Heat and Energy Efficiency: Making Effective Policy

Advisory Group Report

A report for the UK Committee on Climate Change

Professor Janette Webb

THE UNIVERSITY *of* EDINBURGH

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Heat and Energy Efficiency Advisory Group Members

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Summary

In Autumn 2016 the UK Committee on Climate Change (CCC) is advising Government on policy options for energy efficiency and low carbon heat in buildings. The CCC convened an expert Advisory Group to help consider policy, priorities, and decision points up to 2030, to position the UK for near zero emissions from buildings by 2050. The group reviewed three 'What Works' for policy reports and preliminary results from a Frontier Economics study on the future of the gas grid. We discussed with the Secretariat their emerging proposals. This Advisory Group report provides a Chair's summary of discussions about a policy package to achieve 2030 carbon budget scenarios.

In accord with CCC, the Group strongly recommend an integrated policy framework for energy efficient buildings and low-carbon heat supply. This is a major opportunity to create universal benefit for society, industry and environment. Energy performance improvements in buildings are currently running at 1% per annum, rather than the 2-3% required. We need therefore to do more, faster, than building owners or the existing supply chain will do without market intervention. The Group agree with CCC policy proposals, but are particularly concerned with a process for implementation. Our Report focuses on the major issues of governing decision making and achieving measurable progress. We identify key steps in strategy development for a whole building energy performance model, supply chain development and decision making about the future mix of energy networks for low carbon heat supply. Evidence shows that further short term action on low cost energy efficiency is crucial, and there is an urgent need for policy renewal. Longer term, energy efficiency will need to go beyond 'low cost measures', using a whole building approach and addressing the multiple performance gaps between the modelled economic gains from energy efficiency, actual investments and measured performance. The best way to decarbonise heat supply is uncertain, and regional solutions will vary. Some actions can be taken now with minimal risk; these include supporting electric heat pumps in highly insulated off-gas buildings and in large electrically heated and mechanically ventilated buildings, as well as heat networks in urban centres. Beyond this, the most feasible infrastructure may be any of heat networks, electricity, repurposed gas and passive buildings. Solutions will require planning to avoid wasteful duplication of infrastructure. Commencing in this Parliament, the short/medium term action plan for energy efficiency and low carbon heat in buildings should therefore:

- Develop the governance process, necessary institutions, and timelines, for decision making
- Renew incentives and standards for low cost energy efficiency measures
- Conduct development, demonstrations and trials to inform medium-term decisions
- Initiate a comprehensive programme for workforce up-skilling to professionalise the building and heat supply trades.

UK policy does not need to be created in a vacuum. Evidence from past experiences, devolved government and local authority initiatives, and overseas comparators, shows that long term consistency, regulatory standards and performance measurement, combined with targeted incentives, will build dynamic markets. Technical and supply chain challenges are however complex, long-lived and cut across departmental jurisdictions, levels of government and sectors. The investment in buildings and energy infrastructure is significant. Government therefore needs to provide a vision, leadership and long term policy framework. The Group conclude that this requires a White Paper setting out a strategy for a 'Pathway to a Sustainable, Zero Carbon Building Stock'.

Key Messages and Recommendations: Policy for Heat and Energy Efficiency in Buildings

- The evidence clearly establishes
    - The value of an integrated policy framework for energy efficient buildings and low carbon heat supply
    - The cost-effectiveness of regulatory standards for buildings and energy networks
    - The need for a renewed UK governance process to achieve the necessary significant changes in every building and all energy networks and technologies
    - The universal benefits for society, business and environment from this course of action
- Action needs to commence in this Parliament to ensure near zero emissions from buildings by 2050
- There are immediate cost effective opportunities for:
    - Further insulation of existing residential and non-residential buildings
    - Standards and incentives to support appropriate take up of electric heat pumps and development of urban heat networks
    - Standards and tools for measuring in-use energy performance of buildings
    - Near zero energy standards for all new buildings
- It is also imperative to initiate now a governance strategy for post-2020:
    - Whole building retrofit, using results-based evaluation of energy performance
    - An associated comprehensive programme for professionalisation of building and heat supply trades
    - Decision-making about the mix of low carbon heat supply infrastructures (electricity, heat and repurposed gas networks) and regulation, while avoiding wasteful duplication
    - Appropriate demonstrators and trials of low carbon heat systems and low energy building solutions
- This governance process will be critical to assessing best value investments and allocating risks and responsibilities
- Technical and supply chain challenges and investment are significant, and cut across departmental jurisdictions, levels of government and sectors. The Group hence recommend use of a White Paper setting out a 'Pathway to a Sustainable, Zero Carbon Building Stock' as the best available means to provide the necessary vision, leadership and long-term policy framework.

Introduction

The Advisory Group report and its contribution to the work of the UK Committee on Climate Change

The UK Committee on Climate Change (CCC) has advised government that emissions from buildings need to fall by around 22% between 2015 and 2030, to create options for near-zero emissions by 2050. Achieving this target will require concerted action to address the significant shortfall in low-carbon heat, and the Committee also recommends that Government policy should link support for low-carbon heat supply and infrastructures with support for energy efficiency. This presents a

significant policy challenge, and in its 2016 Progress Report, the CCC made a commitment to assist Government by developing one view of an integrated policy package which could realise the 22% reduction in emissions to meet the 2030 carbon budget scenarios for buildings. The CCC has developed its policy proposals through in-depth external and in-house research reviews of 'what works' in policy and practice. In addition the CCC commissioned a study by Frontier Economics of future gas grid scenarios. The resulting policy package, together with appraisal of policy priorities and decision points, is designed to inform the Government's 2016 emissions reduction plan.

The CCC convened an expert Advisory Group to help steer and comment on its advice. The group was asked to consider the credible policy options, priorities and actions required up to 2030, to position the UK for near zero emissions from heating in buildings by 2050. The group reviewed three What Works policy reports on: domestic energy efficiency policy (CCC secretariat); non-domestic buildings energy efficiency policy (Dr Peter Mallaburn UCL) and (in draft form) low-carbon heat supply policy (Imperial College). They also reviewed early results from the Frontier Economics study. These reports are published separately; available at www.theccc.org.uk. Finally they discussed with the Secretariat their market segmentation and pathways analysis, and emerging proposals for policy priorities, instruments and decision points between now and 2030.

The CCC asked the Chair of the Advisory Group (Prof Janette Webb, University of Edinburgh) to produce a report reflecting on the evidence assembled and its implications for credible and effective policy and actions. This report provides a Chair's summary, based on discussions between the Advisory Group, CCC Secretariat and the authors of the evidence-based reports. It comments on the documents, and on the associated strategy for a policy package to give one view of how the 2030 carbon budget scenarios in buildings can be achieved. The report seeks to inform the CCC's analysis of evidence and to assist in translating evidence into advice on effective policy. The Group support the Committee in recommending to Government the value of an integrated policy framework for low energy, low carbon buildings. In addition, we emphasise the need for an inclusive governance and decision-making process to guarantee measureable progress towards 2050 zero carbon buildings.

The Advisory Group is primarily reporting to the CCC, but also has in mind Government, business, civil society and research audiences. For all audiences, the Group wishes to emphasise the evidence of combined social, economic and environmental value of integrating low carbon heat and energy efficiency strategy. There is a strong body of evidence to show that an integrated policy framework is a cost effective route to meeting carbon budgets, and contributing to economic regeneration, business productivity, jobs and social welfare (Cambridge Econometrics and Verco, 2014; Carbon Trust, 2010; Payne et al, 2015).

Problem Definition

The UK CCC 2016 Progress Report to Government noted the lack of a coherent strategy to deliver energy efficiency improvement and low-carbon heating in buildings to meet 2030 carbon budgets. There has been a lack of progress over the last decade in non-residential buildings, and changes in energy efficiency policy for residential buildings have resulted in progress stalling since 2012. The closure of the Green Deal leaves a major policy gap for able to pay home owners, and has weakened the means of complying with regulations for the private-rented sector. Funding and targets for the successor to the Energy Company Obligation (ECO) are reduced, and increasingly directed to support

for energy efficiency in low income households. The use of low carbon heat remains minimal, at around 2.5 % of heating supply.

In this context, the CCC have advised Government that a more comprehensive policy framework is required. This includes policies designed for different categories of buildings and owners (ie. new build developers; private and social housing landlords; home owners, small businesses and commercial and public sector building owners), and for low carbon heat supply and network infrastructures. The Advisory Group support the CCC analysis and conclude that, with building energy performance improvements currently running at 1% per annum, rather than the 2-3% required, a step change in policy formation and delivery is urgently needed.

The Group emphasise three further aspects of problem definition. First, there are performance gaps between: an economic model of cost effective energy efficiency investment and actual levels of investment by building owners; technical models of energy performance of buildings and actual energy consumption, and technical potential of low carbon systems vs actual performance. The Group conclude that a key part of addressing such gaps is to embed requirements for measured (rather than modelled) energy and carbon savings in policy instruments, and to design policy suited to the priorities of the demand side: households, businesses and public services. Second, there is a further significant gap between current and necessary capacity and skills in the building trades and supply chains. Measures to create momentum in retrofit and new buildings must remedy this gap. Third, if we continue with current piecemeal and uncertain policies, then the gap between 2030 carbon budgets for buildings and actual achievements will increase significantly. Emissions from fossil-based heating systems were 85 $MtCO_2e$ in 2015, a 17% share of total UK emissions (UK CCC 2016); a conservative estimate suggests that this could increase to between a quarter and a third of total emissions by 2030, as emissions from other sectors are reduced.

Key Points: Policy Options, Priorities and Actions to Meet the 2030 Carbon Budget

The CCC recommend a policy package to support: timely development, testing and understanding of low carbon heating options and supply chains; action on least regret energy efficiency measures, targeting building owners, and on regulation for both near zero energy buildings, and for gas and heat networks. Among least regret low carbon heat supply measures, for the period between now and 2030, it identifies cost effective potential for: heat pumps in suitable (highly insulated) off-gas homes and in large electrically heated and mechanically ventilated buildings; heat networks in dense urban areas.

The Group support the overall CCC approach and policy proposals. We conclude however that the key means to effective decision making and implementation is lacking. Insights from evidence show that substantive progress depends on government providing clarity on objectives, first for short-term, least cost and least regrets actions for energy efficiency and heat, and second for longer term goals for near zero emissions from buildings using low energy, low carbon infrastructures. The focus now needs to be on signalling intent through a mix of regulatory measures and judicious incentives and rewards, together with strategic piloting, to create dynamic markets, strong supply chains and good quality jobs. We emphasise the necessity for development of co-ordinated governance, institutions and supply chains to guarantee measureable progress towards a low energy, low carbon

heat system in buildings. In this section, the essential components for an effective decision-making process are explained.

Our key recommendation to CCC is to advise Government of the need for a White Paper to set out the pathway to a sustainable, near zero carbon building stock. We make this recommendation for three principal reasons. First the problem is complex, entailing multiple decisions by many actors over a long period about building fabric, building services, heat supply sources and network infrastructures. Second it is critically important for climate change mitigation, highly valuable for business and affects all members of society. Third its solution correspondingly requires vision and leadership from Government. A pathway to a near zero carbon building stock necessarily includes both energy efficiency and decarbonised heat supply, so the two need to be considered together. A White Paper is a direct means for Government to achieve the necessary strategic focus across departments, and Treasury commitment, and to set out the programme of work. It can initiate necessary review first of tax and accounting frameworks to ensure that these work coherently to incentivise low carbon heat and energy efficiency investments, and second of energy efficiency and heat cost benefit appraisals to align these with carbon budgets and societal value. For the UK economy, the White Paper will be instrumental in:

- Capturing the value of energy savings for all energy users across the UK
- Creating new markets for the UK energy saving technology and services sector
- Opening up new opportunities for the UK's energy technology fund markets
- Enabling the public sector to show leadership and to drive change through smart procurement
- Building on the UK's strong track record in energy efficiency policy innovation and research

An alternative option is to incorporate low energy, low carbon buildings into an Industrial Strategy White Paper, making the delivery of the 4th and 5th Carbon Budgets an integral part. This has the advantage of situating the near zero carbon building targets in a wider policy and funding narrative, and allows application by Treasury of productivity and competitiveness tests. It may however risk loss of direct and sustained strategic focus on low energy and low carbon heat in buildings.

Using the White Paper instrument, the Group concludes that actions need to commence in this Parliament to secure:

- The framework for short- and longer-term energy efficiency improvements in all homes and non-domestic buildings. This should include incentives, affordable finance and a timeline for regulatory standards to drive action by building owners;
- The framework for 2020 near zero emissions from heating (and cooling) in new buildings;
- A long term governance process for achieving low energy buildings and decarbonised heat supply. A necessary part of the process will be cross-sector appraisal of interdependencies and trade offs between low energy buildings and heat supply infrastructures, and negotiation of strategy and decision points for the multiple possible 2050 solutions. The quality of this process will be key to effective policy and implementation, and to legitimacy and fairness in allocation of costs and benefits.

Vision, Narrative and Governance

A key part of consistent strategy is a narrative, or vision, conveying the scale of the opportunity and the importance of concerted action. The narrative needs to make low energy, low carbon buildings and heat supply a high-visibility matter, with a story focusing on 'what people and organisations want' from building and energy services, rather than a supply-side focus on modelled heat technology and building efficiency alone. This applies to building owners across sectors and scales, from commercial investors to householders. For example, commercial investors and social housing providers want improved rental returns on buildings; businesses want reputational capital and improved productivity; local authorities want new income streams, cost savings and economic regeneration; public services want high quality, affordable workplaces and community facilities, and a reputation for thrift and efficiency; householders typically want comfortable, attractive, easy to maintain homes, and affordable bills. Low energy, low carbon heat can be part of the answer to all of these.

Articulating such a narrative requires clarity about the institutions governing policy development and a coordinated division of responsibility between them. Present uncertainties over divisions of responsibility between UK BEIS, Treasury, DCLG (England) and the devolved governments of Scotland, Wales and Northern Ireland need to be constructively addressed. Getting the governance process right will require review of the necessary responsibilities, powers, technical capacities and resources of local authorities and city-regions in strategic planning for low carbon heat and area-based energy performance programmes and contracting. The evidence shows the considerable ambition of local authorities, particularly in relation to energy efficiency, heat networks and combined heat and power, but they struggle to assemble capacity and resources at the scale necessary to make material impacts (Webb et al, 2016).

All public sector bodies can take a prominent lead in creating a dynamic market by: using a high energy efficiency standard in building procurement;[1] further improving energy performance of all public estates; connecting buildings to heat networks where density and diversity of heat loads justify such infrastructure; collaborating with other public services to secure district heat network economies of scale; making prominent public statements about the resulting advantages for facilities, services and public spending.

For policy success in creating a dynamic supply side, construction, building services, insulation and heat supply industries need to be parties to performance improvements specified in the narrative. Industry associations and networks can support peer-to-peer capacity building and reward best performers. Policy and regulatory standards need to be progressively refined in response to changes in the industry, sanctioning worst performers at appropriate points. The forthcoming Bonfield Review,[2] although focused on the residential sector, will help to generate necessary visibility and momentum for the industry. On the demand side, building owners' commitment can be secured by high visibility public marketing campaigns promoting the aspirational, reputational and economic worth of investing in energy performance, and by signalling incentives and forthcoming regulatory standards. All large multi-occupancy buildings, for example, can be required to display prominent

[1] Buildings leased to the public sector make up a fifth of the heating demand for non-residential rented properties, (CCC, 2016, based on the BEIS BEES survey data)

[2] https://www.gov.uk/government/publications/bonfield-review-terms-of-reference

energy performance certificates and data, with potential for published league tables to promote the additional value in improved rental returns and reduced operating costs to investors and social housing providers. Home owners, as well as smaller private landlords, can be similarly engaged by a mix of incentives and requirements for a measured energy performance standard at point of sale, rental or major renovation.

Using regulation

Evidence shows that, because of a number of market failures, regulation of performance standards in buildings, appliances, technical systems and networks offers a cost effective means to advance an ambitious vision. It works by enabling responsive markets for measurable improvements in energy efficiency and low carbon heat supply. Regulatory standards do not have to be a burden on business, but can be used to support competitive markets, by signalling new norms, expectations and standards of practice (Carruthers and Stinchcombe, 1999; Fligstein and Calder, 2015). The Group advises the Committee to emphasise to Government the value of regulation in specific circumstances, such as setting higher standards for existing and new buildings,[3] increasing technical performance standards for electric heat pumps; setting system efficiencies for gas central heating with condensing boilers; setting technical standards for performance of heat networks, as developed by the CIBSE 2015 code of practice.

Overall, the Group recommends that regulation designed to deliver low energy and low carbon *buildings* should be directed to *ends not means* (i.e. it should not prescribe particular technologies or materials), allowing scope for more dynamic markets to develop around different combinations of technologies and energy efficiency investments. Second, regulation for energy efficiency in buildings needs to be based on actual, not deemed, performance standards. This will generate virtuous circles of implementing, monitoring, learning and improving, and is a basis for an intelligent customer and a 'payment by results' model for investment and energy performance contracting. For building performance, the Group advocates use of an environmental indicator (gCO_2/m^2/year), with a subsidiary energy efficiency indicator (kWh/m^2). Smart metering technologies provide a means for standardising such performance measurement.[4] To minimise corrupt practice, poor quality work and distrust by buyers, regulation needs to be enforced through independent assessors, as well as by industry. The Group recommends a unitary system, using local Building Control Officers, as a cost effective structure. For building owners, this package of regulation will make action a necessity, rather than an optional extra. Hence it will stimulate the, currently absent or piecemeal, market demand.

A longer term challenge is created by the need to manage and resolve uncertainties about future low carbon heat supply and inter-dependencies between gas, heat and electricity networks. Creating

[3] For example, the very limited increase in new build energy performance standards in 2014 was partly a result of UK Government policy to reduce regulatory costs on business, even if these are more than compensated for by cost savings to households (Department for Communities and Local Government *Changes to Part L of the Building Regulations 2013: Impact Assessment*, https://www.gov.uk/government/publications/changes-to-part-l-of-the-building-regulations

[4] See for example the 'Open energy efficiency meter' used as a standard of measurement in the State of California pilot residential scheme http://www.openeemeter.org/blog/piloting-metered-pay-for-performance-in-california

a heat regulatory authority is an effective means to focus on low carbon network investment fundamentals, while minimising uneconomic duplication of infrastructure and disruption to the public realm. Decisions on specific powers and responsibilities of such a heat regulator will need to be devolved as appropriate to the national governments of the UK. This is because heating requirements and opportunities differ regionally, and because heat is already at least partially a devolved matter. The powers of a heat regulator may encompass efficiency requirements, performance standards and price control rules for network operators, rates of return on capital, and transparency in business operation. Decision making will necessitate review of the role and powers of Ofgem, and consideration of common standards of consumer protection across energy networks.

Assessing cost optimal heat and energy efficiency solutions

A significant part of using regulatory standards to stimulate dynamic markets is ensuring that assessments of cost optimal energy efficiency and low carbon heat investments are attributing best value to these developments. Current cost-benefit analysis of different options in the UK, *in comparison with other European economies*, tends systematically to attribute relatively low value to energy efficiency. This undermines markets. Options appraisal uses the following supplementary Green Book guidance:[5]

- Energy costs for incumbent gas and electricity supply are represented by the long-run variable cost (LRVC) to assign a value to the change in social welfare from changes in final energy consumption. In practice this means that most of the costs of maintaining existing networks are excluded from estimates of future energy costs, because they do not change (in aggregate) with changing demand. The LRVC is lower than the (pre-tax) energy cost seen by consumers, and is lower than that used in other European analyses. In a cost-benefit calculation, this lower cost attributes lower benefit to energy efficiency.
- Financing costs are included as a real socioeconomic cost; this increases the capital cost of technologies used in the calculation. Supplementary guidance notes that economic theory is not clear on whether financing costs should be included. Indeed other government supplementary guidance argues against their inclusion, and instead defines financing costs as social transfers.

These factors have a significant conservative influence on valuation of energy efficiency and low carbon heat technologies. For example, the estimated 'cost optimal' energy performance level for new buildings in the UK results in a considerably higher level of energy consumption than it would if full costs of networks were included in energy cost calculations (Hawkey, 2016). In the case of the estimated optimal level of district heating deployment, inclusion of financing costs has a major impact, reducing the 'optimum' from around 40% to around 3% (Ricardo E&E, 2015). Within the range of CBA theory, these factors, as well as others such as valuation of impacts on health, jobs and employment, can be adjusted to derive alternative optimal levels of energy efficiency.

Furthermore, there are questions about valid use of a concept of cost optimality (Anell, 1985). For example, there are good reasons for Government to aim for a *maximum,* rather than *optimum,* level of energy efficiency:

[5] UK Government DECC (2015) *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*, https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

- There is continuing uncertainty over future UK energy supply, with different scenarios having different implications for 'optimal' energy efficiency. It is prudent, therefore, to ensure that no supply-side options are locked out. This requires future-proofing buildings for compatibility with the supply-side scenario requiring highest levels of efficiency, namely a high-renewables scenario.
- Government has not defined an 'optimal' path for building stock upgrade. One line of argument is that early action results in a needlessly higher total cost, because measures are installed before their costs have fallen. There are however real uncertainties over future costs, and in addition this approach risks failing to complete timely retrofit to meet carbon budgets, hence contributing to the rising costs of climate disruption. A prudent approach is to set an annual target retrofit rate for a renewables-compatible building stock by 2050. This would set the benchmark for evaluation of cost effective policy options to achieve a low energy building stock.

Dynamic markets for low energy, low carbon heat

In all supply industries, whether for heat technologies or building insulation, the task of integrating advanced efficiency and low carbon supply for future whole building retrofit, as well as near zero energy new build, is far beyond the capability of the current supply chain. There is an urgent need for systematic education and up-skilling of the workforce to create high quality, cost-competitive and professional building trades, including project managers, building services engineers, gas fitters, electricians, and insulation installers. This needs to continue over a few decades to create the foundations for high performance standards, new industry norms, business models for whole building low energy solutions, and the, currently lacking, consumer trust.

The necessary changes to building fabric and heating systems will affect everyone; all building owners, but particularly households and small businesses, will need support to manage the significant technical and normative changes in energy use. Evidence shows that incentives, as well as regulation to set expectations, are effective catalysts. Creating efficient markets, delivering high standards of work at competitive prices, will however also require informed consumers, equipped with market intelligence to understand and discriminate between supplier offers. In the domestic sector, evidence on the costly failure of the Green Deal (NAO, 2016; Rosenow and Eyre, 2016) indicates that using independent institutions to collect and analyse performance data, undertake research, promote best practice, accredit technologies and provide consumer advice is a cost effective way to achieve this result.

Commentary on evidence from UK CCC and External Reports

Residential energy efficiency (CCC)

The Group support the conclusions from the CCC review of what works in residential energy efficiency policies. We note the urgent need for new policy directed at home owners able to pay for low energy, low carbon heating improvements. The following points primarily address this sector.

Effective policies target households at the point of decision-making: critical points are sale and purchase, home improvements, renovations, and replacement of old heating. The government and its agencies could work with mortgage and home loan providers, estate agents and lawyers, as well

as the building trades, to make opportunities, requirements and financial terms unavoidably present during these key transactions. The evidence shows that policies work best when consistent over the long-term, use regulatory standards for buildings, energy efficiency labelling of appliances, independent accreditation of suppliers and clear information, backed by a strong marketing strategy, to reset norms and expectations. A mix of measures is most effective, with regulatory standards setting a timeline for upgrading existing homes, backed by subsidies such as tax incentives or grants to reduce high upfront capital costs. Subsidies can be replaced over time by affordable loans. Low energy buildings regulatory strategy in countries such as Denmark and Germany are highlighted as good practice models. Minimum performance standards for new buildings, and for buildings undergoing refurbishment, are determined by cost-optimisation from a user perspective, including taxes and network maintenance costs. Low discount rates are also used; these are justified by the low costs of loan finance currently available.[6]

New policy will require independent assessors to provide quality assurance for consumers. As noted previously, this should be based on verifiable, metered energy and carbon savings, ideally using accessible visual displays for householders. Combining independent assessors with regulatory standards and incentives, will ensure progress, because this package changes energy efficiency and heat improvements from optional extra, which can be put off, into necessary action, in turn generating market demand.

Successful policy needs to encompass the social dynamics of how and when people refurbish their homes, and needs to address what we use energy for, rather than simply its economics (Wilson, et al 2015). There is an opportunity for example to build on cultural forms such as TV home improvement genres, and to enlist media figures to communicate the opportunities and benefits. This strategy uses popular media to set new cultural norms about making an attractive, comfortable and desirable home, and harnesses social networks and aspirational values to engage a broad range of home owners.

Making such cultural shifts practically feasible will require innovation in supply chains. The Group identified the need for a new policy framework for a whole house approach. At present, highly segmented heat and energy efficiency supply chains and trades require each individual house owner to be an expert project manager in technical-economic options appraisal, supply chain assembly, procurement, financing and performance appraisal. For most people, this is untenable, and an unlikely priority. A highly cost effective model for policy is provided by the exemplary UK framework for effecting the major shift to gas condensing boilers in a relatively short period. Policy was time-adjusted, so that initial support was followed by exclusion from the market of less efficient boilers once the technology was established (Mallaburn and Eyre, 2014). This type of streamlined, responsive, multiple-agent policy (regulation, certification and training) geared to take up of technologies at a reliable stage of performance, is needed for low energy, low carbon heat systems. A whole house approach would be enabled by a process for implementing lower temperature heating systems, as a basis for any low carbon heating supply. In the short term, this includes upgrading service and maintenance standards and protocols to ensure best efficiency from gas condensing boiler central heating systems.

[6] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

The Group considered the pros and cons of an area-based model for building retrofit, vs targeting a particular category of buildings. The latter is proposed by CCC in measures for a short-term focus on policies to support use of electric heat pumps in suitable (ie. well-insulated) off-gas buildings. The evidence for an either/or approach is limited, but tends to suggest that both approaches are likely to be needed. The evidence does show that 'what works' is contingent on socio-economic circumstances, indicating the value of local and regional decision-making. Well-managed area-based social housing programmes potentially make improvements more affordable (by reducing unit cost), highly visible and desirable. Systematic improvements to social housing areas in Aberdeen for example are highly regarded by tenants and low income owners, creating a win-win situation for the city council, through improved rental returns, fewer voids and reduced maintenance costs, for supply chains and jobs, and for households through affordable warmth[7] (Webb, 2015). The Group also noted the potential for emulation of the innovative Dutch Energiesprong[8] (Energy Leap) area-based model for upgrading energy performance of existing social housing. The costs of retrofit are funded through energy bill savings, to ensure no net additional cost to tenants. Instead of paying energy bills, tenants pay a similar amount to their housing association. The associations use this fund to pay suppliers, who have 'industrialised' renovation procedures to reduce unit price. The WSW social bank has provided €6bn capital to underwrite government-backed 40-year loans to the housing associations. The Netherlands building stock is more homogeneous than in the UK, but this approach could be developed for specific types of housing and offers a model for cost-effective cross-sector collaboration with significant economic, environmental and welfare co-benefits (Pye and Dobbins, 2015).

Lastly, the Group note the lack of a clear price signal for investment in the residential sector; domestic energy tax structures give fossil fuel gas for heating a market advantage, and weaken incentives for building owners on the gas grid to improve the energy performance of their properties. This structural factor needs to be taken into account in designing policy to incentivise higher energy performance of domestic buildings. Among other issues, it may for example reduce the real energy and carbon savings from building standards which rely on SAP rating. The embedded focus on fuel *cost* in the SAP measure allows for compliance by switching to a lower cost fuel source, rather than by upgrading the building fabric (UK CCC 2016). This reinforces the Group's recommendation that regulation needs to use measured energy and carbon savings to underpin building performance standards. Ultimately, the effectiveness of energy efficiency standards will be enhanced by replacement of carbon subsidies on energy supply with a carbon tax (Advani et al, 2013).

Energy efficiency in non-domestic buildings (UCL)

Lack of progress in non-domestic buildings, for both public and commercial sectors, is evidence that current policies are not working. The lack of a common voice in industry and campaigning organisations has resulted in fragmentation and low impact. The Group agree with the key findings from Dr Peter Mallaburn's (UCL) Report that successful policies need to make energy cost and energy efficiency investments strategically important, or 'salient', to senior management. There are multiple dimensions of salience which can be used to design policy.

[7] http://www.aberdeenheatandpower.co.uk
[8] http://www.energiesprong.nl

When choosing a building, the aim of policy should be to ensure that decision makers opt for the most efficient option available, using direct measures of energy performance and rating tables. This will allow market demand to raise standards. Current UK policy focuses on estimated energy performance (EPCs) and promotes a 'compliance culture' and capture by supply-side interests. For new buildings, the Group find that the UK plan for nearly zero carbon buildings by 2020, to comply with the EU Directive on Energy Performance of Buildings,[9] is a further example of counter-efficiencies; the plan allows reduced emissions through offsetting measure such as solar PV; this is not a substitute for direct emissions reduction from a low energy, low carbon heat system. Instead, for example, the Australian system (NABERS) focuses on performance and reward (using a star ratings system), and so creates a more dynamic market. The outcomes are evident in data showing the increased capital return on property investments.

When considering the renovation of an existing building, the current focus on 'pay back period' has been unproductive, failing to engage with senior management and finance team objectives. Policies can instead focus on business productivity and revenues (such as improved rental values) from energy efficiency investment.

Focusing on the business value of energy efficiency has three major consequences for policy design:

First, policy has three types of 'salience' variables to work on:

- Internal organisational factors: energy costs are a small proportion of total business costs; therefore policy needs to raise the 'signal to noise' ratio of energy spend; senior managers are then required to act by investing in energy efficiency.
- External reputational drivers can raise the profile of energy efficiency. This is especially relevant in organisations with a significant public profile, where adverse publicity damages 'brand value', sales and share price; for the public sector a reputation for thrift and welfare is highly valued.
- Sectoral drivers: businesses are responsive to peer pressure, especially in supply chains.

Second, it follows that multiple, connected policies are needed to make energy costs and energy efficiency strategically significant to senior management AND to support organisations in responding. Support can take the form of both incentives, and regulatory measures, and is likely to need refining over time. This could include provision of working capital for SMEs or facilitating benchmarking for industry. Successful policy needs to incorporate industry-leadership and peer-to peer learning to support culture change, rather than prescribing a check list of obligations. Reporting frameworks offer an excellent example, with the best ones, such as Swedish Audit programmes, combining 'carrots, sticks and tambourines'. A further model is the Investor Confidence Project Europe[10] which aims to unlock financing for the building renovation market using standards and protocols for developing, documenting and measuring energy efficiency projects. The new UK Government reporting scheme, which will go beyond current energy audits, can incorporate good practice elements from these models.

The third consequence concerns policy governance and accountability. The policy mix needs to combine a forensic organisational focus with light touch administrative simplicity. With constrained public funding, policy can step back once the innovation process is working. Most major economies

[9] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/nearly-zero-energy-buildings
[10] http://europe.eeperformance.org/

use a government agency to achieve the necessary mix. If there is UK reluctance to create a free-standing agency, business/government hybrid models could be adopted; DENA[11] in Germany is an apt example.

Heat policy options in UK context (Imperial College)

The Group welcomed the presentation from Imperial College colleagues on the rapid evidence assessment of 'what works' for policy on low carbon heating in UK context. Our brief comments, broadly in support of its interim conclusions are below.

The evidence reinforced the Group's conclusion that a key focus for UK policy must be development of high professional standards and skills in the building and heat supply trades, in order to ensure the best technical performance from any low carbon investments.

In relation to individual building installation of heat pumps, evidence again suggests that a mix of regulation and incentives works best. Incentives may be low cost loans, or in some cases one-off subsidies for early adopters, or for business start ups, combined with grants for low income groups. Over time, subsidies can be replaced by regulation and loans. With this in mind, the Low Carbon Heat "what works" project could provide evidence about practice in effective adaptation of policy as supply chains mature. In relation to subsidy for building owners, upfront capital support appears to be more cost effective than on-going financial payments. German practice provides a useful model for a policy package, combining energy performance standards in buildings with technical standards, and a market incentive programme.[12]

In relation to UK district heating development in dense urban population centres, where DH is assessed as best value area solution to heat supply, a key factor is making long term low cost infrastructure finance available. The UK Government Treasury decision to provide a £320 million capital fund for heat network investment (in England and Wales) over the course of this Parliament is a key step forward for developing a heat networks' industry. Consultation and discussion about the principles for fund allocation is on-going.[13] The open, inclusive and systematic consultative model for policy development, adopted by the Heat Networks Investment Project team is commendable. The pilot phase is making investment available to local authorities, as both direct investors and in partnership with private and community sectors. This provides an important and timely assessment of the potential for city and urban governments to contribute strategically to low energy, low carbon heating systems for the building stock, with co-benefits for local economic regeneration and social welfare.

In the past, UK heat network development has been stymied by a stop-go approach, which has caused bottlenecks and price increases in the supply chain. It has also resulted in small scale 'island' projects, which fail to capitalise on the scale economies of the network infrastructure and future flexibility in exploiting locally available heat sources (Hawkey et al, 2016). Since creation of the Heat Networks Delivery Unit in 2013, the lack of a project pipeline for capital funding has been addressed

[11] http://www.dena.de/en/about-dena.html
[12] http://energytransition.de/2012/10/renewable-energy-heating-act-and-market-incentive-program-map/
[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/532483/HNIP_consultation_vFINAL.pdf

by grant support and advice to local governments for technical-economic appraisal of projects and business model development. We still however need to overcome the limitations of 'island' projects. This can be achieved by creating a regulatory requirement on building owners in a designated area to connect to a heat network, where this is assessed as most competitive low carbon solution, and/or by a regulatory requirement on building owners to collaborate in joint planning and development. Future commitment by Government needs to be in place by 2020, with policy adapting to achievements in the course of this decade, to ensure that such economies of scale are achievable.

A principal advantage of heat networks is their ability to access any locally available heat sources, including using heat pumps to recover heat from underground transport systems,[14] water and geothermal sources, or capturing heat from thermal combustion. Making heat recovery economically viable requires high standards for energy efficiency, in for example, the licensing of waste incineration or other combustion processes. This model is used in Norway to require licensed operators of waste incineration to use the heat, which has stimulated rapid development of district heating networks (Hawkey and Webb, 2014).

Ultimately the questions about relative capital and operating costs of heat networks and gas networks, and the distribution of costs across users, need to be aligned with low carbon heat policy for cost effective options in dense urban areas (UK Government DECC 2013). There are different options for achieving this. Policy could for example emulate Scandinavian countries, using combinations of higher fossil fuel and carbon taxes, upfront support for district heating in targeted areas, and some form of zoning for *either* district heating *or* gas networks. These policies have promoted use of residual heat from electricity generation and other industrial sources, and have increasingly supported fuel switching to renewables, including renewable electricity where the system acts as a thermal store contributing to grid balancing (Bush et al, 2016). One option in the UK is to socialise the costs of heat network infrastructure by merging pricing rules for gas and heat networks. This would require a heat (instead of gas) regulatory body to review network price controls and share infrastructure costs across gas and heat networks (see comments on p.10). A heat regulator could also ensure equivalence in consumer protections and tariff structures across heating systems.

UK gas grid future scenarios (Frontier Economics)

The Group welcomed the presentation of early results of Frontier Economics' analysis of institutional implications of future gas grid scenarios. The centrality of the gas grid to the UK energy system, and the current UK regulated asset base model for network investment, mean that major uncertainties about gas futures need to be addressed by UK Government decisions, probably by the early 2020s. The work to inform such decisions needs to commence in this Parliament. It is critically important however that uncertainties about the future of the gas grid do not result in a hiatus in work on low energy and low carbon heat supply.

The Group note that the early stage of assessments of gas grid futures means there is no current consensus about technical, economic, environmental or societal viability of converting the grid to

[14] http://media.celsiuscity.eu/2015/09/Islington-London-Lucy-Padfield.pdf

hydrogen &/or biogas, either on a regional or a UK-wide basis. There are uncertainties around costs, engineering and institutional arrangements, business models and tariff structures. The Leeds Citygate project has reviewed costs and technical assumptions.[15] This demonstrates the challenges of assessing relative costs and benefits of gas conversion compared with other network options. Findings suggest that tariffs may need to differ between regions, which raises questions about consumer acceptability. In addition there is a lack of robust evidence about the carbon implications of inefficiencies in the conversion process, the availability of a viable CCS industry to capture emissions from production of hydrogen from fossil fuel gas, and implied long-term dependence on gas imports, even if UK shale gas became available.

To support future decision-making, further work is needed to investigate the key sensitivities and sensitivity range on costs. This should include identifying any potential for low-regrets options, and areas where decisions are needed about best value network infrastructure for heat, given the trade-offs between reinforcement of electricity distribution networks, new district heating networks, and gas grid conversion.

Conclusions

The Advisory Group commend the work of the UK CCC in emphasising to Government the urgent need for a new policy framework for energy efficiency and low carbon heat for buildings to meet 2030 carbon budgets. The Reports reviewed by the Advisory Group provide wide-ranging evidence about comparative effectiveness of policy options and are a valuable resource to inform learning, and support material progress. Using the resulting policy proposals will enable governments across the UK to review next steps, and to avoid the weaknesses and counter-efficiencies of an incremental, and piecemeal, approach (Geller et al, 2006; Rayner and Howlett, 2009).

The Group support the CCC policy proposals, but are particularly concerned about the absence of an effective UK governance process for managing the significant changes needed in every building and all infrastructure networks and technologies. Our Report hence focuses on the major questions of governing decision-making and achieving measurable progress. We have identified key steps in institutional development, strategy and supply chains. UK policy for energy efficiency in buildings has been in retreat since 2012, and now needs to make significant advances, building on lessons from closure of the Green Deal and from stasis in the non-residential sector. In this Parliament there is an immediate opportunity for further cost effective action on insulation of existing buildings; incentives and standards to support take up of electric heat pumps; development of urban heat networks; standards and tools for measuring the real energy performance of buildings, and near zero energy standards for new buildings. It is also imperative to initiate the post-2020 process for development of whole building retrofit systems, an associated comprehensive programme for workforce professionalisation, and a strategy for decision-making about low carbon heat supply infrastructures and regulation.

[15] http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf

Governing the move to low carbon heat and energy efficiency in buildings is a whole-system problem, which 'cannot be fully solved by considering one part of the solution in isolation' (UK DECC, 2013 p.7). There are multiple variants for 2050 low carbon heat supply, with an indeterminate mix of gas grid conversion, heat recovery via heat networks and electrification of heat at building level. Best solutions are likely to be circumstance specific, sometimes due to geography and location, but also due to local building types and available infrastructure options. Governments across the UK need to be clear about the identity of the competent decision-makers and agents of change in each case. Business and public sector participation is critical to developing confidence and capacity, and to careful monitoring and piloting to maximise value and minimise burdens. We will need a democratic process for assessing fair divisions of costs and benefits. A local authority, in coordination with UK and devolved national governments, may be the most appropriate institution to review cost effective area-based options, for example, and hence to minimise risks of stranded assets. These local and regional options are not however independent of decisions by UK and devolved Governments, and businesses, about the future decommissioning or repurposing of the gas grid; the feasibility of conversion of the grid to hydrogen, in particular, includes the requirement for a functioning CCS industry.

In summary the Group recommends that, in advice to Government on an integrated policy package for low energy and low carbon buildings, the CCC emphasise:

- The need for a comprehensive governance process to assess options, allocate risks and responsibilities, and to set the framework for decisions about low carbon heat supply infrastructures
- The cost-effectiveness of regulatory standards as a means to achieve progress and market innovation
- The need for a whole building approach based on measured energy performance
- Associated professionalisation of the building and heat supply trades.

Creating a low energy, low carbon heat system is a significant, tangible economic opportunity, benefitting the whole of society. Its realisation needs Government leadership and coordination to steer market development and investment. The Group conclude that the best available means to achieve this is a White Paper setting out a strategy for a 'Pathway to a Sustainable, Zero Carbon Building Stock'.

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