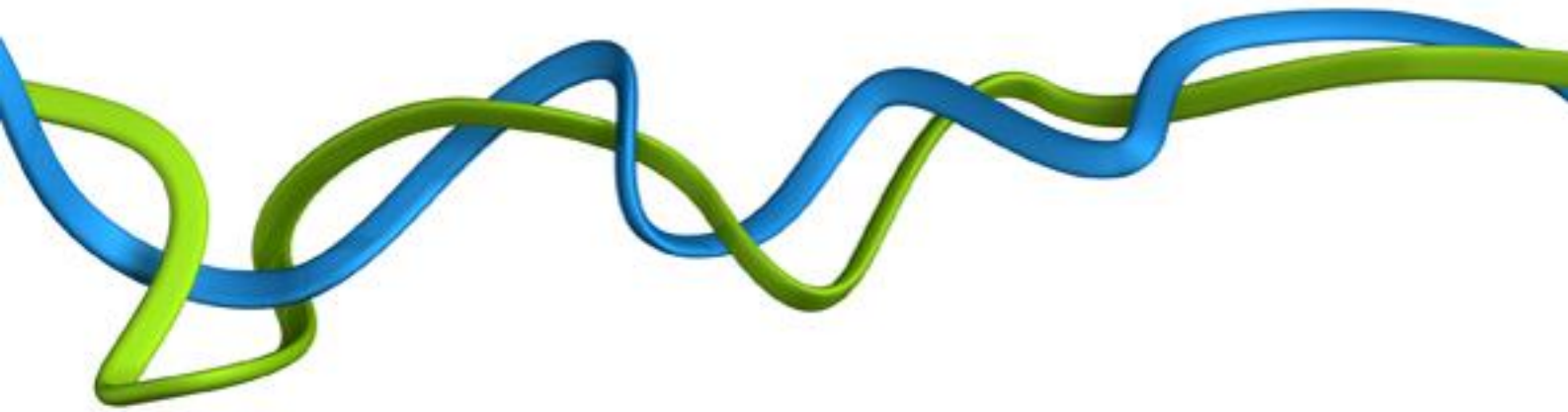
ROYAL ACADEMY OF ENGINEERING

House of Lords Inquiry on National Policy for the Built Environment

Response to the inquiry, 22 October 2015



This evidence is submitted by the Royal Academy of Engineering. As the UK's national academy for engineering, we bring together the most successful and talented engineers from across the engineering sectors for a shared purpose: to advance and promote excellence in engineering.

The views described in this response were assembled through consultation with our Fellows. These include civil, structural and building services engineers, as well as experts in construction, resilience, sustainability and systems engineering.

Executive summary

An overarching strategy for the built environment is needed to address major challenges. This will improve the connectedness of built environment policy across departments. Decision-makers need to take a systems approach to the planning, design and management of the built environment, and to recognise where interdependencies add value.

Smarter targets for sustainability and resilience are essential. For example, it is important to understand what levels of resilience and sustainability are needed and how these translate into design objectives and expectations. Alongside this, decision-making and measures of success must move from cost-based to value-based, necessitating smarter procurement and better educated clients. The planning, design and management of the built environment must be considered alongside infrastructure as the two become increasingly interdependent.

Existing knowledge on energy efficiency of the existing building stock needs consolidation. This will help to improve understanding of the performance/delivery gap and provide a basis for new policies that take into account both social and technical drivers for energy consumption in buildings, and the impacts that any future intervention might have. Any measures to improve the energy efficiency of the built environment must be considered in the context of the future delivery of the UK's whole energy system. Furthermore, sustainable markets are essential, and for this reason policies need to be consistent over time to provide certainty for the market.

The ability for built environment professionals to work collaboratively with other disciplines is central to achieving a holistic approach. This must be at the core of teaching in universities. It is essential that professionals understand and engage with the outcomes of their building projects to a much greater degree. There also needs to be a repeatable, verifiable way of integrating the question of how to reduce carbon emissions into the design, procurement and construction process so that the average is raised. National and local government require better in-house expertise to understand high level issues and to have the ability to act as an educated client.

Understanding the impact of the built environment on people is key to achieving objectives around important challenges for the built environment, including the use of resources, health and well-being, and performance and productivity.

Question 2: How well is policy coordinated across those Government departments that have a role to play in matters such as housing, design, transport, infrastructure, sustainability and heritage? How could integration and coordination be improved?

1 An overarching strategy is vital to address major challenges, such as climate change, improving health and well-being, wealth creation, economic growth, productivity, inward investment, export growth and job creation. The strategy will provide a high level vision and 'asectoral' aims to which all other policies can respond [1].

2 Currently there is a lack of connectedness in policy in relation to how the built environment [2] is conceived, designed, operated and managed. As a result, progress is piecemeal, with policies often running in contrary and conflicting directions. The focus also needs to be on what we should build, rather than just how to build it.

3 Decision-makers must take a systems approach to the planning, design and management of the built environment. This approach considers the interdependencies between the various components, including the fabric of the built environment, the transport and energy networks, water supply and digital infrastructure, in the context of broader challenges such as an ageing society, changes in the economic environment and climate change. A more integrated policy approach is needed across the relevant government departments.

4 Synergistic interdependencies should also be recognised [3]. An umbrella body is required to ensure that the value resulting from positive interdependencies between co-located infrastructure systems is maximised. An evidence base is needed that informs policy development and supports cross-sectoral systems approaches that deliver whole life cost benefits.

5 A stronger voice is crucial within government to champion a high quality built environment, and to lead on a systems approach to policymaking. Government departments should each have a single point of leadership and coordination to further connect and integrate built environment thinking and action.

Question 5: Is there an optimum timescale for planning our future built environment needs and requirements? How far ahead should those involved in the development of planning and built environment policy be looking?

6 Current timeframes for thinking and action in the built environment sector are too long. Realistic but far more aggressive timeframes for strategy, planning and action should be set and then adhered to in order to drive meaningful focus and urgency from all involved.

7 We support the work that Infrastructure UK is doing in co-ordinating and simplifying the planning and prioritisation of investment in UK infrastructure, and await with interest the formation of the new National Infrastructure Commission chaired by Lord Adonis.

Question 7: How do we develop built environments which are sustainable and resilient, and what role should the Government play in any such undertaking? Will existing buildings and places be able to adapt to changing needs and circumstances in the years to come? How can the best use of existing housing stock and built environment assets be made?

A sustainable and resilient built environment

8 The built environment needs to be resilient to a large range of factors that include:

- the impacts of climate change, requiring adaptation of the built environment
- knock-on effects of a failure in one part of a system, for example, a failure of the electricity grid leading to a loss of the ability to pump water
- failures of individual components. Redundancy in systems has been significantly sacrificed over the last few decades in the narrow interests of cost cutting
- failures due to ageing, worn out components. Much of our infrastructure is still dependent on components and facilities that were built more than 100 years ago using the best methods at hand then
- demographic change, for example, the needs of an ageing society and increasing population size, both in the UK and in individual cities.

9 It should be noted that climate change has two very different types of impact, both of which must be considered in adaptation:

- *acute impacts* – resulting from increasingly severe and intense wind storms, rainfall, tidal surges and heatwaves. These will cause damage to buildings (particularly tall buildings), flooding and spikes in mortality caused by heatwaves, for example;
- *chronic impacts* - resulting from gradual increases in sea level and temperature, and changing rainfall patterns. These will require modifications to coastal defences, and will lead to changes in the properties of ground conditions and an increased need for air conditioning, for example.

10 In order to achieve resilience, the planning, design and management of the built environment must be considered alongside infrastructure, as the two become increasingly interdependent.[4] This will minimise the risk of failure in one part of the system affecting other systems. Government intervention in cross-infrastructure 'hardening' will be important, as individual operators have little business motivation to work together to reduce vulnerabilities. Guidance exists that can help lead project sponsors within government departments to a simple systems view of how their project fits within a wider, interdependent, infrastructure system of systems[5].

11 Mitigation measures, that aim to limit the scale of climate change, can often contribute to resilience too. For example, retrofitting buildings with insulation and renewable energy technologies reduce energy use and are also adaptations that increase resilience. Interdependencies between mitigation and adaptation should be identified so that interventions can contribute to both.

12 We must agree what 'good' looks like in order to then set smarter targets that we can collectively aim for, using consistent language and definitions. What do we actually mean by resilience and sustainability? What levels of resilience do we actually need, and how do these differ between sectors? How does this translate into design objectives and

expectations? These issues need to be addressed in the context of the overarching strategy for the built environment.

13 The assessment of future scenarios and resilience must be an integral part of the design process in order to embed sufficient flexibility to provide future adaptability to climate change and to other future societal needs.

14 Decision-making and measures of success must move from cost-based to value-based in order to significantly lift the quality of delivered solutions. At the moment, cost drives too many decisions and important social and environmental issues are too often lost. Smarter procurement is needed, and better educated clients who focus on high-quality design and delivery. This approach need not automatically lead to increased costs, but will result in better and more appropriate long term solutions.

15 A strategy around climate change must consider how to make decisions about demolishing existing buildings, and whether it is appropriate to build very tall buildings that use more energy to construct and operate.

16 The focus of revisions to the building regulations in recent years has been on reducing carbon dioxide emissions from the built environment, but this has not been balanced with proper consideration of the impacts on resilience and on health. A good design team with the proper engineering expertise can take a systems engineering approach to balancing various demands and constraints and avoid these issues. The problems occur when developers lacking this expertise rely instead on the building regulations as a design standard. As long as the standards are developed piecemeal without a full systems engineering approach across the board, then the risk of creating such problems remains.

17 Engineers must develop further their ability to embrace probabilistic methods and flexible solutions, and to deal with complex risk scenarios. There has been a lot of work on risk analysis but for the most part it has been simplistic, for example, addressing just one risk element whereas future challenges involve a range of factors. Promoting the skills needed to address the full range of risks is essential, as is using modelling techniques and the methods of scenario planning. The professional engineering bodies should lead on promoting and developing skills in systems thinking within the workforce[6].

<u>Energy efficiency of the existing building stock</u>

18 New policies are needed urgently in the area of home energy efficiency given the recent withdrawal of funding to the Green Deal and uncertainty over the domestic Renewable Heat Incentive. We welcome the independent review of UK housing energy efficiency by Dr Peter Bonfield OBE FREng. A policy encompassing small business premises is also required.

19 Any measures to increase the sustainability of the built environment should be viewed within the context of the future delivery of the UK's whole energy system, and the need to decarbonise energy supply, including heat and transport. Understanding the uncertainties around the future energy system is key; for example, if the gas grid becomes unsustainable, this will have a large impact on how people heat their homes. The transition from fossil fuel to renewable electricity for heating would place substantial additional burden on the grid – the increasing use of embedded, non-dispatchable domestic renewable generation are already having an impact on some local networks.

20 We must learn from less successful policy initiatives and also from initiatives that are succeeding. In particular, an understanding is required of the performance/delivery gap[7] that exists in relation to energy efficiency measures in housing, and the financial, social, behavioural and technical factors that contribute to this. Existing knowledge is extensive but patchy, and it will be important to identify where gaps in knowledge are and to consolidate existing knowledge.

21 A more detailed understanding of the social and technical drivers for energy consumption in domestic and commercial buildings is crucial for addressing the performance/delivery gap. For example, a more nuanced understanding of occupant attitudes and behaviours is needed, as well as an understanding of how users control their environment using smart technologies.

22 Better dialogue with the public is vital around smart meters, particularly in relation to privacy and trust issues. The benefits to the public of smart meters must be communicated to help ensure that they are accepted.

23 The technologies required to retrofit exist, such as electric heat pumps, CHP units, and district heating, but it is important to appreciate in which contexts and for which types of consumers these will work best. Quality evidence is essential to guide the selection of technologies, which in the past have been blighted by 'hype'. Fitting different technologies means disruption to people's living space and requires people to understand the operation of these technologies which may be very different to conventional technologies.

24 The possible unintended consequences of policy interventions, either beneficial or negative, should be understood and considered as a socio-technical systems matter when planning interventions, for example in relation to retrofitting.

25 Sustainable markets are essential, and for this reason, it is vital that policies are implemented promptly and then not regularly changed, to provide certainty for the market. Standards and procurement policies are effective alternatives to regulation in achieving some of these outcomes. A greater understanding of the motivations and behaviours of all stakeholders is needed, and where these work together or conflict. New approaches should be examined; for example, new business models are in development for retrofitting energy efficiency measures[8].

26 A joined up approach to achieving the right balance between planning and energy-efficiency requirements is essential. We need to ensure that there is openness to new ideas that can help address major challenges.

Question 9: Do the professions involved in this area (e.g. planners, surveyors, architects, engineers etc.) have the skills adequately to consider the built environment in a holistic manner? How could we begin to address any skills issues? Do local authorities have access to the skills and resources required to plan, shape and manage the built environment in their areas?

Professional skills for a holistic approach

27 A report published by the Academy in 2012[9] highlighted the importance of specialist engineering education in providing the knowledge and skills required by the construction industry to contribute to energy efficiency in buildings. This type of education extends beyond traditional boundaries, combining building engineering physics[10] with engineering, architectural and systems design.

28 Built environment professions need to be able to and willing to work in collaboration with other disciplines and built environment stakeholders to develop solutions by means of a holistic approach. For example, architects, behavioural scientists, civil, environmental and building services engineers, planners and urban designers, scientists and technology developers, and clients will need to be able to work in an integrated way. Very few are able to cross disciplines, although individuals that have done so, such as Jan Gehl, Jaime Lerner and, Alejandro Echeverri, have through differing perspectives brought about massive change in cities in different parts of the world.

29 Built environment researchers need to have the ability to understand their contribution to the whole, while focusing on their own specific areas. They also need to understand how to collaborate across research disciplines, such as engineering and social sciences, and this will require the development of shared languages. Built environment research covers (at least) the areas funded by AHRC, EPSRC and ESRC. A greater willingness to fund collaborative funding programmes is needed.

30 A holistic approach has to start with education at undergraduate and postgraduate level so that any architect, planner, engineer, urban designer, has this core principle. Particular skills in these fields can then be developed on that holistic core. For example, Academy Centres of Excellence[11] in integrated sustainable building design have been set up to provide engineers with experience of interdisciplinary, collaborative problem solving. However, universities will follow the market, and are not likely to develop courses unless there is a clear 'pull' from industry. This pull is not currently apparent.

31 While architects remain the authors of building designs in the minds of the public, many of the design issues that must be dealt with in creating sustainable buildings are actually engineering design issues. The engineering professions associated with construction need greater public visibility and clarity of their professional role. Thus clients commissioning building projects will be able to ensure that they receive appropriate professional advice and avoid the problems often cited in relation to the building performance gap. Further, increased visibility for the building engineering professions will aid recruitment into this key sector.

32 There is a need to raise the average, not just support excellent practice. However, there are barriers: the construction supply chain is highly fragmented with design and delivery of

projects divided across may different professions, none with overall responsibility for ensuring the sustainable performance of the finished product. This makes the dissemination of innovation and best practice difficult. The construction industry therefore urgently needs a repeatable, verifiable approach to integrating the question of how to reduce carbon emissions in the design, procurement and construction process[12]. Approaches to procurement and project team organisation need to align risk and reward for all parties to encourage collaboration and team working and to establish smarter ways of driving innovation, especially from the supply chain.

33 National and local government are struggling to justify retaining in-house expertise. It is important that government itself understands the high level issues and is capable of acting as an educated client as a pre-requisite to delivering effective policy. For example, government must be able to understand a quality, high value solution when it is presented, and conversely, when a poor quality (cheap) solution is presented and should be blocked. As the conversation moves from cost towards value, this knowledge and understanding will be essential.

34 Building Information Modelling (BIM) supports integrated teamworking by developing a common language and a standardised process for sharing information. Future developments will extend its applicability to all stages of the lifecycle including operation, and to a scale beyond the individual building, supporting the development of smart cities[13]. The seeds are in place, and we welcome the government's requirement that government contracts use BIM. However, it is essential that the use of BIM is embedded further. Skills development and an 'open systems' approach will be vital in achieving this.

Question 11: Do those involved in delivering and managing our built environment, including decision-makers and developers, take sufficient account of the way in which the built environment affects those who live and work within it? How could we improve consideration of the impacts of the built environment upon the mental and physical health of users, and upon behaviours within communities?

35 The effectiveness of built environment policies and of design is improved by understanding behaviour and by having the appropriate tools to apply this knowledge in practice[14]. Greater understanding is needed of how the built environment functions as a socio-technical system with people as a central component. This will help to achieve objectives around important challenges for the built environment, including the use of resources; health and wellbeing; and performance and productivity.

36 There is scope to improve the consideration of health and wellbeing in spatial planning and in the design of all types of building, including offices and housing for example, as well as hospitals and healthcare centres. It is important to consider the design of buildings alongside the public realm. Collaboration between researchers and practitioners is key to developing evidence-based design principles and guidance.

37 Professionals need to be exposed to, and engage with, the outcomes of the building projects. Ongoing post-occupancy evaluation to measure the actual performance of buildings in operation, assisted by the Internet of Things and data analytics technologies, will improve understanding of the way in which the built environment impacts on people, including how it influences health and wellbeing.

38 Government must promote collaboration between local government, clinical commissioning groups, planners, architects and the local community in planning and design. Lessons should be taken from other initiatives, such as the Center for Active Design in New York[15].

39 Some sectors within the built environment are better at designing in quality at the outset; hospitals that are designed to promote recovery, schools that are designed to promote learning. Key Performance Indicators are identified and measured, with best practice swapped. This approach is not consistent however and many commercial developers do not consider the long term use of their products and their interests too often wane rapidly after completion. Best practice should be shared and smarter targets set for everyone to deliver against, in alignment with an overall strategy. Where deficiencies occur, there should be an obligation to correct these.

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[1] An example of this approach is the 'five cities model', that sets five areas of achievement for all sectors, and places people at the centre. See: Tyler N (2013) *A Vision for Cities: the 5-cities model*, ARGNote (1)5, www.cege.ucl.ac.uk/arg/Pages/ARGnote.aspx

[2] The built environment comprises *the planning, design, construction and operation of buildings, built areas and the public realm, and includes the economic infrastructure required to enable built areas to function (energy, water, waste, transport and ICT)*. So defined, the built environment has a market size of conservatively 10% - 15% GDP in a developed country such as the United Kingdom.

[3] For example, the costs to the NHS of ill health caused by poor quality housing are substantial. Improving the housing stock and preventing health issues would be paid for by reductions in NHS operating costs. Nicol, S., Roys, M. and Garrett, H., (2011) BRE Briefing Paper - *The cost of poor housing to the NHS* http://www.bre.co.uk/filelibrary/pdf/87741-Cost-of-Poor-Housing-Briefing-Paper-v3.pdf

[4] Royal Academy of Engineering on behalf of Engineering the Future (2011), *Infrastructure, Engineering and Climate Change Adaptation – ensuring services in an uncertain future*, http://www.raeng.org.uk/publications/reports/engineering-the-future

[5] HM Treasury (2015) *Valuing infrastructure spend: supplementary guidance to the green book*
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417822/PU1798_Valuing_Infrastructure_Spend_-_lastest_draft.pdf

[6] Royal Academy of Engineering on behalf of Engineering the future (2011), *Infrastructure, Engineering and Climate Change Adaptation – ensuring services in an uncertain future*, http://www.raeng.org.uk/publications/reports/engineering-the-future

[7] The performance/delivery gap means that the measures delivered failed to achieve the expected improvement in performance.

[8] Energiesprong: Transition Zero http://energiesprong.nl/transitionzero/

[9] Royal Academy of Engineering (2012), *The case for Centres of Excellence in sustainable building design*

[10] The discipline of building engineering physics is described in: Royal Academy of Engineering (2012), *Engineering a local carbon built environment: The discipline of Building Engineering Physics*

[11] Royal Academy of Engineering Press Release (May 2013) *Four new Centres of Excellence for Sustainable Building Design launched* http://www.raeng.org.uk/news/news-releases/2013/May/four-new-centres-of-excellence-for-sustainable-bui

[12] Royal Academy of Engineering (2012), *The case for Centres of Excellence in sustainable building design*

[13] HM Government (2015), *Digital Built Britain: Level 3 building information modelling - strategic plan* https://www.gov.uk/government/publications/uk-construction-industry-digital-technology

[14] Royal Academy of Engineering, Arup and ESRC (2015), *Built for living: understanding behaviour and the built environment through engineering and design*. Royal Academy of Engineering: London.

[15] Center for Active Design: promoting health through design http://centerforactivedesign.org/ A non-profit-making organisation that provides training, technical assistance, as well as research and policy support on the implementation of Active Design to promote healthy living and chronic disease prevention.