Stirling & Clackmannanshire City Region Deal

Regional Energy Masterplan

December 2023

StirClacksDeal.com

Contents

UNIVERSITY OF STIRLING

Clackmannanshire Council

Stirling Council

UK Government

Scottish Government
Riaghaltas na h-Alba
gov.scot

Foreword

Councillor Chris Kane
Stirling Council Leader

Stirling Council recognised and declared a Climate and Nature Emergency in October 2019.

Subsequently, our Climate and Nature Emergency Plan was developed with a view to reaching our net-zero aspirations by 2045.

It identified five key areas for action and this Regional Energy Masterplan outlines our aims in one of those important fields - energy use and generation.

The Regional Energy Masterplan has been developed as a joint City Region Deal project between Stirling and Clackmannanshire Councils.

We want to transform our energy systems and tackle fuel poverty by facilitating the provision of/helping to provide low carbon, low cost energy for residents and businesses within the Council areas. This has never been more important at a time when energy costs have been rising sharply.

We are also extremely ambitious in our desire to create employment in the net-zero energy sector, as well as aiding the just transition from fossil fuels.

This document outlines the steps required to create a net-zero energy system across Stirling and Clackmannanshire within that 2045 timescale, with projects being delivered in five-year phases.

Delivery of this plan will require action from a range of teams within the Councils, public sector, third sector, private organisations and, of course, residents and visitors to the area.

We need everyone, working together, to inspire the change required to tackle the climate emergency – and achieve affordable energy for everyone in our region.

Chris Kane

Councillor Ellen Forson
Clackmannanshire Council Leader

Recognising that climate change is one of the defining issues of our time, Clackmannanshire Council unanimously declared a climate emergency in August 2021.

We are committed to achieving net zero by 2045 and the Stirling and Clackmannanshire Regional Energy Master Plan will play a key part in these aspirations.

We consider that switching our reliance on fossil fuels to renewable energy sources that produce lower or no greenhouse gas emissions is critically important in tackling the climate crisis and this plan provides an investment focused framework for the promotion and development of the region's rich renewable energy resources which will assist us to achieve this goal.

Investing in renewable energy not only meets our climate change goals, but it is also a sustainable way to grow the economy, while creating new job opportunities and improving people's health and wellbeing.

The Regional Energy Master Plan also provides further opportunities to enhance local skills and knowledge as well as improving transport and infrastructure sustainability.

Working in collaboration with local business, investors and the community as a whole, we will foster a culture of innovation, research and development which will identify Clackmannanshire as a leader in renewable energy and an innovator in tackling climate change which will be crucial to delivering Scotland's first zero carbon region here in Forth Valley.

1 Introduction

1.1 Plan on a Page

What is the Regional Energy Masterplan?

This document outlines the steps required to reach a net-zero energy system across Stirling and Clackmannanshire, with specific objectives and outcomes set out, and key performance indicators (KPIs) to monitor progress identified.

Why do we Need to Take Action?

Energy used to heat and power the region's domestic and non-domestic buildings currently causes around 373 ktCO2e. Emissions from industrial processes, farming and transport bring the region's total carbon emissions to around 823 ktCO2e, see Figure 1. Without action to reduce this, extreme weather, sea level rise and wildlife loss will continue. Whereas we have the opportunity to reduce fuel poverty, increase well-being, and create new businesses and jobs across the region.

A Clear Vision

Stirling and Clackmannanshire lead the just transition to a fossil fuel-free, climate-ready area by 2045. This transition improves our residents' lives, helps the region's economy to thrive, and improves nature.

The REM (Regional Energy Masterplan) will outline the steps required to transform our energy systems and help deliver zero-carbon, affordable energy for all. This plan primarily focusses on the emissions from the energy use of buildings, but includes actions that will help to reduce the emissions from other sectors as well.

Region Wide Projected Emissions Breakdown

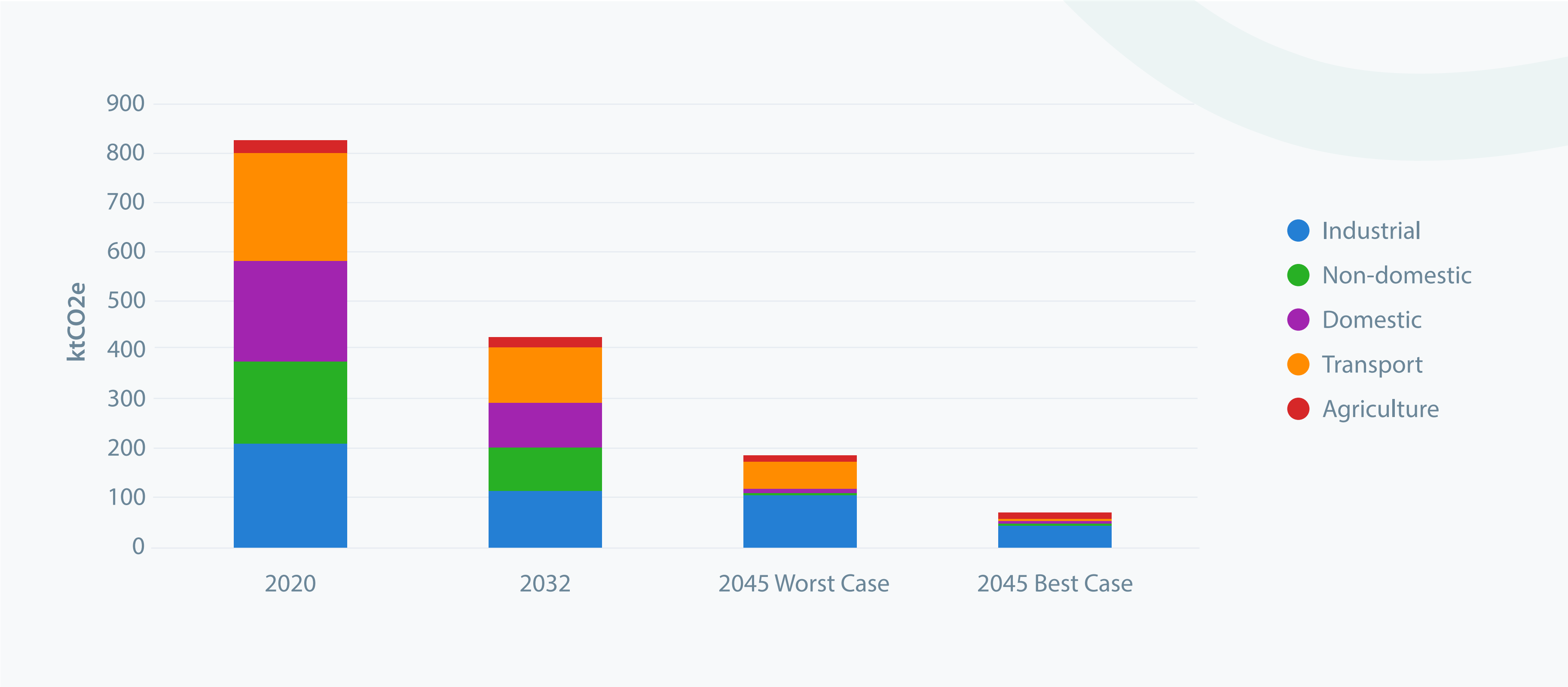


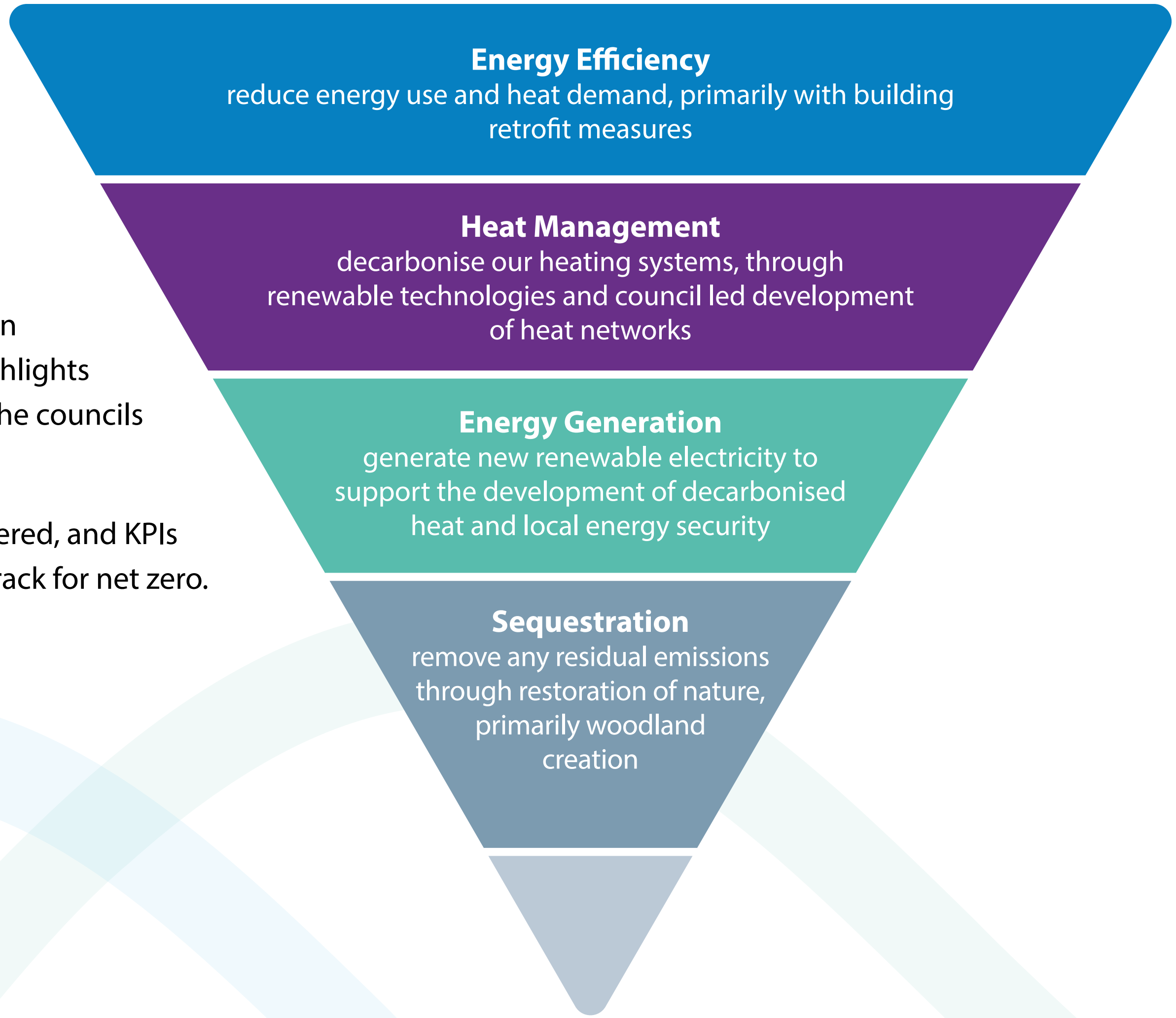
Figure 1: *Region wide projected emissions breakdown across all sectors*

Delivered through 5 objectives, the route to net zero is laid out in line with the energy hierarchy through 4 work-streams:

Urgent Action Required

Actions from each of the work-streams have been prioritised into a phased delivery plan which highlights the timescales and urgent steps to be taken by the councils to address the climate emergency.

A governance board will ensure the plan is delivered, and KPIs will be monitored and reviewed, to keep us on track for net zero.



1.2 Climate Change in Stirling and Clackmannanshire

Climate Emergency

Dependency on the use of fossil fuels to create energy has led to increased levels of carbon dioxide and other greenhouse gases in the air, with global levels increasing year on year accelerating the warming of the atmosphere. This temperature increase is causing extreme weather events such as drought, flooding, strong winds and rising sea levels, while also posing a severe threat to food security.

In 2019, the Scottish Government declared a climate emergency, following reports from the Intergovernmental Panel for Climate Change stating that action must be taken now to significantly reduce carbon emissions in order to avoid extreme weather events, crop failures, sea level rise and wildlife loss. They legislated the Climate Change Act (2019)[1] and updated the targets in their Climate Change Plan (2020)[2] to ensure that Scotland's contribution to climate change will end within a generation, being fully net-zero by 2045 with emissions reducing by 75% by 2030 (compared to a 1990 baseline).

[1] Climate Change (Emissions Reduction Targets) (Scotland) Act 2019.
[2] Securing a green recovery on a path to net-zero: climate change plan 2018–2032 – update.

Our Local Response

Both Stirling and Clackmannanshire councils have also declared a climate emergency, with Stirling council publishing a Climate and Nature Emergency Plan, and Clackmannanshire council's equivalent plan currently under public consultation. These plans outline how to address the climate emergency, with the production of subsidiary plans as a key action. This masterplan represents one such plan.

By 2045, both Stirling and Clackmannanshire council areas will need to have eliminated the use of fossil fuels in meeting energy demand. To reach this net zero society, there will need to be drastic changes in how our buildings are provided with heat and electricity, with behaviour change and direct actions required by everyone (home occupiers, business, industry, and local and national governments etc.). In order to demonstrate leadership and inspire others, Stirling Council has a corporate net-zero emissions target of 2035, and Clackmannanshire Council have a corporate net-zero target of 2040. To avoid the impacts of climate change worsening urgent action must be taken to deliver these changes.

Climate Plans

The diagram below provides an overview of the subsidiary areas addressed by both local authorities' climate plans, what their respective policies cover and how these tie in to the REM. Note, some of the stated policy is in development.

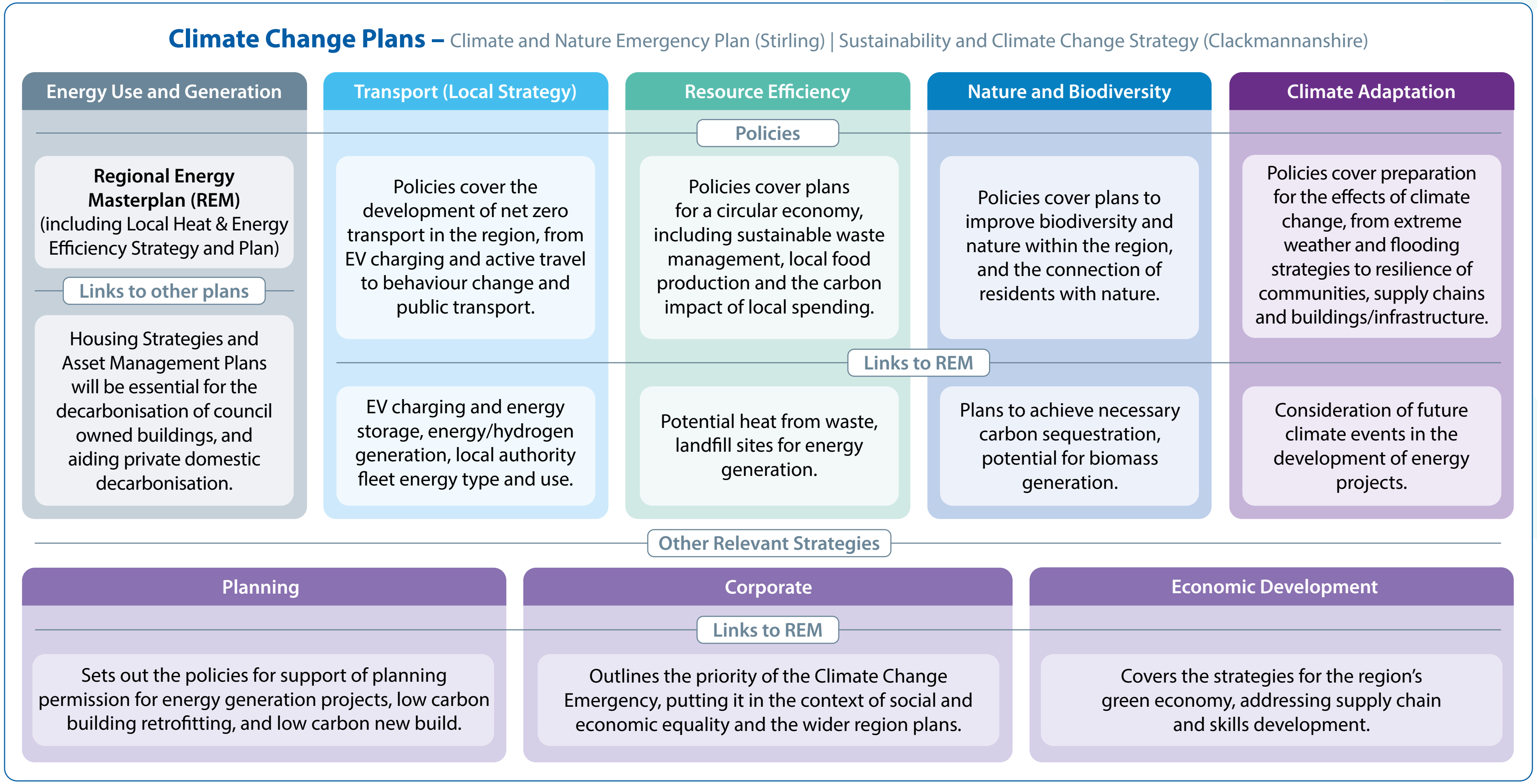


Figure 2: *REM link to Climate Change Plans and other relevant strategies*

Developing the REM

This REM focusses on how to address emissions due to energy use across both councils. It outlines the steps that are required for the region to achieve a net-zero energy system, as well as any potential risks and barriers that currently exist. The transition required faces several major challenges, but will provide opportunities to reduce fuel poverty, increase the security and resilience of local energy supply, increase well-being, and create new businesses, jobs and skills across the region.

Funding to develop this plan was provided via the Stirling and Clackmannanshire City Region Deal. More recently, a statutory order which mandates councils to develop a Local Heat and Energy Efficiency Strategy (LHEES)[3] and Delivery Plan has been enacted. On-going funding for this is currently provided by Scottish Government. This document is intended to satisfy both council's requirements as a response to the climate emergency, as well as the LHEES Statutory Order*[1].

[3] See Appendix VIII on policies and Appendix XI on LHEES

1.3 Stakeholder Engagement – We're Listening

Context

As part of the Regional Energy Masterplan, a thorough stakeholder engagement process was carried out, led by Ricardo Energy. Key stakeholders were identified and contacted for consultation on the objectives and KPIs within the masterplan, as well as their opinions on any assumptions in the modelling work. This builds on the extensive engagement and consultation undertaken throughout the development of the Climate and Nature Emergency Plan.

They included domestic, non-domestic, public sector and third sector, and individual large-scale energy users.

From a number of workshops and individual sessions, the biggest challenges and barriers for decarbonising energy use were identified, along with an understanding of big energy users' decarbonisation plans and expertise in their own fields.

The consultation process fed into the actions outlined for both councils, and enabled us to shape the document in preparation for full public consultation.

Ongoing

Engagement with all stakeholders will continue on to 2045. There will be ongoing communication with communities, which will tie into awareness raising work. Engaging communities in the steps for the route to net zero and meeting with community councils will be essential. This will highlight specific relevant local zone information and data.

Where any projects are proposed and zones identified, all relevant stakeholders will be engaged as part of the project development process. Initial discussions around early stage projects listed in this document such as energy generation and district heat networks have been undertaken.

Both councils remain open to feedback and discussion at any time, with email inboxes available. Clackmannanshire Council holds regular Climate Change Forums, and produces a newsletter.

Summary of Key Outputs

A high level summary of the key themes raised from the Stakeholder Engagement is shown in the following graphics; Figures 3, 4 and 5. For a more detailed information from the engagement sessions, consult Appendix II.

Figure 3 opposite shows a summary of the key themes that arose from the workshop sessions with representatives from the domestic, non-domestic, public and third sectors.

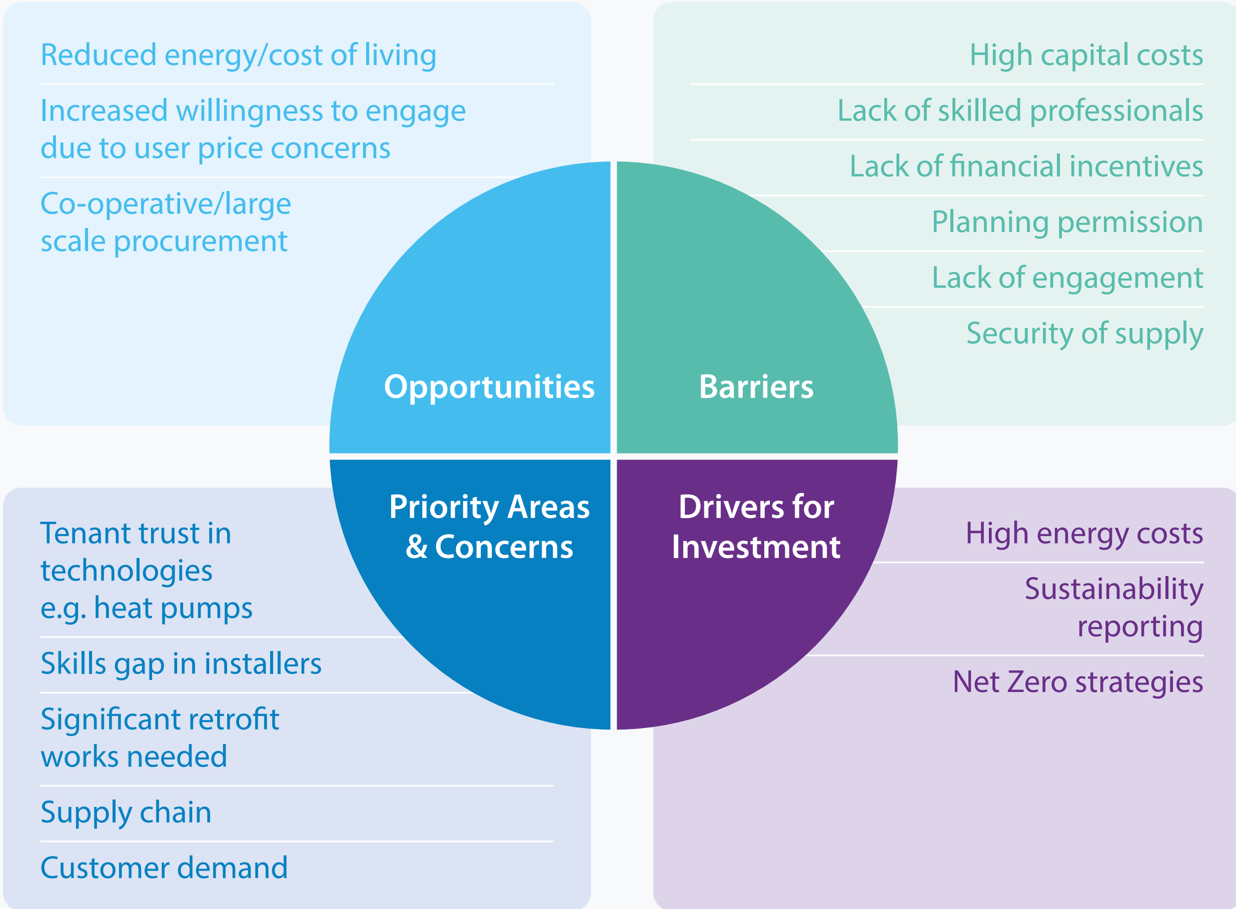


Figure 3: *Key themes arising from stakeholder engagement sessions*

Figure 4 below outlines a summary the key themes and issues that were raised during the one to one interviews hosted with the largest energy consumers in the region.

Strategy

All stakeholders expressed intentions to decarbonise in someway in the future, this is mainly driven by:

- Increasing energy costs.
- End user/customer pressure.
- Own company goals and targets.

Barriers

Most stakeholders have experienced barriers while implementing decarbonisation technology:

- Planning.
- Readiness of technologies such as hydrogen: equipment suppliers and local infrastructure.
- Grid connection – impacts of scale or timeline for connection.
- High cost of investment and payback.

Opportunities

Stakeholders where knowledgeable about the opportunities to replace their equipment with low carbon technologies:

- Generation such as Solar PV.
- Anaerobic Digestion for biogas production for high grade heat.
- Hydrogen for process heat.
- Electrification of heat and transport.
- Provide waste heat to heat networks.

Priority Areas

Decarbonisation of heat is a priority.

Opportunity for a forum for high energy users in the area to allow collaboration and therefore:

- Align timescales for decisions.
- Identify opportunities to share investment & risk.
- Accelerate project development.

Figure 4: *Key themes and issues arising from one to one stakeholder interviews*

Figure 5 below highlights some key quotes from the one to one interviews, covering the common themes that were raised shown in Figure 2.

"Grid constraints can delay projects or sometimes increase cost of investment"	*"Power has become more expensive – making investment decisions is difficult in a volatile market"*	*"Some organisations have earlier net zero target dates than national targets (e.g. 2040) requiring earlier decisions"*

"There are opportunities to reduce risk by collaborating with other parties on investments"	*"End users are very focused on decarbonisation and energy efficiency"*

"A number of current production and industrial process rely on combustion to enable the high temperatures required for production – the ability of hydrogen to replace natural gas in the process is not fully understood"

Figure 5: *Quotes from one to one interviews*

Distribution Network Operators

As well as large energy users, one to one interviews were also carried out with the Distribution Network Operators (DNOs) that supply electricity to buildings in the region, Scottish Power Energy Networks (SPEN), and Scottish and Southern Electricity Networks (SSEN). These two stakeholders were key as they are responsible for grid improvements that may be required for projects such as heat electrification or renewable generation.

Throughout the implementation of the Regional Energy Masterplan, communication will be ongoing with DNOs to ensure they are aware of all key projects and any work or actions that will be required on their end. As other key projects regarding demand or generation of electricity are identified and planned, either by the local authorities or private business, it is crucial that they are communicated to the relevant DNO as soon as possible so that they can account for it in their planning strategy.

For further details on the engagement sessions with the DNOs, consult Appendix II.

Just Transition

It is important that all actions taken to achieve net-zero and deliver a net zero carbon economy do not exacerbate inequality. Those who can least afford the required actions must not be disproportionally affected, and heat decarbonisation must not exacerbate fuel poverty. A key barrier raised in the stakeholder engagement, particularly for homeowners and SMEs was the investment required to implement low carbon solutions. It is crucial that all individuals and businesses are made aware of funding and support available to help them transition their energy use to net-zero. Adequate funding must be made available for those who cannot afford the required measures.

Skills Gap and Supply Chain

Another key barrier raised in the stakeholder engagement sessions regarded the current skills gap and supply chain limitations for several key low carbon technologies. For many low carbon solutions, such as insulation or heat pumps, there is currently a lack of skilled and trusted installers available to undertake works at the rate required per year to achieve local and national targets. Action must be taken to ensure that enough installers of low carbon technologies are being trained and accredited to reliably transition our buildings to net zero.

1.4 Current Position

Figure 7 shows a snapshot of the region's current energy demands across all sectors and demonstrates how different fuels and sources are used to meet them. This Regional Energy Masterplan focusses primarily on how to decarbonise energy use in buildings, with transport covered by other council policies (see Appendix VIII – Policies).

The energy supply breakdown for building heat demand was taken from the digital twin model (see Appendix I and Section 3), the energy breakdown for transport and industry was taken from the UK Government's Department for Energy Security and Net Zero's subnational total final energy consumption data.

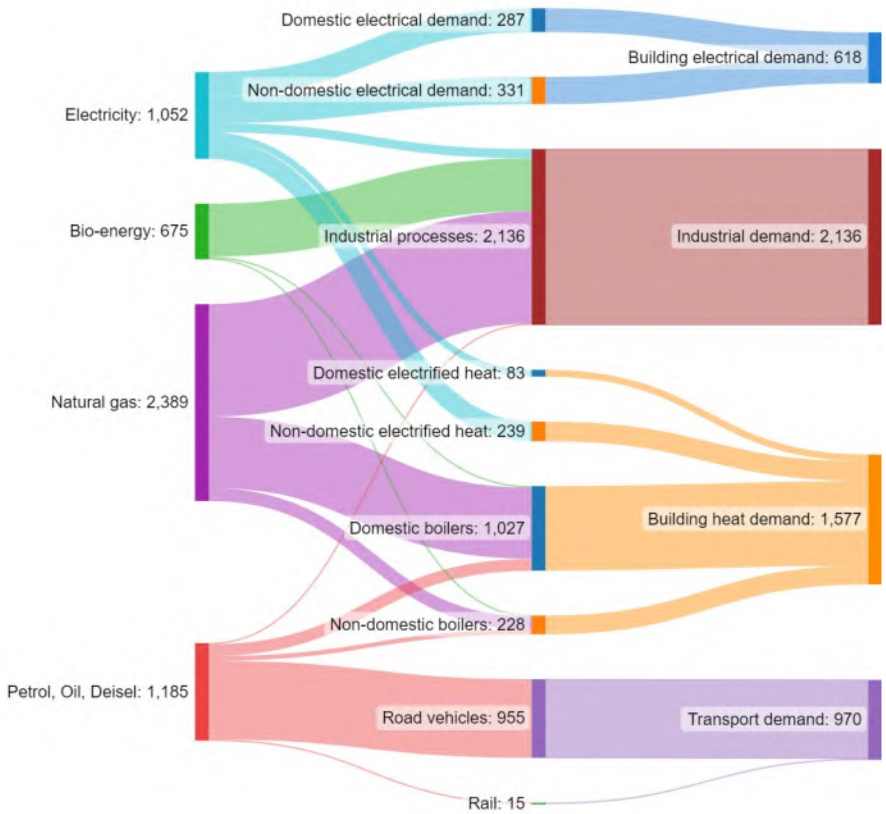


Figure 7: *Sankey diagram of region's current energy use across all sectors*

Figure 6 below shows the current carbon emissions that are emitted due to the energy use of the region's domestic and non-domestic buildings, that this plan aims to de-carbonise. The expected emissions reduction resulting from the implemented actions in each of the three key work streams is shown for each 5-year time phase. The remaining residual carbon in 2045 will be addressed through sequestration (see Section 4.4).

Projected Regional Building Carbon Emission Reductions

Figure 6: *Projected carbon emissions from buildings' energy use across the region*

2

What We Must Achieve

2.1 Objectives & Outcomes

To fully decarbonise the energy use across the region and achieve a just transition to a net-zero economy, the following five overarching objectives were defined:

- **Objective 1:** Continue to reduce demand for energy and strive to remove energy waste.
- **Objective 2:** Maximise energy efficiency in our homes and buildings.
- **Objective 3:** Deliver a zero-carbon energy system for heating, power and transport while matching local demand with local supply, and contributing to national net zero generation.
- **Objective 4:** Provide a resilient and secure energy supply.
- **Objective 5:** Eliminate fuel poverty through improved energy efficiency and the provision of low cost, low carbon energy.

Reaching each of these objectives across the region should enable the following outcomes to be achieved:

- **Outcome 1:** People living in the region have access to warm, energy efficient housing supplied by clean affordable energy, with no risk of fuel poverty.
- **Outcome 2:** The costs of this transition have been fairly distributed, and vulnerable and low-income households have not been disproportionally affected.
- **Outcome 3:** Energy resilience and security of supply have been improved through minimised requirement for imported fuel in the region and reduced system vulnerability to extreme weather events and rising temperatures.
- **Outcome 4:** Local communities have utilised their energy generation potential, and community owned energy assets have created and sustained local jobs, and increased local energy security and affordability.
- **Outcome 5:** Meaningful, sustainable jobs have been created in the energy economy of the region, underpinned by a local trained, skilled and diverse workforce.

- **Outcome 6:** The restoration of nature and biodiversity have been supported, with any potential negative impacts carefully managed or avoided.
- **Outcome 7:** Local greenhouse gas emissions have been removed from our communities, and health outcomes have been improved, including both indoor and outdoor air quality.

To ensure that each of these objectives and desired outcomes are met over the coming years, specific targets and KPIs were identified. These are outlined in Section 2.2.

2.2 Targets & Key Performance Indicators (KPIs)

These targets will allow both councils to track progress and ensure that they are on course for reaching net-zero energy use by 2045. This will enable each of the outcomes to come to fruition. Wherever possible the region must strive to drive forward works ahead of these target deadlines.

The actions required to meet these KPIs are outlined in Section 4.

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 1: % reduction in total carbon emissions from energy use	75% by 2030[4] (327ktCO2e)	Net zero[4]	1309 ktCO2e in 2005	**Objectives:** 3,5 **Outcomes:** 1, 3, 4, 6, 7 **Actions Required Sections:** 4.1, 4.2, 4.3, 4.4

Current Position

2030 Target:

In order to meet this, decarbonisation and/or sequestration above and beyond all KPIs will be required, as current predictions show a ~68% reduction if all interim KPIs are met.

2045 Target:

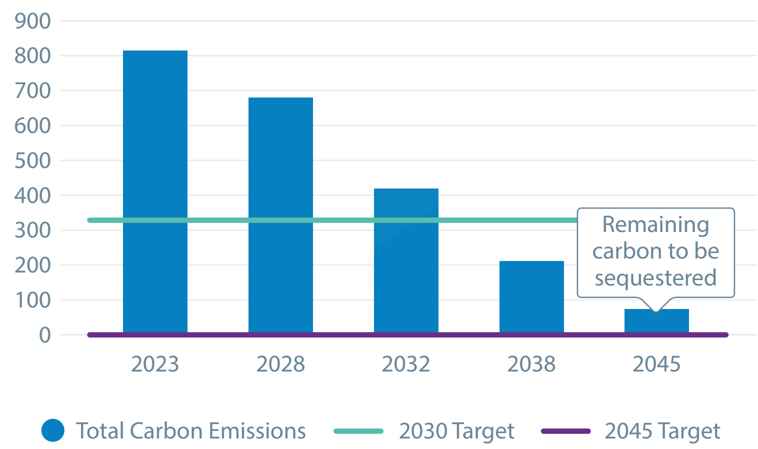
Best case scenario predicts that ~67 ktCO2e will need to be sequestered.

Worst case scenario predicts that ~180 ktCO2e will need to be sequestered, if targets outside of councils' direct control are missed (e.g. energy use by private homeowners/ industry)

Sequestration can take the form of tree-planting or reclamation of peatland, see Section 4.4.

Projections here are taken from digital twin scenario modelling of expected/assumed actions and interventions outlined in REM.

Total Regional Carbon Emissions (ktCO2e)



[4] Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, see Appendix VIII

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 2: % reduction in region residential heat demand	15% by 2032[5] (998 GWh)	25% (880 GWh)	1174 GWh in 2015	**Objectives:** 1, 2, 5 **Outcomes:** 1, 3, 5, 7 **Actions Required Sections:** 4.1

Current Position

National performance: +3.26%, our performance: -20.2% (2015-2021)

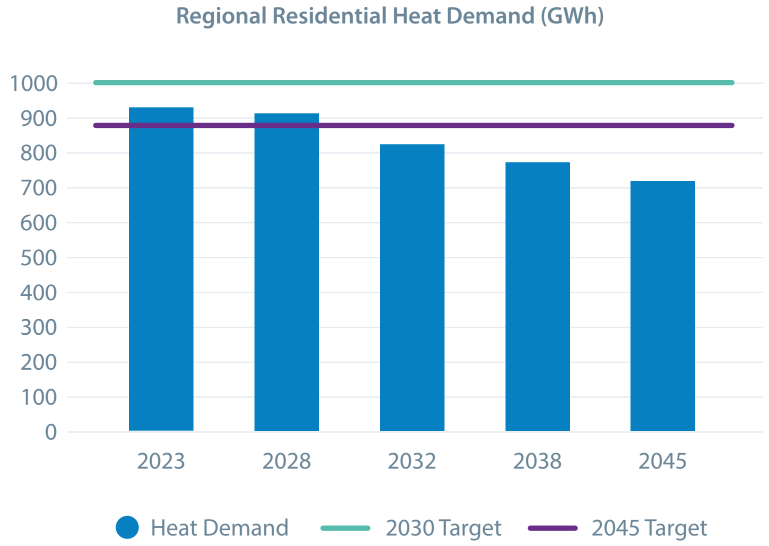
2032 Target:

Following the setting of these targets in 2018, the energy model predicts that this interim target has already been met. Expected heat demand reductions from works to improve EPC (Energy Performance Certificate) ratings are anticipated to reduce this further.

2045 Target:

This 25% reduction target should be met early in 2032, from the expected fabric improvements and other energy efficiency measures expected to be implemented by then to reach the interim EPC rating target.

Projections here are taken from digital twin scenario modelling of expected/assumed actions and interventions outlined in REM.



[5] Climate Change Plan: third report on proposals and policies 2018-2032

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 3: % households in fuel poverty	Less than 15% by 2030[6] (less than 10,206 homes)	Less than 55% by 2040[6] (less than 3,402 homes)	21% in 2019	**Objectives:** 5 **Outcomes:** 1, 2, 4 **Actions Required Sections:** 4.1, 4.3

Current Position

National performance: 24.6%, our performance: 21% (2019)

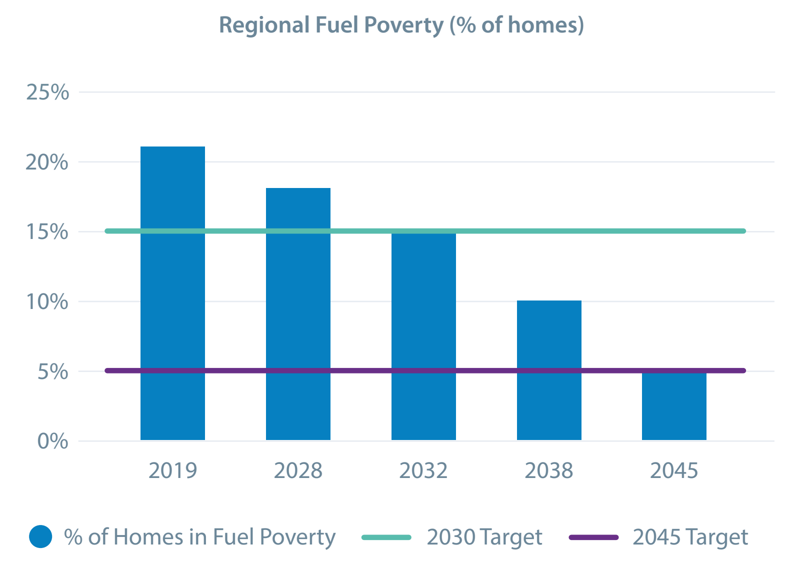
A home is classed as being in fuel poverty if it spends more than 10% of its household income on energy. It is probable that more homes are in fuel poverty now than in 2019 due to the steep rise in energy costs since then.

Both Targets:

Meeting these will be dependent upon a reduction in electricity pricing, through a decoupling from fossil fuel prices. This could be regionally based (which should drastically reduce Scotland's electricity prices due to the large percentage of renewables), or otherwise, and will be decided by the UK government.

Energy efficiency improvements to homes in the coming decade will help to reduce energy costs and therefore fuel poverty, but not to the level that the targets are met. There is also the risk that some measures to decarbonise heat may increase energy costs and exacerbate fuel poverty in the region, so action by the UK government on electricity costs is vital.

Projections here assume a steady reduction of fuel poverty, arising from the implementation of REM actions. Fuel poverty is given a significant weighting in project prioritisation across the four work streams.



[6] Fuel Poverty (Targets, Definitions and Strategy) (Scotland) Act 2019, see appendix VIII

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 4: % homes at set EPC levels: where technically feasible and cost effective to do so	100% EPC C or better by 2033[7] (49,406 homes, excluding hard to treat)	95% EPC A-B by 2045 (64,637 homes)	45% at EPC A-C in 2019	**Objectives:** 1, 2, 5 **Outcomes:** 1, 5, 7 **Actions Required Sections:** 4.1

Current Position

National performance: 63% at EPC A-C. 18% at EPC A-B, our performance:
51% at EPC A-C. 18% at EPC A-B. (2023)

The Scottish Government has set mandatory targets for energy efficiency of:

1. all social homes being EPC D by 2025 and EPC B by 20328.

And will consult in 2023 on setting mandatory targets for introduction in 2025 of:

1. all privately rented homes achieving EPC C by 20287.
2. and all owner-occupied homes achieving EPC C by 20337.

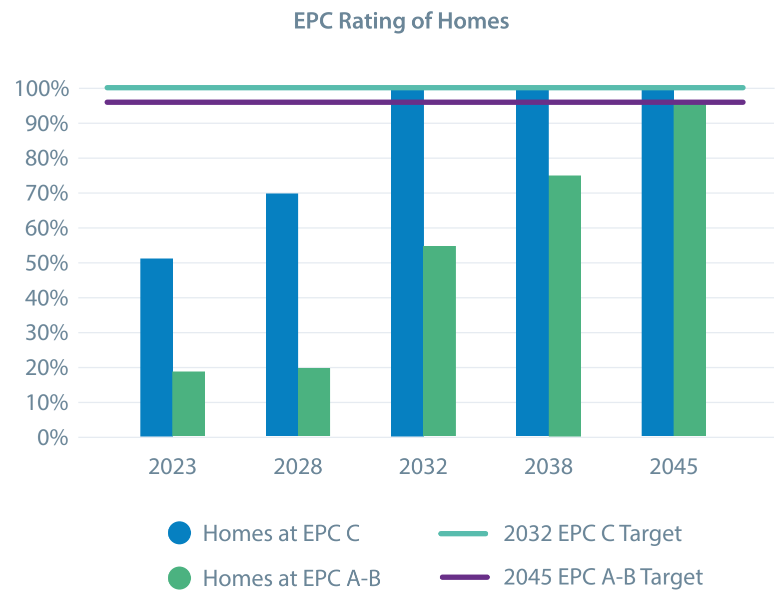
2033 Target:

To reach this ~49% of the region's homes will require some form of retrofit. This is likely to exclude hard to treat homes (~27% of homes). Scottish Government enforcement will contribute to enabling this. The trigger point for rented homes to meet the target is expected to be a change in tenant, whereas for owner-occupied homes the trigger point may be the point of sale. Raising homeowner awareness of these targets and funding will be essential for local authorities.

2045 Target:

To reach this ~88% of the region's homes, including hard to treat homes, will likely require retrofit. However, EPC metrics are due to be reformed to improve their value as a tool in the road to net zero. Our data will be updated to reflect this reform along with any available accurate home energy data. So where the retrofit of 88% of homes may not be feasible, reaching net zero will be possible through heat decarbonisation.

Projections here are an estimation based on the expected fabric improvements and low carbon heating system installations.



[7] Heat in Buildings Strategy 2021, to be followed by the Heat in Buildings Bill in 2025, see Appendix VIII
[8] The Energy Efficiency Standard for Social Housing post 2020 (EESSH2) 2021, see Appendix VIII

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 5: % of total energy (including transportation) to be generated from renewables	50% by 2030[9] (1,409 GWh)	95% (2,677 GWh)	Currently ~30% in region	**Objectives:** 3, 4 **Outcomes:** 1, 3, 4, 5, 7 **Actions Required Sections:** 4.2, 4.3

Current Position

National performance: 23.7% (2021), our performance: ~30% (2023)

2030 Target:

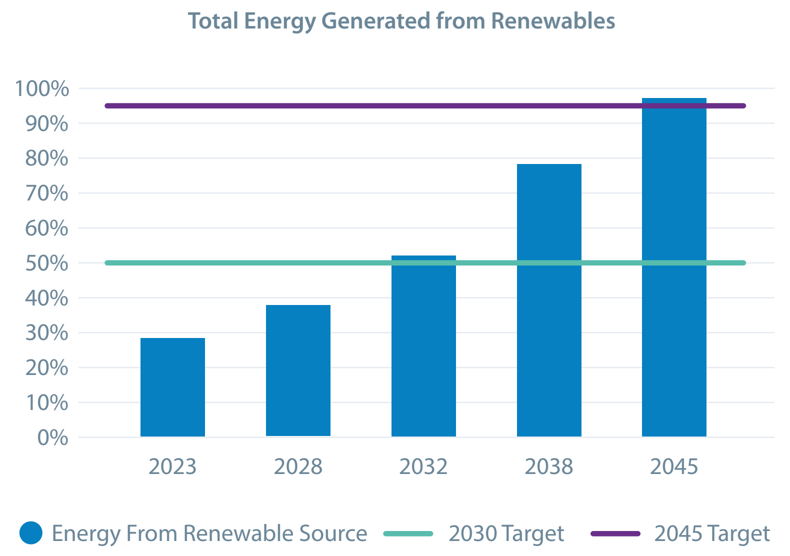
The electricity grid in Scotland is largely decarbonised, with ~97% of the gross electrical demand met by renewables. The main scope for improving this KPI will therefore arise from the decarbonisation of transport and heat – primarily through electrification. Hydrogen may play a role, but this is unlikely to be the case before 2030.

2045 Target:

To reach this, the use of fossil fuels must be almost completely eliminated.

These targets will be dependent upon further decarbonisation of the electricity grid, electricity or hydrogen becoming a cost effective alternative to fossil fuels in the domestic sector, and transport being successfully decarbonised.

Projections in the graph are taken from the digital twin model for buildings' heat and electricity use, and use national projections for transport energy use.



[9] Scottish Energy Strategy, 2017, see Appendix VIII

Target/KPI	Interim Target	2045 Target	Baseline Value	Objectives, Outcomes & Actions
KPI 6: % of buildings with low carbon heat source	75% non-domestic by 2032[10] (4,128 buildings)[10] 58% domestic by 2032[10] (39,463 buildings)[10]	100% overall[11] (73,955 buildings)	55 % non-domestic (2021) (3,532 buildings) 10% domestic (7,067 buildings)	**Objectives:** 3, 4 **Outcomes:** 1, 3, 7 **Actions Required Sections:** 4.3

Current Position

2032 Target:

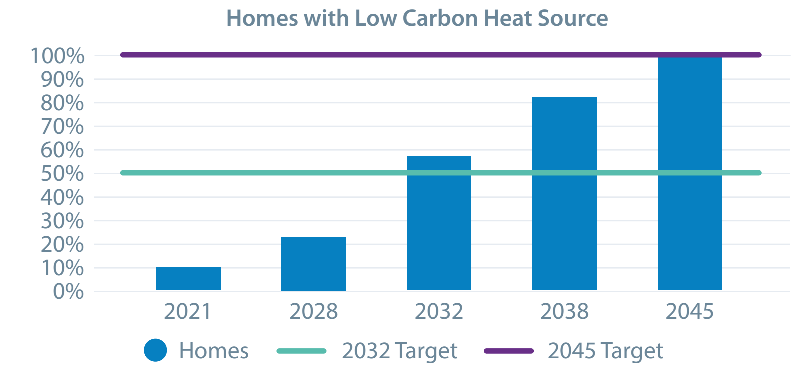
To meet the interim target, all off-gas-grid homes currently heated with fossil fuels will need to transition to a low carbon heating source (these home types are to be prioritised by the Scottish Government for heat decarbonisation by 2032). However, even if all of these homes decarbonise their heat then only 19% of the total housing stock will be using a low-carbon heat source, so an additional 21,000 of homes currently on the gas grid will also need to change to a low-carbon heat source (38% of mains gas connected homes), see section 4.3. A lower proportion of non-domestic buildings will need to transition as comparatively more of them currently have a zero-carbon heat supply (~54%).

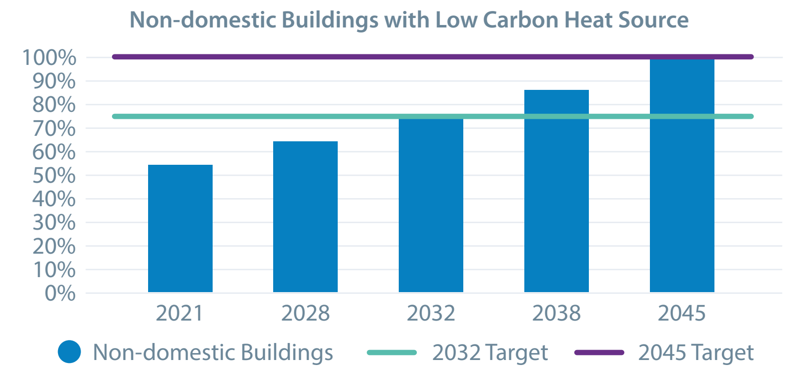
2045 Target:

To achieve this, nearly all current on-gas-grid homes will need to change to a zero-carbon heat supply – this may be possible in the future through green hydrogen or biomethane replacing natural gas in the gas network, however if neither of these fuels are ready at the scale required by then, then alternative heat sources will need to be used such as electrification, or in some cases biofuels. District heating networks will be a vital option for zero-carbon heating in appropriate areas.

Meeting these targets will be dependent on UK Government policy with electricity prices being reduced, or hydrogen replacing natural gas in the mains gas network.

Projections below align with pathways outlined in Sections 4.2.





[10] Update to the Climate Change Plan, 2018-2032 (2020), see Appendix VIII
[11] Heat in Buildings Strategy 2021, to be followed by the Heat in Buildings Bill in 2025, see Appendix VIII

3 Data Analysis & Modelling

To support the delivery of the regional energy masterplan, and provide projections for energy demands and carbon emissions for buildings and networks under different scenarios, IES have created a digital twin model of the region. This model contains 3D geometries for every building in the region and also contains information including building fabrics, heating system, fuel type and primary use (obtained from the local councils, and the Energy Saving Trust) which will affect their energy efficiency and carbon emissions.

Energy simulations are undertaken on the model, using IES's physics-based thermal simulation engine to obtain accurate estimates of the total electrical and heat consumptions, and resultant carbon emissions, for each individual building. Projected scenarios for energy efficiency improvements, heating system replacements and network changes are also simulated, based on both national and regional targets outlined in this document. This allows an understanding of the probable future carbon emissions of each building if these targets are met, and what they might be if they are not. In turn, this enables accurate estimates of the likely impacts on each of the KPIs from projected energy efficiency, heat and renewable projects.

This model will be an on-going resource, continually updated by the councils and used to test various future scenarios for decarbonising energy use across the region.

All current projected values described later in this document for domestic and non-domestic building heating demands, electrical consumption and carbon emissions were calculated from these simulations. The figures below show some of the data sets that were used as inputs for the energy simulations, visualised on the 3D model.

Carbon Accounting

All carbon emissions from fossil fuel consumption are calculated using the UK Government's 2022 conversion factors. For electricity, the UK Government emission factor is not used, due to Scotland's electricity grid having a much lower carbon content compared to the UK average. Instead, an emission factor has been determined using national grid data for southern Scotland between June 2021 and May 2022.

Figures 8a, 8b, 8c:
Example screenshots of the region wide digital twin model

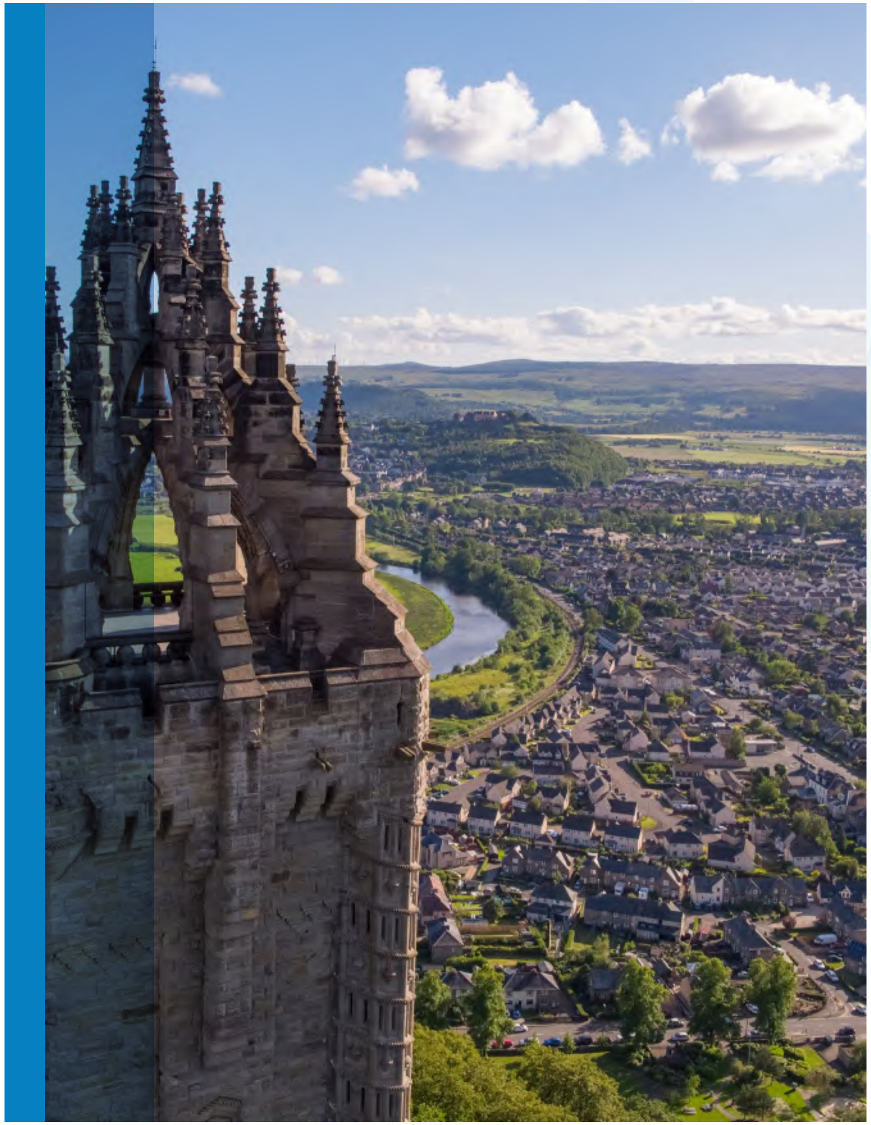
4 Actions Required

Successfully decarbonising energy use in the region will be a significant task, with several barriers to overcome. However, urgent action must be taken to achieve this and avoid the worst effects of climate change. This section covers the steps that will ensure the region reaches net zero and that all objectives, outcomes and KPIs will be met.

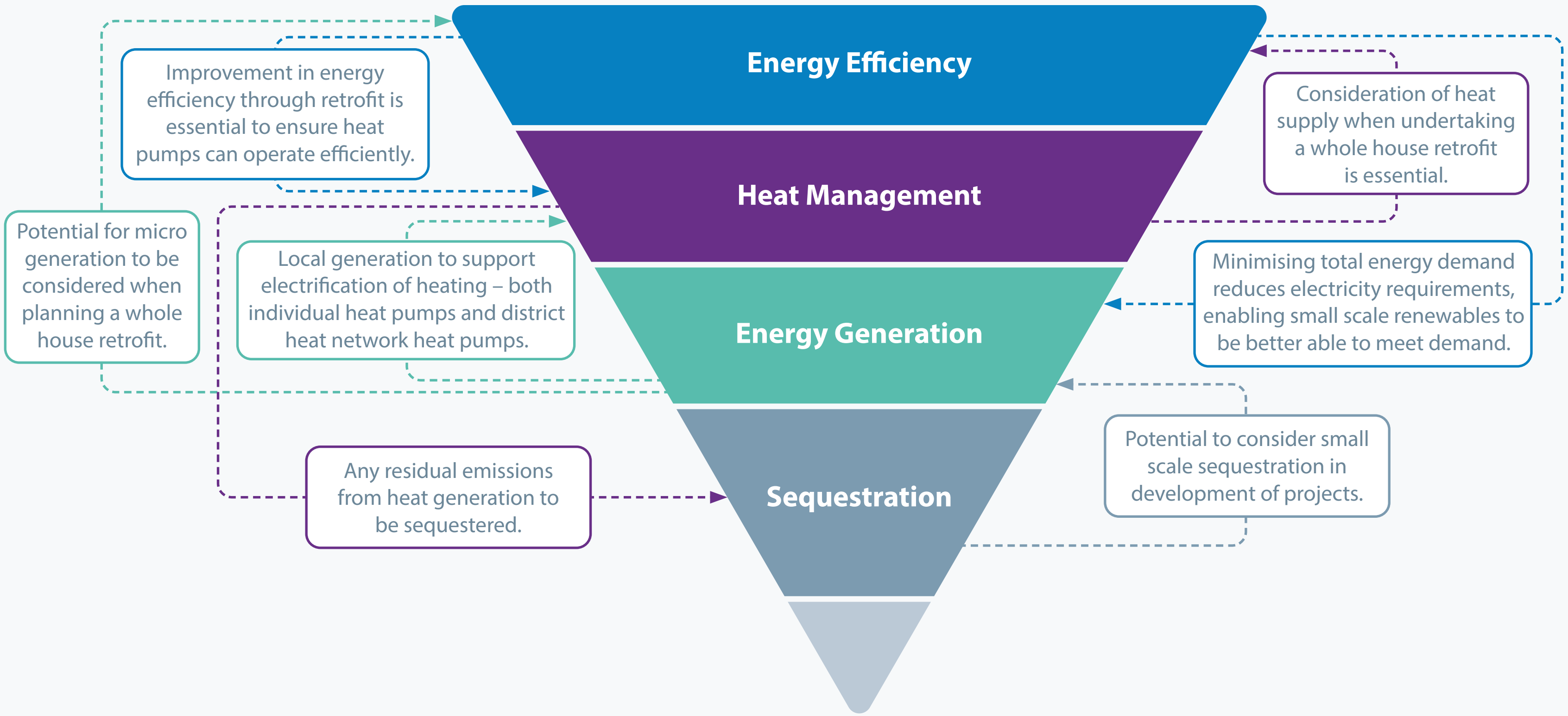
These are split into 4 sections in line with the energy hierarchy: energy efficiency, heat management, energy generation and carbon sequestration. Modelled projections and outputs are displayed alongside specific actions required by the councils and others. Any potential barriers to these actions and the uptake of projects are also covered.

As previously outlined, a digital twin model was used to take a precise, quantitative approach to identify and prioritise the actions and projects. It will also be used to identify future priority areas for delivery of projects by councils and wider partners, in combination with relevant engagement. The resources required for delivery are being considered.

The four work streams must be considered together as there are inevitably many interdependencies. The key ones are outlined in the diagram below.



Interdependencies Across Workstreams



Energy Efficiency

4.1 Energy Efficiency and Demand Reduction

Objective 1
Objective 2
Objective 3

KPI 2
KPI 3
KPI 4

Energy Efficiency & Demand Reduction **Actions**

Outcome 1
Outcome 3
Outcome 5
Outcome 7

Energy Efficiency Summary Box

The reduction of energy use through retrofit measures is the key first step in the energy hierarchy, and therefore an essential first step in the route to net zero. These priority measures will reduce the carbon emissions of buildings in the region by up to 20% compared to current levels.

Privately rented / owner-occupied homes, communities, third sector organisations, and SMEs are a major focus. They are often unaware of the existing and upcoming mandatory energy efficiency requirements set by the Scottish Government and the financial support available.

Social houses, large business and public sector organisations largely have decarbonisation plans already underway, including energy efficiency measures.

The key action for both local councils will be to continue to work towards decarbonisation of their own buildings.

Additional enabling actions, by the councils, Scottish Government and other partners include:

1. helping landlords and businesses keep up to date with national policy and their required actions for their own buildings;
2. promoting awareness of available funding and support;
3. addressing the energy efficiency skills gap;
4. supporting homeowners, landlords and businesses with finding trusted and skilled installers, coordinators and designers.

4.1.1 Domestic

Aims

Objectives

- **Objective 1:** Continue to reduce demand for energy and strive to remove energy waste.
- **Objective 2:** Maximise energy efficiency in our homes and buildings.
- **Objective 5:** Eliminate fuel poverty through improved energy efficiency and the provision of low cost, low carbon energy.

KPI	Interim Target	2045 Target
KPI 2: % reduction in region residential heat demand	15% by 2032	25%
KPI 3: % households in fuel poverty	Less than 15% by 2030	Less than 5% by 2040
KPI 4: % homes at set EPC levels	100% EPC C or better by 2033	95% EPC A-B by 2045

Table 2: *Energy Efficiency KPIs*

Context

As the essential first step in the route to net zero, improvements in energy efficiency have already been made. New-build energy efficiency has been improving, with plans in place to further increase energy performance. Councils have been making great improvements with their own properties.

However, the scale of the challenge remains significant. 80% of all anticipated homes existing in the UK by 2050 have already been built (add as footnote reference: LETI Climate Emergency Retrofit Guide), so improving the energy efficiency of the homes we have is essential. Within the region, the digital twin model shows that there are 33 % buildings in need of retrofit.

Certain types of housing provide particular challenges, such as historic buildings (whether due to planning restrictions or construction type) and homes in mixed tenure or mixed use buildings (i.e. domestic and non-domestic). Within the region there are a number of buildings in these categories, 30%.

Poor energy efficiency can also be a contributor to fuel poverty. This is a key focus of this plan, as the data shows that energy efficiency is a driver for fuel poverty in 11% of homes in the region.

Energy Efficiency

Council Housing

Both councils have made significant progress with improving energy efficiency on their own housing stock.

Multiple energy efficiency programmes have been carried out across the region, with a variety of loft, wall and floor insulation installed. Hard to treat properties such as those in conservation areas have also been addressed and continue to be improved. In Stirling Council, programmes have been carried out since the mid 90s. 64% of stock currently achieves an EPC band B or above (2023) so council housing is well on the way to meeting the Scottish Government target for 2032, and 99% of properties currently meet the target of EPC D by 2025.

Clackmannanshire Council have made huge efforts to ensure that the capital programme of works has focused on improving the energy efficiency of housing stock. A business plan review with expert input is currently underway, with substantial data analysis of the current position of the stock. Early results suggest that a stock condition programme, including a refreshed EPC, will be advantageous in order to feed into future plans. External expert advice will likely be sought to help form decisions on this approach and to ensure transparency in reporting.

Furthermore, both councils have been using EES:ABS funding to help tackle multi tenure buildings. Grant funding is provided for energy efficiency, heat decarbonisation and renewable generation measures to the private owners of flats in blocks where the council also owns flats.

Clackmannanshire Council has also participated in funding for specialist project and demonstration models. The technical details of these have been shared to help improve the knowledge pool within local government. Stirling Council has an award winning programme rolling out environmental sensors to housing to provide accurate condition reporting, enabling further improvements.

The Route to Net Zero

A significant amount of fabric retrofit will need to be undertaken on the housing stock within the region to meet the KPIs. With councils already on track for their own stock, this action will largely be addressed by communities, private home-owners and landlords, with support from Scottish Government and councils. On top of energy reduction and carbon savings, good retrofit brings multiple additional benefits such as long term cost savings with reduced energy bills, and healthier homes with better indoor air quality and reduced damp and mould.

Whilst the majority of properties would benefit from retrofit and the sooner plans are made the better, the primary priority is those off the gas grid with carbon intensive heating sources, or expensive electric heating.

Retrofit Pathway

The main route to improving energy efficiency will be with a whole house assessment of the options available, and the development of approaches for certain typologies of buildings. This can be undertaken on an individual or preferably community level. Assessment should start with low cost high return measures, such as repair and maintenance which can have a big impact on energy use. Next steps in the plan cover a number of possible building interventions (such as increased insulation, airtightness, ventilation, etc.), and can be staged over time until 2045 to allow for long term planning for significant retrofit as funds allow, without taking any step to hinder further energy reduction measures in future. National standards have been developed for this, including the position of 'Retrofit Assessor'. Further detail is available in Appendix III, with resources available in Appendix X

Energy Efficiency

Hard to Treat Properties

Whilst the pathways for hard to treat properties (historic buildings, listed buildings, those in conservation areas, multi-occupancy and mixed use and tenure buildings) can be more difficult, the basic principles are the same. Repair and maintenance is often even greater concern for energy reduction. Whole house assessment is essential, particularly with the additional risks associated with historic buildings. Resources are available in Appendix X, in particular Historic Environment Scotland have guidance and Stirling City Heritage Trust provide building inspections and repairs, retrofit assessment and funding.

Planning regulations have historically been an issue but this is changing, and can be addressed (see Constraints & Actions Required). Whole house plans can help identify the effects and value of any measures possible.

With mixed use and mixed tenure buildings there are funding schemes that focus specifically on these, such as EES:ABS, and research is ongoing into developing typologies of retrofit.

Fuel Poverty

Both councils intend to target any energy efficiency support in these areas of high fuel poverty as a priority, using the digital twin model to identify the zones most affected.

New Build

To achieve net zero all new buildings will have to meet high targets for energy efficiency, such as the Scottish Government's new passivhaus equivalent standards currently planned for introduction in 2024.

KPI 2

The anticipated passing of the Heat in Buildings Bill[12] setting mandatory legislation for the targets in KPI 4 should enable the 2045 target to be met early, with the interim target already plausibly met due to significant energy efficiency improvements across the region since 2015. Some solid wall and hard to treat properties are likely to be exempt from this legislation, if the payback times for external or internal wall insulation prove to be prohibitively high.

The 2045 target will likely be met without insulating the walls of hard to treat properties, however this should still be done on any of these properties which are cost-effective to treat. Aiming beyond these targets where possible is essential as this will only bring benefits.

The expected regional heat demand reduction based on current policy and targets is outlined below. The insulation of walls in solid-wall homes is excluded from all but the last column, SWI.

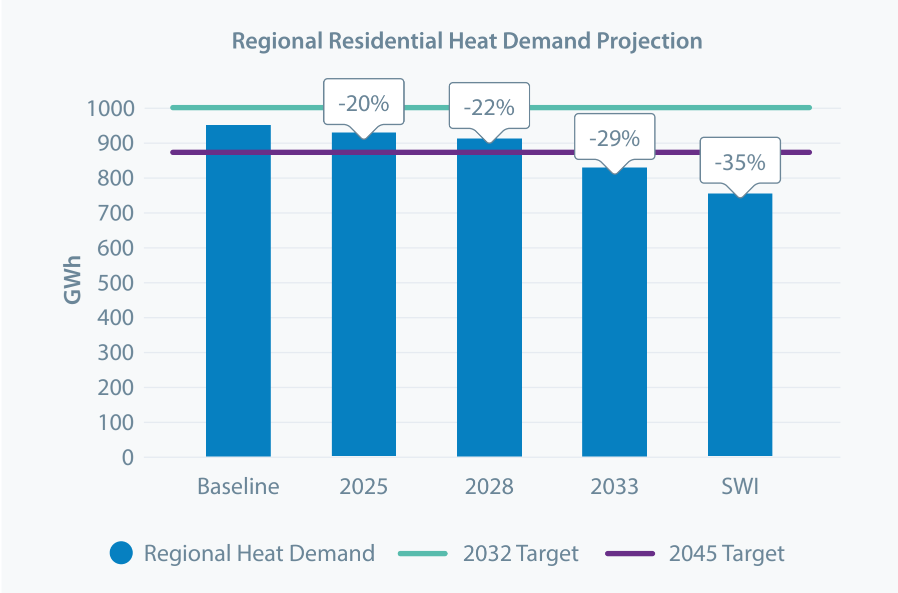


Figure 10

[12] See appendix VIII

KPI 3

Improving energy efficiency across the region's homes will help to directly address fuel poverty. The implementation of fabric improvements and other measures will reduce domestic demand for heat and electricity, reducing the proportion of income spent on energy by residents in the region, and as a consequence the risk of fuel poverty.

KPI 4

The Scottish Government is anticipated to pass the Heat in Buildings Bill which will set the mandatory legislation to enable the interim target to be met. This interim target of 100% of homes to be EPC C does not include solid wall and other hard to treat homes, which make up around 27% of the regions domestic properties. It is likely that the fabric improvements required to meet the interim target of EPC C by 2033, combined with the introduction of a low carbon heating system, will be enough for most homes to reach EPC A-B rating by 2045. Anticipated EPC reform will enable EPCs to be used more effectively to achieve energy reduction.

Assumptions

The projections in Figure 10 assumed that where a home is due to miss their EPC target, they would install each of the following measures to bring the appropriate fabric up to current retrofit standards, where applicable:

- cavity wall insulation,
- loft insulation,
- suspended underfloor insulation,
- replacing single glazing with double glazing.

It was also assumed that a small proportion of solid wall homes will install external or internal wall insulation where they are set to miss their EPC target rating. However these homes will likely be excluded from being required to meet the Scottish Government targets due to being classed as hard to treat.

Caveats

These retrofit measures were modelled as data was available on the specific fabrics of each home in the region. However, it must be noted that when undergoing retrofit works a 'whole house' approach must be taken which will include aspects such as improving air tightness, removing thermal bridges and installing ventilation. As data was not available identifying where these measures already exist or may be required, they were not modelled, but will need to be considered when each individual home undergoes retrofit works.

Estimated Costs

For overall estimated costs to reach the KPI targets, and a full breakdown of the condition of the building fabrics and EPC ratings for each tenure type, and a breakdown of the number of specific works required for each intermediate zone (which shows potential areas to target for specific measures), consult Appendix III.

Constraints & Actions Required

Constraint	Action Required	By Who
No specific constraint.	Ensure that the housing strategy for council owned homes is on track to meet Scottish Government minimum EPC targets, and work with social housing providers to ensure theirs are as well.	Local authorities; Social housing providers.
No specific constraint.	Ensure all private landlords in the region are installing any required cost-effective retrofit measures so that all of their housing stock are EPC C by 2028, as per Scottish Government's upcoming legislation (see Appendix VIII).	Private landlords; Scottish Government.
Lack of public awareness of anticipated Scottish Government mandatory energy efficiency targets, and funding available to help implement these works.	Increase awareness among homeowners of available funding resources and support to ensure all owner-occupied homes are EPC C by 2033. For a full breakdown of available financial support, see Appendix IX.	Scottish Government - Home Energy Scotland; Local authorities (current and project specific actions).

Constraints & Actions Required

Constraint	Action Required	By Who
High capital costs required for some retrofit works.	Investigate the potential to use proceeds from renewable energy generation projects to fund energy efficiency improvements for homeowners who cannot afford the work themselves.	Local authorities.
There is currently a lack of suppliers, skilled and trusted installers, and maintenance options for some retrofit measures and technologies.	Investigate the best solutions for matching homeowners and landlords with trustworthy, skilled installers for different types of retrofit works.	Scottish Government; Local authorities.
	Investigate the possibility of signposting retrofit guidance in partnership with Scottish Government guidance. Outlining a standard process of retrofit for homeowners and landlords.	Local authorities; Scottish Government – Home Energy Scotland.
	Take action to increase the number of skilled installers in the region, to help towards closing the skills gap.	Scottish Government; Education Institutions.

Constraints & Actions Required (Continued)

Constraint	Action Required	By Who
Planning permissions can sometimes delay or block certain retrofit measures.	Planning authorities to support retrofit proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted National Planning Framework 4 (NPF4) and any Local Development Plan for the area. This includes proposals for historic assets, including listed buildings, where proposals do not negatively impact on their character, appearance and/or setting.	Local authorities; Scottish Government (through National Planning Framework 4).
There can be barriers to commissioning common works in mixed tenure and mixed use buildings.	The Scottish Government existing ABS funding scheme is designed to help target these buildings. They are currently drafting a new Tenements Maintenance Bill, which should help to further address this constraint. Technologies are becoming available such as inverters to enable sharing of solar assets.	Scottish Government, Building owners.

Constraints & Actions Required (Continued)

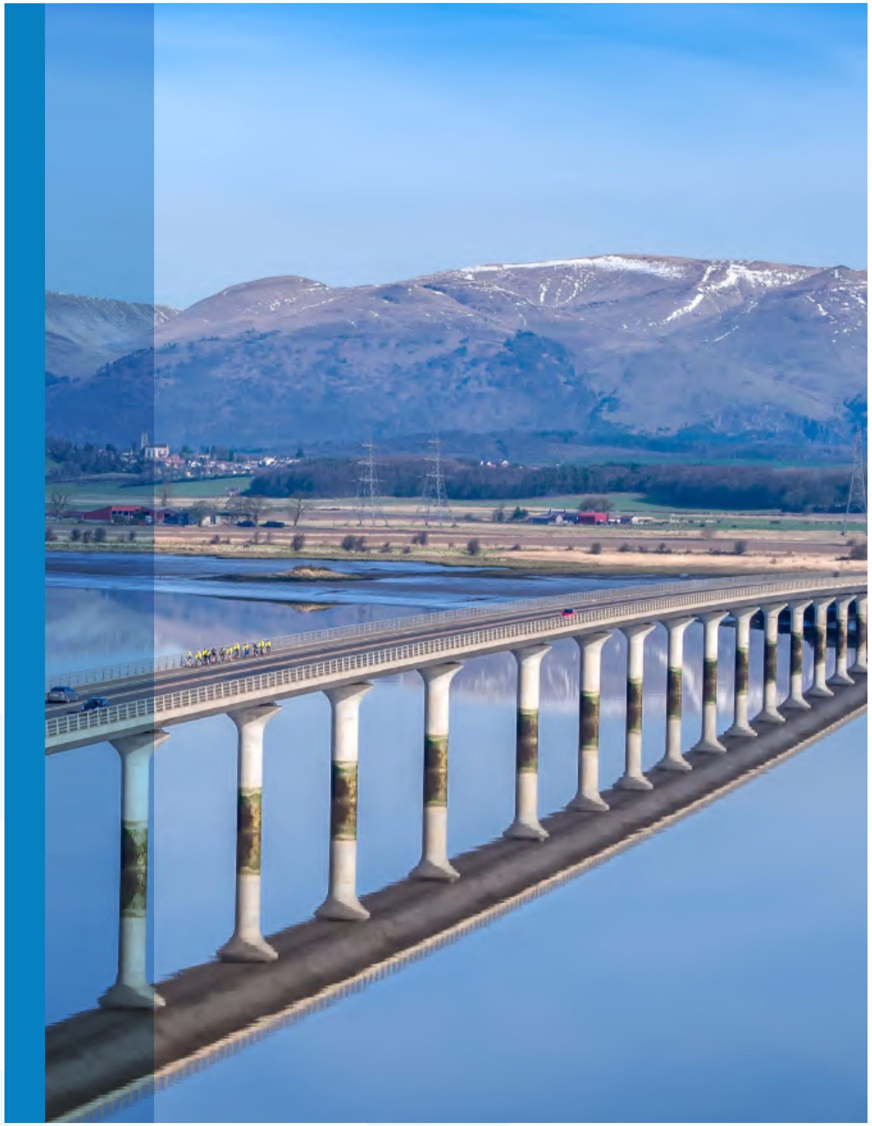
Constraint	Action Required	By Who
No specific constraint.	Promote and increase awareness of behavioural change measures which can help to reduce energy demand in households.	Scottish Government; Local authorities (project specific actions).
Councils have shorter deadlines to reach net zero for their own operations (Stirling: 2035 and Clackmannanshire: 2040), and limited funds to achieve expensive energy efficiency measures with very long pay back times.	Consider the Asset Rationalisation Strategy and identify assets that may be sold off and used more efficiently by others, or replaced with more efficient buildings.	Local Authorities.
EPC data is used to determine energy efficiency but not well suited to this as the metric is also based on cost.	Reform of EPC to align metrics used with industry standard metrics, such as kWh/m2/yr space heating demand.	Scottish Government.

Constraints & Actions Required (Continued)

Constraint	Action Required	By Who
Improving energy efficiency in historic and hard to treat homes is more difficult.	Wider support and raising awareness of existing resources.	Scottish Government; existing support organisations; local authorities.
No specific constraint.	Use digital twin model to target any future retrofit funding schemes	Local authorities
No specific constraint.	Encourage the repair and maintenance of existing buildings as an essential first step for energy efficiency retrofit by raising awareness and signposting resources	Local authorities; other organisations such as Historic Environment Scotland
No specific constraint.	Ensure all owner/occupiers in the region are installing any required cost-effective retrofit measures so that their houses are EPC C by 2033, as per Scottish Government's target.	Currently Scottish Government; communities; owner/occupiers

Table 4: *Energy efficiency constraints and actions required*

Prioritisation and timelines for the above actions are set out in the delivery plan section.




Switched On
STIRLING
Driving green energy

4.1.2 Area Prioritisation

It has been assumed that homes in all areas across the region will implement the required improvements in energy efficiency and energy demand reduction to meet the relevant KPIs and outcomes. This will be achieved through both direct actions from the councils (associated with council housing) and indirect enabling actions such as awareness raising and behaviour change, as well as mandatory compliance with legislation depending on the property type and tenure, as outlined previously.

However, in some cases either local authorities, or smaller community councils, may wish to invest some capital into helping homeowners who cannot afford the required improvements to retrofit their home. This funding could be raised using proceeds from energy generation projects. To help identify and target the areas where this may be most beneficial, the intermediate zones for each council area were ranked in terms of their risk of fuel poverty, displayed in the table below. To obtain this ranking, the percentage risk of fuel poverty metric provided by the Energy Saving Trust for each individual household, was averaged across each intermediate zone. For an estimation of the number of specific fabric improvement measures that will be required in each intermediate zone, consult Appendix III.

Fuel poverty was chosen as the key metric to prioritise, as areas with high levels of fuel poverty will be at most risk of having a significant number of homes not implementing required fabric improvements and energy efficiency measures to reach mandatory government targets. Targeting these areas of high fuel poverty will have a direct effect on KPI 3 and Objective 5 focussing on reducing fuel poverty, as well as helping to achieve the energy demand reductions and EPC rating improvements required to reach the other KPIs and Objectives.

Stirling				Clackmannanshire		
Prioritisation Ranking	Targeted Area (Intermediate Zone)	Average Household Percentage Risk of Fuel Poverty		Prioritisation Ranking	Targeted Area (Intermediate Zone)	Average Household Percentage Risk of Fuel Poverty
1	Highland	30.9%		1	Alloa South and East	32.5%
2	City Centre	28.5%		2	Alva	26.9%
3	Raploch	26.5%		3	Sauchie	25.3%
4	Fallin	25.4%		4	Tillicoultry	24.6%
5	Balfron and Drymen	24.7%		5	Clackmannan Kennet and Forestmill	24.2%
6	Cowie	24.0%		6	Fishcross Devon Village and Coalsnaughton	23.1%
7	Plean and Rural SE	22.8%		7	Tullibody North and Glenochil	22.8%
8	Braehead	22.7%		8	Tullibody South	22.7%
9	Hillpark	22.4%		9	Alloa North	22.2%
10	Cornton	22.3%		10	Alloa West	18.4%
11	Borestone	22.1%		11	Menstrie	17.2%
12	Carse of Stirling	21.7%		12	Dollar and Muckhart	16.0%
13	Forth	21.7%				

Stirling				Clackmannanshire		
Prioritisation Ranking	Targeted Area (Intermediate Zone)	Average Household Percentage Risk of Fuel Poverty		Prioritisation Ranking	Targeted Area (Intermediate Zone)	Average Household Percentage Risk of Fuel Poverty
14	Callander and Trossachs	21.4%				
15	Kippen and Fintry	21.1%				
16	Broomridge	20.6%				
17	Bannockburn	18.8%				
18	Dunblane West	17.9%				
19	Dunblane East	17.8%				
20	Bridge of Allan and University	17.0%				
21	Cambusbarron	16.8%				
22	Blane Valley	16.4%				
23	Causewayhead	15.1%				
24	Kings Park and Torbrex	14.9%				

Table 6: *Zone prioritisation for energy efficiency measures based on fuel poverty*

4.1.3 Non-Domestic

Context

Improving the energy efficiency on non-domestic buildings in the region will be important for reaching Objectives 1 and 2.

From the stakeholder engagement, it was found that most public sector entities and large industrial and commercial businesses in the region already have net-zero plans, either currently being worked on or already in action (SIEC can offer support in developing one if any commercial business requires guidance, see Appendix X), which include installing cost-effective fabric improvement and other energy efficiency measures. Smaller businesses, such as SMEs and third sector organisations, tend to be less likely to already have decarbonisation plans in action.

The scale of work required for non-domestic buildings is harder to determine as there is a lack of data available on energy efficiency and specific building fabrics. However, the available data suggests 41% of the non-domestic buildings across the region require retrofit.

Additionally, non-domestic buildings are typically harder to treat, with a great variety of construction types, mixed use and mixed tenure buildings. Within the region 33% of non-domestic buildings are within this category.

Council Properties

Both councils have been making progress on improving the energy efficiency of council non-domestic properties as part of overall net zero plans. Feasibility studies have been undertaken for council buildings to determine the best retrofit solutions available.

The Route to Net Zero

All parties will have a part to play in improving the energy efficiency of non-domestic buildings, from private property owners and landlords to Scottish Government and local authorities. Public buildings also have stricter deadlines that private, and both councils have set themselves tighter deadlines.

As with houses, off gas grid properties are still the first priority, though both councils also have plans to develop district heat networks in suitable on gas areas that will help decarbonise heat and could be undertaken alongside energy efficiency improvements. This would allow district heating systems to cover a larger area without increasing the capacity of the heating technology.

The pathways to retrofit of non-domestic buildings are the same as for houses, with whole building assessment and development of typology approaches being key. Further information is available in Appendix III.

To maximise energy efficiency within the region, it is crucial that both council areas engage with smaller business and charities – through the creation of an open forum or otherwise – to raise awareness of Scottish Government energy efficiency policies surrounding non-domestic buildings, funding and financial support available, and to help them to identify skilled and trusted installers.

Data Assumptions

A high-level study estimating the region's non-domestic buildings U values based on their date of construction was carried out as there was not enough data available to undertake a detailed study into specific measures required and potential resultant energy demand and carbon emission savings. The high level study predicted that carbon emissions from energy use could be reduced by around 15% from installing appropriate fabric improvements and other energy efficiency measures.

Constraints & Actions Required

Constraint	Action Required	By Who
No specific constraint.	Ensure all council owned and other public sector buildings have installed all appropriate cost-effective energy efficiency measures by 2033.	Local authorities; Public sector bodies.
There is currently a data gap on many non-domestic buildings, with a lack of information available on aspects such as building fabrics.	Work to address the data gap, to obtain information on the fabrics used in each non-domestic building in the region.	Scottish Government – Energy Saving Trust; Local authorities (updating digital twin model).
SMEs and smaller business are less likely to have decarbonisation plans, or be aware of available funding that can help with required measures.	Open dialogue with SMEs and third sector organisations to help with their decarbonisation plans, and raise awareness of available financial support for retrofit works.	Scottish Government; Local authorities (via open forum)[13] in partnership with others.
No specific constraint.	Open dialogue with larger industries and businesses in the region to help them with their decarbonisation plans and keeping up with Scottish Government regulations regarding EPC ratings and energy efficiency.	Scottish Government; Local authorities (via open forum) in partnership with others.

[13] See 4.2 Heat Management Actions Required

Constraints & Actions Required (Continued)

Constraint	Action Required	By Who
EPC data is used to determine energy efficiency but not well suited to this as the metric is also based on cost.	Reform of EPC to align metrics used with industry standard metrics, such as kWh/m2/yr space heating demand.	Scottish Government.
Improving energy efficiency in historic and hard to treat buildings is more difficult.	Wider support and raising awareness of existing resources.	Scottish Government; existing support organisations; local authorities.
No specific constraint.	Encourage the repair and maintenance of existing buildings as an essential first step for energy efficiency retrofit by raising awareness and signposting resources.	Local authorities; other organisations such as Historic Environment Scotland

Table 7: *Non-domestic energy efficiency constraints and actions required*

Prioritisation and timelines for the above actions are set out in the delivery plan section.

4.2 Heat Management

Objective 3
Objective 4
Objective 5

KPI 4
KPI 5
KPI 6

Heat Management **Actions**

Outcome 1
Outcome 3
Outcome 5
Outcome 7

Heat Management Summary Box

Successfully decarbonising building heat supply will be crucial to reach net zero carbon. Decarbonising heat has the potential to reduce the carbon emissions of the built environment in the region by up to 95%.

Many low carbon heating technologies are already operating in Scotland – the solutions are available to achieve our goals.

The electrification of heat must be prioritised firstly in off gas grid areas. Coordination with Distribution Network Operators (DNOs) will be vital to ensure the electricity grid can handle this increase in demand. Any heating system transition must not result in increased fuel poverty.

Hydrogen may play a part in 2035-2045. This depends on a UK Government policy decision, due 2026, on whether heating buildings is a priority for hydrogen as a fuel. This will determine if a predominantly electric or hydrogen pathway will be followed.

A key role for both councils is the development of heat networks. Scottish Government have set a specific target for heat supplied by heat networks (6TWh by 2030) and provided significant funding (£300million).

Additional enabling actions, by the Scottish Government, the councils and other partners include:

1. raising awareness of the options available to decarbonise heat, how to identify the best solution, optimum use of technologies, and financial support available;

2. addressing the skills gap for supply and installation of low carbon technologies.

Heat Management

4.2.1 Heat Decarbonisation

Aims

Objectives

- **Objective 3:** Deliver a zero-carbon energy system for heating, power and transport while matching local demand with local supply, and contributing to national net zero generation.
- **Objective 4:** Provide a resilient and secure energy supply.
- **Objective 5:** Eliminate fuel poverty through improved energy efficiency and the provision of low cost, low carbon energy.

KPI	Interim Target	2045 Target
KPI 4: % homes at set EPC levels	100% EPC C or better by 2033	95% EPC A-B
KPI 5: % of total energy to be generated from renewables	50% by 2030	95%
KPI 6: % of buildings with zero-carbon heat supplies	75% non-domestic by 2032 58% domestic by 2032	100%

Table 8: *Heat Management KPIs*

Context

Decarbonising the energy used for space heating and domestic hot water across the region's buildings is one of the most important challenges in reaching net zero emissions. Due to the largely decarbonised electricity grid in Scotland, over 95% of the region's buildings' carbon emissions are caused by energy consumption for heat.

Demonstrating the importance of this, Figure 11 shows projections of domestic carbon emissions across three scenarios:

- Scenario 1, where the interim 2032 target is met, and by 2045 over 95% of all buildings have a decarbonised heat supply (primarily either electricity or hydrogen, with a smaller number of buildings using biomass and biofuels).
- Scenario 2, where there is a slight delay in the uptake of low carbon heat technologies phasing out fossil fuels, with currently operational fossil fuel boilers assumed to be replaced when they reach the end of their lifespan.

- Scenario 3, a worst-case scenario where it has been assumed that a significant number of consumers will replace their fossil fuel boilers shortly before they are outlawed, so that many are still operational in 2045.

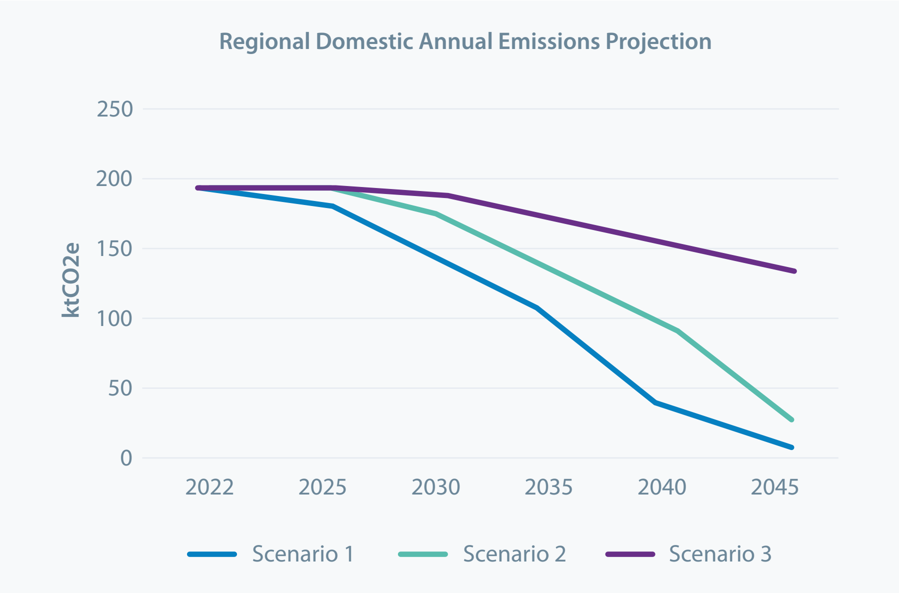


Figure 11: *Projected carbon emissions from domestic heat demand under different low carbon heating system uptake scenarios*

The 5 ktCO2e emitted annually by buildings in 2045 for Scenario 1 would require around 200,000 adult trees to sequester, whereas the 135 ktCO2e for scenario 3 would require 6.4 million. Scenario 3 is unlikely to occur, but this comparison highlights the scale of the challenge and the urgency for local authorities to take action to enable and encourage homeowners, landlords and businesses to decarbonise their heat supply as soon as feasibly possible.

Council Properties

Both councils have made progress with decarbonising their housing stock and have plans in place to continue this.

Stirling Council is focussing on off gas grid housing first and has been replacing any carbon intensive heat supplies with high heat retention electric storage heating, in line with an electrified heat pathway to net zero. Only 65 off gas grid properties remain on carbon intensive heating such as oil. Additionally, 82% of stock has solar PV installed, the highest in Scotland, generating 15.5MWp of electricity. In terms of carbon emissions, EPC data puts average annual CO_2 emissions per property at 2.022 tonnes, so well on the way to achieving the target set out in the Climate and Nature Emergency Strategy of 2.00 tonnes or less by 2025.

Clackmannanshire Council have also targeted off gas areas as part of a plan to reduce fuel poverty whilst offering innovative solutions to tenants. Areas that can be retrofitted with Air Source Heat Pumps and Solar PV continue to be identified, and hard to treat properties such as those in conservation areas have also been addressed and continue to be improved.

Both councils have plans in place to address the decarbonisation of energy in council owned non-domestic properties. Furthermore, district heat network projects are being developed and expanded to decarbonise heat in both public and private buildings in suitable locations (see 4.2.5 District Heating).

The Route to Net Zero

There are a number of different technological options available for decarbonising heat, providing feasible solutions for all buildings. See subsection 4.2.2 for further detail. While some off gas grid homes in the region may be suitable for biomass or biofuel if a sustainable source is available nearby, there will be limited supply of these fuels in the future. This means the majority of buildings across the region will be heated by electricity (either heat pumps or resistive) or hydrogen (via the existing mains gas network). Buildings located in areas with a high concentration of heat demand will be heated by heat networks (which will also likely use electricity or hydrogen as their primary fuel). Electrification and hydrogen pathways depend on a UK Government policy decision, and are addressed in subsections 4.2.3 and 4.2.4.

Retrofit Pathway

Decarbonisation of heat is included within retrofit plans and whole house assessments. So the steps to achieve this are as per those outlines in Section 4.1 Energy Efficiency and Appendix III. The priority remains off gas grid properties, particularly those with wet heating systems and/or high enough energy efficiency to install ASHPs immediately. On gas properties can also change to electric heating, but without the UK Government decoupling the price of electricity from gas this is often an expensive option. Whole house assessments can help to determine the value of any changes. District heat networks will also provide low carbon heat, for details on both councils plans see subsection 4.2.5.

Hard to Treat Properties

Whilst the pathways for hard to treat properties (historic buildings, listed buildings, those in conservation areas, multi-occupancy and mixed use and tenure buildings) can be more difficult, the basic principles are the same, as discussed in Section 4.1.

Inability to reach high levels of energy efficiency can make solutions such as ASHPs less viable, but not impossible. High temperature ASHPs are available and the technology is still improving. Additionally, in suitable areas district heat networks are an option.

Fuel Poverty

The electrification of heat is a particular concern for fuel poverty, as the price of electricity can exacerbate fuel poverty. For this reason, assessments must be undertaken before switching gas heat supplies to electric, and social housing should not be used as guinea-pigs for decarbonising heat where this risks the well-being of inhabitants. Decoupling the price of electricity from gas is also a key action for the UK government that can reduce electricity costs and enable electrification of heat.

New Build

Any new building must have low/zero carbon heating to avoid any abortive works. This is in line with Scottish Government policy on banning gas and oil fired boilers in new builds from 2024. Stirling Council is already achieving this by avoiding gas heating on any new council housing, and installing ASHPs or other zero carbon heating.

New buildings in any future designated Heat Network Zones will also have access to zero carbon heating from any heat networks built.

Hydrogen

Whether hydrogen or electricity is the predominant fuel used across the region to heat networks and buildings will depend on the UK Government's policy decision regarding hydrogen for heating, due in 2026. Scottish Gas Networks have plans for a main hydrogen trunk line to pass relatively near to the region, with aims to convert nearby on gas grid towns to 100% hydrogen from 2026, provided they get the green light from this policy. The following electrification pathway subsection is based on limited hydrogen availability through the existing gas network with most buildings have to electrify. The hydrogen pathway subsection is based on the existing mains gas network is converting to 100% hydrogen in the late 2020s and early 2030s.

KPI 4

The wide scale decarbonisation of heat across domestic buildings will be required for achieving the 2045 target of all homes being EPC A-B. Particularly for homes where appropriate cost-effective retrofit measures may only be able to get them up to an EPC C rating.

KPI 5 & KPI 6

KPIs 5 and 6 are directly linked within this work stream, with the amount of total heating energy supplied by renewables dependent on the number of buildings that will convert to a low carbon heat source. For information on the most suitable technology for each type of home, see the technology appraisal and electrification and hydrogen pathway subsections below, with more details in Appendix IV.

Actions Required

The modelling assumptions, caveats and implementation constraints relevant to heat management depend on the future pathway for the primary fuel source used to heat buildings, either hydrogen or electricity.

There are actions required from both local councils that will be common across both pathways, and actions specific to each pathway. The former are listed in the table below, and the latter are discussed in subsections 4.2.3 and 4.2.4.

Constraints & Actions Required

Constraint	Action Required	By Who
No specific constraint.	Install the most appropriate and cost-effective low carbon heating system on all off-gas grid council owned homes, and work with housing associations to do the same.	Local authorities; Social Housing Providers.
No specific constraint.	Install a low carbon heating system on all public non-domestic buildings by 2038.	Local authorities – asset management (council properties); Public sector.
Electrical grid constraints can limit uptake of heat electrification in some areas.	Determine the grid upgrades required in the rural off gas grid areas which will electrify their heat demand by 2032, pairing with generation projects and using data from the digital twin model where appropriate. Such as indicative heat pump suitability.	DNOs – in partnership with various others, including community groups and local authorities.
No specific constraints – contributes to overcoming several.	Facilitate communication between DNOs, Scottish Gas Network (SGN), council officers and planners, community groups, and larger industrial and commercial sites through the creation of an open forum to share heat decarbonisation strategies. This will allow for the sharing of knowledge and expertise, the identification of potential joint projects, the discussion of waste heat opportunities for district heating, and inform DNOs of required grid improvements.	Local authorities in partnership with others.

Constraints & Actions Required (Continued)

Constraint	Action Required	By Who
Lack of awareness of available funding measures to support heat decarbonisation.	Raise awareness of homeowners and private landlords of the financial incentives and support available for low carbon heating systems, and target this support on the areas most suited to specific technologies (see Appendix IV).	Currently Scottish Government: Home Energy Scotland, Energy Saving Trust, Local authorities (current planned activities/project specific).
Lack of skilled installers for some technologies.	Take action to close the skills gap and increase the number of skilled, accredited installers of low carbon heat technologies.	Scottish Government; Educational Institutions.
Councils have shorter deadlines to reach net zero for their own operations (Stirling: 2035 and Clackmannanshire: 2040), and limited funds to achieve expensive heat decarbonisation measures with very long pay back times.	Consider the Asset Rationalisation Strategy and identify assets that may be sold off and used more efficiently, upgraded or replaced by others. Additionally, consider the heat load of public buildings in the scope of a district heating project.	Local Authorities.

Constraints & Actions Required (Continued)

Constraint	Action Required	By Who
The scope of a heat management project may be reliant on supply/ demand from industry which may close or move within the anticipated lifespan of the project.	Work with internal economic development teams to assess the longevity of an industry considered within the scope of heat management projects. Consider this during the feasibility stage of all projects, and speak to the relevant project specific companies that may be involved.	Local Authorities.
No specific constraint.	Use digital twin model to target any future awareness raising, for example to property types, communities or areas, etc.	Local Authorities.

Table 9: *Constraints and actions required for heat management*

4.2.2 Technology Appraisal

The most optimal, cost effective low carbon heating solution will be different for each building depending on its fabric condition, existing heating system, local grid constraints, future inclusion in heat network zones and local fuel availability. The Scottish Government conducted an investigation into the suitability of Scotland's housing stock for low carbon heating technologies[14], and found that there was a feasible technology suitable for each type of home – testing over 100,000 unique archetypes against 26 low carbon heating system types. All households and businesses within the region could theoretically decarbonise their heat supply tomorrow, however care must be taken to identify the most suitable technology for each building and avoid potential increased energy costs exacerbating fuel poverty.

A summary of the main types of low carbon heating technology available is shown in Table 10. These are also applicable as heat sources in the development of district heat networks. Homes and business in areas of high, concentrated heat demand may have the opportunity to connect to a district heating network, see Section 4.2.5. For a detailed breakdown of the current technologies used in each area (intermediate zone) of the region, and an estimation of the most suitable technology going forward, consult Appendix IV.

[14] Low carbon heating in domestic buildings - technical feasibility: report Accessed here: https://www.gov.scot/publications/technical-feasibility-low-carbon-heating-domestic-buildings-report-scottish-governments-directorate-energy-climate-change/pages/1/


Scottish Water Horizons

Technology	Description	Advantages	Barriers and Constraints
Heat Pumps	Heat pumps take heat from an outside source (the air, ground or nearby water) and consume electricity to deliver it to heat a building. High temperature heat pumps warm water to 65°C and above, and are less efficient but often mean that radiators do not need replaced. Low temperature heat pumps heat water to below this temperature, but may require larger radiators to be installed, particularly in homes with poor energy efficiency.	Due to the largely decarbonised electricity grid in Scotland, and their extremely high efficiency, using a heat pump in Scotland is virtually zero carbon - reducing carbon emissions by a factor of around 17 compared to using a gas boiler for a typical Scottish home. The technology is mature, being widely used in other European countries. As the technology is tried and tested, there are much less implementation uncertainties compared to hydrogen. Heat pumps are significantly cheaper to run compared to other electrical heating technologies such as storage heaters or electric boilers.	At current electricity costs, they can increase the risk of fuel poverty compared to using a gas boiler. There is currently a lack of skilled heat pump installers, and a lack of understanding in the general public of how they best operate. Installing a low temperature heat pump can either cause issues with thermal comfort if not sized properly, or be disruptive if all radiators need to be replaced. Installing a high temperature heat pump can have a higher capital cost and higher running costs. Homes with a peak heat loss of around 150W/m^2 are unsuitable for conventional heat pumps. Ground source heat pumps are more efficient, but require a large area of available land nearby the house.

Technology	Description	Advantages	Barriers and Constraints
Electric Resistive Heating	Electric resistive heating covers all other non-heat pump technologies that use electricity: electric storage heating, direct electric heating and electric boilers.	These technologies are already widely used in Scotland. They are very low carbon due to the low carbon content of the electricity grid. They have fewer potential issues with meeting thermal comfort in homes with poor energy efficiency compared to heat pumps. They can be combined with PV panels and a battery to help reduce running costs.	Running costs are extremely high, increasing risk of fuel poverty compared to fossil fuel heating, particularly for homes that use mains gas. They are significantly more expensive (around three times higher) to run compared to heat pumps. Many homes may be unsuitable to transition to electric resistive heating from fossil fuels if they have a low fuse rating (however this can be upgraded).

Technology	Description	Advantages	Barriers and Constraints
Bioenergy	Bioenergy boilers operate similarly to conventional fossil fuel boilers, but use a zero carbon fuel type such as biomass, bio-LPG or other biofuels.	In some cases, existing fossil fuel boilers can be re-purposed (i.e. a conventional LPG boiler can in most cases run on bioLPG). There is scope to ramp up the production of bio-fuels across Scotland. There are no concerns around overloading the electricity grid, or with these technologies struggling to maintain thermal comfort – so they could be suitable for off-gas-grid homes with poor energy efficiency, in areas with a constrained grid.	Unlikely to be an option for decarbonising heat at scale, due to limited availability of resources of feedstock to create the fuel, and market competition from other sectors. There is also debate around whether some types of biomass and other biofuels can be classed as zero carbon. All of these technologies require significant storage space for the various fuels. These heating technologies increase local emissions compared to other low carbon options, negatively affecting the local environment and well-being.

Technology	Description	Advantages	Barriers and Constraints
Low Carbon Mains Gas	This considers low carbon gas delivered through the existing natural gas grid. This is likely to be hydrogen, but in some areas parts of the gas grid could potentially be fuelled using biomethane.	The existing infrastructure is already there, but it may need to be upgraded, particularly for hydrogen. There is a scope to produce significant amounts of low carbon hydrogen in Scotland, through natural gas with carbon capture and storage, and with renewable electricity generation. If homes on the gas grid use this option, then it reduces potential pressure on the electricity grid compared to large scale heat electrification.	Burning hydrogen still creates some local emissions, negatively impacting the local environment. There are some technical challenges to be overcome to deliver hydrogen at large scale. There is currently implementation uncertainty, with a strategic decision on the role of hydrogen in the existing gas network due from the UK government in 2026. It is also likely that initial hydrogen rollout would predominantly be made up of blue hydrogen, which requires large scale carbon capture and storage to be operational, with widescale green hydrogen not anticipated until the late 2030s.

Technology	Description	Advantages	Barriers and Constraints
Hybrid Heat Pump	This solution involves using a heat pump as the primary heat supply to a building, with a back-up boiler to use during times of peak demand, which could be using low carbon mains gas, electricity, biomass, or another biofuel.	The risk of the heat pump not meeting thermal comfort is reduced. Reduces strain on electrical network as maximum power draw from heat pump is reduced. Improves overall efficiency of heat pump, as they are less efficient at very low temperatures, which is when peak demand is highest and backup source will kick in.	Requires large amount of space to host both a heat pump and a boiler. Will have very high capital costs due to requiring two technologies to be installed.

Table 10: *Low carbon heating system options appraisal*

While some off gas grid homes in the region may be suitable for biomass or biofuel if a sustainable source is available nearby, the limited supply of these fuels in the future means that the majority of buildings across the region will be heated by electricity (either heat pumps or resistive) or hydrogen through the existing mains gas network, with buildings located in areas with a high concentration of heat demand heated through heat networks (which will also likely use electricity or hydrogen as their primary fuel).

Whether hydrogen or electricity is the predominant fuel used across the region to heat networks and buildings will depend on the UK Government's policy decision regarding hydrogen for heating, due in 2026[15]. Scottish Gas Networks have plans for a main hydrogen trunk line to go from Aberdeen to the Central Belt, passing through Fife and Grangemouth, relatively near to the region, with plans to convert towns nearby to the main trunk line currently on the mains gas network to 100% hydrogen in phases starting in 2026, provided they get the green light from this policy. Two different pathways for decarbonising the heat supply of the region are outlined below: one where the existing mains gas network is converted to 100% hydrogen in the late 2020s and early 2030s, and one where there is only limited hydrogen available through the existing gas network and most buildings have to electrify.

[15] UK Hydrogen Strategy, see Appendix VIII

4.2.3 Electrified Heat Pathway

Assumptions

The projected heat electrification pathway assumes that there will be only minimal conversion of the existing mains gas grid in the region to hydrogen, and that this will not occur until after 2032 - presuming the 2026 UK government policy decision does not prioritise using hydrogen for heating homes and buildings. This would mean that the interim target for buildings converting to a low carbon heat source must be met by other means – primarily electrification.

This electrification would largely be through the use of the following technologies:

- **Heat pumps** – low temperature where a home is suitability insulated or can install larger radiators, and high temperature in less energy efficient homes or homes that cannot afford to replace their radiators. Heat networks would primarily use large scale air or water source heat pumps.
- **Direct electric or electric storage heating** – primarily in homes not suitable for any type of heat pump, or where the owner doesn't want to install a heat pump, although these technologies will likely have higher running costs. It is unlikely that heat networks will use either of these technologies.
- **Bioenergy** – only suitable for a limited number of homes in the region. Either biomass or bio-LPG in more rural areas with some pockets of the existing mains gas grid converting to bio-methane created from local anaerobic digestion. Some heat networks may use biomass or biogas if a sustainable local source is available nearby.

The projected changes to the demand of different fuels used for heating in this pathway is shown below.

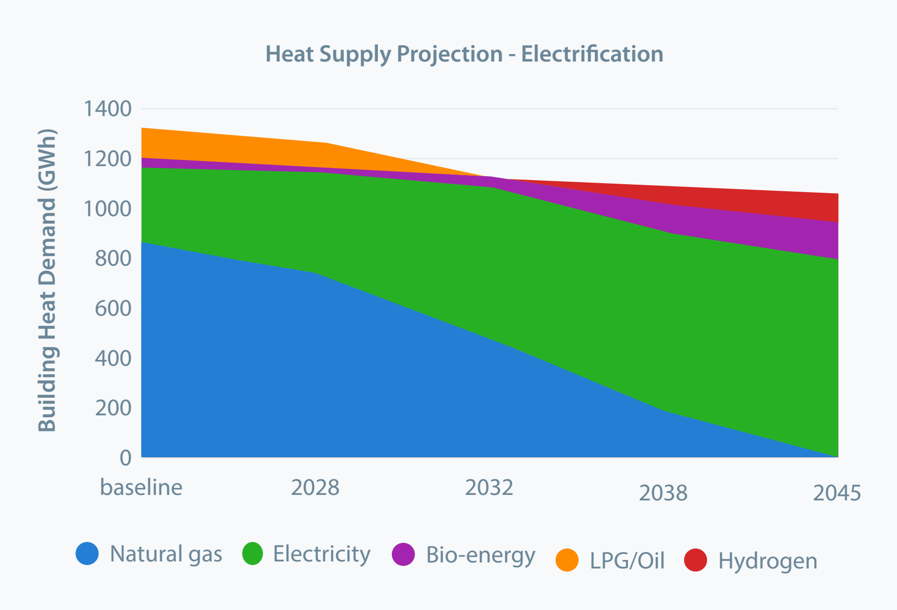


Figure 12: *Heat supply projection for electrification pathway*

Figure 13 opposite shows the assumed energy use across all sectors for the electrification pathway in 2045. Projections for the supply of buildings are taken from the assumptions outlined above, projections for Transport and Industry were taken from Scottish Government reports[15,16,] and information obtained from the stakeholder engagement.

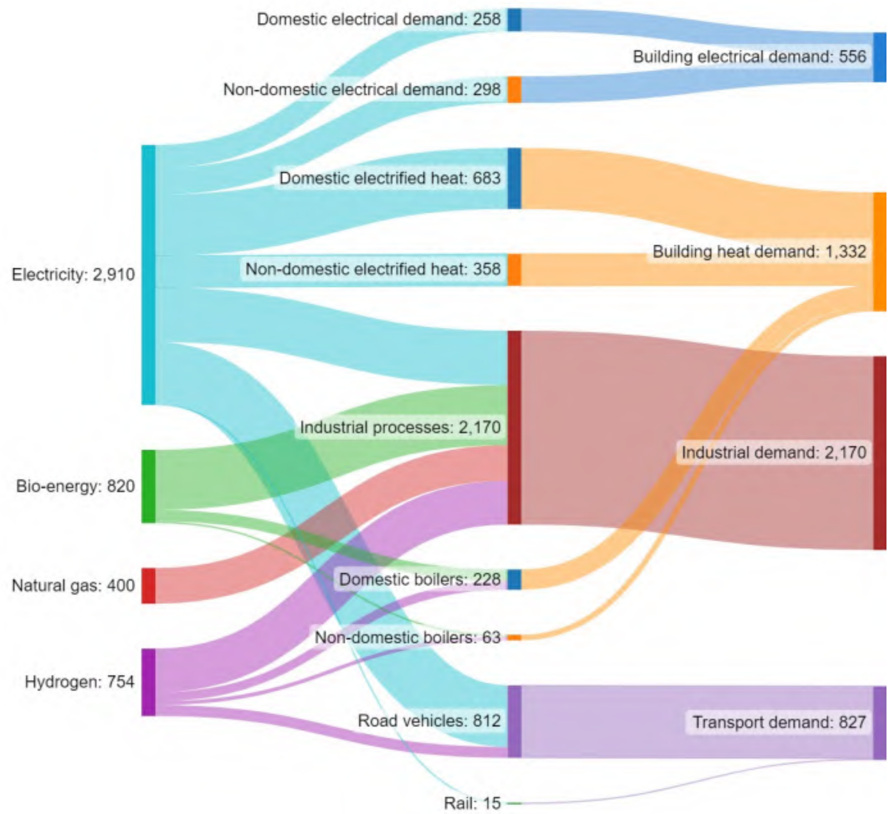


Figure 13: *Sankey diagram showing energy use in 2045 for the electrification pathway*

[15] Zero Emission Energy for Transport Report, available here: https://www.transport.gov.scot/media/51571/updated-zero-emission-energy-for-transport-forecasts-national-demand-forecasts-for-electricity-and-hydrogen.pdf
[16] Deep decarbonisation pathways for Scottish industries: research report, available here: https://www.gov.scot/publications/deep-decarbonisation-pathways-scottish-industries/documents/

Meeting KPI 6 – Pathway Heat Supply Graph Assumptions

2032 target: 80% of off gas grid homes currently using oil or LPG for heating have electrified, with the remaining 20% using some form of biofuel (biomass, bio-oil or bio-LPG), with 35% of homes currently connected to the gas grid electrifying.

2045 target: half of the homes still connected to the mains gas in 2032 have electrified, with the remaining half still connected to the mains gas grid, which has been decentralised with some small pockets using locally sourced blue and green hydrogen and some pockets using biomethane created from local anaerobic digestion.

Caveats

This pathway relies predominantly on existing proven technology and due to the highly decarbonised electricity grid in Scotland, could provide immediate significant carbon savings. However, if electricity prices do not drop in the coming years there would be risks of increased fuel poverty, particularly when homes on the gas grid that aren't well insulated change to a heat pump or electric resistive heating. This pathway would also require there to be drastic electrical grid upgrades by 2032, particularly in rural off gas grid areas, with electrical demand for heat in the region doubling from around 300 GWh per year to 600 GWh by 2032, then increasing to around 800 GWh by 2045.

Pathway Constraints and Specific Actions Required

Table 11 summarises the main barriers and constraints in the implementation of the electrified heat pathway and the required actions to address them.

Constraint	Action Required	By Who
The current grid capacity constraints in some areas will not be able to support the increased electrical demand from heating.	Identify areas where grid re-enforcement will be required and improve grid capacity. Work with other partners to determine heating electrification plans.	DNOs; Local authorities.
Lack of skilled and trustworthy heat pump installers.	Take action to fill the skills gap among workforce and to train a new generation of professional installers.	Scottish Government; Education Institutions.
Lack of communication between installers and DNOs when electric heating systems are installed, which does not allow them to account for the increased load, or required fuse rating upgrades, in their network planning.	Improve communication with installers and other partners involved in planning and implementing new electrical heating loads in the region.	DNOs – in partnership with various others, including Local authorities.
Lack of awareness for homeowners of available funding for low carbon heating, and correct operation of certain technologies.	Increase public awareness of available funding, trustworthy installers and best practise when operating technologies such as heat pumps.	Scottish Government - Home Energy Scotland; Local authorities (project specific).
Increased risk of fuel poverty when converting from a mains gas boiler to an electrified source, due to high electricity costs.	Place pressure on the UK government to decouple electricity prices from, or re-balance compared to, natural gas prices. If done regionally this would significantly reduce electricity prices in Scotland due to the large amount of renewable generation.	Scottish Government.

Table 11: *Electrification pathway specific constraints and actions required*

4.2.4 Hydrogen Conversion Pathway

Assumptions

The hydrogen pathway assumes that the UK Government confirms hydrogen as a priority for supplying heat to buildings and homes in 2026, and that there is a rapid conversion of the existing mains gas network to 100% hydrogen around the main trunk-line (which should be located nearby the region, to the East)[17]. In this pathway, it is assumed that all buildings currently connected to the mains gas network are supplied with hydrogen by 2045, with off-gas grid homes still predominantly electrifying their heat demands, and a smaller percentage of these homes using biomass or other bio-fuel boilers. Any district heating network with back up gas boilers, or some that are constructed after ~2030, will likely use hydrogen as a fuel source.

It should be noted that awaiting the UK Government policy decision must not delay the decarbonisation of heat across domestic and non-domestic buildings, and that any buildings suitable for a heat pump (or other electric or low carbon heating system) conversion before then should do so where technically feasible and cost-effective.

The projected changes to the demand of different fuels used for heating the region's buildings in this pathway is shown in Figure 14.

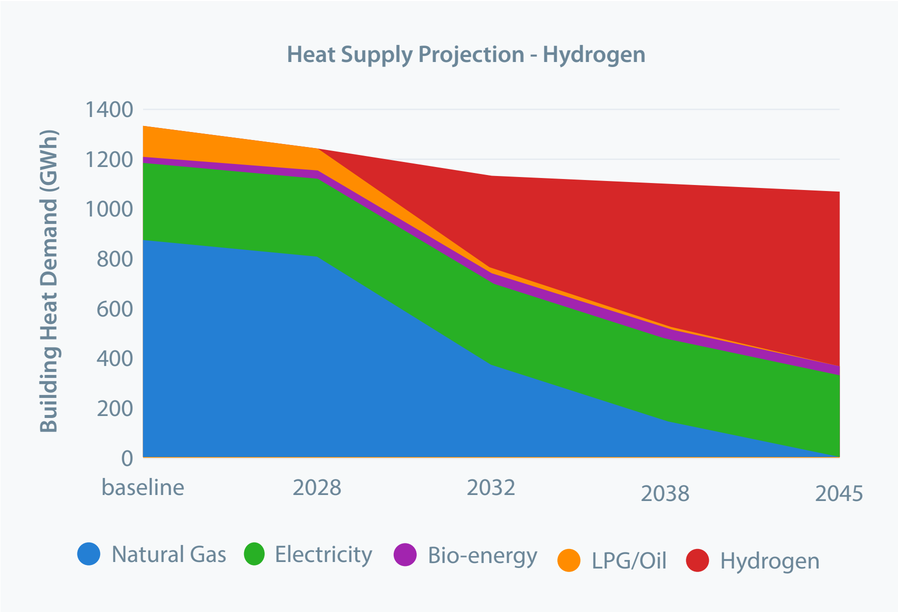


Figure 14: *Heat supply projection for hydrogen pathway scenario*

Figure 15 opposite shows the assumed energy use across all sectors for the hydrogen pathway in 2045. As for the electrification pathway, projections for the supply of buildings are taken from the assumptions outlined above, with projections for Transport and Industry taken from Scottish Government reports and information obtained from the stakeholder engagement.

[17] North East Network and Industrial Cluster Development, see appendix VIII

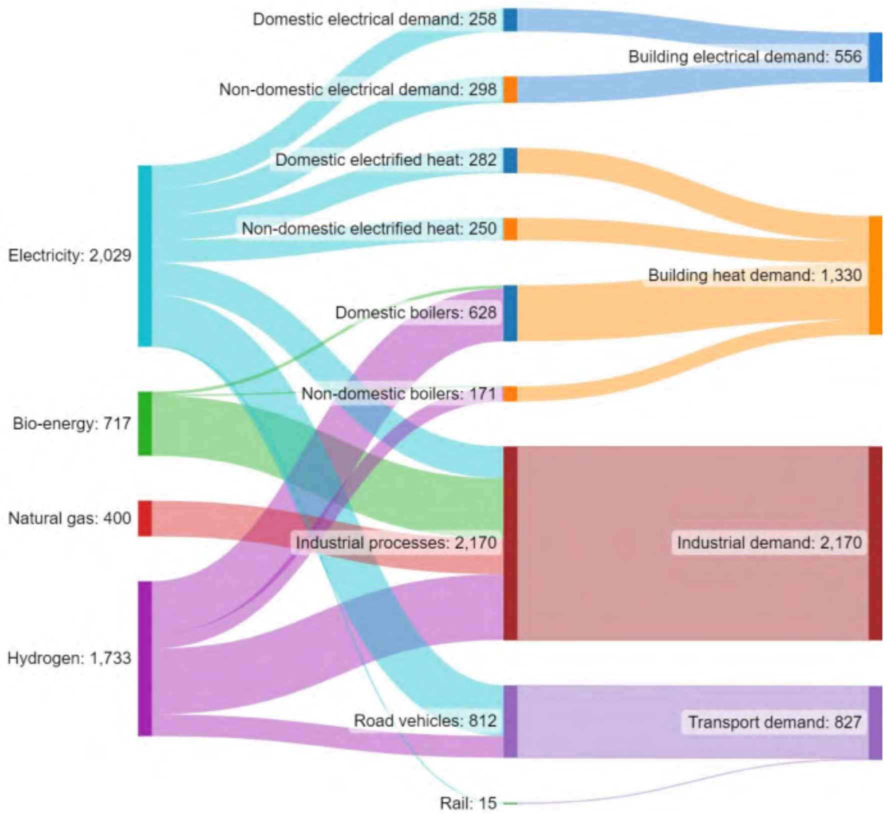


Figure 15: *Sankey diagram showing energy use in 2045 for the hydrogen pathway scenario*

Meeting KPI 6 – Pathway Heat Supply Graph Assumptions

2032 target: 50% of the existing gas network has been converted to 100% hydrogen. For this pathway it was assumed that by 2032 some off gas grid homes are still using oil and LPG, but most have decarbonised through electrification with a small number using biofuel.

2045 target: all buildings connected to the mains gas will be heated with 100% hydrogen and 80% of fossil fuel heated off gas grid homes will have electrified with the remaining 20% using biofuel.

Caveats

The hydrogen in this pathway will be a mix of both blue hydrogen created from natural gas using carbon capture and storage, and green hydrogen created from excess renewable generation at offshore wind farms and local renewable sites. It is expected that blue hydrogen will eventually be phased out by green hydrogen as large-scale renewable generation from off shore wind nation-wide ramps up. This pathway would require significant infrastructure upgrades to the existing mains gas network to allow it to be hydrogen ready, but it has been confirmed as feasible by SGN, pending the UK Government policy decision. Other experts in the field, it should be noted, do not believe that hydrogen will play a significant role in heat, and that it will be restricted to very limited cases.

Hydrogen Pathway Specific Constraints and Actions Required

Table 12 summarises the main barriers and constraints in the implementation of the hydrogen conversion pathway and the required actions to address them.

Constraint	Action Required	By Who
There is implementation uncertainty around widespread hydrogen use to heat homes, which the UK government plan to address in a policy decision due 2026.	Develop a phased natural gas to hydrogen conversion plan for the existing mains gas network, town by town in the region, in partnership with relevant parties.	Scottish Gas Networks; Local authorities (via open forum).
Not all homes on existing gas network may have a hydrogen ready boiler at time of network conversion.	Encourage any homeowners, landlords or businesses installing new gas boilers in the coming years to ensure that they are 'hydrogen ready', so that they do not need to replace their boiler when the gas network converts.	Scottish Government; Gas boiler installers.
Technical feasibility surrounding costs, gas pipe replacement, safety concerns, amount of green hydrogen resource available.	Study outcomes from pilot projects such as H100 in Fife. Use the developed open forum between businesses, DNOs, industry, community groups etc. to identify where potential renewable generation projects may be able to create green hydrogen from their excess generation, potentially avoiding grid constraints limiting capacity.	Scottish Gas Networks; Renewable energy developers; Local authorities.

Table 12: *Hydrogen pathway specific constraints and actions required*

4.2.5 District Heating

Technology Background

In a district heating network, instead of each property or building having their own heat generator (gas boiler, heat pump etc.) there is a central heat generator that heats water, which then gets pumped through underground pipes to nearby buildings. In areas with a high concentration of heat demand, it can often be a low-cost alternative to standard heating. This technology is commonly used in cities across Europe, particularly in the Nordic and Baltic countries. By supplying cheap low carbon heat, district heating can reduce both carbon emissions and fuel poverty. It also provides an excellent opportunity to take advantage of waste industrial heat that is otherwise lost, a vital resource for the future of heating.

One of the Scottish Governments' key targets as part of decarbonising heat is to increase the number of heat networks operating in Scotland, with 3% of national heat demand to be met through networks by 2028, and 8% by 2030[18]. They have setup a Heat Network Support Unit, to help local authorities and the public sector to plan, develop and fund the construction and commissioning of new heat networks. Generous funding is available for this, through the Heat Network Fund (see Appendix IX).

A variation on the concept of district heating is shared boreholes for Ground Source Heat Pumps (GSHP). Each property would have their own GSHP unit and ability to choose their energy supplier, but the source of the ambient ground heat would come from a shared borehole.

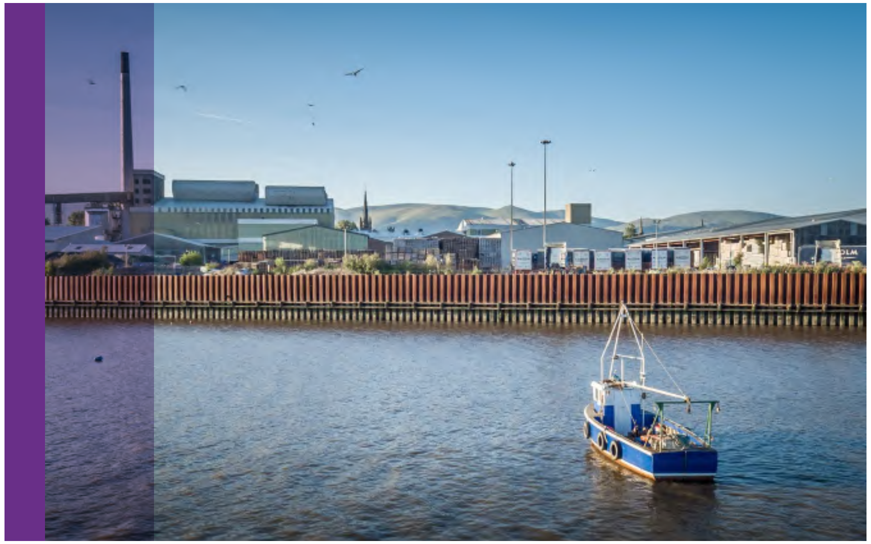
This leaves a role for the management and installation of the shared boreholes, which would suit local authorities, similar to developing district heat networks. There is an opportunity for both councils to be involved in case studies of this system to pilot the approach.

[18] Heat networks Scotland act, see appendix VIII
[19] First National Assessment of Heat Networks

Site Screening & Prioritisation

A Scottish Government investigation into district heating networks[19] identified 16 potential sites across Stirling and Clackmannanshire where district heating may be economically viable, due to high linear heat densities (a significant amount of heat demand across several buildings condensed into a relatively small area). In addition to these sites, a further 3 were identified which could be viable if waste heat from nearby industrial premises is utilised as a heat source, giving 19 potential sites in total.

These 19 sites were narrowed down further to determine which could be viable for construction in the short term. The main factor here was the number of council or social houses and public non-domestic buildings in the vicinity – as it can currently be difficult getting private homes and businesses to initially connect into a network. With public buildings as initial guaranteed heat consumers, private buildings can potentially connect later. The availability of anchor loads is also a key factor which will affect commercial viability. Sites where a district heating network already exists were excluded from the prioritisation process, but are considered for expansion in the delivery plan. This screening process narrowed the number of potential sites down to 9, see Figure 16 for a graphical overview.



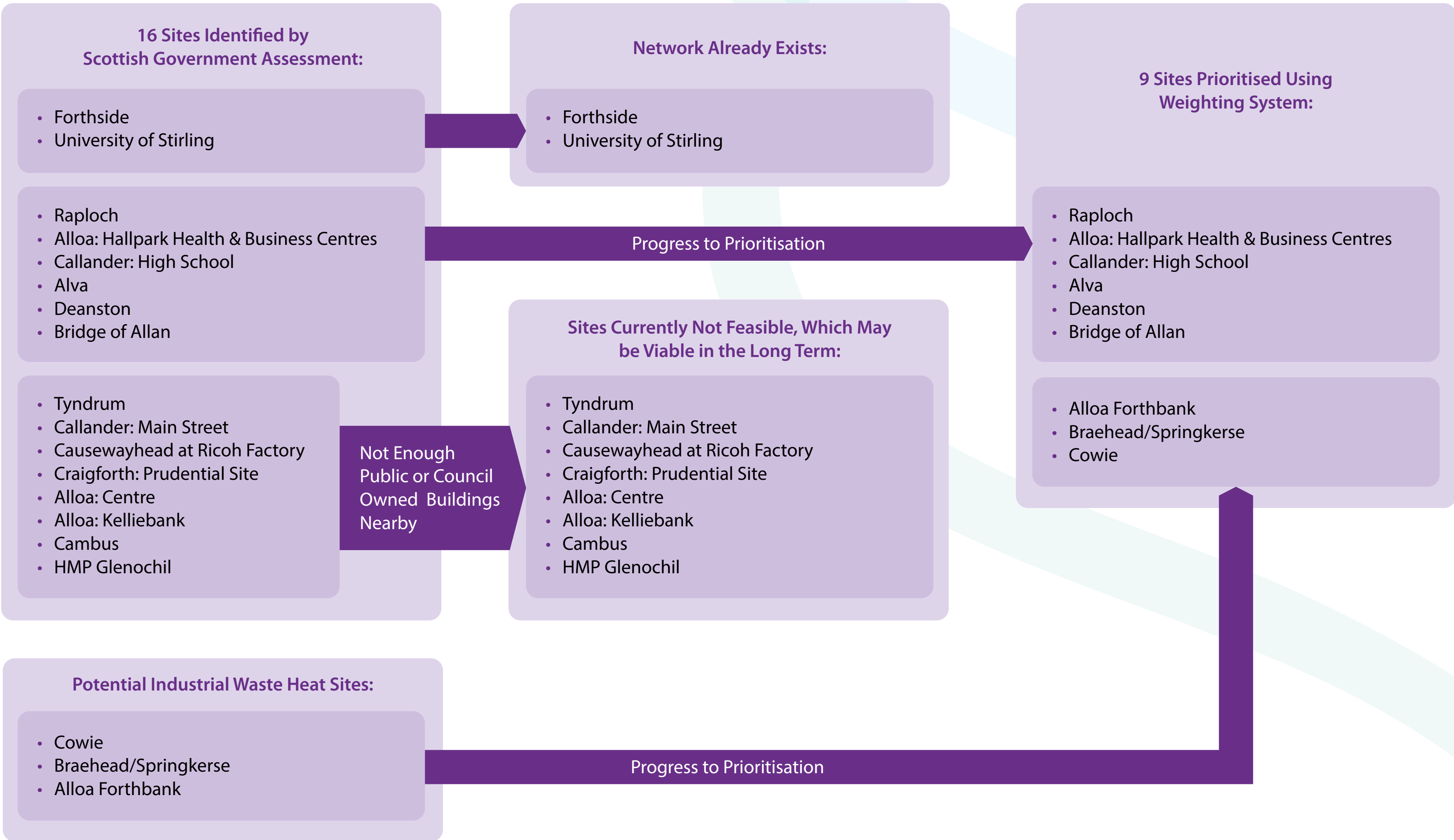


Figure 16: *Site prioritisation and screening for district heating networks*

These 9 potential sites were then ranked and prioritised using the Scottish Government weighting system, which was previously suggested for use in LHEES[20]. To provide inputs for these weightings, networks were modelled at each of these sites to get some initial high-level results – however unknown factors around which heat source would be used at each site, or exactly which buildings would be connected mean there was a high level of uncertainty in the outputs. Therefore, each criteria was provided a score using intervals of 0.5 (ranging from 1-5), as suggested by the Scottish Government for when detailed outputs for each criteria and factor are not available.
Each score is assigned relative to a 'do nothing' baseline, where a score of 3 means there would be no, or minimal, change in this criteria from the network construction, with values above 3 indicating a positive change, and below 3 a negative change. Some of the recommended factors to assess for each criteria were excluded for now, as not enough information was available for each site at this stage to inform even a qualitative assessment. Each criteria, their weighting and how their score was assigned is shown in Table 13.

For more technical details on potential district heating sites that were modelled including specific buildings, their heat demands and fuel types, and potential low carbon technologies used, see Appendix V.

[20] LHEES – previous draft guidance on strategy level socioeconomic assessments.
https://www.gov.scot/publications/guidance-strategy-level-socio-economic-assessments-draft-methodology/pages/3/

Heat Management

Criteria	Weighting	Score Assignment
Carbon Emissions	0.3	**Total annual carbon emissions possible from installing a low carbon heat network at the site:** **5:** >2000 tCO2e avoided **4.5:** 1500-2000 tCO2e **4:** 1000-1500 tCO2e **3.5:** 500-1000 tCO2e **3[21]:** 0-500 tCO2e
Fuel Poverty	0.3	**Average 'percentage risk of fuel poverty' value[22] for all the surrounding homes in each network site:** **5:** >35% **4.5:** 25-35% **4:** 15-25% **3.5:** 5-15% **3[21]:** 0-5%

[21] No values were provided below 3 on the assumption that no networks that increase fuel poverty or carbon emissions will be constructed.
[22] This variable is calculated by the Energy Saving Trust as part of their Home Analytics dataset.

Criteria	Weighting	Score Assignment
Financial	0.08	Two factors contributed equally to the final score: **Qualitative CAPEX. Based on the potential maximum length of pipework that would need to be installed, as this is often the highest cost element when constructing a heating network:** **3:** 0-1250m of pipework **2.5:** 1250-2500m **2:** 2500-3750m **1.5:** 3750-5000m **1:** >5000m **Potential OPEX. Site proximity to low carbon energy sources, such as rivers (for hydroelectric or WSHP) or industrial waste heat, which could significantly reduce the annual fuel and electricity costs required to operate the network:** **5:** two nearby sources **4:** one nearby source **3:** zero sources

Criteria	Weighting	Score Assignment
Local Economic	0.08	**3: all potential network sites.** It is currently too early to be able to compare potential jobs created, or skills supported and developed for the potential networks at each site. Or to assess whether there would be an increase or a decrease in these factors compared to the baseline where heat users continue to use fossil fuel boilers and electricity to heat their buildings.

Criteria	Weighting	Score Assignment
Local Environmental	0.08	Two factors contributed equally to the final score: **Changes in air pollutants** Assumed to be directly proportional to the fossil fuel heat demand reduction (this applies for the majority of low carbon heat technologies apart from biomass, where air pollutants may actually increase compared to some fossil fuel boilers). **Total fossil fuel heat demand of the buildings at the site:** **5:** >10,000 MWh **4.5:** 7500-10,000 MWh **4:** 5000-7500 MWh **3.5:** 2500-5000 MWh **3:** 0-2500 MWh **Change in noise level:** **3:** all sites with an available heat source such as a river or waste heat nearby. **2:** all other sites (due to the likelihood of the need for large air source heat pumps which can produce significant noise pollution).

Criteria	Weighting	Score Assignment
Social	0.08	**3: all sites.** The installation of district heat networks is unlikely to significantly alter any social factors. For any minor effects that do occur, such as thermal comfort, time available to work, or changes to recreational community space, it is again too early to be able to accurately predict these.
Resilience	0.08	Based on potential reductions in fuel imports, assumed to be proportional to fossil fuel heat demand reduction. **Total fossil fuel heat demand of the buildings at the site:** **5:** >10,000 MWh **4.5:** 7500-10,000 MWh **4:** 5000-7500 MWh **3.5:** 2500-5000 MWh **3:** 0-2500 MWh Regulatory requirements were excluded as it can be assumed that all networks would meet them, and reduction in energy demand was also ignored as generally installing a district heating network will not affect energy demands, just their supply.

Table 13: *District heating network site prioritisation weighting scoring method*

The table below outlines the weighted score for each of the 9 potential networks. It is important to note that for the Cowie and Braehead sites (and to a lesser extent, Alloa Forthbank), some of the scores are dependent upon waste heat from nearby industrial sites being available. If this were not to be the case then these sites would be less viable and would achieve a lower rated score.

Site	Carbon Emissions	Fuel Poverty	Financial	Local Economic	Local Environmental	Social	Resilience	Total Score
Score	1-5	1-5	1-5	1-5	1-5	1-5	1-5	
Weighting	0.3	0.3	0.08	0.08	0.08	0.08	0.08	
Raploch	5	4.5	3	3	4	3	5	**4.29**
Alloa Forthbank	4	5	3	3	3.5	3	4	**4.02**
Alloa Health & Business	4.5	4.5	2.25	3	3.25	3	4.5	**3.98**
Braehead	4.5	4	2.75	3	3.75	3	4.5	**3.91**
Callander	4.5	3	3.25	3	3.75	3	4.5	**3.65**
Cowie	3.5	4.5	2.75	3	3.25	3	3.5	**3.64**
Alva	3.5	4	2.25	3	2.75	3	3.5	**3.41**
Deanston	3	4	2.75	3	3	3	3	**3.28**
Bridge of Allan	3.5	3	3.75	3	3.25	3	3.5	**3.27**

Table 14: *Potential district heating network sites scoring*

Heat Management

Stirling

Raploch Site

The Raploch site has a large amount of fossil fuels currently being consumed for heating across domestic buildings, a college, office buildings, a care home and other non-domestic sites which could potentially connect. Relatively high levels of fuel poverty in the area also contribute to the sites' high score. A feasibility study for a district heating network in this area was previously carried out, and it was deemed to be unviable economically at the time, with the caveat that it could be viable in the future depending on factors such as available funding, electricity prices, heat sale prices, and the potential suitability for using water source heat pumps in the Forth.

Braehead/Springkerse Site

The Braehead site is likely dependant on heat being available from the nearby insulation factory, as there are currently no other potential low carbon energy sources in the vicinity (aside from using air source heat pumps). It was assumed that this network could provide heat for all of the non-domestic office, industrial and retail buildings located in-between the railway line to the west, the A905 to the North and East, and the Pelstream burn to the South. This area has a moderate amount of fuel poverty, contributing to its high scoring, however the houses near this site are across the railway line, which could significantly add to the potential construction costs if heat pipes were required to be installed either under or over the line. The site could be viable without a connection to the nearby domestic properties, but in this case there would be no fuel poverty reduction. A heat network here could also potentially connect into the existing Forthside network, were it to be expanded in the future.

Clackmannanshire

Alloa: Forthbank Site

The Forthbank site has high levels of fuel poverty in the nearby homes, and several large consuming non-domestic buildings in Alloa Academy and the various industrial and commercial properties along the banks of the Forth. There are significant opportunities for using low carbon energy sources here, with the possibility of extracting heat from both the nearby waste water treatment plant, and the Forth itself. There is also the possibility of installing renewables through hydroelectric turbines in the Forth and PV panels on the nearby areas of council land, to power the heat pumps that would be required to take heat from the Forth and/or the water treatment plant. These renewables could also be used to power any vertical farms which are currently being investigated for feasibility.

Alloa: Hallpark Health & Business Centres Site

This site focuses on the Hallpark Healthcare Centre, along with the offices, shops, and other non-domestic businesses located around the Beatson buildings and concrete supplies premises. It scores high due to having relatively high levels of fuel poverty in the nearby homes and a large amount of fossil fuels currently being consumed for heat in these buildings. The downside to this site is there is no obvious source of low carbon heat, so air source heat pumps would be the probable technology choice, which could potentially make both the investment and operational running costs too high to be feasible. Other potential low carbon heat sources that could be investigated further at this site are mains sewage pipes and abandoned mine shafts. Not enough data was available to determine if either would be viable but if a mains sewage pipe ran under the site or if there was enough water in the mine shafts beneath this site to be safely extracted for heat then either could potentially be a heat source option.

Constraint	Action	By Who
Installing district heating networks can incur very high capital costs.	Make use of funding available from Scottish Government, obtain detailed feasibility studies and business cases for highest ranked potential sites, progressing onto construction and commissioning if successful.	Local authorities.
Homeowners and private businesses can be reluctant to connect to heat networks, partially due to the lack of currently operational heat networks nation-wide.	Work to increase public awareness of how heat networks operate and the benefits that they can bring.	Scottish government; Local authorities (project specific).
No specific constraint.	Both local authorities to work with the Heat Network Support Unit to further develop heat network projects in the region.	Local authorities; Heat Network Support Unit.

Table 15: *Constraints and actions required for implementing district heating networks*

4.3 Energy Generation

Objectives	KPIs	Actions	Outcomes
Objective 3 Objective 4 Objective 5	**KPI 1** **KPI 3** **KPI 5**	Energy Generation **Actions**	Outcome 3 Outcome 4 Outcome 6 Outcome 7

Summary Box

As part of the route to net zero, generation of renewable energy brings major advantages for the local area and the council:

- Local energy supply resilience
- Income from projects to invest in other areas of decarbonisation
- Helping meet increased electrical demand.

New council planning policy following the publication of Scottish Governments National Planning Framework 4 will be vital for enabling projects, along with communication with DNOs around electricity grid constraint.

A key role for both councils is the development of local energy generation projects. There are a number of potential sites in council ownership.

Additional enabling actions, by the councils, Scottish Government and other partners include:

1. raising awareness of financial support available;
2. supporting communication and collaboration.

Energy Generation

Aims

Objectives

- **Objective 3:** Deliver a zero-carbon energy system for heating, power and transport while matching local demand with local supply, and contributing to national net zero generation
- **Objective 4:** Provide a resilient and secure energy supply
- **Objective 5:** Eliminate fuel poverty through improved energy efficiency and the provision of low cost, low carbon energy

KPI	Interim Target	2045 Target
KPI 1: % reduction in total carbon emissions from energy use	70% by 2030	Net-zero
KPI 3: % households in fuel poverty	Less than 15% by 2030	Less than 5% by 2040
KPI 5: % of total energy to be generated from renewables	50% by 2030	95%

Table 16: KPIs for Energy Generation

The Route to Net Zero

KPIs 1 & 5

The electricity grid in Scotland is already highly decarbonised, with an average carbon factor of around 55g/kWh in 2022, and 97% of the gross electrical demand met by renewables – currently Scotland has a total installed renewable capacity of 13.6GW, with a further 17GW awaiting construction or in planning. DESNEZ predict that the electricity grid across the whole of the UK will be considered net zero by 2035, with a carbon factor of only 5g/kWh, however it is likely that Scotland may reach this milestone earlier due to the high number of renewable installations currently in planning.

Despite this, further renewable installations will be required to meet the increasing demand from green hydrogen and the electrification of heat and transport. Large scale renewable projects in the regions, such as onshore wind, can contribute to national net zero generation. Battery storage at both the level of individual households and large projects will be essential.

Whilst planning and developing large scale renewable sites typically comes under the responsibility of the Scottish Government and energy companies, there is scope to develop mid-sized installations on areas of council owned land within the region. The sites with the best potential for renewable installations are discussed in Section 4.3.2.

Smart local energy systems (SLES) may have an important role to play, particularly in grid constrained and off-gas grid areas. They combine energy assets and infrastructure in local areas to enable smarter operation, and are a key consideration for local authorities and communities with the potential to lower bills, generate income and improve resilience.

Both councils will continue to consider these, and at the feasibility stage of a project and through business case development, the option of forming an SLES will be assessed and taken forward if it is the most valid option.

KPI 3

Support can be provided to community groups and local businesses who may wish to undertake both small and large scale renewable projects where a resource is available. This is primarily done through various funding sources operated by CARES (Community and Renewable Energy Scheme), see Appendix IX. Local renewable installations can be used to reduce energy costs for communities and businesses. There is scope for using income generated from renewable projects to help fund energy efficiency improvements in areas of high fuel poverty.

Energy Generation

4.3.1 EV Planning

The rollout for EV chargers as part of plans to decarbonise transport across the region will greatly increase the demand of low carbon electricity in the area. Renewable generation projects should be matched up to areas where there are likely to be high concentrations of EV chargers, where possible.

An initial assessment carried out for the region highlights the areas across both council areas where a high demand for EVs is anticipated, see the Figure 17 (It also shows the Falkirk council area, which is not included in the REM). This was based on actual and anticipated usage, accounting for usage such as tourism, shopping and commuting. EV demand in the more rural parts of Stirling and Clackmannanshire will be lower due to population density, shown by the blue dots. These areas also have more free demand capacity on the local network, so electrification of transport should be achieved with minimal grid upgrades. The red dots, representing expected areas of high EV demand primarily in and around Stirling and Alloa, are predominantly in areas where the grid has a large number of constraints. Therefore both local authorities will need to work with the DNOs to ensure that the grid will be able to handle the expected amount of additional demand from EV charging anticipated by both council's transport plans, alongside the expected increased demand from heat electrification and heat networks outlined in this document.

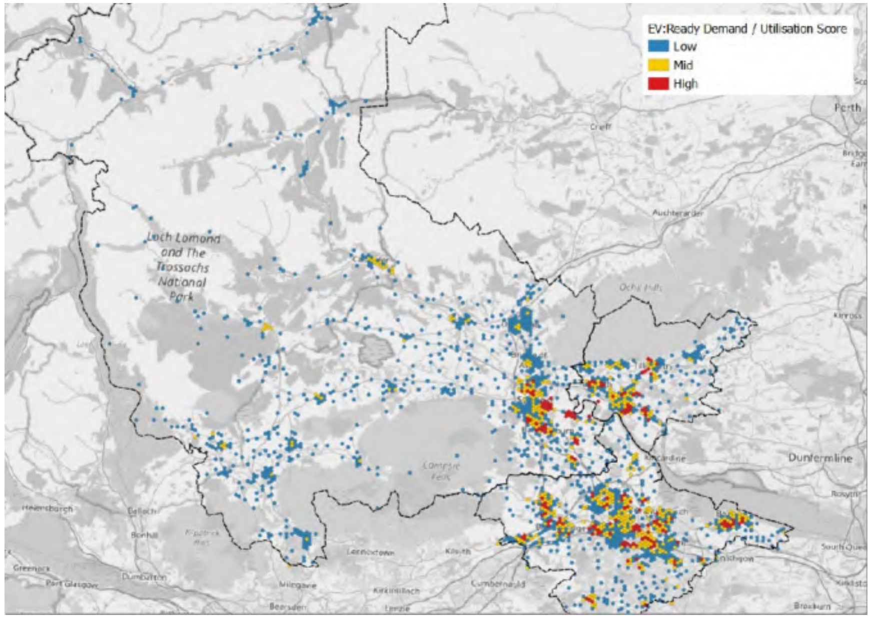


Figure 17: *Initial assessment for regional EV rollout*

4.3.2 Renewable Generation Site Screening and Prioritisation

The process followed to screen and then prioritise potential sites for renewable developments that the Stirling and Clackmannanshire councils could pursue is shown below.

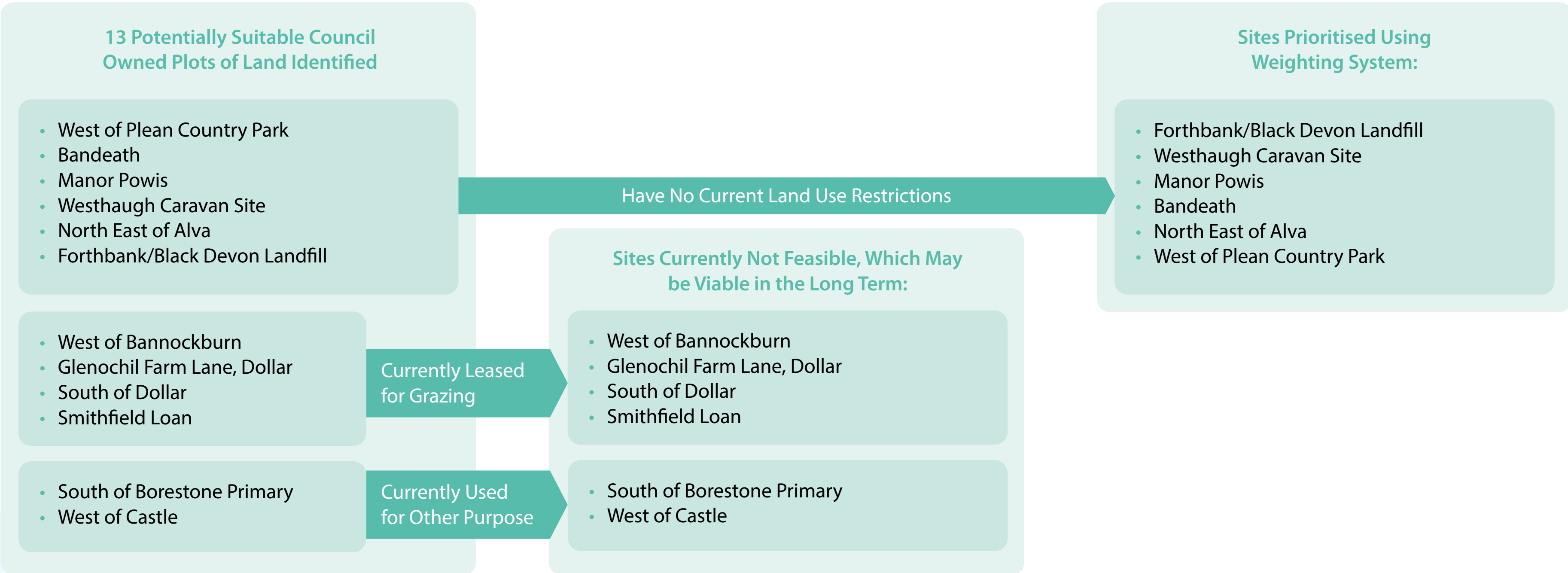


Figure 18: *Site prioritisation for renewable energy generation projects*

Initial Screening

First, maps of council owned land were studied to find locations which may be suitable for renewable developments – typically large fields, of which 13 were identified across both council areas. These were then investigated in further detail to determine the current land use, whether they are derelict, used for grazing, have a planning application pending etc. This allowed these areas of land to be sorted into sites which could be developed on now, and sites which may have to wait until a lease to a farmer ends or on the results of a pending planning application for an alternative use. This process identified 6 potential sites which could currently be developed for renewables.

Each individual site will be subject to feasibility assessment with consideration of all relevant factors such as planning requirements and impacts on historic assets. Various ownership models will be scoped at the feasibility and business case stages, such as community ownership.

Assumptions

Technology

Solar PV is assumed to be the primary technology that would be installed at each site for modelling purposes, but other technologies are also considered, as noted in the following criteria weighting table and further covered in the site specific descriptions. Battery storage can also be considered.

Amount of Land Used

It is also assumed that total available amount of land at each site would be used for PV panels, but this may not be possible at each site due to grid constraints.

Caveats

Grid Constraints

As outlined above, grid constraints may limit the total capacity able to be installed at each site

Private Wires to Local Business

To score the financial criteria outlined below, the number of nearby large consumers to each site that could potentially have a private wire connected to use the energy was assessed. However, it may be the case that not all of these private businesses would be willing to collaborate on such a project.

Fuel Poverty

It has been mentioned that income from these sites could be used to fund energy efficiency measures to reduce fuel poverty. However, this is reliant upon these projects having short payback times, as this income would be generated only after the initial investment was paid off.

Weighting Assignment

Similar to the identification of district heating sites in section 4.2.5, these 6 sites were prioritised using the same weighting system. However, the specific criteria and their weightings used in this instance were different from those used in the prioritisation of potential district heating sites. This was because at this early stage the specific renewable technology or technologies to be used at each site, as well as the end use of the generated electricity, was not known, so not all the inputs to the scoring system criteria could be calculated in the same way as for district heating. Potential end uses for any generated electricity include: selling back to the grid, sending to a local business or industry through a private wire under a PPA agreement, sending to a nearby district heating site through private wire, or converting to green hydrogen using electrolysis.

Energy Generation

Each criteria, their weighting, and how their score was assigned for each potential site is shown in the table below.

Criteria	Weighting	Score Assignment
Carbon Emissions	0.3	**Two factors contributed equally to final score:** **Total land available for development:** It was assumed that the amount of land available for PV panels or turbines etc. will be directly proportional to the amount of zero carbon electricity generated, and therefore emissions avoided. 5: >375,000 m^2 4.5: 300,000 m^2 – 3750,000 m^2 4: 225,000 m^2 – 300,000 m^2 3.5: 150,000 m^2 – 225,000 m^2 3: 0 m^2 – 75,000 m^2 **Potential for multiple generation sources:** It was assumed that if a site has more than one source of renewable generation, it will provide a more consistent output of clean energy throughout daily or seasonal weather cycles. 5: two or more technologies suitable at the site 4: PV and one other technology suitable 3: only PV feasible at the site

Criteria	Weighting	Score Assignment
Fuel Poverty	0.3	There is limited scope for renewable installations at this scale (several MWp) to directly affect fuel poverty, as the generated electricity cannot be used to reduce costs for specific homes on the grid (i.e. council or social homes, or those at most risk of fuel poverty.) Therefore impacts were based on district heating networks and the potential reduction of costs for customers from using generated electricity to power the networks' heat pumps. **Distance to the nearest potential or existing district heating network site:** 5: site less than 0.5 miles away 4.5: site between 0.5 and 1 mile away 4: site between 1 and 1.5 miles away 3.5: site between 1.5 and 2 miles away 3: site over 2 miles away

Energy Generation

Criteria	Weighting	Score Assignment
Feasibility	0.2	**Based on electricity grid constraints, using SPEN's traffic light system:** **3:** green rating on surrounding network **2:** amber rating on surrounding network **1:** red rating on surrounding network Note: even in the case of a private wire connections, grid constraint is a concern as excess generation is typically sent to the grid. Electrolysis with excess generation for hydrogen production may be a possibility to factor into weightings in future.
Financial	0.2	Based on the most likely profitable source of income; private wire connections to sell generated electricity to private consumers. **Number of potential large private consumers nearby:** **5:** 9 or more nearby sites **4.5:** 7-8 nearby sites **4:** 5-6 nearby sites **3.5:** 3-4 nearby sites **3:** 1-2 nearby sites Nearby buildings such as schools, colleges, industrial estates, large retails units etc. were all considered.

Table 17: *Method for scoring weightings criteria for energy generation projects*

Site Scoring

The table below outlines the weighted score for each of the 6 potential sites that could be used for a renewable development.

	Fuel Poverty	Carbon Emissions	Feasibility	Financial	Total Score
Score:	1-5	1-5	1-5	1-5	
Weighting:	0.3	0.3	0.2	0.2	
Forthbank/Black Devon Landfill	5	4.25	2	5	**4.175**
Westhaugh Caravan site	4.5	3.75	2	4.5	**3.775**
Manor Powis	4	4.5	2	3.5	**3.65**
Bandeath	3	5	2	4	**3.6**
NE Alva	4.5	3.25	2	4	**3.525**
West of Plean Country Park	3.5	3.5	2	3.5	**3.2**

Table 18: *Potential site for energy generation projects weighted score*

Forthbank/Black Devon Landfill

The highest scoring site is Forthbank in Alloa, where there is already land marked down for a potential PV array. There are a large number of potential consumers for the electricity nearby: Alloa Academy, the waste water treatment plant, several industrial sites along Forthbank etc. This piece of land lies next to the site where the energy centre for the potential district heating network would be, hence the high score on the fuel poverty criteria. There is also scope for any PV output to potentially be supplemented with hydroelectric or tidal turbines installed in the Forth.

Westhaugh Caravan Site

The second highest scoring is a field located near Westhaugh caravan site, between Alva and Sauchie. This site is located close to both GHP Glenochill, and the site of the potential heat network at Alva which includes the secondary school and the retail units in the industrial estate. Electricity generated could be used to power both the buildings and the potential heat network, hence the relatively high financial and fuel poverty scoring.

Manor Powis

Manor Powis is the highest scoring site in the Stirling council area, however it lies close to the boundary between Stirling and Clackmannanshire, so any energy generated would likely be used by both councils. It is located roughly 2-3 miles away from both the existing Forthside district heating network in Stirling, and the potential Forthbank network in Alloa, so electricity generated could be used at either or both sites if a private wire was constructed. There aren’t many high consuming buildings within a close vicinity to this site, hence its lower scoring on the financial criteria.

Bandeath

The second highest scoring site in Stirling, is Bandeath. This site is relatively large, with a moderate amount of space for potential energy generation. It is on the banks of the Forth and located away from dense areas of buildings or trees so could be suitable for wind or hydro in addition to any PV arrays. These two factors contributed to the scoring of 5 on the carbon criteria, however it is located quite far away from any potential district heating network sites, resulting in the lower score for fuel poverty.

4.3.3 Constraints and Actions Required

Constraint	Action	By Who
No specific constraint.	Develop feasibility studies and business cases for solar PV farms, and any other suitable renewables, on appropriate pieces of council owned land. Investigate feasibility of land currently leased out as potential long-term projects.	Local authorities.
Grid constraints limiting amount of generation capacity that can be added to the network in some areas.	Create an open forum to facilitate conversation between the region's DNOs and large consumers so that all appropriate grid upgrades and re-enforcements required for future plans such as renewable installations and electrification of heat are set in motion. Track all actions and engagements arising from this forum.	Local authorities and various potential partners; Scottish Government: Community And Renewable Energy Scheme; DNOs.
	Through the forum, facilitate conversations between potential generators of electricity, potential consumers, and the DNOs to help match up where a private wire may be beneficial for all parties compared to a grid connection.	
Lack of, and inconsistencies in, available funding measures.	Work to raise awareness of available funding for renewable installations for households, community groups, SMEs and charities, as well as the potential benefits and energy bill reductions they can bring.	Scottish Government; Local authorities (current planned activities/ project specific) and associated funding bodies.

Energy Generation

Constraint	Action	By Who
Planning process identified by some stakeholders as being slow and bureaucratic, delaying or rejecting certain projects on technicalities.	Planning authorities to support renewable proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted National Planning Framework 4 (NPF4) and any Local Development Plan for the area.	Local authorities.
Lack of expertise and resources in non-domestic sector could be addressed through joint procurement exercises, leveraging economies of scale.	Investigate the viability of mass/joint procurement projects – where either council may facilitate procurement and installation of energy improvements on multiple non-domestic buildings in an area and use proceeds as payback.	Local authorities.
No specific constraint	Work with communities to support and help develop where possible any net zero energy projects they identify	Local authorities; communities.

Table 19: *Energy generation constraints and actions required*

4.4 Sequestration

Summary Box

As the final tier in the energy hierarchy, sequestration must be a last resort, but projections show that it will still be essential to meet net zero. Particularly for agriculture and industry, where some systems cannot be decarbonised.

Tree-planting and woodland restoration will be vital, along with peatland restoration and land management changes

We have calculated that we will require between 67 and 180 ktCO2e to be sequestered across the region to account for residual energy related emissions by 2045 in order to reach our net-zero target. This equates to between 3,190,400 and 8,571,429 trees planted.

The key actions for both councils are and will be addressed in respective nature plans*.

Additional enabling actions, by the councils, Scottish Government and other partners include:

1. Determining the carbon sequestration of the regions' peatland.
2. Determining the carbon sequestration of rewilded landscapes.
3. Supporting land management change.

*See policy Appendix VIII

Sequestration

4.4.1 Context

In order to meet KPI 1 and have energy use across all sectors in the region fully net-zero, some additional carbon sequestration will have to occur. The further decarbonisation of the electricity grid, and the potential of blue and green hydrogen as a large-scale national resource, combined with the actions outlined in this masterplan will ensure that by 2045, energy used for heat and electricity in buildings is virtually net-zero - however there will still be a small amount of emissions from grid electricity and hydrogen creation.

Both council's Climate and Nature Emergency plans cover at a high level the decarbonisation of other sectors such as transport, farming, industry, land use, etc. as well as plans for other climate concerns such as resource efficiency, biodiversity and climate adaptation.

Both councils local transport plans will also provide the actions required to decarbonise transport in the region. Stirling council's Alive with Nature Plan and Forestry and Woodland Strategy, and Clackmannanshire council's Biodiversity Action Plan will help to reduce emissions from farming and land use.

However, some emissions from farming and large industry will be unavoidable, unless there are significant technological breakthroughs in the next two decades. Therefore, to be fully net-zero, a significant amount of carbon sequestration will almost certainly be required.

4.4.2 Amount of Sequestration Required

The figure below outlines the potential scale of carbon sequestration required in 2045 for a best and worst case scenario, compared to both the current baseline and projections for 2032.

Region Wide Projected Emissions Breakdown

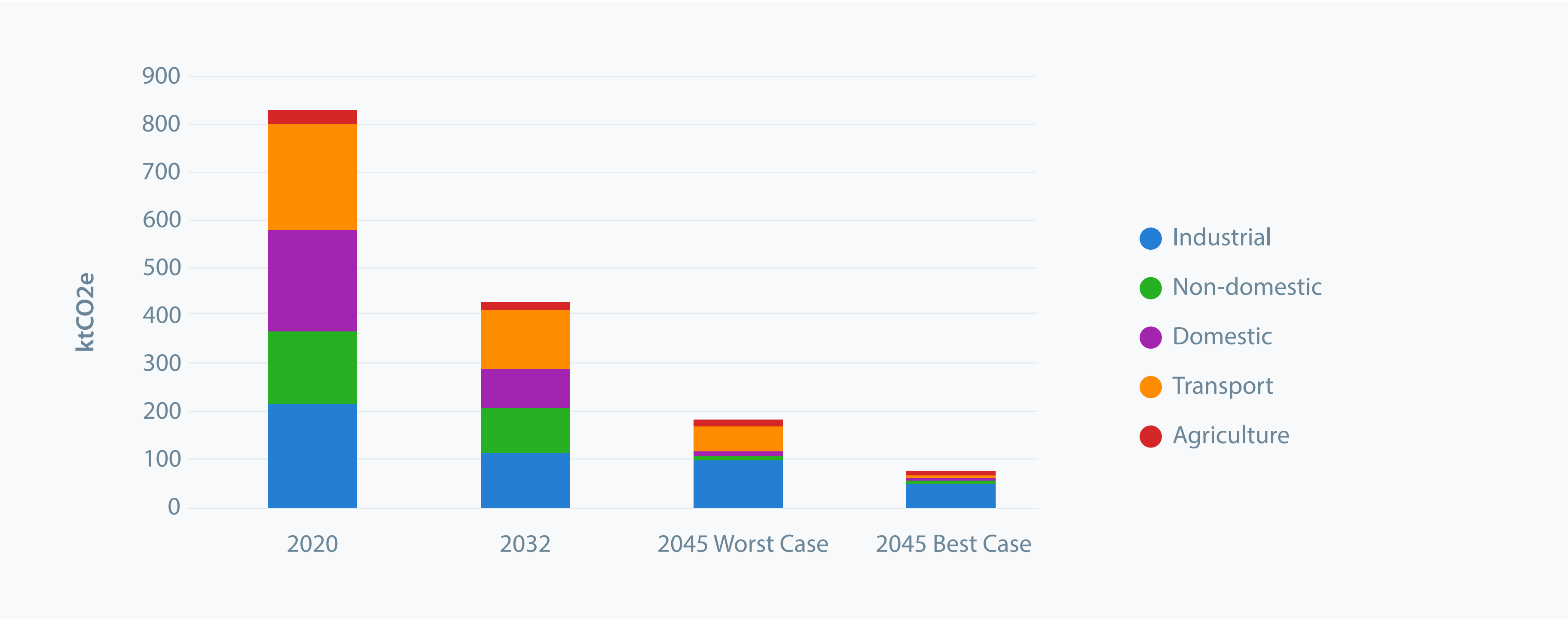


Figure 19: *Regional total emissions projection across all sectors, showing total sequestration required*

Sequestration

The projections for domestic and non-domestic heat and electricity use were obtained through the modelling work, assuming that the REM KPIs and national targets for retrofit, heat system replacement, etc. are met. The projections for transport are based on projections from Stirling and Clackmannanshire councils and the Scottish Government. The projections for industry are based on a report by Element Energy undertaken for the Scottish Government[23,] and for farming they follow decarbonisation projections from the National Farmers' Union[24]. For more details on the assumptions for the emissions of transport, farming and industry see Appendix VII.

The best case scenario for 2045 assumes all other KPIs and targets outlined in the REM have been met. The worst case scenario for 2045 assumes that all targets directly within the councils' control are met, but that private buildings (owner-occupied homes, non-domestic commercial buildings) and energy consuming processes such as industry and farming are slower to decarbonise and do not meet the required 2045 targets. This case also assumes that some forms of transport, such as heavy good vehicles have not managed to fully decarbonise.

Table 20, compares the estimated amount of sequestration needed to reach net zero, for both 2045 scenarios.

The total number of adult trees that would be required to sequester this much carbon is also provided. It is important to note here that the sequestration rate of trees grown for biomass will be much less than that of permanent adult trees.

Scenario	Regional Carbon Emissions (ktCO2e)	Assumed Carbon Absorption Rate (kgCO2e Per Adult Tree Per Year)	Number of Trees Required
2045 Best Case	67	21	3,190,400
2045 Worst Case	180	21	8,571,429

Table 20: *Indicative total sequestration required for best and worst case scenarios*

It is also important to note that this sequestration will not be met entirely from tree planting, the numbers above are to be used as an indication (and comparison between future projections) of the likely scale of the challenge required, even if all other KPIs are met and required actions carried out. There will also be opportunities to sequester significant amounts of carbon through the re-wilding of landscapes, particularly peatlands.

[23] Deep Decarbonisation Pathways for Scottish Industries, Element Energy.
[24] Net zero and agriculture, NFU.

4.4.3 Opportunities

Peatland Restoration

There are several large areas of peatland, peat soil and peat bogs across the region which, if sufficiently reclaimed or re-wetted, have the potential to store significant amounts of carbon. The exact rates of sequestration in tCO2e per meter square vary by location depending on a number of factors including the concentration of peat in the soil, the amount of vegetation present and the amount of moisture contained in the soil. Research suggests that peatland restoration in the UK will be a more efficient method of sequestration, both financially and in terms of land use, compared to tree planting alone. Sites with significant potential for re-wetting include the land east of Callander and north of Doune, all across the Ochil Hills particularly around Ben Buck, the Campsie Fells, Fintry Hills, Gargunnock Hills, and several more sites located within the Loch Lomond National Park.

A map showing all potential peatland restoration sites in both council areas is shown in Figure 20, taken from the Scottish Government's carbon and peatland map[25], with pink and yellow areas representing the highest potential land for peat restoration, blue indicating some potential, and green and grey representing other soil types and non peatland.

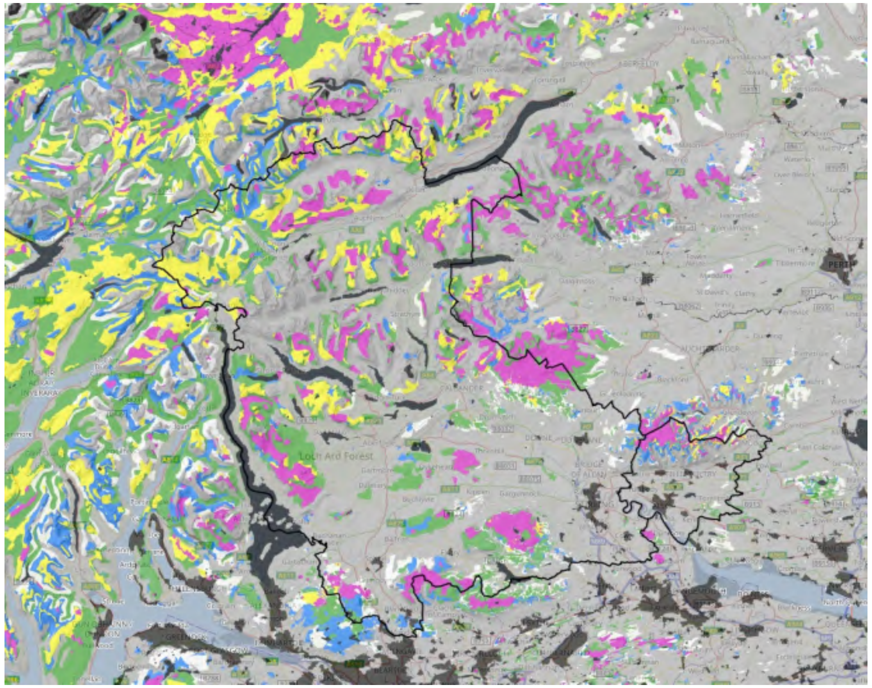


Figure 20: *Region wide map showing potential for peatland restoration*

[25] Available here: https://map.environment.gov.scot/Soil_maps/?layer=10#.

Tree Planting

Tree planting across the region will also be an important method for sequestering any remaining residual carbon emissions, alongside peatland restoration. Both councils already have tree planting plans and pollinator strategies which will act to sequester carbon from increasing tree cover and vegetation in the region. Projects such as the Forth Climate Forest also have potential to sequester large amounts of carbon through wide-scale tree planting. Figure 21, taken from Stirling and Clackmannanshire's forestry and woodland strategy[26], shows the current areas of land being targeted for tree planting. It is important that both councils act to quantify the number of annual emissions likely to be sequestered from current tree planting plans, and potential peatland restoration, so that the magnitude of any additional tree planting required can be determined.

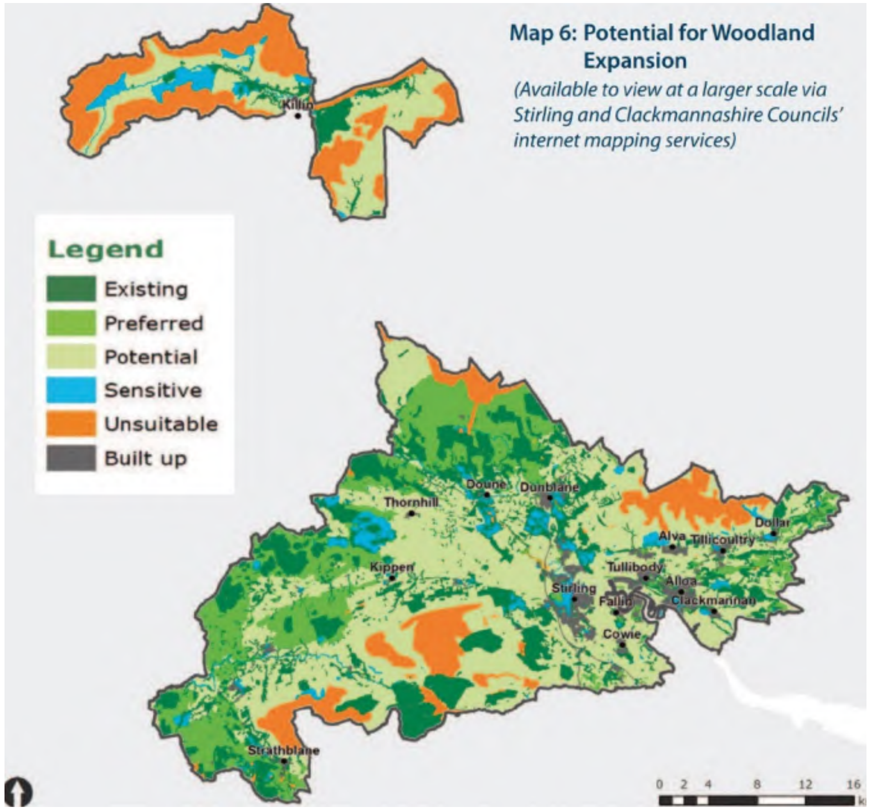


Figure 21: Region wide map showing current prioritisation of land for tree planting

[26] Available here: https://www.stirling.gov.uk/media/uhcjiskp/sg-forestry-29-5-2019.pdf.

Land Use and Land Management

Changes to land use and management can help to sequester more carbon. Examples include polycropping, no plough methods, planting perennial crops, changing fertilisers that are used, and stopping the burning of heather (muirburn). It is likely that most of this sequestration will be used to offset emissions in the agriculture sector, as opposed to energy use, however it will still contribute in the overall pathway to net zero.

There is also potential for energy generation sites to sequester carbon with different management and design techniques, such as raising PV panel heights to enable reduced mowing, or peatland management plans for windfarms, increasing biodiversity and soil carbon content.

4.4.4 Actions Required

For further details on the following actions see Stirling and Clackmannanshire Council's respective Alive with Nature Plan, Biodiversity Action Plan, and subsidiary documents.

- Work with the NatureScot, SEPA, the Loch Lomond and Trossachs National Park, Peatland action and any appropriate landowners to ensure that all suitable peatland across the region has a re-wetting strategy, to sequester carbon, improve biodiversity, improve water quality and reduce flood risk.
- Perform a study to attain high accuracy estimates of the likely total annual carbon sequestration rates that could be achieved from re-wetting all suitable peatlands across Stirling and Clackmannanshire. This will include soil surveys for all appropriate peat and bog land in the region. Stirling University has already begun this process, deploying sensors on peatland to measure carbon exchange.
- Develop a tree planting strategy to cordon off suitable areas of land across the region, required for sequestration through tree planting in order to offset any remaining emissions present in 2045, that are not already sequestered from peat land restoration or existing tree planting plans.
- Work with the Forth ERA (Environmental Resilience Array) to integrate data with the digital twin model where appropriate.

5 Delivery Plan

In this section, the actions required outlined in the previous section are prioritised into a delivery plan, spanning four phases, each five years long (2023-2028, 2028-2033, 2033-2038, 2038-2045). The final phase is slightly longer than the others, as the hardest actions will be towards the end, once all the 'quick wins' have been achieved. The actions and projects for each phase are split into three workstream areas: energy efficiency, heat management and energy generation. Where there are multiple potential sites for a given project type, i.e. district heating, they have been prioritised based on their weighted score outlined in the previous section. Throughout the delivery plan tables the lead responsible party is shown in bold under the 'Who is Responsible' column. A high level roadmap of the actions required to reach net zero is provided in Figure 22.

Figure 23 highlights the projected carbon reduction, provided all of these actions and projects are completed, for the region's building's energy use. Emissions due to transport, farming and industry are not shown here, as each of these areas have their own decarbonisation plans, either at local authority or national level, and the actions here apply almost exclusively to decarbonising domestic and non-domestic energy use. The decarbonisation projections for these other sectors, and the likely sequestration required by 2045, is investigated in Section 4.4 and Appendix VII.

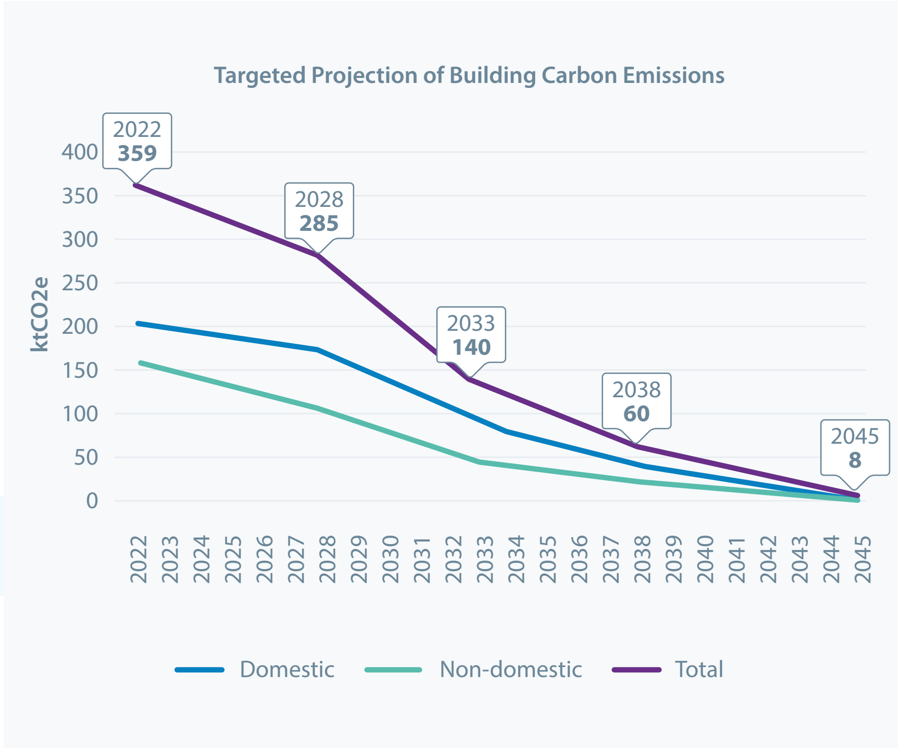


Figure 22: *Projection of building carbon emissions if all targets are met and actions required carried out*

RouteMap to 2045

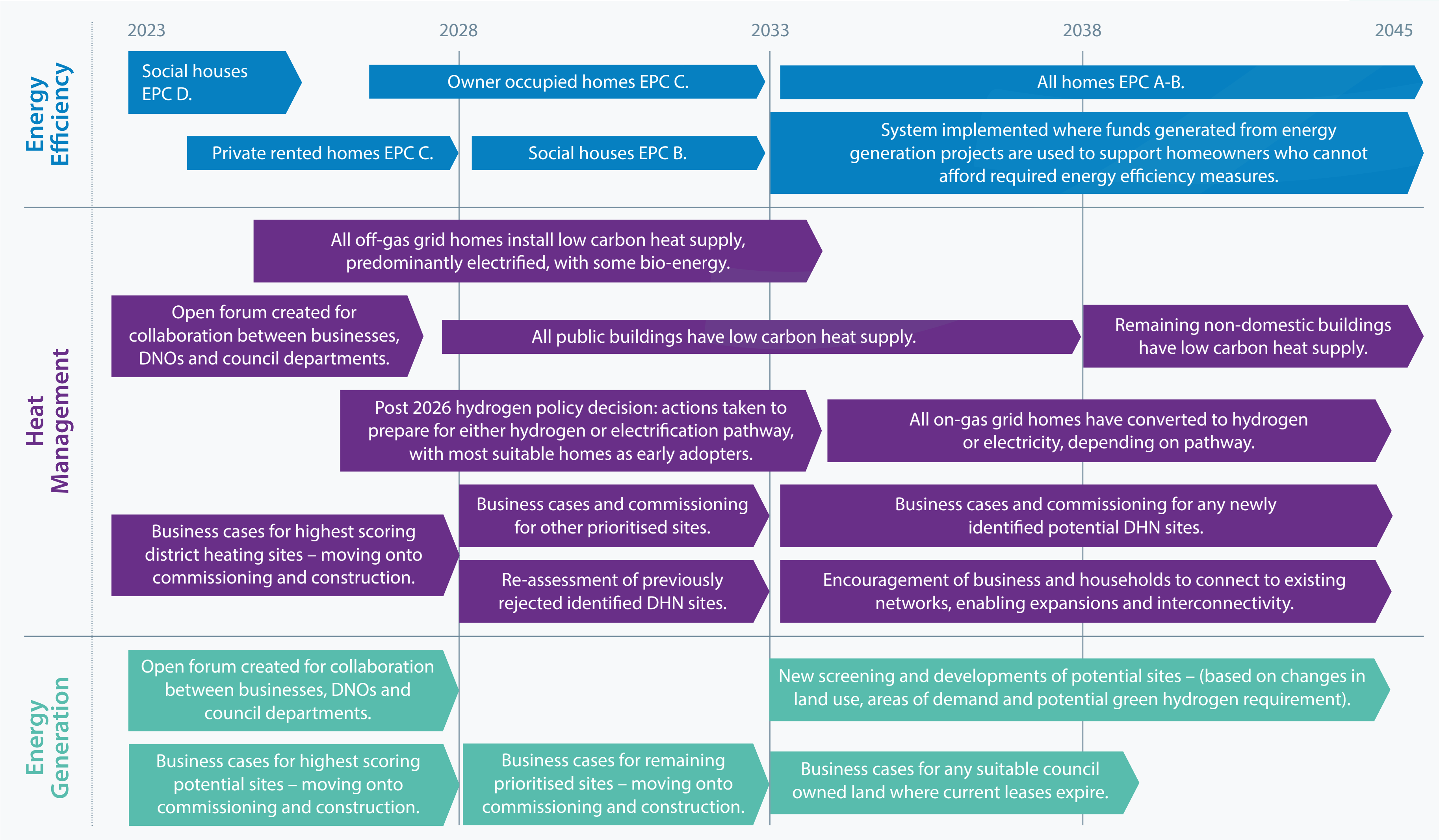


Figure 23: *High level routemap to 2045 of actions required to decarbonise energy use in the region*

Everyday Energy and Carbon Figures

In the following tables in this section, there will be references to electricity and heat generated by potential projects, as well as carbon savings.

Listed here are some useful equivalent values, which may make it easier to put some of the figures listed in the REM into context.

DAY

Amount of electricity used by typical UK home in a day:
7.9 kWh

DAY

Amount of natural gas consumed for heating a typical UK home in a day:
32.8 kWh

Amount of electricity used to boil a full kettle:
0.19 kWh

YEAR

Amount of electricity used by typical UK home in a year:
2900 kWh

YEAR

Amount of natural gas consumed for heating a typical UK home in a year:
12,000 kWh

Amount of carbon emitted by typical petrol car in UK per year:
14.36 tonnes CO2e

Amount of carbon sequestered by one adult tree in a year:
22 kilograms CO2e

5.1 Ongoing Actions

Some enabling actions will have to be carried out continuously throughout the duration of the masterplan to ensure that targets are met. These are listed in the table below.

Work Stream	Action	Who is Responsible	Objectives	KPIs
Energy Efficiency	Increase awareness among home and business owners of available funding resources and support for installing energy efficiency improvements.	**Currently Scottish Government;** Home Energy Scotland; Future Public Energy Agency	1,2,5	2,3,4
	Take action to increase the number of skilled installers in the region, to help towards closing the skills gap.	**Scottish Government;** Educational Institutions	1,2,5	2,3,4
	Planning authorities to support retrofit proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted National Planning Framework 4 (NPF4) and any Local Development Plan for the area. This includes proposals for historic assets, including listed buildings, where proposals do not negatively impact on their character, appearance and/or setting.	**Local authorities;** Scottish Government (through national planning framework 4)	1,2,5	2,3,4

Work Stream	Action	Who is Responsible	Objectives	KPIs
Heat Management	Raise awareness of homeowners, private landlords and SMEs of the financial incentives and support available for low carbon heating systems, and target this support on the areas most suited to specific technologies (see Appendix IV).	**Currently Scottish Government;** Home Energy Scotland; Energy Saving Trust; Local authorities (district heating networks)	3,4,5	4,5,6
	Planning authorities will support retrofit proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted National Planning Framework 4 (NPF4) and any Local Development Plan for the area. This includes proposals for historic assets, including listed buildings, where proposals do not negatively impact on their character, appearance and/or setting.	**Local authorities**	3,4,5	4,5,6
	Use the open forum (see energy generation – phase 1) between business, DNOs, industry, community groups etc. to discuss feasibility of district heat networks and potential waste heat supply and connection	**Local authorities and various potential partners;** DNOs; private companies; communities	3,4,5	4,5,6

Work Stream	Action	Who is Responsible	Objectives	KPIs
Energy Generation	Use the open forum (see energy generation – phase 1) between business, DNOs, industry, community groups etc. to facilitate conversations and help match up where a private wire may be beneficial for all parties compared to a grid connection, tracking all actions and engagements.	**Local authorities and various potential partners;** Scottish Government; Community And Renewable Energy Scheme; DNOs	3,4,5	1,3,5
	Work to raise awareness of available funding for renewable installations for households, community groups, SMEs and charities, as well as the potential benefits and energy bill reductions they can bring.	**Scottish Government;** Community And Renewable Energy Scheme; Local authorities	3,4,5	1,3,5

Work Stream	Action	Who is Responsible	Objectives	KPIs
All	Continuously update the digital twin model to produce a separate data set for public access. This will be used to highlight the councils' plans and actions, providing information to prospective developers, the public, and allowing for co-ordination with planning departments.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Update and review REM each phase.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Develop solution to match homeowners, landlords and businesses with trustworthy, skilled installers for energy reduction and decarbonisation works.	**Currently Scottish Government**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Take action to close the skills gap regarding the number of installers for certain low carbon heating technologies, energy efficiency improvements and renewable generation.	**Scottish Government;** Educational Institutions	1,2,3, 4,5,6	1,2,3, 4,5,6
	In addition to actions where responsibility is assigned to 'Currently Scottish Government', any overall delivery gaps resulting from lack of funding or negative business cases will be addressed as the REM is reviewed and the delivery plan updated.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6

Work Stream	Action	Who is Responsible	Objectives	KPIs
All	Use digital twin model to target areas for delivery of any other future projects.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Work with communities to support and help develop where possible any net zero energy projects they identify.	**Local authorities;** Communities	1,2,3, 4,5,6	1,2,3, 4,5,6
	Use digital twin model to target any future retrofit funding schemes.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Use digital twin model to target any future awareness raising, for example to property types, communities or areas, etc.	**Local authorities**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Work with Scotland's International Environment Centre (SEIC) where possible as a key regional partner. In particular to support businesses with transition planning, deploying innovative technology and enhancing natural sequestration.	**Local authorities and SEIC equally**	1,2,3, 4,5,6	1,2,3, 4,5,6
	Integrate the Forth ERA (Environmental Resilience Array) data with the digital twin model where appropriate.	**Local authorities and Stirling University equally**	1,2,3, 4,5,6	1,2,3, 4,5,6

5.2 REM Actions and Projects Phases

The actions required to reach a net zero energy system in the region are outlined below, split into 4 time phases. Note that all projects at specific sites listed in the tables below will be dependent upon more detailed feasibility studies and business cases being completed. Where a project doesn't progress beyond feasibility or business case stages, projects later in the programme may be brought forward, or new, previously unidentified projects which have become viable may be considered. For more details on specific funding sources and mechanisms mentioned in these tables, consult Appendix IX. Funding sources are those available at time of writing (early 2023) and are liable to change as time progresses.

Prioritisation

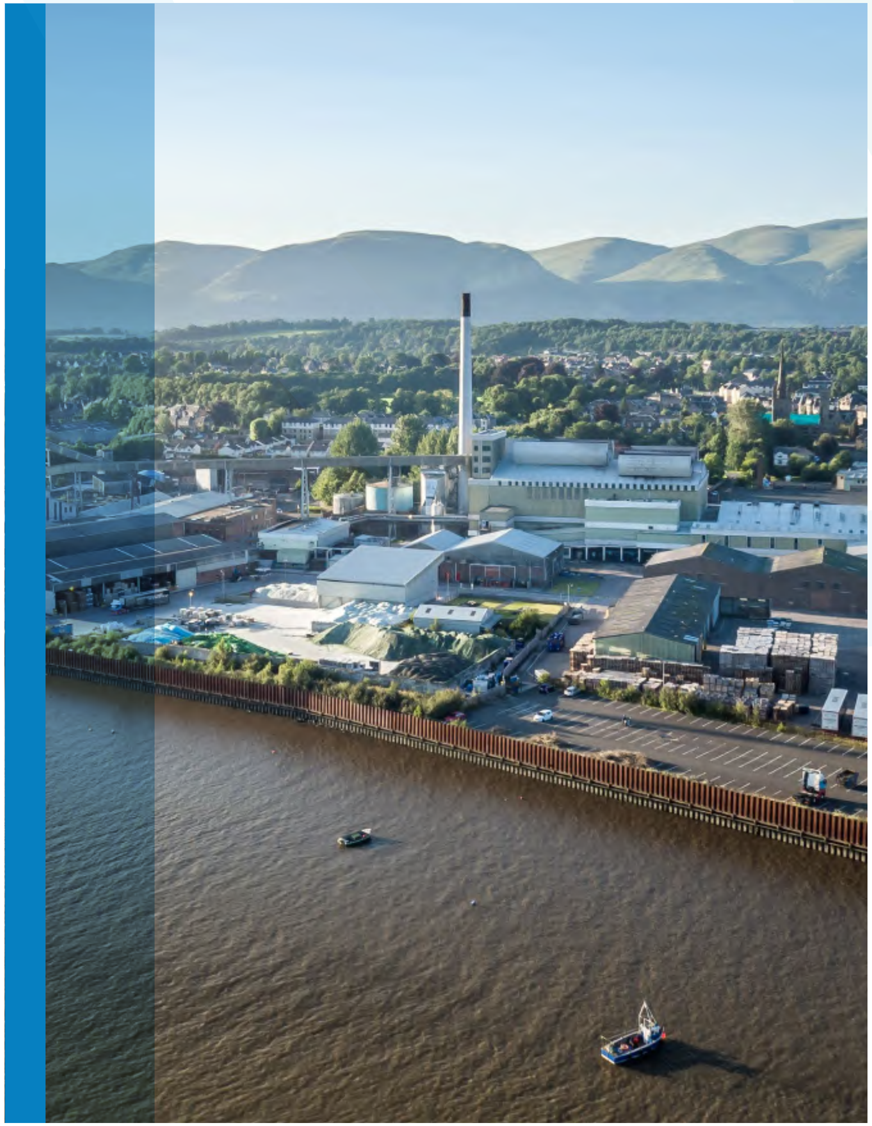
- For each work stream section (Energy Efficiency, Heat Management, Energy Generation) in the following tables, projects and actions which have a legally binding cut-off date based on current Scottish Government targets have been prioritised and are located at the top of each table.
- District heating and energy generation projects which have a specific site, have been ordered based on their weighted score, as outlined in section 4.

Data

- The carbon saving estimations for energy efficiency improvements, district heating projects and energy generation projects have been calculated directly from the modelling work on the digital twin, see Appendices V, VI, VII for technical details. Appendices III and IV contain estimations on the number of specific energy efficiency interventions for each targeted area, and the most suitable low carbon heat technology.
- The potential carbon saving estimations for broader targets (such as decarbonising the heat supply of all public buildings) have been estimated from The Department for Energy Security and Net Zero's local authority emissions data.
- The carbon saving for some of the higher level, enabling type actions cannot be quantified yet.
- Energy and carbon values provided for district heating projects are dependent on the number of buildings that initially connect.
- Energy and carbon values for energy generation projects are dependent upon local grid constraints, which may limit the total capacity that can be installed at a site.

5.2.1 Phase 1: 2023-2028

The phase 1 2023-2028 tables are shown below, with projects prioritised as previously outlined. The two actions with hard deadlines within this time period are to ensure all social houses and privately rented houses meet the required EPC rating improvements, and are thus at the top of the energy efficiency section. However, across all three work streams there are ongoing actions which have deadline in later phases, but will require work to be started on them as soon as possible. Work will also begin on the highest ranked potential district heating and energy generation projects in this phase. District heating networks which may be dependent upon industrial waste heat being available have been included in this phase, as conversations will need to begin with potential industrial partners as soon as possible for these sites.



Energy Efficiency - Phase 1					
Action	**Timescale**	**Carbon Saving (tCO_2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Ensure that the housing strategy for council owned homes is on track to meet Scottish Government minimum EPC targets, and work with social housing providers to ensure theirs are as well.	2023 – 2025/2032 (2025 is cut off for all socially rented homes to be EPC D)	202 (for 2025 target)	Social Housing Net-Zero Fund	**Local authorities – housing;** Social housing providers	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Ensure all private landlords in the region are installing any required cost-effective retrofit measures so that all of their housing stock are EPC C, as per Scottish Government's upcoming legislation (see Appendix VIII).	Completed by 2028 cut off	4330	Private rented sector landlord loan; ECO+ scheme; Warmer Homes Scotland	**Currently Scottish Government;** private landlords	

Energy Efficiency - Phase 1					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Campaign to increase public awareness of mandatory Scottish Government target of all owner-occupied homes being EPC C by 2033.	2023-2033	Will indirectly contribute to 27,000	Home Energy Scotland Grant and Loan; EES:ABS; ECO+ scheme; Homeowner Equity Loan; Warmer Homes Scotland	**Scottish Government;** Home Energy Scotland; Local authorities - current planned activities/ project specific	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Investigate the possibility of signposting retrofit guidance in partnership with Scottish Government guidance. Outlining a standard process of retrofit for homeowners and landlords.	2023-2024	Would indirectly contribute to 35,000	n/a	**Local authorities – online (CaNE platform Stirling);** Scottish Government	

Energy Efficiency - Phase 1					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Encourage the repair and maintenance of existing buildings as an essential first step for energy efficiency retrofit by raising awareness and signposting resources.	2023-ongoing	would indirectly contribute to up to 35,000	n/a	**Local authorities;** other organisations such as Historic Environment Scotland	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Ensure all owner/occupiers in the region are installing any required cost-effective retrofit measures so that their houses are EPC C by 2033, as per Scottish Government's target.	2023-2033	27,000	Home Energy Scotland Grant and Loan; EES:ABS; ECO+ scheme; Homeowner Equity Loan; Warmer Homes Scotland	**Currently Scottish Government;** communities; owner/ occupiers	

Heat Management – Phase 1					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Install the most appropriate and cost-effective low carbon heating system on all off-gas grid council owned homes, and work with housing associations to do the same.	2023-2032 (prioritise off gas grid homes before 2028)[27]	Up to 2730	Social Housing Net Zero Fund	**Local authorities – housing;** Social housing providers	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Prioritise support for owner occupied and privately rented off-gas grid fossil fuel heated homes to decarbonise their heat demand by 2032.	2023-2032	Up to 21,850	Home Energy Scotland Grant and Loan; EES:ABS; SME Loan; Homeowner Equity Loan	**Currently Scottish Government**	
Install a low carbon heating system on all public non-domestic buildings by 2038.	2023-2038	Up to 2320	Scottish Central Government Efficiency Grant Scheme	**Public sector;** Local authorities – asset management (council properties)	

[27] Scottish Government's Heat in Buildings Strategy, refer to Appendix VIII

Heat Management – Phase 1					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Determine the grid upgrades required in the rural off gas grid areas which will electrify their heat demand by 2032, pairing with generation projects and using data from the digital twin model where appropriate. Such as indicative heat pump suitability.	2023-2032	Would indirectly contribute to 2730	Community Heat Development Programme	**DNOs – in partnership with various others, including community groups and Local authorities**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Following the UK Government policy decision on hydrogen (Heat management – phase 2), reassess relevant actions and plans.	2026-ongoing	n/a	n/a	**Local authorities**	
Designation of appropriate Heat Network Zones.	TBC	n/a	n/a	**Local authorities**	

District Heating Projects – Phase 1[28]						
Site	**Timescale**	**Heat Generated (MWh/year)**	**Carbon Saving (tCO2e/year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Stirling – Forthside network expansion	Feasibility Study, Business Case & Planning: 2023-2024, Construction & Commissioning: 2024-2026.	n/a (exact buildings to be expanded to not determined yet)	n/a (exact buildings to be expanded to not determined yet)	Scottish Government Heat Network Fund	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Stirling – Raploch Network	Feasibility Study, Business Case & Planning: 2023-2024, Construction & Commissioning: 2024-2026.	11,000	2300 (depending on buildings that initially connect [applies to all sites])	Scottish Government Heat Network Fund	**Stirling Council**	

[28] See Section 5.2.5 for weightings assignment process to prioritise district heating projects, see Appendix V for full technical details of district heating projects

District Heating Projects – Phase 1[28]						
Site	Timescale	Heat Generated (MWh/year)	Carbon Saving (tCO2e/year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Stirling – Springkerse/ Braehead Network	Feasibility Study, Business Case & Planning: 2024-2025, Construction & Commissioning: 2025-2027.	8,000	1600	Scottish Government Heat Network Fund	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Stirling – Cowie Network	Feasibility Study, Business Case & Planning: 2024-2025, Construction & Commissioning: 2025-2027.	1,800	600	Scottish Government Heat Network Fund	**Stirling Council**	

<table>
<tr><th colspan="7">District Heating Projects – Phase 1[28]</th></tr>
<tr><th>Site</th><th>Timescale</th><th>Heat Generated (MWh/year)</th><th>Carbon Saving (tCO2e/year)</th><th>Relevant Funding Sources</th><th>Who is Responsible</th><th>Objectives & KPIs</th></tr>
<tr><td>Clackmannanshire – Alloa Forthbank Network</td><td>Feasibility Study, Business Case & Planning: 2023-2024, Construction & Commissioning: 2024-2026.</td><td>14,500</td><td>1320</td><td>Scottish Government Heat Network Fund</td><td>Clackmannanshire Council</td><td rowspan="2">Objectives: 3,4,5

KPIs: 4,5,6</td></tr>
<tr><td>Clackmannanshire – Hallpark Health & Business Centre Network</td><td>Feasibility Study, Business Case & Planning: 2024-2025, Construction & Commissioning: 2025-2027.</td><td>7,500</td><td>1720</td><td>Scottish Government Heat Network Fund</td><td>Clackmannanshire Council</td></tr>
</table>

Energy Generation – Phase 1						
Action	Timescale	Energy Generation (MWh/ year)	Carbon Saving (tCO2e/ year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Develop an open forum to facilitate conversation between the region's DNOs, large consumers, communities, and any other significant energy projects. This will support collaboration, potential joint ventures and benefits from economies of scale, along with an indication of where grid upgrades and re-enforcements will be required.	2023-2028	n/a	n/a	n/a	**Local authorities – in partnership with various others**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Planning authorities will support renewable proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted NPF4 and any Local Development Plan for the area.	2023-2028	n/a	n/a	n/a	**Local authorities - planning**	

Energy Generation – Renewables Projects[29]						
Site	Timescale	Energy Generation (MWh/ year)	Carbon Saving (tCO2e/ year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Stirling – Peak Solar Canopies	Feasibility Study, Business case development 2023-2024.	488	17	Likely private borrowing, will require a relatively short payback period.	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Stirling - Polmaise Solar	Feasibility Study, Business case development 2023-2024.	5,358	189	Likely private borrowing, will require a relatively short payback period.	**Stirling Council**	
Clackmannanshire – Forthbank/Black Devon landfill site	Feasibility Study, Business case and planning: 2023-2024 Construction and commissioning: 2024-2025.	3,040	107	Likely private borrowing, will require a relatively short payback period.	**Clackmannanshire Council**	

[29] Energy and carbon results for each site assume that the whole area has been used for PV, see Section 5.3 for full details on the modelling assumptions and caveats used.

5.2.2 Phase 2: 2028-2033

At the start of this phase (and all future phases), there will be an update to the REM, where all of the objectives, KPIs, associated projects and actions required will be reviewed. This phase includes several mandatory deadlines, with associated actions at the top of each work stream table. Such as: meeting EPC requirements for social and owner-occupied housing, and ensuring that the electricity grid has been upgraded to enable the majority of off gas grid homes currently using fossil fuels to electrify their heating demand. By the start of this phase, the predominant domestic heating fuel across the region will be known – either hydrogen or electric – so specific actions for each of these pathways have been included. The site-specific district heating and energy generation projects in this phase include those that were successfully screened and included in the prioritisation process, but that had a lower weighted score compared to the projects recommended for phase 1. Starting during this phase, more targeted action will take place to encourage homes and business to connect to existing heat networks, as well as a new screening process to see if any of the sites previously identified by the Scottish Government would now be suitable.

REM Review – Phase 2		
Action	**Timescale**	**Who is Responsible**
Review and update REM, checking all objectives, KPIs, associated projects and actions, and screening for new potential projects and interventions.	2028	Local authorities

Energy Efficiency - Phase 2					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Ensure that the housing strategy for council owned homes is on track to meet Scottish Government minimum EPC targets, and work with social housing providers to ensure theirs are as well.	2023 – 2025/2032 (2032 is cut off for all socially rented homes to be EPC B)	1200 (between 2025 and 2032 targets being met)	Social Housing Net-Zero Fund	**Local authorities – housing;** Housing Associations	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Campaign to increase public awareness of mandatory Scottish Government target of all owner-occupied homes being EPC C by 2033.	2023-2033	Will indirectly contribute to 27,000	Home Energy Scotland Grant and Loan; EES:ABS; ECO+ scheme; Homeowner Equity Loan; Warmer Homes Scotland	**Currently Scottish Government;** Home Energy Scotland; Local authorities - current planned activities/ project specific	

Energy Efficiency - Phase 2					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Investigate the potential to use proceeds from renewable energy generation projects to fund energy efficiency improvements for homeowners who cannot afford the work themselves.	Start 2028 – ongoing throughout	n/a	n/a	**Local authorities – in partnership with communities**	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Ensure all council owned and other public sector buildings have installed any appropriate cost-effective energy efficiency measures by 2033.	2028-2033	n/a (not enough data to determine)	Scottish Central Government Efficiency Grant Scheme; Scottish Public Sector Loan Scheme	**Local authorities;** Public sector bodies	

Energy Efficiency - Phase 2					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Ensure all owner/occupiers in the region are installing any required cost-effective retrofit measures so that their houses are EPC C by 2033, as per Scottish Government's target.	2023-2033	27,000	Home Energy Scotland Grant and Loan; EES:ABS; ECO+ scheme; Homeowner Equity Loan; Warmer Homes Scotland	**Currently Scottish Government;** communities; owner/ occupiers	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Encourage the repair and maintenance of existing buildings as an essential first step for energy efficiency retrofit by raising awareness and signposting resources	2023-ongoing	would indirectly contribute to up to 35,000	n/a	**Local authorities,** other organisations such as Historic Environment Scotland	

Heat Management – Phase 2					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Determine the grid upgrades required in the rural off gas grid areas which will electrify their heat demand by 2032, pairing with generation projects and using data from the digital twin model where appropriate.	2023-2032	Would indirectly contribute to 27,300	Community Heat Development Programme	**DNOs – in partnership with various others, including Local authorities**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Install a low carbon heating system on all public sector buildings by 2038.	2023-2038	Up to 23,200	Scottish Central Government Efficiency Grant Scheme	**Public sector;** Local authorities – asset management (council properties)	
Designation of appropriate Heat Network Zones.	TBC	n/a	n/a	**Local authorities**	

Heat Management – Phase 2						
Action		**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
If electrification pathway post 2026:	Increase public awareness of heat pump best practice.	2028-2045	Would indirectly contribute to 105,000	Home Energy Scotland Grant and Loan; EES:ABS; SME Loan; Homeowner Equity Loan	**Scottish Government;** Home Energy Scotland; Local authorities - (district heating projects)	**Objectives:** 3,4,5 **KPIs:** 4,5,6
	Improve grid capacity and remove constraints across the whole region which may impede the electrification of on gas grid buildings.	2028-2045	Would indirectly contribute to 307,000	n/a	**DNOs – in partnership with various others, including Local authorities**	

Heat Management – Phase 2						
Action		Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
If Hydrogen pathway post 2026:	Encourage any homeowners, landlords or businesses installing new gas boilers in the coming years to ensure that they are 'hydrogen ready', so that they do not need to replace their boiler when the gas network converts.	2028-2035	Would indirectly contribute to 307,000	n/a	**Scottish Government**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
	Use the open forum (see energy generation – phase 1) between business, DNOs, industry, community groups etc. to identify where potential renewable generation projects may be able to create green hydrogen from their excess generation.	2028-2045	Would indirectly contribute to 105,000	Green Hydrogen Fund	**Local authorities – in partnership with others**	

District Heating Projects – Phase 2						
Site	**Timescale**	**Heat Generated (MWh per year)**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Stirling – Callander Network	Feasibility Study, Business Case & Planning: 2028-2029, Construction & Commissioning: 2029-2031.	8,700	1800	Scottish Government Heat Network Fund	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Stirling – Deanston Network	Feasibility Study, Business Case & Planning: 2029-2030, Construction & Commissioning: 2030-2032.	3,300	50	Scottish Government Heat Network Fund	**Stirling Council**	

District Heating Projects – Phase 2						
Site	**Timescale**	**Heat Generated (MWh per year)**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Stirling – Bridge of Allan Network	Feasibility Study, Business Case & Planning: 2030-2031, Construction & Commissioning: 2031-2033.	1,700	231	Scottish Government Heat Network Fund	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Clackmannanshire – Alva Network	Feasibility Study, Business Case & Planning: 2028-2029, Construction & Commissioning: 2029-2031.	4,600	780	Scottish Government Heat Network Fund	**Clackmannanshire Council**	

District Heating Projects – Phase 2						
Site	**Timescale**	**Heat Generated (MWh per year)**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Assessment of remaining 10 Scottish Government screened sites (which had no suitable public buildings for connection), to see if they may be viable post 2028 as district heating becomes more well-known and understood by business and homeowners.	2028 – ongoing	n/a	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Local authorities**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Encourage homes and business to connect to existing constructed networks to facilitate expansions.	2028 - ongoing	n/a	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Scottish Government;** Local authorities	

Energy Generation – Phase 2						
Site	**Timescale**	**Energy Generated (MWh per year**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Stirling – Manor Powis site (lies near boundary so could be joint project)	Feasibility Study, Business case and planning: 2028-2029 Construction and commissioning: 2029-2030	7,400[30]	262[27]	Likely private borrowing, will require a relatively short payback period.	**Stirling Council; Clackmannanshire Council**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Stirling – Bandeath site	Feasibility Study, Business case and planning: 2028-2029 Construction and commissioning: 2029-2030	6,200	220	Likely private borrowing, will require a relatively short payback period.	**Stirling Council**	

[30] It is likely that in reality this figure will be lower due to grid constraints, values shown in these columns typically assume the whole amount of land available has been used for PV/renewables, which will not always be the case.

Energy Generation – Phase 2						
Site	Timescale	Energy Generated (MWh per year	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Stirling – West of Plean Country Park Site.	Feasibility Study, Business Case & Planning: 2028-2029, Construction & Commissioning: 2029-2030.	1,380	48	Likely private borrowing, will require a relatively short payback period.	**Stirling Council**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Stirling – Discuss with planning if sites South of Borestone Primary or West of the Castle could now be suitable for renewable generation – move forward on business cases if so.	2028-2032	3,540	264	Likely private borrowing, will require a relatively short payback period.	**Stirling Council**	

Energy Generation – Phase 2						
Site	Timescale	Energy Generated (MWh per year	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Clackmannanshire – North East of Alva site.	Feasibility Study, Business Case & Planning: 2028-2029, Construction & Commissioning: 2029-2030.	3,080	109	Likely private borrowing, will require a relatively short payback period.	**Clackmannanshire Council**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Clackmannanshire – Westhaugh Caravan site.	Feasibility Study, Business case and planning: 2030-2031 Construction and commissioning: 2031-2032.	3,330	117	Likely private borrowing, will require a relatively short payback period.	**Clackmannanshire Council**	

5.2.3 Phase 3: 2033-2038

At the start of this phase, the REM will be reviewed and updated again. By 2033, all required EPC rating improvements through fabric retrofit should have been implemented, so there are not many actions under energy efficiency. However there may be some households which have not installed the required interventions, so proceeds from energy generation projects could be used to help fund them during this phase. By the end of this phase, all public sector buildings will be required to have had a low carbon heating system installed. The pathway specific heat management actions will continue to be followed, to maximise the uptake of low carbon heating technologies during this time. Sites for energy generation which were previously not available due to leases will be re-examined at this time to see if they could now be used. A new screening for renewable generation projects will also be done to see if changes in land use and network capacity have freed up any other new potential sites.

REM Review – Phase 3	
Action	**Timescale**
Review and update REM, checking all objectives, KPIs and associated projects and actions, and screening for new potential projects and interventions.	2033

Energy Efficiency – Phase 3					
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
Investigate the potential to use proceeds from renewable energy generation projects to help fund energy efficiency improvements for homeowners who cannot afford the work themselves.	Start 2028 – ongoing throughout	Will indirectly contribute to 27,000	Home Energy Scotland Grant and Loan; EES:ABS; ECO+ scheme; Homeowner Equity Loan; Warmer Homes Scotland	**Local authorities**	**Objectives:** 1,2,5 **KPIs:** 2,3,5

Heat Management – Phase 3					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Install a low carbon heating system on all public sector buildings by 2038.	2023-2032	23,200	Scottish Central Government Efficiency Grant Scheme	**Public sector;** Local authorities – asset management (council properties)	**Objectives:** 3,4,5 **KPIs:** 4,5,6

Heat Management – Phase 3							
Action		**Timescale**	**Carbon Saving (tCO2e per year)**	**Relevant Funding Sources**	**Who is Responsible**	**Objectives & KPIs**
If electrification pathway post 2026:	Increase public awareness of heat pump best practice.	2028-2045	Would indirectly contribute to 105,000	Home Energy Scotland Grant and Loan; SME Loan; Homeowner Equity Loan	**Currently Scottish Government;** Local authorities - (district heating projects)	**Objectives:** 3,4,5 **KPIs:** 4,5,6
	Improve grid capacity and remove constraints across the whole region which may impede the electrification of on gas grid buildings.	2028-2045	Would indirectly contribute to 307,000	n/a	**DNOs – in partnership with various others, including Local authorities**	

Heat Management – Phase 3						
Action		Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
If Hydrogen pathway post 2026:	Encourage any homeowners, landlords or businesses installing new gas boilers in the coming years to ensure that they are 'hydrogen ready', so that they do not need to replace their boiler when the gas network converts.	2028-2035	Would indirectly contribute to 307,000	n/a	**Scottish Government**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
	Use the open forum (see energy generation – phase 1) between business, DNOs, industry, community groups etc. to identify where potential renewable generation projects may be able to create green hydrogen from their excess generation.	2028-2045	Would indirectly contribute to 105,000	Green Hydrogen Fund	**Local authorities – in partnership with others**	

Heat Management – Phase 3					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Assessment of remaining 10 Scottish Government screened sites (which had no suitable public buildings for connection), to see if they may be viable post 2028 as district heating becomes more well-known and understood by business and homeowners.	2028 – ongoing	Potentially up to 28,930	Scottish Government Heat Network Fund	**Local authorities**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
New site screening for potential district heating networks, that may be viable due to changes such as new developments and primary uses of buildings, or a reduction in installation costs.	2033 – ongoing	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Local authorities**	
Encourage homes and business to connect to existing constructed networks to facilitate expansions.	2028 - ongoing	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Currently Scottish Government**	
Designation of appropriate Heat Network Zones.	TBC	n/a	n/a	**Local authorities**	

Energy Generation – Phase 3						
Action/Site	Timescale	Energy Generated (MWh per year)	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Complete a new site screening based on any changes to council owned land, locations of electricity demand and network capacity, and develop business cases for suitable areas.	2033-2045	n/a	n/a (cannot accurately predict)	n/a	**Local authorities**	**Objectives:** 3,4,5 **KPIs:** 1,3,5
Stirling – If lease for grazing has expired, assess suitability of site West of Bannockburn.	Business Case & Planning: 2033-2034, Construction & Commissioning: 2034-2035. (If lease ends at a later date then postpone until then.)	2,390	85	Likely private borrowing, will require a relatively short payback period	**Stirling Council**	

Energy Generation – Phase 3						
Action/Site	Timescale	Energy Generated (MWh per year)	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Clackmannanshire – If leases for grazing have expired assess suitability of the Glenochil farm lane, South of Dollar, and Smithfield Loan sites.	Business Cases & Planning: 2033-2035, Construction & Commissioning: 2034-2036. (depending on date at which leases end)	3,600	Up to 128, depending on which sites are viable	Likely private borrowing, will require a relatively short payback period	**Clackmannanshire Council**	**Objectives:** 3,4,5 **KPIs:** 1,3,5

5.2.4 Phase 4: 2038-2045

A final review of the REM will take place at the start of this phase, outlining exactly what is required in the remaining years to reach net zero. By 2038, most homes should already be EPC A-B through retrofit works and heat decarbonisation, however any homes not achieving this rating at the start of this phase will be targeted to address any interventions required, potentially using funds generated through energy generation projects. Ensuring that any pathway specific actions to encourage and enable households and business to decarbonise their heat have been implemented will be crucial in this phase, so they are listed at the top of the heat management actions. Buildings which have not decarbonised their heat by 2038 could also be targeted by new district heating networks, or expansions to existing networks, depending on their location. Any local energy generation projects being installed during this phase will result from site screenings undertaken in the 2033-2038 phase.

REM Review – Phase 4	
Action	**Timescale**
Review and update REM, checking all objectives, KPIs and associated projects and actions, and screening for new potential projects and interventions.	2038

Energy Efficiency – Phase 4				
Action	**Timescale**	**Carbon Saving (tCO2e per year)**	**Who is Responsible**	**Objectives & KPIs**
Provide awareness and support to homeowners and landlords to enable them to cost effectively maximise the energy efficiency of any remaining hard to treat homes that are not likely to reach EPC A-B by 2045.	2038-2045	n/a (cannot accurately predict yet)	**Currently Scottish Government**	**Objectives:** 1,2,5 **KPIs:** 2,3,5
Investigate the potential to use proceeds from renewable energy generation projects to fund energy efficiency improvements for homeowners who cannot afford the work themselves.	Start 2028 – ongoing throughout	n/a	**Local authorities**	

Heat Management – Phase 4						
Action		Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
If electrification pathway post 2026:	Increase public awareness of heat pump best practice.	2028-2045	Would indirectly contribute to 105,000	Home Energy Scotland Grant and Loan; EES:ABS; SME Loan; Homeowner Equity Loan	**Currently Scottish Government;** Local authorities - (district heating projects)	**Objectives:** 3,4,5 **KPIs:** 4,5,6
	Improve grid capacity and remove constraints across the whole region which may impede the electrification of on gas grid buildings.	2028-2045	Would indirectly contribute to 307,000	n/a	**DNOs – in partnership with various others, including Local authorities**	

Heat Management – Phase 4						
Action		Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
If Hydrogen pathway post 2026:	Use the open forum (see energy generation – phase 1) between business, DNOs, industry, community groups etc. to identify where potential renewable generation projects may be able to create green hydrogen from their excess generation.	2028-2045	Would indirectly contribute to 105,000	Green Hydrogen Fund	**Local authorities – in partnership with others**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Assessment of remaining 10 Scottish Government screened sites (which had no suitable public buildings for connection), to see if they may be viable post 2028 as district heating becomes more well-known and understood by business and homeowners.		2028 – ongoing	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Local authorities**	

Heat Management – Phase 4					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
New site screening for potential district heating networks, that may be viable due to changes such as new developments and primary uses of buildings, or a reduction in installation costs.	2033 – ongoing	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Local authorities**	**Objectives:** 3,4,5 **KPIs:** 4,5,6
Encourage homes and business to connect to existing constructed networks to facilitate expansions.	2028 - ongoing	n/a (cannot accurately predict)	Scottish Government Heat Network Fund	**Currently Scottish Government**	
Designation of appropriate Heat Network Zones.	TBC	n/a	n/a	**Local authorities**	

Energy Generation – Phase 4					
Action	Timescale	Carbon Saving (tCO2e per year)	Relevant Funding Sources	Who is Responsible	Objectives & KPIs
Complete a new site screening, matching up areas of available land to any nearby sites of high demand, based on any changes to council owned land, locations of electricity demand and network capacity, and develop business cases for suitable areas.	2033-2045	n/a	Likely private borrowing, will require a relatively short payback period	**Local authorities**	**Objectives:** 3,4,5 **KPIs:** 1,3,5

5.3 Delivering the Plan

A governance board for this plan will be determined by each council. This will consist of key individuals to oversee the delivery of the plan and ensure that actions are underway, KPIs are monitored and progress is being made. For example, Stirling Council REM Board will sit under the Joint REM Board and Climate Portfolio Board. There will be subsidiary groups for each workstream, and relevant individuals and roles have been identified.

5.4 Monitoring & Evaluation

The REM will be updated every 5 years, at the start of each time phase listed above. This will allow for the identification of any new opportunities or potential projects which may become viable due to changes in policy or technological advances.

Each of the KPIs will continuously be monitored to ensure that the REM is on track to reaching a net-zero energy system across the region. If a KPI is due to be missed, or behind schedule, the REM reviews will allow for projects and actions that will rectify this to be identified and prioritised. How the local authorities will monitor each KPI is outlined below:

- **KPI 1: % reduction in total carbon emissions from energy use**
  For carbon emissions from buildings, keep the digital twin model up to date. For those from other sectors (farming, industry, transport), obtain figures from DESNZ Local Authority emissions data.

- **KPI 2: % reduction in region residential heat demand**
  Keep the digital twin model up to date with domestic building fabric changes, by updating it with each new iteration of the home analytics dataset released by the Energy Saving Trust.

- **KPI 3: % households in fuel poverty**
  Work with housing departments at each local authority to ensure fuel poverty is being appropriately tracked.

- **KPI 4: % homes at set EPC levels: where technically feasible and cost effective to do so**
  Keep track of EPC rating changes, using either the bulk data from Scottish Government or sources such as Home Analytics.

- **KPI 5: % of total energy (including transportation) to be generated from renewables**
  Track changes to heat supply for all buildings types and the carbon content of the electricity grid in Scotland, and work with transport to track the rate of uptake of EVs.

- **KPI 6: % of buildings with zero-carbon heat supplies**
  Track and monitor all heating system changes for domestic and non-domestic buildings in the region.

Stirling &
Clackmannanshire
City Region Deal

Stirling & Clackmannanshire City Region Deal

Regional Energy Masterplan (Appendix)

December 2023

StirClacksDeal.com

Contents

Appendix I – Glossary

Digital Twin Model – A digital representation of the region's buildings and associated energy use, that can be used to test the likely impact of future interventions and scenarios.

Heat Pump – A heating system technology that uses electricity to take thermal energy from an external source to heat a building. A heat pump can be classed as air source, water source, or ground source depending on where the heat is taken from. Their efficiency is expressed as a COP (coefficient of performance) which will depend on the temperature and state of the heat source; this can range from roughly 2 to 5, with warmer heat sources having a higher COP.

Hydrogen – A gas that can be used as an alternative fuel source to natural gas and other fossil fuels to create heat or electricity. Currently hydrogen is predominantly created through processes that consume fossil fuels, but it is possible to create it using only renewables. This type of hydrogen is classed as "green hydrogen", which may represent a zero-carbon alternative to natural gas in the future. Low carbon hydrogen created from burning fossil fuels with carbon capture and storage is known as blue hydrogen.

Distribution Network Operator (DNO) – Companies who maintain and operate parts of the electricity grid supplied to buildings, including high and low voltage cables, primary and secondary substations, etc. The region is served by two DNOs; Scottish Power Energy Networks (SPEN) supply all of Clackmannanshire and most of the area around the City of Stirling, Scottish and Southern Energy Networks (SSEN) supply the more rural parts of the Stirling council area.

Biofuel – A type of fuel that has formed over a relatively short period of time from organic matter. In some cases it can be used as a low-carbon alternative to fossil fuels for transport, heat or electricity. There are various types such as biodiesel, bio oil, bio ethanol etc. It is usually created from plants (bio-crops) or domestic, agricultural or industrial biowaste.

tCO2e – Tonnes of CO2 emissions equivalent. The standard unit used to quantify greenhouse gas emissions, both from carbon and other greenhouse cases such as methane and nitrous oxide.

kWh – The standard unit for energy, heat and electricity consumption. It represents the equivalent amount of energy consumed by running a 1,000 Watt appliance for 1 hour.

Carbon Capture, Utilisation and Storage (CCUS) - Technologies that mitigate carbon emissions resulting from burning fossil fuels, by capturing, transporting and permanently storing or using them.

KPI – Key Performance Indicator, a quantifiable metric that can be tracked over time to evaluate the success of an objective.

Biomass – A fuel used for generating heat and electricity made up of organic plant material, such as wood, crops or agricultural waste.

U Value – A numerical value that indicates how easily heat travels through a solid surface. Homes that have higher U value construction materials will lose more heat through their walls, windows, roof and floors, and will therefore be less energy efficient.

Insulation – The U values of walls, roofs and floors can be improved by adding insulation. There are several types of wall insulation available depending on the construction type. Cavity wall insulation (CWI) fills the empty space in between the two solid layers of a cavity wall with an insulating material, external wall insulation (EWI) adds insulation to the outside of a wall underneath a new screed or render, internal wall insulation (IWI) adds insulation to the inside of the external walls in a buildings which may slightly reduce floor space.

EPC Rating – Energy Performance Rating, an assessment carried out to demonstrate compliance with energy standards. Often used somewhat inaccurately to provide an indication of how energy efficient a home or building is. The ratings (A-G) produced for the main metric, the Energy Efficiency Rating (EER), are based on modelled running cost rather than solely energy efficiency. EPC metrics are due to be reformed to better suit it’s use as a measure of energy efficiency, likely to be kWh/m2yr for space heating/cooling, in line with other industry standards.

Fuel Poverty – In Scotland, a household is classed as being in fuel poverty when it needs to spend more than 10% of its income on energy bills to heat the home to an adequate level.

Extreme Fuel Poverty – When household spending on energy bills is more than 20% of income.

Solid Wall Homes – Homes with a construction type made from solid stone or bricks and that do not have a cavity which can be insulated, normally sandstone in this region. These are usually older homes which can be comparatively difficult and expensive to improve the energy efficiency of, classed as 'hard to treat'.

System Built Homes – Homes built from non-traditional construction methods, often using concrete, aluminium or steel. These homes are also often classed as 'hard to treat'.

District Heating Networks – A heat network where heat is supplied from a central source to a series of buildings through underground pipes containing hot water.

Carbon Factor – often expressed as gCO2e/kWh or kgCO2e/kWh, representing the amount of greenhouse gas emissions released from using a kWh of energy from a specific fuel source or an electricity network.

Electric Vehicles (EVs) – Vehicles that have a large electrical battery to power them, instead of a petrol or diesel engine.

Carbon Sequestration – The reduction or removal of carbon emissions to compensate for unavoidable emissions made elsewhere. This can be achieved through planting trees, re-wilding areas of land or reclaiming/re-wetting peatlands.

Passivhaus – A tried & tested solution that gives us a range of proven approaches to deliver net-zero-ready new and existing buildings optimised for a decarbonised grid and augmented for occupant health and wellbeing.

Appendix II – Stakeholder Engagement Details

This appendix outlines the methodology followed by Ricardo for undertaking the Stakeholder Engagement of the REM, as well as providing anonymised results of the workshops and interviews.

Elected Members

A pre-engagement session was held with local authority representatives in which the masterplan Objectives outlined in Section 2.1 were presented.

Identifying Key Stakeholders

The diagram opposite outlines the process followed by Ricardo, IES and the local authorities to identify relevant key stakeholders, and plan the engagement.

Longlist

Longlist of stakeholders developed and ranked in priority of 1-4.

Grouping

Grouped into following sectors:

- Commercial & SME, Domestic, Third Sector, Public.

Engagement Approach

Engagement approach agreed per stakeholder category:

- Online workshops per sector type.
- One to one interviews with priority stakeholders such as DNOs, large energy users and local academic institutions.

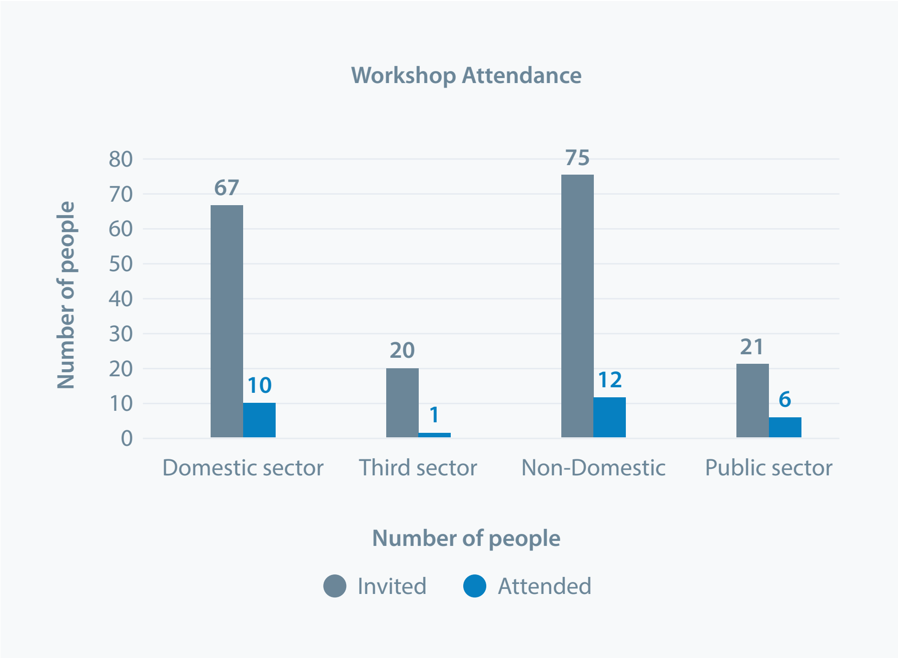
Workshop Overview

Four sector specific online workshops were held to gather stakeholders views and identify opportunities for building and energy systems decarbonisation relevant to their sector as well as their barriers, priorities and current drivers. Participants were invited to both discuss and place views against specific topics within the Miro board, which is an interactive collaborative online platform. An overview of each workshop is shown in the following pages of this appendix.

Workshop Assumptions/Caveats

- The Miro board doesn't capture the amount of times that a comment was raised.
- The comments captured from the Miro board assume that this is the voice of the workshop and any other comments not captured in the Miro board may not be captured in this evaluation. Any views raised in discussion were also captured by the workshop host.
- The Miro boards were minorly tailored to the audiences so some headings, such as Future Engagement Plans were not captured in every workshop but queried where appropriate, e.g. commercial workshop.

See below for a summary of the attendance of each themed workshop



Overview per Sector

Domestic Sector Overview(1/3)

Stakeholder attendee types

- Domestic construction developers
- Housing association
- Low carbon heating installers
- Local authority housing team members
- Residents Association

- This session had significant engagement via Miro board on both domestic retrofits and decarbonising domestic heating
- Views provided from both development and housing stock management perspective as well as residential

Domestic Sector Overview(2/3)

Domestic Retrofit

Opportunities:

- Reduce energy costs for vulnerable people and low income households
- Utilise masterplan spatial mapping tool to spark debate and engagement by driving discussion
- Increase local employment and training opportunities for delivering retrofit works

Barriers:

- Retrofit costs a concern for residents generally, especially those in hard to treat homes
- Less incentives for landlords quoted as a barrier to undertaking energy efficiency works
- Access to installers and reliable information for tenants
- Developers noted security of supply chain for materials

Priority Areas & Concerns:

- Housing association noted reassuring tenants on stability, reliance and security of
- Knowledge of skill requirements for installations and home types
- From homeowners perspective information needs developed on identifying low risk/low cost quick wins

Drivers for investment:

- High energy prices driving tenants and residents
- Financial providers for developers and stock operators increasingly require sustainability reporting
- Net zero and carbon literacy becoming societal norm

Domestic Sector Overview(3/3)

Domestic Heating Decarbonisation

Opportunities:	Housing developers noted the need for considering low carbon heating installations for ESG reporting purposes Discussion held over the potential for local partnerships to utilise waste industrial heat for providing to domestic heat networks Housing developers noted opportunity to coincide gas boiler ban for heat pump deployment however uncertainty over ban implementation date
Barriers:	Closure of incentive such as RHI and feed in tariffs driving reductions in customer demand Developers and housing association noted risk of strict planning conditions associated with low carbon heat projects Grid capacity in rural areas a concern as well as security of supply offered by solid fuel heating systems Ambiguity in regulations and expected transition times can hinder planning Housing association voiced concern over capital costs of intense heat pump deployment alongside new heat dispersion systems
Priority Areas & Concerns:	For homeowners the significant enabling works required across housing stock (such as radiator upgrades/underfloor heating installation Discussion noted the need to close skills gap with not enough qualified installers for current demand or a significant uptick in demand for heat pumps Housing associations noted the need to built their tenant confidence in technologies like heat pumps ASHP vs Hydrogen as little incentive to replace gas boilers for residents if hydrogen is anticipated in 2030s'
Drivers for investment:	Customer demand from owners considering new builds has increasing developer focus in decarbonised heating Regulations driving developers and housing providers towards decarbonisation

Non-Domestic Sector Overview(1/2)

Stakeholder attendee types

- Manufacturing
- Healthcare/Pharma
- Shopping centre operator
- Third Sector
- Academic/Research institutes
- Low carbon heat system manufacturer
- Food and drink production

- This session focussed only on Non-Domestic Retrofits and heating decarbonisation
- No comments were made on “Priority areas & concerns” or “Future engagement strategies”
- No comments were made against specific technologies

Non-Domestic Sector Overview (2/2)

Opportunities:

- Opportunity in sequencing of upgrades, such as LED lighting as a quick cost reduction win followed by heating upgrades
- Improved heating lighting controls to drive immediate low investment required efficiency in businesses

Barriers:

- Lack of support and lack of consistency in support and funding options over time
- Capital expenditure sign off can be a lengthy process for commercial entities
- Industrial buildings are hard to treat particularly in relation to fabric improvements and lack specific funding streams
- Lack of public engagement on driving mandatory targets in sector

Drivers for Investment:

- Primarily driven by ‘Financial savings’ presently
- Value beyond finances to organisations can be achieved
- Carbon reduction strategies increasingly a consideration for tenders, particularly public body contracts

Public Sector Overview (1/2)

- This session had engagement on both Domestic and Non-Domestic Retrofits.
- There were only two comments raised against Domestic heating within the Miro boards
- Clackmannanshire council provided the most representation and input to the session

Public Sector Overview

Domestic

Opportunities

- Delivering co-benefits

Barriers

- Private Landlord engagement
- Match funding requirements changes
- Cost for materials
- Listed buildings

Priority Areas & Concerns

- No comment

Drivers for investment

- No comment

Non- Domestic

Opportunities

- Reducing reliance on volatile fossil fuel pricing
- Reduction of industrial emission

Barriers

- Communities using former buildings struggle to find retrofit funding

Priority Areas & Concerns

- No comment

Drivers for investment

- Public net zero targets
- Climate change forums

Third Sector Overview

- There was just one attendee at this workshop who provided comments on Domestic Retrofit and Non-domestic retrofit topics.
- Attendee was representing a third sector organisation located within Clackmannanshire
- More formal approach adopted with key masterplan points discussed to gain feedback from an operational charities perspective
- No opportunities identified

Third Sector Overview

Domestic

Opportunities
- No comment

Barriers
- No Comment

Priority Areas & Concerns
- Energy efficiency improvements needed

Drivers for investment
- As a homeowner CO_2 reductions matter too

Non- Domestic

Opportunities
- No comment

Barriers
- Lack of public engagement to drive energy efficient behaviours across public facing sectors

Priority Areas & Concerns
- Examining potential PV array at premises to offset high electricity costs

Drivers for investment
- Demonstrating responsibility
- Cost saving

Measure Specific Workshop Feedback

Measure specific feedback (1/2)

Measure	General Comments	Specific barriers
External Wall Insulation	Can improve appearance of buildings. Less favourable than other insulation methods and in private housing.	Difficult to implement on historic buildings. Emerging damp concerns. Requires skilled installers. Cost.
Glazing upgrades	Potential for improving drafty areas. Easier to implement than other measures.	Difficult to implement on historic buildings. Cost.
Heat pumps	Public sector plans undertaken on wide range of buildings.	Noise. Maintenance Access (for roof installations). Reliability of system, need backup. Legal requirements to provide secure heating system. Enabling works can be extensive. Gas boilers achieve EPC B rating. Requires domestic hot water cylinder which takes away floor space. Security in supply. Conflicting advice (i.e. hydrogen being preferable). Engagement of installers. Cost.
Connecting to district heating scheme	Interest from planning. Expanding of existing networks should also be considered.	Financially hard to implement. Difficult to convert from plan to installation- significant time. Funding/investment. High up front capital costs. Removes tenant choice on heating system. Customer service. Lack of skills in sector.

29 © Ricardo plc February 2023 Stirling & Clackmannanshire Regional Energy Masterplan Stakeholder Engagement

RICARDO

Measure specific feedback (2/2)

Measure	General Comments	Specific barriers
Roof/loft insulation	Easy to implement, especially in older/historic homes.	Uncertainty of commercial premises location in future
Cavity wall insulation		Requires skilled installers. Requires significant remedial works.
Solar PV		Supply chain fluctuations in cost
Waste heat		
EV charging points	Demand management vs distribution upgrades. Delivery plan needs to be agreed by DNOs. Should be considered by both councils	Planning on new developments. Capacity of grid system. Lack of incentives for home owners. Highly payback.

One to One Interviews

The following figures provide an outline summary of the one to one interviews that were carried out with the DNOs and large energy consumers across the region. They have been anonymised, but include information on the relevant sector.

1-2-1 Interview: Commercial Manufacturing

Opportunities & Projects

- Opportunities for waste heat recovery from manufacturing process, with use in a local district heat network, if customers were available.
- Possibility of installing electrolyser in the area, which would supply hydrogen to replace natural gas in manufacturing process.

Barriers

- If hydrogen or green gas were available, ability to replace natural gas is not fully understood particularly to incorporate it into niche manufacturing process. Considerations of current infrastructure such as pipework.
- Funding available to upgrade infrastructure and plant.

Priority Areas

- Process: the natural gas currently used for high temperature heat required for manufacturing is not easily replaced.
- Electrification of small vehicle fleet.
- End users very focused on decarbonisation.

Current decarbonisation strategies

- Company has tried to electrify where possible.
- Currently using most efficient plant available.
- Looking at alternative fuel for combustion processes.
- Large opportunity to decarbonise vehicles when transporting products to customers.

1-2-1 Interview: Manufacturing Sector

Opportunities & Projects

- Hydrogen usage and experimentation to replace heat production in manufacturing process
- Waste heat reduction and usage in production process

Barriers

- Planning process and permitting applications can be onerous
- Public perceptions of novel technologies
- Focus on investment in production equipment takes priority.

Current decarbonisation strategies

- Improving reducing waste and recycling raw materials for manufacturing
- Driven strategy by UK ETS

Communication and engagement

- Manufacturer is a member of a new group with other local companies that are looking at local issues. Potentially for more collaboration with companies in the local area.

1-2-1 Interview: Commercial Manufacturing

Opportunities & Projects	Barriers
• Fuel switching being examined for reducing gas consumption (hydrogen under examination) • Potential for waste heat capture for reuse • Local level engagement opportunities e.g. Have an interest in becoming electricity customer from low carbon sources	• Planning and permitted applications • Public perception • Need to ensure robust supply of recycled materials available

Priority Areas	Current decarbonisation strategies
• Furnace decarbonisation • Increasing efficiencies in process equipment	• Working with customers to reduce emissions. • Increased sourcing of recycled raw materials • Some heat electrification of LEERS

1-2-1 Interview: Utility Company

Opportunities & Projects

- Hydro opportunities from reservoirs and networks (pressure reducers)
- District heating systems with local HPs from grey water.
- Lots of local solar and some wind turbines.

Barriers

- Biggest barrier is the grid and the impacts of the scale or the timeline on projects. Grid is not accommodating at the moment and can increase costs of projects.

Priority Areas

- Housing projects, delivering efficient heat to customers
- Maintain current standards of utility provision to customers

Current decarbonisation strategies

- Target to be Net Zero by 2040 in all aspects of the business.
- Committed to 120 GWh of new generation by 2030.
- £850 million for capital projects and investment.

1-2-1 Interview: Food & Drink Producer

Opportunities & Projects

- Working with other local manufacturing companies to tackle emissions
- Looking for potential of solar PV and wind generation.
- Electric HGV charging infrastructure and installing ASHPs for office spaces.

Barriers

- Need of infrastructure to be readily available if fleet was to convert to electric.
- Old buildings require energy efficiency upgrades to make appropriate for ASHPs.
- Low priority site for decarbonisation compared to other sites

Priority Areas

- Distillation process is a large contributor to operational emissions.
- Ensure that change to alternative fuel will not impact on production process.
- Scope 1 and Scope 3 emissions

Current decarbonisation strategies

- Net-Zero Carbon by 2030 across all global operations.
- Looking at hydrogen and biomethane for production process.
- Replacing forklift fleet with electric variants.

1-2-1 Interview: Education Sector

Opportunities & Projects

- CHP Plant coming to end of life and looking to examine replacement systems.
- Looking at ASHP for some of the buildings to replace oil systems.
- Solar array being explored with opportunities to export electricity over low periods on campus
- Battery storage being examined for feasibility.
- Grants being examined for retrofitting 1960's residences with a range of insulation/fabric first measures to bring up to current standards.
- Small scale hydro potential present.

Barriers

- Financing and resourcing.
- Large stock of energy inefficient buildings on site (1960s')
- Somewhat undetermined on avenue for heat decarbonisation.

Priority Areas

- Tie in with local partners and community more effectively to advance projects.
- Stability/Security of supply for the university.
- Significant quantities of hot water demand for aquaculture projects which could be utilised for hydro
- Large stock of energy inefficient buildings on site.

Current decarbonisation strategies

- Combination of projects underway across the estate including upgrades and replacement options for existing plant.
- Sustainability strategy/plan is being broken down into deliverable projects.
- Opportunity for tying in funding opportunities across the LAs to allow a nimble/agile approach to approach funding opportunities as a conglomerate.

36 February 2023 Stirling & Clackmannanshire Regional Energy Masterplan Stakeholder Engagement RICARDO

1-2-1 Interview: Education Sector/Research

Opportunities & Projects

- Examining sustainable energy systems: heat pumps to be twinned with food programmes.
- Waste heat recovery/geothermal from disused mineshafts
- Full scale digital model of region to integrate with Regional Energy Masterplans.

Barriers

- Engaging with domestic users on low carbon heating, main issue is retrofitting of properties to ensure they are "heat pump ready"
- Community resistance if technology perceptions are poor

Priority Areas

- Identifying areas for improving energy efficiency
- Plant on site is coming to end of life and identifying alternative heating options that would be suitable.

Drivers for investment in energy decarbonisation

- Variety of factors including policy forcing organisations' options, net-zero and public perception.
- Cost of living crisis.

1-2-1 Interview: Food Production

Opportunities & Projects

- Significant cooling and heating requirement for production, this is currently being supplied, looking to replace this with sustainable resource.
- Examining potential for biogas production from effluent plant.

Barriers

- Potential of renewable sources to provide significant amounts of heat for production process. This includes need for constant amount of high temperature heat supply. Replacing this is challenging without changing the internal production process significantly.

Priority Areas

- Process heat decarbonisation – high temperatures required for process
- Decarbonisation strategy will require large capital costs, finding a way to fund transition in relation to long term plant operations.

Current decarbonisation strategies

- Implemented CO_2 reduction target for 2025 and 2030: 55% reduction to be achieved.
- Net Zero by 2050
- Road map for identifying uses for waste heat within system

1-2-1 Interview: Agriculture

Opportunities & Projects	Barriers
• Planning for an AD plant to provide natural gas replacement. • Feasibility of installing a fossil fuel CHP system. • Collaboration with other companies and communities.	• Power has become more expensive – making investment decisions is risky in a volatile market. • Planning process has caused significant barriers in the past.

Priority Areas	Current decarbonisation strategies
• High grade heat/demand processes make a total of 60% of energy consumption • Opportunity to share risk of investment in new technologies with others to reduce risk.	• Plan to decarbonise, going back to district heating and distributed generation of energy. • Installing 240kW of solar PV

1-2-1 Interview: Education Sector

Opportunities & Projects

- Already has some renewable generation looking at installing heat pumps across estate.
- Expanding solar PV generation on campuses is being investigated

Barriers

- Availability of capital funding for implementation of identified measures.
- Availability of space for measure installation for heat pump arrays.

Priority Areas

- Decarbonisation of gas heating; examining feasibility of heat pumps and where these would be located
- Determining the grid capacity to cope within the local area if significant switches to electric heating are pursued.

Communication and engagement

- Certain issues will require cooperation with local authorities in the area to determine grid capacity or land availability for renewable generation.
- Currently reporting sustainability progress in annual financial return as Scottish funding council desire updates. Could have a benchmark inbuilt.

1-2-1 Interview: Public health service

Opportunities & Projects

- £2m for energy efficiency works at various sites in 2023/2024 – PV, glazing, controls
- District heating opportunities across numerous sites in both LA areas
- Policy position will prevent gas boiler installs on estate
- Exploring heat pumps viability for estate areas. Hybrid heating project under development.

Barriers

- Grid issues limiting PV development opportunities and system size
- Refused export/G99
- Limited by funding to short term planning
- Costs for heat pumps excessively above any funding streams

Priority Areas

- Improved sustainability and climate change governance
- Renewable heat/no fossil fuel heating by 2038
- Net Zero 2040 with interim 75% by 2030 target
- Strategy and Action plan developed centrally (NHS Scotland) for rollout

Communication and engagement

- NHS Scotland commissioned net zero route mapping
- Collaboration potential on future decarbonisation activities
- Potential for shared estates with other public bodies and 20 minute neighbourhoods.

1-2-1 Interview: Commercial Manufacturing

Opportunities & Projects

- Negative emissions technology trials underway
- Heat recovery for internal use under review
- Solar PV being examined
- Direct connections/Private wire with local wind generation assets

Barriers

- Initial difficulties with grid (G99) application
- Waste heat may be intermittent with gas turbines not also utilised.
- Need to confirm benefits of heat recovery, stacks are low temp (50º C)

Priority Areas

- Significant process gas consumption (£5-7 million pa)
- Signed up to Paris protocol. Strict Emissions reduction targets internally
- Ensuring adherence to air quality compliance requirements

Communication and engagement

- Dedicated environmental team in the company for direct engagement potential.

1-2-1 Interview: Utility Company – Gas Network Operator

Opportunities & Projects

- High level study looking at 75% reduction in natural gas consumption to be replaced with Hydrogen. Driven by blue and sources of green hydrogen
- Demonstrators for domestic hydrogen heating
- Open to demonstrators with local authorities if hydrogen production in local area
- Hydrogen fuelled transport
- Large industrial plants to contribute to hydrogen supply
- Forthbank has potential for green hydrogen site due to grid constraints

Barriers

- Waiting on heat policy decisions from UK Government – cannot take action before then (2026).
- No mandate for the build out and delivery of hydrogen ready boilers.

Priority Areas

- Storage requirements for hydrogen need to be solved.
- Transition will be predominantly focused on hydrogen with only minor biogas anticipated.

Current decarbonisation strategies

- Late 2020's before high volume roll out of hydrogen in gas network, may only cover east coast trunk phase first
- Hydrogen deployment acceleration

Distribution Network Operator Interviews

- Individual Stakeholder meetings undertaken with Scottish Power Energy Networks (SPEN) and Scottish and Southern Electricity Networks (SSEN)

- Key Masterplan themes discussed in relation to barriers and opportunities in:

  - Heat and transport electrification

  - Renewable electrical generation projects

  - Collaboration and engagement

Scottish Power Energy Networks – Key points of note

Opportunities

SPEN priorities are supporting LA net zero strategies and increasing open access data availability

- LAs will be able to share their plans with SPEN to feed into network planning via new data sharing platform
- New tools allowing exploration of EV charge point feasibility and access to network capacity forecasts over time
- Potential for SPEN as intermediary between parties such as large users and generation and housing developers
- Improving customer connection process via internal optimisation and Significant code review workshops

Scottish Power Energy Networks – Key points of note

Barriers

- Low generation/export capacity on grid remaining with 1.8MW available in Stirling and 1.4MW in Devonside. Import significantly less constrained.
- Transmission constraints remain in the area
- Once required reinforcement is triggered, reinforcement works will have timeframe of 7-10 years.
- Network complexity requires individual project assessment as opposed to generic solutions

Scottish and Southern Electricity Networks – Key points of note

Opportunities

- Change in connection charges means that reinforcement costs will be socialised to a limit.
- Feasibility studies offered by SSEN to examine project potential and maximum generation potential prior to triggering reinforcement
- Post code assessments of network can be provided to support projects deploying low carbon technology
- Willing to engage pre-application stage with projects.

Scottish and Southern Electricity Networks – Key points of note

Barriers

- Reinforcement delays significant with up to 5 years for transmission reinforcement
- Issues in supply chain driving delays of network upgrades
- Challenges with rural locations and demand, better engagement with agricultural bodies a potential need.

DNO Engagement: Key considerations for local authority

Connections undertaken on first come, first served basis

Early applications vital in order to avoiding reinforcement works queue

DNOs remain reactive to applications however willing to engage with projects at early stages to understand future plans

There exists a role for the local authority to facilitate an engagement forum with customers prior to applications as well as aggregating plans of customers in geographic areas

DNO - Collaboration and Engagement

Data sharing – The earlier the DNO has sight of customer plans, the sooner than can feed into their network planning.

SPEN is planning customer workshops in the future to increase availability of applications process and detail project requirements for interested parties

Customers can request a surgery via SPEN's website. SPEN also as publications e.g. an EV booklet for customers

Recommendations for further engagement

Forum for high energy users

Significant interest raised across numerous large users in participation in a forum facilitated by local authorities:

1. **To enable the identification of partnerships in projects to support collaboration and reduce investment risks**
2. **Allow potential partnerships organisations project timelines to be developed in tandem**
3. **Enable discussion between industry and public bodies in cross sectoral energy project partnerships e.g. With public infrastructure or domestic housing**
4. **Designated network operators inclusion to support early feasibility discussions amongst parties**

Recommendations for further engagement

Identifying options at council level for wider community level engagement

Across wider region communications of specific projects and plans to target communities to:

1. **Enable discussions between LA and target communities at early stage to increase buy in**
2. **Commencing dialogue with other stakeholders (e.g. businesses and relevant bodies).**
3. **Build confidence with communities in technologies**

Overall Estimated Costs

The table below displays the total number of buildings requiring specific fabric intervention measures to reach their 2032 EPC rating target of C (KPI 4) and the heat demand reductions for KPI 2, as per assumptions stated in Section 4.1.1. The estimation of the total capital cost of these works is based on UK government costing data from 2019.

The actual cost required is likely to be higher now, but the figures provide an indication of the cost implications of solid wall insulation. The lack of identification of other essential works, such as ventilation systems or improved air tightness will also contribute to an increase in cost.

Scenario	No. of Buildings Requiring Retrofit	Average Cost per Household Requiring Retrofit	Total Investment Required
No insulation on solid wall homes.	12,819	£3,100	£35,235,000
External wall insulation on solid wall homes.	17,972	£11,000	£182,435,000
Internal wall insulation on solid wall homes.	17,972	£13,500	£149,353,000

Analysis by Zone

A breakdown of these costs, with property and intervention type numbers, is provided in the following two tables. Two columns for estimated costs are provided, one with solid wall insulation excluded as this can be a harder retrofit measure that may not always be cost effective to carry out.

These tables allow for a high level targeting of areas for specific retrofit measures, where there are common interventions required across a zone, that will need to be implemented as part of a whole building retrofit. A couple of key examples include Blane Valley where around a quarter of the homes require cavity wall insulation, Stirling city centre where around 20% of the domestic properties require a glazing upgrade, or Alloa West where a quarter of the properties may require some form of solid wall insulation. With this data any potential public awareness campaigns by Scottish Government or the local authorities (dependent on resources) can be targeted.

Stirling Zones

Intermediate zone	No. of domestic buildings	No. of domestic buildings requiring cavity wall insulation	No. of domestic buildings requiring new glazing	No. of domestic buildings requiring loft insulation	No. of domestic buildings requiring solid wall insulation	No. of 'hard to treat' domestic buildings	Total no. of domestic buildings requiring some fabric retrofit	Percentage of total domestic buildings in zone needing retrofit	Estimated total cost per zone (excluding solid wall insulation)	Estimated total cost per zone (including solid wall insulation)
Balfron and Drymen	1713	261	85	154	360	497	731	42.7%	£1,085,834	£7,166,051
Bannockburn	1231	99	29	73	129	349	287	23.3%	£350,532	£2,206,667
Blane Valley	2152	556	187	204	412	534	1078	50.1%	£2,361,942	£9,737,941
Borestone	1571	102	36	111	69	332	291	18.5%	£405,428	£1,394,947
Braehead	924	45	14	31	83	527	157	17.0%	£150,133	£1,685,644
Bridge of Allan and University	1890	395	295	182	382	492	921	48.7%	£2,838,491	£13,769,846
Broomridge	2123	313	56	215	48	87	556	26.2%	£756,989	£1,822,470
Callander and Trossachs	1484	213	162	130	363	480	629	42.4%	£1,583,497	£7,742,459
Cambusbarron	1326	246	83	103	116	185	449	33.9%	£1,008,528	£3,025,119
Carse of Stirling	1981	190	273	185	664	835	953	48.1%	£2,606,814	£13,190,880
Causewayhead	1132	305	39	65	95	153	441	39.0%	£609,087	£1,922,678
City Centre	467	40	104	40	166	251	232	49.7%	£565,961	£10,199,700
Cornton	962	78	11	66	51	157	157	16.3%	£181,549	£893,983
Cowie	1083	21	10	50	166	574	231	21.3%	£129,755	£1,645,755

Intermediate zone	No. of domestic buildings	No. of domestic buildings requiring cavity wall insulation	No. of domestic buildings requiring new glazing	No. of domestic buildings requiring loft insulation	No. of domestic buildings requiring solid wall insulation	No. of 'hard to treat' domestic buildings	Total no. of domestic buildings requiring some fabric retrofit	Percentage of total domestic buildings in zone needing retrofit	Estimated total cost per zone (excluding solid wall insulation)	Estimated total cost per zone (including solid wall insulation)
Dunblane East	1902	242	166	109	321	447	656	34.5%	£1,623,758	£7,442,252
Dunblane West	1603	322	85	91	185	277	582	36.3%	£1,042,284	£3,779,085
Fallin	1137	103	12	57	28	194	181	15.9%	£190,220	£521,119
Forth	759	83	93	85	242	290	381	50.2%	£762,943	£5,028,234
Highland	1489	246	192	216	477	573	833	55.9%	£2,059,512	£9,832,660
Hillpark	1414	51	9	47	132	627	223	15.8%	£130,150	£1,429,961
King's Park and Torbrex	1339	168	295	98	425	494	668	49.9%	£2,246,960	£13,014,855
Kippen and Fintry	1320	143	119	132	368	494	607	46.0%	£1,241,931	£7,055,215
Plean and Rural SE	1440	149	31	57	172	442	376	26.1%	£394,355	£2,755,069
Raploch	1126	27	16	23	10	116	68	6.0%	£130,767	£254,767

Clackmannanshire Zones

Intermediate zone	No. of domestic buildings	No. of domestic buildings requiring cavity wall insulation	No. of domestic buildings requiring new glazing	No. of domestic buildings requiring loft insulation	No. of domestic buildings requiring solid wall insulation	No. of 'hard to treat' domestic buildings	Total no. of domestic buildings requiring some fabric retrofit	Percentage of total domestic buildings in zone needing retrofit	Estimated total cost per zone (excluding solid wall insulation)	Estimated total cost per zone (including solid wall insulation)
Alloa North	2459	353	89	159	178	242	678	27.6%	£968,029	£4,160,613
Alloa South and East	1767	137	122	68	194	638	421	23.8%	£933,155	£5,556,661
Alloa West	1290	136	98	68	320	390	504	39.1%	£853,665	£7,223,750
Alva	2005	320	64	143	296	461	693	34.6%	£827,865	£6,040,715
Clackmannan Kennet and Forestmill	2126	231	75	89	145	446	461	21.7%	£699,464	£3,187,600
Dollar and Muckhart	1552	281	186	89	446	574	800	51.5%	£1,880,885	£8,866,433
Fishcross, Devon Village and Coalsnaughton	979	104	70	37	100	164	272	27.8%	£541,918	£2,065,644
Menstrie	1124	156	50	35	90	203	278	24.7%	£468,652	£2,060,748

Intermediate zone	No. of domestic buildings	No. of domestic buildings requiring cavity wall insulation	No. of domestic buildings requiring new glazing	No. of domestic buildings requiring loft insulation	No. of domestic buildings requiring solid wall insulation	No. of 'hard to treat' domestic buildings	Total no. of domestic buildings requiring some fabric retrofit	Percentage of total domestic buildings in zone needing retrofit	Estimated total cost per zone (excluding solid wall insulation)	Estimated total cost per zone (including solid wall insulation)
Sauchie	2061	374	157	84	133	209	627	30.4%	£1,312,421	£3,400,247
Tillicoultry	1852	310	99	70	329	451	696	37.6%	£971,674	£6,665,813
Tullibody North and Glenochil	1888	246	150	51	171	387	560	29.7%	£1,152,924	£4,296,166
Tullibody South	1625	203	37	40	49	334	294	18.1%	£471,277	£1,393,543
Cornton	962	78	11	66	51	157	157	16.3%	£181,549	£893,983

The previous tables are useful for identifying areas where common fabric interventions are required to improve energy efficiency. However, as outlined in section 4.1, it is important when retrofitting homes that a whole building approach is taken where possible to include aspects such as air tightness, removing thermal bridges and installing ventilation. This will help to address the performance gap and ensure that the expected savings from the individual fabric improvements listed in the tables above are maximised. It is also worth considering if any existing maintenance required, or other works planned – combining energy efficiency measures alongside any other renovation plans, such as a new kitchen, intensive redecoration or a flooring replacement, is more cost effective.

The recommended approach to take for retrofit is outlined below:

1. Retrofit Coordination

- Get professional help or seek existing guidance at an early stage, to coordinate the project. See Appendix X - Retrofit Resources.
- Define the project and outcomes, both retrofit and any other improvement works. This starts the retrofit plan by outlining the brief.

2. Whole-dwelling Assessment

- Including context, condition, occupancy, energy, ventilation, historical significance.
- Consider risks.

3. Improvement Option Evaluation

- Evaluate all of the options for energy reduction, heat decarbonisation and potential energy generation, alongside the budget and needs of the owner/building users, in line with the project outcomes.
- Development of the retrofit plan, which can be phased if required.

4. Design

- Including ventilation upgrades, details, moisture management.

5. Installation

- By qualified professional, in accordance with PAS 2030 or MCS standards.
- Undertake quality checks throughout to ensure outcomes are achieved as designed.

6. Evaluation

- Monitor the building following completion of the project, to confirm agreed outcomes and identify and address any unintended consequences.

A brief summary of the interventions highlighted in the table above, along with those not included is provided below:

- **Loft Insulation:** Assumes adding insulation to the loft or roof space, typically with mineral wool, to bring the roof up to current standards which require around 270mm of insulation. Properties with no loft insulation should be targeted first, before fully insulating lofts in homes that have some insulation already, but not enough to meet current standard. This is one of the easiest and most cost effective changes to make.
- **Cavity Wall Insulation:** Involves insulating the cavity between the outer and inner leaves of a property's external and internal walls by filling it with an insulation material. Can only be applied on cavity or timber frame walls. Some homes which have had cavity wall insulation installed over 20 years ago may need it replaced. This needs to be carefully considered as there is significant risk of damp if done incorrectly.
- **External Wall Insulation:** One option for insulating solid or system built homes, where cladding with a layer of insulating material is applied to the outside walls of the building. It is less disruptive compared to internal wall insulation, with less risk of damp and higher thermal efficiencies available. However, it can have a significant visual impact and therefore planning implications. It also typically has higher associated costs due to the requirements of scaffolding.

- **Internal Wall Insulation:** Involves insulating the inside of a homes external walls. It is more disruptive compared to external wall insulation, due to the need to strip out and replace some flooring, internal walls, plugs and light fittings etc. and can reduce internal area. It needs more careful specification and should typically be water vapour permeable to avoid risk of damp. It does not have any planning implications however. It is also typically cheaper than external wall insulation.

- **Glazing Upgrade:** Figures in the table assume the replacement of single glazed windows with high quality double glazing. If undertaking or planning a phased deep retrofit, triple glazed windows should be used. Windows, doors and rooflights are one of the more expensive items to replace, but also have a huge impact on heat loss. Consideration should be made of the whole retrofit plan when replacing windows, in order to minimise thermal bridges and maintain airtightness where the window frames meet the walls.

Not included in table above (due to lack of data):

- **Floor Insulation:** There are a variety of approaches possible depending on the existing floor construction and level of disruption that is acceptable. Suspended timber floors can have insulation added into the cavity under the floor, maintaining adequate airflow to minimise risk of damp, or be replaced with a new solid floor to allow for a greater depth of insulation. Existing solid floors if not replaced can be the hardest to insulate due to limited space, but thin, high performing insulations are available, though more expensive.

- **Roof Insulation:** Other than loft insulation, roofs with rooms in them and flat roofs can also be insulated. It is possible to insulate between the rafters of a sloped roof, but may require the removal of the internal lining if there is no other access. Flat roofs are best suited to external insulation to minimise risk of damp.

- **Thermal Bridging:** Any gaps in insulation, or areas of structure that penetrate insulation, act as thermal bridges. This lets cold into the building, creating potential for condensation and damp, and reducing the overall thermal performance of the external envelope of the building. Thermal bridges are often found at the junctions between building elements such as the eaves, and around windows and doors. With careful consideration of the overall retrofit plan, thermal bridges can be minimised with good design details.

- **Airtightness:** Also known as infiltration, this is the measure of how much uncontrolled air passes through the building envelope. Often experienced as drafts. This can be a major contributing factor to heat loss as warm air escapes the building, and has implications for moisture risk due to the ability of air to carry or loose water at different temperatures. Increasing airtightness and reducing drafts is an essential consideration. At a basic level it involves draft proofing, and at an advanced level should carried out hand in hand with an insulation strategy, with airtightness membranes or coatings and taping of junctions.

- **Ventilation:** A vital consideration that can have the most impact on health; affecting damp risk and internal air quality. Inadequate ventilation leads to build up of moisture and pollutants, including mould, and can worsen overheating. However, natural ventilation lets cold air into our buildings. With increased airtightness there is the opportunity to use Mechanical Ventilation Heat Recovery (MVHR), which recovers heat from the stale air leaving the building to provide fresh warm air. Excess moisture and pollutants are also removed. With a well designed and installed systems, MVHRs provide some of the highest internal air qualities, though maintenance is required.

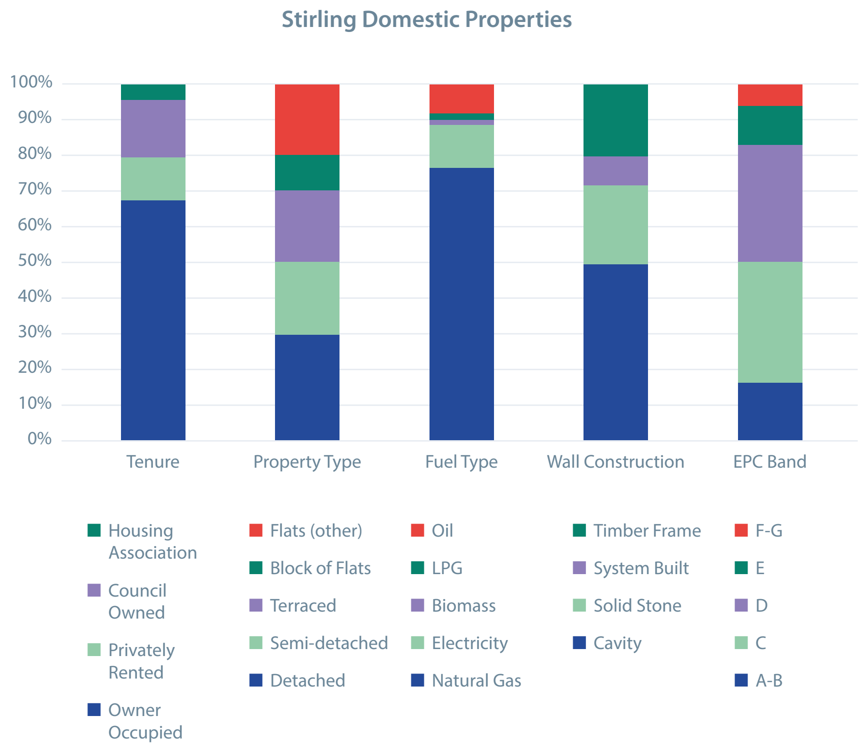
- **Hot Water:** Whilst the decarbonisation of the heating system for hot water is not strictly an energy efficiency measure, there are energy savings to be considered here with the insulation of storage tanks and pipework. When planning the retrofit of the whole building, the water heating system along with pipework and storage tanks must be considered together.

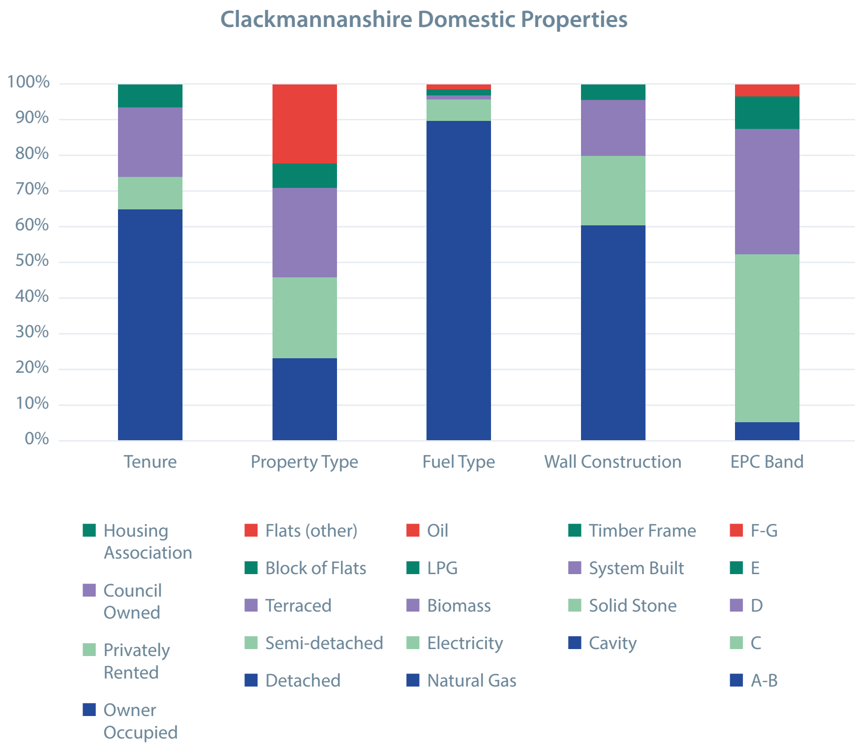
- **Other Energy Uses:** Low energy appliances and lights should also be considered to reduce overall energy use.

Though not within the category of energy efficiency and reducing heat loss and energy use, heat decarbonisation must be considered as part of the retrofit plan. This includes the chosen heat source for both hot water and space heating. See Appendix IV for details on heat supply. Also worth considering is any energy generation, such as solar panels.

Overview of Council Area Domestic Properties

The following bar charts below provide an overview of the domestic properties in each council area. Both local authorities have a similar split for property tenure and type, which shows the major focus that will be required for private homeowner awareness campaigns. Stirling council has more off gas grid properties (and therefore more homes heated with oil, LPG and electricity), though both local authorities have predominantly on gas grid homes. There is good opportunity for potential replacement of wet heating systems with heat pumps and district heat networks. Clackmannanshire council has proportionally more cavity wall constructions, which can provide easier opportunity for retrofit if done carefully. Across both local authorities, around half the domestic properties already meet the target for KPI 4, of achieving an EPC rating of C or better. This is a good starting position from which to improve.





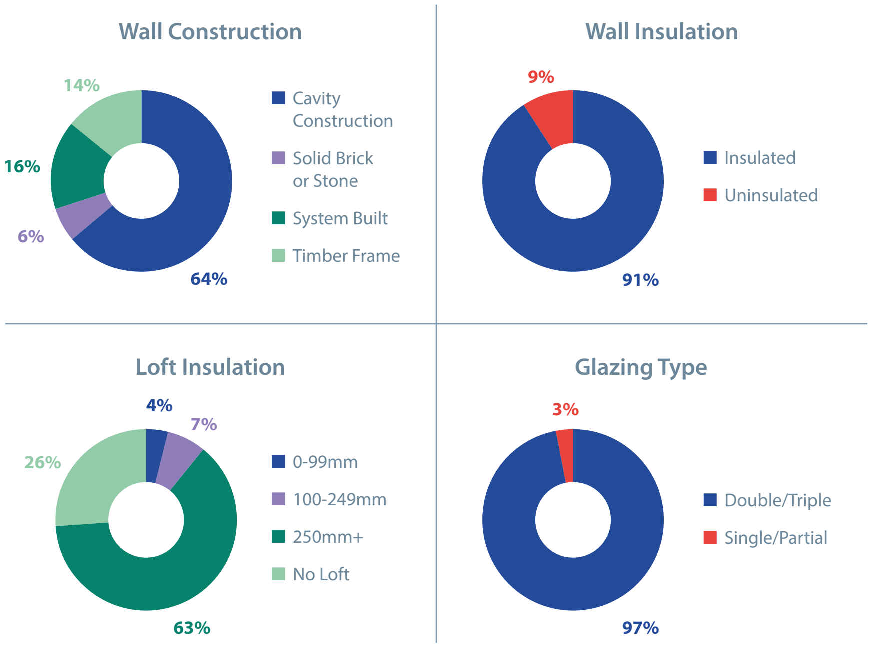
Analysis by Tenure Type

Different types of tenure have been analysed to help determine where funding and awareness efforts can be best directed. This includes an estimation of the total costs required for all properties in this tenure type to reach their 2032 EPC rating target of C, based on the UK Government 2019 costing data. These cost estimates include one case with solid wall/hard to treat homes excluded, one case where these homes have internal wall insulation (IWI), and one case where these homes have external wall insulation (EWI). For a comparison between internal and external wall insulation see the previous summary of retrofit interventions in this appendix.

As can be seen in the graphs and tables below, typically socially rented homes are in the best condition across both council areas – with less homes needing retrofit work to reach their target as most have insulated walls and roofs with double glazing. Privately rented homes are the worst performing tenure type regarding energy efficiency with a high proportion of these homes having uninsulated walls and roofs and single glazing.

There is a significantly larger investment required to bring privately rented homes up to standard compared to socially rented homes, despite there being less privately rented homes in total. The majority of homes in the region are owner occupied, which generally tend to be in worse condition than socially rented homes, but better condition than privately rented homes, as can be seen in the following figures and tables. The fabric condition pie charts give an indication of the number of specific measures required across each tenure type, but ideally each individual household should undergo a 'whole house' retrofit approach which includes aspects such as air tightness, ventilation and thermal bridges.

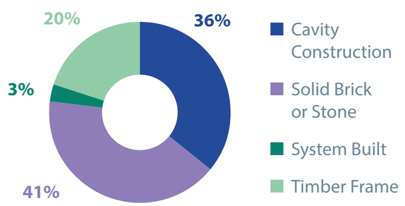
Stirling Council area socially rented homes condition breakdown and investment required



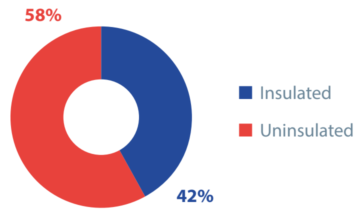
Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	703	12.3%	£1,258,637	£1,790
IWI on solid wall homes	795	13.9%	£4,287,974	£5,394
EWI on solid wall homes	795	13.9%	£5,191,627	£6,530

Stirling Council area privately rented homes condition breakdown and investment required

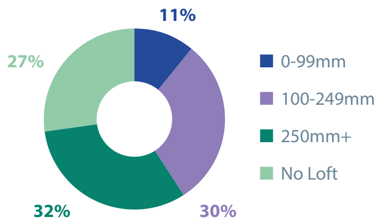
Wall Construction



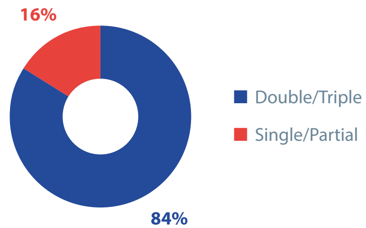
Wall Insulation



Loft Insulation



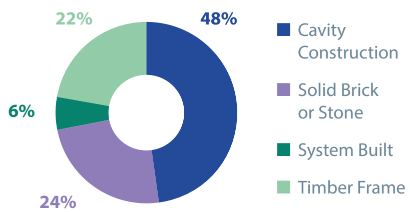
Glazing Type



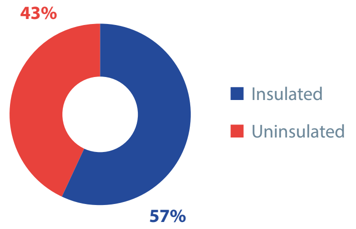
Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	1634	47.8%	£4,623,628	£2,829
IWI on solid wall homes	1907	55.8%	£20,820,412	£10,918
EWI on solid wall homes	1907	55.8%	£26,911,163	£13,474

Stirling Council area owner-occupied homes condition breakdown and investment required

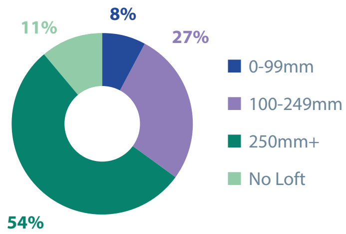
Wall Construction



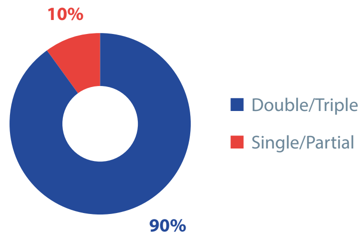
Wall Insulation



Loft Insulation

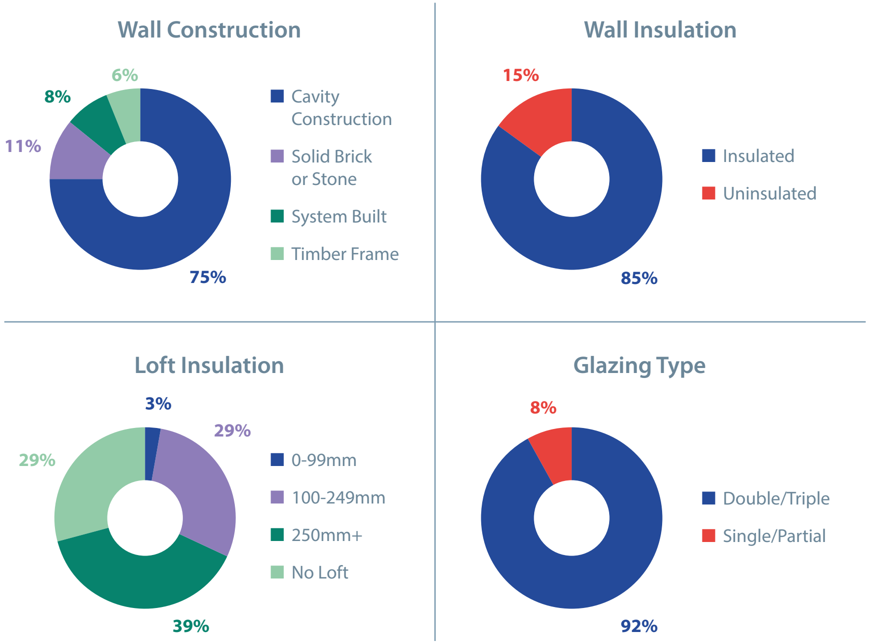


Glazing Type



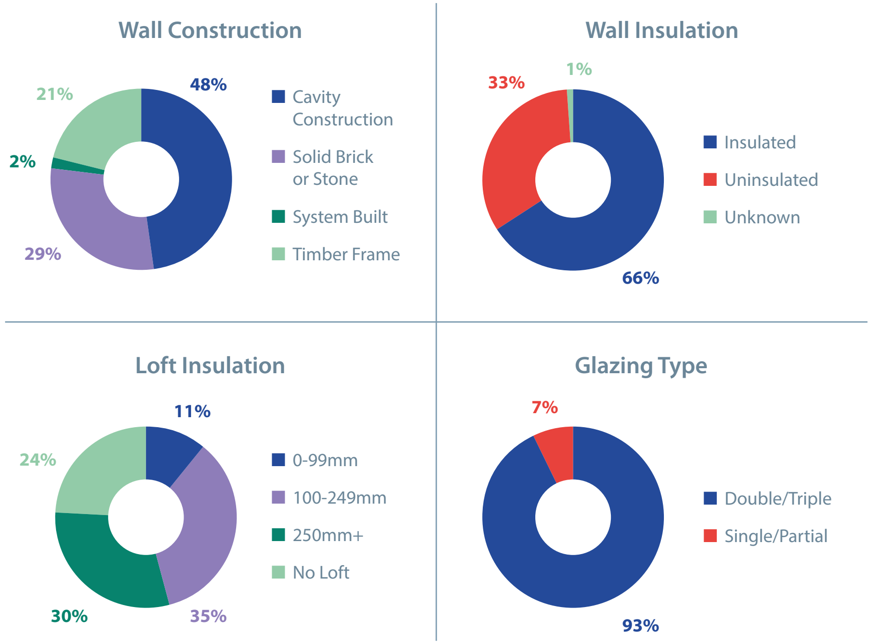
Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	5953	24.4%	£18,575,155	£3,120
IWI on solid wall homes	8986	36.8%	£78,817,463	£8,771
EWI on solid wall homes	8986	36.8%	£101,071,831	£10,754

Clackmannanshire Council area socially rented homes condition breakdown and investment required



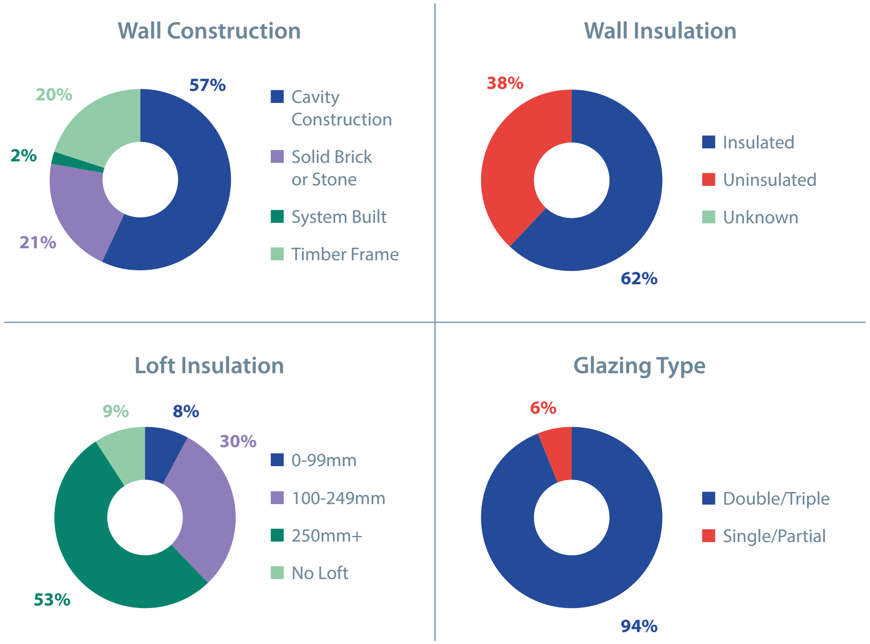
Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	728	16.1%	£2,899,505	£3,983
IWI on solid wall homes	894	19.8%	£6,917,079	£7,737
EWI on solid wall homes	894	19.8%	£8,051,271	£9,006

Clackmannanshire Council area privately rented homes condition breakdown and investment required



Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	699	43.6%	£1,255,910	£1,797
IWI on solid wall homes	789	49.2%	£4,287,974	£6,445
EWI on solid wall homes	789	49.2%	£5,191,627	£7,771

Clackmannanshire Council area owner-occupied homes condition breakdown and investment required



Scenario	No. of buildings requiring retrofit	% of total social housing	Total investment required	Average cost per household requiring retrofit
No solid wall insulation	3102	21.2%	£6,926,515	£2,233
IWI on solid wall homes	4601	31.5%	£33,425,400	£7,265
EWI on solid wall homes	4601	31.5%	£41,559,133	£8,853

Appendix IV – Heat Supply by Zone

The following two tables provide a breakdown for each council area of the current heating fuel types used, split by zone. The most suitable low carbon heat source for each zone is noted, with an estimation of the total number of different low carbon heat installations that will be required in each zone. This number will be dependent upon future UK policy and whether an electrification or hydrogen pathway is followed, see section 5.4. The assumptions for these pathways are that:

- the majority of homes in off gas grid areas transition to heat pumps with a small percentage (0-20%) of homes in the most rural areas using some form of bio-energy;
- and on gas grid homes either predominantly electrify (through heat pumps or elsewise) or transition to hydrogen depending on the policy decision, see Section 4.2 for more details.

The homes most suitable for immediate conversion to heat pumps will be those in off gas grid areas currently using oil or LPG, which are already well insulated. Some homes may need to implement fabric improvements in order to be heat pump ready, but even larger older buildings with inefficient building fabrics can still be suitable for a heat pump if larger radiators are installed and a high temperature model is used. The use of fossil fuels for heating should be eliminated in off gas grid areas across the region by 2032.

For homes on the gas grid which wish to decarbonise their heat in the short term, heat pumps are generally the most viable option (although each house will need to be assessed individually) – but currently unless the house is very well insulated their energy prices will likely be higher when changing from a gas boiler to a heat pump, or other electrical heating system. If electricity prices are de-coupled from gas prices in the future then it should reduce the running cost of a heat pump, making them a cheaper option than a gas boiler. Many of the homes currently on the gas grid in Stirling and Clackmannanshire may have a hydrogen supply in the future, but this is dependent upon the UK Government policy decision as previously outlined along with investigations and determination of the best use for hydrogen by industry experts.

It should be noted that the following zones will also likely have some domestic properties connected to district heating networks for low carbon heat supply: Braehead, Raploch, Bridge of Allan, Callander, Alloa South and East, Sauchie, Alva. The precise number of which will be dependent on successful business cases for developing new networks, and for expanding them to enable connections to domestic properties.

Stirling Council Area

Zone	Total no. of domestic buildings	% using natural gas	% using electricity	% using biomass	% using oil or LPG	Most suitable low carbon heat source for area	Expected no. of heat pump installations	Expected no. of hydrogen boiler conversions	Expected no. of new bio-fuel systems
Balfron and Drymen	1711	51.9%	19.6%	2.8%	25.7%	Electrification, potentially some hydrogen	440 - 1328	up to 888	up to 256
Bannockburn	1233	97.8%	1.8%	0.0%	0.4%	Hydrogen or electrification	5 - 1211	up to 1206	0
Blanevalley	2164	71.1%	8.0%	2.9%	17.8%	Electrification, potentially some hydrogen	386 - 1925	up to 1539	up to 385
Borestone	1571	90.5%	8.0%	0.0%	1.5%	Hydrogen or electrification	23 - 1444	up to 1421	0
Braehead	926	87.3%	9.2%	0.0%	3.5%	Hydrogen or electrification	32 - 840	up to 808	0
Bridge of Allan and University	1888	91.4%	6.1%	0.7%	1.8%	Hydrogen or electrification	34 - 1759	up to 1725	0
Broomridge	2121	94.4%	5.5%	0.0%	0.1%	Hydrogen or electrification	0 - 2005	up to 2003	0
Callander and Trossachs	1532	79.0%	7.4%	1.9%	11.7%	Electrification, potentially some hydrogen	179 - 1390	up to 1211	up to 278
Cambusbarron	1411	92.8%	3.0%	0.8%	3.3%	Hydrogen or electrification	46 - 1355	up to 1309	0
Carse of Stirling	1996	31.0%	15.5%	6.2%	47.3%	Electrification, potentially some hydrogen	945 - 1562	up to 618	up to 312
Causewayhead	1134	95.4%	3.9%	0.0%	0.5%	Hydrogen or electrification	6 - 1088	up to 1082	0
City Centre	486	82.7%	14.6%	0.0%	0.4%	Hydrogen or electrification	2 - 404	up to 402	0
Cornton	963	93.5%	6.3%	0.0%	0.2%	Hydrogen or electrification	2 - 902	up to 900	0
Cowie	1083	92.7%	6.5%	0.0%	0.8%	Hydrogen or electrification	9 - 1013	up to 1004	0
Dunblane East	1896	87.4%	6.9%	0.9%	4.7%	Hydrogen or electrificiation	90 - 1748	up to 1658	0

Zone	Total no. of domestic buildings	% using natural gas	% using electricity	% using biomass	% using oil or LPG	Most suitable low carbon heat source for area	Expected no. of heat pump installations	Expected no. of hydrogen boiler conversions	Expected no. of new bio-fuel systems
Dunblane West	1602	94.9%	4.2%	0.0%	0.5%	Hydrogen or electrificiation	8 - 1529	up to 1521	0
Fallin	1137	90.8%	7.9%	0.0%	0.9%	Hydrogen or electrification	10 - 1042	up to 1032	0
Forth	759	81.9%	11.1%	0.0%	7.4%	Hydrogen or electrification	56 - 678	up to 622	0
Highland	1489	0.0%	38.0%	11.8%	49.9%	Electrification	743	0	up to 148
Hillpark	1414	98.6%	1.1%	0.0%	0.6%	Hydrogen or electrification	9 - 1403	up to 1394	0
Kings Park and Torbrex	1338	95.7%	3.4%	0.0%	0.5%	Hydrogen or electrification	7 - 1288	up to 1281	0
Kippen and Fintry	1293	0.0%	35.5%	5.8%	58.4%	Electrification	755	0	up to 151
Plean and Rural SE	1434	63.5%	9.1%	2.2%	25.2%	Electrification, potentially some hydrogen	361 - 1272	up to 911	up to 254
Raploch	1160	97.9%	2.0%	0.0%	0.1%	Hydrogen or electrification	1 - 1137	up to 1136	0

Clackmannanshire Council Area

Zone	Total no. of domestic buildings	% using natural gas	% using electricity	% using biomass	% using oil or LPG	Most suitable low carbon heat source for area	Expected no. of heat pump installations	Expected no. of hydrogen boiler conversions	Expected no. of new bio-fuel systems
Alloa North	2463	91.9%	7.6%	0.0%	0.4%	Hydrogen or electrification	10 - 2274	up to 2264	0
Alloa South and East	1801	91.2%	8.1%	0.0%	0.6%	Hydrogen or electrification	11 - 1654	up to 1643	0
Alloa West	1292	94.4%	5.0%	0.0%	0.2%	Hydrogen or electrification	3 - 1223	up to 1220	0
Alva	2001	92.0%	6.2%	0.0%	1.1%	Hydrogen or electrification	22 - 1863	up to 1841	0
Clackmannan Kennet and Forestmill	2119	91.6%	2.6%	0.7%	5.2%	Hydrogen or electrification	110 - 2050	up to 1940	0
Dollar and Muckhart	1551	72.1%	6.8%	1.4%	19.7%	Hydrogen or electrification	306 - 1425	up to 1119	up to 285
Fishcross, Devon Village and Coalsnaughton	977	92.2%	3.1%	0.4%	4.3%	Hydrogen or electrification	42 - 943	up to 901	0
Menstrie	1123	98.5%	1.3%	0.0%	0.0%	Hydrogen or electrification	0 - 1106	up to 1106	0
Sauchie	2064	96.0%	3.0%	0.0%	0.9%	Hydrogen or electrification	18 - 19998	up to 1981	0
Tillicoultry	1850	94.1%	5.4%	0.0%	0.3%	Hydrogen or electrification	6 - 1747	up to 1741	0
Tullibody North and Glenochil	1884	95.3%	2.1%	0.0%	2.2%	Hydrogen or electrification	41 - 1837	up to 1796	0
Tullibody South	1625	97.4%	2.3%	0.0%	0.0%	Hydrogen or electrification	0 - 1583	up to 1583	0

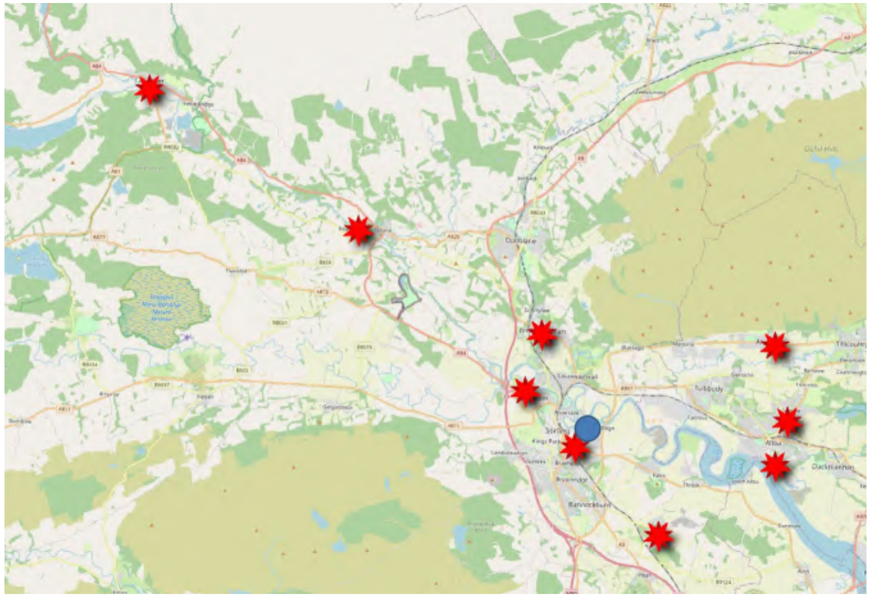
Appendix V – District Heating Site Technical Details

This appendix lists the technical details and assumptions for the district heat network modelling, for each of the sites that weightings are applied to in Section 5.4. They are ordered below by their final weighted score.

All of the district heating sites were modelled assuming that air source heat pumps would be the primary heat source, apart from sites near a large body of water, where water source heat pumps with a higher COP were assumed to meet at least part of the demand. As outlined in Section 4.2.5, only non-domestic buildings, and socially rented properties in the immediate vicinity were assumed to be suitable for connection upon initial construction. However, each of the networks are close to residential areas which could connect into them if they were to be expanded at a later date.

Many of the sites may be suitable for alternative low carbon heat sources, such as biomass or other bio energy, hydrogen, waste incineration, geothermal, or abandoned flooded mine water, depending on future policy decisions or availability determined from feasibility studies.

The location of each of the sites that were assessed and modelled are shown by the red markers in the map below. The blue circle highlights the location of the existing heat network at Forthside in Stirling.



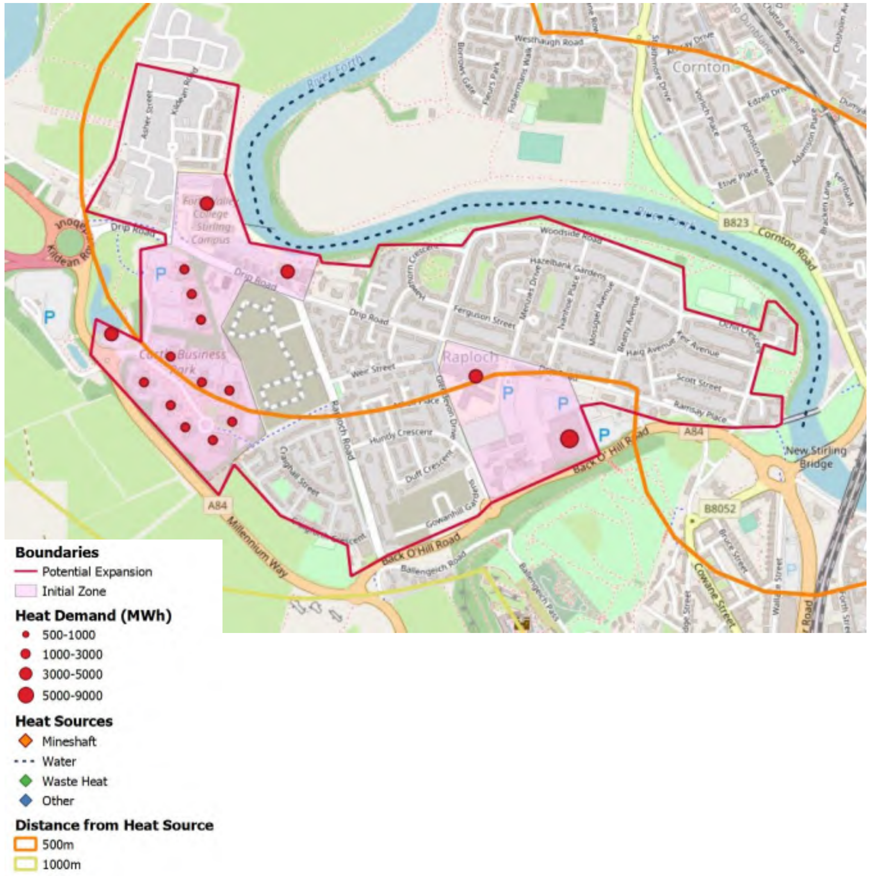
The buildings that were assumed to be suitable for connection to each network are listed in the following tables. This was determined based on their initial construction, current fuel type, floor area, primary use simulated annual heat demand and current carbon emissions that could be avoided through connection to a low carbon district heating network. In some cases, for non-domestic buildings, where there was a lack of data to obtain a high accuracy output from the energy simulation, the annual total was scaled up or down to match CIBSE benchmark figures for heat demand intensity per metre squared of floor area.

In order to finalise the extent and heat source of these district heat networks, feasibility studies must be carried out, followed by business cases.

Raploch Network

The assumptions around the buildings that could be connected into the Raploch network, their heat consumption and potential carbon reductions, were taken from an existing pre-feasibility study. Some details from this are outlined below:

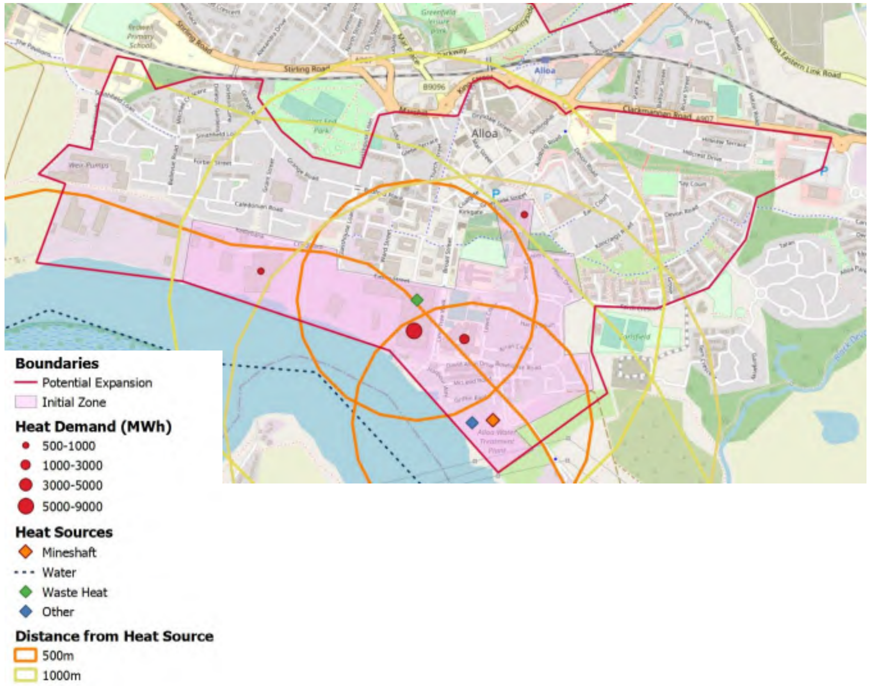
Primary Use	Assumed Fuel Type	Assumed Heat Demand (MWh)	Assumed Carbon Emissions (tCO2e)
Higher Education	Natural Gas	1784	386
Healthcare Longstay	Natural Gas	1430	310
Catering: Restaurant with Bar	Natural Gas	1153	365
Higher Education	Natural Gas	1685	250
Offices	Natural Gas	4922	1065



Alloa Forthbank Network

In addition to the non-domestic buildings listed below, the circa 100 or so socially rented domestic buildings located next to Alloa Academy could also be connected when the network is initially constructed.

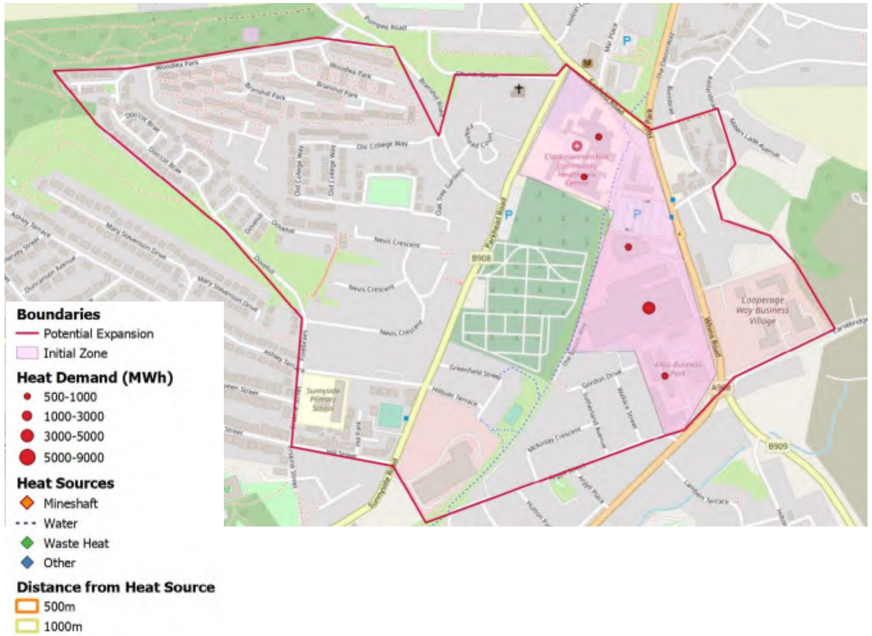
Primary Use	Fuel Type	Floor Area (m²)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO2e)
Industrial	Electricity	89492	9218	326.3
Secondary School	Natural Gas	17352	1961	302.9
Childcare	Electricity	781	137	4.0
Primary School	Natural Gas	2561	312	50.4
Library	Electricity	3630	425	10.9
Office	Electricity	594	106	2.0
Office	Electricity	4704	837	16.2
Warehouse	Natural Gas	11395	1174	238.2
Childcare	Oil	946	166	37.2
Childcare	Oil	2874	506	113.0
Office	Natural Gas	3283	355	52.6
Warehouse	Oil	11442	618	169.9



Alloa Healthcare and Business Centre Network

In addition to the non-domestic properties listed below, the circa 50 or so socially rented buildings South of Alloa Business Park, in and around Argyll street could also be connected when the network is initially constructed.

Primary Use	Fuel Type	Floor Area (m^2)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO2e)
Office	Electricity	1402	250	8.8
Warehouse	Natural Gas	39344	6688	1357.8
Office	Natural Gas	2539	274	55.7
Office	Natural Gas	4446	791	160.7
Health Care – Health Centres and Clinics	Electricity	5676	840	29.7
Health Care- Primary Health Care Buildings	Electricity	5694	928	32.9
Health Care - Health Centres and Clinics	Natural Gas	179	27	5.4
Office	Electricity	1293	140	4.9
Office	Electricity	3189	568	20.1
Office	Natural Gas	1232	219	44.5



Braehead/Springkerse Network

The sites which originated from the Scottish Government's initial screening were simulated in detail using IES Virtual Network software. Following stakeholder engagement sessions, additional potential district heating sites which could make use of waste heat from industrial processes were identified. Due to time constraints these sites could not be modelled in detail, however a high level assessment was carried out to provide inputs for the weighting system.

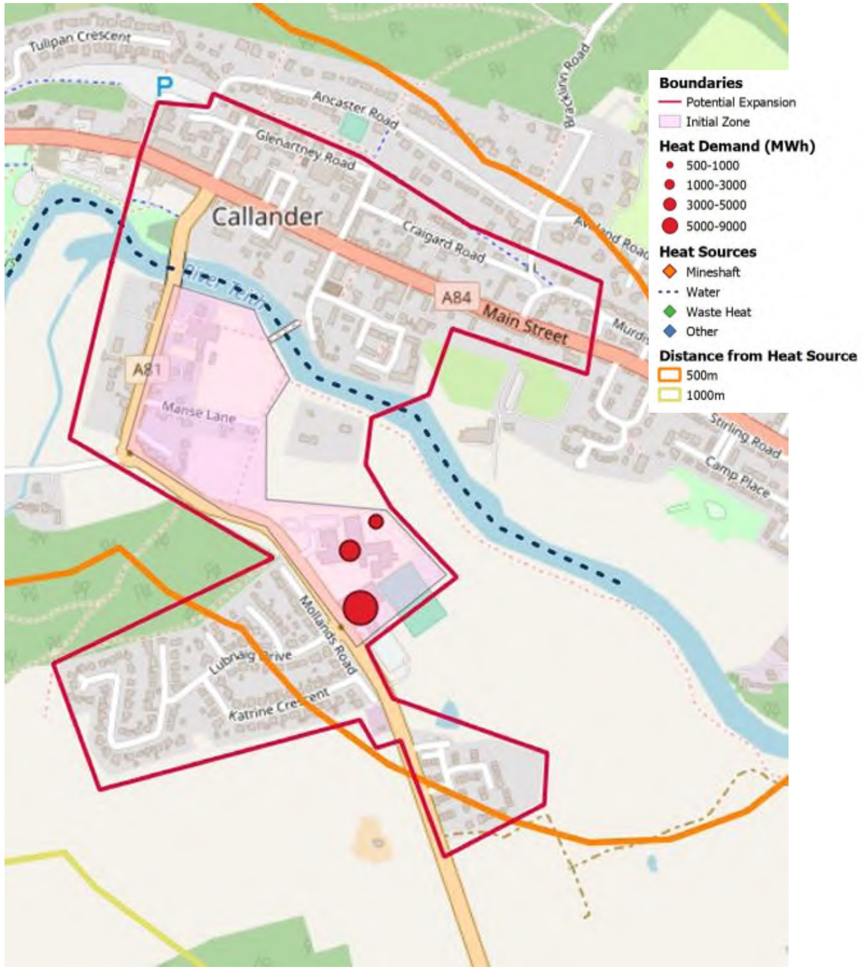
The inputs for the weightings assumed that most of the buildings in Springkerse industrial site located in between Kerse road and the railway line would be connected into the network, using waste heat from the factory. There are homes to the west of this site that could potentially be connected in. This would require the pipes to cross the railway line which could be expensive to implement unless the use of utilities ducts was possible. Similarly, the industrial buildings North of Kerse road could also connect in, but this would require the pipes to cross the A905 main road - if this was to happen in the future then the network could also potentially connect into the existing Forthside network.

Cowie Network

Similar to the Braehead network, as this site was not in the initial screening it was not modelled in detail, but a high level assessment to provide inputs to the weighting system was carried out. The inputs to the district heating network weightings were determined assuming that the community centre, health care centre, library and most of the homes in the southern half of the village were connected in a district heating network, using waste heat from the nearby factory. Other technologies could be used in place of waste heat.

Callander Network

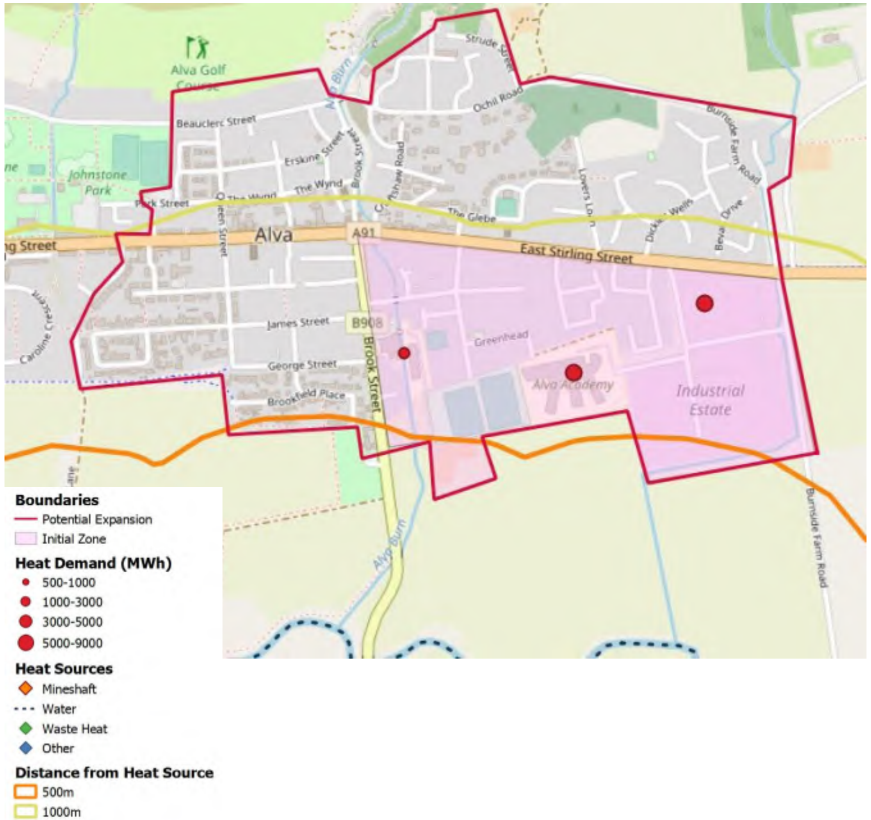
Primary Use	Fuel Type	Floor Area (m²)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO2e)
Secondary School	Natural Gas	13553	1531	310.8
Sports Activities Indoor	Natural Gas	5491	7254	1472.5
Single Family Detached	Electricity	123	19	0.67
Primary School	Electricity	3831	467	16.5
Hotel	Electricity	1006	362	12.8



Alva Network

In addition to the non-domestic buildings listed below, the 25 socially rented properties around Greenhead and Minto Gardens could also be connected to the network when it is initially constructed.

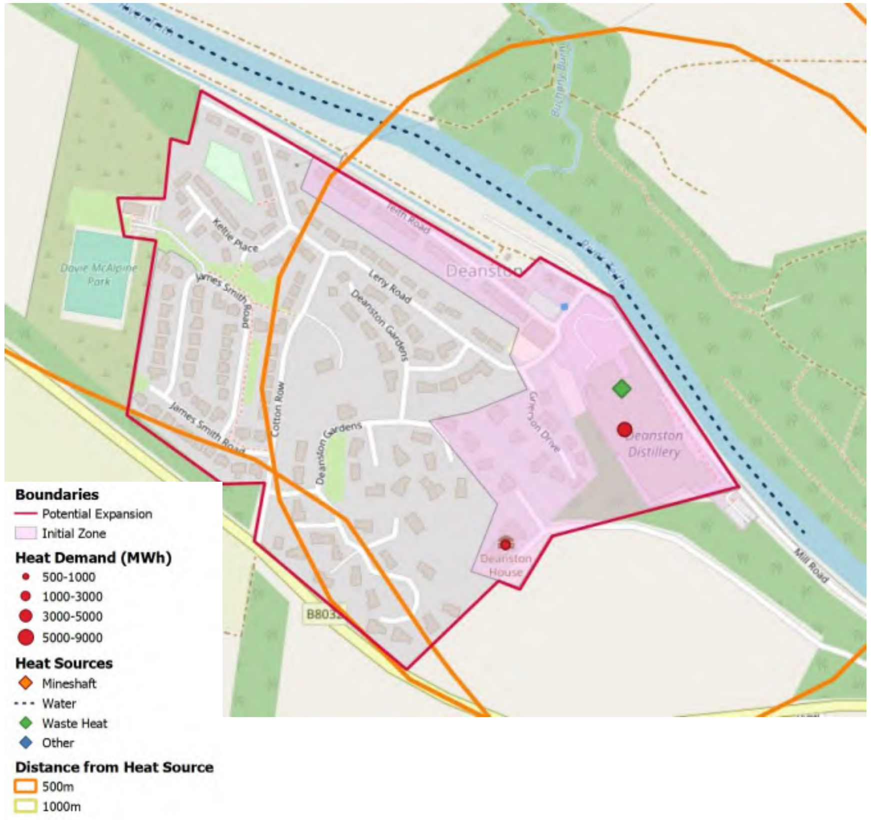
Primary Use	Fuel Type	Floor Area (m^2)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO_2e)
Secondary School	Electricity	17403	1967	69.6
Primary School	Electricity	3789	462	16.4
Office	Natural Gas	830	148	30.0
Office	Natural Gas	1119	199	40.4
Office	Natural Gas	1118	199	40.4
Office	Natural Gas	1123	200	40.6
Office	Natural Gas	1760	313	63.6
Industrial	Natural Gas	1226	206	42.0
Office	Natural Gas	848	151	30.6
Office	Natural Gas	558	99	20.2
Office	Natural Gas	458	82	16.6
Office	Natural Gas	1001	178	36.2
Warehouse	Natural Gas	7385	1255	254.8



Deanston Network

In addition to the non-domestic buildings listed below, the circa 25 socially rented domestic buildings on Teith Road could also be connected to the network when it is initially constructed.

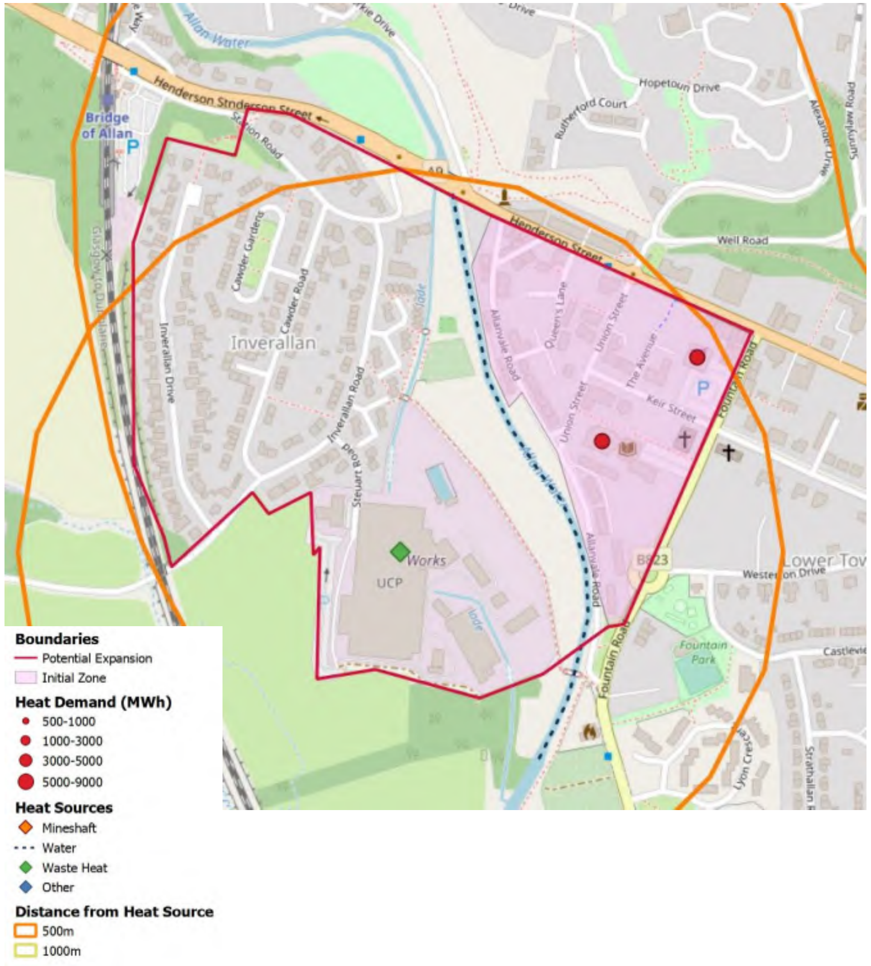
Primary Use	Fuel Type	Floor Area (m^2)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO_2e)
Industrial	Electricity	19822	918	32.5
Health Care	Biomass	2456	255	3.8
Primary School	Electricity	596	19	0.7



Bridge of Allan Network

In addition to the non-domestic buildings listed below, the council houses located on Allanvale road could also be connected when the network is initially constructed.

Primary Use	Fuel Type	Floor Area (m^2)	Current Heat Consumption (MWh)	Potential Carbon Emissions Avoided (tCO2e)
Church	Natural Gas	486	73	14.8
Church	Natural Gas	722	108	22.0
Retail Store	Electricity	825	215	7.6
Health Care	Electricity	799	130	4.6
Sports Activities Indoor	Natural Gas	1719	772	156.7
Library	Natural Gas	448	52	10.6



Appendix VI – Renewable Generation Site Details

The table below outlines the total area available at each site, the assumed portion of this area that could be used for PV, the MWp installed capacity provided by this area of panels, and the simulated annual generation and resultant carbon saving.

PV was assumed to be the primary renewable technology used at each site when modelling, as an initial scoping exercise. A further technological assessment must be undertaken at each site to determine potential viability for wind, hydro, storage etc.

Site	Area of Land Available (m^2)	Assumed Area of PV Panels (m^2)	Capacity (MWp)	Annual Generation (MWh)	Annual Carbon Saved (tCO2e)
Forthbank/Black Devon Landfill	82,969	16,179	2.84	3,042	108
Westhaugh Caravan Site	90,911	17,728	3.11	3,333	118
Manor Powis	195,565	39,380	6.80	7,403	262
Bandeath	171,000	33,345	5.85	6,269	222
NE Alva	84,043	16,388	2.88	3,081	109
West of Plean Country Park	37,666	7,345	1.29	1,381	49

The images below show the assumed area that could be used for PV at each site circled in red.
For a short description of each site see Section 4.4.

Forthbank/Black Devon Landfill

Westhaugh Caravan Site

Manor Powis

Bandeath

NE Alva

West of Plean Country Park

Appendix VII - Carbon Projection Assumptions

Industry

The Deep Decarbonisation Pathways for Scottish Industries, Element Energy report for Scottish Government indicates that industry can reduce emissions by over 80% compared to 2018, through either a green hydrogen pathway or an electrification pathway. Some processes may also be suitable for partial fuel switching to biodiesel or bio oil if this is available as a cost-effective resource in the future at the scales required. It is hoped that the remaining 20% of emissions from industrial processes not suitable for either hydrogen or electrification could eventually become fully net zero through carbon capture and storage, however this may not be viable by 2045. It has been identified through the stakeholder engagement sessions that planning permission and permit applications are often a significant barrier to completing large-scale works for decarbonisation. It is therefore important for local councils to engage in dialogue with large industry, DNOs and planning departments to help facilitate the decarbonisation of industry, and discuss potential infrastructure requirements, i.e. gas pipes suitable for hydrogen.

Transport

Both councils have transport plans that outline their vision and targets for decarbonising transport. The UK is currently planning to ban the sale of all petrol and diesel cars in 2030, with a ban on hybrid cars from 2035. Scotrail are also planning to fully decarbonise all passenger train operations by 2035. This means that by 2045 nearly all cars, light vehicles and passenger trains in the region will be net-zero, or nearly net-zero, predominantly powered by the decarbonised electricity grid in Scotland. There will likely still be some heavy goods vehicles and freight trains running on petrol and diesel in operation by 2045, so there will be some transport emissions requiring offsetting at this point.

Farming

Some emissions from farming and agriculture will always be unavoidable and need to be offset due to the rearing of livestock. The farming industry is a major employer in Scotland, particularly in rural areas and contributes significantly to the economy, so the Scottish Government does not wish to scale it down. However, some of the land in the region currently used for growing food crops or grazing may be required for re-wildling, afforestation, renewable energy projects or bio crops in order to reach the 2045 net-zero target. The National Farmers' Union is targeting a 50% reduction in carbon emissions from farming across the UK, which can be achieved through various techniques such as precision fermentation, manure/slurry management and anaerobic digestion, arable rotations, livestock diet changes and more.

Appendix VIII - Policies

Local Policies and Climate Change Plans

The diagram below gives an overview of the other local plans and policies both councils have published or are developing, which tie into their overall climate change plans, alongside this REM.

Climate Change Plans – Climate and Nature Emergency Plan (Stirling) | Sustainability and Climate Change Strategy (Clackmannanshire)

Energy Use and Generation	Transport (Local Strategy)	Resource Efficiency	Nature and Biodiversity	Climate Adaptation
Regional Energy Masterplan (including Local Heat & Energy Efficiency Strategy and Plan)	Public Transport Strategy	Circular Economy Plan	Alive with Nature Plan	Climate Adaptation Strategy
	Active Travel Action Plan	Sustainable Food Plan	Open Space Strategy	Community Emergency Plans
	Behaviour Change Strategy	Zero Waste Strategy	Forestry and Woodland Strategy	Extreme Weather & Emergency Response Strategy
	Parking Strategy	Household Recycling Charter	Biodiversity Action Plan	Scottish International Environment Strategy
	Sustainable Travel Plan	Food Strategy	Open Space Strategy & Park Play Strategy	Forth Local Flood Risk Management Plan
	Road Traffic Reduction Plan	Community Growing Policy + Community Action Plans		
	Active Travel Strategy			
	EV Charging Strategy			

Local Authority:
- Stirling
- Clackmannanshire
- Both

Other Linked Strategies

Planning	Corporate	Economic Development	
Strategic Housing Investment Plan	10 Year Strategy	City Centre Strategy	Regional Connectivity Plan
Loch Lommond & Trossachs LDP	Corporate Plan	Culture Strategy	Wellbeing Economic Strategy
National Planning Framework 4	Community Wealth Building	Capital Investment Programme 2023-43	Economic Strategy
Local Development Plan (LDP)	Low Carbon Fleet	Inward Investment Strategy	Local Outcomes Improvement Plan
Local Housing Plan	Low Carbon Heating (currently assessing all buildings)		

Note; some of the policy stated is in development

Scottish Government

Policy Name	Summary	Link
Climate Change Plan	Sets out the Scottish Government's national targets to reach net-zero, covering all sectors and industries. Was updated in 2020. Outlines key targets and KPIs and gives an overview of what is required in each sector, with relation to the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019.	https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/12/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/govscot%3Adocument/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero.pdf
Heat in Buildings Strategy	Sets out the vision for how to decarbonise building's energy use across Scotland, while maximising economic opportunities, ensuring a just transition and addressing fuel poverty. Updated in 2022. Includes the New Renewable Heat Target, for at least 22% of non-electrical heat in buildings to be directly supplied by renewable sources by 2030. And by 2030 over 1 million homes and 50,000 non-domestic buildings to convert to using zero or low emissions heating systems. To be followed in 2025 by the Heat in Buildings Bill regulations to set proposed mandatory targets.	https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2021/10/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/documents/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/govscot%3Adocument heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings.pdf
Energy Strategy & Just Transition Plan	Currently out for consultation – Sets out clear policy positions and a route map of actions required to deliver a net-zero energy system that supplies affordable resilient and clean energy to Scotland's workers, households, communities and businesses. Builds upon the previous Scottish Energy Strategy (2017).	https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/01/draft-energy-strategy-transition-plan/documents/draft-energy-strategy-transition-plan/draft-energy-strategy-transition-plan/govscot%3Adocument/draft-energy-strategy-transition-plan.pdf
Heat Networks Act	Legislation which aims to accelerate the deployment of heat networks in Scotland through a new regulatory system which hopes to boost consumer confidence and security for investors. Sets statutory targets for certain levels of heat network deployment by 2027 and 2030 and statutory duties.	https://www.legislation.gov.uk/asp/2021/9/2021-03-31

Scottish Government

Policy Name	Summary	Link
Fuel Poverty Strategy	Sets out the key policies and proposals required for the Scottish Government and local authorities to take action to address fuel poverty and meet the targets set out in the Fuel Poverty Act (2019), with an overarching target that in the year 2040, as far as reasonably practicable, no household in Scotland is in fuel poverty. Covers • Actions to make progress now on the four drivers of fuel poverty • Actions to ensure fewer people are at risk of fuel poverty in the future by making systemic change • Actions to ensure that we continue to make progress to tackling fuel poverty at the same time as we decarbonise the way we heat and power our homes	https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2021/12/tackling-fuel-poverty-scotland-strategic-approach2/documents/tackling-fuel-poverty-scotland-strategic-approach/tackling-fuel-poverty-scotland-strategic-approach/govscot%3Adocument/tackling-fuel-poverty-scotland-strategic-approach.pdf
National Planning Framework 4	Sets out the national spatial strategy for Scotland including principles, regional priorities, national development and national planning policy.	https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/02/national-planning-framework-4/documents/national-planning-framework-4-revised-draft/national-planning-framework-4-revised-draft/govscot%3Adocument/national-planning-framework-4.pdf
Heat Policy Statement	Sets out how low carbon heat can reach more householders, business and communities. It addresses the three key aspects of the heat system: how we use it (heat demand and its reduction); how we distribute and store it (heat networks and heat storage); where our heat comes from (heat generation). Published 2015.	https://www.gov.scot/binaries/content/documents/govscot/publications/speech-statement/2015/06/heat-policy-statement-towards-decarbonising-heat-maximising-opportunities-scotland/documents/00478997-pdf/00478997-pdf/govscot%3Adocument/00478997.pdf

Policy Name	Summary	Link
Hydrogen Policy Statement	Sets out vision for Scotland's future in sustainable hydrogen production to meet an initial ambition of generating 5GW of renewable and low-carbon hydrogen by 2030. Published 2020.	https://www.gov.scot/publications/scottish-government-hydrogen-policy-statement/
The Planning (Listed Building Consent and Conservation Area Consent Procedure) Regulations	Listed building consent is the mechanism by which planning authorities ensure that any changes to listed buildings are appropriate and sympathetic to their character. It helps to protect what is a rare and unique resource. Conservation area consent controls the demolition of unlisted buildings in conservation areas	https://www.legislation.gov.uk/ssi/2015/243/contents/made
Scotland's Sustainable Housing Strategy	Published in 2013, this set out Scotland's position on warm, healthy and low carbon homes, and supported the delivery of Home Energy Efficiency Programmes (HEEPS) that are ongoing.	https://www.gov.scot/publications/scotlands-sustainable-housing-strategy/
Tenements Act	The Climate Change (Scotland) Act 2009 amended the Tenement Management Scheme to log insulation installation as a maintenance measure rather than an 'improvement' so changes can be approved via a majority rather than unanimously.	https://www.legislation.gov.uk/asp/2004/11/contents

Scottish Government

Policy Name	Summary	Link
Scottish Government Learning Estate Strategy	Includes guiding principles to ensure that learning environments are greener and more sustainable. Increasing energy efficiency in building performance must be amongst the core objectives of all new infrastructure projects.	https://www.gov.scot/publications/scotlands-learning-estate-strategy-connecting-people-places-learning/
Learning Estate Investment Programme (LEIP)	Designed to improve school estate conditions and support growth projects/ sustainable estate planning. Sets energy efficiency targets and funding for all new-build learning facilities.	Learning Estate Investment Programme: information - gov.scot (www.gov.scot)
The Energy Efficiency Standard for Social Housing (EESSH2)	Under review, this aims to improve the energy efficiency of social housing in Scotland and help reduce energy consumption, fuel poverty and the emission of greenhouse gases. It will set new targets for social housing energy efficiency, which may be based on reformed EPC metrics.	Energy efficiency in social housing - Home energy and fuel poverty - gov.scot (www.gov.scot)

UK Government

Policy Name	Summary	Link
Net Zero Growth Plan	Outlines the UK Government's plan to reach net-zero while improving energy security through removing demand for fossil fuels, and aims to decouple emissions from economic growth by using clean domestic sources of energy.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147457/powering-up-britain-net-zero-growth-plan.pdf
Net Zero Strategy: Build back greener	Outlines the UK Government strategy to reach net zero, including a ten point plan for a green industrial revolution.	https://www.gov.uk/government/publications/net-zero-strategy#:~:text=This%20strategy%20builds%20on%20that,reduce%20emissions%20for%20each%20sector
UK Hydrogen Strategy	Sets out plans for developing a low carbon, UK wide hydrogen sector to help decarbonise power, heat and transport.	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf

Other Organisations

Policy Name	Summary	Link
North East Network and Industrial Cluster Development	Phased plan by Scottish Gas Networks for converting most of the existing gas network across Scotland, pending the UK Government policy decision due 2026.	https://www.sgn.co.uk/sites/default/files/media-entities/documents/2021-11/North%20East%20Network%20and%20Industrial%20Cluster%20Development%20Summary%20Report%20November%202021.pdf
Historic Environment Policy Scotland (May 2019)	HEPS is a policy statement directing decision-making that affects the historic environment. It outlines six policies on managing change to the historic environment. It is non-statutory, but relevant to a wide range of decision-making.	https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=1bcfa7b1-28fb-4d4b-b1e6-aa2500f942e7

Appendix IX – Funding Sources Table

Name	Who Can Apply	What Technologies Does it Cover	How Much Funding is Available	How Long is it Available	Link for More Information
Home Energy Scotland Grant and Loan.	Private homeowners.	Most types of fabric improvements or low-carbon heating systems, see link for more details.	Up to £7,500 grant funding, (or £9,000 for some rural homes), with an additional £7,500 interest-free loan depending on the technology being installed. If multiple measures are being installed then grants and loans can be applied for each of them.	Indefinitely, until funding runs out. However it is likely that additional funding will be made available when the current pot runs out.	https://www.homeenergyscotland.org/funding/grants-loans/detail/
Private Rented Sector Landlord Loan.	Registered private landlords, businesses that own private rental properties.	Same as above.	Up to £15,000 per property for energy efficiency measures, up to £17,500 per property for renewables and low carbon heating, up to £500 for secondary improvements.	Same as above.	https://www.homeenergyscotland.org/funding/private-landlord-loans/
Social Housing Net-Zero Fund.	Social landlords and local authorities.	Fabric improvements, low-carbon heating systems, some renewables and storage.	Grant funding for 50% of the costs, with a loan available for an additional 30%. A minimum of 20% must be funded from applicant's capital or private financing.	£30 million available each year, applications close when funding runs out.	https://www.gov.scot/publications/social-housing-net-zero-heat-fund---call-for-funding-applications/pages/overview/
Scottish Central Government Efficiency Grant Scheme; Scottish Public Sector Energy Efficiency Loan Scheme.	Public sector bodies that do not have access to borrowing.	Various fabric improvements, low-carbon heating and renewable technologies.	Up to £5,000,000 of capital funding per applicant each year.	Open for applicants until 2025/2026, however there is a limited amount of funding available each year.	https://www.gov.scot/publications/scottish-central-government-energy-efficiency-grant-scheme-form-and-guidance/#:~:text=As%20a%20minimum%2C%20the%20Scottish,the%20fund%20in%202022%2F2023

Name	Who Can Apply	What Technologies Does it Cover	How Much Funding is Available	How Long is it Available	Link for More Information
Stirling City Heritage Trust – Traditional Buildings Health Check.	Traditional building owners within eligible areas.	Various surveys and energy efficiency improvements.	Amount dependent on circumstances.	Open for applicants until 2025.	https://www.stirlingcityheritagetrust.org/traditional-buildings-health-check/building-advice-and-support
ECO+ Scheme.	Any household with an EPC rating of D or below and a council tax band of A-E.	Various types of insulation.	Grant funding, % of total investment funded by grant will vary with each application, can be up to 100% in some cases.	Summer 2023 until March 2026.	https://energysavingtrust.org.uk/what-is-the-uk-governments-eco-scheme/
SME Loan.	Businesses that fall within the EU definition of an SME, non profit organisations and charities. Must also meet other eligibility criteria.	Various energy efficiency and fabric improvements, low carbon heating systems, ventilation/air conditioning upgrades, renewables and storage.	Loans of up to £100,000 available per business. Cashback grants of up to £30,000 available depending on the measures being installed.	Unspecified.	https://businessenergyscotland.org/smeloan/
Homeowner Equity Loan.	Certain private homeowners, eligibility to be confirmed.	Likely to cover energy efficiency improvements and low carbon heating systems.	Not been announced yet, previous pilot scheme allowed homeowners to borrow up to £40,000 from the Scottish Government against the value of their property.	Start date has not been announced, policy proposal is currently out for consultation.	https://www.gov.scot/publications/home-energy-efficiency-equity-loan-pilot-call-evidence-potential-national-rollout-analysis-responses/pages/3/

Name	Who Can Apply	What Technologies Does it Cover	How Much Funding is Available	How Long is it Available	Link for More Information
CARES: Off Electricity Grid Communities Fund.	Independent community electrical grid, not connected to the national network.	Development plans and professional advice, zero-carbon heating, energy infrastructure and controls upgrades, renewables and storage.	Up to £25,000 grant funding for development plans, up to 90% of capital funding for projects depending on works being done.	Until March 2024.	https://localenergy.scot/funding/lets-do-net-zero-off-electricity-grid-communities-fund/
CARES: Community heat development programme.	Community organisations and groups of householders.	Expert advice from consultants on available options for heat decarbonisation across a community, including technical, financial and risk assessments.	No funding for project implementation is available, just free support advice and technical expertise.	Until March 2024.	https://localenergy.scot/funding/community-heat-development-programme/
CARES: Net-Zero community buildings fund.	Community organisations and charities.	Renewable technologies and low carbon heating in community managed buildings, or in shared ownership buildings.	Grant funding available for up to 80% of capital costs of projects, to a maximum of £80,000 per project.	Unspecified.	https://localenergy.scot/funding/lets-do-net-zero-community-buildings-fund/
Warmer Homes Scotland.	Homeowners and private tenants who have lived in a property with a "poor energy rating" for at least 12 months.	Depends on the results of the assessment, can potentially include wall and loft insulation, draught-proofing, new heating systems and renewables.	All costs will be met by the Scottish Government in most cases.	Unspecified.	https://www.homeenergyscotland.org/find-funding-grants-and-loans/warmer-homes-scotland/
Scottish Government heat network fund.	Any public or private sector applicants, including proposals from consortiums.	District Heating Networks, including heat sources, pipes and connectors.	Up to 50% of total costs, provided that a low carbon heat source is used, and that likely carbon reductions and economic and social benefits from the project can be demonstrated.	Indefinitely.	https://www.gov.scot/publications/heat-network-fund-application-guidance/

Name	Who Can Apply	What Technologies Does it Cover	How Much Funding is Available	How Long is it Available	Link for More Information
UK Infrastructure Bank.	Local authorities and private investors.	Large scale infrastructure projects, as long as they align with the UK Government's net zero objectives and encourage regional growth.	Length of loan and repayments profile can be matched to needs of the project, loan is repayable in full. Minimum loan size of £5,000,000.	Unspecified.	https://www.ukib.org.uk/where-we-invest/local-authority-lending
Area Based Schemes (EES:ABS).	Local authorities.	Specific eligibility criteria set by local authority focussing on hard to treat, fuel poor homes in low council tax bands.	Contributions for individual works capped at £450 for flats and terraced properties and £950 for other built forms.	Unspecified.	https://www.gov.scot/publications/area-based-schemes/
Heat Network Support Unit.	Aimed at public sector, but anyone can apply.	Free support and expertise on developing heat networks, grant funding available for developing feasibility studies and business cases.	Unspecified.	Unspecified.	https://www.heatnetworksupport.scot/
District Heating Loan Fund.	Social landlords, local authorities, SMEs.	Capital loans for low carbon district heating networks.	Up to 100% of project cost, interest rates and repayment plans depend on total capital cost.	Open loan fund, applicants can apply at any time.	https://energysavingtrust.org.uk/programme/district-heating-loan-fund/
Green Heat Innovation Fund.	Scottish based companies or companies investing in Scotland.	Funding available to support projects using existing green heat technology in an innovative way.	Up to £17.6 million of total funding available this parliament.	Available until March 2026.	https://www.scottish-enterprise.com/support-for-businesses/funding-and-grants/business-grants/green-heat-innovation-support-programme

Appendix X - Retrofit Resources

The following is a list of some resources available for retrofit, to provide a good starting point. There is of course more advice and guidance available, with other organisations offering help.

Guides and websites, covering a variety of different levels of detail:

Guidance	Description	Link
Built Environment – Smarter Transformation (BE-ST) Future Proof Your Home (2023)	Scotland specific, good lightweight guide for homeowners who don't need so much technical detail. Includes some videos.	Homenotes - Futureproof your home (be-st.build)
Low Energy Transformation Initiative (LETI) Climate Emergency Retrofit Guide (2021)	UK wide guide, very comprehensive.	Climate Emergency Retrofit Guide | LETI
Scottish Ecological Design Association (SEDA) Sustainable Renovation (2018)	Scotland specific comprehensive guide.	Design Guides — Scottish Ecological Design Association (seda.uk.net)
Historic Environment Scotland (HES) Guide to Energy Retrofit of Traditional Buildings (2021)	Scotland specific comprehensive guide for historic buildings.	Guide to Energy Retrofit of Traditional Buildings | Hist Env Scotland (historicenvironment.scot)
West Oxfordshire District Council, Cotswold District Council and Forest of Dean District Council Net Zero Carbon Toolkit (2021)	England specific guide so building standards are different, but the principles of retrofit apply. More technically detailed so aimed more at professionals.	Net Zero Carbon Toolkit - South Oxfordshire District Council (southoxon.gov.uk)

Websites	Description	Link
Net Zero Scotland Home Energy Scotland	The main Scottish Government website with multiple links on energy reduction, including funding.	Home Energy Scotland
HES Saving energy in traditional buildings	Website with multiple links for energy reduction in traditional buildings in Scotland	Saving Energy in Traditional Buildings | Historic Environment Scotland

Some standards for achieving a high standard of retrofit beyond building regulation requirements:

Standard	Link
Association for Environment Conscious Building (AECB) Retrofit Standards Level 1 and 2	AECB CarbonLite Retrofit Standards Level 1 and 2 - AECB
Passivhaus EnerPHit standard	Passivhaus Retrofit (passivhaustrust.org.uk)
LETI retrofit standards	See LETI retrofit guide above

Some local organisations providing retrofit help:

Organisation	Description	Link
Stirling University Scotland's International Environment Centre (SIEC)	A pioneering collaboration that will create an 'innovation community' in the Forth Valley, driving the creation of a net zero regional economy and acting as a global exemplar of low-carbon growth.	Scotland's International Environment Centre | About | University of Stirling
Stirling City Heritage Trust (SCHT)	With a focus on protecting and preserving the historic heritage, Stirling City Heritage Trust are offering support in the form of Traditional Buildings Health Check, repair and retrofit service. Traditional buildings, under any ownership, may qualify for inspections, repairs, EPC improvements and on-going advice, along with funding support. See appendix IX for more info.	Stirling City Heritage Trust

Appendix XI - LHEES

Local Heat and Energy Efficiency Strategies (LHEES) are at the heart of a place based, locally-led and tailored approach to the heat transition. These local Strategies will underpin an area-based approach to heat and energy efficiency planning and delivery. LHEES Strategies will set out the long-term plan for decarbonising heat in buildings and improving their energy efficiency across an entire local authority area.

The REM is intended to meet the statutory requirement of LHEES for Stirling and Clackmannanshire councils. The LHEES methodology is split into 8 stages, how each of these stages were tackled in the REM is provided Table 21. The content requirements for the LHEES Strategy and Delivery Plan based on the LHEES Guidance are linked to their equivalent in the REM in Table 22.

As per the LHEES Guidance, the REM is primarily driven by Scotland's statutory targets to achieve net zero emission by 2045, and no fuel poverty by 2040 (as far as possible). Its purpose aligns with the function of the LHEES, in setting out a long term plan for improving energy efficiency and heat decarbonisation, with the addition of energy generation plans and consideration of sequestration required. This long term plan is based on evidence, criteria aligning with the LHEES considerations, and prioritised spatial zoning available with the digital twin model.

LHEES Stage	Equivalent in REM
Stage 1: Policy and strategy review	A policy review was undertaken to assess and understand all relevant local and national policies which would directly effect the REM, either in terms of KPIs and targets or for assessing and prioritising projects and interventions. See Appendix VIII for list of specific policies. Ricardo led a thorough stakeholder mapping exercise alongside IES and both councils, where all relevant stakeholders were identified with engagement sessions in the form of workshops and interviews carried out, see stakeholder engagement appendix for more details.
Stage 2: Data and tools library	Home analytics and non-domestic analytics used as core dataset inputs for building level energy modelling. IES' iCL digital twin tools (iCD, iSCAN, iVN, iCIM) were used as the core for energy modelling. These were used in place of the standard LHEES tools (domestic baseline, PEAT) as they can simulate different scenarios for large numbers of buildings faster, and also provide a physics based dynamic thermal simulation. These tools were used to undertake simulations for each domestic and non-domestic building with results saved to the digital twin model and hourly profiles available. All energy models will be handed over to the local authorities for continual updates and analysis to their REM/LHEES. Additional supplementary datasets from the local authorities, such as land use and ownership, were used to help zone and prioritise energy generation and heat network projects.
Stage 3: Strategic zoning and pathways	The digital twin model has baselines for whole region showing simulated baseline energy and carbon results for each individual building as well as key inputs such as: fabrics, fuel types, heating systems etc. This can be visualised across the entire region, showing each buildings current characteristics and energy performance to help inform decision making. Each intermediate zone has its own masterplan model where energy simulations were undertaken. Suggested heat decarbonisation technology for each zone provided in Appendix IV.
Stage 4: Generation of initial Delivery Areas	Informed by the work carried out in the previous stages, for Stage 4 the digital twin model provided an opportunity to take an enhanced approach to the generation of delivery areas, with the ability to carry out analysis at a level of granularity above and beyond that outlined in the LHEES methodology. Expected Individual Building level interventions required to meet local and national energy efficiency and heat decarbonisation targets were simulated across whole region for different scenarios - therefore the delivery areas can be considered as the entire local authority. Some examples of potential high priority building clusters where a common intervention is appropriate are are provided below. Potential Zones for heat networks were generated using Scottish Governments previous linear heat density analysis as a starting point, with these sites narrowed down based on a high level feasibility analysis, and some additional sites added for assessment post stakeholder engagement.
Stage 5: Building-level pathway assessment	A building level pathway assessment considering the likely required interventions to decarbonise was conducted across the whole region, rather than limited to smaller geographic areas. This has enabled us to establish in more detail the type of intervention(s) required to decarbonise buildings from a heating and energy efficiency perspective at a level above and beyond that of the proposed delivery areas. Priority buildings for specific interventions can be more precisely targeted across the region (by filtering buildings in the digital twin by attributes such as tenure, age band, fuel type, construction typed etc.) and can continue to be dynamically assessed. An indication of the potential measures, costs and CO2 abatement involved with improving energy efficiency and low carbon heat performance is shown in Appendices III and IV.

LHEES Stage	Equivalent in REM
Stage 6: Finalisation of delivery areas	Areas for heat networks were ranked based on weightings and prioritised based on this in the delivery plan. For interventions regarding energy efficiency and heat decarbonisation at the individual building level, each council area is regarded as the delivery area – with expected interventions under different scenarios applied at building level based on local and national policies and targets. Projects and actions arising from this are outlined in the delivery plan. Examples of where specific building level fabric retrofit and heating system replacement interventions are suitable across clusters of buildings provided below.
Stage 7: LHEES Strategy	Covered by REM as a whole, from the engagement and consultation carried out, to local authority baselines and policy context, following on to Potential Zones for heat networks, Strategic Zones and pathways. When assessing the likely interventions surrounding energy efficiency and heat the LHEES Considerations were incorporated into the model, with: • different strategies for on gas grid or off gas grid homes • conservation areas and listed buildings marked on the model and assumed to be more difficult/expensive to retrofit • risk of fuel poverty included for each building as well as fabric conditions and insulation levels to help identify areas where energy efficiency is a fuel poverty driver. Anticipated routes for each local authority in terms of the expected number and type of interventions for each intermediate zone are provided in Appendices III and IV.
Stage 8: LHEES Delivery Plan	Covered by Delivery Plan section. The Delivery Plan was developed using outputs from the previous LHEES stages along with additional assessments on potential energy generation projects. Comprehensive internal and external stakeholder engagement fed into to the plan, which starts to develop a portfolio of projects for the councils. These also align with other local authority plans around transport, planning, biodiversity and land use etc. where appropriate. Plans to develop targeted awareness and engagement campaigns are covered, along with identification of gaps by highlighting actions that are within the competence of the Scottish Government and wider partners. Consideration of existing programmes and schemes within both local authorities has been considered with internal consultation. Through continued work with associated teams as they develop and refresh their strategies, synergies with the REM will be ensured.

Table 21: *REM equivalents for LHEES Stages*

LHEES Strategy and Delivery Plan Contents	Equivalent in REM
Overview of LHEES	See paragraph the paragraph at the start of this Appendix.
Engagement and consultation	See 1.3 Stakeholder Engagement, Appendix II – Stakeholder Engagement Details, 5.3 Delivering the Plan, and Appendix XII – Public Consultation.
Local authority progress	See 2.2 Targets & Key Performance Indicators (KPIs) for how policies have shaped the targets and REM itself, Appendix VIII – Policies for policy descriptions. Background information is available throughout the workstreams and appendices of the REM. See Energy Efficiency and Heat Management sections for ongoing council activities. Targeting of future activities is included in the Delivery Plan, whilst existing activities require no additional targeting from the REM.
Policy and strategy context	See 2.2 Targets & Key Performance Indicators (KPIs) for how policies have shaped the targets and REM itself, 1.2 Climate Change in Stirling and Clackmannanshire for local policy overview and difference to national policy, and Appendix VIII – Policies for details on national policy and the context of the REM within local policy.
Considerations, Targets and Indicators	See 2 What We Must Achieve, and 3 Data Analysis & Modelling. LHEES considerations are addressed in 4.1 Energy Efficiency and Demand Reduction and 4.2 Heat Management.
Baselining of local authority building performance	See 1.4 Current Position, 4.1 Energy Efficiency and Demand Reduction, 4.2 Heat Management, Appendix III – Retrofit for Energy Efficiency Technical Details, Appendix IV – Heat Supply by Zone and maps on following pages.
Generation of Strategic Zones and pathways, including Potential Zones for heat networks	See workstreams (4 Actions Required), Appendix III – Retrofit for Energy Efficiency Technical Details, Appendix IV – Heat Supply by Zone, Appendix V – District Heating Site Technical Details. Further zoning is achieved by means of the digital twin model but not displayed for data protection reasons.
Summary of LHEES Strategy findings and next steps	Integrated throughout the REM, with findings and projections shown in 1.4 Current Position, 2.2 Targets & Key Performance Indicators (KPIs) and 4 Actions Required. Next steps are also incorporated into the actions identified and Delivery Plan, including priority projects and consideration of future development of the REM.
Delivery Plan - near-term actions, opportunities and priority Delivery Areas	See 5 Delivery Plan. Prioritised projects, engagement and awareness raising have been identified, and gaps have been considered by highlighting the current responsible parties and identifying constraints (see action tables in workstream sections). Future council programmes and activities have been identified, and existing plans aligned with the REM such as heat network development.

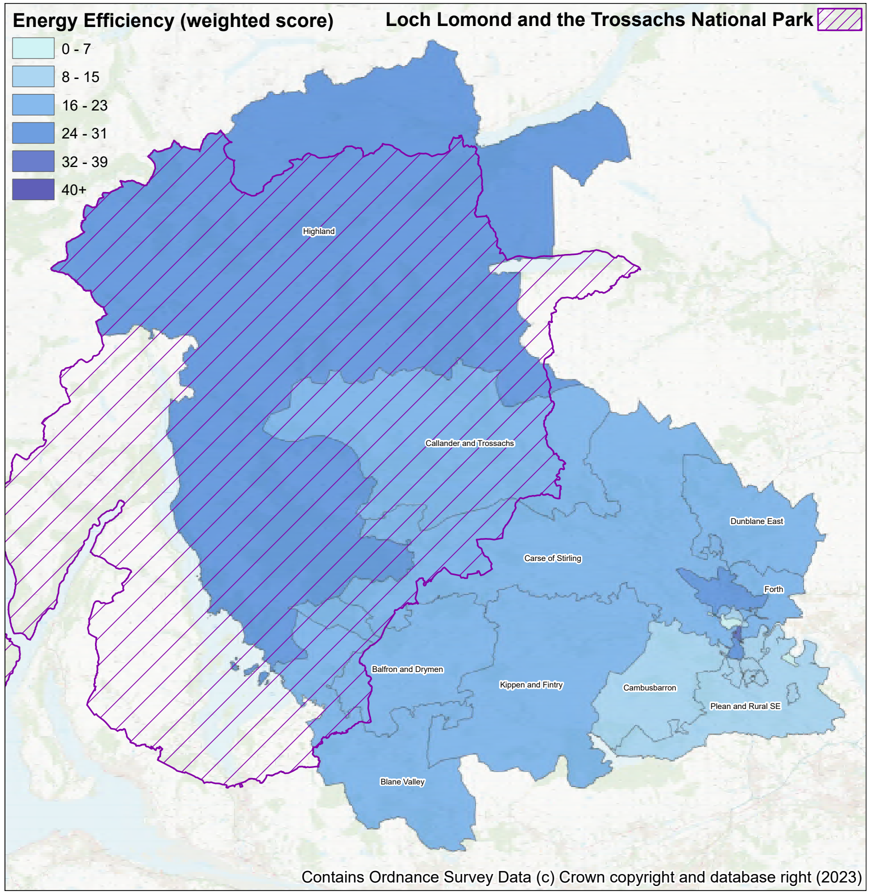
Table 22: *REM equivalents for LHEES Strategy and Delivery Plan*

Stage 3 Zone Maps

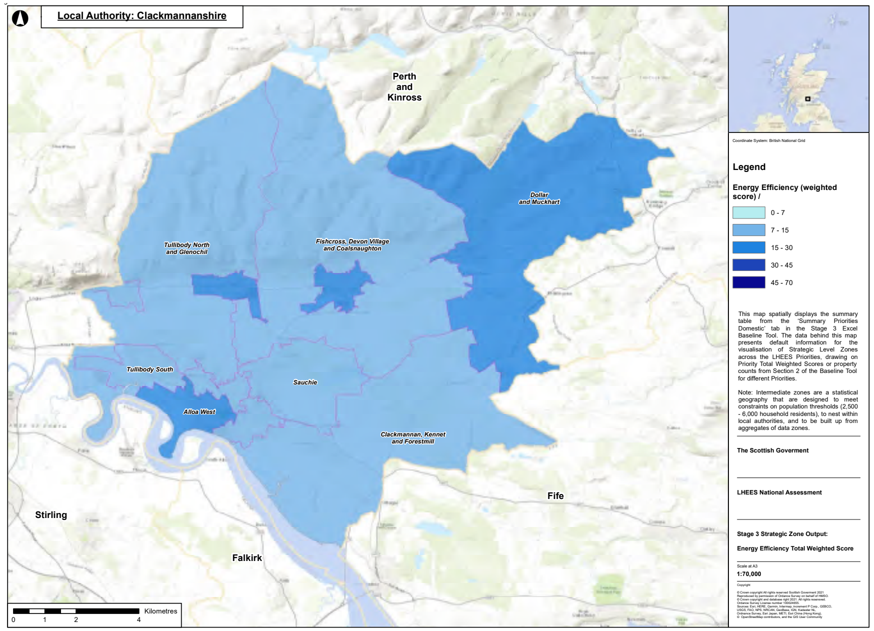
The following section includes zonal maps showing a strategic level overview of each of the LHEES priorities. Separate maps are provided for Stirling and Clackmannanshire for each consideration. The Stirling maps were produced by Ricardo, and the Clackmannanshire maps were produced by the Scottish Government.

Energy Efficiency

Each zone's weighted score has been determined by assessing the percentage of homes in each zone that have any of the following three energy efficiency indicators, each with an equal weighting: 0-99mm loft insulation, single glazed windows, uninsulated walls.



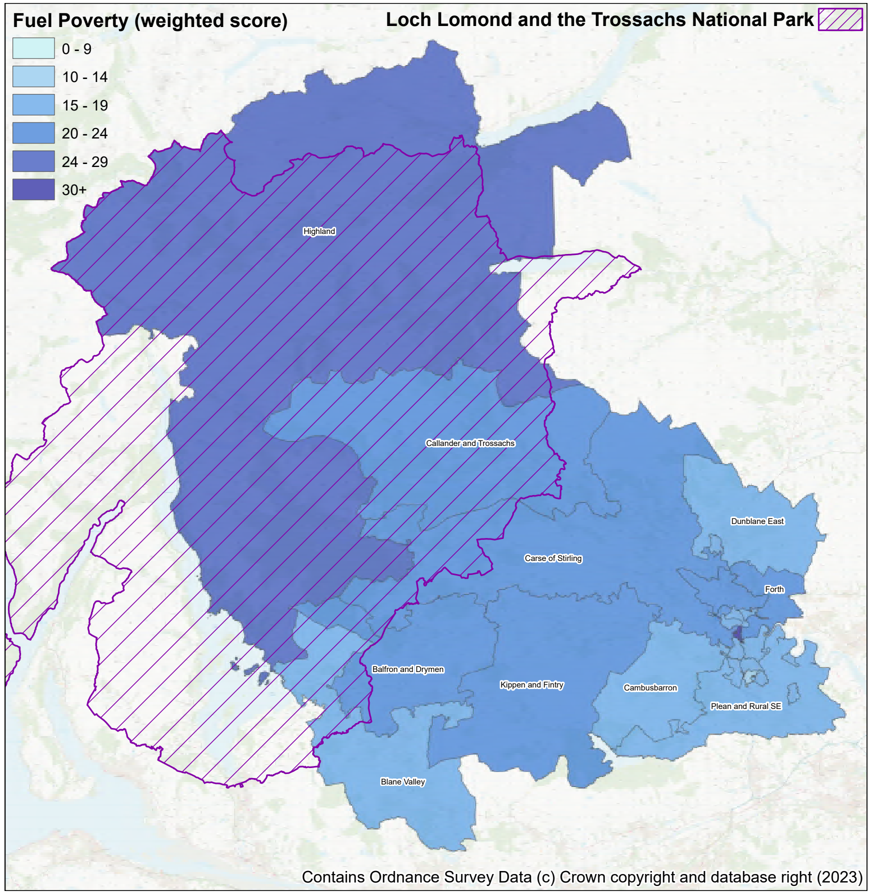
Stirling energy efficiency weighted score by zone



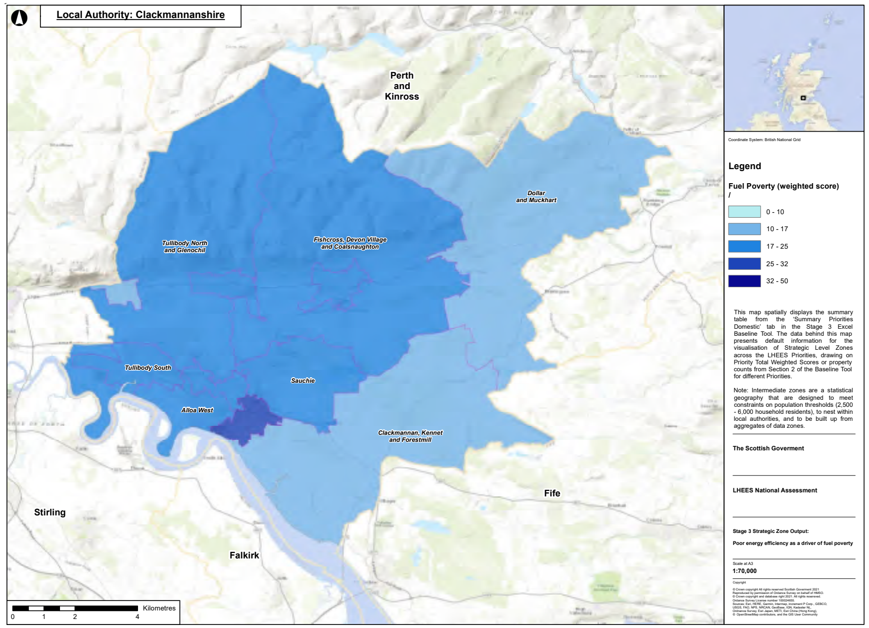
Clackmannanshire energy efficiency weighted score by zone

Fuel Poverty

The scope to reduce fuel poverty through energy efficiency improvements in each zone is shown in the maps below. Here, half the weighted score was determined by the percentage of households in fuel poverty, and half was determined by the three indicators highlighted previously for energy efficiency.



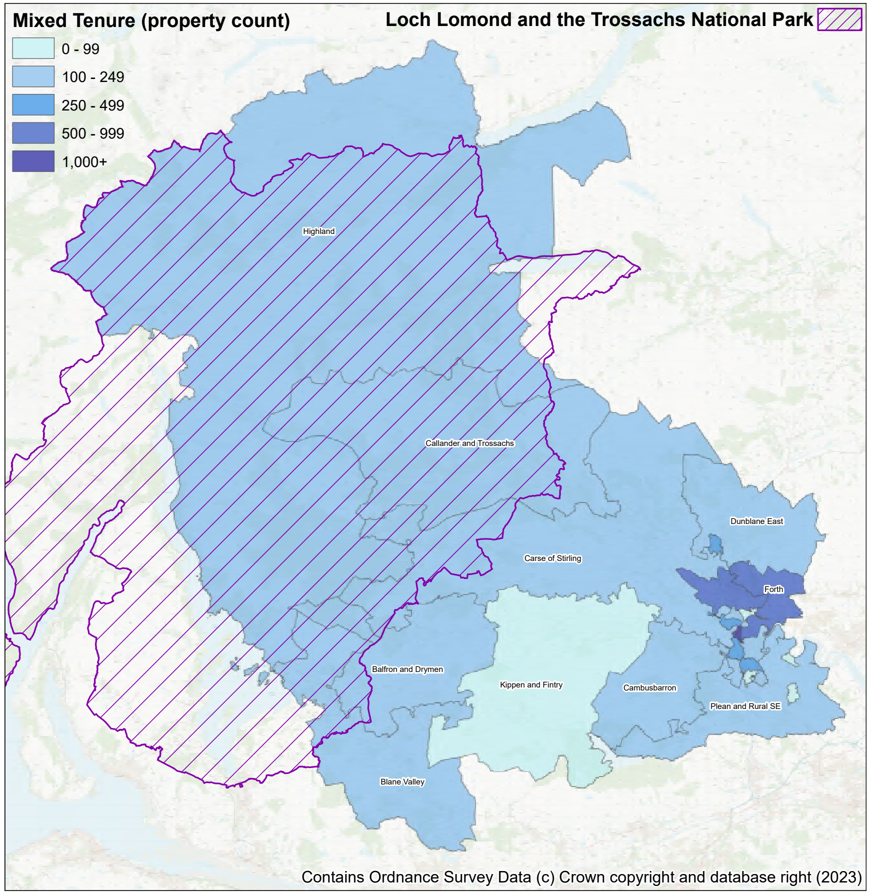
Stirling fuel poverty weighted score by zone



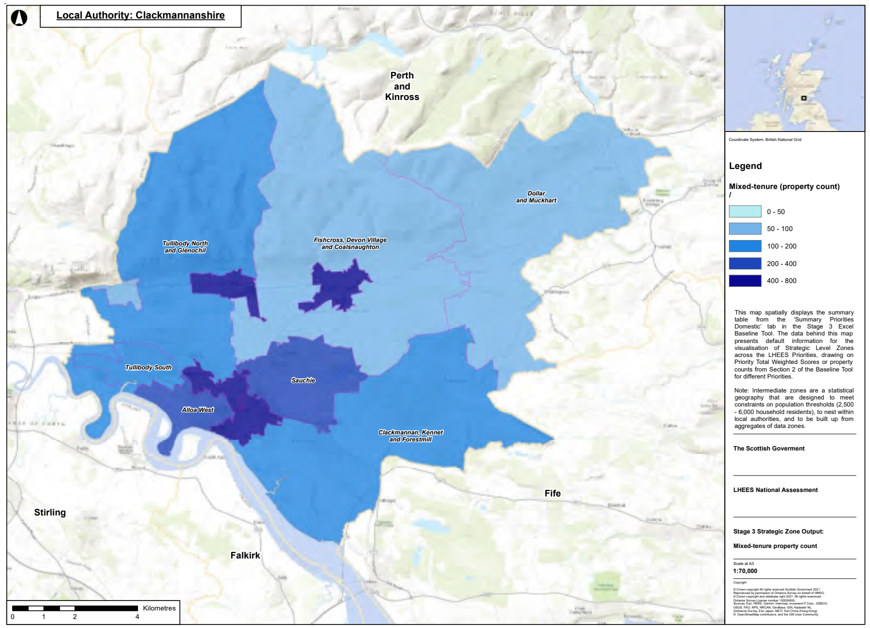
Clackmannanshire fuel poverty weighted score by zone

Mixed Tenure Properties

The maps below show the number of mixed tenure properties in each zone across Stirling and Clackmannanshire. These properties can be challenging to treat as they different tenure types may have different mandatory targets, funding sources and drivers.



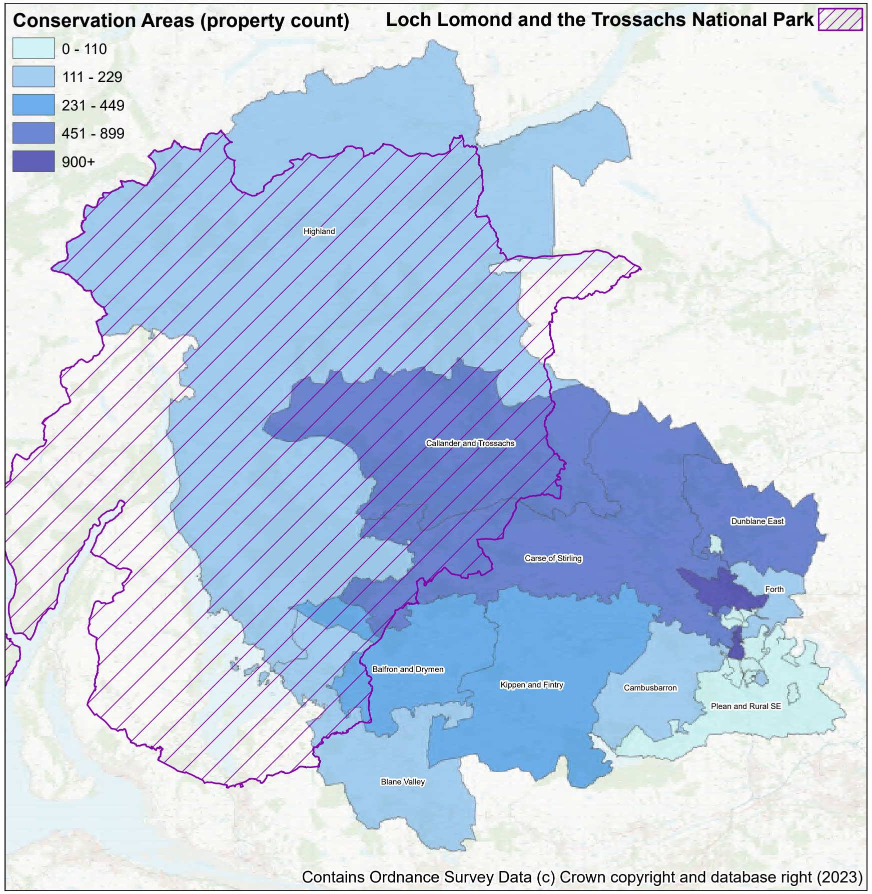
Stirling mixed tenure properties



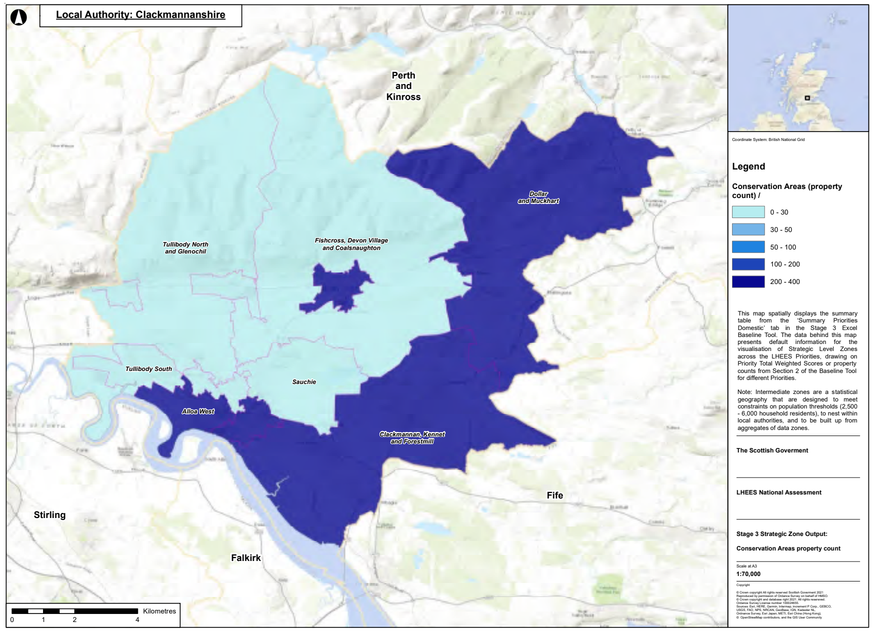
Clackmannanshire mixed tenure properties

Conservation Areas

Installing energy efficiency measures and low carbon heating can be more difficult, time consuming and costly on properties in conservation areas. It can also be more difficult to obtain planning permission for certain works. The number of homes in conservation areas by zone for Stirling and Clackmannanshire is shown in the maps below.



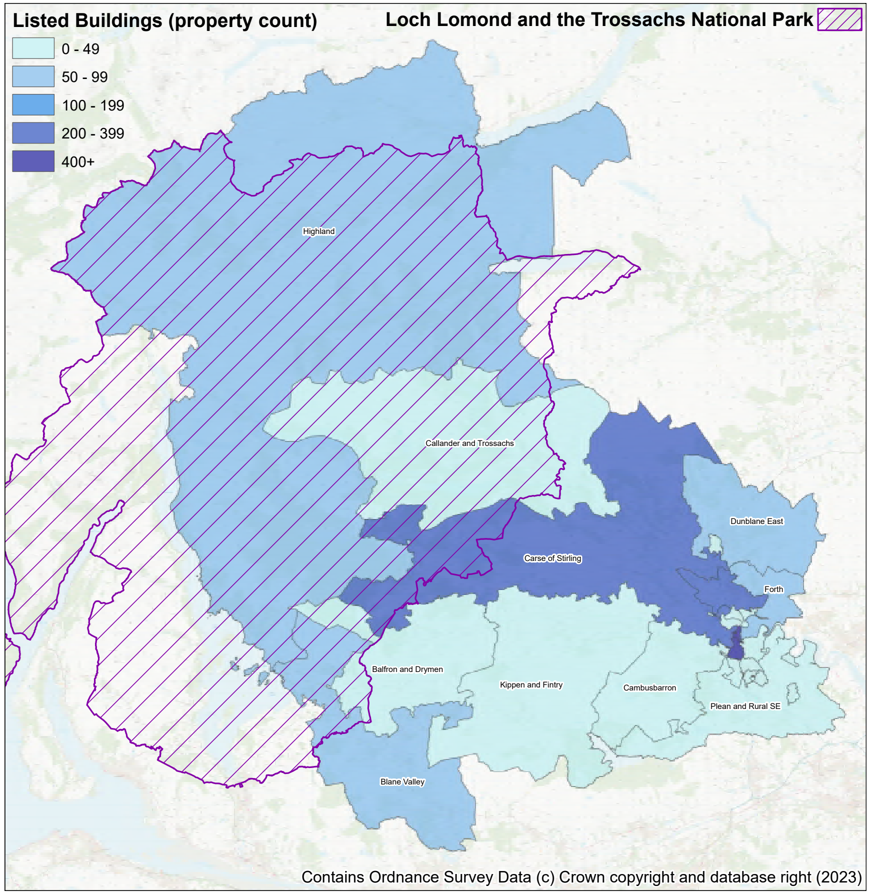
Stirling Conservation areas



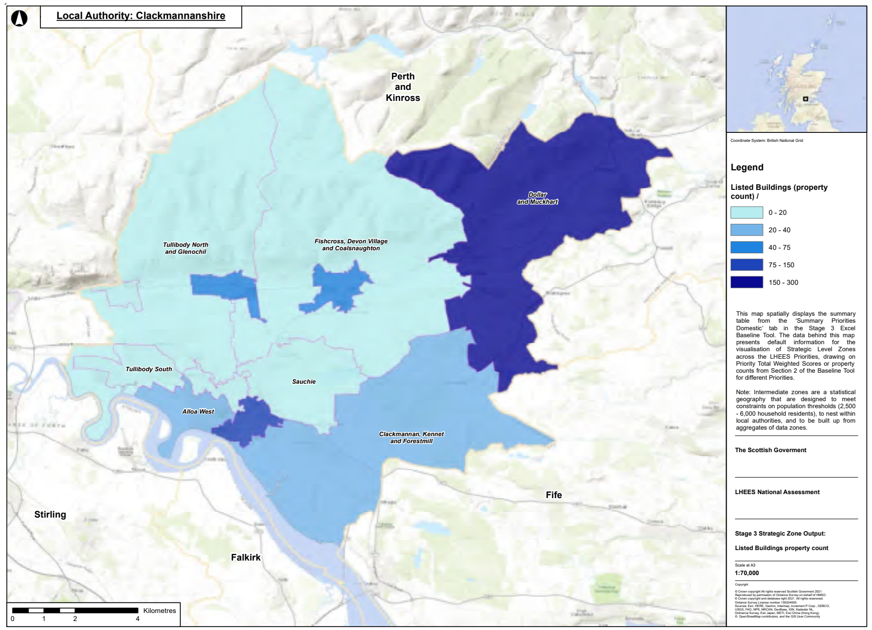
Clackmannanshire Conservation areas

Listed Buildings

Many of the additional challenges that arise from retrofitting properties in conservation areas also apply to listed buildings. Maps showing the number of listed buildings in each zone across Stirling and Clackmannanshire are presented below.



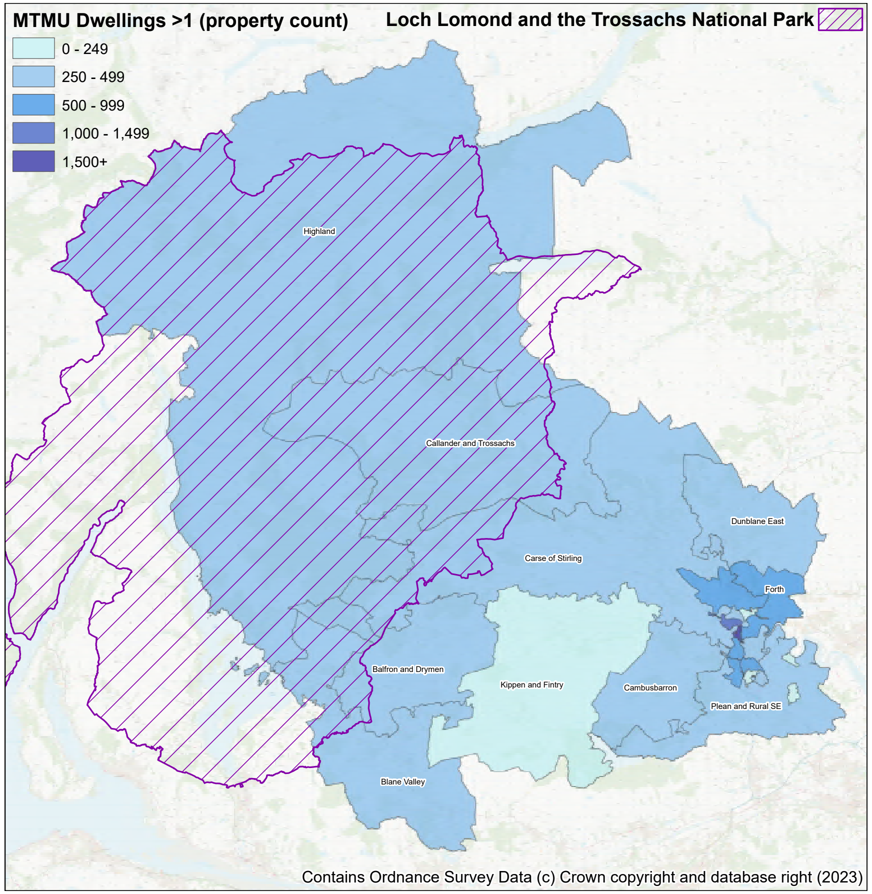
Stirling Listed Buildings



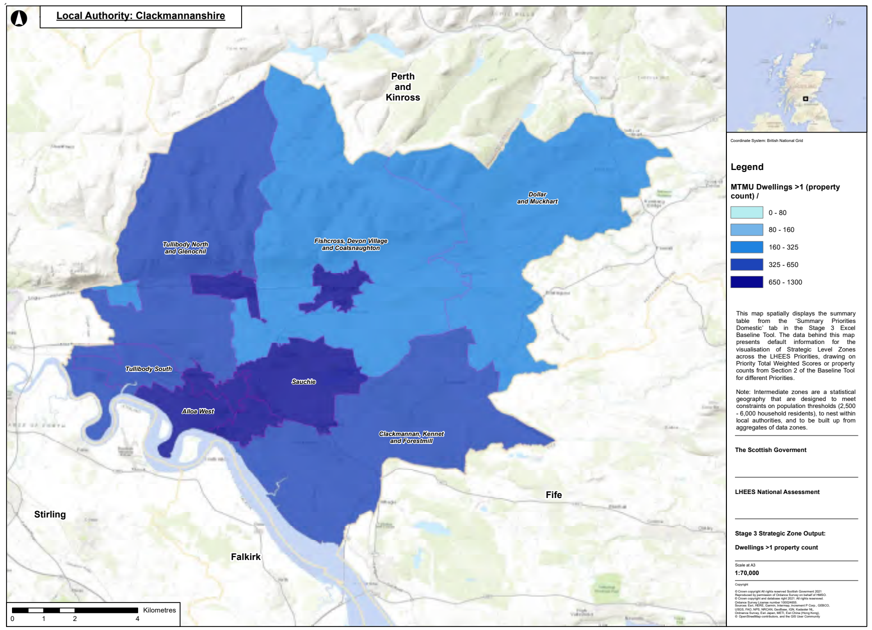
Clackmannanshire Listed Buildings

Mixed Tenure Mixed Use Buildings

Buildings that have a mixed primary use as well as a mixed tenure can also be difficult to successfully decarbonise, due to potential conflicting drivers and requirements across the different owners. The number of mixed tenure mixed use buildings in each zone is shown in the maps below.



Stirling Mixed Tenure Mixed Use Properties

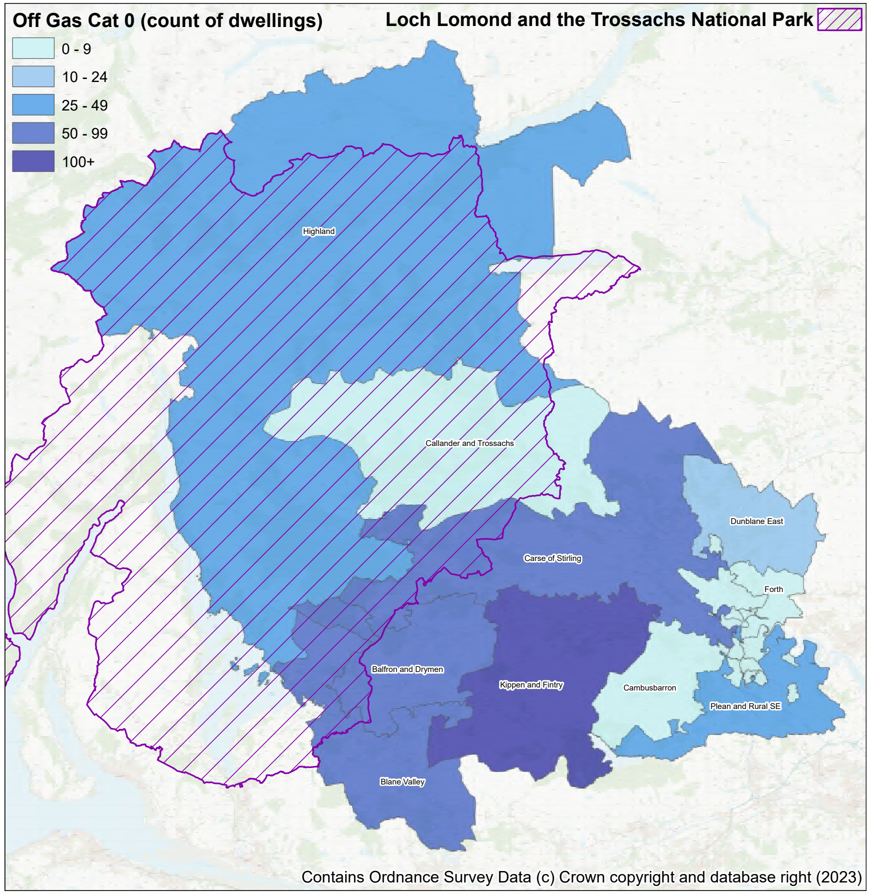


Clackmannanshire Mixed Tenure Mixed Use Properties

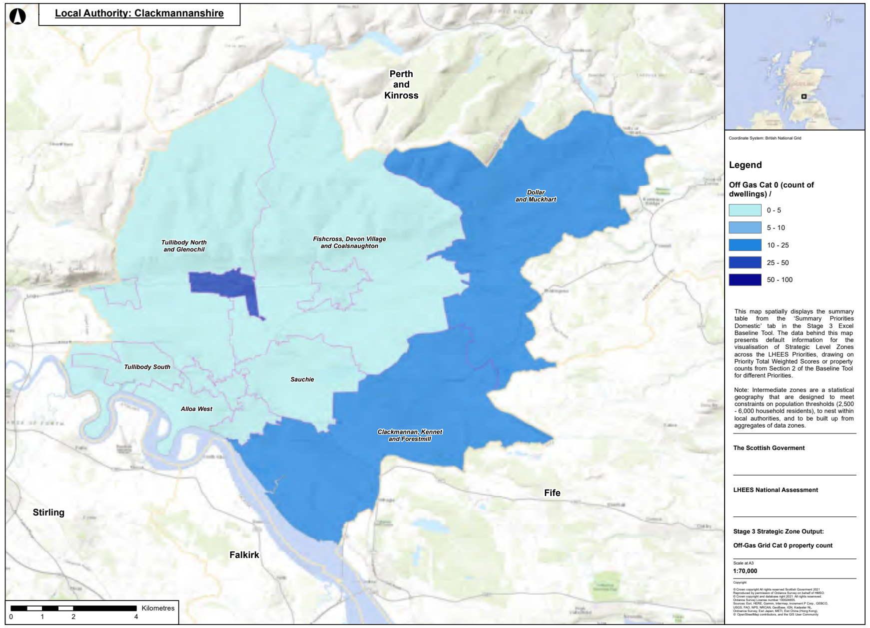
Heat Pump Suitability Category Maps

Maps showing the number of properties in each zone that belong to each LHEES heat pump suitability category are shown below, split between off gas grid and on gas grid properties. The categories are as listed below:

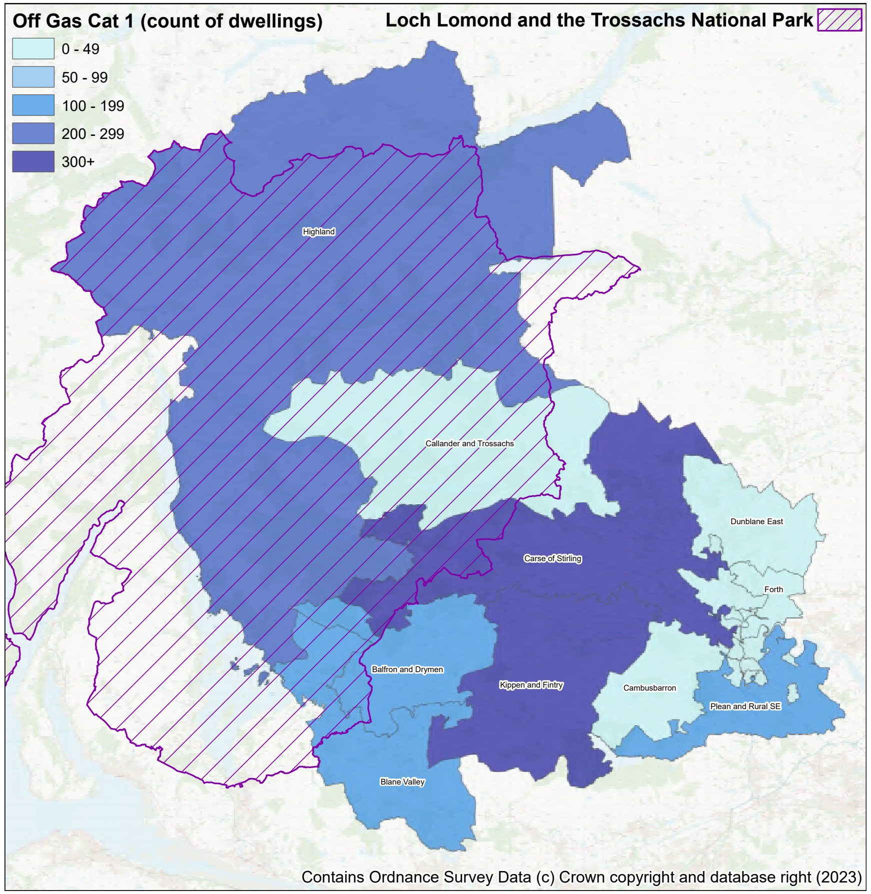
0. Homes which already have a low or zero emissions heating system installed.
1. Homes which have immediate potential for a heat pump installation – typically well insulated properties with an existing wet heating system.
2. Homes with potential for a heat pump – typically will require some fabric retrofit and/or heat distribution system upgrades in order to be considered heat pump ready.
3. Homes in need of significant fabric or heat distribution system upgrades in order to be considered heat pump ready, and homes which may likely never be considered heat pump ready (where electrical storage, hydrogen, or biomass may have to be used instead).



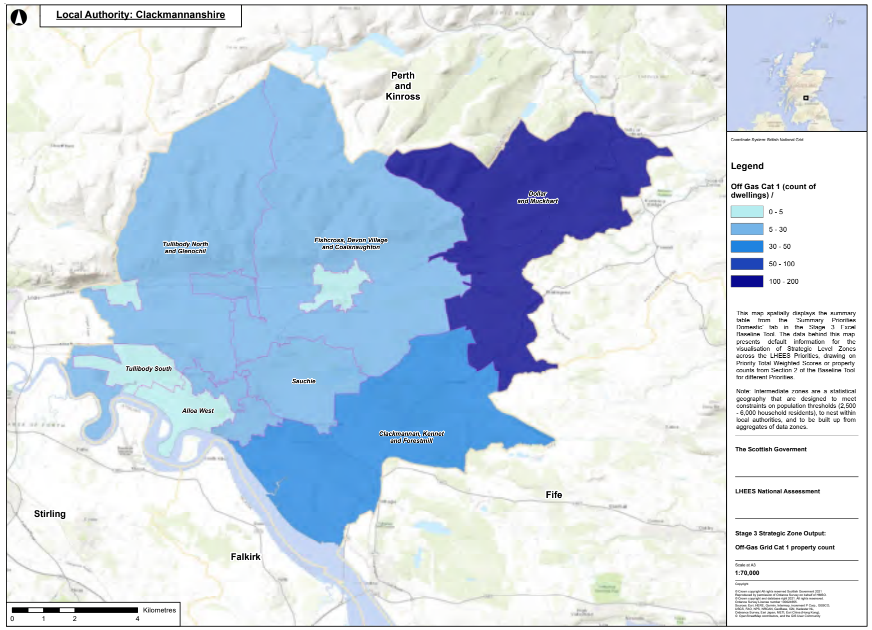
Stirling Off-gas Category 0 Properties



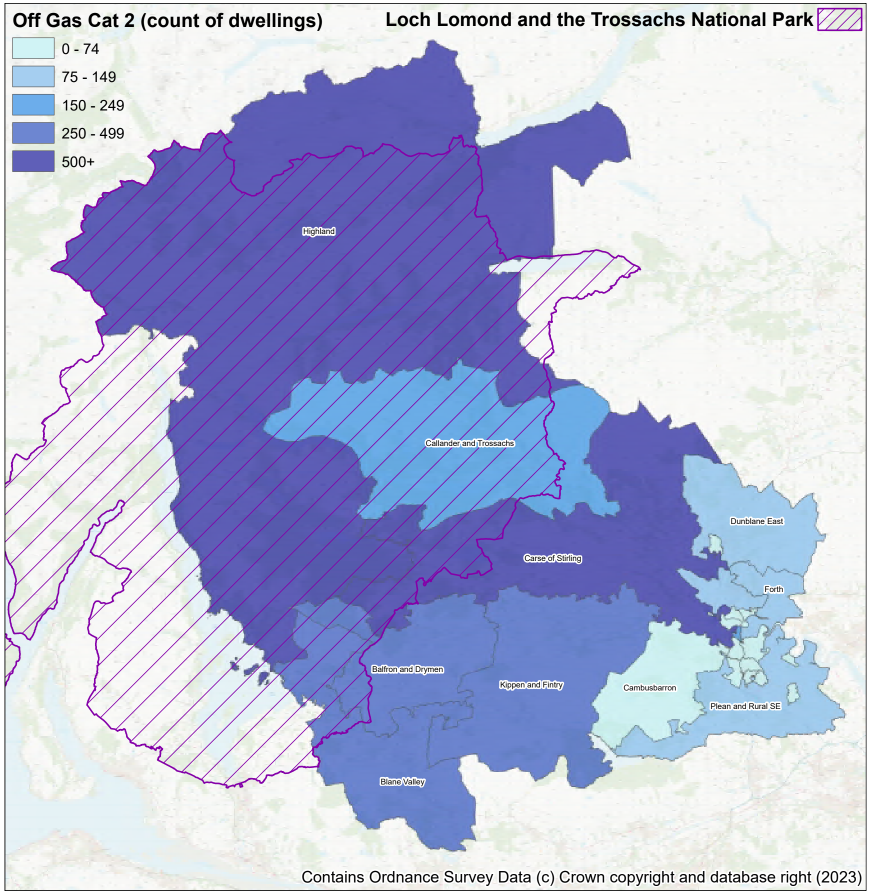
Clackmannanshire Off-gas Category 0 Properties



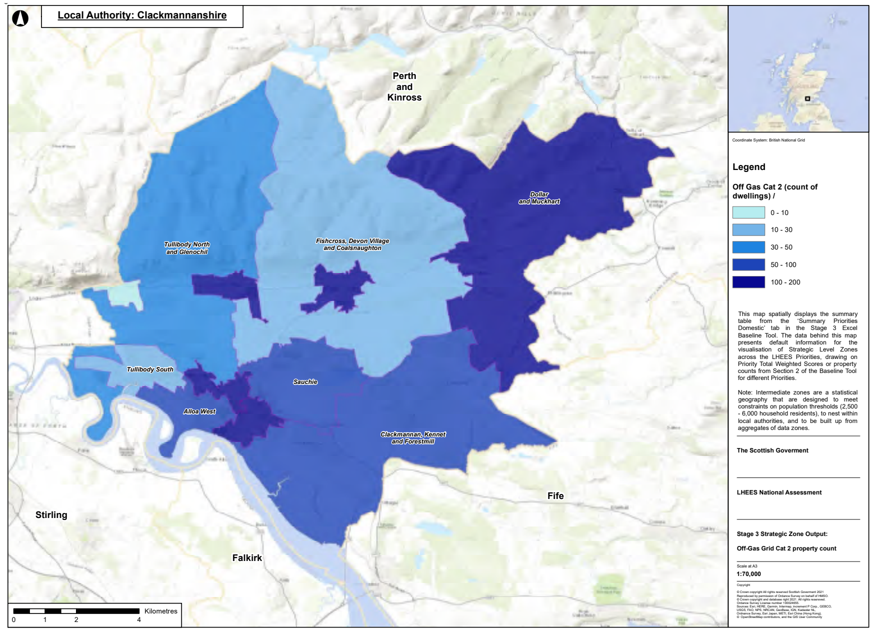
Stirling Off-gas Category 1 Properties



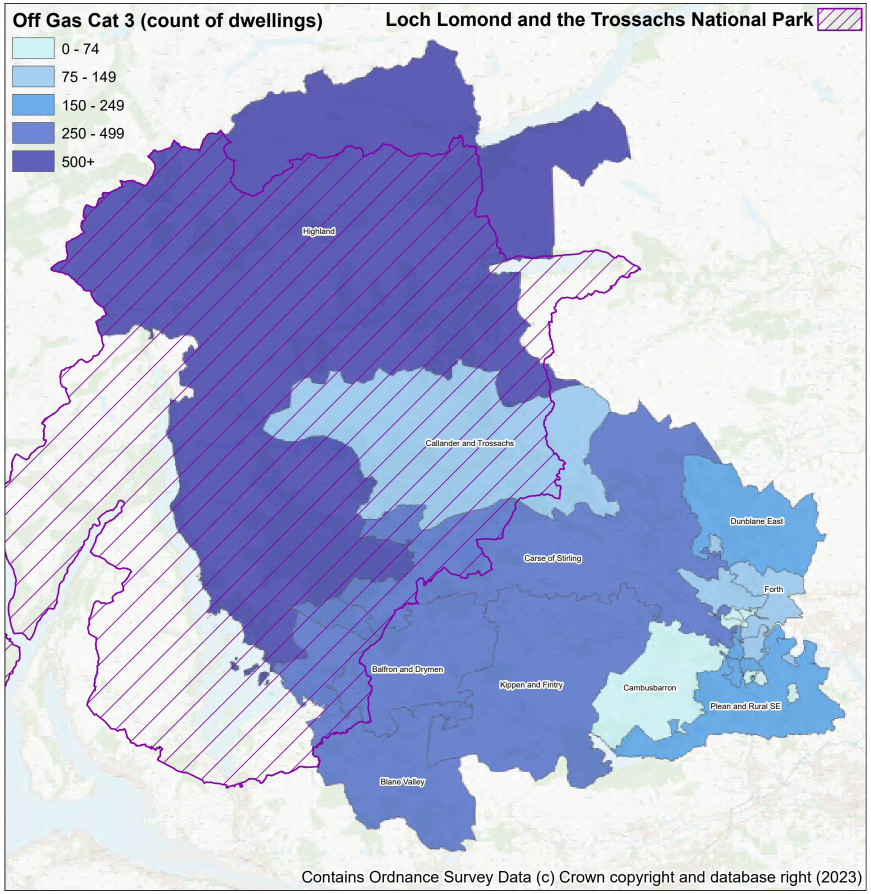
Clackmannanshire Off-gas Category 1 Properties



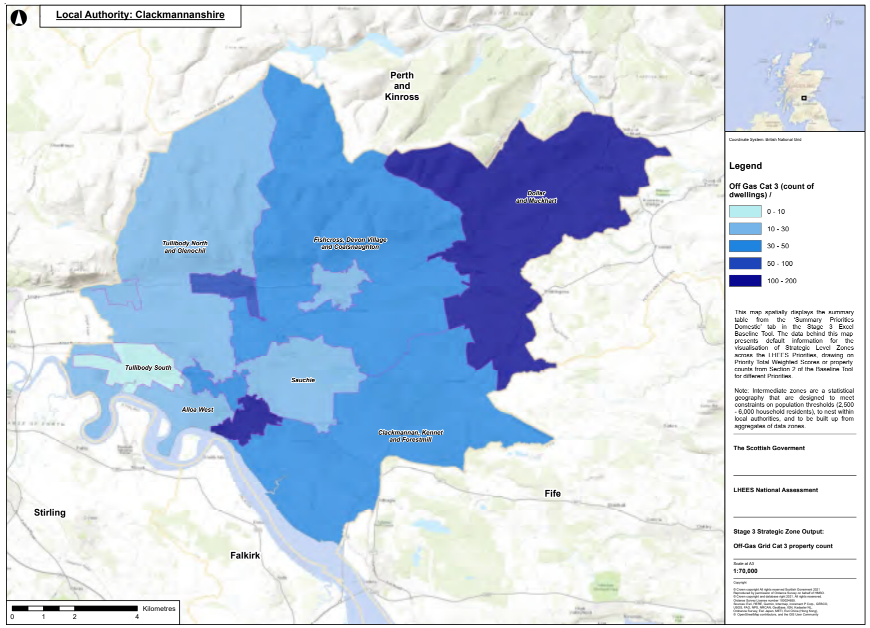
Stirling Off-gas Category 2 Properties



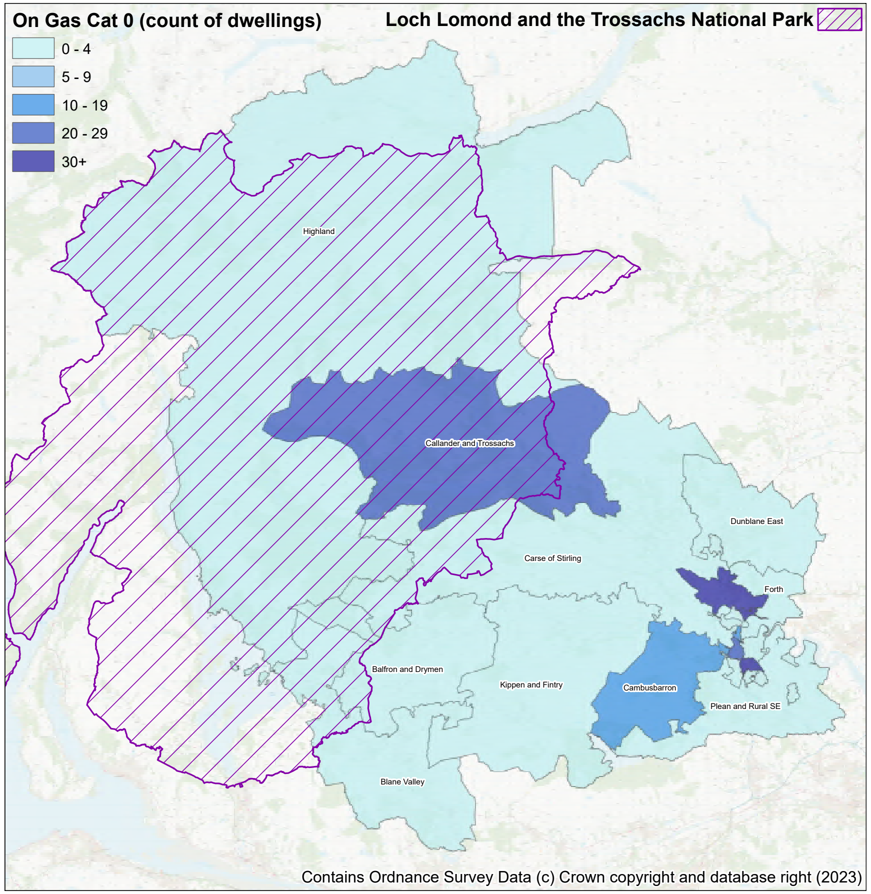
Clackmannanshire Off-gas Category 2 Properties



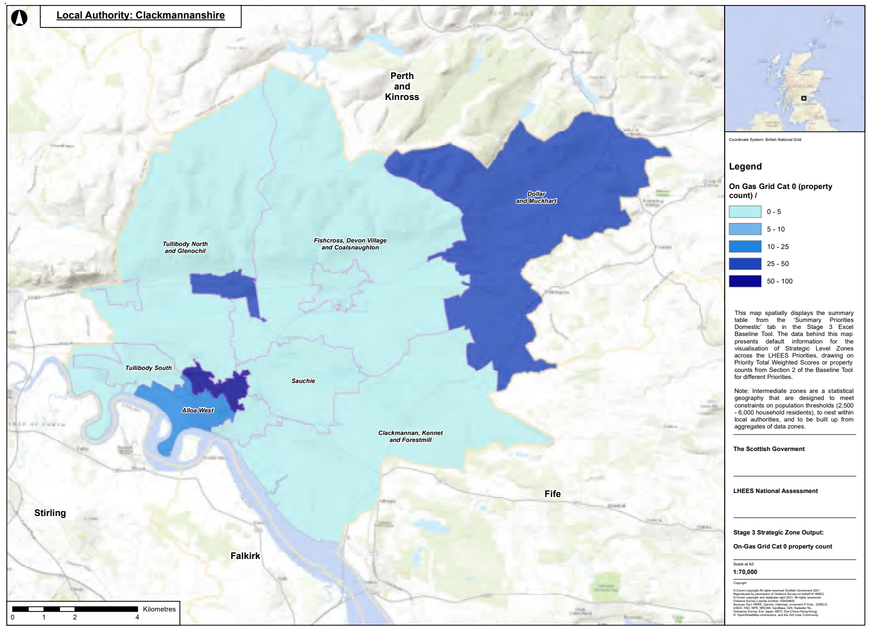
Stirling Off-gas Category 3 Properties



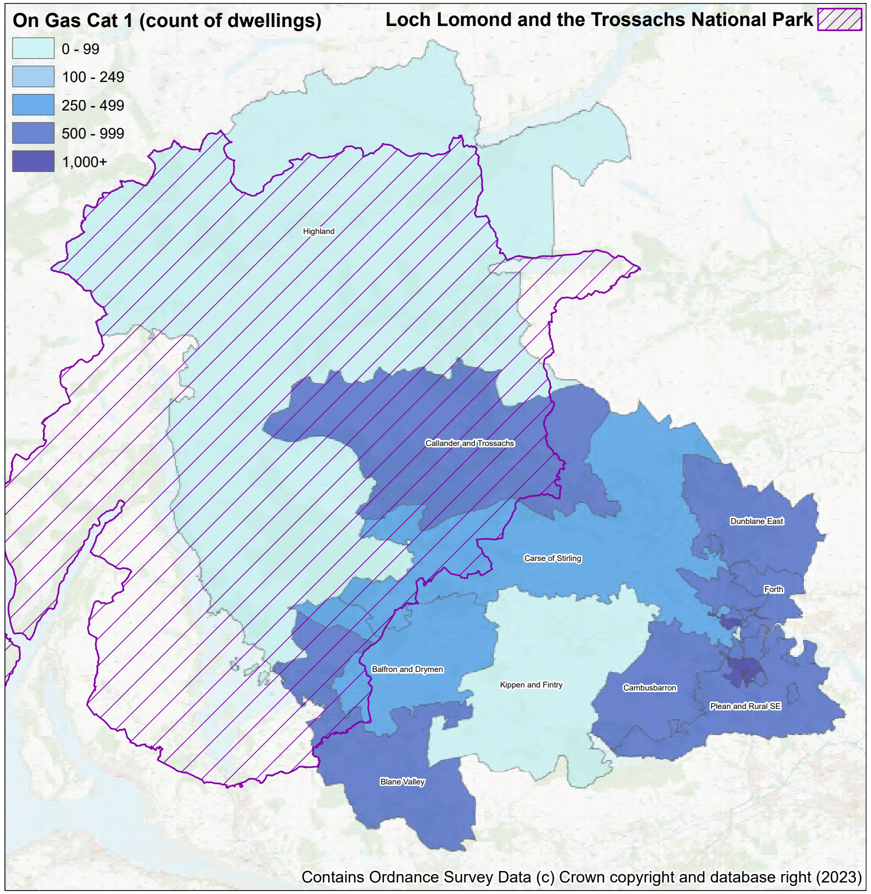
Clackmannanshire Off-gas Category 3 Properties



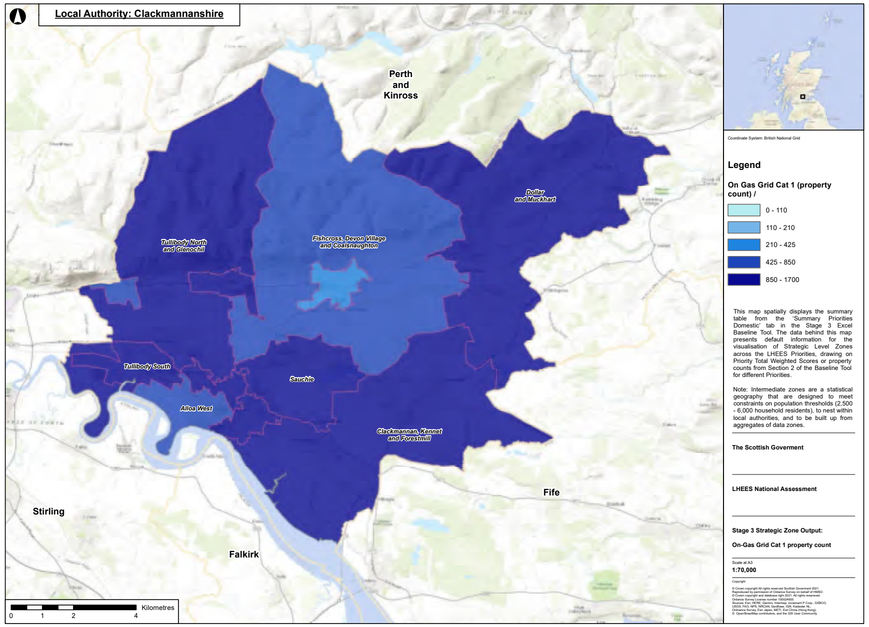
Stirling On-gas Category 0 Properties



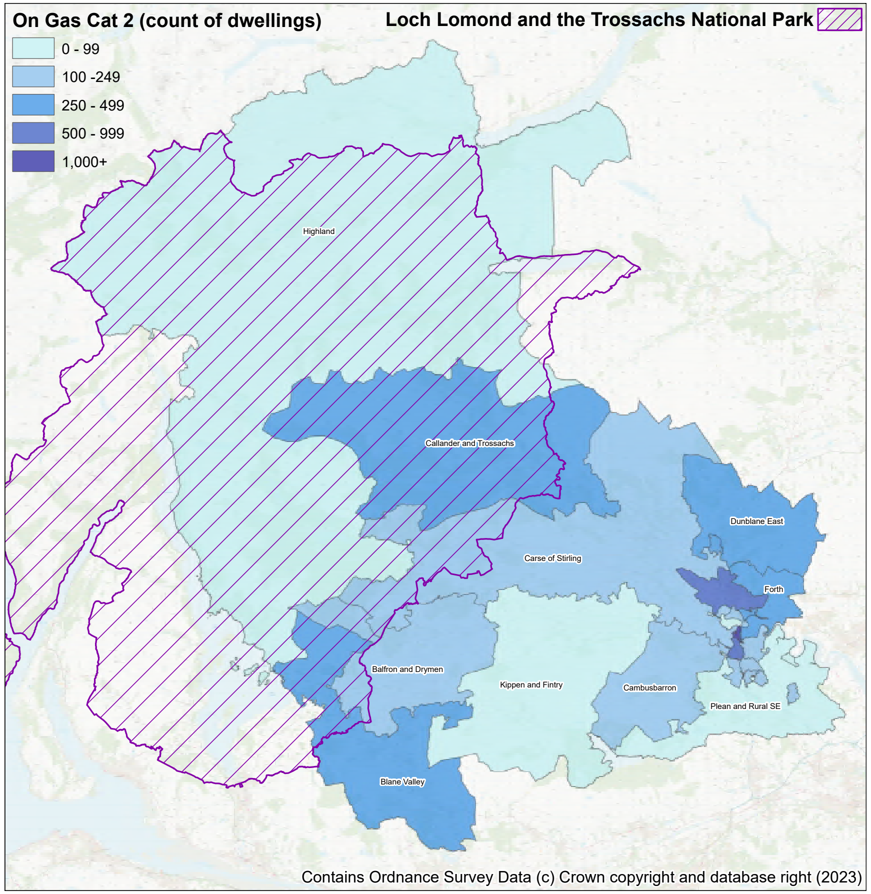
Clackmannanshire On-gas Category 0 Properties



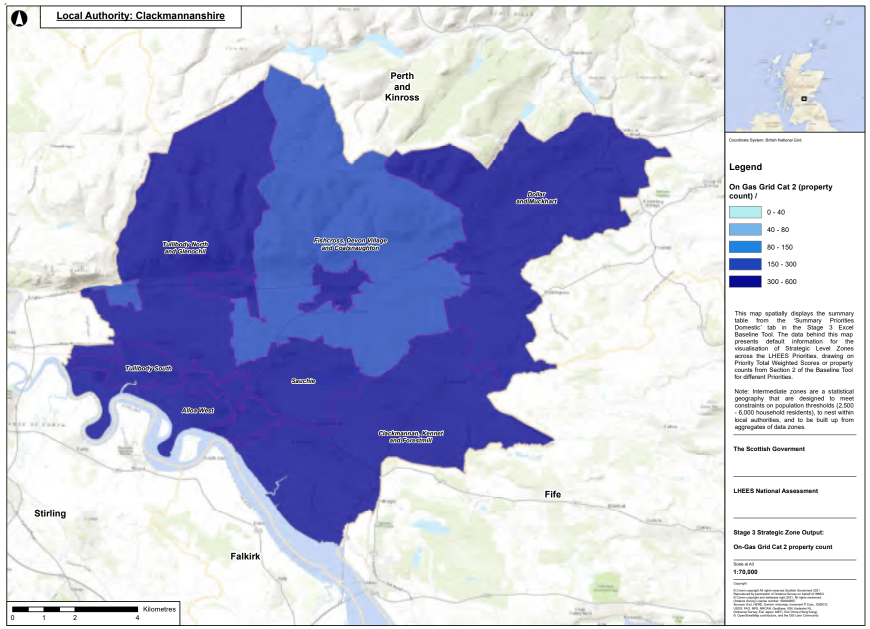
Stirling On-gas Category 1 Properties



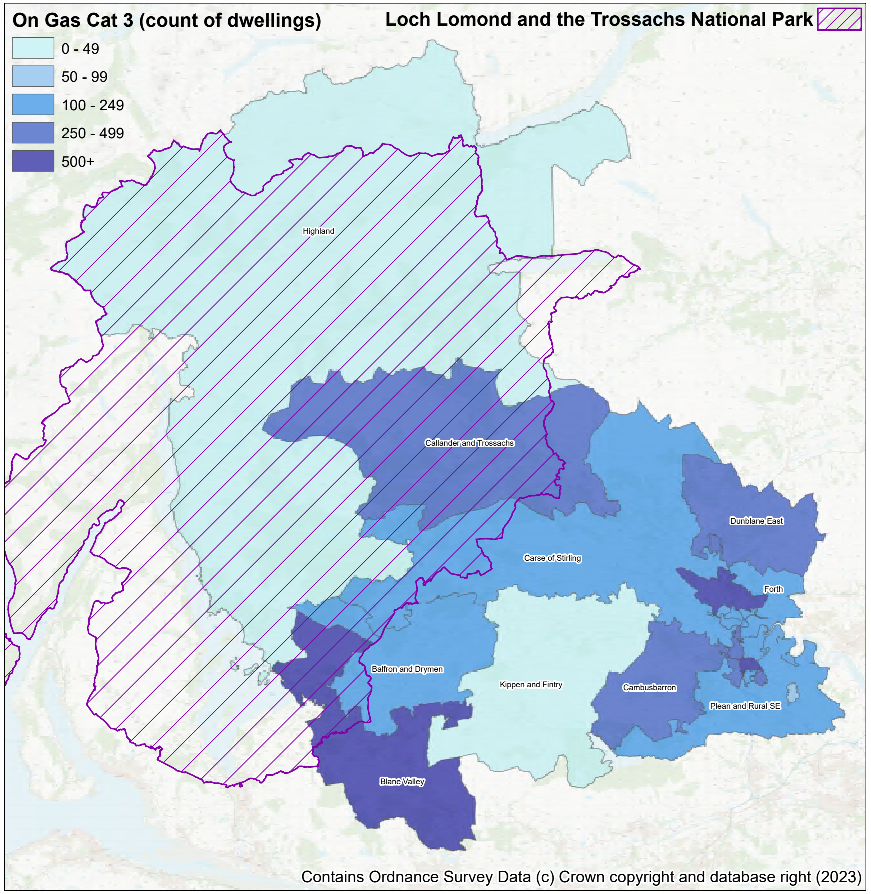
Clackmannanshire On-gas Category 1 Properties



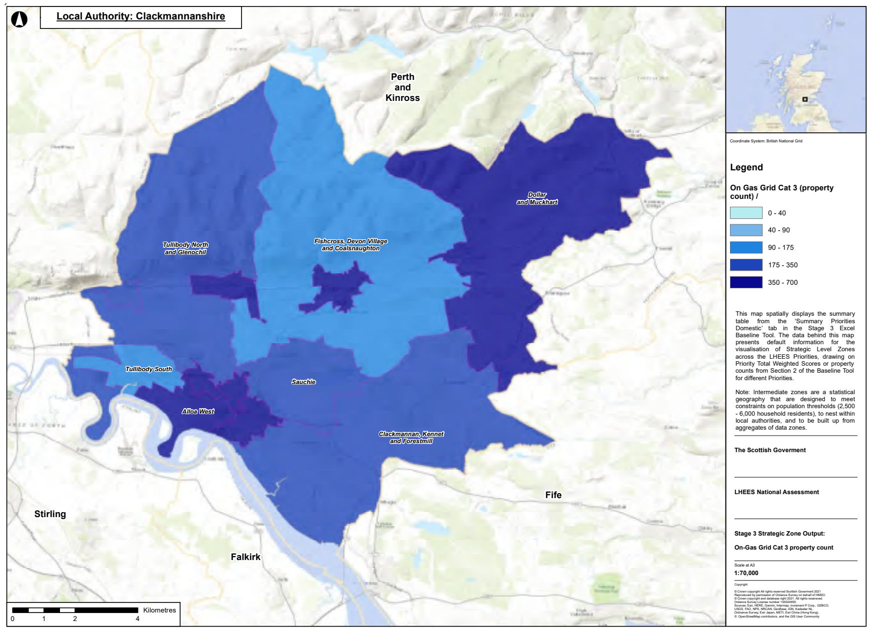
Stirling On-gas Category 2 Properties



Clackmannanshire On-gas Category 2 Properties



Stirling On-gas Category 3 Properties



Clackmannanshire On-gas Category 3 Properties

Examples from the digital twin model of areas to potentially target for specific interventions

Heat Pumps

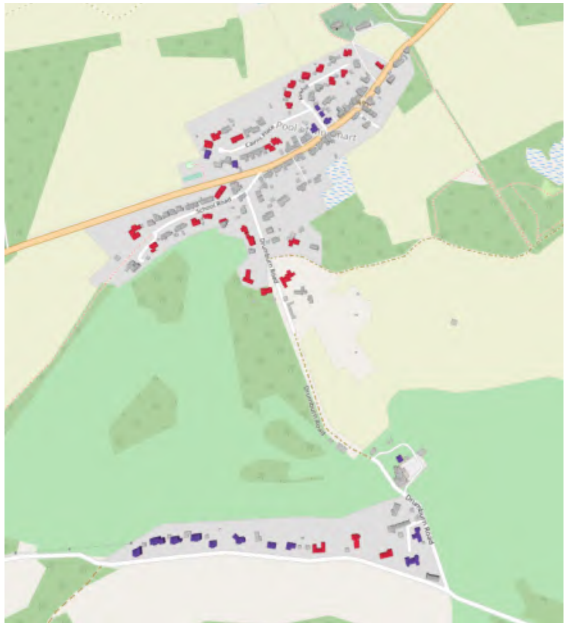
The following areas are clusters of homes across Stirling and Clackmannanshire council areas which are currently using oil or LPG and have relatively thermally efficient building fabrics. These homes have been chosen as off gas grid homes using fossil fuels are currently high priority for heat pump implementation to decarbonise their heating use (ideally all of these homes will be decarbonised by 2032 based on national and local targets). Homes which have thermally efficient building fabrics will be most suitable for installing heat pumps in the short term – as they will likely not have to implement any building fabric measures before installation, or install larger radiators. They are also more likely to be able to install a higher efficiency low temperature heat pump, as opposed to a low efficiency high temperature model. At current electricity prices homes which are not very well insulated will also be at higher risk of fuel poverty when installing a heat pump – if electricity prices were to be decoupled from natural gas, then many more homes across the region would be able to install a heat pump without higher risk of fuel poverty.

Dollarberg Park

The homes highlighted below were constructed after 2002 so have good thermal properties, but are currently using LPG as their heat source. They should be suitable for heat pumps immediately, many of them may also have suitable available space for a ground source heat pump.

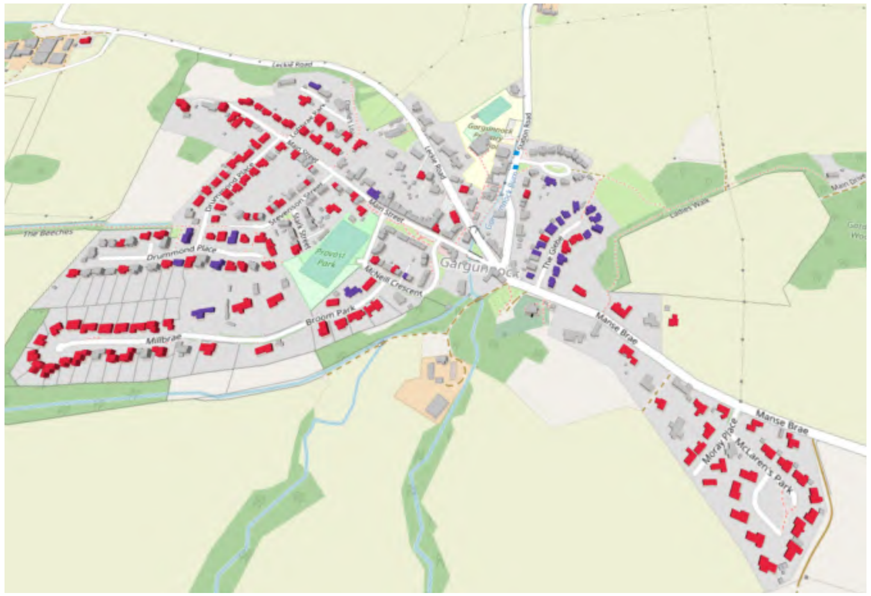
Pool of Muckhart

There are a large number of off-gas grid. homes using oil (red) or LPG (purple), as shown below. Only homes with relatively efficient fabrics are highlighted below, but there are several other homes in the village with solid walls using oil or LPG, which may also be suitable for a heat pump after some fabric retrofit or if using a high temperature pump with larger radiators.



Gargunnock

Here, there are a large number of oil and LPG heated homes and more efficient buildings fabrics than most rural Stirling homes, on average. Only those homes most suitable for a heat pump currently are highlighted below (oil or LPG fuel type, cavity or timber frame wall constructed following 1950) but there are other homes in the village which would likely be suitable post some retrofit, or with larger radiators and/or a high temperature model installed.



Scott Brae, Kippen

All homes in this cluster were constructed during the 90s or early 2000s so have relatively well performing fabrics. They're currently using oil for heating and should be suitable for an immediate heat pump conversion. Some properties may also have sufficient space for the installation of a ground source heat pump.

Manse Road and Craignavie Road, Killin

Similar to the previously identified areas – there are a high proportion of homes with efficient fabrics currently using oil or LPG, space around homes means ground source heat pumps may be suitable. Some of the non-highlighted homes may also be suitable with larger radiators or a high temperature model.

Fabrics

The areas highlighted below show buildings which are requiring each specific fabric intervention, with multiple factors considered to select each priority zone, such as fuel poverty, other deprivation indexes, EPC ratings etc.

Glazing

Rosebank and Posthill, Sauchie

Stirling City Centre

Loft Insulation

North Alva

Borestone

Cavity Wall Insulation

Raploch, Stirling

Fallin

Alloa East

Sauchie

Appendix XII - Public Consultation

Introduction

The Regional Energy Masterplan (REM) is a joint City Region Deal project between Stirling and Clackmannanshire Councils. It outlines what we need to do to reach a net-zero energy system across the region by 2045, with projects being delivered in five-year phases.

Switching our reliance on fossil fuels to renewable energy sources that produce lower or no greenhouse gas emissions is critically important in tackling the climate crisis. It will enable us to tackle fuel poverty by facilitating the provision of/helping to provide low carbon, low cost energy for residents and businesses within the Council areas.

There will also be opportunities to enhance local skills and knowledge as well as improving transport and infrastructure sustainability.

Stakeholder Engagement (29 workshop attendees, 12 individual meetings)

As part of the development Regional Energy Masterplan, a thorough stakeholder engagement process was carried out, led by Ricardo Energy. Key stakeholders were identified and contacted for consultation on the objectives and KPIs within the masterplan, as well as their opinions on any assumptions in the modelling work.

They included domestic, non-domestic, public sector and third sector, and individual large-scale energy users.

From a number of workshops and individual sessions (with 29 workshop attendees and 12 individual meetings), the biggest challenges and barriers for decarbonising energy use were identified, along with an understanding of big energy users' decarbonisation plans and expertise in their own fields. Results are recorded separately in documentation provided by Ricardo.

The consultation process fed into the actions outlined for both councils, and enabled us to shape the document in preparation for full public consultation.

Engagement with all stakeholders will continue on to 2045. There will be ongoing community engagement and discussions on project development.

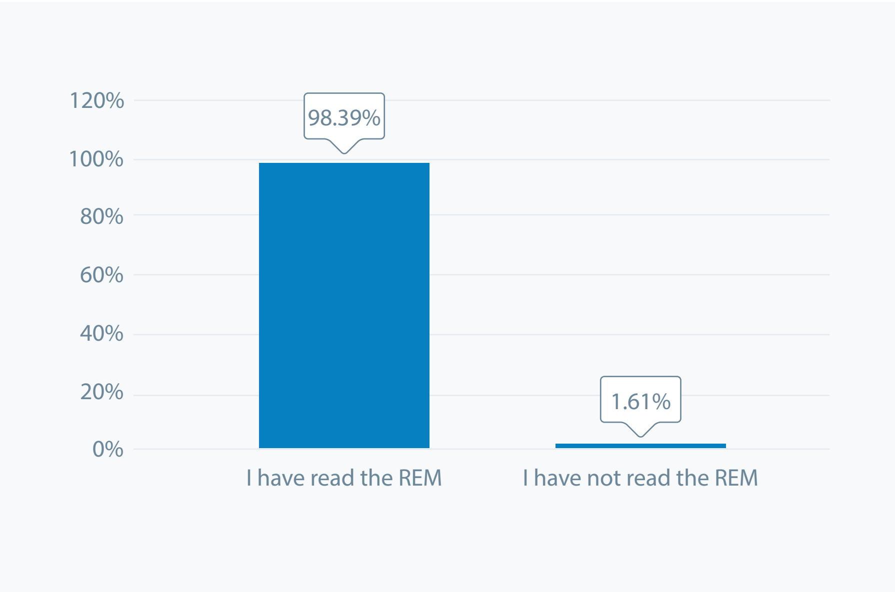
Public Consultation (62 responses)

Public consultation on the draft REM Plan was carried out between 2nd August and 27th September 2023 on Stirling Council's public engagement platform (https://engage.stirling.gov.uk/en-GB/). The second phase of public consultation consisted of a brief survey that asked a number of closed questions (questions 1-9) focussing on the content of the draft Plan. Questions 10 and 11 were more open and allowed respondents to provide comments as free text.

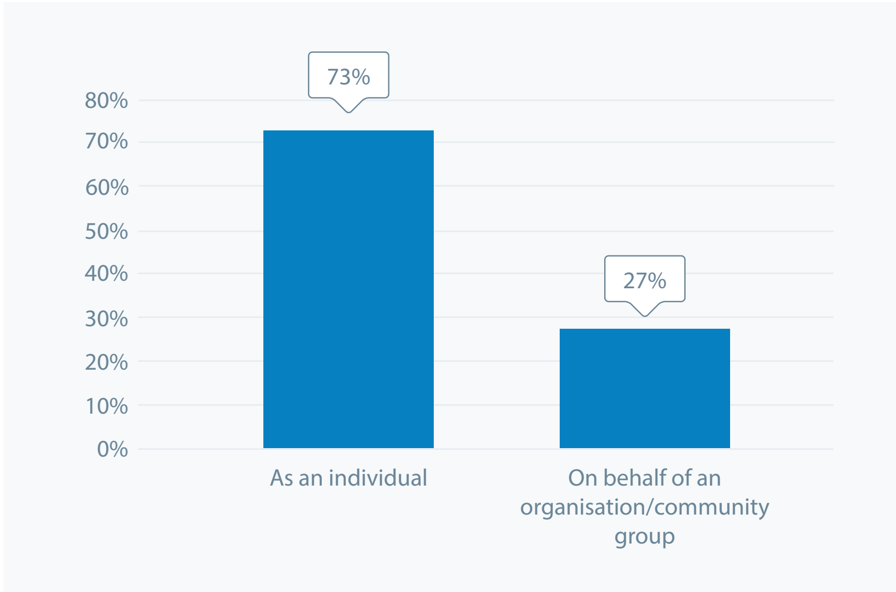
In addition, the Council received one consultation response through direct email. Three community groups expressed interest in arranging meetings to discuss the REM. One meeting has been arranged for November, but two did not reply further to any invitations within the consultation timeframe. Both councils remain open to any meetings in future however, on both the REM in general and local priority areas, once the REM has been published.

The following tables detail the written comments and representations received on the draft REM Plan and both Councils' responses to those comments.

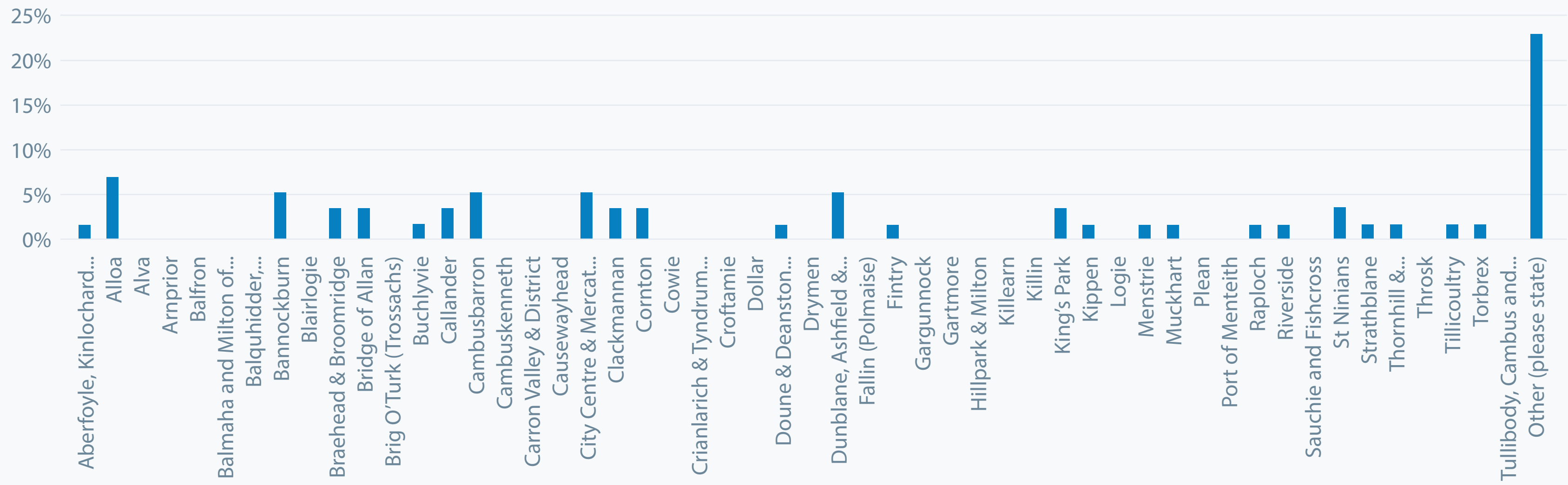
Q1. Please confirm that you have read the Regional Energy Masterplan



Q2. Are you responding as an individual or on behalf of an organisation?



Q3. Where do you live?

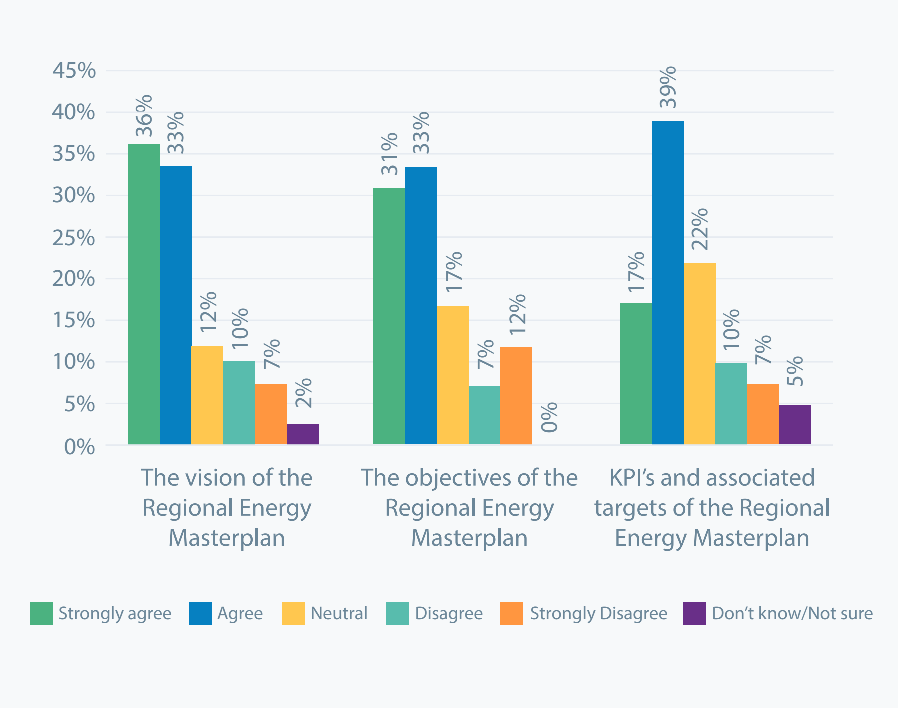


Q4. Please state your levels of agreement or disagreement with each of the following:

The vision of the Regional Energy Masterplan

The objectives of the Regional Energy Masterplan

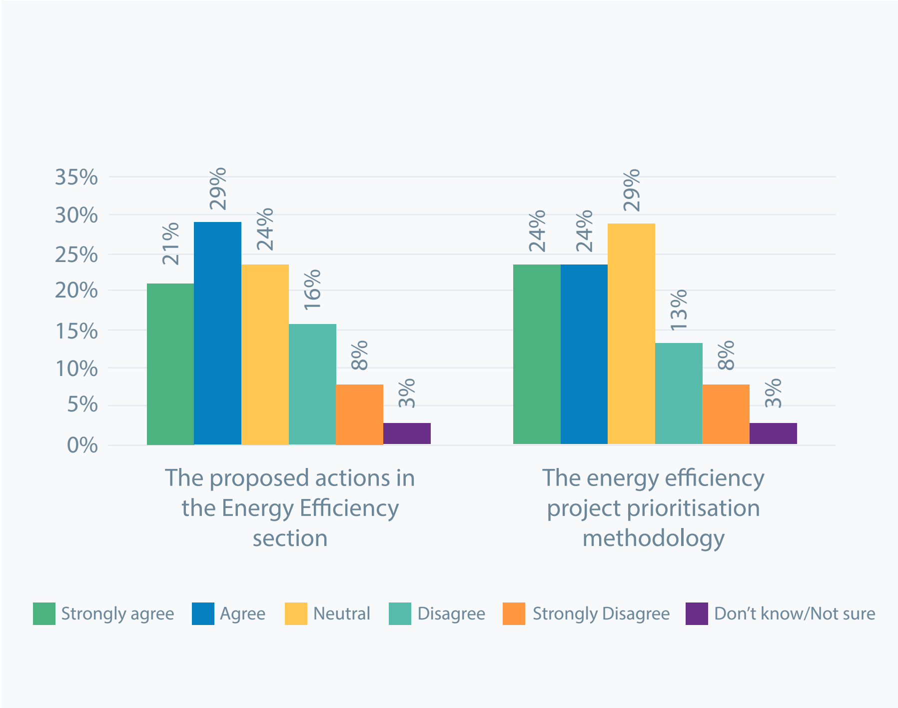
KPI's and associated targets of the Regional Energy Masterplan



Q5. Please state your levels of agreement or disagreement with each of the following:

The proposed actions in the Energy Efficiency section

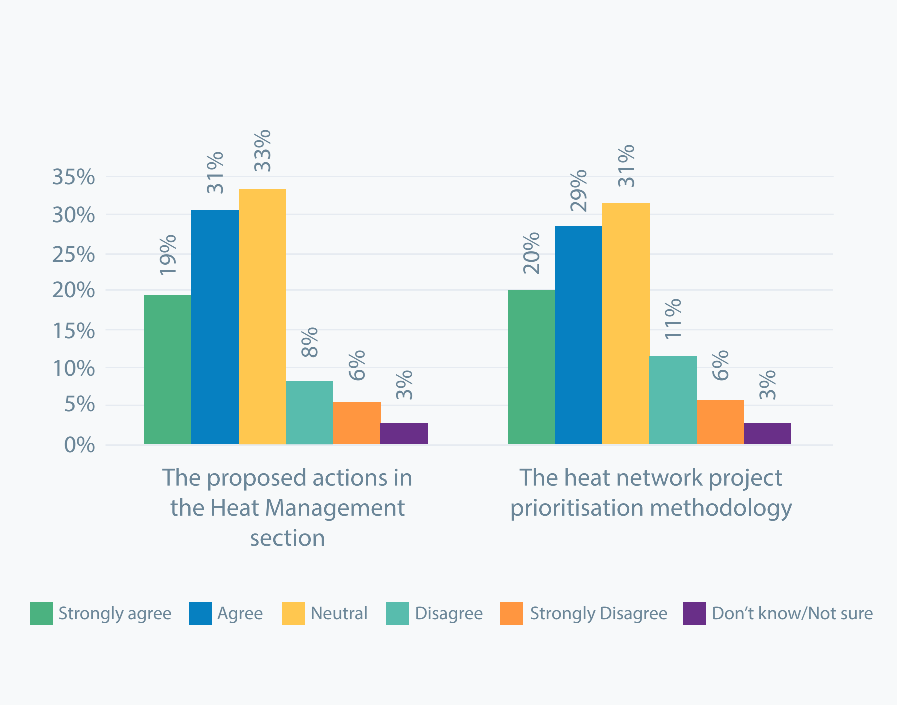
The energy efficiency project prioritisation methodology



Q6. Please state your levels of agreement or disagreement with each of the following:

The proposed actions in the Heat Management section

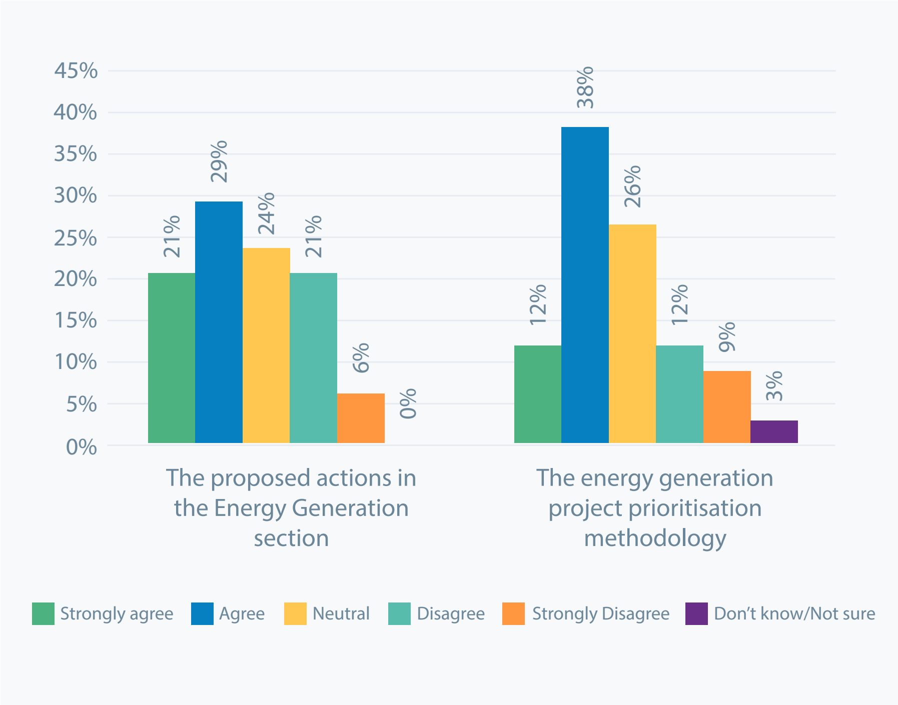
The heat network project prioritisation methodology



Q7. Please state your levels of agreement or disagreement with each of the following:

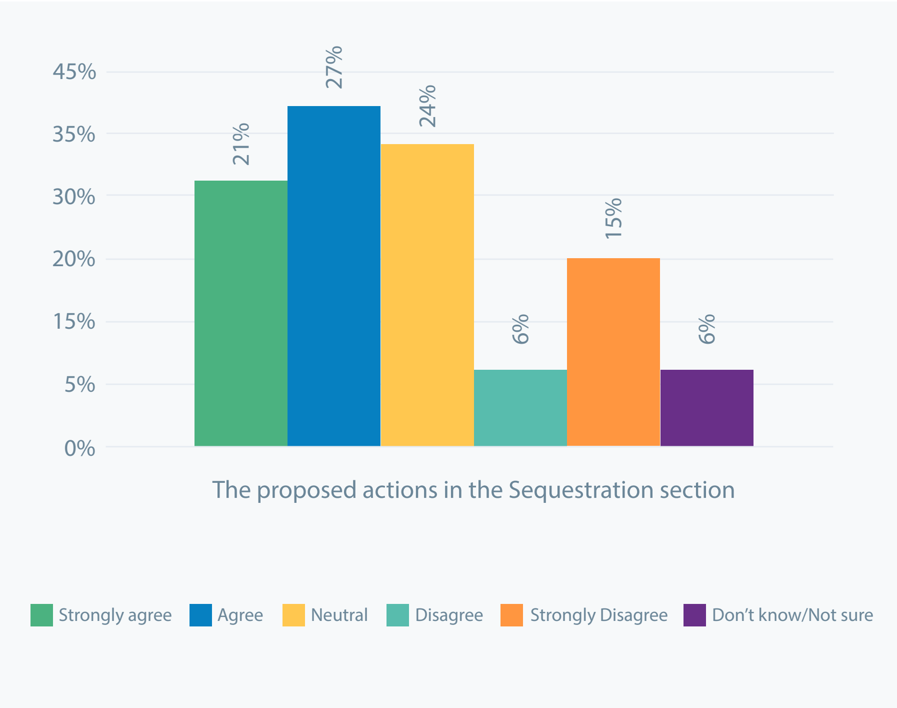
The proposed actions in the Energy Generation section

The energy generation project prioritisation



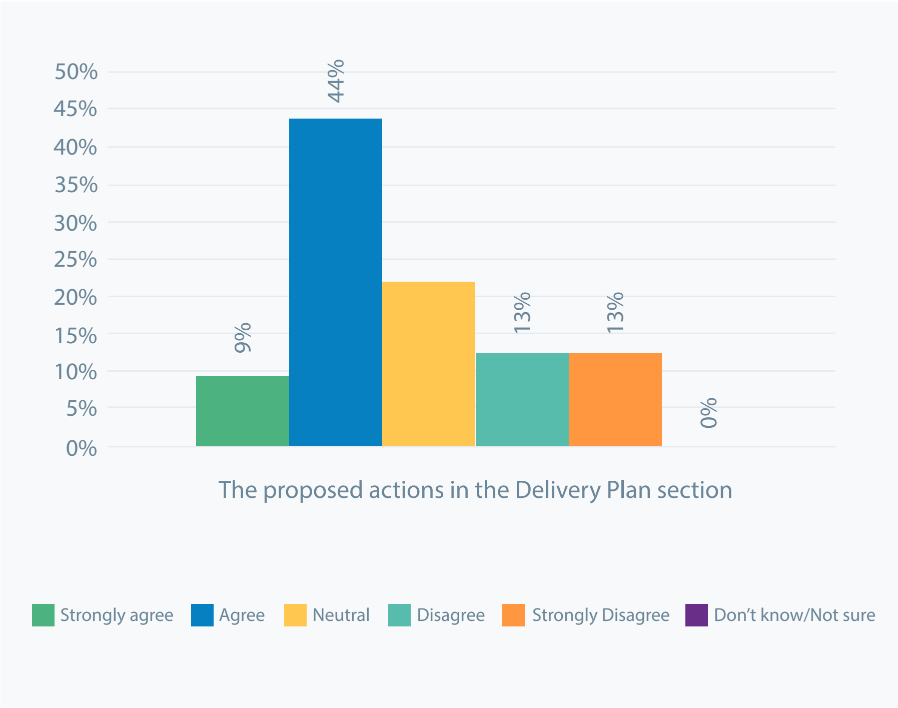
Q8. Please state your levels of agreement or disagreement with the following:

The proposed actions in the Energy Generation section



Q9. Please state your levels of agreement or disagreement with the following:

The proposed actions in the Sequestration section



Q10. If you disagreed with any aspect of the Regional Energy Masterplan please tell us why

This question included an unlimited, free text box and enabled respondents to elaborate on their reasons for disagreement with any elements of the draft Plan. The responses to this question have been included in this table.

No.	Date of Response	Comments made	Councils' response and amendment	Theme
1	27th Sept.	1. Objective 3 of the Masterplan does not consider that Stirling and Clackmannanshire can play a role in the national context to meet zero-carbon energy generation. Local generation should not be limited by the requirement to match local demand, and the possibility that the region could be a net exporter of zero-carbon energy should be considered. This objective could be more clearly worded to contemplate the contribution of the region to a national zero-carbon energy system. 2. Utility scale projects have the potential to supply a large capacity of renewable generation and can contribute towards habitat restoration and carbon sequestration through Habitat and Peatland Management Plans. The Masterplan does not capture the opportunities that large onshore wind and other types of renewable projects can provide in meeting the targets and contributing to the region's energy priorities. 3. Communities can benefit from the community benefit funds that renewable companies give back as part of the developments. This can be a source of funding for other actions, such as renewable installations for households, community groups, SMEs and charities, as well as the potential benefits and energy bill reduction they can bring.	1. Ensuring local demand can be met with local supply ensures resilience, however it is likely that supply would exceed demand and contribute to the national net-zero energy requirements. This has been worded more clearly in the document to ensure the national context is recognised, please see Objectives & Outcomes, Objective 3. 2. Each site for renewable generation will be considered separately. Estimated carbon savings and generation have been calculated based on solar PV as this would be the preferred options for most sites. Where a site is identified for renewable generation, of any scale, habitat restoration and sequestration will also be considered to maximise the positive impacts of the project. The potential for sequestration from energy generation projects is noted under 'Actions Required' in the Interdependencies Across Workstreams diagram, however we have articulated this more clearly in the Sequestration section of the document. 3. Agreed. This will be considered in developing any feasibility studies or business cases centred around renewable generation.	Maximise renewable generation opportunities without impacting historical sites Community ownership potential

No.	Date of Response	Comments made	Councils' response and amendment	Theme
2	27th Sept.	1. The Climate Action Callander group welcomes the Regional Energy Masterplan and its detailed mapping of a journey towards achieving net zero in the region by 2045. 2. We would like clarity on the measures proposed in the Regional Energy Masterplan that will assist rural communities like Callander in achieving net zero faster than the national situation. The reason for seeking this clarification is that Callander seems to fall below the threshold for many of the interventions proposed in the Regional Energy Masterplan, which are prioritised around fuel poverty, off grid properties and population density. 3. We would like to see the report refer more explicitly to planned population growth pressures. For example, areas of new housing are planned in the Callander South Master Plan and there is currently insufficient ambition by the National Park to ensure that these are carbon neutral. The Energy Masterplan refers to the need to work with planning policy but we would like to see this element strengthened and given a specific delivery KPI. 4. We would like the Energy Master Plan to take more account of the impact of tourism on energy demand in communities like Callander. For example on p83 it states "EV demand in the more rural parts of Stirling and Clackmannanshire will be lower due to population density, shown by the blue dots. These areas also have more free demand capacity on the local network, so electrification of transport should be achieved with minimal grid upgrades". We aren't clear that this statement takes sufficient account of the tourist pressures on charging points in Callander, being a popular re-charging point on long distance journeys.	1. Thank you. 2. When considering the whole region, we had to prioritise any actions based on a number of factors. The prioritisation of off gas grid areas will of course apply to most rural communities, though not those buildings in Callander that are on the gas network. Callander specifically has been identified as a potential district heat network location which if feasible will help advance the community towards net zero faster. There are existing funds and support available for communities, such as the CARES funding (see REM Appendix IX – Funding Sources Table) Otherwise both councils are happy to support communities who are keen to do more with whatever resources we have available. Currently this is likely to be signposting to resources, information and funding available, including community case studies. We have included further information in the REM on next steps and resources regarding retrofit (see Appendix X). Many of the proposed actions in the REM delivery plan are outwith the scope of the council and the responsibility of, for example, the Scottish Government, so we would anticipate that there may be more help for rural communities in future. For example, the Scottish Government plans to establish a Public Energy Agency to provide advice. 3. The REM and it's KPIs deal largely with our existing building heat demand, as this is by far the largest portion of energy that must be decarbonised so therefore the main priority. We have addressed new-build (see Energy Efficiency section), but the main policy areas that will cover this in more detail and provide regulations required to enforce steps required for net zero will be within Planning and Building Standards. We will of course continue to work with planning and building standards colleagues to align with the REM.	Community ownership potential Energy efficiency Energy efficiency of new builds Maximising tree planting, minimising tree removal, and manage planted areas appropriately

No.	Date of Response	Comments made	Councils' response and amendment	Theme
2	27th Sept.	5. We note that the Masterplan earmarks the area around Callander for increased woodland planting to sequester the remaining carbon to allow the regional to achieve its net zero target. Please note that our group is becoming increasingly concerned about the danger from forest fires on our community as we start to see the impact of a warming climate in Callander and so would want to be consulted further on this as a stakeholder group.	4. The study undertaken on future EV charger requirement takes into account tourism usage demand across the council areas. Furthermore, there is provision for chargers at 'destination' areas and carparks such as Callander, where they're used for 2 hrs+ whilst occupants are doing something else at that destination, such as work, shopping or indeed something tourism related. A note has been added to the REM to highlight tourist demand (see Energy Generation, EV Planning) 5. The map showing potential for woodland planting comes from Stirling and Clackmannanshire Councils' Forestry and Woodland Strategy which was published in 2019. However, on the topic of potential forest fires from a warming climate, Stirling Council's Alive with Nature Plan confirms the council commitment to planting the 'Right Tree in the Right Place' (https://forestrycommission.blog.gov.uk/2020/07/17/right-tree-right-place-right-reason/) The UK Forestry Standard referenced as part of this covers the requirement to consider and plan for climate change adaptation such as forest fires. The benefits of tree planting significantly outweigh, and in some cases mitigate, the risks. Furthermore, on the topic of climate adaptation we would like to highlight that Stirling Council will shortly be publishing a Climate Adaptation Strategy for consultation which covers the measures needed for adaptation to a warming climate. Clackmannanshire Council are presently consulting on their Climate Emergency strategy and would welcome any input from the local community in relation to adaptation. Please forward your thoughts and comments to lhunter@clacks.gov.uk	Community ownership potential Energy efficiency Energy efficiency of new builds Maximising tree planting, minimising tree removal, and manage planted areas appropriately

No.	Date of Response	Comments made	Councils' response and amendment	Theme
3	26th Sept.	Thank you for the opportunity to comment on the REM. It is evident that a huge amount of work has gone into the masterplan and, as a local business actively involved in planning for decarbonisation projects from generation through to distribution, the vision, key themes, objectives & KPI's are supported. 'Disagreement' - which is based on the survey categories available and is instead one of 'consideration and refinement in support of the plan' - relates to the following points. These are informed by a view that climate adaptation necessitates integrated solutions that connect energy generation, storage and use with transport and digital infrastructure designed and developed in parallel. Points for consideration and refinement are: 1. Within the key themes, figure 3, 'grid constraint' is not referenced yet is a key barrier to delivering scaleable energy transformation. This highlights the value of exploring Smart Local Energy (neighbourhood) Systems (SLES) consistent with objective 4 but not evident in the KPI's.	1. Figure 3 was derived from stakeholder consultation workshops, so summarises the any themes raised at the time by stakeholders. The issue of grid constraint is addressed in the Heat Management, Electricity Generation and Delivery Plan of the REM. We have now highlighted SLES in the Energy Generation section, KPIs 1 & 5. 2. Industry emissions are outwith the scope of the REM and largely covered by national and industry targets, except where heat in buildings is concerned and any industrial waste heat is a consideration for district heat networks. Both councils Local Transport Strategies are being developed so we would recommend engaging with consultation on these when available. Furthermore, ahead of this both councils are bringing forward the development of their Active Travel and Public Transport Strategies which are due for consultation in 2024. We will continue to collaborate with colleagues on these plans where relevant, and incorporate any opportunities as the REM will be an ongoing live project.	Grid Constraints and working with DNO's (distribution networks operators) Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Should have more ambitious targets and delivery plan

No.	Date of Response	Comments made	Councils' response and amendment	Theme
3	26th Sept.	2. With 40% of Stirling's CO2e generated by transport, developing solution for the heavy duty vehicle sector is a key sector to focus on, particularly as the energy vectors would support the wider green hydrogen pathway promoted by the masterplan. The same applies to industry which generates 36% of Stirling's CO2 e and points to enabling heat decarbonisation within key industrial and commercials areas of the city that could be integrated with transport plans. The emerging Regional Transport Strategy has the potential to be an enabling platform for the REM, particularly for early stage energy generation, and would be worth exploring as a dedicated 'energy generation' workstream. 3. The range of actions set out in the plan are wide, detailed and highly ambitious. Huge reliance is placed on local government to delivery these actions at a time of challenging resources, complex projects and very tight timelines. It is recommended that further consideration is given to the potential for partnership and collaboration between public, academic, community and private sector groups to support the council, and projects are prioritised to a core set that tackle deep emission sources through infrastructure and governance models that can unlock transformative change, such as SLES and industrial cluster heat networks.	3. The actions in the delivery plan are the responsibility of a number of parties beyond local government, as noted in the 'Who is Responsible' column. We have highlighted to Scottish Government where there are gaps in the plan, for example areas that local government would be best suited to address but to not currently have resources for. Both councils are also currently collaborating with certain organisations and open to further collaboration and partnership, as has been noted in various actions in the delivery plan. Projects have been prioritised based on the weightings stated in the REM, and will all be subject to feasibility studies on the best approach, including consideration of infrastructure and governance models. In the case of heat networks, project prioritisation has taken into account industrial areas. As noted above, we have now highlighted SLES in the Energy Generation section, KPIs 1 & 5.	Grid Constraints and working with DNO's (distribution networks operators) Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Should have more ambitious targets and delivery plan

No.	Date of Response	Comments made	Councils' response and amendment	Theme
4	22nd Sept.	1. Not enough detail on land being proposed for change / energy site. 2. Tree planting site sensitive area in Stirling. Fourth Climate Forest only had funding for two years. Who will manage and properly risk assess these trees when grown in a climate where storms are or frequent. 3. As you refer in document cost for people at present is too high. Government announcement in 2026 on hydrogen is a key one which would shape peoples choices. Even with grants replacing heat source is not an option at present. 4. 2023 is nearly over and I haven't seen any publicity on EPC?	1. Details will become available as we develop and consult on each individual project, as studies will be required for all sites first to ascertain project feasibility. 2. For specific information on the Forth Climate Forest we would recommend getting in touch with the University of Stirling's Scotland International Environment Centre who are hosting the partnership (siec@stir.ac.uk). On the issue of a changing climate and the measures we need to take to be ready for this, Stirling Council will shortly be publishing a Climate Adaptation Strategy for consultation. Clackmannanshire Council are presently consulting on their Climate Emergency strategy and would welcome any input from the local community in relation to adaptation. Please forward your thoughts and comments to lhunter@clacks.gov.uk. 3. We will highlight this feedback with the Scottish Government who have control over funding matters. We would also note that where possible both councils are looking into developing district heat networks that can provide low carbon heating to residents. Furthermore, we support the Scottish Government's call to the UK Government to decouple the price of electricity from the price of gas which will reduce the payback costs of heat electrification. 4. If this is referring to the EPC reform, there has been a consultation from the Scottish Government out for responses on their proposed reform from the 25th July to 10th October 2023. If referring to the setting of mandatory EPC targets via the anticipated Heat in Buildings Bill, this is the latest information we have received from the Scottish Government is that they intend to consult on this proposal in 2023.	Delivery plan should be detailed and achievable Maximising tree planting, minimising tree removal, and manage planted areas appropriately Hydrogen importance emphasised EPC's (energy performance certificates) and associated targets

No.	Date of Response	Comments made	Councils' response and amendment	Theme
5	21st Sept.	1. The CO2 emissions to make green energy is greater than the current method of energy. 2. Also to make an EV vehicle is more dangerous to the environment then a combustion engine vehicle.	1. This is incorrect, please refer to the UNECE Life Cycle Assessment of Electricity Generation Options, Figure 1 (Life Cycle Assessment of Electricity Generation Options | UNECE). Renewable energy generation does not emit CO2 unlike fossil fuel energy generation. In other words, there are no direct emissions from renewable electricity. There is whole life carbon involved in both forms of generation in the production of the machinery/technology required, and its end-of-life disposal. When combined, the CO2 emissions from fossil fuels still outweigh those from renewable electricity generation. 2. The actions towards decarbonising transport and making it less dangerous to the environment are outwith the scope of the REM and will be addressed in Local Transport Strategies being developed by both councils, which will be based on solid evidence and understanding of the best routes to net zero in the context of transport. These will align with the Scottish Government's National Transport Strategy 2 (NTS2).	CO2 emissions EV's (electric vehicles)
6	18th Sept.	In Appendix V, we noted that in several of the proposed heat networks, industrial sites are listed as consumers of heat (for example, p. 209), despite being mentioned elsewhere as potential sources of heat (i.e. capturing waste heat from existing industrial activity). While the report notes that the waste heat potential and availability at these sites is currently undetermined, we believe that the potential for these industrial sites to be contributors (almost certainly in excess of their level of consumption) to heat networks should be emphasised in this section	Thank you for your suggestion, the energy hierarchy favours using industrial waste heat as a vital resource, and have further highlighted throughout the REM (see District Heating, and Ongoing Actions). The reason for not highlighting this further in Appendix V is largely due to engagement that has already been carried out with the industrial sites involved, along with the modelling used to enable comparison of networks which didn't account for waste heat.	Heat networks utilising waste heat and coordinating with other works

No.	Date of Response	Comments made	Councils' response and amendment	Theme
7	10th Sept.	1. I am in favour of the Plan but have concerns about the funding of measures to implement the Plan.	1. This is a valid concern, which can be broken down further: • There are numerous funding sources available already, as highlighted in Appendix IX of the REM. These cover a range of recipients, from individuals and communities to businesses and local government. • In undertaking the REM we are highlighting to the Scottish Government areas that will require further funding, and will continue to do so with our ongoing energy analysis via our digital twin model. There has been a drive by the Scottish Government to provide funding for net zero, with good funding already available such as the Heat Network Support Unit. • Both councils are already making use of existing funding available to advance the actions in the REM and reduce the burden for residents in reaching net zero, along with exploring additional sources of funding and investment. • Within the broader net zero industry, further schemes and research on funding required is being undertaken, so we remain optimistic on further funding and solutions becoming available.	Funding issues, opportunities and appropriate signposting

No.	Date of Response	Comments made	Councils' response and amendment	Theme
8	28th August	I disagree with most since the Councils have no appreciation of the following :- 1. The heat pumps advocated are lowest efficiency. 2. Recent work started on national aquaculture centre at Stirling Uni demonstrate no credentials for net zero, since no renewables, no stormwater capture and reuse in the design of a grand titled project with words like Innovation… and technology. An absolute disgrace. 3. Decarbonising transport does not mean wasting money on cycle paths, it means removing hydrocarbon vehicles and replacing with electric. 4. Clacks council allowed the decommissioning of a 5MW solar farm by Balheartie and didn't even know it had happened. 5. Clacks council stores thousands of tonnes of felled and chipped timber, mostly imported from North America and used to generate electricity. This produces 30% more CO2 than coal yet is regarded as zero carbon because you can grow more trees. This is a lie, anyone can do the maths. It is the environmental equivalent of a war crime.	1. The best heat pump, or indeed low/zero carbon heating system for any building will depend on its specific circumstances, and as such we have not recommended any specific type of heat pumps within the REM. It is widely acknowledged however that heat pumps themselves are likely to be one of, if not the main solution to decarbonising heat in buildings. Therefore Appendix IX of the REM takes a very high level look at overall numbers of heat pumps required for the purposes of data analysis, but this does not advocate any particular technology type. 2. The REM deals with the overall route to net zero for energy in the whole region up to 2045, and will help guide projects going forward. The construction of individual buildings is not directly addressed, and the Stirling University building mentioned was developed prior to the REM. However, both councils are working to reduce their building energy emissions to net zero to meet the targets outlined in the REM. We would recommend getting in touch with Stirling University directly for a direct response at j.c.craig@stir.ac.uk 3. The specific steps required towards the decarbonisation of transport are not addressed within the REM as these will be addressed in Local Transport Strategies being developed by both councils, which will be based on solid evidence and understanding of the best routes to net zero in the context of transport. These will align with the Scottish Government's National Transport Strategy 2 (NTS2), which identifies the need to reduce car use and replace with electric vehicles, alongside promoting public transport and active travel.	Heat pumps efficiency University buildings Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Clacks solar generation and wood pellets

No.	Date of Response	Comments made	Councils' response and amendment	Theme
8	28th August		4. The solar farm wasn't allowed to be "decommissioned" but in fact had been destroyed by storm Arwen. The owners have been attempting to re-activate the site but have experienced challenges with insurance and also current market conditions on securing site specific equipment. It is understood that the items required are on long lead times. It is expected that the site will be operational in early 2024. It should be noted that Clackmannanshire planning authority are working pro-actively with the developer and have already agreed to extend the time period which would have triggered a requirement to decommission and reinstate the site. 5. We are unclear as to what this comment is referring to, but if you would like to engage further please get in touch via lhunter@clacks.gov.uk.	Heat pumps efficiency University buildings Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Clacks solar generation and wood pellets
9	18th August	1. I disagree with the use of a Scottish emissions factor for electricity, rather than for the whole of the UK. Scottish Government guidance states: "The only occasion where the UK grid emission factor does not apply for reporting and target setting purposes is where renewable electricity generation is on site or connected via direct wire." https://www.gov.scot/publications/public-sector-leadership-global-climate-emergency/pages/11/ 2. On page 225 it's stated that £2m of funding is available per year through the Scottish Central Government Efficiency Grant Scheme. This has been increased to £5m.	1. The Scottish emissions factor was used to increase the accuracy of the modelling, to avoid for example the underestimation of carbon reduction if swapping a gas boiler for a heat pump. This is consistent with advice on Local Area Energy Planning from the UK government. When undertaking our public bodies climate change reporting duties both councils apply the UK emissions factor as per the quoted guidance. 2. Noted thank you, this has been updated in the REM	CO2 emissions Funding issues, opportunities and appropriate signposting

No.	Date of Response	Comments made	Councils' response and amendment	Theme
10	9th August	Clackmannanshire council recently increased EV tariffs to amounts that make owning and EV more expensive than owning a petrol or diesel car, so how can they endorse any of this the whole idea is to reduce the use of fossil fuels yet owning an electric car in Clackmannanshire is more expensive than owning a fossil fuel run car and the leader of Clackmannanshire council voted for the increase to the tariffs,	The Clackmannanshire tariff is based on no further financial subsidy from the Council and no burden to the public purse, therefore is set higher than some adjacent local authorities, where tariffs remain subsidised. Full details of the scheme along with the Council report are available at https://www.clacks.gov.uk/transport/evtariffs/. This approach ensures the day to day running costs of the network is covered by users and will address increased costs to the Council due to providing energy for free at a time when energy costs are increasing. Furthermore the Council would have been unable to access future government funding for EV infrastructure, unless a 'market rate' tariff was in place by Spring 2023. Implementing a tariff supports the low carbon transition in the move towards Net Zero by ensuring that the EV infrastructure is maintained over the longer term, providing confidence for users on the EVCP network. Clackmannanshire Council is aware that some EV drivers have no choice but to use the public EV network, so have introduced a 10% resident's discount scheme for any Clackmannanshire resident with no access to off-street parking to facilitate home charging, and are currently the only local authority in Scotland to offer this. While electrification of private vehicles will go some way towards reducing the use of fossil fuels, electric vehicles still have an environmental impact. These vehicles still create congestion in our towns and do not meet the Scottish Government target to reduce all vehicle kilometres by 20%. Therefore as a local authority Clackmannanshire Council would hope to encourage more local residents to follow the transport hierarchy set out by the Scottish Government and use other more sustainable modes such as active travel (walking, cycling and wheeling) and public transport in the first instance.	Clackmannanshire Councils EV (electric vehicles) charger tariffs

No.	Date of Response	Comments made	Councils' response and amendment	Theme
11	8th August	This is not council business. How much time and resources are being wasted on this pie in the sky nonsense	Councils have a statutory duty to develop a Local Heat and Energy Efficiency Strategy and Delivery Plan, which is encompassed within this REM. Furthermore, similar local area energy planning is being carried across Britain as an essential step in the process to reduce emissions and achieve net zero by the stated targets (2045 for Scotland)	LHEES – where the necessity of this work is being questioned
12	2nd August	Recommendations put forward are unworkable.	We believe that the actions outlined in the REM will be challenging, and require the effort and support of the entire region, industry, education institutions, Scottish and UK Governments, and many others. However, in the face of a climate and nature emergency we must face this challenge. By undertaking masterplanning work we are helping to highlight the areas that will require more focus and support to reach our targets. It is worth noting that this is not an impossible task, the solutions to achieving net zero emissions buildings are already available.	Delivery plan should be detailed and achievable

Q11. Do you have any suggestions of improvements that could be made to the Regional Energy Masterplan?

This final question included an unlimited, free text box and enabled respondents to submit any suggestions, final thoughts or detailed feedback on any elements of the draft Plan. The responses to this question have been included in this table.

No.	Date of Response	Comments made	Councils' response and amendment	Theme
13	27th Sept.	1. Community ownership of large scale renewable projects is possible and included in Scottish Government targets. The opportunity of communities investing in large scale renewable projects could be contemplated as part of the Energy Masterplan. 2. While there is an action for Planning authorities to support renewable proposals, it does not contain actions that target the identified constraints. For example, will training be provided on NPF4 to decision makers? How will the planning process be sped up and delays be reduced? Will additional resources be allocated to overcome the constraint?	1. Yes, we have now highlighted this in the plan within the Energy Generation section, KPI3, and emphasised that various ownership models will be scoped at the feasibility and business case stages (see Energy Generation, Renewable Generation Site Screening and Prioritisation, Initial Screening) 2. Decision makers will be expected to familiarise themselves with NPF4 where appropriate. However, all elected members have been given a briefing on NPF4 and the how this relates and impacts on consideration and decision making at the relevant Committees such as the Stirling Planning and Regulation Panel and Environment, Transport and Net Zero Committee. Section 45 of the Planning (Scotland) Act 2019, also prohibits elected members from carrying out certain specified planning functions if they have not completed training specified by Scottish Ministers. These functions are to be specified in regulations which will be set out by the Scottish Government and may for example include the determination of planning applications. The central aim of the new Planning (Scotland) Act 2019 was also to implement a package of measures to improve the performance of the planning system as a whole. These changes and enhancements will come through various processes and procedures that will be set out by the Scottish Government and will be implemented by the Council. Commensurate resources within Stirling Council will be applied to this and adjusted according to demand to ensure the planning process minimises delays. The council aligns itself with the direction of NPF4 and our strategic objectives are aligned to achieve this.	Community ownership potential Restrictions and delays associated with planning

No.	Date of Response	Comments made	Councils' response and amendment	Theme
14	27th Sept.	1. Take more account of projected housing growth e.g. Callander South Masterplan 2. Take more account of tourism pressures on energy demand in rural communities like Callander, for example for electric charging points 3. Clearer targets and actions to resolve restrictive planning policies in historic rural environments for example on solid wall insulation and solar PV installations 4. Our group is very committed to helping Callander become more energy resilient and would welcome further involvement in the Energy Master Plan please	1. New build has been considered as part of the overall modelling for our KPIs, and any new developments will be considered in the context of district heating moving forwards. However, as an overall priority the impacts of new build on progress towards net zero are far smaller than existing buildings. A note has been added in the Energy Efficiency section on the scale of existing building changes required compared to new build. 2. As stated above, the study undertaken on future EV charger requirement takes into account tourism usage demand across the council areas. Furthermore, there is provision for chargers at 'destination' areas and carparks such as Callander, where they're used for 2 hrs+ whilst occupants are doing something else at that destination, such as work, shopping or indeed something tourism related. A note has been added to the REM to highlight tourist demand (see EV Planning) Likewise, any impacts of tourism on building heat demand have been accounted for within the data used for modelling. 3. The National Planning Framework 4 (NPF4) which was published in early 2023 sets out the overarching national planning policy. This new framework goes a long way to addressing any blocks to improving building energy efficiency and allowing for renewable generation. The establishment of both councils new Local Development Plans (LDP) will build on this framework. We would recommend taking part in consultation process on this document, which is ongoing. 4. For further involvement please get in touch via sustainability@stirling.gov.uk.	Energy efficiency of new builds Tourism impact on local energy demand Restrictions and delays associated with planning Community ownership potential

No.	Date of Response	Comments made	Councils' response and amendment	Theme
15	27th Sept.	1. The historic environment has a key role to play in tackling the climate emergency and realising a just transition to net zero. Traditional buildings (those which are pre-1919) make up 19% of our existing housing stock in Scotland, and a significant proportion of our infrastructure is historic. The maintenance, reuse and adaptation of existing heritage assets mitigates resource scarcity, prevents waste and can reduce carbon emissions if low carbon materials are used. It also makes best use of the embodied carbon in the built assets we already have. We welcome that the Masterplan recognises that historic buildings may require different approaches to ensure that energy efficiency and energy supply measures are appropriate, effective and support the principles of a Just Transition. Our experience tells us that the first step to successful energy efficiency retrofit is to ensure that buildings are in a good state of repair. We recommend that the Masterplan recognises this a key step on the route to net zero, and that you explore how the principles of good repair and maintenance can be embedded into the outcomes and actions of the Masterplan. Historic Environment Scotland has a range of resources and research which address repair and energy efficiency in traditional, and our work in this area is ongoing and developing. You can find out more here: Saving Energy Guidance | Historic Environment Scotland | HES and here: Guide to Energy Retrofit of Traditional Buildings | Hist Env Scotland (historicenvironment.scot) We also recognise that a skilled workforce is crucial for the management, protection and promotion of the historic environment, our places and landscapes. The Skills Investment Plan for Scotland's Historic Environment Sector identifies a series of actions to address the skills challenges and opportunities in the sector, which supports an estimated 20,000 direct jobs across Scotland covering construction, the creative industries and tourism.	1. We have noted that successful energy retrofit firstly requires a good state of repair and maintenance (see Energy Efficiency section), and incorporated this into our actions. (see Delivery Plan, Energy Efficiency Phase 1) 2. All potential sites identified for renewable generation will be assessed individually at feasibility and business case stages, which will include an assessment of the impact on the area and historic assets within the vicinity, and planning applications as required. We have ensured that this is clearly stated in the document, see Renewable Generation Site Screening and Prioritisation, Initial Screening.	Energy efficiency and building repair Maximise renewable generation opportunities without impacting historical sites

No.	Date of Response	Comments made	Councils' response and amendment	Theme
15	27th Sept.	2. Renewable Generation Site Screening and Prioritisation Most of the sites identified with potential for renewable energy development are in the vicinity of historic environment assets within our statutory remit. The potential for adverse effects on these and other historic environment assets should be considered in any further decision making in relation to these sites.		Energy efficiency and building repair Maximise renewable generation opportunities without impacting historical sites
16	22nd Sept.	1. Move up as much as possible the timescales for District Heating Networks as this is not only one of the, very admiral, objectives but if implemented faster would reduce the amount of homes requiring other heat generation measures increasing benefits.	1. Wherever possible we will strive to undertake any timescales sooner, but we must work within the limits of the resources available to us. We will however highlight this comment as a key concern.	Should have more ambitious targets and delivery plan
17	22nd Sept.	1. Make it more user friendly. Written like it was for a university degree 2. Break it down into clear steps so general public can see each one	1. We have aimed to make this as user friendly as possible, and provided a summary of the document. 2. This has been done in the delivery plan of the REM. Furthermore, as detail develops the REM will be updated.	Readability of the REM Delivery plan should be detailed and achievable
18	18th Sept.	1. We strongly support the urgent need (mentioned on p. 110) for the Stirling and Clackmannanshire Councils to work closely with local industrial partners, and take concrete steps towards incorporating industrial waste heat sources into future heat and energy planning, especially with respect to district heat network modelling. 2. We strongly support the need (mentioned on pp. 206-207) for further analyses and feasibility studies on the potential for incorporating industrial waste heat into district heat network planning.	1. Thank you for the feedback, as stated in the REM we will continue to engage with industry where relevant and develop ongoing engagement pathways such as the open forum mentioned in the Delivery Plan and in Actions under each workstream section. 2. Thank you for your support, along with the actions outlined in the delivery plan we have been actively pursuing feasibility studies to develop heat networks including looking at the potential to incorporate waste heat.	Heat networks utilising waste heat and coordinating with other works

No.	Date of Response	Comments made	Councils' response and amendment	Theme
19	10th Sept.	1. I live in an off gas grid village with a Conservation Area. This type of settlement has particular challenges 2. Possible projects under the Plan could include retrofit in Conservation Areas and older dwellings 3. Particular problem with heating in off-gas grid housing	1. We acknowledge that this is a difficult area, and have elaborated further on this issue in the REM Energy Efficiency section. 2. As part of overall priorities, historic buildings are a smaller proportion of the total houses so not as high a priority as off gas grid homes that are already adequately insulated for example. Additionally, councils only currently have the ability to retrofit any council housing or certain private houses via EES:ABS funding with owner cooperation. For this reason we deemed it best not to include an actions that private individuals are solely responsible for. However, we do have actions to support this wherever possible, such as via awareness raising and signposting to support, such as Historic Scotland guidance on historic building retrofit. Some resources have now been highlighted in the REM, (see Appendix X). 3. We agree with this, which is why this has been highlighted as a priority to target over on-gas grid areas in the Heat Management Summary Box. We have elaborated further on this is in the Energy Efficiency section, and there is further information in Appendix III on the routes to retrofit,	Energy efficiency in conservation areas Heat management in off-gas grid properties
20	5th Sept.	1. Liaise with Stirling City Heritage Trust who have recently secured funding for the green retrofit of traditional buildings.	1. Thank you for highlighting this, Stirling Council is keen to engage with any relevant organisations that have not already been contacted and will follow this up.	Engagement suggestions

No.	Date of Response	Comments made	Councils' response and amendment	Theme
21	4th Sept.	1. Having read the time frames felt that in certain instances the target time frame to be too long ie Non Domestic buildings to be low carbon heating by 2038, this should be targeted a lot sooner. 2. DNO engagement is key and creating the energy generation requirements as soon as possible to develop grid connection plan with the DNO is important. Again time frames could potentially be improved however appreciate the volume. 3. Battery Storage systems are not mentioned with the Energy generation, should be considered as part of the mix.	1. We agree with this sentiment. The REM has been developed in line with national targets set by the Scottish Government, but these are not targets to aim for so much as deadlines. Any work that can be done before this should be done so. Both councils have set themselves a tighter deadline than the national targets for decarbonisation of all council specific emissions (2035 for Stirling Council and 2040 for Clackmannanshire Council). We will also strive to drive forward works ahead of targets. A note has been added to the REM to reflect this sentiment in Targets & Key Performance Indicators (KPIs). 2. We agree that DNO engagement is key, and have multiple actions around this outlined in the delivery plan of the REM. Regarding timeframes we would reiterate that both councils will strive to drive forward works ahead of targets. 3. The REM has been updated to reflect this comment, please see Energy Generation section.	Should have more ambitious targets and delivery plan Grid Constraints and working with DNO's (distribution networks operators) Energy storage to be mentioned more in energy generation section

No.	Date of Response	Comments made	Councils' response and amendment	Theme
22	4th Sept.	1. Installation of a District Heat Network as part of the Campus incorporating the new Callendar Primary School. The heating media should be a mid-scale, water-source heat pump utilising the river Teith to draw from. This has been developed locally and demonstrated showing how water from a river can provide heat to a number of different types of customers via a connected heat network. 2. Alternative to Suggestion 1 is to install a Combined Heat & Power (CHP) system to generate both power & heat for the Campus, and thus removing the need for Gas as the primary source of heating.	1. Thank you for your support of our district heat network ambitions, we would welcome any further engagement if you would like to get in touch with officers directly - (sustainability@stirling.gov.uk) Callander is noted as one of the district heat network projects to be developed by Stirling Council, and weighted for prioritisation alongside other district heating projects (see REM Heat Management, District Heating section. This includes the primary school (see Appendix V). Within the delivery plan, the Callander network is in Phase 2, 2028-2031, due to the other projects that have been prioritised ahead of this. We are in discussions to investigate feasibility and align these ambitions and timescales where possible. 2. Avoiding gas as the primary source of heating is certainly a priority. When not addressed by a district heat network, this would likely be achieved with a electric heating and a heat pump. CHPs in themselves are not inherently fossil fuel free as they burn fuel to generate heat and power. This is sometimes biomass, but most often gas. Biomass is not a priority over heat pumps with renewable electricity as it still emits carbon.	Heat networks utilising waste heat and coordinating with other works

No.	Date of Response	Comments made	Councils' response and amendment	Theme
23	28th August	1. Recovering waste heat from what industry is left 2. Changes to the public contracts Scotland procurement process to allow innovation 3. Changes to national standards and specifications to allow innovation 4. You can never improve building efficiency if planners stop progress in terms of renewables placement, insulation and other innovative actions. Planners need to facilitate action not block them	1. We very much agree with this statement. The potential to recover waste heat from industry was a key factor of our district heating analysis in the REM (see District Heating section), and we are actively investigating projects where this may be possible, and will continue to do so. 2. Public Contracts Scotland is under control of the Scottish Government so outwith council remits, but we will pass on this comment to Scottish Government. If you have any queries relating to Procurement in either Stirling or Clackmannanshire, please contact the relevant procurement teams at procurement@clacks.gov.uk and procurement@stirling.gov.uk 3. National standards and specifications are outwith council remits, however as we work closely with the Scottish Government this feedback will be addressed back to them. 4. The National Planning Framework 4 (NPF4) which was published in early 2023 sets out the overarching national planning policy. This new framework goes a long way to addressing any blocks to improving building energy efficiency and allowing for renewable generation. This is mentioned in the actions and delivery plan of the REM, and further detail can be found in Policy 1, 2 & 11 of the NPF4.	Heat networks utilising waste heat and coordinating with other works Procurement innovation should be enabled Scope of the plan should be wider Restrictions and delays associated with planning

No.	Date of Response	Comments made	Councils' response and amendment	Theme
24	27th August	1. My main concern is one of speed. Somehow, this needs to be done sooner. 2. I feel that there is a "middle" bulge of people, like myself, who are going to get little to no help. I would LOVE to implement solar, heat pumps, etc, but as a pensioner I simply cannot see where the money is coming from and I know I will earn too much to be eligible for high financial assistance. 3. Improved engagement with the general public and community organisations. Bring the people along with you. Don't drag them kicking and screaming.	1. We agree with this sentiment. The REM has been developed in line with national targets set by the Scottish Government, but these are not targets to aim for so much as deadlines. Any work that can be done before this should be done so. Both councils have set themselves a tighter deadline than the national targets for decarbonisation of all council specific emissions (2035 for Stirling Council and 2040 for Clackmannanshire Council). We will also strive to drive forward works ahead of targets. A note has been added to the REM to reflect this sentiment in Targets & Key Performance Indicators (KPIs). 2. This is certainly a key concern, and we are working to address this and highlight the issue with others such as Scottish Government. Priority for the decarbonising of heat must of course be first directed to addressing fuel poverty, but following this various actions in the delivery plan of the REM will help to address this issue. Such as the development of low carbon heat networks by both councils that have the potential to provide low carbon heat to homes in the region. Furthermore, there is existing funding available that is not dependent on income, such as the Home Energy Scotland Grant (see Appendix IX of the REM). Another route is through funding available to communities, also outlined in Appendix IX). There are some excellent case studies of successful community energy efficiency and generation projects in the region, though these have not been included in the REM, but will fall under our ongoing actions to raise awareness.	Should have more ambitious targets and delivery plan Funding issues, opportunities and appropriate signposting Engagement suggestions

No.	Date of Response	Comments made	Councils' response and amendment	Theme
24	27th August		3. Thank you for this feedback, we always endeavour to carry out good public engagement, and will develop a robust engagement strategy for the actions of the REM going forward. The REM is very much a live document, we will be continuously updating data and consultation will be ongoing. Both councils look to make best use of the resources available to us to reach as much people as we can. Stirling Council implemented the engage platform by Citizen Lab as part of an effort to improve engagement, as it has proven very successful in achieving extensive engagement in multiple situations. Clackmannanshire Council is developing 5 climate forums (5) to improve engagement and cross community collaboration on all issues around climate change.	Should have more ambitious targets and delivery plan Funding issues, opportunities and appropriate signposting Engagement suggestions
25	23rd August	1. Installation of ammonia based centralised heat pumps for district heating, covering St Modans HS, The Peak, Holiday Innotel fac 2. Act as an energy provider to charge for heating demand generated via the new District Heating system	1. Thank you for the suggestion, Stirling Council is currently investigating the feasibility of expanding the Forthside district heat network which already covers these buildings, and the most appropriate technology to facilitate this expansion will be identified as part of this process. 2. Stirling Council does charge for heating supplied as part of the exiting Forthside district heat network, and both councils have ambitions to charge for low carbon heat supply at a lower rate than existing energy prices as part of their commitment to develop heat networks, outlined in the REM (District Heating section)	Heat networks utilising waste heat and coordinating with other works

No.	Date of Response	Comments made	Councils' response and amendment	Theme
26	23rd August	1. Greater education required for changing farming methods to improve soil health and carbon sequestration. New technology is not required instead we need to use alternative approaches eg polycrop and no plough methods. 2. Although mentioned skills gaps and the problems finding qualified reliable retrofit trades people is a real problem. 3. We need to ensure mature trees are protected.	1. Whilst we very much agree with this statement and understand that soil has a great potential for carbon sequestration, this specific topic is largely outwith the scope of the REM. In terms of modelling, the decarbonisation of the agriculture sector is considered as separate whole. So any sequestration will be used to offset emissions within the sector and therefore not accounted for to offset energy related emissions within the REM (see "Land Use and Land Management, p100 of the REM) Support for agricultural decarbonisation is provided by the Scottish Government (see the SG website - policy; Agriculture and the environment), rather than specific to Councils. However, there is a requirement to value, protect and restore soils within the National Planning Framework 4 (NPF4) Policy 5 which will be incorporated into both councils Local Development Plans. We would also highlight that sequestration is a key part of council plans, as covered in Stirling Council's Alive with Nature Plan and Clackmannanshire Council's Biodiversity Action Plan. The Forth Climate Forest is an example of an excellent project that will increase sequestration across the region. 2. Noted, thank you. We would highlight work that is being done by the Scottish government in this field (such as the Climate Energy Skills Action Plan, due to be updated by the end of 2023), and whilst currently outwith the scope of councils to achieve much meaningful impact in this are we would welcome further resources to enable us to do this, as we believe councils are well placed to address change in this area locally. This is also in line with our community wealth building ambitions such as the creation of jobs. In the meantime, we aim to signpost to available resources for retrofit (as stated in the REM Delivery Plan), including any guidance on finding qualified retrofit trades people. Any signposting developed will be continually updated with any new guidance and hopefully provide a good reference point as the sector develops. 3. We agree with this statement, however this is outwith the scope of the REM. Council planning departments already support the protection of existing trees, in particular where Tree Protection Orders are in place, and the NPF4 sets out in Policy 6 measures to ensure existing trees and woodlands are protected.	Maximising tree planting, minimising tree removal, and manage planted areas appropriately Skills gap

No.	Date of Response	Comments made	Councils' response and amendment	Theme
27	14th August	1. Council buildings, Schools, peak, leave lights on all the time, car park lights do not need to be on at night. Turn off 2. All roofs fitted with Solar, with an agreed payment plan to help all households benefit. 3. Council car parks also School car parks covered in solar panels. 4. More wind turbines, you now have more small and effective turbines available, stop blocking on planning	1. Whilst both councils aim to carry out environmentally responsible behaviours in all buildings under council control, including turning off lights, there are some situations where this is unfortunately not possible. For example there are security concerns around lighting levels that must be taken into account. 2. Stirling Council has the highest levels of solar PV on council housing roofs in the country & Clackmannanshire is developing plans for more in the future on both domestic and non-domestic buildings, so we agree that renewables on roofs are an excellent idea and have already put a lot of resources into making this happen where possible. Of course it is not possible for solar panels to be installed on all roofs for a number of reasons, such as orientation or structural limitations. 3. We agree that this is an excellent measure where financially and practicably feasible. There are a number of restrictions, such as grid capacity, site restrictions and school ownership. Stirling Council are actively investigating the development of further solar car canopy projects, building on the success of the Castleview Solar Canopy project. Clackmannanshire Council are looking into development opportunites, and both councils are working together to share knowledge and experience. 4. The National Planning Framework 4 (NPF4) which was published in early 2023 sets out the overarching national planning policy. This new framework addresses most of the previous issues around planning for renewables, wind turbines included. This is mentioned in the actions and delivery plan of the REM, and further detail can be found in Policy 11 of the NPF4.	Energy efficiency Maximise renewable generation opportunities without impacting historical sites

No.	Date of Response	Comments made	Councils' response and amendment	Theme
28	9th August	1. the main one is getting petrol and diesel cars of the road 2. lower EV tariffs in Clackmannanshire (Stirling has acceptable tariffs) 3. more photovoltaic solar panels 4. stop wasting money on master plans consultations	1. We agree with this suggestion as part of the broader route to net zero, which is reflected in the Scottish Government's National Transport Strategy 2 (NTS2) that identifies the need to reduce car use. However, the specific actions required in this area are outwith the scope of the REM. They will be addressed in each councils' respective Local Transport Strategies, which will align with the NTS2. Furthermore, ahead of this both councils are bringing forward the development of their Active Travel and Public Transport Strategies which are due for consultation in 2024. 2. The Clackmannanshire tariff is based on no further financial subsidy from the Council and no burden to the public purse, therefore is set higher than some adjacent local authorities, where tariffs remain subsidised. Full details of the scheme along with the Council report are available at https://www.clacks.gov.uk/transport/evtariffs/. This approach ensures the day to day running costs of the network is covered by users and will address increased costs to the Council due to providing energy for free at a time when energy costs are increasing. Furthermore the Council would have been unable to access future government funding for EV infrastructure, unless a 'market rate' tariff was in place by Spring 2023. Implementing a tariff supports the low carbon transition in the move towards Net Zero by ensuring that the EV infrastructure is maintained over the longer term, providing confidence for users on the EVCP network. Clackmannanshire Council is aware that some EV drivers have no choice but to use the public EV network, so have introduced a 10% residents discount scheme for any Clackmannanshire resident with no access to off-street parking to facilitate home charging, and are currently the only local authority in Scotland to offer this.	Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Clackmannanshire Councils EV (electric vehicles) charger tariffs Maximise renewable generation opportunities without impacting historical sites Funding issues, opportunities and appropriate signposting

No.	Date of Response	Comments made	Councils' response and amendment	Theme
28	9th August		While electrification of private vehicles will go some way towards reducing the use of fossil fuels, electric vehicles still have an environmental impact. These vehicles still create congestion in our towns and do not meet the Scottish Government target to reduce all vehicle kilometres by 20%. Therefore as a local authority Clackmannanshire Council would hope to encourage more local residents to follow the transport hierarchy set out by the Scottish Government and use other more sustainable modes such as active travel (walking, cycling and wheeling) and public transport in the first instance. 3. We agree with this statement, and have addressed it in the Energy Generation section of the REM. 4. It is important to both councils to consult with all residents and business as part of a democratic process to listen to the people of the region and incorporate any feedback. In this instance, we deem the feedback gained more valuable than any money spent on consultation, which is a minimal cost.	Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope) Clackmannanshire Councils EV (electric vehicles) charger tariffs Maximise renewable generation opportunities without impacting historical sites Funding issues, opportunities and appropriate signposting
29	8th August	Drop it	This is not possible due to our statutory duties, nor desirable due to the current climate and nature emergency.	LHEES – where the necessity of this work is being questioned

No.	Date of Response	Comments made	Councils' response and amendment	Theme
30	6th August	1. Increased ambition - Net Zero by 2045 should be the worst case scenario, not the primary aim. We need to strive for Net Zero ASAP. 2. Make use of low cost, high value initiatives - more trees/wildflower meadows/hedgerows. Stop mowing the vast majority of grass lands in Stirlingshire. 3. Ban artificial lawns - these are a fire and flood hazard. 4. Public transport needs to be prioritised and completely ban cars from Stirling City. Low carbon tourism is a huge opportunity for increasing revenue into the council area.	1. We agree with this sentiment. The REM has been developed in line with national targets set by the Scottish Government, but these are not targets to aim for so much as deadlines. Any work that can be done before this should be done so. Both councils have set themselves a tighter deadline than the national targets for decarbonisation of all council specific emissions (2035 for Stirling Council and 2040 for Clackmannanshire Council). We will also strive to drive forward works ahead of targets. A note has been added to the REM to reflect this sentiment in Targets & Key Performance Indicators (KPIs). 2. We agree with the sentiment of making use of low cost, high value initiatives, which is why the REM is structured and prioritised around the energy hierarchy. The specific suggestions made for Stirling Council are addressed within the Council's Pollinator Strategy Implementation Plan. Clackmannanshire Council is also developing a Pollinator Strategy that will address similar actions. 3. Thank you for your suggestion, unfortunately local authorities do not have the power to do this. 4. We agree that improved public transport and car reduction is essential as part of the broader route to net zero, this is reflected in the Scottish Government's National Transport Strategy 2 (NTS2) which identifies the need to support public transport and reduce car use. However, the specific actions required in this area are outwith the scope of the REM. They will be addressed in each councils' respective Local Transport Strategies, which will align with the NTS2. Furthermore, ahead of this both councils are bringing forward the development of their Active Travel and Public Transport Strategies which are due for consultation in 2024. Low carbon tourism is outwith the scope of the REM, but both councils Economic Development teams are fully supportive of the opportunities around tourism and the net zero and sustainability agenda.	Should have more ambitious targets and delivery plan Maximising tree planting, minimising tree removal, and manage planted areas appropriately Scope of the plan should be wider Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope)

No.	Date of Response	Comments made	Councils' response and amendment	Theme
31	3rd August	In the energy efficiency section you neglect to take responsibility for tackling EPC ratings in hard to treat homes, this lacks insight as a lot of the 'hard to treat homes' will also be those who are most likely to be in fuel poverty. Retrofit in pre-1919 tenements should be a priority and something that the council looks to help fund.	Data on hard to treat homes and respective risk of fuel poverty has been included in the digital twin model which was used to derive the prioritisation of any actions. However, we have updated the REM to address hard to treat homes further in the Energy Efficiency section, and added an appendix with retrofit resources. Please also see Appendix III for further detail on the routes for retrofit. We would note that where councils support the retrofit of old buildings where possible with existing funding measures, this funding comes from the Scottish Government.	Energy efficiency In hard to treat properties

Other consultation responses

In addition the Councils received one detailed consultation response through direct email. A summary of the comments is provided here.

No.	Date of Response	Summary of comments made	Councils' response and amendment	Theme
32	15th August	Summarised as follows: 1. The report is silent on the potential role of Scotland's International Environment Centre (SIEC). Other than the Forth Climate Forest and peatland sensors, there are many more implementation areas where SIEC could be a key regional partner. These include skills development, support for businesses with transition planning, development and deployment of innovative technologies, and enhanced natural sequestration. 2. The integration of the Digital Energy twin with the wider regional environmental array (Forth ERA) also offers significant potential. 3. Businesses in the region are expressing a strong interest in clean technologies as part of the distinctive narrative of the regional economy, so there is significant economic development potential here too.	Alongside offering a meeting, the councils have the following response: 1. We have added an action to the REM on working with SEIC as a key partner, see the Delivery Plan, Ongoing Actions. 2. The Forth ERA (Environmental Resilience Array) in now mentioned in the actions within the Sequestration section, and a delivery plan action has been added to Ongoing Actions section addressing integration of this data with digital twin model where appropriate. 3. Thank you for this input, we continue to engage with our respective internal economic development departments on these issues.	Scope of the plan should be wider Economic development opportunities

Key Themes from Open Ended Consultation Responses

Below is a table summarising the key themes emerging from the open ended questions included in the public consultation.

Theme	Number of related responses
Should have more ambitious targets and delivery plan	5
Heat networks utilising waste heat and coordinating with other works	5
Maximise renewable generation opportunities without impacting historical sites	4
Community ownership potential	4
Funding issues, opportunities and appropriate signposting	4
Maximising tree planting, minimising tree removal, and manage planted areas appropriately	4
Reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope)	4
Scope of the plan should be wider	3
Delivery plan should be detailed and achievable	3
Restrictions and delays associated with planning	3
Energy efficiency of new builds	2
CO2 emissions	2
LHEES – where the necessity of this work is being questioned	2
Energy efficiency	2
Engagement suggestions	2
Clackmannanshire Councils EV (electric vehicles) charger tariffs	2
Grid Constraints and working with DNO’s (distribution networks operators)	2
Tourism impact on local energy demand	1

Theme	Number of related responses
Energy efficiency in conservation areas	1
Energy efficiency and building repair	1
Energy efficiency In hard to treat properties	1
Heat management in off-gas grid properties	1
EPC's (energy performance certificates) and associated targets	1
Hydrogen importance emphasised	1
EV's (electric vehicles)	1
Heat pumps efficiency	1
Economic development opportunities	1
University buildings	1
Clacks solar generation and wood pellets	1
Readability of the REM	1
Energy storage to be mentioned more in energy generation section	1
Procurement innovation should be enabled	1
Skills gap	1

The key themes which arose from these were that we should have more ambitious targets and delivery plan, and heat networks utilising waste heat and coordinating with other works. Closely followed by maximising renewable generation opportunities without impacting historical sites; community ownership potential; funding issues, opportunities and appropriate signposting; maximising tree planting, minimising tree removal and manage planted areas appropriately; reducing fossil fuel powered vehicles, banning them from areas (outwith REM scope).

Stirling &
Clackmannanshire
City Region Deal