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Technologies that can support Scotland's Energy Efficiency Programme

ClimateXChange

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Summary

Innovation and new technology will be key to improving energy efficiency and reducing heat demand through the delivery of Scotland's Energy Efficiency Programme (SEEP). SEEP will deliver the Scottish Government's commitment to make energy efficiency a national infrastructure priority, boosting energy efficiency investment in Scotland and decarbonising heat provision over the long term.

ClimateXChange has commissioned research, steered by representatives of Scottish Government and Scottish Enterprise, to inform Scottish Government on the status of certain technologies, so that they can make informed decisions on the potential suitability of them for inclusion within SEEP.

The research was conducted via three technology landscaping studies to feed into the Research and Development (R&D) workstream of SEEP:

- Landscaping research into heat generation technologies available to deliver SEEP – undertaken by the Building Research Establishment (BRE)
- Landscaping research into energy efficiency (retrofit solutions to buildings) technologies available to deliver SEEP – undertaken by the National Energy Foundation
- Landscaping research into smart energy technologies available to deliver SEEP – undertaken by CAG Consultants (with Smarter Grid Solutions and Innovas)

The studies have reviewed the status and suitability of a number of near-term technologies that are not already significantly established in the market-place, but which may be suitable for commercial application under SEEP.

Introduction

SEEP

The 2017-18 Programme for Government stated that the Scottish Government will accelerate work on SEEP, publish a SEEP route map to set out longer term ambition, develop financial mechanisms to attract private sector investment, build on SEEP pilots, and consult on detailed proposals for Local Heat and Energy Efficiency Strategies and regulation of district heating. There is also the possibility of a wider SEEP Bill for later in this Parliament.

SEEP includes:

- measures to make homes and places of work warmer, promoting more affordable energy for consumers, helping to tackle poverty and improve the competitiveness of the Scottish economy;

- the opportunity to create a substantial Scottish market and supply chain for energy efficiency services and technologies, with an estimated 4,000 jobs per annum across Scotland, including in remote areas, based on the estimated overall investment of up to £10 billion;
- measurable health and early years improvements through people living in warmer homes;
- regeneration of communities through upgraded building stock;
- substantially reduced greenhouse gas emissions contributing to meeting our ambitious climate change targets.

The Scottish Government's SEEP research and development workstream is exploring the role of R&D in providing the energy efficiency and heat solutions required to deliver the SEEP's vision, and is looking in particular at:

- New materials and approaches
- Viability of technologies
- Assessment methodologies and measurement

The workstream is also seeking to characterise any relationships between these aspects and to provide recommendations on possible approaches for the 15-20 year timeframe of SEEP.

Research aim and objective

The three landscaping studies are intended to provide the Scottish Government's SEEP research and development workstream with an understanding of what the short-term technological options are for the SEEP. Ultimately, this will help steer the technological direction of SEEP as a long-term programme of investment.

The studies provide a comparative review of 'ready' (Technology Readiness Level - TRL level 8 or 9) heat generation, energy efficiency and smart energy technologies available, against a set of pre-agreed assessment criteria.

Methodology

Identifying technologies

The approach taken by all three project teams focused on producing working deliverables that can be maintained as SEEP moves into development and implementation phases.

In order to identify technologies suitable for inclusion in the study, some project teams relied on their own experience and knowledge, and others used desk based research, literature review, and online databases. The focus on TRL 8 and 9 meant that technologies being tested and used in the real-world were looked at.

In addition to identifying technologies, the energy efficiency project team reviewed the Scottish housing stock and identified archetypal buildings to provide context for their work.

The energy efficiency and smart energy project teams also included an element of market testing to test their findings:

- NEF held a workshop with leading practitioners and researchers in the field of retrofit in Scotland. The workshop provided a space for discussion around technologies and materials that could underpin the SEEP objectives. Attendees also helped review the methodology for scoring across the three projects, by scoring example technologies.
- CAG consultants (with Smarter Grid Solutions and Innovas) used market testing, after their literature review, to check they had a complete picture of the smart technology landscape. Key (UK-based) practitioners and researchers with an interest in and experience of smart energy were asked to comment on the technology database. The team simply requested pointers as to any important omissions but any contextual comments were also gratefully received.

Assessing Technologies

The original research specification included a list of suggested assessment criteria for the project teams to start working from. The project teams worked together to expand on this list, and to finalise and group the criteria by categories.

The assessment criteria were then used across the three technology areas to score the different technologies identified. Please see the technical note (Page 7) for information on how scoring was done.

Scorecards and Databases

The research outputs produced for the different technology areas can be viewed on the ClimateXChange website;

- the databases developed through the landscaping studies provide an ongoing resource on the technologies (heat generation, energy efficiency, smart energy) ready to make a contribution to energy savings; and
- the reports make a number of broad observations on where technologies might fit under SEEP.

Policy relevant findings

Context

The Scottish House Condition Survey[1] notes that from an energy efficiency perspective there has been a general trend of improvement in Scottish housing stock. Over the period 2010-2015, properties in the lowest EPC bands (E – G) dropped from 27% in 2010 to 15% in 2015. The biggest gains were seen in the social housing sector, which is important when it comes to considering the type and nature of innovation that may be required to be driven under the new SEEP programme.

Anecdotally, challenges for the private housing sectors include awareness, upfront costs, technical complexity and installation disruption, especially when it comes to harder to treat buildings such as those with solid walls and in off-gas areas.

Smart Energy

There are some big questions around the utility of smart meters and, related to this, their interoperability within a smart home and wider smart energy system. Scotland is trialing access to smart meter data (with consent) for Home Energy Scotland (HES) advisors, with the potential for much more tailored advice and enhanced energy savings. This is just one of many ways in which smart meters could be used to achieve energy savings, and an area where the SEEP could have impact, by leveraging UK investment in the meters themselves.

The smart energy project team did not find any Scottish-based suppliers of particular technologies, but Scotland has a strong Information and Communications Technology (ICT) sector and so there is a good match with existing skills. Where information is lacking, is on how worthwhile these interventions are in terms of energy savings and carbon cost effectiveness. For the most part, assessments have relied on claims by manufacturers. The SEEP could intervene by working with consumer organisations to understand how to get the most from these technologies.

The SEEP could also be used to address issues around consumer acceptance of third party control. This has yet to be tested in earnest, and could be run in partnership with consumer organisations. At the domestic level, much more experience is required around demand response as part of a more flexible energy system; this is a necessity for Scotland's low carbon agenda.

[1] http://www.gov.scot/Publications/2016/12/1539/335994

Given existing familiarity with electric storage heaters in Scotland, upgrades to smart versions would be a good contender for energy efficiency measures, especially in off-gas areas. And, even if not directly supported by SEEP, knock-on effects of power quality monitoring and intelligence systems on local networks need to be identified and managed.

A recent consultation by Ofgem and the UK Department for Business, Energy and Industrial Strategy (BEIS) called for evidence on a Smart, Flexible Energy System in order to better understand how they can support the development of greater flexibility within Great Britain[2]. This call for evidence discussed areas such as removing policy and regulatory barriers to owning and operating storage, clarifying the role of aggregators in the future energy system, providing price signals for flexibility, smart appliances, demand side response and electric vehicles. While this research project was in progress, Ofgem and BEIS jointly published their response and "plan."[3] Proposed actions include a formal classification and licensing system for storage which would avoid it being charged final consumption levies (such as the Renewables Obligation), and re-confirmation by Ofgem of storage-related network charging reforms. Government also intends to consult on common standards for smart home appliances to promote "interoperability." These and other changes clearly signal a paving the way for a smarter energy future.

Energy Efficiency

From an innovation point of view, statistics contained within the Scottish House Condition Survey highlighted the need to consider not only the applicability of technologies to certain building types, but also that household composition, occupant patterns, and the financial position of owners and occupants all stand to influence the likely take-up and potential impact of certain interventions.

The universal applicability of many of the technologies identified by the energy efficiency project team bodes well for Scotland and the opportunity for supply chain stimulation, job creation and economic impact potential.

This study was unable to identify any notable new materials that stand to offer a step change in the way fabric energy efficiency of existing building stock is insulated and improved. Instead, incremental enhancements are being observed across the board. For example, existing insulants have been subject to extensive continued research and development; improving their overall durability, robustness and moisture management properties. Higher capital cost solutions such as vacuum insulation panels, aerogel based boards and quilts and other ultra-thin insulants also continue to gain traction. It is suggested that the SEEP could be used to ensure correct insulants are specified for given applications, as opposed to focusing on supporting any one particular technology. This may be achieved through better funding of survey, specification and design stages or in helping to make things like thermal bridging analysis, moisture risk assessments and overheating risk analysis more mainstream.

The way that insulation materials are being used to form whole-system based solutions may also be of particular interest to the SEEP, for example, using off-site panel system manufacturing techniques to deliver "ready insulated" panels and cassettes to site. Similarly, internal wall insulation system providers are embedding well established insulants within systems that comprise of thermal bridge free studwork, vapour control layers and airtightness grommets and sealants. It is recommended that SEEP continues to encourage greater efficiencies in the way that building fabric insulation solutions are specified, installed, evaluated and maintained. For example, technologies such as 3D scanners, laser measuring devices and off-site assembly are increasingly being used to minimise waste and disruption whilst also reducing costs and speeding up the process of onsite installation.

Heat Generation

High temperature, hybrid and gas driven heat pumps all have the potential to increase the uptake of low carbon heating solutions in the UK in the short to medium term. High temperature heat pumps are particularly suited for off-gas grid retrofit projects, whereas hybrids and gas driven products are suited to on-gas grid properties. They may all be used

[2] https://www.gov.uk/government/consultations/call-for-evidence-a-smart-flexible-energy-system

[3] Ofgem, BEIS. July 2017. Upgrading our energy system. Smart systems and flexibility plan. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/631724/upgrading-our-energy-system.pdf

with no or limited upgrades to existing heating systems, and each offers some advantages (but also some disadvantages) compared with standard electric heat pumps. However, it is not yet clear that these advantages are sufficient to stimulate widespread uptake of the technologies.

High temperature heat pumps may remain a niche market in the short term. Their target market tends to be large, old, or listed properties (i.e. with high heat loss), often off the gas grid and with high domestic hot water demand. Hybrid heat pumps could be a competitive low-carbon transition technology, delivering the carbon saving benefits of an electric heat pump with the performance of a gas boiler when required. Gas heat pumps may help to overcome consumer inertia (as consumers are familiar with gas fired heating), however they are still very new in the domestic market and have a high initial capital cost. These heat pump technologies can deliver cost and carbon savings compared with a standard electric heat pump, particularly where expensive and disruptive upgrades to the heat distribution system would otherwise be required. However only gas driven products are likely to deliver a significant operational cost saving versus a new gas boiler.

In addition to heat pump technology a range of other technologies identified by this study are likely to present specific opportunities, most likely at smaller scale. District heating may continue to have a significant role to play – albeit more on 3rd and 4th generation systems than the large high temperature systems typical in other parts of Europe in the 1950s and 60s – due to lower heating requirements of modern retrofitted buildings. Longer term, the development of low carbon heating fuel markets may also present significant opportunity e.g. biogas, and possibly hydrogen.

Technical note: the scoring process

- Each criterion is given a 1-5 score against an agreed high / low scale.
- Between studies the technologies can differ substantially and some criteria may not apply – for example it is difficult to see how to assess the technical efficiency of a smart energy web-based platform. In cases like these 'not applicable' has been recorded instead of a score.
- Appropriate comments are also included in the scoring narrative to further help explain the basis of the scoring.
- Scores are generally of medium to high confidence. Where this isn't the case a narrative description for the individual assessment category is included.
- The quantitative scoring is useful for an 'at a glance' comparison of technologies, however investigation into the qualitative context is also advised before conclusions are drawn.