2050 Group Final Report

October 2010

Authors:

- Matthew Byrne, The University of Nottingham
- Hannah Collie, CIC (Secretary)
- Robert Corbyn, Low Carbon Energy Assessors Ltd (for RICS)
- Gary Evans, CIPHE
- Crystal Fernandes, National Housing Federation
- Nathan Jarman, Turner & Townsend (for Constructing Excellence)
- Anastasia Kiochou, CIC
- Robert Macdonald, Zero Carbon Hub (for NHBC)
- Emma Nicholson, Rider Levett Bucknall (for CIOB)
- Dr Kieran Owens, Queen's University Belfast (for ICE)
- Antonio Pisanó, Sheppard Robson (for RIBA, as nominated alternate for Alan Shingler)
- Mark Renshaw, Elliott Wood Partnership (for the Institution of Structural Engineers)
- Andrew Stanford, INSIGHT (for CIAT)
- Anna Whitehead, BIID
- David Whysall, Turner & Townsend (for Constructing Excellence)
- Morwenna Wilson, Arup (for CIBSE)

Introduction

It is clear that there are significant challenges for the industry ahead, and we hope that as we continue our careers we can drive forward the changes required. In doing this, we think there are four key stakeholders – Government, industry, supply chain organisations and educational institutions.

The Government needs to drive change and innovation amongst the construction community. This will involve both push (e.g. legislation) and pull (e.g. incentives to create a market). It will require a definite long-term plan allowing business to adapt and plan ahead to deliver the infrastructure and buildings required for the UK to meet its low carbon targets in the long-term. Without their backing and support there will not be impetus to move forward and work towards a low carbon society. This in turn will aid in trying to change the perception of the general populous.

Working with institutions and educational establishments, Government needs to attract the next generation into the construction industry. Fiscal incentives and support for initiatives in educational outreach will enable young people to recognise various career paths in the low carbon construction field.

There is also a role for supply chain organisations in attracting the next generation of construction professionals. Supply chains needs to collaborate and innovate more in order to enable the necessary transformation. These innovations and greater transparency and knowledge sharing will ultimately result in economic benefits.

Supply chain organisations, Government and institutions all have a responsibility in educating end-users who maintain, operate and live in completed construction projects. Significant time and money will be wasted if these stakeholders are not educated sufficiently in order to realise the benefits of improved construction and materials.

Above all before any of these changes and actions can be taken, Government, supply chains and institutions need to adapt to a behavioural change. This can only be achieved through a bottom up approach to multidisciplinary education starting with undergraduates and apprentices and rising right through an organisation. This could have the largest and most positive effect on the low carbon agenda. It is necessary for this process to begin now. It is not enough for the status quo to continue where the industry is predominantly reactive.

While we in the 2050 group have been looking at 2020-2050, the later this process of behaviour change begins the more difficult the task will become and the more extreme a change will be needed.

1) Aspirations: The kind of industry we would like to see in the period 2020-2050

Infrastructure

- We would like to see a major innovation push in the UK infrastructure sector so that it is seen as the solution to address the UK's carbon and distributed energy challenges.

- Increased global sector learning needs to be managed centrally and the UK innovations and best practice projects will be celebrated and promoted internationally.

- We would like infrastructure procurement methods to be modified to take into account and reward the value created in carbon reduction of the asset. Public sector projects need to start the drive for change in infrastructure creation with poor performing projects cancelled or instructed to improve. Eventually investment within poorly performing assets will become fiscally unviable. The public sector infrastructure stock will be seen to set an example for the private sector on which it should follow and further innovation.

- We wish to see the intelligent use of energy and power, and the recognition of the drivers to energy use becoming systemic within individuals; the UK's social attitudes will have changed to a more collaborative approach to reducing carbon. Individuals will become familiar with revised social habits driven by a changing UK infrastructure.

- We wish to see more ownership of carbon in terms of both fiscal and social responsibility, the drivers for change can be fed into our supply chains and national infrastructure system but we believe ownership identification will drive social change with regard to aligning 'business as usual' towards our carbon reduction commitments.

- Our industry needs to recognise and reward revolution, innovation and change. Innovation towards hitting the 2050 carbon targets is not a linear process with a start and an end, change must constantly be encouraged and driven, the most radical change and movement in technology or approach will become the norm when it is adopted globally, the UK must win, lead and manage the change to how we procure, build and manage infrastructure.

Housing

- A change of industry thinking with new focuses the performance of housing provision will require the industry to move away from a more conservative approach. Refurbishment of the existing stock could prove a long term source of work for the industry.

- We hope that further thought about urban design as a whole could lead to benefits for the consumer. Regeneration could be used positively as a mechanism for helping push change to resolve social conflicts or to help people travel.

- Modular construction may be encouraged with the resulting benefit of more standardised products, to drive quality and a more commercial future. Modern international construction companies with standardised products could emerge from this.

- Assurance of quality and performance is viewed as essential, with the discipline of post occupancy evaluation (POE) being cited as having potential to become much more mainstream. It is hoped that this could be used for ongoing performance monitoring and continual improvement.

- The desire to create a built environment where people want to live is strong, with a variety of dwelling designs, internal and external space requirements all correlated with consumer demands. The needs of the consumer are key and the inclusion of current and future residents in decision making to influence design is felt to be a positive ambition.

- Good design and ‘green’ design should be thought of as the same thing.

- Legislation and planning are currently considered to be areas where there is complexity. Whilst there is concern that power generation is a step too far for house builders, policy alterations and incentives could bring about significant change, potentially encouraging things like community power generation. Some consider this and fiscal incentives as drivers for altering consumer views of homes to something more than a financial asset, which could even lead to establishment of a more permanent rental sector where consumers view housing as the provision of a utility.

- The existing housing stock will present opportunities for improving energy and resource efficiency. There is also an opportunity for refurbishment or renewal to be used as a mechanism to regenerate and improve any transport or social issues that could be already evident in the area.

- As house building develops, those working in the sector would like to see more co-operation and collaboration across the whole of the industry, including between contractors, the supply chain and professional institutions to provide a uniform feeling to the sector.

- Recognition is needed for an understanding across many specialist roles and disciplines so that the result is a quality product that continues to fulfil the role it was designed for and which is valued and in demand.

- The provision of Quality Assured Kitemark awarded on successful completion of a home retrofit programme by contractors. This would act as a homeowner’s guarantee and would ensure all retrofits are carried out to an agreed standard with approved sustainable products.

Non - Domestic Buildings

- Being a global leader will allow UK construction companies and professionals to sell their skills and products internationally. There will also be opportunities to learn from abroad and adopt successful practices tested in other countries

- The transition to a low carbon economy creates many opportunities for the construction industry, and the buildings sector in particular. An industry professional reports *"the vast majority of carbon reduction in future will come from first retrofitting buildings and then improving transport"*[1]. We would like to see our industry realising these opportunities in order to gain and sustain a leading position in the global low carbon agenda in 2050.

- We believe that the massive refurbishment programme of the existing building stock will drive increase in demand for construction professionals. Furthermore, the industry should place more emphasis on Research & Development, as well as re-skilling the employees in the sector.

- There are very tangible opportunities and benefits associated with behavioral change of building users. For instance, reducing the energy demand of buildings to half of the current usage can then allow the remaining demand to be met by a mix of renewable energy and micro technologies.

Leadership

- It is crucial for that the industry becomes less fragmented, with design teams working together on multiple projects rather than being formed on a project by project basis. The environment can encourage innovation and reduce inefficiencies as members of the teams know how to work together. For example, in Leadership Energy Environment and Design (LEED) projects, multi disciplinary group brainstorming sessions are held at the outset of each project and jointly owned sustainable objectives are agreed or signed off.

[1] New Civil Engineer Magazine, 15.07.10, p. 20

- A less fragmented industry would be in a better position to educate the public in how buildings work and how to alter their behaviour, creating a pro low carbon atmosphere and reducing costs of products due to increased demand.

- The profile of the industry would have to be increased to a level where it attracted students who want to work in construction over traditionally more attractive Medical and Legal sectors. This would create a desire for more people to work in a popular industry.

- Institutions working together on major issues with cross institution panels directing the industry in a single purpose. Institutions provide world class training on sustainable design to professionals and guide the content for related academic qualifications, apprenticeship routes or vocational accreditations.

- Government policy regarding construction would focus on legislating low carbon and sustainable design. The programme of major works will be more consistent between Governments producing a stable working environment. Low carbon taxes on energy, based on individual allowances per person.

- Clients will continue to monitor new-build and retrofitted buildings to provide greater feedback on low carbon construction. The feedback can then be used to improve design, advise on behavioural changes and promote both public and private development policy.

- The public will want to improve the energy efficiency of their property and will use government grants to part fund the works. Retrofitted insulation, triple glazed windows, energy efficient boilers and domestic scale renewable energy generators will be considered as the standard for existing stock houses. Feed-in-Tariffs will become more popular and smart meters will become an essential fixture in houses.

- Local Authority Planning Department will be familiar with all aspects of sustainable design and the latest technologies and have an accepting attitude towards them. They allow the demolition of sub-standard existing stock buildings and the promotion of sustainable developments including single dwellings, estates, suburbs and towns, and barriers for sustainable developments and properties will be less of a challenge. An Olympic style fast track system for planning will be available for the majority of low carbon and sustainable developments.

- Educational institutions will focus their courses primarily on current and future needs rather than traditional construction. First principle design is taught to promote innovation. Greater interaction with industry teaches how to work in the industry and current design methods.

Future Skills

- The industry requires an effective marketing campaign to promote it as a pioneering, progressive, green, highly skilled industry of the future. e.g. See marketing campaigns of U.S. Green Building Council (USGBC)

- Become a global leader in education, following lessons learnt from international countries. This will make the industry respected amongst the general populous.

- Membership bodies such as the Construction Industry Council (CIC) or UK Green Building Council (UKGBC) to lead collaborative, cross industry communication: ensure all sectors of industry are simultaneously consulted, informed & trained as each new initiative, legislation or technology is launched. Consistency of message & standards are critical.

- End users such as, homeowners and facilities managers need to be more aware of the low carbon agenda and should be more open to suggestions for change with initially incentivised retrofit schemes.

- Incentivised retrofit schemes must be meaningful at the outset to avoid reluctance from homeowners to carry out costly home retrofit programme in return for disproportionately small utility savings. This needs to be tracked/audited, and a post occupancy evaluation carried out.

- For homeowners to have “high street” or web access to skilled low carbon retrofit advisors, similar to the level of offer of a Citizens Advice Bureau e.g. Energy Savings Trust to answer all questions on low carbon housing issues.

- Trained, accredited interior designers and architects would encourage homeowners carrying out a remodelling to include retrofit options.

- Low carbon construction and sustainable design graduates to have a common foundation level of “low carbon design” training i.e. all architects, engineers and designers to receive the same training on low carbon and sustainable design principles, as agreed by UKGBC for example.

- The establishment of a cross industry accreditation, e.g. similar to a LEED-Accredited Professional (AP), open to all sectors of industry at all levels: allows for a common sustainable language to be spoken and encourages cross industry communication. This enhances public perception of a skilled, progressive industry and workforce.

- The current total absence of skills regarding indoor air quality in low carbon buildings will have been addressed e.g. by Zero Carbon Hub, British Research Establishment (BRE). Each construction project will have a mandatory Indoor Air Quality Management Strategy Plan agreed by integrated design teams at the outset of each project. Indoor contaminant targets e.g. formaldehyde levels, would be regulated and third party testing of all interior fit outs & retrofits, carried out as standard.

- The current limited level of skills addressing sustainably sourced, non toxic materials for construction & interior fit-out would have been addressed through industry continuing professional development (CPD) programmes for

interior designers, engineers, architects or contractors. Holistic rating tools & improved green Guides could facilitate the existing skills.

- An overhaul of all existing rating tools is required to eliminate confusion, clearly defining the properties of a sustainable product/material e.g. BRE Environment Assessment Method (BREEAM), LEED, Code for Sustainable Homes, Cradle to Cradle, Carbon Profiling, international agreement might be sought.

- Holistically designed low carbon sustainable buildings and structures are common path, not an afterthought or something that is done to gain rewards. Avoid rating tool “tick box” mentality.

2) Potential changes and challenges that will shape the industry during 2020-2050

Infrastructure

- During the 2020-2050 timeframe there will be a drive towards electrification of the UK energy grid. The contribution of renewable energy to the energy mix will be limited as the major political parties acknowledge that nuclear is the key to stable distributed energy.

- We believe fiscal policies will start to drive carbon strategies; taxation will be introduced to propel and enforce a change. Planning will become focused on assessing the “fit” of infrastructure schemes into national plans that are focused on carbon rationalisation and whole life value. The role and subsequent recognition of the UK built environment sector to unlock and implement sustainable infrastructure solutions will become recognised by infrastructure operators globally.

- Poor carbon performing assets will be taxed and penalised forcing new social changes and attitudes towards sustainable construction. Social pressure from both the wider public and stakeholders in infrastructure projects will then promote energy and carbon issues to the front of project aims and objectives.

- Carbon tax calculations will start to become dominant in providing an objective review tool for infrastructure projects. Design and construction teams will need to demonstrate a credible level of collaboration on carbon reduction across the whole supply chain for projects to be given the go-ahead.

- Transportation (including highways, railways, aviation, and shipping) will undergo a series of reviews as it is recognised it is critical to retaining the UK's competitiveness within global markets. The UK is unable to "scale back" transport systems; instead investment is made to find the "right" solution. This is most likely to have resulted from the Government and construction industry failing to formulate a coordinated strategy to meet the reduction commitments with regard our large infrastructure transportation base.

- A major innovation push in the UK infrastructure sector will be seen as the solution to address the UK's carbon and distributed energy challenges. Increased global sector learning will be managed centrally and the UK innovations and best practice projects will be celebrated and promoted internationally.

- In the final years before 2050 a government push will ensure remaining badly performing assets are dismantled as their market value diminishes to nothing.

Housing

- It is likely that the first challenge to be completed by 2020 is the implementation of the zero carbon policy for new homes which is due from 2016. The eventual shape of the allowable solutions regime will be significant for reductions of CO_2 emissions.

- Higher levels of consistent quality performance is expected to be delivered and technology driven with more modular construction. Optimal cost effective low carbon housing will find its place by 2020 with a repeatable solution, however there is the danger of creating a checklist which may not enhance further improvements.

- Retrofit can only go so far and there may be greater replacement programmes. The economics of demolition and replacement vs. renovation will be a major factor in future decisions. There is space for a big plan – potentially for large scale renewal which is implemented by Local Authorities. In the timescale 2020-2050 it is likely that industry will have found a way to deliver either mass refurbishment or mass demolition.

- Build or refurbishment costs are a major consideration, especially when the developer may have to absorb the cost of building to higher standards. It is also hoped that once a new technology becomes widely utilised, cost will reduce and from 2020, new technologies that we see today will likely become commonplace.

- Consumer schemes like PAYS (Pay As You Save) could help finance the change and establish consumer demand and the desire to live in a low carbon home. In the interim period, different tax incentives (such as stamp duty) could be used to encourage demand.

- The trend to urbanisation will probably continue, before peaking and possibly reversing. 2020-2050 could see a peak in urbanisation with a balance struck between communication technologies, working from home and the need or desire to meet centrally with colleagues.

- In rural areas especially, major issues that can be addressed by the house building industry will likely continue to be ageing populations and social care. Models such as McCarthy and Stone retirement living could provide solutions, however this depends on shifts in housing tenure, between owner occupation and renting (owner occupation already showing signs of reducing). This could continue to reduce, perhaps balanced by a social policy recognising the benefits of more balanced fiscal treatment for different housing tenures.

- Dwellings will evolve with consumer attitudes taking designs from other sectors including those of retail. More advanced materials will probably

appear, but styles evolve slowly and the need for character and interest to remain in architecture is considered important.

Non-Domestic Buildings

- The non-domestic buildings sector currently accounts for 17% of the UK's carbon emissions. Better control of waste, increased use of passive techniques that minimise energy and water consumption, more prefabrication and modularization are some changes we anticipate occurring in the ways in which we design, build and operate buildings from 2020 onwards.

- Upgrading the existing building stock is recognised by the industry and our group as the major challenge for the non-domestic buildings sector. The key is to determine the source of finance for the scale of refurbishment required and ensuring the timescales involved are sufficient for quality decisions and action.

- The construction industry is currently fragmented with high levels of competition between firms, which prohibits collaborative ways of working. Lack of transparency because of manufacturers' reluctance to publicise data about the embodied carbon, energy performance and environmental standards of their products obstructs the effective use of lifecycle analysis (LCA) and therefore auditable sustainable solutions.

- High cost of energy as a driver for change may result in social unrest, because portions of the population may not be able to afford to occupy energy inefficient buildings.

- The industry has always been ahead of the government in terms of knowledge and awareness of low carbon issues; as a result the government may not recognize the need of investing and providing commercial drivers in the industry thus urge to take action.

Leadership

- Industry wide low carbon and related sustainability education will improve with in-house lunchtime seminars and organised evening seminars by respected forerunners of sustainable design.

- Institutions will be fragmented working with their own agendas. Whilst low carbon will be a priority, duplication in research will reduce efficiency and slow gains in carbon reduction.

- Government will continue to gradually increase grants and funding for low carbon and sustainable materials and micro-generation products. During Government changes policies are not continued and framework agreements, infrastructure, education and health projects are started and stopped regularly.

- Clients will slowly move towards basing decisions on cost rather than the environment without legislation or financial incentives. Due to the slow increase in demand in sustainable materials and micro-generation the prices lower at a slow rate.

- Private clients will not greatly increase the demand for low carbon and sustainable materials and micro generation unless the government increase the funding and grants available. Limited increase in demand will not significantly reduce the cost of the products.

- Local Authority Planning Departments have limited knowledge and limited training regarding low carbon and sustainable materials and micro-generation. Low carbon developments are not promoted and innovative products are not approved without extensive detailed information being provided from testing completed in other areas.

- Energy prices have greatly increased and the majority of energy is provided by renewables and nuclear. An increasing number of people are sending excess energy from domestic micro-generation.

Future Skills

- The main challenge is to ensure that established generations 'stuck in ways' of working engage fully with the changes required to meet the 2050 targets.

- Part L Building Regulations taught rigorously throughout university courses and Sustainable Building Practice as a compulsory subject

- The Building Engineering Physics profession suggested in a Royal Academy of Engineering report to be recognised amongst the built environment community and professional institutions will begin to work collaboratively to include the profession.

- The UKGBC will take a greater lobbying lead with regulation, industry standards, training resources, disseminating communication/marketing of exemplar buildings and best practices both nationally & internationally through the World Green Building Council.

- An industry culture of continuous learning through accredited CPD programmes needs to be established: Low Carbon Construction/Sustainable Design will still be an emerging industry with as yet, undiscovered new technologies & practices

3) New technologies that could make a difference to our industry by 2050

Infrastructure

- Innovation in the construction industry is currently a non linear process, we need to change the current model of creating 'hidden' innovation in our industry, and it should be celebrated and rewarded.

- New approaches need to be invested in and encouraged, industry changing innovation and research should be viewed as a potential saviour and unique selling point of the UK infrastructure sector, for example we currently look at our power generation deriving from either renewable or non renewable traditional fuels, research and innovation such as the power generation from methods such as fusion may be a saving grace as we near our target dates.

Housing

- From 2016, it is expected that the majority of in use emissions generated from a new house will be from appliances, with space and water heating contributing less to the burden. Therefore, appliance efficiencies currently being built into devices or measures to turn off items when not in use such as whole house shutdown systems (excluding items like freezers and alarms) have potential to contribute to emission reductions. Efficiencies across new and existing housing are likely to increase gradually as appliances are renewed.

- The intended rollout of smart meters could drive consumer awareness of the running costs for their house, potentially generating more demand for energy efficient dwellings if the price of fuel increases.

- 'Green' energy infrastructure, whether it is a mixture of renewable (photovoltaics, wind, wave, biogas), Nuclear (Fission or Fusion), or cleaner fossil fuels, even without alterations to the existing stock would reduction grid carbon intensity and greatly improve the carbon footprint of the housing sector. (Reducing carbon emissions from the UK housing stock (2005) Shorrock, L.D., Henderson, J. & Utley, J.I. Building Research Establishment).

- As on-site renewable technologies become tried, tested and accepted, more will be utilised albeit at a cautious rate.

- Technologies of interest also include anaerobic digestion where waste material is converted into biogas. This could target both a reduction in waste and production of a greener fuel.

Non-Domestic Buildings

- We believe that investment in developing new techniques and technologies, as well as in re-skilling the workforce, are key drivers that can make a different to our industry. For instance, energy generation from the façade of buildings could be an emerging technique in energy production.

- Further development and use of biotechnologies and renewable energy generation are of paramount importance for achieving the 2050 carbon targets. Furthermore, development and deployment of lifecycle analyses and strategies can encourage the retention of design flexibility, the ability to investigate multiple low carbon issues and can be applicable to scalable assessments.

Leadership

- A dramatic shift is needed in government policies, notably creating a higher level of long-term policy certainty over future demand for low carbon technologies, upon which industry's decision makers can rely.

- Another key technology is the capture and storage of CO_2 emitted from power-generation or industrial processes. If we do not succeed in making carbon capture storage (CCS) viable, the cost of mitigating CO_2 emissions will be much higher

- Deploy innovative and smart grid technologies to foster energy conservation potentials.

- In 2010 planning permission for a commercial-scale geothermal power plant was granted by Cornwall Council. The plant is constructed on the United Downs industrial estate near Redruth by Geothermal Engineering Ltd. The plant will produce 10MW of electricity and 55MW of renewable heat. There is potential for more government research in to geothermal energy and installation of power plants

Future Skills

- The required skills will mainly be focused at graduate level that will look to develop and manufacturer and implement new technologies, however undergraduates will be fully aware of the issues surrounding low carbon.
- Product designers, manufacturers and consumers are nervous about using new, untested sustainable materials as they is no current commercial driver or incentive.
- Buildings need to have "knowledge built in" to minimise homeowners' "tinkering" with an optimised system
- Biomimcry principles & products will continue to drive technological changes e.g. cement which absorbs atmospheric CO_2, solvent free or pigment free "colour" dyes e.g. morphotex fibres. See www.asknature.org
- Cradle to Cradle principles applied as standard to all products i.e. non toxic products that are either recycled at end of life or biodegradable eliminating need for any future use of fossil fuel derived products.
- Assume a building code that delivers a zero carbon envelope but allows for individuality of design to meet individual needs and universally designed with ageing in place, putting health & wellbeing of occupants as equal priority. e.g. in Denmark, homeowners were persuaded of the benefit of retrofitting homes not through a reduction in utility bills, but through selling the benefit of creating warmer, healthier, more comfortable homes.

- We will require new technology to deal with potential issues of future “industrial” waste as a consequence of pursuing the low carbon agenda today.
- Living Building Standards will be adopted as natural successors to BREEAM and LEED.

4) Recommendations

To Government:

1. We strongly recommend that the 2050 Young Professionals Group continues beyond the remit of the IGT work currently undertaken.

2. We recommend that the Government and regulatory bodies encourage change and innovation.

3. The Government and regulated industry operators must lead the way in exploring how procurement processes can be streamlined to drive efficiency and reduce the barriers (cost) that currently exist to supply chain organisations wishing to successfully undertake major infrastructure work.

4. Procurement models should consider assets whole life performance to enable a comprehensive solution to be found that provides optimal carbon performance over an assets lifetime.

5. Government should drive change by establishing the right combination of legislation and incentive/penalty policies.

6. Funding and grants from Government need to greatly increase for home improvements that increase the energy efficiency of properties.

7. Government must encourage and drive behavioural change to achieve the biggest effects on the low carbon agenda, via means such as legislation, media, incentives, training and financial backing where required.

8. Energy taxation and legislation needs to be put into place to promote retrofitting of existing stock.

9. Local Authority Planning Departments need to train their staff to know about low carbon design and products. Planning should allow and promote sustainable developments of all scales.

10. We need to establish a multidisciplinary consultation platform now, which could bring together all professional and academic energies of the built environment, for this platform to have immediate effect; the built environment needs government support.

11. Universal rewards to be made available to homeowners and communities for generating all forms of renewable green energy, similar to Feed In Tariffs – whatever is appropriate for site or community.

12. Government and industry need to work towards greater shared knowledge with other European and Non European countries and become more unified in reducing emissions.

13. There needs to be a creation of a single European power market by 2020 and international energy rating system for buildings rather than several.

To Industry

1. We recommend that the industry should not view potential changes to the current model as a threat and should maintain focus on the global prize.

2. Industry should raise social awareness and educate end-users on how to efficiently use their buildings. Industry needs to keep its clients and employees up-to-date with rapidly changing technologies, techniques and products that become available.

3. Industry and Government should consider rewarding good design and construction via fiscal incentives, increased financing options, sales incentives, consumer incentives or industry awards best practice.

4. An overall strategy for the private house building sector needs to be decided by industry and Government to shape the nature of development and funding sources and structure.

5. Delivery of the standards like the Code for Sustainable Homes currently through the planning process should be achieved through simplified methods which will provide a level playing field. Checklists may not necessarily enhance innovation.

6. Industry and government collaboration should continue in the future. Institutions need to increase their communication and collaborate together to create roadmaps for research, training and educating the public.

7. Long term schemes such as infrastructure, school and health programs need to provide consistent and stable work and limit wasted design.

8. The industry needs to be more integrated from design teams working together, supply chains having less tiers, and partnerships between clients and contractors

9. Continued support and funding of the National Occupational Standards (NOS) for the industry is integral to increasing future skills.

10. We suggest there should be a broad spectrum of advantages through the establishment of a network of Centres of Excellence in Low Carbon Construction. As suggested by industry, “Centres could be established in universities with architecture and civil engineering departments to promote interdisciplinary teaching of new construction skills led by research.” The industry can direct the type of research to suit the skills and jobs required.

11. Greater transparency and sharing of best practices for exemplar green buildings is required by industry within the UK but also internationally e.g. USGBC and LEED buildings, with illustrated cost benefit cases. This should

be implemented before or after 2020. Provide Green Building Tours to industry members.

12. Industry should agree and implement Indoor Air Quality standards to include Indoor Air Quality plans, and enforceable targets for a maximum allowable concentration of toxic contaminants and emissions in interior environments for Low Carbon buildings with sealed envelopes.

13. To avoid the legacy of sick buildings, for the low carbon transition plan to evolve into sustainable design building practice, the current emphasis on carbon reduction should be placed equally on promoting the health and wellbeing of inhabitants.

14. Simplify and co-ordinate all available Building Rating Tools. E.g. BREEAM, LEED, Carbon Profiling, Cradle to Cradle, Living Building Standards.

To Supply Chain Organisations

1. Manufacturers should produce clear, transparent, auditable low carbon-label goods which meet regulations and standards that are robustly enforced e.g. as for LEED approved products, with audited life cycle assessments.

2. Small medium enterprises (SMEs) or product designers with new low carbon products to market to be given incentives or assistance of providing CPD skills training for the industry – perhaps through a central cross industry skills academy or through UKGBC training provision.

3. Institutions need to increase their communication and collaborate together to create roadmaps for research, training and educating the public.

4. Cross-institution advisory panels should be set up to make sure that the sustainability agendas are coordinated. Multidisciplinary education and cross-Institution task forces must be established to define the agenda for the construction industry and provide suitable leadership.

Acknowledgements for each section

Infrastructure:

- Malcolm Ball, Arup Energy Strategy Group
- Chris Holmes, Director, NIBC
- Andrew Crudginton, ICE
- Will Day, SDC and Philip Blond, ResPublica at 'Future is Local' launch

Housing:

- Mark Clare, Chief Executive, Barratt Homes
- Imtiaz Farookhi, Chief Executive, NHBC
- Mike Freshney, Non-Executive Director, Cala Group
- Derek Field, Operations Director South West, McCarthy and Stone
- Neil Jefferson, Chief Executive, Zero Carbon Hub
- Jae Mather, Director of Sustainability, Carbon free group
- SPONGE - Sustainable Development Network for Property and Construction Professionals who share an interest in Sustainable Development

Non-domestic Buildings:

- Ben Stubbs, Sustainability and Energy Consultant, Faithful + Gould
- Jane Thornback, Sustainability Policy Advisor, Construction Products Association
- Kristian Steele, Material Consultant, Arup
- Andrea Charlson, Structural engineer, Arup
- Mark Way, Originator of Soft Landings, RIBA and CIC
- Seamus McKeague, Director, Creagh Concrete Products Limited
- Dr Sreejith Nanukuttan, Queen's University Belfast

Leadership:

- Professor Peter Morris, Head of School of Construction and Project Management at the Bartlett, University College London
- Ruth Reed, RIBA President
- John Knowles, South Bank University
- Nick Pollard, Chief Executive, Bovis Lend Lease
- Marcus Hill, Comet Consulting
- Steve Howe and Angus Stephen, ICL Estates
- Eddie Tuttle, CIOB Policy Ambassador
- David Stockdale, CIOB Ambassador
- Sue Roaf, Professor, Heriot-Watt University
- Paul Everall, Chief Executive, LABC
- John Ioannou, Office of Government Commerce
- Sarah Fray, Technical Director, IStructE

Future Skills:

- Martin Townsend, Director, BRE Global
- Anna Surgenor, Senior Technical Advisor, UKGBC
- Anonymous private home owner for extensive renovation
- Alastair Fuad-Luke, Eco-design author / educator
- Diana Yakeley, Director for Professional Practice, BIID
- Kate Ainslie Williams, Interior Designer
- Melanie Starrs, Senior Consultant, Inbuilt Consultancy
- Professor Doug King, King Shaw Associates & University of Bath
- Hwyel Davies, Technical Director, CIBSE
- Tony Illes, Associate Director, Atkins & a Member of Cross Cutting IGT Group

- Andrew Crudginton and Simon Whalley, Senior Policy Manager and Executive at ICE
- Mark Way, Originator of Soft Landings, RIBA and CIC
- David Cracknell, Director of Skills and Lifelong Learning, CIC
- Professor Robert Best, Pro Dean in Engineering Faculty at London South Bank University