

According to European Commission findings, investments in cost effective energy efficiency improvements almost always have a positive impact on employment … Improvements in energy efficiency create three or four times the number of jobs created by investments in additional energy supply. It has been estimated that an

[19] German Federal Ministry for Transport, Building and Urban Affairs
[20] Climate change and employment: Case of the UK; CES-ETUC Study; 2006

energy efficiency increase of 1% a year, sustained over a ten year period, creates two million man-years of employment – i.e. 200,000 additional (EU) jobs sustained over ten years.[21]

Based on 12 energy savings programmes within Germany designed to reduce energy consumption, the employment benefit between 2006 and 2029 of the Energy Savings Fund is 300,000 person years – mainly in the building construction and refurbishment sectors. The Fund has a net positive impact of about 1 million person years to 2030, with a maximum of 75,000 person years in 2015. The development of net employment will remain positive to 2030 – even after expiry of the projects, because of reduced energy costs, with saved revenue spent elsewhere in the economy.[22]

Judging from the range of assessments presented above, and depending on the scheduling of work, between 50,000 and 75,000 long-term jobs could be created or retained in the UK's construction sector from a programme of accelerated refurbishment of non-domestic buildings.

[21] DG Internal Policies of the Union, Economic and Scientific Policy Dept, Briefing Note on the employment potential of renewable forms of energy and increased efficiency of energy use, p13, referencing European Commission, 2005, Doing More With Less – Green Paper on energy efficiency

[22] Impact on activity & employment of Climate Change and GHG mitigation policies in the enlarged Europe: Final Country Report – Germany; Wuppertal Institute for Climate, Environment & Energy; 2006

4 REFURBISHMENT DRIVERS & CONSTRAINTS

4.1 REFURBISHMENT DRIVERS

4.1.1 CURRENT DRIVERS

Energy Performance in Buildings Directive:

The Energy Performance in Buildings Directive (EPBD) is designed to provide information on the energy performance of a building to prospective buyers and tenants, or, in the case of 'public' buildings, the information is to be displayed inside the building to inform all visitors. The objective is to raise awareness of the energy use of buildings, allowing prospective buyers and tenants to make informed decisions, and encouraging building owners and occupiers to improve the energy performance of new and existing buildings. Energy Performance Certificates (EPCs) are based on the Asset Rating (a calculated annual energy consumption based on a standard use of the building). EPCs provide the building's relative energy efficiency in a similar form to domestic product energy ratings, and must be provided to prospective buyers or tenants when a building is constructed, sold or rented.

Display Energy Certificates (DECs) are based on the Operational Rating (the measured annual energy consumption of the building). DECs are required for buildings over 1,000m^2 that are occupied by public authorities or other institutions that provide public services to a large number of people from October 2008. DECs must be prominently displayed in the building to inform visitors. The Government has committed to consult on the possible widening of these requirements to privately owned or occupied public buildings including retail outlets, cinemas and hotels. In Scotland EPCs will be used for public display.

EPCs and DECs are produced by accredited energy assessors and are accompanied by a report detailing voluntary options for improving the energy efficiency of the building. The whole of the UK has opted for the requirement to provide advice on the energy efficiency of boilers, and it is likely that an inspection scheme for boilers will be introduced in the future. An inspection regime for air-conditioning systems is being implemented in England and Wales, and persons who control and operate systems rated above 250kW will need to arrange regular (not exceeding five years) inspections by accredited inspectors from January 2009. All other air-conditioning systems above 12kW will require regular inspections from January 2011.

Planning & Building Regulations (England & Wales):

Building refurbishment is increasingly being brought within the scope of planning and building regulations. This has been a clear trend for at least the last decade, with Building Regulations, planning policies and requirements regarding the provision of information to stakeholders all progressively strengthening.

Difficulties with gaining planning approval for new build can make refurbishment a more attractive option. Demolition of buildings over 50 cubic metres requires the owner to apply to the local authority for approval. The authority carries out an assessment but does not always grant approval, with planning permission required in some cases. If the building is listed, in a conservation area or adjacent to other buildings, planning permission is required.

Local planning policies supported by government legislation and Regional Planning increasingly require developments to use local heating networks (where available) and/or to use renewable energy sources (on, near or off site) to supply a proportion of their energy requirements. Exact local planning requirements regarding building refurbishments can differ significantly between local authority areas.

The main and most obvious policy tool currently governing energy consumption in new non-domestic construction is Part L of the Building Regulations 2006. Building Regulations sets the legal minimum standards for construction in the UK, and Part L deals specifically with energy consumption, regulating areas such as air-tightness, solar gains, and energy for heating, lighting and ventilation. In 2006 Building Regulations was updated and Part L was revised to be more demanding. Revisions in April 2010 and in 2013 will further strengthen Part L, although a report by the National Audit Office[23] has drawn attention to the prospect of a reduced effectiveness of the Building Regulations through non-compliance.

Building refurbishments that accompany a ‘change in use’ are subject to energy use, and other provisions, of planning and Building Regulations control. Replacements to building envelope components, including windows, ventilation equipment and mechanical and electrical services, must comply with the Building Regulations 2006. Additionally, building energy performance must be improved when major refurbishments are conducted for buildings over 1,000m^2. Energy requirements for building extensions and the commissioning of services are also included in Building Regulations, with Approved Document L2B forming the official guidance on compliance for refurbishment projects.

Large scale refurbishments, or those which lead to a change in use of the building, may result in the project being considered equivalent to a new build, in which case

[23] Programmes to reduce household energy consumption; NAO, 2008

Approved Document L2A would form the official guidance on compliance with Building Regulations Different Building Regulations apply in Scotland and Northern Ireland.

Voluntary Schemes:

Voluntary schemes may be strong drivers for refurbishing buildings to low carbon standards and are often the forerunners to mandatory control or are used by some organizations to impose standards on buildings they occupy. BREEAM has for many years been accepted by industry as a general standard for assessing the environmental sustainability of non-domestic buildings. It has been an important driver for the improvement of the building stock and has been widely used for promotional purposes. From spring 2009, BREEAM will make available a specific Refurbishment package (BREEAM In Use), designed to assist in implementing refurbishment projects.

Corporate Social Responsibility:

Many organizations have environmental policies and regularly report on their Corporate Social Responsibility (CSR). Carbon emissions form a key element of this, with energy efficiency credentials often highlighted as an indicator of a responsible approach in the community.

Year on year improvements in reducing carbon emissions are usually a component of this reporting, with upgrading existing buildings an increasingly common action item. This potentially leads to better comfort, satisfaction and productivity for occupants. There may also be sales and marketing benefits from demonstrating a commitment to reducing carbon emissions. The pace of change in the business sector has meant that change of use of buildings has provided opportunities for contractors and stakeholders to undertake refurbishment contracts. Some of the changes are a direct result of market demand whilst others are part-driven by regeneration schemes.

4.1.2 FUTURE DRIVERS

Carbon Reduction Commitment:

The Carbon Reduction Commitment (CRC) is a new scheme, announced in the Energy White Paper 2007, which will apply mandatory emissions trading from 2010 to cut carbon emissions from large commercial and public sector organizations (including supermarkets, hotel chains, government departments, large local authority buildings), with carbon reductions of 1.1MtC per year expected by 2020. It is currently unclear to what extent the CRC will encourage measures that are currently not being encouraged under other initiatives – such as improvements to the building fabric.

Recast EPBD:

The draft revised Energy Performance of Buildings Directive was published in November 2008. It requires national plans for increasing the number of very low energy buildings (new and refurbished) by 2020. The European Commission will develop common principles for defining such buildings. The Commission is to develop a methodology for calculating the cost-optimal levels of minimum energy performance requirements.

Member States may not provide incentives after mid 2014 to construct or renovate buildings that do not meet these minimum energy performance requirements. Member States minimum performance requirements must conform to the Commission's calculations by 2017. The 1000 m^2 threshold for major renovation of existing buildings has been removed completely. For existing buildings, minimum requirements must be respected for new, replacement or retrofit of technical buildings systems.

Displays of Energy performance certificates (EPC) must be prominent in all buildings over 250m^2 occupied by public authorities, and private buildings which have acquired a certificate. In the case of public buildings, a separate target must be set by 2020 when providing details of low carbon buildings. Tenants must be given details not just of rating, but also recommended improvements through the EPC. There must be stricter enforcement of implementation of EPBD via penalties, and the transposition into national law must happen by 31 December 2010.

Possible Code for Sustainable Buildings:

The Code for Sustainable Buildings (CSB) is an evolving voluntary scheme being developed by Government and Industry. The aim of the CSB is the active promotion of more sustainable building practices. The initial concept had been that all new buildings should meet certain sustainability criteria, but the first manifestation was in the form of the Code for Sustainable Homes (CSH). In spring 2008 the Chancellor announced the Government’s aspiration that all new non-domestic buildings will be zero carbon by 2019. The UKGBC is currently leading the development of a Code for Sustainable Buildings covering non-domestic buildings. While the focus remains on new construction, there may also be additional guidance for refurbishment projects. The UKGBC also hopes for an introduction of a “continuing requirement” to improve energy efficiency of buildings.

4.2 REFURBISHMENT – KEY BARRIERS

4.2.1 KEY BARRIERS

Continued Focus on supply-side Measures

Current energy efficiency obligations do not support the transformation of the energy supply business model to one of providing energy services. There are aspects of the energy market and its regulatory framework that could make it more difficult for building owners or occupiers to benefit from or consider energy efficiency. Examples include: limits on the types of contracts offered by suppliers, assignment of responsibility for metering, and treatment of distributed generation.

Focus on Complex Solutions

Delivering a low carbon refurbishment doesn't require significant increases in complexity, or adoption of high risk or unproven technical solutions. On the contrary, nearly all refurbishments offer opportunities to reduce carbon emissions beyond the standards set by building regulations through tried & tested solutions that 'design out' energy consumption. Conventional refurbishment projects often miss the opportunities available, leading to unintentional and unnecessary increases in energy use and associated emissions. It is also important to consider the whole life cost of buildings. Whole life cost refers to the projects costs of running a building, repair and maintenance, refurbishment and disposal. These costs are often not considered when designing a new building or refurbishing an existing building.

Lack of Up-front Capital Funding

There is a lack of financial packages which help spread the upfront costs of measures over time, thus making them more affordable. The persistence of the use of payback as criterion for energy efficiency decisions acts against a number of technologies.

Available finance based incentive schemes can be seen as insufficient, overly complex and/or poorly targeted. As an example, the Enhanced Capital Allowances Scheme is not an effective mechanism for key energy efficiency measures in buildings, as it is only available on equipment. It doesn't make efficient options cost competitive on an initial cost basis – which can be crucial to decisions as to whether they will be included in a refurbishment as standard. It is difficult for smaller companies to use, and requires a good understanding of finance, tax status and tax rules. ECA's are only available to a small percentage of the property industry, and many of the other grants and loans systems are challenging to access.

Another scheme, the Climate Change Levy is directed at the wrong people. There is a need to see that installing energy efficient plant leads to a reduction in costs that are seen within the same management accounting category, not just across the whole company costs[24]. Increased fiscal incentives such as stamp duty allowances for purchasers or business rates reductions for occupiers of green buildings (as practiced overseas) would generate rapid change in the market.

[24] Energy Efficiency in Offices: Motivating Action; ACE, 2003

Salix Finance offers 'invest to save' schemes to public sector recipients such as NHS foundation trusts; Further Education/Higher Education colleges; Local Authorities & Government in England, Wales & Scotland. Salix projects typically pay for themselves within ½ their useful lives, thereby ensuing cost savings from reduced energy costs. We estimate that up to £30m is available for recipients per year via funding calls on a 5 - 7.5 year payback for capital funds based on a lifetime capital cost of up to £100/tCO2. Existing projects have identified key energy efficiency measures, including pipe insulation and thermal insulation of cavities & lofts as consistent with £50-£100/tCO2 lifetime cost.

Funding appears to be available in two strands: 1) Institutional small projects strand and; 2) Transformation fund strand. The latter is for larger projects which have a potential bearing on the sector/region – typically from £1-£4 million. ISPs are typically in smaller packages. It appears that all projects are match funded against beneficiaries' existing capital funds.

Self-generating ring fenced funds for energy savings projects are based on recipient identifying a number of projects with an estimate of the capital costs. Recipients apply for Salix funding to deliver one or more projects; savings generated are paid into a ring-fenced instrument, from which the recipient then makes further energy efficiency investments – until the original project goals (in terms of number of projects; investments; savings etc.) are met.

Funding is available as a time-limited interest free project loan or grant that is repaid from total savings – once the projects identified at the outset have been implemented and savings have been achieved. Subsequent savings are then owned by the beneficiary.

	Option	**Comments**
Current Financing Options	Energy Efficiency Loans & Loan Action Scotland	£5000 - £400000 interest free unsecured loans to SMEs (up to 250 employees); 5 year payback from savings; estimate ~ £27m/yr available funds
	Low Carbon Buildings Programme	Support mechanism for micro-generation technologies; replaces Clear Skies & PV support programmes
	CCA	Not clear what proportion of energy efficiency investment relates to buildings related energy use
	ECA	Complex; not applicable for measures to reduce energy demand via building fabric improvements
	CCL	Not sufficient to trigger refurbishment
	Salix Finance	Salix Finance is an independent company that provides interest free loan funding to the public sector to invest in energy efficiency measures & technologies that will reduce carbon emissions. The company is funded through the Carbon Trust. It typically requires a 5 year payback and lifetime cost of measures to be less than £100/tonne of carbon saved. Loans are disbursed on a matched-funding basis

	Option	Comments
Possible future Financing Options	Improved ECA	Extend to cover fabric measure; but would need to be simplified for use by building owners & tenants
	Extended CERT	Unlikely – because non-domestic energy user is typically in a more complex set of supply relationships – not always with big six suppliers to which CERT applies
	Extended Salix-type Finance	This could work – provided the Fund could be extended to commercial & industrial users and provided that up to 100% of capital funds are available – perhaps with government loan guarantee

Low Recognition of Energy Security & Employment Benefits

Much of the emphasis of reducing emissions from non-domestic buildings has been on fuel-switching. While using a decarbonised fuel supply is an important goal in its own right, it is not a credible strategy for either energy security or the improvement of the building stock. Efforts to improve the building stock have a positive impact on construction job retention and the growth of construction employment. The best way then to contribute towards a better level of energy security and employment growth is to focus on energy demand reduction in existing buildings – preferably via thermally improving building envelopes.

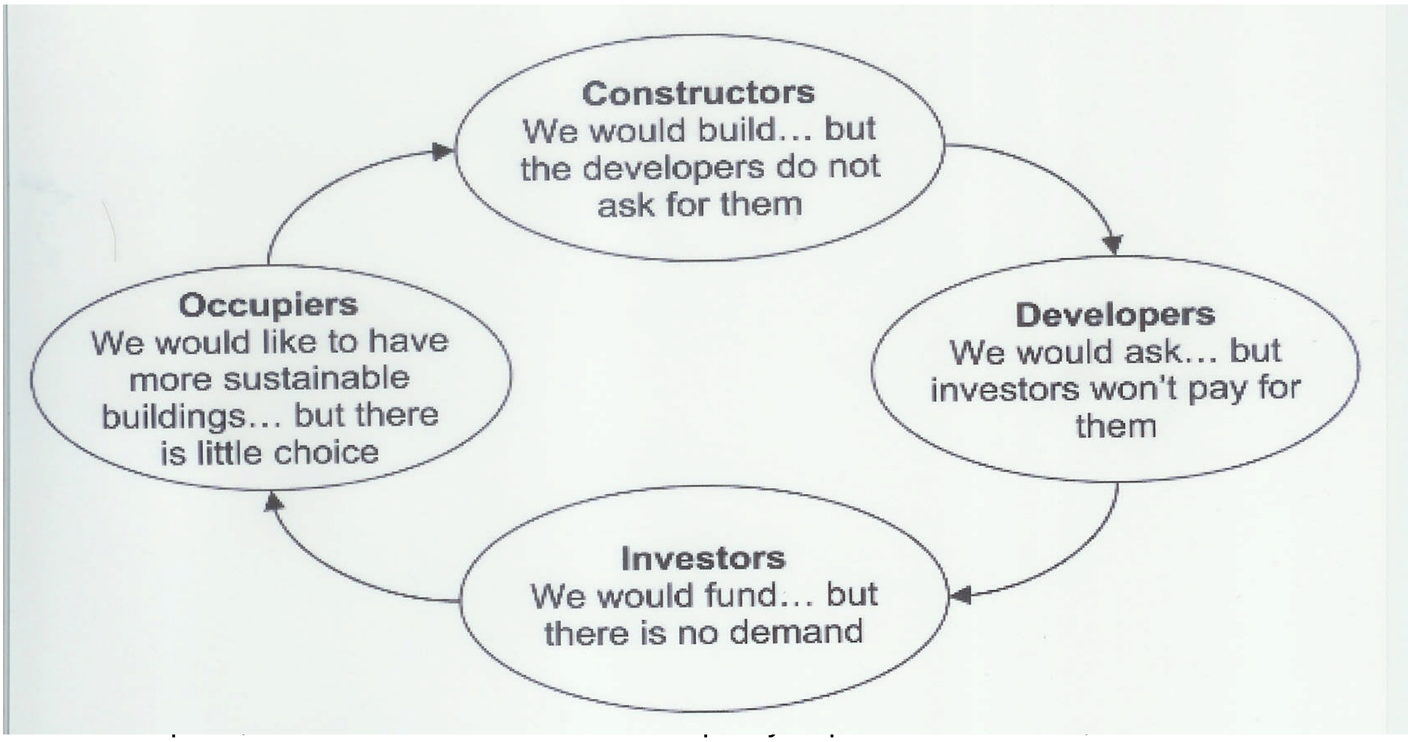
4.2.2 UNDERLYING PROBLEMS

Absence of Clear and Consistent Long Term Policy Framework:

The introduction of the Code for Sustainable Homes (with 2010, 2013 and 2016 milestones set) has produced a significant change in the new build sector's willingness to innovate. The prospective Code for Sustainable Buildings could potentially also assist in the improvement of new no-domestic buildings. There is, however, a lack in similar approaches for the existing building stock – both domestic and non-domestic. The recast EPBD may lead to improvements in time, but more consistent support for refurbishment is needed.

Detailed stock knowledge is inadequate to really understand what needs doing to existing buildings. Building Regulations are highly complex which many people believe is acting as a barrier to full compliance. The wider benefits of low carbon sustainable refurbishment are not included within cost effectiveness calculations.

In summary, energy efficiency in existing buildings has not enjoyed high or consistent policy support over the years, and up to now dispensation on advice, funding and action has not enabled the construction industry to break out of the 'circle of blame' when it comes to improving energy performance through a more sustainable approach to construction or refurbishment: -



may reduce the net benefit derived from efficiency measures. Uncertainty about future energy prices may deter businesses from investing, since they cannot be assured of future savings (this may now be cancelled out by the prevalent trend of price increases).

Supply-chain Capacity:

There is often a lack of supply chain confidence. Industry is not geared up to deliver low carbon refurbishment. Energy saving potential of existing technologies is often neglected in the name of innovation. Technologies can only be proven if we have evidence of their performance in situ.

The majority of architects, like the rest of the construction sector, view the energy standards in Building Regulations as a maximum to aim for, rather than a minimum that can be exceeded in many situations. In any case, there are many instances of major refurbishment work where a design professional is not needed, and the contractor takes the lead on specifying and carrying out the work. Where Building Regulations do not apply at all, energy issues are typically ignored, even though there are many potential intervention points during refurbishment for insulation and other works (for example, during re-wiring, re-plastering, structural timber repairs).

Complexity of Building Stock & Building Uses:

The complexity of the stock is further exacerbated by the web of relationships between premises and buildings, and by mixed activities within buildings. Buildings may contain a single occupant or a single occupant may be spread through numerous buildings as in a hospital or university. Many buildings contain numerous occupants. Each of the combinations may be metered in various idiosyncratic ways, so that landlord and tenant use may be indistinguishable or unidentified. A single building may contain multiple sources of heating and cooling, some under control of a landlord, others under control of tenants. Business parks may provide central heating and cooling to multiple buildings of different characteristics, tenancies and uses.

Common examples of mixed activities are banks and shops with their own offices above, or warehouses with shops. Offices above shops are a common office type. Petrol stations are commonly found combined with small grocery shops, or attached to supermarkets. Any mix of groceries, car repair workshops, garages, car sales and petrol sales may exist on a single site. There often is a disconnection between the cost of measures that are paid by an owner/landlord and the energy efficiency benefits that are enjoyed by the tenant. Energy efficiency measures and carbon emission reductions often fail to materialise for lack of this split incentive.

Planning Capacity Issues Hinder Low Carbon Buildings:

Planners have little training and experience in low carbon solutions. Many planning departments are understaffed and do not have the time or knowledge to deal with queries on energy saving measures, refurbishment or low carbon technologies. They may have little experience of what it means in practice to have Low or Zero Carbon measures installed and utilized and may discourage their use.

There appear to be a variety of approaches and levels of guidance relating to refurbishment across different local authorities. Clarification is typically provided by means of Supplementary Planning Guidance (SPG) documents, whose purpose is to amplify policies & proposals of the Local Plans. Additional information is provided upon which planning applications can be formulated and determined.

Overcoming the barriers to accelerated building refurbishment

It is essential that we overcome the barriers to more and better refurbishment by putting a higher priority on solving the underlying issues that are preventing a more wide-spread uptake of tried & tested solutions. By focusing on the reduction of energy demand in the first instance, we can gain the dividends associated with better energy security and financial savings. By committing to an accelerated programme of refurbishment of existing non-domestic buildings we can ensure that construction jobs are retained and more employment is created. The main key to unlock these benefits is the one that bridges the ‘capital gap’ that is largely responsible for preventing the uptake of thermal refurbishment measures. The best way to do this may be to offer government guaranteed zero or low interest revolving finance for up front capital costs to be repaid from cost savings.

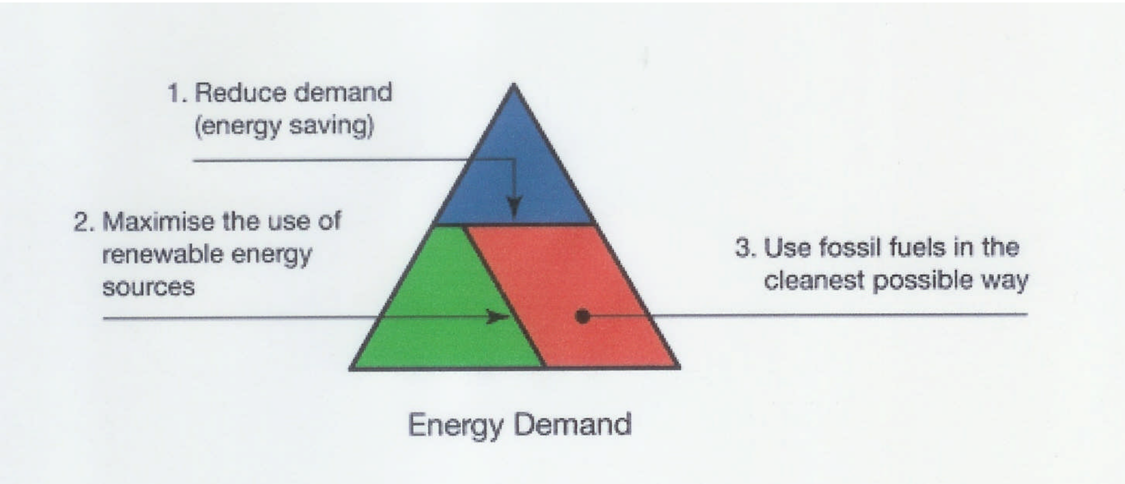
5 ACHIEVING ACCELERATED REFURBISHMENT IN THE UK

5.1 INTRODUCTION

In order to make an effective contribution towards the UK achieving its climate change reduction targets in the period leading up to 2050, there needs to be a step change in the way that existing buildings are managed and cared for. Arguably, the focus, to date, on improving the energy performance of new buildings, was the 'easy bit'. There is an urgent need to comprehensively thermally improve existing buildings as they come up for refurbishment. This requires a series of interventions, including information support and stimuli that take the pain out of the high up-front cost of making such improvements.

5.2 CALEB PROPOSALS

A better application of the 'Trias Energetica' in policy & practice: There should be a clear hierarchy for achieving emissions reductions, starting with demand reduction, through passive design measures and high-performance specification. There should be more focus on 'designing out' energy demand from buildings before investing in energy supply or even carbon offsetting. Once high levels of passive performance have been achieved the issue of energy supply can be addressed. Ideally the generation capacity should be located as close to the development as possible in order to avoid unnecessary distribution losses, increase local awareness of energy supply issues, and ensure that all available renewable energy capacity is exploited. The 3 elements of Trias Energetica[25] are:



[25] http://www.ecn.nl/fileadmin/ecn/units/eei/EEI/entrias.gif

Implementation of Readily Available Solutions

Delivering energy efficient refurbishment does not require significant increases in complexity, or adoption of high risk or unproven technical solutions. On the contrary, nearly all refurbishments offer opportunities to reduce carbon emissions beyond the standards set by building regulations. However, conventional refurbishment projects often miss the opportunities available, leading to unintentional and unnecessary increases in energy use and associated emissions. It is also important to consider the whole life cost of buildings. Whole life cost refers to the projects costs of running a building, repair and maintenance, refurbishment and disposal. These costs are often not considered when designing a new building or refurbishing an existing building.

In refurbishment processes, basically the same principles apply as in new construction. The operational energy is the major cause for the CO_2 emissions in buildings to be refurbished and this should be the first issue to be addressed, typically via:

- Energy efficient envelope
- Good insulation levels
- Modern window technology
- Controlled ventilation and heat recovery of the exhausted air
- Low temperature systems in the heat distribution
- Energy efficient electrical appliances
- Hot water production using renewable or regenerative sources

Improving the thermal property of the existing building envelope is one of the most logical solutions in order to reduce the building's energy consumption – and thus – one of the most important strategies in building refurbishment.

The level of improvement achieved depends on a combination of factors. Interventions may involve windows, doors, walls and roofs – with an unbalanced intervention between different components leading to suboptimal results.

Adding insulation is found always to produce cost savings when the measure is done at the same time as the other refurbishment efforts involving that component (e.g.

roof replacement) Even when action is taken to solely upgrade insulation levels (not combined with other refurbishment) – it is still cost effective in the case of roof, floor and cavity wall insulation.[26]

Bridging the Capital Gap

There are insufficient financial incentives to trigger a large-scale refurbishment effort of non-domestic buildings. Current options – such as loans, Enhanced Capital Allowances, the Climate Change Levy and/or grants – are often complex, are not of a sufficiently scale, nor are they well targeted for buildings. There are other potential options, such as an extended ECA scheme that is simpler and also applicable to building fabric measures; a possible extension of CERT to non-domestic buildings; Business Rate or Stamp Duty relief for buildings that implement EPC/DEC recommendations and so on.

A more ambitious dispensation is needed. The key elements of successful finance mechanisms appear to be that they: -

- Help to spread the cost of refurbishment to ensure that customers save more money than they spend each month (i.e. on energy bills and loan repayments)
- Enable 100% of up front costs to be met, if needed by occupier or owner
- Allows/encourages third parties to be involved in offering financing
- Are simple to access and easy to understand
- Offer extra incentives for early adopters

A successful intervention might require a variety of different and complementary financing options based on long-term loan arrangements linked to proven incremental improvements of energy performance. Energy performance improvements could be evaluated via EPCs before and after improvement work, where this work would be based on the EPC options report. Loans should be linked to a whole building approach, where as many measures as possible are taken in the building.

A scaled-up Salix Finance type approach could potentially be an interesting financing model – provided it was adaptable for private sector clients and was able to advance up to 100% of capital funds. Salix Finance currently offers 'invest to save' schemes to public sector recipients in England, Wales & Scotland.

[26] Cost-Effective Climate protection in the EU Building Stock; Ecofys; 2005

In general terms, it should be possible to secure capital funds on the basis of a commitment to implement the recommendations of EPC reports. More specifically, funding could be offered on the condition that the recipient improves existing energy performance ratings to a given rating level. Caleb has modelled the impact of a large number of buildings being improved to a 'C' rating – based on the recommendations offered in the EPC reports.

Recognizing and maximizing the energy security & employment potential of buildings via thermal refurbishment

The Tres Energetica should be given full consideration by funders when evaluating bids; by building owners deciding on refurbishment strategy and be government in setting the framework for action. By focusing on energy demand reduction goals as a first priority, energy security and employment goals are then easier to achieve – particularly if the strategy involves installing tried and tested technologies. Successful energy demand reduction projects also result in cost savings that are then spent on products and services – leading to secondary job benefits.

5.3 HOW PROPOSALS ADDRESS/OVERCOME THE BARRIERS

BARRIER	PROPOSAL	RELEVANCE
Regulation of energy based on supply rather than efficiency	**Better application of the 'Trias Energetica' in policy & practice**	Focus on the importance of passive energy reduction measures in buildings as priority, with behavioural and/or energy supply aspects as important, but still secondary; Has benefits for energy security; employment; cost & emission savings
Lack of up-front capital finance	**A scaled-up Refurbishment Programme with third party (Salix-type) funding guaranteed by Government & paid back from savings**	Offer a 'front-funded' resource that makes it easier for landlords or tenants to make refurbishment investments to be paid back from savings. Introduce a large scale programme of refurbishment based on reaching a specified EPC rating achieved by the implementation of EPC report findings as a pre-condition for long-term loans
Preference for higher risk solutions (e.g. some renewables; measures that require consistent occupier behaviour for emission reduction)	**Concentrate on implementing readily available solutions**	Nearly all refurbishments offer opportunities to reduce carbon emissions beyond the standards set by building regulations. Improving the thermal property of the existing building envelope is, in many cases, one of the most logical solutions in order to reduce the building's energy consumption – and thus – one of the most important strategies in building refurbishment

BARRIER	PROPOSAL	RELEVANCE
Low recognition of energy security and employment	**Recognition & Maximizing the energy security & employment potential of buildings via thermal refurbishment**	Much of current policy & practice is about how to tackle carbon emissions from the supply-side; i.e. – decarbonising the energy system; fitting renewable technologies. Energy security and carbon reductions should also be tackled from the 'demand-side' – by actively reducing demand and thereby ensuring that less energy is needed in the first place. Demand-side strategies also have the benefit of generating 3-4 times more jobs than supply-side strategies

5.4 THE POTENTIAL IMPACT, COST & COST EFFECTIVENESS

5.4.1 IMPACT

Caleb has identified an emissions saving potential of up to 4.7Mt CO_2 per year at a cost of £24.55 billion, equating to approximately £30 - £35 per tonne of CO_2 saved assuming an average 20 year life of the fabric insulation based measures taken. If implemented over a thirteen year period, an additional 0.36Mt CO_2 per year could be saved at a cost of £1.96 million. The financial savings associated with the reduced energy consumption is approximately £450 million per year. The employment benefit is an estimated at in excess of 750,000 person years over the project.

5.4.2 MARGINAL REFURBISHMENT COSTS & COST EFFECTIVENESS

Data[27] from Kingspan Insulation Ltd & Bucknall Austin, show that refurbishment costs involving fabric insulation measures range from approximately £12/m² to £68/m² depending on application. The average values for marginal costs are as follows: -

MEASURE	AVERAGE MARGINAL COSTS (£/m²)
Dry Lining Solid Wall	48.3
External Insulated Solid Wall	46.9
Injected cavity Wall Insulation	12.8
Metal Deck Flat Roof	50.0
Timber Deck Flat Roof	44.9
Relined Pitched Roof	56.3
Retiled Pitched Roof	68.2
AVERAGE COSTS	**46.8**

[27] Construction cost data; Kingspan Insulation Ltd & Bucknall Austin; 2005

The cost of these fabric insulation-based measures compare well with other, broader refurbishment measures as shown in the table below, being approximately 40% of the average values for the broader range of energy efficiency measures.

Building Type/ Location	**Description**	**Cost/m²**	**Source Reference**
UK non domestic building	**Complete retrofit:** Significant structural alterations, such as extension of floors or partial demolition to create atrium or stripping building back to concrete frame; new cladding may be fitted together with installation of new services and full fitting out	£800 - £1500 (£120 - £225)	BSRIA GN7/99 & (UKGBC)
UK office building	Good quality office retrofit (excluding equipment)	£850 - £2100 (£127.50 - £315)	RICS & (UKGBC)
UK Town Hall Building	Retrofit of Town Hall	£750 (£112.50)	BCIS & (UKGBC)
UK Administrative Building	Retrofit of Administrative Building	£604 (£90.60)	BCIS & (UKGBC)
UK Schools	Average cost of 35 major school retrofits in Kent completed between 2003 & 2007	£1425 (£213.75)	Kent County Council research
AVERAGE VALUES - FULL		**£676 - £937**	
AVERAGE VALUES – ENERGY EFFICIENCY RETROFIT ONLY		**£101.40 - £140.50**	

Source: As indicated & Caleb estimates

6 CONCLUSIONS

In order to help meet Government's carbon reduction targets, the UK as a whole must address its inefficient non-domestic building stock. The scale of the challenge, to refurbish up to 2 million existing non-domestic buildings and achieve at least an 80 per cent cut in carbon emissions by 2050[28], is somewhat daunting, and clearly cannot be done by a business as usual approach.

Much of the existing non-domestic building stock can be characterized as having poor energy performance[29]. Many buildings have poor fabric, inefficient plant, poor controls and low levels of occupant energy awareness. Overheating is common, leading to increased cooling demand. Improved controls and the appropriate use of thermal mass, glazing, shading and ventilation are important to mitigate overheating.

Refurbishment of such buildings represents an opportunity because making cost effective energy performance improvements could reduce greenhouse gas emissions by 20 - 23Mt per year while also benefiting energy security and competitiveness.

There is already a missed opportunity for cost effective emission reductions that could have led to the retention and growth of employment in the construction industry. In as far as the climate change impacts of buildings are being addressed at this time, the focus largely remains on the performance of new buildings and the decarbonization of buildings energy supply.

There are several reasons for low levels of energy performance and the slow progress with making improvements. There are also several drivers for better energy performance. Unfortunately, the barriers currently outweigh the drivers in most instances, and this will not change unless a specific effort is made to accelerate refurbishment of non-domestic buildings.

Caleb believes that the following needs to happen to achieve a step-change in refurbishment:-

- Better application of the Trias Energetica (Energy hierarchy) framework in policy & practice – where the first focus is on 'designing out' the need for energy use in buildings as part of their refurbishments

[28] Interim advice by the Committee on Climate Change; Lord Turner of Ecchinswell; October 2008
[29] Altering existing buildings in the UK; Energy Policy 36 (2008) 4482-4486; Simon Roberts

- A scaled-up Refurbishment programme with third party funding guaranteed by Government & paid back from savings – possibly along the lines of Salix Finance, as currently offered to public sector organizations

- A commitment to concentrate on implementing readily available tried-and-tested solutions, in preference to newer, more risky technologies (e.g. urban wind power)

- A commitment to place a high priority on the energy security & employment potential of buildings and to maximize these via thermal refurbishment measures

Specifically, Caleb proposes that there should be up-front capital funding for beneficiaries willing to commit to achieving EPC/DEC Rating 'C' based on implementing Energy Performance Report recommendations. Energy Performance Reports are key outputs from the buildings energy performance certification process, but their implementation is discretionary at this time.

Caleb has modeled a range of potential benefits and costs associated with building fabric based refurbishment measures and can confirm that: -

- A programme of accelerated refurbishment of the non-domestic building stock could be achieved at a cost of £1.96 billion per year. This would save 0.36 $MtCO_2$ per year through a package of thermal insulation measures with an assumed lifetime of 20 years. It could also result in financial savings of £450 million per year

- Over the period 2010 - 2022, a yearly average of 54 million m^2, or 8% of the technically available non-domestic building stock would be refurbished to a DEC/EPC rating of 'C'. This would achieve annualized savings of nearly 4.74$MtCO_{2e}$ per year in 2022 - approximately 2% of the UK's 'none traded' carbon dioxide budget.[30] - from tried & tested fabric insulation measures alone

- The total cost of thermally refurbishing the non-domestic building stock to a DEC/EPC Rating of 'C' by 2022 would be £24.55 billion, and related financial savings would be in the region of £5.65 billion per year

- A accelerated refurbishment programme focusing on 'tried & tested' thermal efficiency measures could be delivered with a cost effectiveness of £30 -

[30] CCC interim budget for 2022 from averaged emissions over 3rd Budget Period 2018-2022, as indicated on Page 20; Building a low-carbon economy – the UK's contribution to tackling climate change; CCC, 2008

£35/tonne CO_2; an average life time benefit of £120 per tonne CO_2 and an average simple payback rate of <5years. Total energy cost savings would be over £40 billion between 2010 and 2022

- Depending on the scheduling of work between 50,000 and 75,000 long-term jobs could be created or retained in the construction sector on the basis of an average of 100 person years gained from each £1million investment in buildings energy efficiency[31]

- Energy Security could be enhanced, with primary energy savings of 24,000 GWh per annum – equivalent to 1.25% of total primary energy requirements in 2022

<u>Now</u> is the time to accelerate the refurbishment of non-domestic buildings. A survey[32] for the World Business Council for Sustainable Development shows that buildings professionals in Europe and other parts of the world routinely misjudge the costs & benefits of energy efficient buildings. They seriously over-estimate the cost of achieving energy efficiency and underestimate the potential to reduce emissions. The cost of completing energy efficiency refurbishments is often lower than estimated by building professionals, building owners & users – particularly if done on a 'whole building' basis. Meanwhile the climate, energy security and employment benefits of accelerated refurbishment are significant and increasingly important for the country as a whole.

[31] Climate change and employment: Case of the UK; CES-ETUC Study; 2006
[32] Our Vision: A world in which buildings consume zero net energy; EEB #2; WBCSD; 2008

7 APPENDICES

7.1 REFERENCES

1. Interim advice by the Committee on Climate Change; Lord Turner of Ecchinswell; October 2008
2. Altering existing buildings in the UK; Energy Policy 36 (2008) 4482-4486; Simon Roberts
3. Our Vision: A world in which buildings consume zero net energy; EEB #2; WBCSD; 2008
4. Building a Low Carbon Economy – The UK's contribution to tackling climate change; CCC; 2008
5. Low Carbon Buildings Initiatives: Non-domestic Refurbishment; Carbon Trust, 2006
6. Report on carbon reductions in new non-domestic buildings; UKGBC; 2007
7. Government buildings emit more CO2 than all of Kenya; Robert Booth; The Guardian; 23/12/08
8. The Warren Report: The forgotten sector at the heart of UK's effort to cut carbon emissions; Sept. 08
9. Commission Green Paper: A European strategy for sustainable, competitive & secure energy [COM (2006) 105]
10. Report on public consultation prior to the 2nd strategic energy review; DG-TREN; 2008
11. Carbon dioxide emissions from non-domestic buildings: 2000 and beyond; Pout, McKenzie, Bettle; 2002
12. McKinsey Global GHG Abatement Cost Curve 2.0
13. Background to the refurbishment & maintenance of Buildings; www.palgrave.com; 2002
14. German Federal Ministry for Transport, Building and Urban Affairs
15. Climate change and employment: Case of the UK; CES-ETUC Study; 2006
16. DG Internal Policies of the Union, Economic and Scientific Policy Dept, Briefing Note on the employment potential of renewable forms of energy and increased efficiency of energy use, p13, referencing European Commission, 2005, Doing More With Less – Green Paper on energy efficiency
17. Impact on activity & employment of Climate Change and GHG mitigation policies in the enlarged Europe: Final Country Report – Germany; Wuppertal Institute for Climate, Environment & Energy; 2006

18. Energy Efficiency in Offices: Motivating Action; ACE, 2003

19. Cost-Effective Climate Protection in the EU Building Stock; Ecofys; 2005

20. Construction cost data; Kingspan Insulation Ltd & Bucknall Austin; 2005

21. Programmes to reduce household energy consumption; NAO, 2008

22. Energy Efficiency Watch: Screening of National Energy Efficiency Action Plans; Wuppertal Institut GmbH; Ecofys, 2007

7.2 ACCELERATED NON-DOMESTIC BUILDINGS REFURBISHMENT MODEL – SELECTED OUTPUTS

Total Floor Area (000 m^2) – By Building Use

TOTAL FLOOR AREA (000m^2) BY BUILDING USE

Size range m^2 floor area		0-100	100-250	250-500	500-750	750-1,000	1,000-1,250	1,250-2,500	2,500-5,000	5,000-7,500	7,500-10,000	10,000-50,000	50,000 plus	Total
General Type Assumed	*Average Area*	*50*	*175*	*375*	*625*	*875*	*1125*	*1875*	*3750*	*6250*	*8750*	*30000*	*70000*	
Offices	Commercial Office	6555	12254	10493	5384	3514	2488	7548	6962	3551	2,016	11,092	407	72,262
Offices	Communications & Transport	1498	2550	3166	2286	1866	1634	5446	6894	3619	2,011	8,686	965	40,621
Offices	Health Centre & Surgery	749	1593	1031	352	155	99	171	31	7	-	35	-	4,223
Offices	***Sub-Total***	***8801***	***16397***	***14690***	***8023***	***5535***	***4220***	***13165***	***13886***	***7178***	***4026***	***19814***	***1372***	***117107***
Public	Education	151	924	2111	1628	2296	3991	6700	18842	13182	8,315	27,929	70,882	156,950
Public	Local Government	53	411	1106	1825	2589	3516	6319	13589	22082	30,187	104,076	247,433	433,188
Public	Hospital	2	15	147	34	110	81	451	953	897	730	12,864	10,187	26,472
Public	LA Sports Centre	21	183	470	274	340	304	282	1078	1336	855	1,526	1,127	7,795
Public	Government Estate	0	23	80	7	20	64	85	256	355	298	341	6364	7,892
Public	***Sub-Total***	***226***	***1555***	***3914***	***3769***	***5355***	***7955***	***13838***	***34718***	***37853***	***40385***	***146736***	***335992***	***632297***
Retail	Hotel & Catering	2280	6620	4125	2010	1543	1553	1891	2313	2848	3,214	5,353	430	34,179
Retail	Retail	17746	20406	10718	5141	3536	2459	7500	9903	4744	2,029	6,402	682	91,266
Retail	Other Sport & Entertainment	438	2313	9147	1915	932	659	1798	1644	632	509	1,453	234	21,672
Retail	***Sub-Total***	***20463***	***29338***	***23989***	***9065***	***6011***	***4671***	***11189***	***13859***	***8224***	***5752***	***13208***	***1346***	***147117***
Industrial	Other	5011	15796	16974	9578	5980	4265	11079	6464	2088	872	3,426	170	81,702
Industrial	Warehouse	2899	7274	10563	8118	6704	5273	18864	19276	9065	5,523	30,493	1,850	125,902
Industrial	***Sub-Total***	***7910***	***23070***	***27537***	***17695***	***12684***	***9538***	***29943***	***25740***	***11153***	***6395***	***33919***	***2020***	***207604***
	All Public & Commercial	**37400**	**70360**	**70131**	**38552**	**29585**	**26385**	**68134**	**88204**	**64407**	**56,558**	**213,677**	**340,730**	**1104124**

Number of Buildings by Energy Rating

No. of Buildings

A	B	C	D	E	F	G
2,510	12,550	45,179	75,298	50,199	22,589	42,669
661	3,303	11,891	19,819	13,212	5,946	11,231
278	1,388	4,996	8,327	5,551	2,498	4,718
3448	***17241***	***62066***	***103443***	***68962***	***31033***	***58618***
363	1,815	6,534	10,890	7,260	3,267	6,171
363	1,817	6,542	10,903	7,269	3,271	6,179
18	91	328	546	364	164	309
26	129	466	776	517	233	440
5	25	90	150	100	45	85
776	***3878***	***13960***	***23266***	***15511***	***6980***	***13184***
1,034	5,170	18,613	31,022	20,682	9,307	17,579
5,224	26,121	94,034	156,724	104,482	47,017	88,810
374	1,872	6,738	11,231	7,487	3,369	6,364
6633	***33163***	***119386***	***198977***	***132651***	***59693***	***112753***
2,699	13,494	48,578	80,964	53,976	24,289	45,879
1,714	8,569	30,848	51,414	34,276	15,424	29,134
4413	***22063***	***79426***	***132377***	***88252***	***39713***	***75014***

Floor Area by Energy Rating

Total Floor Area

Average Floor Area	*A*	*B*	*C*	*D*	*E*	*F*	*G*
287.90	722,623	3,613,113	13,007,206	21,678,677	14,452,452	6,503,603	12,284,584
614.89	406,211	2,031,054	7,311,794	12,186,323	8,124,215	3,655,897	6,905,583
152.17	42,234	211,168	760,205	1,267,009	844,673	380,103	717,972
339.63	***1,171,067***	***5,855,335***	***21,079,205***	***35,132,009***	***23,421,339***	***10,539,603***	***19,908,138***
4,323.51	1,569,504	7,847,522	28,251,078	47,085,130	31,390,086	14,125,539	26,681,573
11,918.86	4,331,876	21,659,382	77,973,775	129,956,292	86,637,528	38,986,888	73,641,899
14,544.99	264,719	1,323,594	4,764,939	7,941,564	5,294,376	2,382,469	4,500,220
3,013.08	77,948	389,742	1,403,072	2,338,454	1,558,969	701,536	1,325,124
15,784.09	78,920	394,602	1,420,568	2,367,614	1,578,409	710,284	1,341,648
8,153.05	***6,322,968***	***31,614,842***	***113,813,432***	***189,689,054***	***126,459,369***	***56,906,716***	***107,490,464***
330.52	341,786	1,708,932	6,152,153	10,253,589	6,835,726	3,076,077	5,810,367
174.70	912,659	4,563,296	16,427,866	27,379,777	18,253,184	8,213,933	15,515,207
578.93	216,721	1,083,603	3,900,973	6,501,621	4,334,414	1,950,486	3,684,252
221.81	***1,471,166***	***7,355,831***	***26,480,992***	***44,134,987***	***29,423,325***	***13,240,496***	***25,009,826***
302.73	817,015	4,085,075	14,706,272	24,510,453	16,340,302	7,353,136	13,889,257
734.64	1,259,021	6,295,103	22,662,371	37,770,618	25,180,412	11,331,185	21,403,350
470.48	***2,076,036***	***10,380,178***	***37,368,643***	***62,281,071***	***41,520,714***	***18,684,321***	***35,292,607***
723.13				331,237,120	220,824,747	99,371,136	187,701,035

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Total CO_2 Emissions by Energy rating

Total CO2 Emissions

A	B	C	D	E	F	G	Total
9,033	135,492	812,950	1,896,884	1,625,901	894,245	1,996,245	
5,078	76,165	456,987	1,066,303	913,974	502,686	1,122,157	
528	7,919	47,513	110,863	95,026	52,264	116,670	
14,638	***219,575***	***1,317,450***	***3,074,051***	***2,634,901***	***1,449,195***	***3,235,072***	***11,944,883***
19,619	294,282	1,765,692	4,119,949	3,531,385	1,942,262	4,335,756	
54,148	812,227	4,873,361	11,371,176	9,746,722	5,360,697	11,966,809	
3,309	49,635	297,809	694,887	595,617	327,590	731,286	
974	14,615	87,692	204,615	175,384	96,461	215,333	
987	14,798	88,786	207,166	177,571	97,664	218,018	
79,037	***1,185,557***	***7,113,340***	***16,597,792***	***14,226,679***	***7,824,673***	***17,467,200***	***64,494,278***
4,272	64,085	384,510	897,189	769,019	422,961	944,185	
11,408	171,124	1,026,742	2,395,730	2,053,483	1,129,416	2,521,221	
2,709	40,635	243,811	568,892	487,622	268,192	598,691	
18,390	***275,844***	***1,655,062***	***3,861,811***	***3,310,124***	***1,820,568***	***4,064,097***	***15,005,896***
10,213	153,190	919,142	2,144,665	1,838,284	1,011,056	2,257,004	
15,738	236,066	1,416,398	3,304,929	2,832,796	1,558,038	3,478,044	
25,950	***389,257***	***2,335,540***	***5,449,594***	***4,671,080***	***2,569,094***	***5,735,049***	***21,175,564***
12.5	***37.5***	***62.5***	***87.5***	***112.5***	***137.5***	***162.5***	
							112,620,621

Projected Annual Carbon Savings (tCO_2) by Energy Rating

Projected Annual Carbon Savings(tCO2)

A	*B*	*C*	*D*	*E*	*F*	*G*	
			433,574	578,098	390,216	982,767	
			243,726	324,969	219,354	552,447	
			25,340	33,787	22,806	57,438	
			702,640	***936,854***	***632,376***	***1,592,651***	***3,864,521***
			941,703	1,255,603	847,532	2,134,526	
			2,599,126	3,465,501	2,339,213	5,891,352	
			158,831	211,775	142,948	360,018	
			46,769	62,359	42,092	106,010	
			47,352	63,136	42,617	107,332	
			3,793,781	***5,058,375***	***3,414,403***	***8,599,237***	***20,865,796***
			205,072	273,429	184,565	464,829	
			547,596	730,127	492,836	1,241,217	
			130,032	173,377	117,029	294,740	
			882,700	***1,176,933***	***794,430***	***2,000,786***	***4,854,849***
			490,209	653,612	441,188	1,111,141	
			755,412	1,007,216	679,871	1,712,268	
			1,245,621	***1,660,829***	***1,121,059***	***2,823,409***	***6,850,918***
		% Saving	*22.86%*	*35.56%*	*43.64%*	*49.23%*	***32.35%***
							36,436,083

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Projected Capital Costs (£m) to achieve Energy Rating improvement to Level ‘C’

Projected Capital Costs (£m)

A	*B*	*C*	*D*	*E*	*F*	*G*	
			634	423	190	359	
			357	238	107	202	
			37	25	11	21	
			1,028	***685***	***308***	***583***	***2,604***
			1,378	919	413	781	
			3,803	2,535	1,141	2,155	
			232	155	70	132	
			68	46	21	39	
			69	46	21	39	
			370	***247***	***111***	***210***	***938***
			300	200	90	170	
			801	534	240	454	
			190	127	57	108	
			1,291	***861***	***387***	***732***	***3,272***
			717	478	215	406	
			1,105	737	332	626	
			3,114	***2,076***	***934***	***1,765***	***7,889***
							14,702

Projected Annual Savings (£m) from achieving Level 'C' Energy Rating improvement

Projected Annual Financial Savings(£m)

A	*B*	*C*	*D*	*E*	*F*	*G*	
			67.23	89.63	60.50	152.38	
			37.79	50.39	34.01	85.66	
			3.93	5.24	3.54	8.91	
			109	***145***	***98***	***247***	***599***
			146.01	194.68	131.41	330.96	
			403.00	537.33	362.70	913.46	
			24.63	32.84	22.16	55.82	
			7.25	9.67	6.53	16.44	
			7.34	9.79	6.61	16.64	
			588	***784***	***529***	***1,333***	***3,235***
			31.80	42.40	28.62	72.07	
			84.90	113.21	76.41	192.45	
			20.16	26.88	18.15	45.70	
			137	***182***	***123***	***310***	***753***
			76.01	101.34	68.41	172.28	
			117.13	156.17	105.41	265.49	
			193	***258***	***174***	***438***	***1,062***
							5,649

Refurbishment Measures – Marginal Costs

Potential Refurbishment Measures - Marginal Costs

	% of mix	Cost/m2 *(£/m2)*
Dry Lining Solid Wall	10%	48.26
Externally Insulated Solid Wall	10%	46.94
Injected Cavity Wall Insulation	40%	12.79
Metal Deck Roofing	10%	50.08
Timber Deck Flat Roof	10%	44.87
Re-lined Pitch Roof	10%	56.28
Re-tiled Pitch Roof	10%	68.20
Average Mix		36.58

Cost Effectiveness & Lifetime of Measures

Assumed Lifetime	20.00	Years
Average Capital Cost Eff.	20.18	£/te CO2
Average Lifecycle Cost Eff.	-134.88	£/te CO2
Average Simple Payback	2.60	years

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