

Sustainable Construction and the Green Deal

Evidence to the All Party Parliamentary Committee for Excellence in the Built Environment

Bruce Tofield, b.tofield@uea.ac.uk; John French, john.french@uea.ac.uk

Adapt Low Carbon Group, University of East Anglia, 30 November 2012

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Summary

- The construction industry is not fit for purpose to deliver the low-energy homes we need, either as new build or via refurbishment of the existing stock. Studies all show a performance gap between expected and delivered energy performance of new buildings. In almost every case, actual performance is worse, sometimes far worse, than predicted.
- The problem is one of quality throughout the design and construction process. Examples show that the industry can deliver, but the “traditional construction model”, where teamwork is poor across the whole process, creates defects, often hidden, that compromise energy performance.
- This ‘energy performance gap’ means that current and future building codes and standards cannot ensure delivery of buildings that comply with these codes. Requirements such as so-called “zero-carbon homes” in the UK or the European Performance of Buildings Directive are ineffectual without confidence that buildings, either new or refurbished, will perform as designed and as Energy Performance Certificates (EPCs) claim.
- The energy performance gap may not have greatly mattered when energy standards for buildings were less stringent than they are today. But if quality in construction does not improve, then programmes to build more homes and to improve the energy efficiency of the existing stock could create a legacy spanning many decades of higher bills, poorer health, and the country unable to meet climate change targets.
- It is urgent to improve the energy efficiency of the current building stock as well as to make new buildings as energy efficient as possible. Nearly one-third of all energy used in Britain is used in homes and two-thirds of this goes on heating. Energy for heating homes has gone up by forty per cent in recent decades in spite of more stringent regulations and efforts to improve the stock. Bills have more than doubled because of increases in the price of gas.
- Studies make clear that ‘deep’ refurbishment of the building stock can bring multiple benefits, not just reduced bills, but job creation, improved public finances and greatly improved public health. These benefits are largely public and will not be realised unless there is significant public investment to support the cost of refurbishment, something that is not part of the Green Deal in the UK.
- Successful retrofits can halve carbon emissions at least. New build homes now demonstrate that energy for heating can be ten per cent or less than the average for the UK stock. Further gains will be achieved once increased efficiency in electricity use is achieved.
- These benefits will only be gained through a transformation in the quality of design and construction. Such a transformation is possible but can only be achieved by demanding a passivhaus quality approach. Such a transformation of the construction industry will bring

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benefits of a kind that the automobile industry has achieved in recent decades and will accelerate innovation, growth in jobs, skill formation, local supply chains, and competitiveness.

- If Government and the industry accept the quality challenge, the UK could become a global leader in sustainable construction. The examples of what to do and how to do it already exist.

The Performance Gap....

As part of the University of East Anglia's contribution to a European project on low-energy and sustainable construction from 2008 to 2012, we produced two major reports detailing the barriers to sustainable construction and the quality issues (in the UK in particular) that create an energy performance gap in buildings, both domestic and non-domestic.

There have been significant barriers to progress in energy efficiency in general, and to low-energy buildings, in particular, across the EU. These barriers exist across a wide spectrum and could be summarised as political and structural barriers (to do with political ambition, regulation etc), industry barriers (lack of ambition or willingness to change, for example), and social barriers (lack of awareness of the benefits of low-energy homes and buildings, for example).

The clearest evidence for these barriers was the lack of progress in energy efficiency across the EU. While progress towards the EU mandates of twenty per cent reduction (relative to 1990) in greenhouse gas emissions and twenty per cent proportion of renewables in energy supply by 2020 was good, only half the twenty per cent target for energy efficiency relative to 1990 was being achieved. It remains to be seen if the initiatives mandated in the EU Energy Efficiency Directive, 2012, will improve matters.

Refurbishing Europe: An EU Strategy for Energy Efficiency and Climate Action Led by Building Refurbishment, Bruce Tofield and Martin Ingham, February 2012¹ highlights the reasons why making buildings much more energy efficient is the biggest step change that can be made to achieve wider energy efficiency and climate change targets. The generic barriers to progress in energy efficiency reflect a similar set of barriers that inhibit progress in energy efficient buildings. Key political, industry and social barriers are summarised on pp26-28 of that report.

Delivering a low-energy building: Making quality commonplace, Bruce Tofield, October 2012², deals in particular with the industry barriers that prevent sustainable construction and that create the energy performance gap. This report is submitted with this submission.

¹ *Refurbishing Europe: An EU Strategy for Energy Efficiency and Climate Action Led by Building Refurbishment*, Bruce Tofield and Martin Ingham, February 2012; see <http://www.buildwithcare.eu/news/231-refurbishing-europe> and <https://www.uea.ac.uk/mac/comm/media/press/2012/February/EU-energy-efficiency>.

² *Delivering a low-energy building: Making quality commonplace*, Bruce Tofield, October 2012; see <http://www.buildwithcare.eu/news/244-delivering-a-low-energy-building> and <http://www.uea.ac.uk/mac/comm/media/press/2012/October/passivhaus-bruce-tofield>.

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In this report we highlight UK studies over the last twenty years that have demonstrated the performance gap, not just in respect of energy performance but also in ventilation. As new or refurbished homes and buildings become more air tight, mechanical ventilation with heat recovery (MVHR) will become necessary and often standard. If this does not perform as it should, internal air quality and comfort may be compromised. Instead of supposed low-energy homes providing an excellent and healthy internal environment, exactly the opposite could often be the case.

Both energy and MVHR concerns are the result of poor quality across the design and construction process and the “traditional construction model” where there is poor teamwork across the design and construction process. We give detailed references in *delivering a low-energy building*² but one quote from a contractor summarises the situation:

“A quality culture where tradesmen take ownership of their work in a ‘no blame’ culture is alien to the construction industry. In the adversarial culture that is widespread, costs are cut to the bone and contractors are looking to charge sub-contractors for any alterations or delay and to charge the client for chargeable works not in the tender. In such an environment, the tradesman on site has no awareness of the impact of his work on the eventual performance of the building, and the various trades are interested only in meeting time and cost targets, not in working together to create a quality outcome.”

Such an environment cannot create a quality product. Only in a quality process with teamwork from start to finish can construction of low-energy homes be guaranteed and can refurbishment of the existing stock be undertaken in a satisfactory manner. Chapter 8 in *Refurbishing Europe*¹ and Chapter 5 in *Delivering a low-energy Building*² discuss quality and the construction industry in more detail.

.... and How to Overcome it

In *Delivering a low-energy Building*², Chapter 3, we provide specific examples of buildings that have been designed and delivered in a quality manner: in particular, the Elizabeth Fry Building at the University of East Anglia in the 1990s and new passivhaus schools at Wolverhampton in 2011. These examples demonstrate that, with management commitment to a quality process, staff on a construction site are perfectly able to deliver a high-quality product that need cost no more than one built in a conventional manner.

As the Elizabeth Fry Building showed in the 1990s³, and continues to show to this day⁴, a building constructed in a quality manner will out-perform other buildings and provide an environment that

³ “For example, in the Probe series of post-occupancy studies, only one out of 20 buildings looked at – the Elizabeth Fry Building, University of East Anglia, Norwich, UK – could reasonably be argued to meet all three criteria” [occupant satisfaction and good environmental and energy performance at acceptable cost], **Building evaluation: practice and principles**, Adrian Leaman, Fionn Stevenson and Bill Bordass, Building Research & Information, 38(5), 564-577 (2010)

⁴ **Test of Time**, Bill Bordass and Adrian Leaman, CIBSE Journal, March 2012, pp30-36, (<http://www.buildwithcare.eu/images/pdfs/cibse%20journal%20e%20fry%20revisit%20mar12.pdf>) and **Elizabeth Fry**

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enhances well-being and promotes productivity. In Chapter 6 of *Delivering a low-energy Building*² we outline the factors that enhance (or inhibit) productivity in offices and other buildings.

The key factors of teamwork and simplicity that lead to excellent building fabric and low-energy operation lead also to creation of an excellent internal environment. Together, these factors can generate a sense of comfort and well-being that seem, fairly conclusively, to lead to enhanced productivity. As we note at the conclusion of the Chapter:

The financial benefits of low-energy buildings seem very likely to extend far beyond low fuel bills to lower maintenance costs, healthier occupants, less cost to society of ill-health, better rents and occupancy levels in commercial and office buildings, and more productive work environments. Such benefits are likely to outweigh the costs of making the transition to quality many times over, while the costs to society at large of not creating quality and foregoing the ability to deliver low-energy buildings will be huge.

There is now good evidence from several European countries that the passivhaus standard⁵ (followed in the construction of the Wolverhampton schools) ensures the necessary high quality of construction leading to good internal air quality and high levels of occupant satisfaction, as well as to very low energy use for heating and cooling, without any noticeable energy performance gap.

A new build regulatory mandate at or near to the passivhaus standard is essential for the successful delivery of new low-energy buildings in the UK (and across the EU). Only with a new build standard of this nature can supply chains be developed and high quality practices become standard. It is not just the energy performance of passivhaus homes and buildings that is important⁶. Especially relevant to

- *ageing gracefully?*, Roderic Bunn, BSRIA Delta t Magazine, February 2012 (and at <http://www.bsria.co.uk/news/elizabeth-fry/>); see <http://www.buildwithcare.eu/articles/78-partners/217-elizabeth-fry-building-still-as-good> and <http://www.buildwithcare.eu/component/content/article/233-revisit-to-the-elizabeth-fry-building>.

⁵ See http://passipedia.passiv.de/passipedia_en/basics/what_is_a_passive_house; the Passive House Certificate for refurbished buildings, EnerPHit, is outlined at http://passipedia.passiv.de/passipedia_en/certification/enerphit

⁶ The energy for heating of a passivhaus new building must be no more than 15kWh/m²/year (this figure is relaxed somewhat for a building refurbished to the EnerPHit passivhaus standard). This figure is only 10 per cent of the value we estimate for the UK building stock as a whole of 160kWh/m²/year. As we note below, increasing energy efficiency standards for new buildings, and efforts to improve the insulation of existing buildings, have not resulted in reduced energy use for heating in UK homes. On the contrary, the average heating energy per home has hardly changed in nearly 40 years while the total energy used for heating homes has increased by 40 per cent. This is because of the so-called rebound effect – occupants opt for warmer rooms and more rooms being warm to achieve comfort. Going to passivhaus standards, however, overcomes this perverse outcome. There is no rebound effect because the energy from the surroundings, from occupants, and from appliances can keep buildings warm and comfortable as well as healthy and with a sense of well-being without the need for a heating system. See the quotes from residents of Hastoe Housing Association's new passivhaus homes at Wimbish in Essex (Footnote 11) at the front pages of *Delivering a low-energy building* (and quoted below).

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sustainable construction are the quality demands that are made in building to the passivhaus quality standard. The quality process essential to deliver passivhaus will enable the transformation from the “traditional construction model” to a high quality construction process.

A similar quality transformation must also occur within the refurbishment sector. Refurbishment of existing buildings is a more complex process than designing and building new ones. The documented problems with new buildings make it certain that similar or worse ‘energy gap’ and other quality problems will be found in refurbishment of the existing building stock. Only with the same quality approach as for passivhaus new build can successful low-energy refurbishment of the existing building stock be achieved. We give an example from Sweden, with contractor Skanska, below.

Passivhaus in practice

The benefits of high-quality, sustainable and low-energy construction extend far beyond the saving of energy and lower bills, important as these are. There are public benefits of improved health and well-being as well as benefits of improved productivity. However, much of the discussion about homes and buildings centres around construction cost only. There is a fairly widely-held view that building to the passivhaus standard is more expensive than conventional construction and is, therefore, not an option for large-scale construction, either new-build or refurbishment. This view is a reflection more of ignorance and the industry’s reluctance to change than of reality.

Housing associations are leading the way in demonstrating that passivhaus is the sensible option taken over a longer time horizon. Reduced energy bills mean a greater certainty of rental income from potentially financially-challenged tenants. Together with lower maintenance costs, the financial case for building new to passivhaus quality becomes evident.

As a significant proportion of the population experiences increasing financial stress in the coming years, the benefit of living in a passivhaus home will become even more marked for occupants and owners alike. The recent report by the Commission for Living Standards has highlighted⁷ that a typical low-income household in 2020 is set to have an income 15 per cent lower in 2020 than in 2008.

Broadland Housing Group executives have engaged with Build with CaRe partners in Sweden and Germany⁸ and worked with their construction industry partners and associates to create a passivhaus strategy. The UK’s largest passivhaus new build project, 250 privately-financed apartments at Carrow

⁷ ***Gaining from growth: The final report of the Commission on Living Standards, The Resolution Foundation***, 31 October 2012, <http://www.resolutionfoundation.org/publications/final-report-commission-living-standards/>

⁸ Broadland’s experience and ambition have been described by Andrew Savage, Executive Director: Business Growth in a presentation to the Build with CaRe seminar in Brussels, 7 March 2012: ***Transnational learning – the confidence to make a change, Andrew Savage***, see http://www.buildwithcare.eu/images/pdfs/bwc_andrew_savage_120307.pdf.

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Road, will begin construction in Norwich in 2013 and the Broadland Housing Group Corporate Strategy 2012-2015 states⁹ that at least 75 per cent of new homes will be built to passive house standards.

Andrew Savage, executive director for business growth at Broadland Housing Group, has said¹⁰:

“Broadland Housing Group sees passivhaus construction as not just the right way forward environmentally, but economically too. Reduced maintenance and more reliable income streams make this the sensible way to help solve Britain’s housing crisis. All housing associations, private rental developers and savvy investors should now be thinking passive as Broadland is.”

Broadland Housing has demonstrated that with ambition and initiative it is possible to move to passivhaus as a financially viable mode of construction. Another exemplar is Hastoe Housing Association with its new passivhaus homes at Wimbish, Essex¹¹ and, soon, elsewhere also.

The architecture practice, Architype, that is designing the University of East Anglia’s new Enterprise Centre¹² that will be passivhaus certified, has developed a strategy¹³ to rethink the design of the house as an optimised passivhaus product to maximise performance efficiency and suitability for factory manufacture. Passivhaus development will stimulate the adoption of modern methods of construction that have been long recommended (see, for example Footnote 24) but that have been resisted by the industry.

These initiatives by far-sighted housing associations demonstrate that rather than creating a high-cost option, moving to passivhaus quality as the standard for new build dwellings will not only lead to sustainable and desirable homes that cost little to heat but also to much healthier environments and potentially very significant improvements in public health. Moving to passivhaus will also stimulate a cascade of innovation that will drive up quality and competitiveness for the benefit of the UK economy as a whole and for jobs across the country.

A way forward

⁹ See http://www.broadlandhousing.org/files/publications/corp_strategy/corporate_strategy_2012_2015.pdf.

¹⁰ See UEA press release <http://www.uea.ac.uk/mac/comm/media/press/2012/October/passivhaus-bruce-tofield>, Case Study 1

¹¹ **Wimbish Passivhaus: Building Performance Evaluation; 12 month’s monitoring**, Martin Ingham, presentation at the UK Passivhaus Conference, 7, 8 November 2012, Nottingham, downloadable from <http://www.ukpassivhausconference.org.uk/2012-conference-presentations>

¹² See UEA press release <http://www.uea.ac.uk/mac/comm/media/press/2012/October/passivhaus-bruce-tofield>, Case Study 2

¹³ **Mainstreaming Passivhaus Housing Development**, Lars Carlsson and Jonathan Hines, presentation at the UK Passivhaus Conference, 7, 8 November 2012, Nottingham, downloadable from <http://www.ukpassivhausconference.org.uk/2012-conference-presentations>

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We need to take the same approach [as to the Olympic Games]: a clear, ambitious vision; the courage to take decisions that bear fruit decades later; openness to new opportunities as they develop; focus on the things we do best; and an enduring commitment far beyond the normal parliamentary timescale.¹⁴

Vince Cable's words could describe the desirable situation where the construction industry, supported by Government, transforms itself to be able to deliver passivhaus quality on a large scale. As we have detailed in *Delivering a low-energy building*², however, proceeding with current plans for more stringent building codes - with so-called "zero-carbon homes" from 2016 - is likely to lead to a continuing situation where homes (and other buildings as well) perform less well in energy terms than the designs would indicate. The outcomes will be higher bills, poorer internal air quality, and poorer design than could be the case with a more enlightened approach.

The ambition articulated by Vince Cable in the autumn will be totally absent. Already there is concern about new homes being "shoe box homes¹⁵" or badly designed "homes from hell¹⁶".

In responding to the RIBA findings articulated in the "shoe box homes" report¹⁷, the Future Homes Commission has recommended¹⁸ that there should be a three-fold increase in the number of new homes being built each year and a greater focus on design to ensure that the homes meet current residents' needs and making them fit for future generations.

¹⁴ From ***Strategy for the future of British industry***, Industrial Strategy speech given by **Vince Cable**, Imperial College, London, 11 September 2012

<http://news.bis.gov.uk/Press-Releases/Strategy-for-the-future-of-British-industry-67fdf.aspx>

¹⁵ ***Shameful shoe box homes: new research reveals how thousands of brand new houses are failing to provide the space families need***, RIBA Press Release, 14 September 2011,

<http://www.architecture.com/NewsAndPress/News/RIBANews/News/2011/Shamefulshoebboxhomesnewresearchrevealshowthousandsofbrandnewhousesarefailingtoprovidethespacefamiliesneed.aspx>

¹⁶ "Polls have shown that a significant number of prospective buyers believe that new-builds are badly designed and built. And three-quarters of people would embrace more housing in their area if they knew it was better designed" in ***Sir Terence Conran joins drive to build higher quality homes: Housebuilders challenged to prove the quality of new-build homes***, 22 August 2012, <http://www.communities.gov.uk/news/newsroom/2203353>

¹⁷ ***The Case for Space: the size of England's new homes***, Royal Institute of British Architects, September 2011, <http://www.architecture.com/Files/RIBAHoldings/PolicyAndInternationalRelations/HomeWise/CaseforSpace.pdf>

¹⁸ ***Building the Homes and Communities Britain Needs***, The Future Homes Commission, 26 October 2012

<http://www.architecture.com/HomeWise/FutureHomesCommission/FutureHomesCommission.aspx>

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Sadly, the Future Homes Commission has nothing to say about energy performance. What would actually enable its design ambitions and low-energy ambitions both to be fulfilled would be to build these homes to passivhaus standard.

The responses of occupants in Hastoe Housing's new passivhaus homes at Wimbish in Essex¹¹ articulate so clearly the benefits in well-being as well as of lower bills of living in a passivhaus home.

"You just don't have the bills you would have in a normal house"

"The houses are so light and spacious"

"I'm happy putting my children's bunk beds by the window as there's no draughts, and the glass is not cold"

"I'm less stressed. Having a lovely house we are proud of and look forward to coming home to is benefitting all of us"

Not only is passivhaus a solution to poor health and fuel poverty in poorly heated, damp and draughty homes. The homes also promote well-being. The exact opposite of "shoe-box homes" or "homes from hell" being built today.

The quality problems with the construction industry noted above are well documented. But apart from a resistance to change within the industry, there is a wider problem of ignorance about the benefits of change. The majority of businesses and organisations that might support change are unaware of the long-term financial benefits of building homes to passivhaus standard.

Neither the Future Homes Commission¹⁸ nor the Montague Report¹⁹ on the private rental sector discuss the benefits, financial and otherwise, of constructing to passivhaus standard. Yet, in spite of the lack, today, both of an effective supply chain and of widespread passivhaus skills among the design and construction industry, progressive organisations such as Broadland Housing are showing that passivhaus is the sensible way forward, financially, environmentally, and for the benefit of occupants. If momentum can build, skills will become more widely available, supply chains will develop, costs will fall, and the benefits will become even more marked.

These financial benefits of passivhaus are over the long term. Until passivhaus homes become better known it is unlikely that their value will be reflected in firmer prices and an active desire of purchasers to own a passivhaus home. That day may hopefully not be far off, but, until that point, it seems likely that it will be the social housing and private rented sectors, rather than the homes-for-sale sector that can drive forward passivhaus new build, and build volumes and supply chains to the point that can stimulate transformation of the wider market.

With the growth of "affordable rents" in the social housing sector, it seems likely that there will be an increasing overlap between building for social housing and building for private rental. Developers of both

¹⁹ **Review of the barriers to institutional investment in private rented homes (The Montague Report)**, Department for Communities and Local Government, August 2012, <http://www.communities.gov.uk/documents/housing/pdf/2204242.pdf>

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kinds will be concerned with the long-term financial case. Hence the need is to make clear to developers of social housing and private rental homes the financial case for passivhaus quality and standards.

The case for increased investment in new housing by local authority pension funds is being made from several quarters. These funds total at least £120billion. Investment of even a modest proportion of this sum could have a significant impact on new house starts. Montague¹⁹ discusses this option as do the IPPR²⁰ and the Smith Institute²¹.

A few days ago, groups representing the world's largest investors published an open letter²² to the governments of the world's largest economies calling for a new dialogue on climate change policy in order to avert dangerous climate change and its resulting economic impacts. One of the signatories, the Institutional Investors Group on Climate Change²³, is based in London and has many UK members including several local authority pension funds. Investing in passivhaus rental new build and passivhaus quality refurbishment is one very effective way investors could explicitly support efforts to tackle climate change.

Every effort must now be made to make the financial case for passivhaus quality to long-term investors that wish to invest in sustainable but profitable ways. If new build social and private rental properties can be constructed to passivhaus standards, not only can financial and environmental objectives be effectively targeted. Occupants and wider society will also both benefit, and the construction industry and its supply chains can undertake the quality transformation that has been demanded over many years²⁴ but which is still to be made: *"Twenty years ago the British car industry was a joke because cars were broken when they left the factory. British houses are still a joke because they leave the factory broken."*²⁵

²⁰ **Together at home: A new strategy for housing**, Graeme Cooke and Andy Hull, IPPR, 21 June 2012, <http://www.ippr.org/publication/55/9279/together-at-home-a-new-strategy-for-housing>

²¹ **Local Authority Pension Funds: Investing for Growth**, prepared by a research consortium of the Smith Institute, the Centre for Local Economic Strategies (CLES), Pensions Investment Research Consultants (PIRC) and the Local Authority Pension Fund Forum (LAPFF), published by **The Smith Institute**, September 2012, <http://www.smith-institute.org.uk/file/local%20authority%20pension%20funds%20-%20investing%20for%20growth.pdf>

²² **World's Largest Investors Call For More Decisive Action By Governments on Climate Change**, 20 November 2012, <http://www.ceres.org/press/press-releases/worlds-largest-investors-call-for-more-decisive-action-by-governments-on-climate-change>

²³ <http://www.iigcc.org/>

²⁴ **Rethinking Construction**, The report of the Construction Task Force to the Deputy Prime Minister on the scope for improving the quality and efficiency of UK construction (The Egan Report), 1998, http://www.constructingexcellence.org.uk/download.jsp?url=/pdf/rethinking_construction/rethinking_construction_report.pdf

²⁵ Reported remark by Andrew Stunell OBE MP, Parliamentary Under Secretary of State, Department for Communities and Local Government, at the EcoBuild Conference, London, March 2012, quoted in **Stunell:**

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If this change to sustainable passivhaus construction does not happen, the pressure from so many quarters to stimulate new house building is likely to lead to a legacy over decades of poorly-designed homes that are expensive to run and which make achievement of climate change targets impossible. If it really is necessary to build on land equivalent to a third of that we currently occupy across the country as planning minister Nick Boles asserted this week²⁶ then only well-designed, fit-for-purpose, passivhaus homes could possibly provide an acceptable option.

While the task of refurbishing the existing stock to much higher standards of energy efficiency is far greater than the new build challenge, it is new build that drives innovation in the supply chain and develops the skills and techniques that are needed more widely. If transformation in new build does not happen, it is almost certain that the quality challenge of the refurbishment task cannot be met. Homeowners and tenants will be locked-in for decades to an increasingly expensive to heat housing stock. Problems of fuel-poverty, poor health and financial pressures on increasingly hard-pressed homeowners and tenants will inevitably all grow and intensify.

Low-carbon energy supply can only become a reality if there is a step-change improvement in energy efficiency and in demand reduction that has to be led by the housing sector. Only a transformation in construction quality can enable this goal to be met. Building to passivhaus standards of quality is the means to drive this transformation. As we have noted, the cumulative benefits for occupants, for jobs, for health, for the environment, for innovation and for competitiveness will be massive.

The urgent need to cut energy use in homes

The UK is already experiencing the problems of extreme weather patterns that are, in part, driven by climate change and warmer oceans²⁷. The flooding experienced by many in recent days is just a taster of much more extreme events that are inevitable if there is ineffective action to curb greenhouse gas emissions and to tackle climate change. Self-evidently, the UK cannot tackle global climate problems on its own but it can set an example to other nations on its own and via concerted action with its EU partners. As with passivhaus new build, the benefits from a serious programme of whole-house retrofit to low-energy standards will extend far beyond reduced energy bills.

Performance of UK homes is a 'joke', Joey Gardiner, Building.co.uk, 22 March 2012, <http://www.building.co.uk/technical/sustainability/ecobuild/stunell-performance-of-uk-homes-is-a-%e2%80%98joke%e2%80%99/5033859.article>

²⁶ **Could better-looking homes solve housing shortage?**, Allegra Stratton, Political editor, BBC Newsnight, 29 November 2012, <http://www.bbc.co.uk/news/uk-politics-20535467>; **Nick Boles offers a recipe for senseless sprawl**, Telegraph View, 28 November 2012, <http://www.telegraph.co.uk/comment/telegraph-view/9708802/Nick-Boles-offers-a-recipe-for-senseless-sprawl.html>

²⁷ The European Environment Agency has reported this month that the last decade was the warmest on record in Europe with European land temperatures 1.3°C warmer than the pre-industrial average: **Climate change evident across Europe, confirming urgent need for adaptation**, European Environment Agency, Press Release, 21 November 2012, <http://www.eea.europa.eu/pressroom/newsreleases/climate-change-evident-across-europe>

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Several recent, authoritative reports^{28, 29, 30} highlight the urgency of action to tackle greenhouse gas emissions if global temperatures are to be kept within an acceptable 2 degree rise from pre-industrial levels. The issue is not targets for 2050 but cumulative emissions. If drastic action is not taken in a very few years, then it becomes almost impossible to limit global temperature rise to 2 degrees.

Global greenhouse emissions have accelerated in recent years. Global temperature rises of 4 degrees or higher are now predicted unless there are big reductions in global greenhouse gas emissions starting well before 2020. The decarbonisation of energy supply must accelerate but cannot take full effect in such a limited time horizon. An essential parallel action is to greatly accelerate progress in energy efficiency and demand reduction³¹.

Adaptation must certainly take place because at least 2 degrees of warming, and probably more, is inevitable. But action to mitigate climate change and to cut emissions to minimise warming will always be cheaper than the costs of trying to adapt to dangerous and irreversible change. This point has recently

²⁸ For example **Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, A Report for the World Bank** by the Potsdam Institute for Climate Impact Research and Climate Analytics, 18 November 2012; the press release (at <http://www.worldbank.org/en/news/2012/11/18/new-report-examines-risks-of-degree-hotter-world-by-end-of-century>) notes that: “The world is barreling down a path to heat up by 4 degrees at the end of the century if the global community fails to act on climate change, triggering a cascade of cataclysmic changes that include extreme heat-waves, declining global food stocks and a sea-level rise affecting hundreds of millions of people, according to a new scientific report released today that was commissioned by the World Bank.”

²⁹ The PricewaterhouseCoopers Low Carbon Economy Index 2012 highlighted the difficulty of limiting global temperature rise to 2 degrees: “This year we estimated that the required improvement in global carbon intensity to meet a 2°C warming target has risen to 5.1% a year, from now to 2050. We have passed a critical threshold – not once since World War 2 has the world achieved that rate of decarbonisation, but the task now confronting us is to achieve it for 39 consecutive years. ... Even doubling our current rate of decarbonisation, would still lead to emissions consistent with 6 degrees of warming by the end of the century. To give ourselves a more than 50% chance of avoiding 2 degrees will require a six-fold improvement in our rate of decarbonisation. ... Now one thing is clear: businesses, governments and communities across the world need to plan for a warming world – not just 2°C, but 4°C, or even 6°C.”, **PwC Low Carbon Economy Index 2012: Too late for two degrees?**, 5 November 2012, http://www.pwc.com/en_GX/gx/low-carbon-economy-index/assets/pwc-low-carbon-economy-index-2012.pdf

³⁰ “Action on climate change needs to be scaled-up and accelerated without delay if the world is to have a running chance of keeping a global average temperature rise below 2 degrees Celsius this century.”, **UNEP: The Emissions Gap Report 2012, United Nations Environment Programme**, 21 November 2012, <http://www.unep.org/newscentre/Default.aspx?DocumentID=2698&ArticleID=9335&l=en>

³¹ The **2012 World Energy Outlook** by the **International Energy Agency**, 12 November 2012, press release at <http://www.iea.org/newsroomandevents/pressreleases/2012/november/name,33015,en.html> notes that: “Our analysis shows that in the absence of a concerted policy push, two-thirds of the economically viable potential to improve energy efficiency will remain unrealised through to 2035. Action to improve energy efficiency could delay the complete ‘lock-in’ of the allowable emissions of carbon dioxide under a 2°C trajectory – which is currently set to happen in 2017 – until 2022, buying time to secure a much-needed global climate agreement. It would also bring substantial energy security and economic benefits, including cutting fuel bills by 20% on average.”

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been reinforced by Ambassador Richard Jones, Deputy Executive Director of the International Energy Agency in an interview³² following the publication of the 2012 World Energy Outlook³¹. In this context, the costs of effecting low-energy retrofit/refurbishment of the existing building stock would seem good value for money.

We have argued¹ that the EU should set a demand reduction target of at least 40 per cent by 2050 – which would entail action beginning now – in order to act decisively to combat potentially disastrous climate change. As we highlight in *Refurbishing Europe*¹ housing provides the biggest opportunity and potential gain in energy efficiency.

The multiple benefits from a ‘deep’ refurbishment programme

We note in *Refurbishing Europe*¹ that partial refurbishment of homes will lock-in energy use for decades and make achieving energy efficiency and climate change targets difficult if not impossible.

Recent reports^{33, 34} have confirmed the multiple benefits of ‘deep’ refurbishment³⁵ of Europe’s housing stock. The conclusions also apply to individual countries such as the UK.

³² “Let me tell you: adaptation's more expensive. I don't want to abandon a less expensive alternative prematurely, just because politically people are having problems with it. I can't say that the recent hurricane [in the US] was caused by global warming, but all the models predict that there will be more such events. Think about the expense for that. It makes so much more sense to pay to avoid climate change than to adapt to it.”, interview in **IEA's 'changing energy landscape' portends a dysfunctional future**, Alex Forbes, European Energy Review, 19 November 2012, http://www.europeanenergyreview.eu/site/pagina.php?id=3969#artikel_3969

³³ “A so-called shallow renovation track will completely miss both environmental targets (CO₂-emission and final energy savings) while not providing substantial economic advantage. ... A deep renovation track, combining a focus on energy efficiency with high use of renewables can be considered as a financially viable route, meeting CO₂-targets while showing the lowest energy consumption and offering the largest job creation potential of the assessed tracks.”, **Renovation Tracks for Europe up to 2050: Building renovation in Europe - what are the choices?** Thomas Boermans, Kjell Bettgenhäuser, Markus Offermann and Sven Schimschar, Ecofys, June 2012, http://www.eurima.org/uploads/ModuleXtender/Publications/90/Renovation_tracks_for_Europe_08_06_2012_FIN_AL.pdf

³⁴ “Energy savings through the renovation of the existing building stock is one of the most attractive and low cost options to reduce the emissions of CO₂ and potentially improve energy security by reducing imports of fossil fuels. Indeed, there is wide evidence that undertaking energy efficient renovations at current energy prices often pay for themselves i.e. have negative investment costs. Now is a particularly good time for pursuing such renovations. In addition to the permanent benefits these renovations may bring, it will also produce a much needed stimulus to the European economy at a time of economic underperformance, spare capacity and record low real interest rates in a number of countries. ... In addition to the energy savings that renovation of the existing buildings stock will bring, there are a range of co-benefits, which can also be harvested. By reducing energy consumption and focusing on indoor climate issues when renovating, co-benefits can be achieved such as reduced outlay on government subsidies, and improved health due to less air pollution and a better indoor climate, both of which also lead to fewer hospitalisations and improved worker productivity. ... Harvesting renovation opportunities could bring huge benefits to the EU economy over the coming decades.”, **Multiple Benefits of Investing in Energy Efficient Renovation of**

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These reports highlight the range of benefits that follow from ‘deep’ refurbishment. In the UK the Energy Bill Revolution campaign³⁶ argues that a proportion of funds generated by carbon taxes should be used for targeted energy efficiency schemes.

Recent research³⁷ shows that significant Government energy efficiency infrastructure investment could:

- Generate up to 71,000 jobs and boost GDP by 0.2 per cent by 2015 and create up to 130,000 jobs by 2027.
- Lift up to nine out of ten households out of fuel poverty, reducing energy bills in all treated homes by at least £200 per year.
- Cut household energy consumption by 5.4 per cent by 2027 and quadruple the impact of the government’s energy savings schemes – Green Deal and Energy Company Obligation.
- Cut overall carbon emissions by 1.1 per cent, including household emissions reduced by around 5.6% by 2027.

Ed Matthew, Director of the Energy Bill Revolution Campaign, said:³⁷

“The Energy Bill Revolution is the biggest fuel poverty alliance that has ever been formed in the UK. We are united by our conviction that there is a financial solution which can end the suffering and generate more jobs than any equivalent investment. This is the Marshall Plan the UK needs to slash the energy bills of the most vulnerable and re-build the economy.”

Buildings: Impact on Public Finances, A Study by Copenhagen Economics commissioned by Renovate Europe, 5 October 2012 (Released at Renovate Europe Day, 11 October 2012), <http://www.renovate-europe.eu/Multiple-Benefits-Study>

³⁵ By which we mean energy efficient retrofit that reduces energy use by half or more and carbon emissions by up to 80 per cent. As we note above, the energy used for heating a passivhaus home (15kWh/m²/year maximum) is only ten per cent of that of the housing stock as a whole (about 160kWh/m²/year). The limit for an existing home refurbished to passivhaus standard is a little higher, 25kWh/m²/year, but still six times less than the current average figure. An active refurbishment campaign to bring homes to or close to the passivhaus retrofit standard coupled with effective action to reduce electricity use from appliances and lighting can be seen to achieve at least a fifty per cent reduction in overall energy use. Once fabric energy performance is enhanced in this way, local renewables can further reduce carbon emissions to achieve reductions of up to 80 per cent or even more in favourable cases. Note that renewables should always be used in addition to work on fabric efficiency not as an alternative, for example to achieve a code for sustainable home rating.

³⁶ <http://www.energybillrevolution.org/>

³⁷ **Jobs, growth and warmer homes: Evaluating the Economic Stimulus of Investing in Energy Efficiency Measures in Fuel Poor Homes**, Verco and Cambridge Econometrics, Final Report for Consumer Focus, October 2012, <http://www.consumerfocus.org.uk/news/energy-efficiency-investment-is-one-of-best-ways-to-boost-the-economy-new-research-reveals>

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The principle and the idea are admirable. The problem, not mentioned in either the Consumer Focus report³⁷ or the European reports^{33, 34} is that the anticipated benefits are unlikely fully to be achieved without a transformation in the quality of the work.

The problems that have been identified with new build are compounded in refurbishment. Refurbishing an existing building to a low-energy standard is more complex than building new because the existing building will not have been designed for low-energy performance. In addition, unanticipated problems will almost certainly arise during the work and demand solutions as work proceeds. Hence any energy performance gap is likely to be worse, on average, for refurbished buildings than for new buildings. Not only that, but air quality problems will inevitably also arise. What should be a beneficial exercise could become a frustrating, expensive and potentially hazardous one.

This is why a quality transformation in construction is essential. Not just for new build but to ensure that the massive challenge of retrofitting and refurbishing the existing housing stock to low-energy standards is undertaken effectively.

The refurbishment challenge

It might be assumed that four decades of increasingly demanding building regulations in respect of energy efficiency for new homes, and of Government initiatives such as Warm Front, CESP and CERT to insulate homes and reduce energy use, would have reduced the total energy use in UK homes, and reduced the energy for heating in particular.

In fact the reverse is true. Energy for heating homes has increased by 40 per cent since 1970 and total household energy consumption has gone up by over 20 per cent³⁸. Even with the improvements in homes since 1970, the heating energy per house has not fallen between 1970 and 2008. This is because of the widescale penetration of central heating and the fact that occupants now are able to keep their homes warmer, with all rooms being warm rather than just one or two. Likewise electricity use has gone up because of the proliferation of appliances and devices.

In perspective, in 38 years from 1970 to 2008, energy for heating homes went up by 40 per cent and total household energy consumption by over 20 per cent. It is another 38 years to 2050 when the UK has committed to an economy that is decarbonised by at least 80 per cent. It is inconceivable that with current (lack of) progress in energy efficiency, low-carbon energy supply can be developed to cope with such energy hungry homes. It is essential to be able to guarantee energy efficiency improvements (i.e. demand reduction) of at least 50 per cent in refurbishment and to achieve this over the next 38 years for the majority of the UK housing stock – as well as for non-domestic buildings.

³⁸ Data may be found in *Great Britain's housing energy fact file*, Jason Palmer and Ian Cooper, Cambridge Architectural Research, Prepared for DECC, September 2011, <http://www.decc.gov.uk/assets/decc/11/stats/climate-change/3224-great-britains-housing-energy-fact-file-2011.pdf>; see Table 5b for energy for heating, Table 2a for total household energy consumption, and Table 4a for household numbers. The Housing Energy Fact File gives data each year from 1970 to 2008.

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A Marshall Plan, as Ed Matthew puts it³⁷, is certainly needed. If around 20 million UK homes are to be refurbished by 2050, this means treating one every minute from now until 2050! The challenge is to construct as part of the “Marshall Plan” a quality approach that guarantees effective “whole house” refurbishment where the energy efficiency and carbon reduction targets can actually be met.

The shortcomings of the green deal

The Green Deal along, with the Energy Company Obligation, will replace all existing household energy efficiency measures (CERT, CESP etc) at the end of 2012. We have identified serious concerns with the Green Deal in an earlier report³⁹. In particular, the cost of all but the simplest works is unlikely to be covered by the ‘Golden Rule’, the house assessment process cannot do more than the most superficial survey, and the process is pick and mix rather than a whole-house approach leading, almost inevitably, to sub-optimal work and lock-in of energy use. The recently published UK Energy Efficiency Strategy⁴⁰ does not give confidence that the Government is aware of these concerns: “*Our broad assessment of the policy framework is that the energy efficiency agenda for households is well covered by existing initiatives...*” (on p5, para 4).

To achieve the energy savings and carbon reductions required requires at least three things that are not present in the current Green Deal arrangements:

- Subsidy to the home owner
- A whole house approach
- A quality and teamworking approach to the work.

We discuss aspects of these concerns briefly. The key point to make yet again is that undertaking a high-quality low-energy refurbishment of the existing building stock is a massive undertaking which can so easily go wrong. If it does, and if problems become widely known, then it will be very difficult to persuade owners to take part. In which case concerns about bills, poor health and fuel poverty would just escalate (and also, of course, climate change concerns).

Doing it right certainly does require investment along the lines of a Marshall Plan as the Energy Bill Revolution Campaign³⁶ has suggested³⁷ but it also requires the careful planning and strategic oversight of an Operation Overlord⁴¹. Decision making on the basis of a twenty minute or so survey and owner choice from a pick-and-mix of options is totally inadequate.

³⁹ *The ‘Green Deal’ Appraised*, Martin Ingham, October 2011, see <http://www.buildwithcare.eu/articles/78-partners/219-the-green-deal-appraised>

⁴⁰ *The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK*, DECC, 12 November 2012, <http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/saving-energy-co2/6927-energy-efficiency-strategy--the-energy-efficiency.pdf>

⁴¹ http://en.wikipedia.org/wiki/Operation_Overlord

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Refurbishment of homes to low-energy standards has proceeded far further in Germany than in the UK because home owners have been able to access grants and low-cost loans. This process was described to the Build with CaRe conference in Norwich, October 2010, by Tatjana Bruns of KfW Bankengruppe⁴² who noted that over 200,000 jobs had already been created or saved in Germany via the promotion of energy efficient refurbishment of buildings.

Even in Germany, however, the rate of refurbishment, is hardly half of that required. The conclusion is that even bigger subsidies are necessary⁴³. Interestingly, the figure of four or five million euros mentioned in this article as being necessary in Germany is similar to the figures for the UK being discussed by the Energy Bill Revolution Campaign³⁶.

We discuss aspects of the financing of the low-energy refurbishment of the UK housing stock in some detail in Chapter 10.6 of Refurbishing Europe¹. There will undoubtedly be several options to consider but we note there that long-term investors such as insurance companies might have more concern to ensure that work is done well and correctly than energy supply companies. If long-term investors were to invest also in refurbishment activity and to take a charge on a property as a return, this could be an attractive long-term investment if values of well-refurbished properties rose relative to the market.

The whole house approach is essential. A twenty minute visit to a property by a SAP assessor cannot begin to unravel the details of the multitude of problems of leaks, thermal bridges and other faults that will need to be understood and dealt with if work is to be done well and effectively.

As well as pioneering passivhaus new build, Broadland Housing Group are also undertaking one of the first European Regional Development Fund supported 'deep' retrofit projects in the UK on a selection of homes in Norwich. This work is still on-going but it has become clear, for example, that integrated teams can function more effectively than conventional ways of working. Also that working on occupied

⁴² **Supporting the energy efficient rehabilitation of the building stock – The German experience**, Tatjana Bruns, KfW Bankengruppe, Presentation to Build with CaRe Conference, Norwich, 21 October 2010, downloadable from <http://www.buildwithcare.eu/articles/66-conferences/170-build-with-care-annual-conference-2010>

⁴³ *The implementation of energy efficiency measures - insulation, heat pumps, intelligent building technologies, efficient lighting systems - is falling ever further behind schedule, despite unequivocal evidence of its long-term benefits to consumers: "Anyone who refurbishes their house without improving its energy efficiency is missing a golden opportunity," says DENA's Kohler [Stephan Kohler, Chief Executive of the German Energy Agency (DENA)]. ... But despite this convincing logic, home owners are not biting at the incentives. The costs of insulating and other measures can run into the tens of thousands of euros and the existing state incentives, like low-interest loans, which are provided by the investment bank of the federal government, simply do not offset those costs sufficiently for most homeowners to make the investment. The only solution, according to Kohler, is "better, bigger incentives." ... "Four hundred million is really nothing," says Lars Brischke, an energy efficiency specialist at the Institute for Energy and Environmental Research in Heidelberg, to EER. "In order to meet the targets of renovating 2 to 3 percent of buildings a year, Germany would require three to four billions euros, at least." Kohler of DENA uses the figure of five billion euros...*, in **Germany's stalled energy transition: waiting for the master plan**, Paul Hockenos, European Energy Review, 19 April 2012, <http://www.europeanenergyreview.eu/site/pagina.php?id=3655>

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properties creates several issues that have to be planned for and dealt with - yet it will be normal for retrofits to be conducted on occupied properties.

It also becomes evident that other work, not initially part of the refurbishment/retrofit plan, for example rewiring, would often sensibly be undertaken as part of the work. It does not make financial sense, or sense either from the perspective of disruption to the occupants, to return to a property in a few years to undertake other planned upgrades.

Such thinking – nowhere part of the Green Deal – is evident from work we have observed on the continent of Europe. As noted in Footnote 43, *"anyone who refurbishes their house without improving its energy efficiency is missing a golden opportunity"*. This is a general principle. Low-energy refurbishments to passivhaus standard of apartments by housing provider alleewonen in Roosendaal in The Netherlands⁴⁴ and by housing association Alingsåshem at Brogården in Alingsås in the south of Sweden⁴⁵ have been cost-effective investments by the housing associations but only because other upgrading work was undertaken at the same time.

If other renovations are done but not the low-energy refurbishment, however, then the economics may change. It may well not be cost effective to revisit the properties at a later date to do just the low-energy refurbishment. Indeed, for just this reason, alleewonen do not go back to do energy-related refurbishment on properties at Roosendaal that were upgraded for other reasons prior to their decision to undertake 'deep' passivhaus low-energy refurbishment.

A description of the Broadland Housing low-energy retrofit work is available⁴⁶. The slides emphasise the importance of a whole-house approach and show thermal images from several properties and describe the detailing – for example in sealing leaks – necessary to achieve the desired low-energy result. The thermal images demonstrate that quite modern properties – for example from the 1990s – can have just as many problems to tackle⁴⁷ as much older properties. A quick SAP survey of a property for a Green Deal assessment would neither undertake thermal imaging nor give the consideration to measures and detailing that are all necessary to achieve a satisfactory result.

⁴⁴ See the presentation by **Erik Franke**, Franke Architekten, Build with CaRe conference, Norwich, October 2010, downloadable from <http://www.buildwithcare.eu/articles/66-conferences/170-build-with-care-annual-conference-2010>

⁴⁵ See the presentation by **Hans Eek**, Swedish Passive House Centre, Build with CaRe conference, Norwich, October 2010, downloadable from <http://www.buildwithcare.eu/articles/66-conferences/170-build-with-care-annual-conference-2010>, and **Skanska Case Study 64, Brogården, Sweden**, http://skanska-sustainability-case-studies.com/pdfs/64/64_Brogarden_v001.pdf

⁴⁶ **Retrofitting Broadland Housing Association's stock - lessons learned, David Daniels**, December 2011, <http://incrops.tridan.it/documents/Events/Construction2011/DDaniels%20Dec%201%202011.pdf>

⁴⁷ A consequence no doubt of the quality problems discussed above

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Finally, we return to the quality issues that have perhaps been the principal theme of this submission. Teamworking and a quality way of working are just as essential for successful retrofit/refurbishment work as they are to deliver successful low-energy new build properties. Skanska have demonstrated just such a teamworking approach in the passivhaus refurbishment of the apartments at Brogården⁴⁵. Outstanding quality and passivhaus performance is the result.

This work in Sweden by a major contractor shows that high quality retrofit/refurbishment can be successfully achieved on site. Now, if sustainable construction - whether new build or retrofit - is to become a reality, such quality must become the norm. The retrofit example at Brogården and the new build examples given in *Delivering a low-energy building*² show that, where there is management commitment, quality can be achieved. Government, the industry and all interested parties must now work together to make such quality standard. As we have already noted, if Government and industry accept the quality challenge, the UK could become a global leader in sustainable construction with benefit to the environment, to homeowners and occupants, to public health, to jobs, to innovation and to competitiveness.

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Dr Bruce Tofield led The University of East Anglia's activity in the international Build with CaRe project (2008-2012; <http://www.buildwithcare.eu/>) which has stimulated innovation and learning about passivhaus construction in the East of England and made many advances in understanding and monitoring building performance. He authored two major evidence-base papers published in 2012, *Refurbishing Europe*¹ (with Martin Ingham), and *Delivering a low-energy building*² that identify barriers to energy efficiency and to low-energy construction and how to overcome these.

Bruce has led outreach low-carbon innovation programmes for UEA since 2003. In the Civitas SMILE project (2005-9), he set up a new supply chain for sustainable biodiesel, demonstrating use of blends in commercial bus fleets and in heating oil, and worked with commercial partners to convert the first UK bus to make possible dual-fuel diesel-biomethane fuelling. Previously he has been Director of The Technology Centre, Johnson Matthey plc, and Head of Materials Physics and Metallurgy Division, Harwell, where he ran a pioneering EU-supported energy research programme from which came key materials to make possible the lithium batteries that are now powering the increasing numbers of electric vehicles in European cities.

Dr John French is the CEO of the Adapt Low Carbon Group, based at the University of East Anglia.

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With a BSc in Applied Biology from London University and a PhD from Cambridge, John has enjoyed a diverse and exciting career in both academia and business including Head of Science and Dean of Science & Technology. In the past decade he has specialised in the fundraising for major infrastructure projects.

John initially created the original concept for the InCrops Project and, in 2008 after gaining funding from EEDA and ERDF, the project became live and the InCrops Enterprise Hub was born. With a team of specialist staff, the aim of the Enterprise Hub is to promote innovation in alternative non-food crops across the East of England.

From there The Adapt Low Carbon Group has been created which brings together a broad range of expertise and builds on the widely acknowledged successes of the University of East Anglia's business activities in the low carbon sector. Based at Norwich Research Park (NRP), Adapt promotes enterprising low carbon concerns and we work closely with the Norwich Business School and the School of Environmental Sciences. Its work falls within the following four main areas; Innovation Funding, Low Carbon Consultancy, InCrops and the Centre for Built Environment. As part of the Centre for Built Environment planning permission has been submitted to build an exemplary low carbon building at the UEA which will be built to Passivhaus and BREEAM Outstanding classification. The centre aims to bring together teaching and learning facilities with work spaces for local companies. It will also house an early-stage incubator for start-up businesses to provide opportunities for UEA graduates and encourage staff on the research park to start their own businesses.