climateXchange

Scotland's centre of expertise connecting climate change research and policy

Incorporating climate change adaptation in housing policy delivery – lessons from three case studies

Michelagh O'Neill, Royal Botanic Gardens Edinburgh
March, 2018

1 Climate and non-climate drivers for housing policy

The Scottish Government's vision for housing and regeneration comprises four high level outcomes: a well-functioning housing system; that delivers high quality sustainable homes; that meet people's needs; and that supports sustainable communities. Climate change could threaten the delivery of these outcomes in the following ways:

- **More frequent intense rainfall, wind driven rain and high winds/storms** causing wind and water penetration damage to the fabric of buildings.
- **Warmer wetter winters** affecting internal humidity and the condition of the building and health of its occupants.
- **Hotter drier summers** causing problems for water quality and supply, and overheating.
- **An increase in extreme weather** and disruptive events such as flooding, droughts, landslides or heatwaves interrupting or limiting access to vital services and impacting on people's physical and mental health.
- **Sea level rise** affecting the viability of coastal communities and coastal infrastructure through flooding and erosion.

Part one of this report provides examples of how climate change adaptation can be part of and help address current and future challenges in meeting housing policy outcomes. These are supported by three case studies in part two.

1.1 Homes that meet people's needs

A well-functioning housing system that delivers sufficient homes to meet the needs of all Scotland's households

The number of households in Scotland is increasing due to population rise, and an increase in the number of smaller households and people living alone. These trends are projected to continue with most of the growth in older age groups (National Records of Scotland, 2017a, 2017b).

More homes are required to meet this demand over and above the replacement of older housing stock.

Incorporating climate change adaptation can ensure that:

- land allocation for housing is informed by current and future flood risk;
- new houses are designed and constructed using appropriate materials and weather detailing; and
- water is managed sustainably.

Case study one demonstrates how sustainable urban drainage (adaptation action) can unlock development sites as well as manage the water within them.

Case study two highlights how sustainable urban drainage and water conservation measures (adaptation actions) can also facilitate community capacity building.

1.2 High quality sustainable homes

All homes are warm and dry, resource efficient and in good repair to reduce inequality and fuel poverty.

The UK has the oldest housing stock in Europe and a very slow rate of housing replacement (Nicol et al, 2016). At current rates of demolition [c.4000 homes per year(Scottish Government, 2017b)], the vast majority of Scotland's current housing stock [2.58 million dwellings (National Records of Scotland, 2017a)] will continue to be in use by 2050.

48% of dwellings in Scotland have disrepair to critical elements[1], of which 28% are urgent[2] (Scottish Government, 2017a). The costs to the NHS for treating ill-health resulting from sub-standard housing have been estimated at £2.5 billion per year (Nicol, Roys and Garrett, 2015). This compares with the range of £2.3 billion to £3.3 billion quoted for the annual impact of smoking to the UK NHS (Scarborough et al, 2011).

Energy efficiency has been designated a national infrastructure priority by the Scottish Government (Scottish Government, 2015). 26.5% of Scotland's households are fuel poor (Scottish Government, 2017a). Fuel poverty is related to both income and energy costs. Energy costs vary depending on fuel type, the construction and condition of the property.

In addition to building more homes, there is a considerable role for retrofit of existing homes to make them more sustainable.

Incorporating climate change adaptation can ensure that:

- houses are built, repaired and upgraded using materials and techniques that are suitable for the current and future climate;
- house conditions are improved, including adequate insulation and ventilation to ensure that heating and cooling is affordable for all households;
- retrofit co-benefits are realised, for example by installing mitigation and adaptation measures together; and

[1] Disrepair to parts of a building central to its weather proofing, and/or its structural integrity

[2] If not addressed, would cause the fabric of the building to deteriorate further and/or place the health and safety of residents at risk.

- houses sit sustainably with their surroundings and are easily maintained.

Case study three shows how retrofitting micro-renewables and thermal storage (adaptation and mitigation actions) can reduce fuel poverty and keep homes warm and dry.

1.3 Sustainable communities

Our most disadvantaged communities are supported and all places are sustainable and promote well-being

Scotland has one of the lowest life expectancies at birth in Western Europe for both males and females. This includes an inequality gap of 10.5 years for males and 7.8 years for females in the 20 per cent most and least deprived areas across Scotland (National Records of Scotland, 2017c).

The 2016 Scottish Household Survey reports that 56.7% of adults view their neighbourhood as a very good place to live. The likelihood of holding this view increases with age and the proportion of all adults rating their neighbourhood as a very good place to live increases as deprivation decreases.

More than three-quarters (77 per cent) of all adults felt a very or fairly strong sense of belonging to their neighbourhood. Women, older people, white people, and those who are less deprived are most likely to hold this view.

Three quarters of adults in Scotland strongly agreed that they would assist neighbours in an emergency.

Placemaking that enhances quality of life is important to reduce inequality and ensure that all members of the community feel that they belong.

Incorporating climate change adaptation can ensure that:

- surface water is managed sustainably in ways that enhance the local environment;
- greenspace provides opportunity to be outdoors and enjoy a healthy and active lifestyle;
- communities are resilient and have adequate social capital to respond to extreme events;
- access to vital services is protected; and
- business, employment and education opportunities are realised.

Case study one supports place making and regeneration, by advocating multifunctional greenspace and surface water management (adaptation actions). Sustainable and resilient communities are supported through delivery of community and education facilities as a priority, and connectivity across city neighbourhoods and to the countryside are increased through new roads and active travel networks.

Case study two complements the first case study by supporting sustainable water management and green infrastructure (adaptation actions). It shows how to increase the local community's adaptive capacity (adaptation action) through engagement with householders and young people. Creation of guidance and advocacy (adaptation action) encourages others from the private sector to consider how local actions such as raingardens can help build and sell more homes.

Case study three illustrates how retrofitting existing buildings (adaptation action) supports innovation, employment and local businesses.

2 Three illustrative case studies

Each case study has been chosen to demonstrate in detail how climate change adaptation can be part of and help support housing policy outcomes.

1. Case study one sets out how a strategic and systematic approach to urban planning and supply of enabling infrastructure, in particular blue green infrastructure, can unlock opportunities for new home construction and development of sustainable communities.

   It is an approach motivated by the local authority's desire to regenerate and repopulate a neighbourhood through the creation of new homes and community facilities.

2. Case study two demonstrates how the gardens of new homes can deliver co-benefits for green infrastructure, biodiversity and storm water management; and act as a canvas to engage with developers, buyers and the local community.

   It is a partnership project motivated by a research need to understand how plot-level raingardens can contribute to sustainable drainage now and in the future, a commercial need to market new developments and understand how potential buyers will respond to the installed water management and water conservation measures, and a societal need to increase engagement with the impacts of climate change and sustainable water management.

3. Case study three shows how combining micro renewables and thermal storage can help combat fuel poverty and ensure that homes are warm and dry, and more resilient to power cuts.

   It is a partnership project motivated by a research and commercial need to understand how innovative technologies for low carbon heat can be used at scale, and a societal need to reduce inequality and ensure that all Scotland's households are able to afford to heat their homes.

Each case study is followed by its key messages for housing and adaptation policy.

3 Case study one (Whitfield)

3.1 Using blue green infrastructure to increase housing supply

The number of households in Scotland is rising, with a projected increase of around 345,000 in the period 2014-2039. Supply of housing must increase to meet this need.

Factors influencing housing supply include the availability of land for development through the planning system, and the supply of enabling infrastructure.

In urban areas, local authorities may favour the development of brownfield land to address housing shortages, regenerate the urban environment and invest in existing communities. However, developers can be discouraged from building on brownfield land because of uncertainty linked to costs and increased business risks. For example through a requirement to remediate disturbed or contaminated land, or overcome lack of capacity in existing community facilities such as schools, or drainage and road networks.

Dundee City Council have encouraged and incentivised use of brownfield land in its Whitfield neighbourhood by creating a Planning Framework, issuing design guidance and investing in strategic enabling infrastructure to provide clarity and minimise risk for developers.

3.2 Whitfield strategic urban regeneration

Whitfield, in the North of Dundee, is a residential area undergoing regeneration and repopulation. Plans include up to 900 new homes and supporting community infrastructure.

A historically deprived area, Whitfield underwent rapid development in the 1960s with prefabricated multi-storey blocks housing 12,500 people. The blocks were isolated from surrounding neighbourhoods and poorly constructed leading to social problems and a reluctance of people to settle there, with the population declining from the early 1980s to just under 4000 in 2006. The multi-storey blocks have now been demolished to make way for new lower density housing.

The 2011 Scottish census indicates that work completed so far is having a positive impact with more people moving into the area and the population is rising.

3.3 Whitfield Planning Framework

In 2006, Dundee City Council produced the first Whitfield Planning Framework to ensure that Whitfield is redeveloped sustainably and consistently through the sequenced implementation of proposed developments.

The Framework is the principal planning document for the area and sets out a number of design principles to ensure good placemaking and support sustainable communities. It is dynamic and regularly updated (most recently in 2015) to reflect the learning and progress that has been made to regenerate the area.

The Framework is supported by 4 site planning briefs, a neighbourhood masterplan and design guides for green infrastructure and sustainable urban drainage.

3.4 Infrastructure as an enabler of housing development

To accelerate development and encourage private sector investment, Dundee City Council invested around £20 million to deliver the enabling infrastructure necessary to support an enlarged community and new housing. This included a primary school; a new community building containing healthcare services, community facilities and extensive retail space; and regional sustainable urban drainage (SUDS).

Upfront investment in regional SUDS helps to maximise development opportunities. More homes can be built as the overall land required for drainage and the cost burden for developers is reduced.

Investment in community facilities helps support sustainable communities with capacity to react to extreme weather.

3.5 Green infrastructure and sustainable urban drainage

The green infrastructure and SUDS guides promote creation of comprehensive, connected blue green networks.

The green infrastructure guide supports the development of green infrastructure to promote healthy and active lifestyles across the neighbourhood. This includes green routes to encourage active travel, allotments for urban growing, and strategic tree planting for shade and cooling.

The sustainable urban drainage guide ensures water is managed sustainably now and in the future, with all SUDS infrastructure requiring an allowance in its design for climate change. The SUDS guide encourages a creative design based approach to ensure that SUDS infrastructure contributes to good place making, creating attractive and useable public open spaces through high quality design solutions that maximise visual amenity. Specifically it encourages developers to consider incorporating features such as basins, ponds and swales into existing green infrastructure as integral and attractive additions to the landscape.

3.6 Key messages from Whitfield for housing and adaptation policy

The approach taken at Whitfield is designed to encourage the sustainable development of as many new homes as possible, building on learning from past housing failures in the area and maximising co-benefits.

Many of the process and design principles set out at Whitfield can be followed in other areas.

- An overarching dynamic Framework ensures there is a consistent approach across the neighbourhood and that learning is incorporated as the area is developed.
- Public sector seed funding for enabling infrastructure can begin or accelerate regeneration, helping to fulfil the aspirations for an area and for housing policy overall.
- Regional SUDS allows multiple sites to be developed. More homes can be built because the overall land required for drainage and cost burden for developers is reduced providing economic incentive to build.
- Managing water sustainably and including green infrastructure are aspects of positive placemaking because they support sustainable and resilient communities.
- Placing blue green infrastructure at the heart of regeneration, makes it visible to the community, providing opportunities to educate and normalise adaptation.

4 Case study two (Greener Gardens)

4.1 Plot level adaptation

Gardens are an integral part of the green infrastructure resource of a housing development. The Greener Gardens project seeks to demonstrate how developers, home owners and the wider community can get more out of their gardens and realise co-benefits for managing surface water and increasing biodiversity to create good places and sustainable communities.

Increasing plot level drainage can also reduce the size of site level SUDS ponds, freeing up more land for housing.

4.2 Torrance Park show home

Taylor Wimpey worked with Abertay University, the Scottish Government, C&D Associates and the Central Scotland Green Network (CSGN) to introduce a number of plot level sustainable drainage measures at its Torrance Park show home in Holytown, North Lanarkshire. Measures installed include a natural rain garden, a raised rain garden, water butts and a 'SUDSBox'.

Taylor Wimpey is the first large volume housebuilders in Scotland to develop plot level raingardens at their show home for use in research, marketing and engagement activities.

4.2.1 Research

The show home demonstration site can be used for both civil engineering and social research. The former includes understanding how each of the different measures installed can help deal with storm water management in a sustainable way and the latter includes gauging the response of potential buyers to the measures at the show home. Taylor Wimpey has also stated a particular interest in using the demonstration site to gather *'insights into how the housing industry will adapt and plan for the challenges brought about by climate change'* (Scottish Housing News, 2016).

4.2.2 Engaging with buyers

The show home is used to promote the benefits of rain gardens to potential house buyers and create discussion about how planning and planting choices for their garden can have positive impacts for water use, flood risk and biodiversity. An information leaflet is also included within the homeowners pack.

The Scottish Government and CSGN also provided the first 80 new owners with a free 200 litre water butt to capture rainwater for reuse in their gardens and to remind them about the need to be more aware of their water use.

4.2.3 Engaging with young people

The project partners invited pupils from Holytown primary school to the launch of the show home to learn about sustainable water management. This initial engagement inspired the partners and teachers to work together to develop a STEM[3] learning package for primary 5 pupils. The package is aligned with the Curriculum for Excellence and enables pupils to learn and discuss raingardens, sustainable drainage, and the environment.

The collaboration has been so successful that in 2018 the primary school is installing its own raingarden within the school grounds, designed with the help of students and their parents.

Building on the success of working with one local school, North Lanarkshire Council has agreed to work with project partners to roll out the learning package across the local authority area. Funding has been secured to work directly with 7 more schools and the project team hope to eventually inspire every school in Scotland to install its own raingarden.

4.2.4 Engaging with developers

The Central Scotland Green Network Trust has published a 'Greener Gardens' guide for developers. It demonstrates how gardens can become an economical selling point within a development and gives practical tips on incorporating green infrastructure to deliver policy objectives on housing, sustainable drainage, place-making, and environmental impact. This has been endorsed by the Scottish Government and industry body Homes for Scotland, and complements the Scottish Government's own Green Infrastructure: Design and Placemaking Guidance.

4.3 Key messages from Greener Gardens for housing and adaption policy

Many of the philosophies and principles demonstrated by the project and the project partners are relevant to others:

- Connecting champions from different industries who support the same vision can be a powerful enabler of change; the initial willingness to experiment and explore at the Taylor Wimpey show home has spun out into a number of successful linked initiatives.
- The drainage and green infrastructure provisions advocated at Torrance Park help to support sustainable and resilient communities. The Greener Gardens Guide means that other developers can try similar things.
- Placing blue green infrastructure at the heart of the development makes it visible to the community, providing opportunities to educate. Over time this normalises adaptation. The

[3] Science, technology, engineering and maths

success of plot level adaptation requires buy-in from the homeowner as they will need to maintain the infrastructure.

- Young people and their teachers can be enthusiastic proponents of change; the enthusiasm of the primary school children, and the support of their teachers enabled a simple engagement activity to grow into a local authority scale initiative.
- Co-design, as demonstrated at the primary school, helps to create buy-in.

5 Case study three (EastHeat)

5.1 Addressing fuel poverty, carbon emissions and adaptation in social housing

Keeping homes warm/dry in winter is important for the health and comfort of the occupants and maintaining the building condition. Inadequate or unaffordable heating and fluctuating internal temperatures combined with warmer, wetter winters expected as a result of climate change may increase the internal humidity of homes. This exacerbates damage from condensation, insect or fungal attack.

53% of Scotland's energy is currently used to provide heating to buildings and industry, so heat demand is a significant contributor to Scotland's carbon emissions. Finding ways to reduce heat demand, store heat and adopt low carbon heat solutions will be important to reduce carbon emissions and alleviate fuel poverty.

Fuel poor households are more likely to report difficulties staying warm in winter. 26.5% of Scotland's households were reported as fuel poor in 2016. Fuel poverty is more common in the social sector than in the private sector, with 32% of households in the social sector experiencing fuel poverty.

The Energy Efficiency Standard for Social Housing (EESSH) was introduced in March 2014 to help reduce energy consumption, fuel poverty and the emission of greenhouse gases. By 2020 all social housing must meet a minimum standard for energy efficiency. Suggestions for landlords to help achieve this standard include routine practice such as improving insulation, and upgrading boilers. However, these solutions are unlikely to be sufficient on their own, and there is also provision for use of innovative solutions, including new technology to help meet the standard. This innovation provides the opportunity for new pathways to climate change adaptation explored here.

This case study will set out how adapting home energy systems by linking micro renewables and heat storage can help keep houses warm and dry, alleviate fuel poverty, reduce carbon emissions, and ensure homes are more resilient to a changing climate.

5.2 The EastHeat project

The EastHeat project was delivered in partnership by Sunamp, Edison Energy, East Lothian Housing Association and Castlerock Edinvar. The c. £10 million project was funded by the Local Energy Challenge Fund and a private investor. At the time of completion in 2016, it was the UK's largest domestic energy storage project.

The primary motivations for the project were to increase residents' comfort and tackle fuel poverty by providing low cost heating and hot water. 83% of tenants questioned as part of the project were in fuel poverty.

Heat storage and micro-renewables were installed or retrofitted across a range of property and fuel types, including sheltered housing for older people and individual housing for social rent.

The project was delivered in phases so that lessons learned could be incorporated into the next phase. A systematic design approach looked at the combined energy source + heating source + heat storage source, but allowing for variation in the solution to match the needs of the property.

Around 1000 housing association tenants across the Lothians and Falkirk benefitted from the project with reductions in utility bills of 10-60% after 18 months of monitoring.

5.2.1 Co-benefits

Whilst primarily motivated to reduce fuel poverty for tenants, the EastHeat project also had a number of co-benefits:

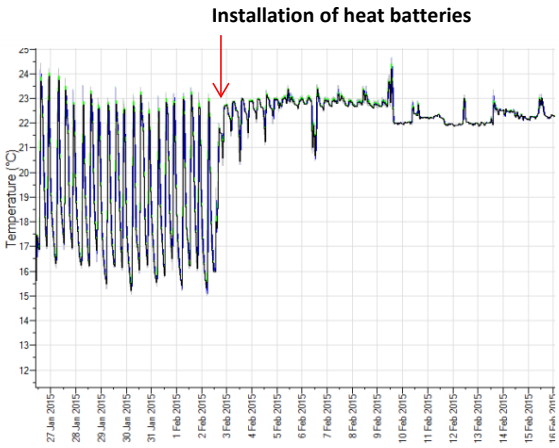
Creating resilience during power cuts

There is expected to be an increase in extreme high winds and storms due to climate change. Local energy systems including micro renewables and heat storage can help improve resilience because the heat batteries are able to provide continued heating for tenants during power cuts.

Protecting the health of the building and its occupants

Affordable heating (combined with adequate insulation and draught proofing) helps to avoid large variations in internal humidity, protecting the health of the occupants and building condition from condensation and mould.

Fluctuations in temperature can be particularly apparent in homes where electricity is the main fuel with dual meter tariffs encouraging energy use at off-peak times.



In one of the EastHeat sample properties, the existing Economy 7 tariff is used to heat the apartment and charge the battery during cheaper off-peak time, with the battery providing heating and hot water during peak-time. This approach reduced energy use and significantly improved comfort; in particular, by maintaining a constant temperature rather than the temperature oscillating in response to tariff periods.

The graph (from Sunamp's monitoring) shows temperature fluctuations before and after the installation of the heat batteries.

Helping meet the Energy Efficiency Standard for Social Housing

Across Scotland, there has been significant investment to improve insulation and energy efficiency of homes using different schemes. As a result, many of the properties targeted through EastHeat were already well insulated.

Where 'quick win' insulation and energy efficiency improvements have already largely been achieved, further improvement towards the EESSH can only be made by considering how energy is produced and used.

The EastHeat project demonstrated the value of integrating renewable energy solutions and heat storage in addition to improved insulation, to provide an innovative contribution towards compliance with EESSH.

Reducing carbon emissions

Teamed with solar PV, heat batteries reduce carbon emissions by allowing more of the energy produced to be used in the home, rather than exported to the grid. The heat battery creates a direct link between local energy demand and local renewable energy production.

Testing of locally manufactured, innovative technology at large scale

At the peak of the EastHeat project, 50 people were employed in R&D, manufacturing and installation. The project proved that heat storage technology can be used in a range of different housing types and configurations.

The Sunamp heat batteries are developed, designed and manufactured in Scotland and there are plans for a new factory in East Lothian to support demand.

5.3 Key messages from EastHeat for housing and adaptation policy

The EastHeat project helped to deliver warm and dry, resource efficient homes, with a range of co-benefits that added value to the project. Lessons that can be drawn out to inform future retrofit, energy, and other adaptation type. projects include:

- Retrofit of existing housing at scale is achievable.
- It is possible to take the same overall approach to retrofit but tweak the local solution to suit the circumstances/ housing type.
- Installing micro-renewables and heat storage built on the fabric improvements already carried out, however a joined up approach could allow the more efficient retrofit of multiple elements in one visit.
- Adaptation can be delivered as a co-benefit of other interventions. Making 'hidden' adaptation like EastHeat explicit could help raise awareness of adaptation.
- Retrofit of renewable heat will be required to meet Scottish Government targets for low/ zero carbon homes and emissions reduction; retrofit of adaptation measures could take place at the same time.
- Householders who use electric heating are more likely to report that their heating does not keep them warm enough in the winter compared to other fuel types. Levels of fuel poverty among households using electricity as their main heating fuel is consistently high at around 51%. There is therefore considerable opportunity for heat storage and other innovative solutions for homes with electric heating.

6 References

National Records of Scotland (2017a). *Estimates of Households and Dwellings in Scotland, 2016*. National Statistics, Edinburgh

National Records of Scotland (2017b). *Households Projections for Scotland, 2014-based*. National Statistics, Edinburgh

National Records of Scotland (2017c). *Life expectancy for areas within Scotland 2014-2016.* National Statistics, Edinburgh

Nicol S., Roys M., and Garrett H. (2015). *The cost of poor housing to the NHS*. IHS BRE Press, Bracknell.

Nicol, S., Roys, M., Ormandy, D., Ezratty, V. (2016). *The cost of poor housing in the European Union*. IHS BRE Press, Bracknell.

Scarborough P., Bhatnagar P., Wickramasinghe KK., Allender S., Foster C., Rayner M. *The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006/07 NHS costs*. Journal of Public Health, May 11, 2011.

Scottish Government (2015). *Infrastructure Investment Plan*. Scottish Government, Edinburgh

Scottish Government (2017a). *Scottish House Condition Survey: 2016 Key Findings*. National Statistics, Edinburgh

Scottish Household Survey (2017). *Scotland's People Annual Report | 2016.* National Statistics, Edinburgh

Scottish Government (2017b) *Housing Statistics for Scotland: Annual Key Trends (Demolitions 1990-2017).* National Statistics, Edinburgh

Scottish Housing News (2016). Greener gardens project aims to grow in North Lanarkshire [online] Available at: http://www.scottishhousingnews.com/12504/greener-gardens-project-aims-to-grow-in-north-lanarkshire/ [Accessed 17 Mar. 2018].

7 Bibliography

7.1.1 Scottish Housing policy

Gov.scot (2018). *Housing and Regeneration Framework.* [online] Available at: http://www.gov.scot/About/Performance/scotPerforms/partnerstories/HARO

Joint Housing Delivery Group (2015). *Joint Housing Delivery Plan for Scotland.* Scottish Government, Edinburgh

Scottish Government (2011). *Homes Fit for the 21st Century.* Scottish Government, Edinburgh

Scottish Government (2013). *Scotland's Sustainable Housing Strategy.* Scottish Government, Edinburgh

7.1.2 Case study one (Whitfield regneration)

Dundeecity.gov.uk (2015). *Whitfield Planning Framework*. [online] Available at: https://www.dundeecity.gov.uk/sites/default/files/publications/CD_Whitfield_Planning_FrameworkAug15.pdf [Accessed 21 Mar. 2018].

Dundeecity.gov.uk (2016). *Whitfield Green Infrastructure Guide.* [online] Available at: https://www.dundeecity.gov.uk/sites/default/files/publications/CD_Whitfield_Green_Infrastructure_2016.pdf [Accessed 21 Mar. 2018].

Dundeecity.gov.uk (2016). *Whitfield Sustainable Urban Drainage Guide*. [online] Available at: https://www.dundeecity.gov.uk/sites/default/files/publications/SUDS%20Guidance%20Feb%202017%20optimised.pdf [Accessed 21 Mar. 2018].

Dundeecity.gov.uk. (2018). *Whitfield Regeneration Area | Dundee City Council*. [online] Available at: https://www.dundeecity.gov.uk/service-area/city-development/planning-and-economic-development/development-plans-and-regeneration/whitfield-regeneration-area [Accessed 21 Mar. 2018].

7.1.3 Case study two (Greener Gardens)

Abertay.ac.uk. (2017). *Abertay takes on rain garden project*. [online] Available at: https://www.abertay.ac.uk/news/2017/abertay-takes-on-rain-garden-project [Accessed 21 Mar. 2018].

Central Scotland Green Network, (2016). *Greener Gardens: An Introduction to Raingardens for Developers | green infrastructure, design and placemaking.* Central Scotland Green Network Trust, Shotts.

Scottish Government (2011). *Green Infrastructure : Design and Placemaking*. Scottish Government, Edinburgh.

Taylorwimpey.co.uk. (2018). *Torrance Park - New Homes in Holytown, Motherwell | Taylor Wimpey.* [online] Available at: https://www.taylorwimpey.co.uk/find-your-home/scotland/north-lanarkshire/motherwell/torrance-park [Accessed 21 Mar. 2018].

Travers, J. (2018). *Holytown Primary Raingarden.* In: Sniffer Flood Risk Management Conference, 2018. 6 February 2018, Glasgow. Available at: https://www.sniffer.org.uk/Handlers/Download.ashx?IDMF=24c1f284-00c3-4975-8385-59261341e5af [Accessed 21 Mar. 2018].

7.1.4 Case study three (EastHeat)

Bissell, A. (2018). *Optimising Electrical Systems via Smart Heat Batteries*. In: Energy Storage & Connected Systems event, 7 February 2018, London. Available at: https://www.sunamp.com/wp-content/uploads/2018/03/Sunamp-Optimising-Electrical-Systems-via-Smart-Heat-Batteries-PUBLIC.pdf [Accessed 21 Mar. 2018].

Bissell, A. (2018). *Social fuel poverty impacts and the role that new technology might play.* In: Cross Party Group in the Scottish Parliament on Renewable Energy and Energy Efficiency.11 January 2018, Edinburgh. Available at: https://heatandthecity.org.uk/wp-content/uploads/2018/01/A_Bissell_Sunamp_SPREEE-Heat2018.pdf [Accessed 21. Mar. 2018].

Pisanek, J. and Conway, J. (2016). *Installing PV from design to delivery – EastHEAT case study*. In: Developing solar PV projects. 20 April 2016, Edinburgh [online] Available at: http://www.apse.org.uk/apse/assets/File/John%20Conway%2C%20Edison%20Energy%20%26%20Joan%20Pisanek%2C%20Sunamp.pdf [Accessed 21 Mar. 2018].

Ricardo Energy & Environment (2016). *The Energy of Scotland: Heating, moving and powering our lives from now to 2030*. WWF Scotland, Edinburgh

Scottish Government (2015). *Heat Policy Statement Towards Decarbonising Heat: Maximising the Opportunities for Scotland*. Scottish Government, Edinburgh

©Published by Royal Botanic Gardens Edinburgh 2018 on behalf of ClimateXChange

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publishers. While every effort is made to ensure that the information given here is accurate, no legal responsibility is accepted for any errors, omissions or misleading statements. The views expressed in this paper represent those of the author(s) and do not necessarily represent those of the host institutions or funders.